L4Re Operating System Framework

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Chapter 1

Overview

Welcome to the documentation of the L4Re Operating System Framework, or L4Re for short. There are two parts to this documentation: a user manual, which provides a birds eye view of L4Re and its environment, and a reference section which documents the complete programming API.

User Manual

1. Introduction shortly explains the concept of microkernels and introduces the basic terminology.
2. Programming for L4Re explains in detail the most important programming concepts.
3. L4Re Servers provides a quick overview over standard services running on the L4Re operating system.

Reference

The second part provides the complete reference of all classes and functions of the L4Re Operating System Framework as well as a list of example code.

Chapter 2

Introduction

The intention of this section is to provide a short overview about the L4Re Operating System Framework.

The general structure of a microkernel-based system will be introduced and the principal functionality of the servers in the basic environment outlined.

2.1 L4Re Microkernel

The L4Re Microkernel is the lowest-level component of software running in an L4Re-based system. The microkernel is the only component that runs in privileged processor mode. It does not include complex services such as program loading, device drivers, or file systems; those are implemented in user-level programs on top of it (a basic set of these services and abstractions is provided by the L4 Runtime Environment).

Microkernel services are implemented in kernel objects. Tasks hold references to kernel objects in their respective *"object space"*, which is a kernel-protected table. These references are called *capabilities*. System calls to the microkernel are function invocations on kernel objects through the corresponding capabilities. These can be thought of as function invocations on object references in an object-oriented programming environment. Furthermore, if a task owns a capability, it may grant other tasks the same (or fewer) rights on this object by passing the capability from its own to the other task's object space.

From a design perspective, capabilities are a concept that enables flexibility in the system structure. A thread that invokes an object through a capability does not need to care about where this object is implemented. In fact, it is possible to implement all objects either in the kernel or in a user-level server and replace one implementation with the other transparently for clients.

2.1.1 Communication

The basic communication mechanism in L4-based systems is called *"Inter Process Communication (IPC)"*. It is always synchronous, i.e. both communication partners need to actively rendezvous for IPC. In addition to transmitting arbitrary data between threads, IPC is also used to resolve hardware exceptions, faults and for virtual memory management.

2.1.2 Kernel Objects

The following list gives a short overview of the kernel objects provided by the L4Re Microkernel:

- **Task** A task comprises a memory address space (represented by the task's page table), an object space (holding the kernel protected capabilities), and on x86 an IO-port address space.
- **Thread** A thread is bound to a task and executes code. Multiple threads can coexist in one task and are scheduled by the microkernel's scheduler.
- **Factory** A factory is used by applications to create new kernel objects. Access to a factory is required to create any new kernel object. Factories can control and restrict object creation.
- **IPC Gate** An IPC gate is used to create a secure communication channel between different tasks. It embeds a label (kernel protected payload) that securely identifies the gate through which a message is received. The gate label is not visible to and cannot be altered by the sender.
- **IRQ** IRQ objects provide access to hardware interrupts. Additionally, programs can create new virtual interrupt objects and trigger them. This allows to implement a signaling mechanism. The receiver cannot decide whether the interrupt is a physical or virtual one.
- **Vcon** Provides access to the in-kernel debugging console (input and output). There is only one such object in the kernel and it is only available, if the kernel is built with debugging enabled. This object is typically interposed through a user-level service or without debugging in the kernel can be completely based on user-level services.
- **Scheduler** Implements scheduling policy and assignment of threads to CPUs, including CPU statistics.

2.2 L4Re System Structure

The system has a multi-tier architecture consisting of the following layers depicted in the figure below:

- **Microkernel** The microkernel is the component at the lowest level of the software stack. It is the only piece of software that is running in the privileged mode of the processor.
- **Tasks** Tasks are the basic containers (address spaces) in which system services and applications are executed. They run in the processor's deprivileged user mode.

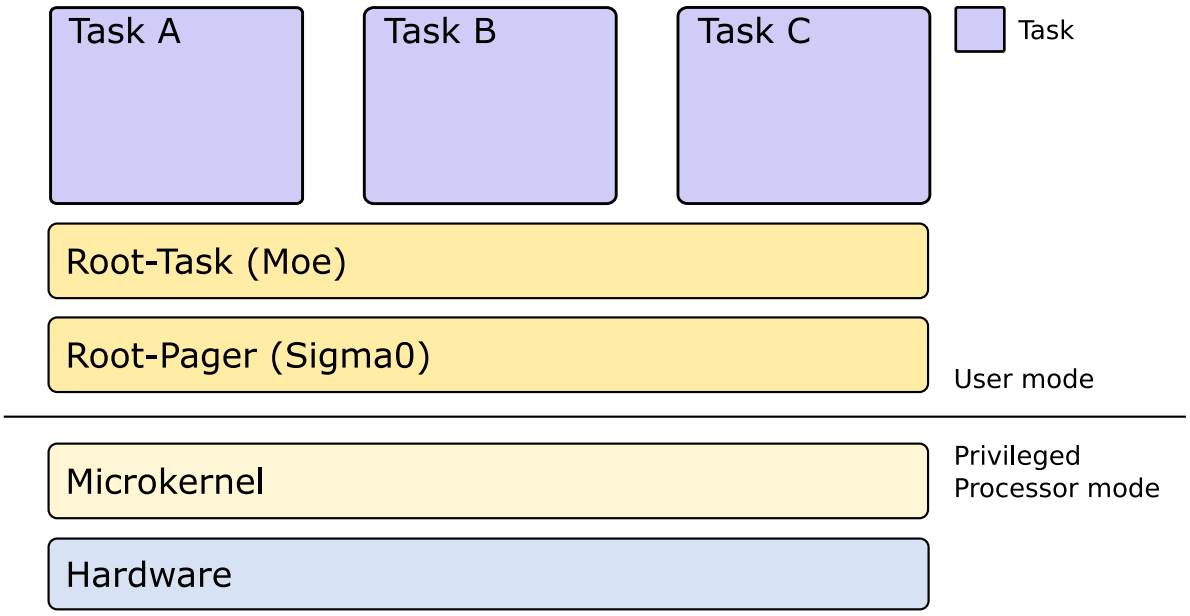


Figure 2.1 Basic Structure of an L4Re based system

In terms of functionality, the system is structured as follows:

- **Microkernel** The kernel provides primitives to execute programs in tasks, to enforce isolation among them, and to provide means of secure communication in order to let them cooperate. As the kernel is the most privileged, security-critical software component in the system, it is a general design goal to make it as small as possible in order to reduce its attack surface. It provides only a minimal set of mechanisms that are necessary to support applications.

- **Runtime Environment** The small kernel offers a concise set of interfaces, but these are not necessarily suited for building applications directly on top of it. The L4Re Runtime Environment aims at providing more convenient abstractions for application development. It comprises low-level software components that interface directly with the microkernel. The root pager *sigma0* and the root task *Moe* are the most basic components of the L4Re Runtime Environment. Other services (e.g., for device enumeration) use interfaces provided by them.

- **Applications** Applications run on top of the system and use services provided by the runtime environment – or by other applications. There may be several types of applications in the system and even virtual machine monitors and device drivers are considered applications in the terminology used in this document. They are running alongside other applications on the system.

Lending terminology from the distributed systems area, applications offering services to other applications are usually called *servers*, whereas applications using those services are named *clients*. Being in both roles is also common, for instance, a file system server may be viewed as a server with respect to clients using the file system, while the server itself may also act as a client of a hard disk driver.

2.3 L4Re Runtime Environment

The L4Re Runtime Environment provides a basic set of services and abstractions, which are useful to implement and run user-level applications on top of the L4Re Microkernel. They form the L4Re Operating System Framework.

The L4Re Operating System Framework consists of a set of libraries and servers. L4Re follows an object-oriented design. Server interfaces are object-oriented, and the implementation is also object-oriented.

A minimal L4Re-based application needs 3 components to be booted beforehand: the L4Re Microkernel, the root pager (Sigma0), and the root task (Moe). The Sigma0 root pager initially owns all system resources, but is usually used only to resolve page faults for the Moe root task. Moe provides the essential services to normal user applications such as an initial program loader, a region-map service for virtual memory management, and a memory (data space) allocator.

Chapter 3

Programming for L4Re

This part of the documentation discusses the concept of microkernel-based programming in more detail.

You should already have a basic understanding of the L4Re programming environment from the tutorials available on l4re.org(https://l4re.org/).

- L4 Inter-Process Communication (IPC)
- Kernel ABI
- Capabilities and Naming
- Spaces and Mappings
- Initial Environment and Application Bootstrapping
- Memory management - Data Spaces and the Region Map
- Program Input and Output
- Initial Memory Allocator and Factory
- Application and Server Building Blocks
- Pthread Support
- tasks and threads
- communication channels
- server loops
- Interface Definition Language
- hardware access
- L4Re Build System
- Kernel Factory

3.1 L4 Inter-Process Communication (IPC)

Inter-process communication (IPC) is the fundamental communication mechanism in the L4Re Microkernel.

Basically IPC invokes a subroutine in a different context using input and output parameters. It is used to communicate between userland threads and, as a special case, to communicate between a userland thread and a kernel object. IPC provides the only (non-debugging) way of doing system calls.

3.1.1 IPC mechanism

When using this API, an IPC operation can be conducted using the l4_ipc() function (or one of its related helpers). In general it causes a method to be invoked on the called kernel object. An IPC operation consists of a send and receive phase, but either of them can be skipped, that is, an IPC operation can consist of only either a send or a receive phase. IPC is always synchronous and blocking and can be given a timeout. Timeouts can be specified separately for each phase. Invoking the IPC syscall without any phase is deprecated.

On the lowest abstraction level, IPC operations need the following arguments:

- syscall flags describing the IPC mode,
- the capability selector of the communication partner,
- a label,
- a message tag, and
- a pair of timeout values.

During an IPC operation the kernel accesses the UTCB of the current thread to read parameters which are not passed as direct arguments.

As result of an IPC operation the kernel returns a message tag and a label and the kernel also changes UTCB content. For the detailed call signature, refer to l4_ipc(). Furthermore, depending on the IPC parameters, the kernel might have transferred the FPU state and capabilities (memory, I/O ports, and/or object capabilities) from the sender to the receiving thread.

When both, a send phase and the a receive phase, are requested, the receive phase is entered only after the send phase was finished successfully. A relative receive timeout does not start before the send phase has finished (see also below). When a thread received an IPC call from another thread, it is guaranteed that there won't be a send timeout when the thread replies to the call using a reply capability, i.e., the reply can be done with a send timeout of zero, see IPC Timeouts.

For performance optimization and under certain conditions, the kernel may perform a context switch from the IPC sender to the IPC receiver without consulting the scheduler after the send phase finished. For instance, a client performing an IPC call to a server has to wait for the server anyway. Hence, after the client request was sent to the server, the kernel switches directly to the server thread. This behavior can be disabled by setting the L4_MSGTAG_SCHEDULE flag in the sender message tag (see below).

3.1.1.1 Syscall Flags

The *syscall flags* (L4_SYSF_SEND, L4_SYSF_RECV, L4_SYSF_OPEN_WAIT, L4_SYSF_REPLY) are used by the invoking thread to define the intended IPC operation. The variants of l4_ipc() (see Object Invocation) use the flags

- to request the IPC phases (send-only IPC, receive-only IPC, IPC with send and receive phase), and
- to decide, if the reply capability (see below) should be used instead of the capability of a dedicated kernel object as target for the send phase (*reply*), and
- to decide, if receiving should wait for an incoming message from any possible sender (*open wait*) instead of a message from a dedicated sender (*closed wait*).

3.1.1.2 Partner capability selector

The *partner capability selector* defines a kernel object as partner of the IPC operation. Some kernel objects forward IPC to a userland thread.

Basically an object capability is represented by l4_cap_idx_t where the bits starting from L4_CAP_SHIFT are used as index into the local capability table of the current address space.

Specifying L4_INVALID_CAP as target for an IPC operation is equivalent to specifying a thread capability of the current thread with full permissions. As a result, the userland thread either communicates with its corresponding kernel thread object (if L4_PROTO_THREAD is specified as protocol value, see the description of the message tag below) or the IPC target is the current userland thread. In the latter case, no IPC will be performed and the send phase and the receive phase will block until the corresponding timeout has expired, see below.

A special partner is defined by the *reply capability*. Since it would be impractical (and a security flaw) to always pass an explicit object capability to reply to for each IPC, the kernel generates an implicit one that can be used for just that purpose if the IPC contains an **open wait** phase. The reply capability is valid after a receive phase and points to the kernel object that sent the IPC just received. It can be used only once. The reply capability is selected by setting the L4_SYSF_REPLY flag, see above.

3.1.1.3 IPC Label

The IPC label is a machine word which is transferred unchanged from the IPC sender to the IPC receiver when directly sending to a userland thread. However, the primary purpose of the label is to create a relationship between an L4::Rcv_endpoint (L4::Ipc_gate or L4::Irq) and the bound thread.

During L4::Rcv_endpoint::bind_thread(), a label is specified. If the thread receives an IPC message through the endpoint, that label is delivered to the receiving thread as output parameter of l4_ipc() instead of the label specified during the corresponding IPC send operation (see the detailed description of L4::Ipc_gate for more details on the label with IPC gates). The label is usually used by the receiving thread to invoke the object which is responsible for handling the IPC request of the corresponding endpoint. This mechanism is used by the L4::Epiface mechanism for server loops.

3.1.1.4 IPC Message Tag

The *message tag* (l4_msgtag_t) describes the payload of the IPC and can also be used to enable certain features. It contains:

- a *protocol value* (cf. l4_msgtag_t::label(), also called the tag's *label*),
- the number of items in UTCB message registers to transfer (cg. l4_msgtag_t::words() and l4_msgtag_t::items()), and
- flags (cf. l4_msgtag_t::flags() and L4_msgtag_flags, may be 0).

The information from the message tag is required by the kernel to transfer the message. The IPC system call returns a message tag as result of the IPC operation. On success, a copy of the message tag specified by the sender is returned if there is a receive phase. Without receive phase, a successful IPC syscall returns the message tag specified as input parameter.

Failures during IPC are signalled using the L4_MSGTAG_ERROR flag in the message tag. If this bit is set by the kernel, the content of the returned message tag apart from that bit is undefined and the kernel wrote the actual error code into the l4_thread_regs_t::error register of the UTCB (see also IPC Thread Control Registers). When an IPC error occurs after the rendezvous of the IPC partners, both partners observe the same error information. If, for

instance, the IPC was aborted using L4::Thread::ex_regs(), the sender gets an L4_IPC_SECANCELED error while the receiver gets an L4_IPC_RECANCELED error. The function L4Re::chkipc() can be used to verify that an IPC operation finished successfully: It throws an error if the IPC failed.

The *protocol value* is usually used to distinguish between different protocols of the same interface. Certain protocol IDs are pre-defined when talking to kernel objects, see L4_msgtag_protocol. From IPC point of view, the protocol value is just payload that is transferred from sender to receiver and hence doesn't have a dedicated meaning.

By convention, during IPC calls, the protocol value is used for return values, where negative values signify errors. See the section about L4 RPC return types for further information. The function L4Re::chksys() can be used to verify that an RPC call using IPC was successful: It throws an error if the IPC failed or if the returned protocol value is negative.

3.1.1.5 IPC Timeouts

As written above, IPC *timeouts* are specified separately for the send phase (IPC send timeout) and the receive phase (IPC receive timeout). The timeout of one phase is encapsulated by l4_timeout_s. Both timeouts are combined into a single l4_timeout_t parameter. Timeouts are either relative to the current time of the invoking thread or absolute. In the latter case, the absolute time of the deadline of the respective phase is written into a UTCB buffer register (see l4_timeout_abs()). The relative timeout of the receive phase starts immediately after the send phase has finished.

Two specific timeout values are sufficient for most IPC operations:

- L4_IPC_TIMEOUT_NEVER is used if the IPC partner might not yet be ready. Usually a client trusting a server will perform an IPC call with an infinite timeout for both phases. The send phase will take some time if the IPC receiver is currently not ready. The receive phase will take some time as the server needs time to serve the request. Also, a server will usually wait with an infinite receive timeout for the next request (see below for a possible exception).
- L4_IPC_TIMEOUT_0 is used when it is certain that the IPC receiver is currently ready, when the IPC sender doesn't want to wait if the IPC receiver is not ready, or when replying to an IPC call using a reply capability. The latter case applies for example to a server that received a call from a client. The reply to the IPC call should use a reply capability and a timeout of zero to ensure that a client doesn't block a server (server could not deliver the result of the request). See also L4::Ipc_svr::Default_timeout. Another case is an IPC send operation for waking up another thread from an IPC receive operation. If the other thread is not ready to receive, then it might be already woken up and it does not make sense to wait any longer. Also triggering an IRQ is usually done with a send timeout of 0, see L4::Triggerable::trigger().

In certain cases it also makes sense to specify an IPC timeout different from "never" or "zero":

- A server might leave the server loop after some time to perform idle work (see L4::Ipc_svr::Server_iface::add_timeout()).
- A thread does not want to wait for an infinite time if the partner is not ready. This could be also some safety measure.
- A thread wants to block for a certain amount of time without consuming CPU time. The l4_ipc_sleep() function specifies the L4_INVALID_CAP as target for an IPC receive operation and specifies the intended relative waiting period as IPC timeout. Waiting for an absolute timeout would be possible with similar code.

Note

The kernel IPC path is optimized for the two special cases using L4_IPC_TIMEOUT_NEVER and L4_IPC_TIMEOUT_0. Specifying a different timeout causes more maintenance effort for the kernel.

Special care is required if a finite timeout for the receive phase of an IPC call is specified: The IPC receive operation could abort before the partner was able to send the reply message. Under certain circumstances the partner may still have the temporary reply capability to the calling thread and may use this capability to reply to the caller at a later, unexpected time specifying an arbitrary IPC label. This case is relevant for servers which call another, possibly untrusted, server while serving a client request.

3.1.1.6 User-level Thread Control Block

The UTCB is located on a power-of-2-sized and power-of-2-aligned memory area shared between userland and the kernel (L4::Task::add_ku_mem()). The UTCB is bound to a thread during the L4::Thread::control() operation with the L4::Thread::Attr parameters set up using L4::Thread::Attr::bind(). The UTCB is used for IPC-related data exchange and is set up before invoking l4_ipc(). To access certain parts of the UTCB, the corresponding functions have to be used (there is no data type L4_utcb or similar). The UTCB consists of:

- the message registers `MR[0]`, `MR[1]`, ..., `MR[n-1]` with n = L4_UTCB_GENERIC_DATA_SIZE (access using l4_utcb_mr()),
- the buffer descriptor register `BDR` (access using l4_utcb_br(), see l4_buf_regs_t::bdr),
- the buffer registers `BR[0]`, `BR[1]`, ..., `BR[m-1]` with m = L4_UTCB_GENERIC_BUFFERS_SIZE (access using l4_utcb_br()),
- the thread control registers (access using l4_utcb_tcr(), includes the IPC error code), and
- in case of an exception IPC, the register state of the thread which triggered the exception (access using l4_utcb_exc()).

IPC to a kernel object requires the setup of the UTCB of the corresponding userlevel thread. IPC between userlevel threads requires the setup of UTCBs of both partners.

The kernel changes only the following UTCB content:

- The message registers of the UTCB of the receiver of an IPC, and
- the IPC error field of the thread invoking l4_ipc() if there was an error during IPC.

3.1.1.6.1 IPC Message registers

The *message registers* contain *untyped items* and *typed items*. The sender's typed items are interpreted by the kernel in conjunction with the receiver's *receive items*. Each typed send item occupies two message registers. The untyped items, on the other hand, are free to be used by the communication partners to exchange data: The content of all message registers used for untyped items (l4_msgtag_t::words()) is copied from the UTCB of the IPC sender to the UTCB of the IPC receiver.

A typed send item consists of a *flexpage* (see l4_fpage(), l4_obj_fpage(), and l4_iofpage()) of the to be transferred capabilities (*flexpage word*) and a *message word*. There are two types of send items: *map items* and *void items*. For a void item, the message word is all zero. For a map item, the message word contains:

- the *compound bit* allowing to use the same receive buffer for the subsequent typed send item (scatter-gather behavior, see L4_ITEM_CONT of l4_msg_item_consts_t),
- the *type bit* defining this typed send item as a *map item*,
- the *grant flag* for delegating the access to the flexpage from the sender to the receiver and atomically removing the rights from the sender (see l4_msg_item_consts_t),
- *attributes* with semantics depending on the item type; for memory mappings, they contain cacheability information (see l4_fpage_cacheability_opt_t); for objects, they contain additional rights (see Attributes and additional permissions for object send items),
- the *send base* (also called *hot spot*) defining what is actually mapped when send and receive flexpages have a different size.

A typed send item can be created using l4_sndfpage_add(). This function sets the compound bit unconditionally. Alternatively, the functions l4_map_control() and l4_map_obj_control() can be used to set up the message word of a map item for a memory flexpage respective for objects.

See below for a description how typed items are transferred.

3.1.1.6.2 IPC Buffer Registers

The *buffer registers* and *buffer descriptor register* are interpreted by the kernel during the receive phase (if any). Buffer registers define *receive items* which are required to receive typed send items (memory, I/O ports or object capabilities). To specify a receive item, up to three buffer registers are required:

- A *small receive item* (L4::Ipc::Small_buf) occupying one buffer register is sufficient to receive one object capability.
- A *receive item* (L4::Ipc::Rcv_fpage) occupying two or three buffer registers (*message word*, a *flexpage*, and an optional destination task capability index) is required to receive memory flexpages, I/O ports, or multiple object capabilities.

3.1.1.6.3 IPC Buffer Descriptor Register

The buffer descriptor register defines indices of buffer registers used to receive dedicated types of send items and also contains a flag:

- 5 bits starting at L4_BDR_MEM_SHIFT define the index of the first receive item used for memory flexpages.
- 5 bits starting at L4_BDR_IO_SHIFT define the index of the first receive item used for I/O flexpages.
- 5 bits starting at L4_BDR_OBJ_SHIFT define the index of the first receive item used for object flexpages.
- The L4_UTCB_INHERIT_FPU can be set using l4_utcb_inherit_fpu() and allows to receive the FPU state from the IPC sender. This is only relevant if the sender set L4_MSGTAG_TRANSFER_FPU in the message tag.

For most use cases, a BDR value of zero is sufficient. In that case, if `BR[0]` contains a void item, no capabilities are received. Otherwise, only one type of capabilities (memory, I/O ports or objects) can be received even if there are several receive items. For more complex setups that require receiving different types of capabilities in one receive operation, other BDR values are necessary.

The BDR of the receiving thread is only used by the kernel if at least one typed item is transferred during the IPC or if L4_MSGTAG_TRANSFER_FPU is set in the UTCB of the sending thread.

3.1.1.6.4 IPC Thread Control Registers

The l4_thread_regs_t::error register contains the IPC error code in case the L4_MSGTAG_ERROR flag is set in the message tag returned by an IPC syscall. Otherwise this register is not touched by the kernel. See l4_ipc_tcr_error_t for a detailed enumeration of all possible error codes during an IPC operation.

The l4_thread_regs_t::free_marker is set by the kernel to zero immediately before a thread is destroyed. This value indicates that the kernel does not longer use the UTCB and it can be re-used by other threads.

The other members of l4_thread_regs_t are never touched by the kernel.

3.1.1.7 Transfer of Typed Send Items

The kernel interprets all typed items in the sender UTCB (l4_msgtag_t::items()) and performs the following operations while modifying the corresponding typed items in the receiver UTCB:

- If the message item of the sender is void, this item is ignored and the message word of the corresponding typed item in the receiver UTCB is set to zero (making it a void item). The flexpage word of this item is not changed.
- Otherwise, if the type bit of the message item of the sender is not set, the IPC is aborted with L4_IPC_SEMSGCUT / L4_IPC_REMSGCUT.
- Otherwise, if there is a receive item corresponding to the flexpage type of the send item available (see IPC Buffer Descriptor Register), information described by the flexpage is transferred to the receiver.

In the last case, the message word of the typed item in the receiver UTCB is modified to contain the send base, the type and the size of the transferred flexpage, as well as a copy of the compound bit and the type bit of the send item. If the receiver ordered a local ID in the corresponding receive item, the kernel attempts to apply special rules, see L4_RCV_ITEM_LOCAL_ID. Otherwise, regular mappings as described by the flexpage of the send item are created in the receiver space.

A receive item forms a *receive window* of a specific address and size in the receiver space. Each typed send item that is a map item requires a corresponding receive item. By default, there is a one-to-one mapping (one receive item per typed send item) but it is also possible to use one receive item to receive several typed send items: The compound bit (see l4_msg_item_consts_t) of a send item defines if the following typed send item shall use the same receive item as the current one for receiving the flexpage. If the compound bit is set, proper values of the send base shall be used to prevent overlapping of addresses in the receiver space.

The send base is relevant when the size of the receive flexpage differs from the size of the transferred resource. As a typical example, triggering a memory page fault opens a receive window covering the entire memory address space of the faulting thread. The pager will usually reply a memory flexpage smaller than the entire address space of the faulting thread. Hence, the pager has to specify a proper base which is used as offset of the sent object in the receive flexpage in the *receiver space*. If the sender flexpage is bigger than the receive window, a flexpage of the size of the receive window starting at the send base in the *sender space* is transferred to the receiver.

The kernel will stop transmission of typed items before l4_msgtag_t::items() is reached either if it finds a void item as receive buffer or if the flexpage type of the send item does not match the flexpage type of the corresponding receive item. Under both conditions, the IPC is aborted with L4_IPC_SEMSGCUT / L4_IPC_REMSGCUT.

Note

The kernel ignores the flexpage access rights of the receive items. The actual rights for a transferred resource in the target address space are defined by the access rights to that resource of the IPC sender address space and the flexpage access rights in the typed send item. Additionally, when transferring object capabilities, the transferred rights also depend on the sender's rights on the capability invoked for IPC.

The kernel does not unmap capabilities in the receive window when there is no capability present at the corresponding index at the sender. Further, the receiver cannot reliably detect at which capability indices it received capabilities in its receive windows. Therefore, before receiving from an untrusted source, all receive windows should be cleared. Otherwise the receiver may erroneously associate a capability in one of its receive windows with his last IPC partner although it was actually received in an earlier IPC.

However, the kernel indicates if at least one object capability was received or not, see L4::Ipc::Snd_fpage::cap_received().

3.1.2 Examples

A number of examples show the interplay of the concepts introduced so far.

3.1.2.1 User Thread to Kernel Object

The L4::Scheduler kernel object has a method L4::Scheduler.idle_time(). It takes a set of CPUs to query, represented by two machine words.

In user space, the function L4::Cap<L4::Scheduler>->idle_time() is called, which does the following:

- Fill `MR[0]` with a constant identifying the method being called (L4_SCHEDULER_IDLE_TIME_OP).
- Fill `MR[1]` and `MR[2]` with the two words making up the CPU set.
- Set up the message tag with the protocol value (L4_PROTO_SCHEDULER), the number of untyped and typed items (3 and 0), and some flags.
- Call l4_ipc() with the partner capability ID, the tag, the pointer to the filled UTCB, infinite timeouts, and with flags indicating a send and receive phase. (The label does not matter in this case.)

This function traps into kernel space using standard platform specific mechanisms. The kernel reads the protocol value on the message tag, checks that the partner capability ID refers to a valid object that speaks that protocol, and dispatches the message to the appropriate handler. The handler fills the first 64 bits of the message registers with the computed time value. This will cover `MR[0]` on 64-bit architectures and `MR[0]` and `MR[1]` on 32-bit architectures. It then sets up the return message tag:

- The number of untyped items is 1 or 2.
- The number of typed items is 0.
- The protocol value contains the return value and is set to 0.
- An error would be signalled as a negative protocol value. Under certain conditions (e.g. wrong kernel object capability specified), the error is signalled as IPC error (see L4_MSGTAG_ERROR in the description of the IPC Message Tag).
- (The return label is as irrelevant in this case as the send label.)

This reply is received by the receive phase of the original l4_ipc() call from userland. Finally the l4_ipc() function copies the time value out of the message registers and forwards it with a possible error from the message tag flags to its caller.

3.1.2.2 User Thread to User Thread

When the target kernel object is of type L4::Thread (or L4::Ipc_gate, but we will cover this in the example below) and the message tag's protocol value is not L4_PROTO_THREAD, the kernel will forward the IPC message to the userland thread represented by the kernel object. There it can be received by a call to l4_ipc(). The restriction of the protocol number is necessary because one also wants to invoke L4::Thread's control methods such as L4::Thread.switch_to() or L4::Thread.ex_regs(). Besides this restriction, the interpretation of all the IPC parameters and the untyped items of the UTCB is up to the communication partners.

3.1.2.2.1 Simple Messages

A simple example is a client calling a server to have a computation performed on a value: Similar to IPC from a userland thread to a kernel object, the client writes the value to `MR[0]`. It sets up the message tag with some agreed upon protocol value (which, as explained above, must be different from L4_PROTO_THREAD), number of untyped items to 1, typed items to 0, and no flags set. The client may want to pass a label that identifies itself, as many clients can use the server. In this context, the identifier might also be passed via the message registers, but the label is the proper place for this, as it gets a special treatment by the kernel for IPC gates (covered by the example below). The client then calls l4_ipc() with the tag, label and flags indicating it wants a send phase and a receive phase (as it wants a result back). The target is the capability index referring to a capability for the L4::Thread kernel object of the server.

To be able to receive an IPC message, the server has set up a UTCB of its own and called l4_ipc() with flags indicating it only wants to enter a receive phase and it accepts IPCs from any partner. This is called an **open wait**. (The alternative would be to specify a capability index referring to a L4::Thread capability to exclusively receive from.)

Both system calls (the send IPC initiated by the client and the receive IPC initiated by the server) may be seen by the kernel in any order but the IPC will not start before sender and receiver are ready. In that case the kernel will copy the relevant message registers the client specified in the message tag from the client's UTCB to the server's UTCB, in the current example just `MR[0]`. It will then switch the client to the receive phase of its call (which cannot yet be executed) and return the server's call with the message tag and label.

The server inspects the tag for the correct protocol value and number of untyped items passed, inspect the label to decide whether it maybe wants special treatment of this particular client, performs the computation on `MR[0]` and writes the result back to `MR[0]` (or to more words, depending on what exactly it computes). It sets up the tag in the usual way, but probably needs to pass no label, as the client knows who it is talking to.

For the reply, the server makes use the reply capability (see above). Since the client sent the last IPC to the server, the reply capability will point to it. So when the server calls l4_ipc() with the computed result in the message registers and using the reply capability as target, the kernel knows to forward this to the client's thread. The kernel copies the message registers from the server's UTCB to the client's UTCB, and the client's l4_ipc() system call, which is still stuck in the receive phase, is returned with the tag.

The client looks at the tag and then the message registers for its wanted result and the example is concluded.

3.1.2.2.2 Send Items

IPC between userland threads is also used to transfer typed items: Memory, I/O ports, and objects, all represented as flexpages. Typed items and untyped items can be part of the same IPC. As general rule, the sender specifies what he wants to send, the receiver where and how much it wants to receive, and the kernel checks the required permissions before doing the actual transfer. As written before, this mechanism is synchronous and the receiver cannot be transferred items against its will.

See also

Flexpages

Suppose a client wants a server to have read only access to a page of its memory. The client sets up a flexpage covering the page and with only the L4_FPAGE_RO right set. The server sets up a flexpage of a memory region where it will receive the mapping. This may be larger than one page, suppose for our case four pages, in which case the exact position of the mapping will be resolved by the send base provided by the sender. The client combines the hot spot and some flags into a machine word and writes it to `MR[0]` (see also l4_map_control()). At `MR[1]` follows the flexpage it wants to send (see also l4_fpage()). The server does almost the same but writes the words to `BR[0]` and `BR[1]`. (The server could also specify a hot spot, but it is currently ignored by the kernel.) The

client specifies 1 typed and 0 untyped items in the message tag. The server writes 0 to `BDR` to specify that the first receive item starts at the first buffer register.

Both client and server initiate their IPC, the client with only a send phase to the server, and the server with an open wait receive phase. The kernel checks the compatibility of the send items and the receive buffers (e.g. that no object capability flexpage is sent to a receive buffer describing a memory mapping flexpage) and updates its internal structures to reflect the change. In our case, the sender's hot spot indicates to which of the four pages that make up the receive buffer the sent page should be mapped. The kernel also translates the typed send item to the server's address space and stores it in the server's UTCB at `MR[0]` and `MR[1]`.

Once the server returns from its syscall, it will have read access to the client's shared page.

3.1.2.3 User Thread to User Object

A common use case for thread to thread communication is when a server implements a number of object interfaces and a client wants to invoke methods on them. For security reasons, the server does not want to hand out its thread capability to everyone it nonetheless wants to serve. It also may not want to allow every client access to everyone of its interfaces. For this purpose, IPC gates implemented by the kernel object L4::Ipc_gate can be used. An IPC gate can be bound to a thread and forwards IPC to it. In doing so it applies two transformations

1. It sets the label to a predefined value.
2. It changes the rights of transferred items (see L4_CAP_FPAGE_S).

For each object of every interface the server implements, it creates an IPC gate and binds it to itself (see L4::Ipc_gate::bind_thread()). It sets the gate's label to a unique value identifying the object. Then it hands the gate out to clients. Several clients can be handed the same gate and will all end up invoking methods on the same object.

Instead of setting the target as the server's thread kernel object, the client uses the IPC gate's instead. The label the client sends is irrelevant, as the gate will overwrite it with the value the server has set during the bind operation. The server executes an open wait, and the kernel performs the same operation as in the above example with the transformed IPC finally ending up in the server's thread.

The server checks that the received label refers to one of its objects. It then checks if the protocol value in the message tag matches the interface the object implements. Then it invokes the method specified in `MR[0]` with the rest of the arguments. Finally it returns the results via UTCB and message tag to the reply capability and waits for the next IPC.

3.2 Kernel ABI

This section details the binary representation of the IPC interface of the kernel.

It accompanies the L4 Inter-Process Communication (IPC) section. The details presented here are usually not relevant when developing L4Re applications and can therefore be skipped by many readers.

Note

The kernel ABI is subject to change. Please use the API instead of relying on particular binary representations.

The following notation is used to indicate how particular data fields are used:

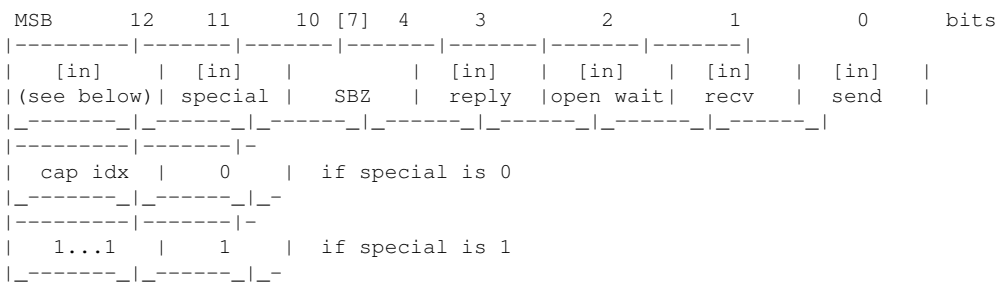
- [in]: The kernel reads and interprets this field.
- [out]: The kernel writes this field with information provided by the kernel.
- [cpy]: The kernel copies this field from sender to receiver (without interpretation if [in] is not listed as well).

The above indications may be combined.

3.2.1 Capability selector and syscall flags

See partner capability selector and syscall flags.

The kernel reads and interprets all the fields ([in]).



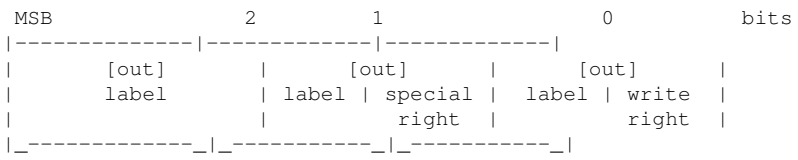
- Bits 0...3 [in]: These bits correspond to the syscall flags. The individual bits correspond to L4_SYSF_REPLY, L4_SYSF_OPEN_WAIT, L4_SYSF_RECV, L4_SYSF_SEND. Note that not all combinations of those bits are valid.
- Bits 4...10 [in] `SBZ`: should be zero
- Bit 11 [in] `special`: Set when using L4_INVALID_CAP, otherwise unset.
- Bits 12...MSB [in]: Capability index if `special` is unset, otherwise all those bits should be one (see L4_INVALID_CAP, partner capability selector and l4_cap_idx_t).

3.2.2 Label

See IPC label.

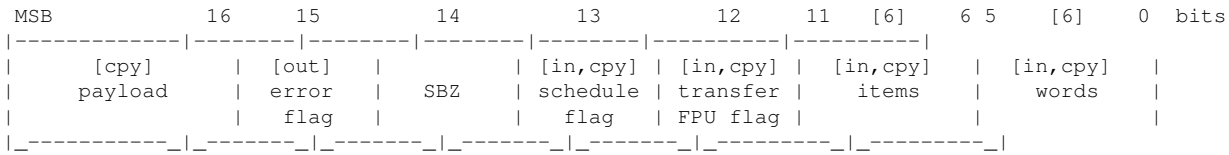
When IPC is sent via a thread capability, the label is copied to the receiver unchanged ([cpy]).

When IPC is sent via an IPC gate, the sent label is ignored and the kernel provides the bitwise OR (|) of the IPC gate label and the sender's write and special permissions (see L4_CAP_FPAGE_W and L4_CAP_FPAGE_S) of the used capability ([out]):



3.2.3 Message tag

See IPC message tag. Note that, for a message tag returned by the kernel, if the error flag is set, all other contents of the message tag is undefined.



- Bits 0...5 [in,cpy] `words`: Number of (untyped) message words in the UTCB's message registers. See l4_msgtag_words() and l4_msgtag_t::words().
- Bits 6...11 [in,cpy] `items`: Number of typed message items in the UTCB's message registers. See l4_msgtag_items() and l4_msgtag_t::items().
- Bit 12 [in,cpy] `transfer FPU flag`: See L4_MSGTAG_TRANSFER_FPU.
- Bit 13 [in,cpy] `schedule flag`: See L4_MSGTAG_SCHEDULE.
- Bit 14 `SBZ`: should be zero
- Bit 15 [out] `error`: See L4_MSGTAG_ERROR, l4_msgtag_has_error() and l4_msgtag_t::has_error().
- Bits 16...MSB [cpy] `payload`: Transferred to receiver unchanged; not interpreted by kernel (unless it is the communication partner). For IPC calls or send-only IPC, this is usually the protocol. For replies, this is usually used for return values and server error signaling. See l4_msgtag_label() and l4_msgtag_t::label().

3.2.4 Timeouts

See IPC timeouts and l4_timeout_t.

The kernel reads and interprets all the fields ([in]).

```
 31     [16]    16 15     [16]     0  bits
|-------------|-------------|
|       [in]      |       [in]      |
|  send timeout   | receive timeout |
|_-----------_|_-----------_|
```

A timeout has the following format. There are two special timeout values:

- *Zero timeout:* Only bit 10 is set. See L4_IPC_TIMEOUT_0.

```
 15  [5]  11  10   9        [10]        0  bits
|---------|-----|----------------|
|     0     |  1  |          0           |
|_-------_|_---_|_---------------_|
```

- *Infinite timeout:* All bits are unset. See L4_IPC_TIMEOUT_NEVER.

```
 15                [16]                0  bits
|----------------------------|
|                   0                   |
|_---------------------------_|
```

Otherwise, the timeout is either relative or absolute, which is specified by bit 15.

- *Relative timeout:* If bit 15 is unset, the timeout is `mantissa * 2 ^ exponent` micro seconds relative to the current time. The `mantissa` must not be zero:

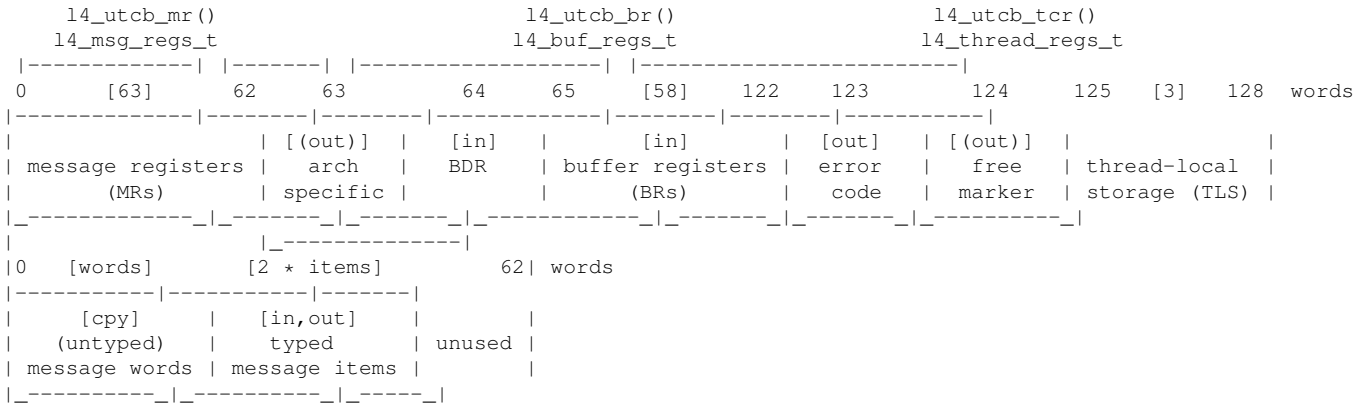
```
  15   14  [5]  10 9        [10]        0  bits
|-----|---------|----------------|
|  0  | exponent  |     mantissa ≠ 0     |
|_---_|_-------_|_---------------_|
```

- *Absolute timeout:* If bit 15 is set, an absolute timeout is specified in the UTCB's buffer registers starting at `buf reg idx` (the particular number of registers depends on the architecture; see l4_timeout_s):

```
  15   14       [9]       6 5    [6]    0  bits
|-----|---------------|----------|
|  1  |         SBZ        | buf reg idx |
|_---_|_-------------_|_---------_|
```

3.2.5 User-level thread control block (UTCB)

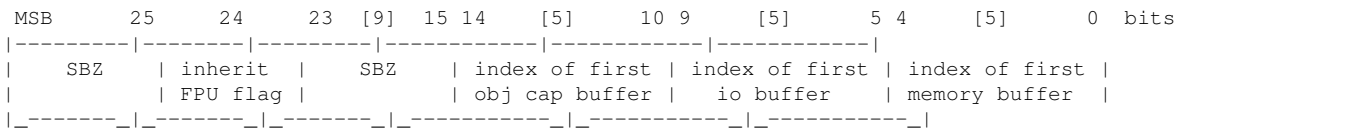
See User-level thread control block (UTCB).



- Words 0...62 `MRs`: See IPC Message registers and l4_utcb_mr(). The number of message registers is defined by L4_UTCB_GENERIC_DATA_SIZE. The actually used message registers are defined by `words` and `items` in the message tag. The layout of a typed message item varies depending on being an input or output value, see typed message items.
- Word 63 [(out)]: Depending on the architecture, this word may be used by the kernel to signify the position of a thread's UTCB in memory. See architecture-specific implementation of l4_utcb(). If at all, the kernel writes this word when kernel-user memory is set up as UTCB while binding a thread to a task; see l4_thread_control_bind(), L4::Thread::Attr::bind().
- Word 64 [in] `BDR`: See buffer descriptor register.
- Words 65...122 [in] `BRs`: See IPC Buffer Registers, receive items and l4_utcb_br()->br. The number of buffer registers is defined by L4_UTCB_GENERIC_BUFFERS_SIZE.
- Word 123 [out] `error code`: See IPC Thread Control Registers and l4_utcb_tcr()->error.
- Word 124 [(out)] `free marker`: Written by the kernel, but not necessarily during IPC. See IPC Thread Control Registers and l4_utcb_tcr()->free_marker.
- Word 125...128 `TLS`: Ignored and left untouched by the kernel. See IPC Thread Control Registers and l4_utcb_tcr()->user.

3.2.5.1 Buffer descriptor register

See IPC Buffer Descriptor Register and l4_utcb_br()->bdr.



3.2.6 Typed message items

The number of words in a typed message item varies depending on the particular kind of item. However, for the first word, the following properties are shared:

- *Void item:* If all bits of the first word of a typed message item are zero, then it is a void item.
- *Non-void item:* The first word of a non-void typed message item has the following binary layout:



  Bit 3 (`t`) is the type bit. If `t` is set, the item is a map item. Currently, map item is the only supported type. Hence, this bit must be set for all items except for void items.

There are three sub-types of typed message items: *send items*, *receive items*, and *return items*; see Message Items.

Many typed items make use of flexpages, therefore, these are described before the various kinds of typed items. Note that flexpages are also used outside of typed message items, e.g., for L4::Task::unmap().

3.2.6.1 Flexpages

A flexpage consists of a single word and, except for some special values, describes a range in an address space, see flex pages.

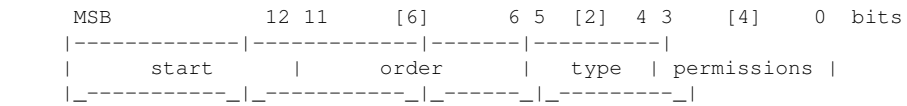
The general layout is defined as follows:



- Bits 4...5 `type`: See l4_fpage_type() and L4_fpage_type.

The type L4_FPAGE_SPECIAL only supports some selected values, which are only supported for selected interfaces; see L4_FPAGE_SPECIAL.

The other types share the same layout:



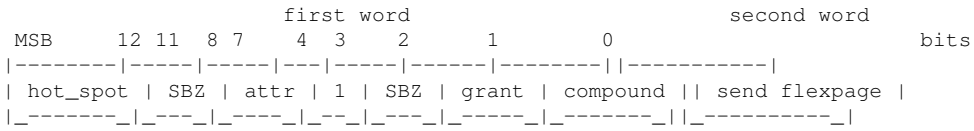
- Bits 0...3 `permissions`: See l4_fpage_rights(), L4_fpage_rights (memory space) and L4_cap_fpage_rights (object space). Should be zero for I/O port space.
- Bits 6...11 `order`: The $\log_2$ size of the flexpage. See l4_fpage_size.
- Bits 12...MSB `start`: The starting page number / I/O port number / capability index of the flexpage. Must be aligned to the flexpage size. See l4_fpage_page(), l4_fpage_memaddr(), l4_fpage_ioport() and l4_fpage_obj().

Also see l4_fpage() (memory space), l4_iofpage() (I/O port space) and l4_fpage_obj() (object space).

3.2.6.2 Send items

A send item consists of two words. The second word of a non-void send item is a flexpage. The type of the flexpage determines the interpretation of the `attr` bits in the first word (see below).

If not void, the layout of the first word is defined as follows:



`SBZ` means “should be zero”.

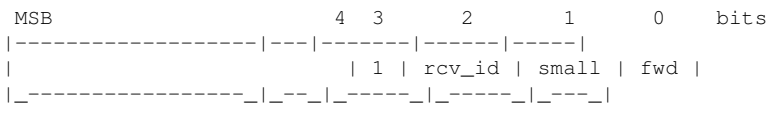
- Bit 0 (`compound`): Compound bit. See L4_ITEM_CONT and L4::Ipc::Snd_fpage::is_compound().
- Bit 1 (`grant`): Grant flag. See L4_ITEM_MAP, L4_MAP_ITEM_GRANT and L4::Ipc::Snd_fpage::Map_type.
- Bits 7..4 (`attr`): Attributes. See Attributes and additional permissions for object send items and l4_fpage_cacheability_opt_t, L4::Ipc::Snd_fpage::Cacheopt.
- Bits MSB..12 (`hot_spot`): Send base (also called hot spot). See L4::Ipc::Snd_fpage::snd_base().

For details, see IPC Message registers.

3.2.6.3 Receive items

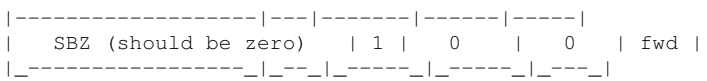
A non-void receive item consists of up to three words.

If not void, the general layout of the first word is defined as follows:

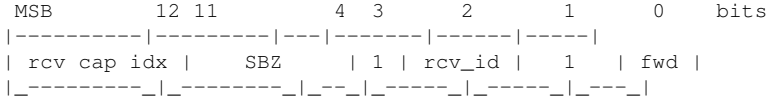


The `small` and `fwd` bits determine the details of the layout of the whole message item.

If `small` is unset, then also `rcv_id` must be unset, and the most significant bits should be zero:

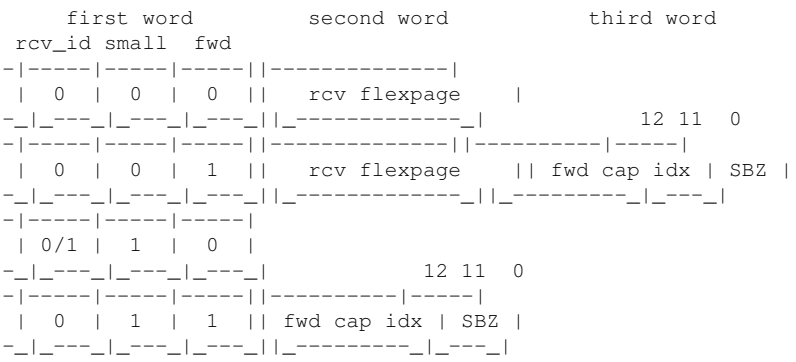


If `small` is set, the most significant bits are layouted as follows:



At most one of `rcv_id` and `fwd` may be set.

The number and meaning of the words in the whole item are determined by the `small` and `fwd` bits:

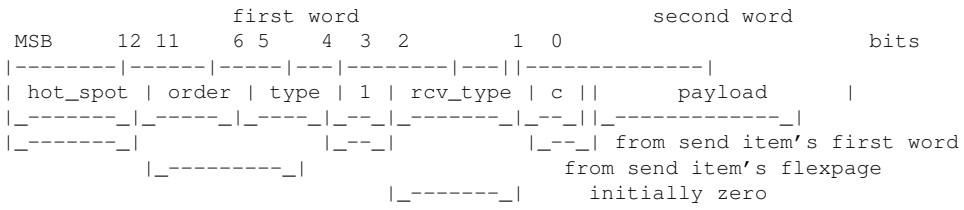


The meaning of the bits in detail:

- Bit 0 (`fwd`): See L4_RCV_ITEM_FORWARD_MAPPINGS and L4::Ipc::Rcv_fpage::forward_mappings(). For `fwd cap idx` see L4::Ipc::Rcv_fpage::rcv_task().
- Bit 1 (`small`): See L4_RCV_ITEM_SINGLE_CAP and L4::Ipc::Small_buf vs. L4::Ipc::Rcv_fpage.
- Bit 2 (`rcv_id`): See L4_RCV_ITEM_LOCAL_ID.

3.2.6.4 Return items

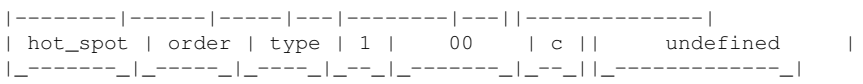
A return item always consists of two words. The general layout of a non-void return item is defined as follows:



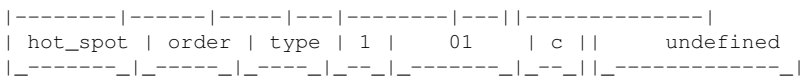
As indicated above, the `hot_spot`, `1`, and `c` (`compound`) are copied from the sender's send item's first word, and `order` and `type` are copied from the sender's send item's flexpage. The `rcv_type` and `payload` are determined by what is actually transferred, which is also affected by the `rcv_id` bit in the receiver's receive item. The `rcv_type` determines the content and layout of the payload.

There are four cases for `rcv_type`:

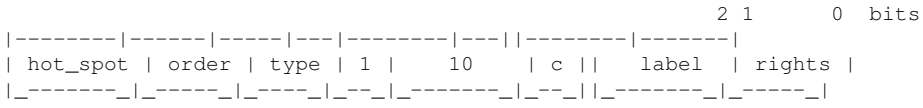
`00`: Used if at least one mapping was actually transferred for the corresponding send item. The payload is undefined: (also see L4::Ipc::Snd_fpage::cap_received()):



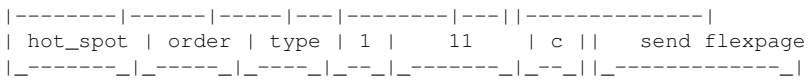
`01`: Used if transfer of mappings was attempted, but actually nothing was transferred, because nothing was mapped on the sender's side for the corresponding send item. The payload is undefined:



10: Used if the receive item's rcv_id bit was set and the conditions for transferring an IPC gate label were fulfilled. In that case, no mapping is done for this item and the payload consists of the bitwise OR (|) of the IPC gate label and the write and special permissions (see L4_CAP_FPAGE_W and L4_CAP_FPAGE_S) that would have been mapped (also see L4::Ipc::Snd_fpage::id_received()):



11: Used if the receive item's rcv_id bit was set and the conditions for transferring the sender's flexpage word were fulfilled. In that case, no mapping is done for this item and the payload is a copy of the sender's flexpage word (also see L4::Ipc::Snd_fpage::local_id_received()):



3.3 Capabilities and Naming

The L4Re system is a capability based system which uses and offers capabilities to implement fine-grained access control.

Generally, owning a capability means to be allowed to communicate with the object the capability points to. All user-visible kernel objects, such as tasks, threads, and IRQs, can only be accessed through a capability. Please refer to the Kernel Objects documentation for details. Capabilities are stored in per-task capability tables (the object space) and are referenced by capability indices or object flexpages. In a simplified view, a capability index is a natural number indexing into the capability table of the current task.

As a matter of fact, a system designed solely based on capabilities uses so-called 'local names' because each task can only access those objects made available to this task. Other objects are not visible to and accessible by the task.

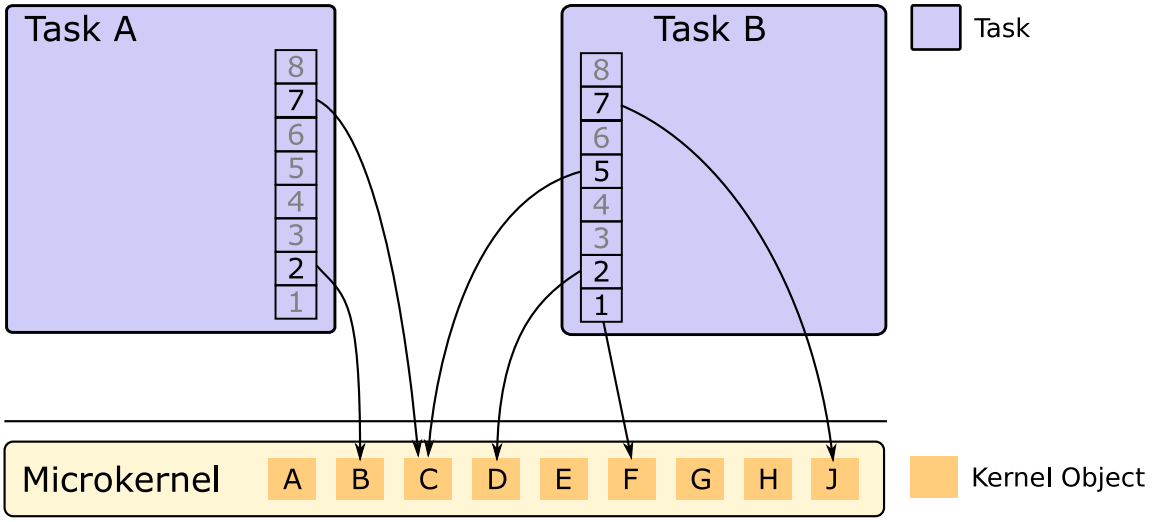


Figure 3.1 Capabilities and Local Naming in L4

So how does an application get access to a service? In general all applications are started with an initial set of available objects. This set of objects is predetermined by the creator of a new application process and granted directly to the new task before starting the first application thread. The application can then use these initial objects to request access to further objects or to transfer capabilities to its own objects to other applications. A central L4Re object for exchanging capabilities at runtime is the name-space object, implementing a store of named capabilities.

From a security perspective, the set of initial capabilities (access rights to objects) completely define the execution environment of an application. Mandatory security policies can be defined by well known properties of the initial objects and carefully handled access rights to them.

3.4 Spaces and Mappings

Each task in the L4Re system has access to two resource spaces (three on IA32) which are maintained by the kernel.

These are the

1. object space,
2. memory space, and
3. IO-port space (only on IA32).

The entities addressed in each space are capabilities to objects, virtual memory pages, and IO ports. The addresses are unsigned integers and the largest valid address depends on which space is referenced, the hardware, and the configuration of the kernel. Although a program can access memory at byte granularity, from the kernel's point of view the address granularity in the memory space is not bytes but pages, as determined by the hardware. The address of a capability is also called its *capability index* or, synonymously, capability slot∗.

Flexpages describe a range in any of the spaces that has a power-of-two length and is also aligned to this length. They additionally hold access rights information and further space specific information.

When a resource is present at some address in a task's corresponding resource space, then we say that resource is mapped to that task. For example, a capability to the task's main thread may be mapped to capability slot 5, or the first page of the code segment a thread executes is mapped to virtual memory page 12345. However, there need not be any resource mapped to an address.

Tasks can exchange resources through a process called "mapping" during IPC and using the L4::Task::map() method. The sending task specifies a send flexpage and the receiving task a receive flexpage. The resources mapped to the send flexpage will then be mapped to the receive flexpage by the kernel.

Memory mappings and IO port mappings are hierarchical: If a resource of such a type is subject of a map operation, the received mapping is a child mapping of the corresponding mapping in the sending task (parent mapping). The kernel usually respects the relationship between these two mappings (granting is an exception; see below): If rights of a parent mapping are revoked using L4::Task::unmap(), these rights are also removed from its child mappings. Also, if a mapping is completely removed (via L4::Task::unmap() or by mapping something else at its place), then also all child mappings are removed. In contrast, revoking rights of a child mapping leaves the rights of its parent mapping untouched.

The mapping of a resource can be performed as *grant* operation (see L4_MAP_ITEM_GRANT): Such an operation includes the removal of all involved mappings from the send flexpage (basically a move operation). While with a map operation without grant the mapping in the send flexpage remains the parent of all child mappings (including the new child mapping in the receive flexpage), a grant operation moves the mappings covered by the send flexpage to the corresponding addresses from the receive flexpage while leaving the parent/child relationship of the moved mappings with other mappings untouched.

During a map operation at most the access rights of the source mapping(s) can be transferred but no additional rights can be added. So only rights that are present in the source mapping and that are specified in the send item/flexpage are transferred. This also holds for grant mappings, however, rights revocation is *not* guaranteed to be applied to descendant mappings in case of grant.

There are cases where a grant operation is not or cannot be performed as requested; see L4_MAP_ITEM_GRANT for details.

Object capabilities are not hierarchical – they have no children. The result of the map operation on an object capability is a copy of that capability in the object space of the destination task.

3.5 Initial Environment and Application Bootstrapping

New applications that are started by a loader conforming to L4Re get provided an Initial Environment.

This environment comprises a set of capabilities to initial L4Re objects that are required to bootstrap and run this application. These capabilities include:

- A capability to an initial memory allocator for obtaining memory in the form of data spaces
- A capability to a factory which can be used to create additional kernel objects
- A capability to a Vcon object for debugging output and maybe input

- A set of named capabilities to application specific objects

During the bootstrapping of the application, the loader establishes data spaces for each individual region in the ELF binary. These include data spaces for the code and data sections, and a data space backed with RAM for the stack of the program's first thread.

One loader implementation is the `moe` root task. Moe usually starts an *init* process that is responsible for coordinating the further boot process. The default *init* process is `ned`, which implements a script-based configuration and startup of other processes. Ned uses Lua (`https://www.lua.org`) as its scripting language, see Ned Script example for more details.

3.5.1 Configuring an application before startup

The default L4Re init process (Ned) provides a Lua script based configuration of initial capabilities and application startup. Ned itself also has a set of initial objects available that can be used to create the environment for an application. The most important object is a kernel object factory that allows creation of kernel objects such as IPC gates (communication channels), tasks, threads, etc. Ned uses Lua tables (associative arrays) to represent sets of capabilities that shall be granted to application processes.

```
local caps = {
    name = some_capability
}
```

The L4 Lua package in Ned also has support functions to create application tasks, region-map objects, etc. to start an ELF binary in a new task. The package also contains Lua bindings for basic L4Re objects, for example, to generic factory objects, which are used to create kernel objects and also user-level objects provided by user-level servers.

```
L4.default_loader:start({ caps = { some_service = service } }, "rom/program --arg");
```

3.5.2 Connecting clients and servers

In general, a connection between a client and a server is represented by a communication channel (IPC gate) that is available to both of them. You can see the simplest connection between a client and a server in the following example.

```
local loader = L4.default_loader; -- which is Moe
local svc = loader:new_channel();  -- create an IPC gate
loader:start({ caps = { service = svc:svr() }}, "rom/my_server");
loader:start({ caps = { service = svc:m("rw") }}, "rom/my_client");
```

As you can see in the snippet, the first action is to create a new channel (IPC gate) using `loader:new_channel()`. The capability to the gate is stored in the variable `svc`. Then the binary `my_server` is started in a new task, and full (`:svr()`) access to the IPC gate is granted to the server as initial object. The gate is accessible to the server application as "service" in the set of its initial capabilities. Virtually in parallel a second task, running the client application, is started and also given access to the IPC gate with less rights (`:m("rw")`, note, this is essential). The server can now receive messages via the IPC gate and provide some service and the client can call operations on the IPC gate to communicate with the server.

Services that keep client specific state need to implement per-client server objects. Usually it is the responsibility of some authority (e.g., Ned) to request such an object from the service via a generic factory object that the service provides initially.

```
local loader = L4.default_loader; -- which is Moe
local svc = loader:new_channel():m("rws");  -- create an IPC gate with rws rights
loader:start({ caps = { service = svc:svr() } }, "rom/my-service");
loader:start({ caps = { foo_service = svc:create(object_to_create, "param") }}, "rom/client");
```

This example is quite similar to the first one, however, the difference is that Ned itself calls the create method on the factory object provided by the server and passes the returned capability of that request as "foo_service" to the client process.

Note

The `svc:create(..)` call blocks on the server. This means the script execution blocks until the my-service application handles the create request.

3.6 Memory management - Data Spaces and the Region Map

3.6.1 User-level paging

Memory management in L4-based systems is done by user-level applications, the role is usually called *pager*. Tasks can give other tasks full or restricted access rights to parts of their own memory. The kernel offers means to give access to memory in a secure way, often referred to as *memory* mapping.

The mapping mechanism allows one task to resolve page faults of another: A thread usually has a pager assigned to it. When the thread causes a page fault, the kernel sends an IPC message to the pager with information about the page fault. The pager answers this IPC by either providing a backing page, or with an error. The kernel will map the backing page into the address space of the faulting thread's task.

These mechanisms can be used to construct a memory and paging hierarchy among tasks. The root of the hierarchy is `sigma0`, which initially gets all system resources and hands them out once on a first-come-first-served basis. Memory resources can be mapped between tasks at a page-size granularity. This size is predetermined by the CPU's memory management unit and is commonly set to 4 kB.

3.6.1.1 Data spaces

A data space is the L4Re abstraction for objects which may be accessed in a memory mapped fashion (i.e., using normal memory read and write instructions). Examples include the sections of a binary which the loader attaches to the application's address space, files in the ROM or on disk provided by a file server, the registers of memory-mapped devices and anonymous memory such as the heap or the stack.

Anonymous memory data spaces in particular (but in general all data spaces except memory mapped IO) can either be constructed entirely from a portion of the RAM or the current working set may be multiplexed on some portion of the RAM. In the first case it is possible to eagerly insert all pages (more precisely page-frame capabilities) into the application's address space such that no further page faults occur when this data space is accessed. In general, however, only the pages for some portion are provided and further pages are inserted by the pager as a result of page faults.

3.6.1.2 Virtual Memory Handling

The virtual memory of each task is constructed from data spaces backing virtual memory regions (VMRs). The management of the VMRs is provided by an object called *region map*. A dedicated region-map object is associated with each task; it allows attaching and detaching data spaces to an address space as well as reserving areas of virtual memory. Since the region-map object possesses all knowledge about the virtual memory layout of a task, it also serves as an application's default pager.

3.6.1.3 Memory Allocation

Operating systems commonly use anonymous memory for implementing dynamic memory allocation (e.g., using `malloc` or `new`). In an L4Re-based system, each task gets assigned a memory allocator providing anonymous memory using data spaces.

See also

L4Re::Dataspace and L4Re::Rm.

3.7 Program Input and Output

The initial environment provides a Vcon capability used as the standard input/output stream.

Output is usually connected to the parent of the program and displayed as debugging output. The standard output is also used as a back end to the C-style printf functions and the C++ streams.

Vcon services are implemented in Moe and the loader as well as by the L4Re Microkernel and connected either to the serial line or to the screen if available.

See also

Virtual Console

3.8 Initial Memory Allocator and Factory

The purpose of the memory allocator and of the factory is to provide the application with the means to allocate memory (in the form of data spaces) and kernel objects respectively.

An initial memory allocator and an initial factory are accessible via the initial L4Re environment.

See also

L4Re::Mem_alloc

The factory is a kernel object that provides the ability to create new kernel objects dynamically. A factory imposes a resource limit for kernel memory, and is thus a means to prevent denial of service attacks on kernel resources. A factory can also be used to create new factory objects.

See also

Factory

3.9 Application and Server Building Blocks

So far we have discussed the environment of applications in which a single thread runs and which may invoke services provided through their initial objects.

In the following we describe some building blocks to extend the application in various dimensions and to eventually implement a server which implements user-level objects that may in turn be accessed by other applications and servers.

3.9.1 Creating Additional Application Threads

To create application threads, one must allocate a stack on which this thread may execute, create a thread kernel object and setup the information required at startup time (instruction pointer, stack pointer, etc.). In L4Re this functionality is encapsulated in the pthread library.

3.9.2 Providing a Service

In capability systems, services are typically provided by transferring a capability to those applications that are authorised to access the object to which the capability refers to.

Let us discuss an example to illustrate how two parties can communicate with each other: Assume a simple file server, which implements an interface for accessing individual files: read(pos, buf, length) and write(pos, data, length).

L4Re provides support for building servers based on the class L4::Server_object. L4::Server_object provides an abstract interface to be used with the L4::Server class. Specific server objects such as, in our case, files inherit from L4::Server_object. Let us call this class File_object. When invoked upon receiving a message, the L4::Server will automatically identify the corresponding server object based on the capability that has been provided to its clients and invoke this object's *dispatch* function with the incoming message as a parameter. Based on this message, the server must then decide which of the protocols it implements was invoked (if any). Usually, it will evaluate a protocol specific opcode that clients are required to transmit as one of the first words in the message. For example, assume our server assigns the following opcodes: Read = 0 and Write = 1. The `dispatch` function calls the corresponding server function (i.e., `File_object::read()` or `File_object::write()`), which will in turn parse additional parameters given to the function. In our case, this would be the position and the amount of data to be read or written. In case the write function was called the server will now update the contents of the file with the data supplied. In case of a read it will store the requested part of the file in the message buffer. A reply to the client finishes the client request.

3.10 Pthread Support

L4Re supports the standard pthread library functionality.

Therefore L4Re itself does not contain any documentation for pthreads itself. Please refer to the standard pthread documentation instead.

The L4Re specific parts will be described herein.

- Include pthread-l4.h header file:
  ```
  #include <pthread-l4.h>
  ```
- Return the local thread capability of a pthread thread:

  Use `pthread_l4_cap(pthread_t t)` to get the capability index of the pthread t.

  For example:
  ```
  pthread_l4_cap(pthread_self());
  ```
- Setting the L4 priority of an L4 thread works with a special scheduling policy (other policies do not affect the L4 thread priority):
  ```
  pthread_t t;
  pthread_attr_t a;
  struct sched_param sp;

  pthread_attr_init(&a);
  sp.sched_priority = l4_priority;
  pthread_attr_setschedpolicy(&a, SCHED_L4);
  pthread_attr_setschedparam(&a, &sp);
  pthread_attr_setinheritsched(&a, PTHREAD_EXPLICIT_SCHED);

  if (pthread_create(&t, &a, pthread_func, NULL))
    // failure...

  pthread_attr_destroy(&a);
  ```

- You can prevent your pthread from running immediately after the call to `pthread_create(..)` by adding `PTHREAD_L4_ATTR_NO_START` to the `create_flags` of the pthread attributes. To finally start the thread you need to call `scheduler()->run_thread()` passing the capability of the pthread and scheduling parameters.

```
pthread_t t;
pthread_attr_t attr;

pthread_attr_init(&attr);
attr.create_flags |= PTHREAD_L4_ATTR_NO_START;

if (pthread_create(&t, &attr, pthread_func, nullptr))
  // failure...

pthread_attr_destroy(&attr);

// do stuff

auto ret = L4Re::Env::env()->scheduler()->run_thread(pthread_l4_cap(t),
                                                     l4_sched_param(2));
if (l4_error(ret))
  // failure...
```

Constraints on pthread_t, user-land capability slot, and kernel thread-object

- `pthread_l4_cap()` is guaranteed to return the valid capability slot of the pthread (A) until `pthread_join()` or `pthread_detach()` is invoked on (A)'s `pthread_t`.
- `pthread_l4_cap()` exposes internal state of the pthread management, take the necessary precautions as you would for any shared data in concurrent environments. If you use `pthread_l4_cap()` guarding against concurrency issues is your duty.
- There is no guarantee that a valid capability slot points to a present capability.
- **Example**

  It is possible to obtain a valid thread capability slot and for `l4_task_cap_valid()` to return the capability as not present. The following example showcases a possible sequence of events.

```
// Assume: void some_func(void *)
pthread_t pthread = nullptr;
pthread_create(&pthread, nullptr, some_func, nullptr);

// pthread running some_func()
l4_cap_idx_t cap_idx = pthread_l4_cap(pthread);
l4_is_valid_cap(cap_idx); // ---> true

long valid = l4_task_cap_valid(L4RE_THIS_TASK_CAP, cap_idx).label());
// valid == 1 --> capability object is present (refers to a kernel object).


// some_func() exits

cap_idx = pthread_l4_cap(pthread);
l4_is_valid_cap(cap_idx); // ---> true

valid = l4_task_cap_valid(L4RE_THIS_TASK_CAP, cap_idx).label());
// valid == 0 --> capability object is not present (refers to no kernel object).


pthread_join(pthread, nullptr); // invalidates the cap slot and frees
                                // the pthread's data structures

// using cap_idx here is undefined behavior.
```

3.11 Interface Definition Language

An interface definition in L4Re is normally declared as a class derived from L4::Kobject_t.

For example, the simple calculator example declares its interface like that:

```
struct Calc : L4::Kobject_t<Calc, L4::Kobject>
{
```

```
  L4_INLINE_RPC(long, sub, (l4_uint32_t a, l4_uint32_t b, l4_uint32_t *res));
  L4_INLINE_RPC(long, neg, (l4_uint32_t a, l4_uint32_t *res));

  using Rpcs = L4::Typeid::Rpcs<sub_t, neg_t>;
};
```

The signature of each function is first declared using one of the RPC macros (see below) and then all the functions need to be listed in the Rpcs type.

Clients invoke these functions with the name given to the RPC macros, `sub` and `neg` above. Servers implement them by defining functions with an `op_` prepended, `op_sub` and `op_neg`. The types of the parameters in the macro definition, on the server side, and on the client side are not the same. The following section describes how they are related to each other.

3.11.1 Parameter types for RPC

Generally all value parameters, const reference parameters, and const pointer parameters to an RPC interface are considered as input parameters for the RPC and are transmitted from the client to the server.

Note

This means that `char const *` is treated as an input `char` and not as a zero terminated string value, for strings see L4::Ipc::String<>.

Parameters that are non-const references or non-const pointers are treated as output parameters going from the server to the client.

There are special data types that appear on only one side (client or server) when used, see the following table for details.

```
L4_RPC(l4_ret_t, test, (int arg1, char const *arg2, unsigned *ret1));
```

The example shows the declaration of a method called `test` with `l4_ret_t` as return type, `arg1` is an `int` input, `arg2` a `char` input, and `ret1` an `unsigned` output parameter.

Type	Direction	Client-Type	Server-Type
`T`	Input	`T`	`T`
`T const &`	Input	`T const &`	`T const &`
`T const *`	Input	`T const *`	`T const &`
`T &`	Output	`T &`	`T &`
`T *`	Output	`T *`	`T &`
`L4::Ipc::In_out<T &>`	In/Out	`T &`	`T &`
`L4::Ipc::In_out<T *>`	In/Out	`T *`	`T &`
`L4::Ipc::Cap<T>`	Input	`L4::Ipc::Cap<T>`	`L4::Ipc::Snd_fpage`
`L4::Ipc::Out<L4::Cap<T> >`	Output	`L4::Cap<T>`	`L4::Ipc::Cap<T> &`
`L4::Ipc::Rcv_fpage`	Input	`L4::Ipc::Rcv_fpage`	`void`
`L4::Ipc::Small_buf`	Input	`L4::Ipc::Small_buf`	`void`

Array types can be used to transmit arrays of variable length. They can either be stored in a client-provided buffer (L4::Ipc::Array), copied into a server-provided buffer (L4::Ipc::Array_in_buf) or directly read and written into the UTCB (L4::Ipc::Array_ref).

Constraints on L4::Ipc::Array_ref:

- the start position of this array type needs to be known in advance.
- it must be the last parameter of a message.
- the size of the array type is not transmitted to the server, only the client side knows the intended size of the input array. The server assumes the rest of the UTCB as the actual array. Different server-side behavior must be steered otherwise, e.g. through another parameter.

Type	Direction	Client-Type	Server-Type
L4::Ipc::Array<const T>	Input	L4::Ipc::Array<const T>	L4::Ipc::Array_ref<const T>
L4::Ipc::Array<const T>	Input	L4::Ipc::Array<const T>	L4::Ipc::Array_in_buf<T> const &
L4::Ipc::Array<T> &	Output	L4::Ipc::Array<T> &	L4::Ipc::Array_ref<T> &
L4::Ipc::Array_ref<T> &	Output	L4::Ipc::Array_ref<T> &	L4::Ipc::Array_ref<T> &

Finally, there are some optional types where the sender can choose if the parameter should be included in the message. These types are for the implementation of some legacy message formats and should generally not be needed for the definition of ordinary interfaces.

Type	Direction	Client-Type	Server-Type
L4::Ipc::Opt<T>	Input	L4::Ipc::Opt<T>	T
L4::Ipc::Opt<const T*>	Input	L4::Ipc::Opt<const T*>	T
L4::Ipc::Opt<T &>	Output	T &	L4::Ipc::Opt<T> &
L4::Ipc::Opt<T *>	Output	T *	L4::Ipc::Opt<T> &
L4::Ipc::Opt<Array_ref<T> &>	Output	Array_ref<T> &	L4::Ipc::Opt<Array_ref<T>> &

3.11.2 Server Side Interface

The server side function signature for the Calc example above is

```
long op_sub(Calc::Rights, l4_uint32_t a, l4_uint32_t b, l4_uint32_t &res);
```

The first rights parameter is a bitfield encoding the rights the client has on the used capability in the lower two bits. Currently, the W-right and S-right are supported. The rest of the Rights-bitfield is reserved.

The second and third arguments are input parameters as can be deduced from the tables above. The fourth parameter is an output parameter, delivered to the client with the return value of type long.

3.11.3 RPC Return Types

On the server side, the return type of an RPC handling function is always `l4_ret_t`. The return value is transmitted via the label field in l4_msgtag_t and is therefore restricted to its length. Per convention, a negative return value is interpreted as an error condition. If the return value is negative, output parameters are not transmitted back to the client.

Attention

The client must never rely on the content of output parameters when the return value is negative.

On the client-side, the return value of the RPC is set as defined in the RPC macro. If `l4_msgtag_t` is given, then the client has access to the full message tag, otherwise the return type should be `l4_ret_t`. Note that the client might not only receive the server return value in response but also an IPC error code.

3.11.4 RPC Method Declaration

RPC member functions can be declared using one of the following C++ macros.

For inline RPC stubs, where the RPC stub code itself is `inline`:

- `L4_INLINE_RPC(res, name, (args...), flags)`
  Define an inline RPC call (type and callable).
- `L4_INLINE_RPC_OP(op, res, name, (args...), flags)`
  Define an inline RPC call with specific opcode (type and callable).
- `L4_INLINE_RPC_NF(res, name, (args...), flags)`
  Define an inline RPC call type (the type only, no callable).
- `L4_INLINE_RPC_NF_OP(opcode, Ret_type, func_name, (args...), flags)`
  Define an inline RPC call type with specific opcode (the type only, no callable).

For external RPC stubs, where the RPC stub code must be defined in a separate compile unit (usually a `.cc` file):

- `L4_RPC(Ret_type, func_name, (args...), flags)`
  Define an RPC call (type and callable).
- `L4_RPC_OP(opcode, Ret_type, func_name, (args...), flags)`
  Define an RPC call with specific opcode (type and callable).
- `L4_RPC_NF(Ret_type, func_name, (args...), flags)`
  Define an RPC call type (the type only, no callable).
- `L4_RPC_NF_OP(opcode, Ret_type, func_name, (args...), flags)`
  Define an RPC call type with specific opcode (the type only, no callable).

To generate the implementation of an external RPC stub:

- `L4_RPC_DEF(class_name::func_name)`
  Generate the definition of an RPC stub.

The `NF` versions of the macro generally do not generate a callable member function named `<name>` but do only generate the type `<name>_t`. This data type can be used to call the RPC stub explicitly using `<name>_t::call(L4::Cap<Iface_class> cap, args...)`.

3.12 L4Re Build System

L4Re uses a custom make-based build system, often simply referred to as *BID*.

This section explains how to use BID when writing applications and libraries for L4Re.

3.12.1 Building L4Re

Setting up the Build Directory

L4Re must be built out-of-source. Therefore the first mandatory step is creating and populating a build directory. From the root of the L4Re source tree run

```
make B=<builddir>
```

Other targets that can be executed in the source directory are

update

Update the source directory from svn. Only makes sense when you have downloaded L4Re from the official subversion repository.

help

Show a short help with the most important targets.

Invoking Make

Once the build directory is set up, BID make can be invoked in one of two ways:

1. Go to the build directory and invoke make without special options.
2. Go to a source directory with a BID make file and invoke `make O=<builddir> ...`

The default target builds the source (as you would expect), other targets that are available in build mode are

cleanfast

Quickly cleans the build directory by removing all subdirectories that contain generated files. The configuration will remain untouched.

clean

Remove generated files. Slower than `make cleanfast` but can be used on selected packages. Use `S=...` to select the target package.

In addition to these targets, there are a number of targets to generate images which are explained elsewhere.

3.12.2 Writing BID Make Files

The BID build system exports different roles that define what should be done in the subdirectory. So a BID make file essentially consists of defining the role and a number of role-dependent make variables. The basic layout should look like this:

```
PKGDIR  ?= <path to package's root directory>  # e.g., '.' or '..'
L4DIR   ?= <path to L4Re source directory>     # e.g. '$(PKGDIR)/../..'

<various definitions>

include $(L4DIR)/mk/<role>.mk
```

`PKGDIR` in the first line defines the root directory of the current package. `L4DIR` in the next line must be pointed to the root of the L4Re source tree the package should be built against. After this custom variable definitions for the role follow. In the final line of the file, the make file with the role-specific rules must be sourced.

The following roles are currently defined:

- project.mk - Sub-project Role
- subdir.mk - Directory Role
- prog.mk - Application Role
- lib.mk - Library Role
- include.mk - Header File Role
- doc.mk - Documentation Role
- test.mk - Test Application Role
- idl.mk - IDL File Role (currently unused)
- runux.mk - Tests in FiascoUX Role

BID-global Variables

This section lists variables that configure how the BID build system behaves. They are applicable for all roles.

Variable	Description
CC	C compiler for target
CXX	C++ compiler for target
HOST_CC	C compiler for host
HOST_CXX	C++ compiler for host

3.12.3 prog.mk - Application Role

The prog role is used to build executable programs.

General Configuration Variables

The following variables can only be set globally for the Makefile:

`MODE`

Kind of target to build for. The following values are possible:

- `static` - build a statically linked binary (default)
- `shared` - build a dynamically linked binary
- `l4linux` - build a binary for running on L4Linux on the target platform
- `host` - build for host system
- `targetsys` - build a binary for the target platform with the compiler's default settings

`SYSTEMS`

List of architectures the target can be built for. The entries must be space-separated entries either naming an architecture (e.g. amd64) or an architecture and ABI (e.g, arm-l4f). When not defined, the target will be built for all possible platforms.

`TARGET`

Name or names of the binaries to compile. This variable may also be postfixed with a specific architecture.

Target-specific Configuration Variables

The following variables may either be used with or without a description suffix. Without suffix they will be used for all operations. With a specific description their use is restricted to a subset. These specifications include a target file and the architecture, both optional but in this order, separated by underscores. The specific variables will be used in addition to the more general ones.

`SRC_C` / `SRC_CC` / `SRC_F` / `SRC_S`

.c, .cc, .f90, .S source files.

`REQUIRES_LIBS`

List of libraries the binary depends on. This works only with libraries that export a pkg_config configuration file. Automatically adds any required include and link options.

DEPENDS_PKGS

List of packages this binary depends on. If one these packages is missing then building of the binary will be skipped.

CPPFLAGS / CFLAGS / CXXFLAGS / FFLAGS / ASFLAGS

Options for the C preprocessor, C compiler, C++ compiler, Fortran compiler and assembler. When used with suffix, the referred element is the source file, not the target file.

LDFLAGS

Options for the linker ld.

LIBS

Additional libraries to link against (with -l).

PRIVATE_LIBDIR

Additional directories to search for libraries.

CRT0 / CRTN

(expert use only) Files containing custom startup and finish code.

LDSCRIPT

(expert use only) Custom link script to use.

3.12.4 include.mk - Header File Role

The header file role is responsible for installing header file at the appropriate location.

The following variables can be used for customizing the process:

`INCSRC_DIR`

Source directory where the headers can be found. Default is the directory where the Makefile resides.

`TARGET`

List of header files to install. If left undefined, then `INCSRC_DIR` will be scanned for files with suffix `.h` or `.i`.

Supports the specification of special filenames to allow for different source and target filenames to be installed. The syntax is `TARGET<SRC`, where a filename including the path of `SRC` is installed as `TARGET`. An example is

```
libfoo.h<contrib/libfoo_linux.h
```

which installs the header from the contrib directory under the name without that contrib directory and without the platform specific suffix.

`EXTRA_TARGET`

When TARGET is undefined, then add these files to the headers found by scanning the source directory. Has no effect if `TARGET` has been defined.

The filenames specified allow for the same rule specifications as supported by `TARGET`.

`CONTRIB_HEADERS`

When set, the headers will be installed in `${BUILDDIR}/include/contrib/${PKGNAME}` rather than `${BUILDDIR}/include/l4/${PKGNAME}`.

`INSTALL_INC_PREFIX`

Base directory where to install the headers. Overwrites `CONTRIB_HEADERS`. The headers will then be found under `${BUILDDIR}/include/${INSTALL_INC_PREFIX}`.

`PC_FILENAME`

When set, a pkg_config configuration file is created with the given name.

3.12.5 test.mk - Test Application Role

The test role is very similar to the application role, it also builds an executable binary.

The difference is that is also builds for each target a test script that executes the test target either on the host (MODE=host) or a target platform (currently only qemu).

The role accepts all make variables that are accepted by the application role. The only difference is that the `TARGET` variable is not required. If it is missing, the source directory will be scanned for source files that fit the pattern `test_*.c[c]` and create one target for each of them.

Note

It is possible to still use SRC_C[C] when targets are determined automatically. In that case the specified sources will be used in addition* to the main `test_*.c[c]` source.

In addition to the variables above, there are a number of variables that control how the test is executed. All these variables may be used as a global variable that applies to all test or, if the target name is added as a suffix, set for a specific target only.

`TEST_TARGET`

Name of binary containing the test (default: same as `TARGET`).

`TARGET_$(ARCH)`

When TARGET is undefined, these targets are added to the list of targets for the specified architecture. For all targets `SRC_C[C]` files must be defined separately.

`TEST_KERNEL_ARGS`

Arguments to append to the kernel command line. These are also appended when specifying custom ones via a .t-file's -f parameter or when using -d.

`TEST_EXPECTED`

File containing expected output. By default the variable is empty, which means the test binary is expected to produce TAP test output, that can be directly processed. When the `TEST_TAP_PLUGINS` variable is given, `TEST_EXPECTED` is ignored.

`TEST_EXPECTED_REPEAT`

Number of times the expected output should be repeated, by default 1. When set to 0 then output is expected to repeat forever. This is particularly useful to make sure that stress tests that are meant to run in an endless loop are still alive. Note that such endless tests can only be run by directly executing the test script. They will be skipped when run in a test harness like `prove`.

TEST_TAP_PLUGINS

Specify the plugins that are used to process the output of the test run. The syntax is of the values is:

plugin1:arg1=a,arg2=b plugin2:arg=foo

Multiple plugins separated by a space are loaded in order. Spaces are not allowed inside a plugin specification. One or more arguments are optionally passed to the plugin separated by commas and delimited by a colon.

If the variable is not specified the plugins for TAPOutput and OutputMatching (depending on the TEST_EXPECTED variable) are automatically loaded.

For the supported plugins and their options please refer to their in-line documentation in tool/lib/L4/TapWrapper/↩ Plugin/. The plugin name corresponds to the file stem name in that directory.

TEST_TIMEOUT

Non-standard timeout after which the test run is aborted (useful for tests involving sleep).

NED_CFG

LUA configuration file for startup to give to Ned

REQUIRED_MODULES

Additional modules needed to run the test. By adding `[opts]` to the name of a module you can add module options that are reflected in the generated modules.list.

BOOTSTRAP_ARGS

Additional parameters to supply to bootstrap.

QEMU_ARGS

Additional parameters to supply to QEMU.

MOE_ARGS

Additional parameters to supply to moe.

TEST_ARGS

Additional arguments for the TEST_STARTER (tapper-wrapper per default).

TEST_ROOT_TASK

Alternative root task to be used during a test instead of moe.

TEST_ROOT_TASK_ARGS

Arguments passed to TEST_ROOT_TASK if TEST_ROOT_TASK is different from moe.

KERNEL_CONF

Features the L4Re Microkernel must have been compiled with. A space-separated list of config options as used by Kconfig. `run_test` looks for a `globalconfig.out` file in the same directory as the kernel and checks that all options are enabled. If not, the test is skipped. Has only an effect if the `globalconfig.out` file is present.

L4RE_CONF

Features the L4Re userland must have been compiled with. A space-separated list of config options as used by Kconfig. `run_test` will look for these in the `.kconfig` file in the L4Re build directory.

L4LINUX_CONF

Features the L4Linux kernel must have been compiled with. Similar to KERNEL_CONF but checks for a `.config` file in the directory of the L4Linux kernel.

TEST_SETUP

Command to execute before the test is run. The test will only be executed if the command returns 0. If the exit code is 69, the test is marked as skipped with the reason provided in the final line of stdout.

TEST_LOGFILE

Append output of test execution to the given file unless TEST_WORKDIR is given.

TEST_WORKDIR

Create logs, temp and other files below the given directory. That directory is taken as base dir for more automatically created subdir levels using the current test path, in order to guarantee conflict-free usage when running many different tests with a common workdir. When TEST_WORKDIR is provided then TEST_↩ LOGFILE is ignored as it is organized below workdir.

TEST_TAGS

List of conditions for tags provided during execution of a test. A tag can be set to 1, set to 0 or be unspecified via TEST_RUN_TAGS during execution. Therefore there are 4 possible conditions for a tag that can be specified in TEST_TAGS: tag, !tag, +tag and -tag. The following table shows the conditions they represent.

TEST_RUN_TAGS \ TEST_TAGS	tag	!tag	+tag	-tag
tag or tag=1	y		y	
unspecified		y	y	
tag=0		y		y

Example usage:

The tag `long-running` is used by tests which take a long time and should be skipped by default. These tests are marked with the tag long-running unprefixed.

The tag `hardware` is set to 1 at runtime when the tests will run on real hardware. Tests that must not run on real hardware are marked with `!hardware`.

The tag `+impl-def` is used by tests that test implementation details. Due to the nature of this flag we require the "+" prefix to be used, so they are run by default but can be excluded from execution by setting TEST_RUN_TAGS to impl-def=0 at runtime.

If you want to specify multiple tag conditions they need to be separated with a comma.

TEST_PLATFORM_ALLOW **and** TEST_PLATFORM_DENY

Deny and allow lists of platforms a test is banned from or limited to. If you list platforms in the TEST_↩ PLATFORM_ALLOW variable the test will only be run on these listed platforms and will be skipped on any other platform. If you list platforms in the TEST_PLATFORM_DENY variable the test will be skipped on the listed platforms and will be run on any other platform. You can only use one of these variables per test, not both. See mk/platforms/ for the various identifiers.

Example usage:

```
# Do not run this test on the Raspberry Pi platform
TEST_PLATFORM_DENY_test_xyz := rpi

# Only run this test on this test on the RCar3 platform.
TEST_PLATFORM_ALLOW_test_abc := rcar3
```

TAPARCHIVE

Filename for an archive file to store the resulting TAP output.

In addition to compiled tests, it is also possible to create tests where the test binary or script comes from a different source. These tests must be listed in EXTRA_TARGET and for each target a custom TEST_TARGET must be provided.

Running Tests

The make role creates a test script which can be found in <builddir>/test/t/<arch>/<api>. It is possible to organise the tests further in subdirectories below by specifying a TEST_GROUP.

To be able to execute the test, a minimal test environment needs to be set up by exporting the following environment variables:

KERNEL_<arch>, KERNEL

L4Re Microkernel binary to use. The test runner is able to check if the kernel has all features necessary for the test and skip tests accordingly. In order for this to work, the globalconfig.out config file from the build directory needs to be available in the same directory as the kernel.

L4LX_KERNEL_<arch>, L4LX_KERNEL

L4Linux binary to use. This is only required to run tests in mode=l4linux. If no L4Linux kernel is set then these tests will simply be skipped. The test runner is also able to check if the kernel has all features compiled in that are required to run the test successfully (see make variable L4LINUX_CONF above). For this to work, the .config configuration file from the build directory needs to be available in the same directory as the kernel.

LINUX_RAMDISK_<arch>, LINUX_RAMDISK

Ramdisk to mount as root in L4Linux. This is only required to run tests in mode=l4linux. If not supplied, L4Linux tests will be skipped. The ramdisk must be set up to start the test directly after the initial startup is finished. The name of the test binary is supplied via the kernel command line option l4re_testprog. The tool/test directory contains an example script launch-l4linux-test. which can be copied onto the ramdisk and started by the init script.

TEST_HWCONFIG and TEST_FIASCOCONFIG

Some userland tests rely on external information about the underlying platform and the configuration of the L4Re Microkernel to decide whether or not to test specific features or to determine which and how much resources are available. Some examples for this are whether or not virtualization is supported by the platform, how many cores the platform has, how many cores the kernel supports or how much memory the platform provides. To convey this information to these tests you can set the two environment variables TEST_↩HWCONFIG and TEST_FIASCOCONFIG.

Using TEST_HWCONFIG requires a plain text document containing key-value pairs separated by a = symbol. On top of that comment lines starting with # are supported. Simply create a plain text file such as the following and set TEST_HWCONFIG to its absolute path.

```
VIRTUALIZATION=y
MP=y
NUM_CORES=4
MEMORY=2048
```

Using TEST_FIASCOCONFIG is easier since it only needs to contain the absolute path of the globalconfig.↩out file in the L4Re Microkernel's build directory. The build system will then extract the information when a test is started.

When starting a test the build system will read both files and provide their content as a lua table to the test. A ned script can then make decisions based on them. To simplify some decisions the build system merges some information by itself, e.g. virtualization is only available if both the platform and the L4Re Microkernel support this feature. More details can be obtain from the perl module in tool/lib/L4/TestEnvLua.pm.

In addition to these variables, the following BID variables can be overwritten at runtime: PT (for the plaform type) and TEST_TIMEOUT. You may also supply QEMU_ARGS and MOE_ARGS which will be appended to the parameters specified in the BID test make file.

Once the environment is set up, the tests can be run either by simply executing all of them from the build directory with

```
make test
```

or executing them directly, like

```
test/t/amd64_amdfam10/l4f/l4re-core/moe/test_namespace.t
```

or running one or more tests through the test harness prove, like

```
prove test/t/amd64_amdfam10/l4f/l4re-core/moe/test_namespace.t
prove -r test/t/amd64_amdfam10/l4f/l4re-core/
prove -rv test/t/amd64_amdfam10/l4f/l4re-core/
```

TEST_TAGS allow for a way to include or exclude whole groups of tests during execution, primarily with prove. You can specify which tests to run at runtime using one of the following ways:

```
$ test/t/amd64_amdfam10/l4f/l4re-core/test_one.t --run-tags slow,gtest-shuffle=0
$ test/t/amd64_amdfam10/l4f/l4re-core/test_one.t -T slow,gtest-shuffle=0
$ prove -r test/t/amd64_amdfam10/l4f/l4re-core/ :: -T slow,gtest-shuffle=0
$ TEST_RUN_TAGS=slow,gtest-shuffle=0 prove -r test/t/amd64_amdfam10/l4f/l4re-core/
```

For each test tag requirements defined in the corresponding TEST_TAGS Makefile variable are tested. If the requirements for tags do not match the test is skipped. The SKIP message will provide insight why the test was skipped:

```
$ make test
...
test/t/amd64_amdfam10/test_one.t .... ok
test/t/amd64_amdfam10/test_two.t .... skipped: Running this test requires tag slow to be set to 1.
test/t/amd64_amdfam10/test_three.t .. ok
```

When tags are provided, the tests requiring those tags are now also executed while the tests that forbid them are skipped:

```
$ TEST_RUN_TAGS=slow,gtest-shuffle
$ make test
...
test/t/amd64_amdfam10/test_one.t .... ok
test/t/amd64_amdfam10/test_two.t .... ok
test/t/amd64_amdfam10/test_three.t .. skipped: Running this test requires tag gtest-shuffle to be set to 0 or
```

For further details on how values in TEST_TAGS and TEST_RUN_TAGS interact, see the help text for TEST_TAGS.

Running Tests in External Programs

You can hand-over test execution to an external program by setting the environment variable `EXTERNAL_TEST↩_STARTER` to the full path of that program:

```
export EXTERNAL_TEST_STARTER=/path/to/external/test-starter
make test
```

`EXTERNAL_TEST_STARTER`

This variable is evaluated by `tool/bin/run_test` (the backend behind `make test`) and contains the full path to the tool which actually starts the test instead of the test itself.

The `EXTERNAL_TEST_STARTER` can be any program instead of the default execution via `make qemu E=maketest`. Its output is taken by `run_test` as the test output.

Usually it is just a bridge to prepare the test execution, e.g., it could create the test as image and start that image via a simulator.

Running Tests in a Simulator

Based on above mechanism there is a dedicated external test starter `tool/bin/teststarter-image-telnet.↩pl` shipped in BID which assumes an image to be started with another program which provides test execution output on a network port.

This can be used to execute tests in a simulator, like this:

```
export EXTERNAL_TEST_STARTER=$L4RE_SRC/tool/bin/teststarter-image-telnet.pl
export SIMULATOR_START=/path/to/configured/simulator-exe
make test
```

After building the image and starting the simulator it contacts the simulator via a network port (sometimes called "telnet" port) to pass-through its execution output as its own output so it gets captured by `run_test` as usual.

The following variables control `teststarter-image-telnet.pl`:

SIMULATOR_START

This points to the full path of the program that actually starts the prepared test image. Most often this is the frontend script of your simulator environment which is pre-configured so that it actually works in the way that `teststarter-image-telnet.pl` expects from the following settings.

SIMULATOR_IMAGETYPE

The image type to be generated via `make $SIMULATOR_IMAGETYPE E=maketest`. Default is `elfimage`.

SIMULATOR_HOST

The simulator will be contacted via socket on that host to read its output. Default is `localhost`.

SIMULATOR_PORT

The simulator will be contacted via socket on that port to read its output. Default is `11111`.

SIMULATOR_START_SLEEPTIME

After starting the simulator it waits that many seconds before reading from the port. Default is `1` (second).

Running tests without tapper-wrapper

In case you want to replace the tapper-wrapper test starter, you can replace the default one by setting the environment variable `TEST_STARTER` to the path of your test starter. Then your test starter can use the same environment which is normally set up for the default starter, which includes environment variables provided by the build system as well as the test itself. Among these are `SEARCHPATH`, `MODE`, `ARCH`, `MOE_CFG`, `MOE_ARGS`, `TEST_TIMEOUT`, `TEST_TARGET`, `TEST_EXPECTED`, `QEMU_ARGS` and many more.

Debugging Tests

The test script is only a thin wrapper that sets up the test environment as it was defined in the make file and then executes two scripts: `tapper-wrapper` and `run_test`.

The main work horse of the two is `tool/bin/run_test`. It collects the necessary files and starts qemu to execute the test. This script is always required.

There is then a second script wrapped around the test runner: `tool/bin/tapper-wrapper`. This tool inspects the output of the test runner and reformats it, so that it can be read by tools like `prove`. If the test produces tap output, then the script scans for this output and filters away all the debug output. If `TEST_EXPECTED` was defined, then the script scans the output for the expected lines and prints a suitable TAP message with success or failure. It also makes sure that qemu is killed as soon as the test is finished.

There are a number of command-line parameters that allow to quickly change test parameters for debugging purposes. Run the test with '–help' for more information about available parameters.

3.13 Kernel Factory

The kernel factory is a kernel object that provides the ability to create new kernel objects dynamically.

The kernel factory enforces a memory quota. This quota defines the maximum amount of kernel memory the factory service can use to construct the requested objects. When the quota is depleted, the factory refuses the creation of new objects.

The quota may be higher than the amount of available kernel memory; ultimately, the amount of available kernel memory is the strict limit for the factory to remain operational.

The kernel factory creates the following kinds of objects:

- DMA space
- L4::Factory
- L4::Ipc_gate (L4_PROTO_NONE, L4_PROTO_KOBJECT)
- L4::Irq (L4_PROTO_IRQ_SENDER)
- L4::Semaphore
- L4::Task
- L4::Thread
- L4::Vm
- L4::Vcpu_context

The protocol IDs for objects in this list are given in L4_msgtag_protocol. Kernel objects whose protocol ID is not immediately clear from the documentation of L4_msgtag_protocol have their protocol IDs stated within parenthesis. As an exception, L4::Ipc_gate can be identified by more than one protocol IDs. The protocol ID shall be used as the second argument for L4::Factory.create(Cap<void>, long, l4_utcb_t *).

For the C++ interface see L4::Factory, for the C interface see Factory.

3.13.1 Passing parameters for the create stream

L4::Factory.create() returns a create stream that allows arguments to be forwarded to the constructor of the object to be created.

Objects that support additional parameters on their creation are presented with a non-empty list of parameters. The parameters are listed in the order they should be provided to a create stream returned by L4::Factory.create().

- Dmar_space()
- L4::Factory(l4_umword_t)
  - Argument: factory quota (in bytes).
  - See L4::Factory.create_factory() for details.
- L4::Ipc_gate()
  - Creates an unbound IPC gate.
  - Alternatively, an IPC gate can be immediately bound to a thread upon creation using L4::Factory.create_gate().

- L4::Irq()
- L4::Semaphore()
- L4::Task(l4_fpage_t)
  - Argument: utcb_area
  - See L4::Factory.create_task() for details.
- L4::Thread()
- L4::Vm()
- L4::Vcpu_context()

Chapter 4

L4Re Servers

Here you shall find a quick overview over the standard services running on the L4Re Microkernel.

Sigma0, the Root Pager

Sigma0 is a special server running on L4 because it is responsible of resolving page faults for the root task, the first useful task on L4Re. Sigma0 can be seen as part of the kernel, however it runs in unprivileged mode. To run something useful on the L4Re Microkernel you usually need to run Sigma0, nevertheless it is possible to replace Sigma0 by a different implementation.

For more details see Sigma0, the Root-Pager

Moe, the Root Task

Moe is our implementation of the L4 root task that is responsible for bootstrapping the system, and to provide basic resource management services to the applications on top. Therefore Moe provides L4Re resource management and multiplexing services:

- **Memory** in the form of memory allocators (L4Re::Mem_alloc, L4::Factory) and data spaces (L4Re::Dataspace)
- **Cpu** in the form of basic scheduler objects (L4::Scheduler)
- **Vcon** multiplexing for debug output (output only)
- **Virtual memory management** for applications, L4Re::Rm

Moe further provides an implementation of L4Re name spaces (L4Re::Namespace), which are for example used to provide a read only directory of all multi-boot modules. In the case of a boot loader, like grub that enables a VESA frame buffer, there is also a single instance of an L4Re graphics session (L4Re::Goos).

To start the system Moe starts a single ELF program, the init process. The init process (usually Ned, see the next section) gets access to all resources managed by Moe and to the Sigma0 root pager interface.

For more details see Moe, the Root-Task.

Ned, the Default Init Process

To keep the root task free from complicated scripting engines and to avoid circular dependencies in application startup (that could lead to dead locks) the configuration and startup of the real system is managed by an extra task, the init process.

Ned is such an init process that allows system configuration via Lua scripts.

For more information see Ned.

Io, the Platform and Device Resource Manager

Because all peripheral management in L4Re is done in user-level applications, there is the need to have a centralized management of the resources belonging to the platform and to peripheral devices.

This is the job of Io. Io provides portable abstractions for iterating and accessing devices and their resources (IRQ's, IO Memory...), as well as delegating access to those resources to other applications (e.g., device drivers).

For more details see Io, the Io Server.

Other Servers

The following additional server package are available on top of the core L4Re environment.

- Rtc, the Real-Time Clock Server

  is a simple multiplexer for real-time clock hardware on your platform.

- fb-drv, the Low-Level Graphics Driver

  provides low-level access and initialization of various graphics hardware. It has support for running VESA BIOS calls on Intel x86 platforms, as well as support for various ARM display controllers. `fb-drv` provides a single instance of the L4Re::Goos interface and can serve as a back end for the Mag server, in particular, if there is no graphics support in the boot loader.

- Virtio Net P2P, a virtual network point-to-point link
- Virtio Net Switch, a virtual network switch
- Uvmm, the virtual machine monitor
- RTC driver
- Mag, the GUI Multiplexer
- Sigma0, the Root-Pager
- Cons, the Console Multiplexer

4.1 Sigma0, the Root-Pager

Sigma0 is a special L4 server that serves as the origin for mapping memory.

It is started by the Fiasco kernel on system boot and gets full access to all userland RAM and device memory. It functions as the pager (main memory provider) for Moe and as the provider for device memory for Io. Moe and Io are trusted and usually the only applications besides Ned that get a capability for Sigma0. Memory can be requested from Sigma0 directly via an IPC, or indirectly by causing page faults and having them resolved by Sigma0.

4.1.1 Factory

There is only one instance of Sigma0 in an L4Re system, which is made accessible to Moe via an IPC gate capability. Using this capability, Moe can request Sigma0 to create new communication channels to itself by creating additional IPC gate capabilities. This request is done using the L4::Factory interface. This is the only kind of object that can be created by the factory in Sigma0.

List of objects that the Sigma0 Factory can create:

- Sigma0 ()
  - Use protocol id L4_PROTO_SIGMA0 for creation
  - No arguments supported

See also

Sigma0 API

4.2 Moe

4.2.1 Description

Moe is the default root-task implementation for L4Re-based systems.

Moe is the first task which is usually started in L4Re-based systems. The microkernel starts *Moe* as the Root-Task.

4.2.2 Moe objects

Moe provides a default implementation for the basic L4Re abstractions, such as data spaces (L4Re::Dataspace), region maps (L4Re::Rm), memory allocators (L4::Factory, L4Re::Mem_alloc), name spaces (L4Re::Namespace) and so on (see L4Re Interface). These are described in the following subsections.

4.2.2.1 Factory

The factory in Moe is responsible for all kinds of dynamic object allocation.

Moe's factory allows allocation of the following objects:

- L4Re::Namespace
- L4Re::Dataspace, RAM allocation
- L4Re::Dma_space, memory management for DMA-capable devices
- L4Re::Rm, virtual memory management for application tasks
- L4::Vcon (output only)
- L4::Scheduler, to provide a restricted priority / CPU range for clients
- L4::Factory, to provide a quota limited allocation for clients

Note

Creating L4::Scheduler objects requires the *scheduler* permission of the factory (see Factory configuration). By default only the factory that Moe provides to the initial application holds this permission.

4.2.2.1.1 Passing parameters to the create stream

L4::Factory.create() returns a create stream that allows arguments to be forwarded to the object creation in Moe.

4.2.2.1.2 Factory configuration

Every factory in Moe carries a configuration that determines the physical memory the factory may hand out and the operations it is allowed to perform. The configuration of the root factory, which Moe provides to the init process, is set with the `--root-factory` command line option. The configuration of a sub-factory is provided when creating the factory.

A configuration consists of a list of physical memory regions and a set of permissions. It is described by the following arguments:

- `untyped=<size>@<base>`, or short `ut=<size>@<base>`

  Adds an untyped memory region. Untyped memory backs ordinary dataspace allocations of a factory. Additionally, moe's internal allocations are governed by the untyped memory of the root factory. If any regions were specified on the root factory, at least one untyped region must be present.

- `typed=<name>=<size>@<base>`, or short `t=<name>=<size>@<base>`

  Adds a typed memory region named `<name>`. Typed memory is never used for ordinary allocations. It is handed out only to clients that request it explicitly by passing `type=<name>` when creating a dataspace. The name must consist of alphanumeric characters only and must not be longer than 23 characters. Multiple regions may carry the same name, in which case they form a single pool.

- `allow=<permissions>`, or short `a=<permissions>`

  Grants permissions to the factory. `<permissions>` is a string built from the following characters:

  - `p`: *Physical address constraints* permission — the factory may create sub-factories that specify their own memory regions.
  - `d`: *DMA constraints* permission — the factory may constrain allocations by a DMA mask.
  - `s`: *Scheduler* permission — the factory may create L4::Scheduler proxy objects.

  This argument must be given at most once.

`<size>` and `<base>` are unsigned numbers, written either in decimal, in hexadecimal with a `0x` prefix or in octal with a leading `0`. Both may carry a single `K`, `M` or `G` suffix, which multiplies the value by 1024, 1024^2 or 1024^3 respectively.

`<size>` must not be zero and a region must not extend beyond the end of the physical address space. Regions carrying the same name must neither overlap nor exceed the number of 15 regions per configuration. Adjacent regions of the same name are merged.

The configuration of a sub-factory must be covered by the configuration of the factory that creates it:

- Specifying any memory region requires the *physical address constraints* permission in the creating factory.
- Each specified region must be contained in a region of the creating factory.
- Only permissions held by the creating factory can be granted.

If a sub-factory does not specify any memory region, it inherits the untyped regions of the creating factory. Likewise, a root factory that does not specify any memory region get's all memory of the system as untyped memory. Typed regions and permissions are never inherited implicitly.

Namespace

Moe provides a name space conforming to the L4Re::Namespace interface (see Namespace. Per default Moe creates a single name space for the Boot FS. That is available as `rom` in the initial objects of the init process.

4.2.2.1.3 Boot FS

The Boot FS subsystem provides access to the files loaded during the platform boot (or available in ROM). These files are either linked into the boot image or loaded via a flexible boot loader, such as GRUB.

The subsystem provides an L4Re::Namespace object as directory and an L4Re::Dataspace object for each file.

By default all files are read only and visible in the namespace *rom*. As an option, files can be supplied with the argument `:rw` to mark them as writable modules. Moe will allow read and write access to these dataspaces and make them visible in a different namespace called *rwfs*.

An example entry in 'modules.list' would look like this:

```
module somemodule :rw
```

Note

In order for a client to receive write permissions to the dataspace, the corresponding cap also needs write permissions.

4.2.3 Capabilities

- `svr`

  Server Capability of application. Endpoint for IPC calls

  Mandatory capability.

4.2.4 Command Line Options

- `--debug=<flags>`

  This option enables debug messages from Moe itself.

  Multiple Flags in one string separated through '|', '+' or ','.

  Possible values for `<flags>` are

  - info
  - warn
  - boot
  - server
  - exceptions
  - loader
  - ns
  - all

- `--init=<init_process>`

  This options allows to set the init process binary.

  String value.

  Default: `rom/ned`

- `--root-factory=<config>`

  This option provides the configuration of the root factory, that is the physical memory regions the factory may allocate from and the permissions it holds. The value is a comma separated list of configuration arguments, see Factory configuration.

  At least one untyped memory region must be specified. Note that no permission is granted implicitly, in particular `allow=s` is required to let the init process create L4::Scheduler proxy objects.

  The option must be given at most once and is mutually exclusive with the `--brk` option.

  Example: `--root-factory=ut=256M@0x40000000,t=vram=16M@0x80000000,a=ps`

  If the option is not given, the root factory may allocate from the whole physical address space and holds the *scheduler* permission.

  String value.

- `--l4re-dbg=<flags>`

  This option allows to set the debug options for the L4Re runtime environment of the init process.

  Multiple Flags in one string separated through '|', '+' or ','.

  Possible values for `<flags>` are

  - info
  - warn
  - boot
  - server
  - exceptions
  - loader
  - ns
  - all

- `--ldr-flags=<flags>`

  This option allows setting some loader options for the L4Re runtime environment.

  Multiple Flags in one string separated through '|', '+' or ','.

  Possible values for `<flags>` are

  - pre_alloc
  - all_segs_cow
  - pinned_segs

- `--brk=<address>`

  This option is only present on systems without MMU. It restricts dynamic allocations to addresses equal or higher than `<address>`. Use it to prevent moe from allocating memory in regions that shall later be used by other applications or virtual machines.

  This option is obsolete and only kept for backwards compatibility. Use the `--root-factory` option instead, which is mutually exclusive with this option.

  Hexadecimal number without '0x' prefix.

- `-- <init_options>`

  All command-line parameters after the special `--` option are passed directly to the init process.

4.2.5 Namespace

Call: `create(L4.Proto.Namespace)`

4.2.6 Dataspace

Dataspaces can be allocated with an arbitrary size. The granularity for memory allocation however is the machine page size (L4_PAGESIZE). A dataspace user must be aware that, as a result of this page-size granularity, there may be padding memory at the end of a dataspace which is accessible to each client. Moe currently allows most dataspace operations on this padding area. Nonetheless, the client must not make any assumptions about the size or content of the padding area, as this behaviour might change in the future.
The provided data spaces can have different characteristics:

- Physically contiguous and pre-allocated
- Non contiguous and on-demand allocated with possible copy on write (COW)

Dataspaces allocated via the Moe's factory allow mappings with any combination of the read-write-execute (RWX) rights, subject to a possible restriction of the writable right for client capabilities lacking the 'W' right.
The physical memory backing a dataspace is taken from the memory regions of the factory the dataspace is created by, see Factory configuration. By default the untyped regions of the factory are used. The optional `type` argument selects the typed regions of the given name instead.
Allocations can be further constrained to a range of physical addresses, as required by devices with a limited DMA addressing capability. Use `L4Re::Mem_alloc::Dma_mask()` to construct the `flags` value that restricts the allocation to physical addresses that fit into the given number of bits. Together with the `L4Re::Mem_alloc::Invert_dma_mask` flag the allocation is restricted to the addresses above that limit instead. Both require the `Continuous` flag to be set and the *DMA constraints* permission of the factory (see Factory configuration), otherwise the allocation is rejected with -L4_EPERM. A DMA mask of less than L4_PAGESHIFT bits is rejected with -L4_EINVAL.
Call: `create(L4.Proto.Dataspace, size [, flags, align, base, type])`

- `size`

  Size in bytes.

  Numerical value.

- `flags`

  Special dataspace properties

  Bitmap of length 4 with the single bits holding the following meaning:

  - 0x01: Continuous Allocate physically contiguous memory.
  - 0x02: Pinned Deprecated, use L4Re::Dma_space instead.
  - 0x04: Super pages Allocate super pages.
  - 0x08: Fixed physical Address Allocate at fixed physical address. Only honored on no-MMU systems. Will fail on MMU systems.

- `align`

  Log2 alignment of dataspace if supported by allocator

  Numerical value.

- `base`

  Physical base address of the dataspace. Only consumed if the `Fixed physical Address` flag is set. The requested address range must be covered by the memory regions of the factory.

  Numerical value.

- `type`

  Allocate from typed memory. The argument is the string `type=<name>`, where `<name>` refers to the typed memory regions of the factory. Without this argument the dataspace is allocated from untyped memory.

  String value.

4.2.7 DMA space

Call: `create(L4.Proto.Dma_space)`

4.2.8 Region Map

Call: `create(L4.Proto.Rm)`

4.2.9 Virtual console

The logging facility of Moe provides per application tagged and synchronized log output.
Call: `create(L4.Proto.Log [, label, "color=(string|int)"])`

- `label`
  Label used as prefix for the console output.
  String value.
- `"color=(string|int)"`
  Color of client's output
  The Value for this parameter can be one of the following:
  - `string`
    Define the color by the first character of the given string
    Possible values are
    - `n`: gray
    - `r`: red
    - `g`: green
    - `y`: yellow
    - `b`: blue
    - `m`: magenta
    - `c`: cyan
    - `w`: white
    - `N`: black
    - `R`: light red
    - `G`: light green
    - `Y`: light yellow
    - `B`: light blue
    - `M`: light magenta
    - `C`: light cyan
    - `W`: bright white
  - `int`
    Define the color by integer.
    Possible values are
    - `0`: gray
    - `1`: red
    - `2`: green
    - `3`: yellow
    - `4`: blue
    - `5`: magenta
    - `6`: cyan
    - `7`: white
    - `8`: black
    - `9`: light red
    - `10`: light green
    - `11`: light yellow
    - `12`: light blue
    - `13`: light magenta
    - `14`: light cyan
    - `15`: bright white

  Default: `white`

4.2.10 Scheduler

The scheduler subsystem provides a simple scheduler proxy for scheduling policy enforcement.
The priority offset provided on the creation of a scheduler proxy defines the minimum priority assigned to threads which are scheduled by that instance of the scheduler proxy. The offset is implicitly added to priorities provided to L4::Scheduler.run_thread().
Call: `create(L4.Proto.Scheduler, limit, offset [, bitmap])`

- `limit`

  Maximum priority.

  Numerical value.

- `offset`

  Priority offset.

  Numerical value.

- `bitmap`

  Bitmap of CPUs - can be repeated to address higher order CPUs

  Numerical value.

4.2.11 Factory

Creates a sub-factory with a restricted quota and, optionally, a restricted factory configuration.
The configuration of the sub-factory must be covered by the configuration of the factory that creates it. Otherwise the creation fails with -L4_EPERM. Malformed configuration arguments are rejected with -L4_EINVAL.
If no memory region is specified, the sub-factory inherits the untyped memory regions of the creating factory. Typed memory regions and permissions are never inherited implicitly.
Call: `create(L4.Proto.Factory [, quota, config])`

- `quota`

  Limit in bytes. The limit is deducted from the limit of the factory that creates the new factory.

  Numerical value.

  - Must not be zero.

- `config`

  Factory configuration argument, either `untyped=<size>@<base>`, `typed=<name>=<size>@<base>` or `allow=<permissions>` - can be repeated to provide multiple arguments.

  String value.

4.3 Ned, the Init Process

Ned's job is to bootstrap the system running on L4Re.
The main thing to do here is to coordinate the startup of services and applications as well as to provide the communication channels for them. The central facility in Ned is the Lua (`http://www.lua.org`) script interpreter with the L4Re and ELF-loader bindings.
The boot process is based on the execution of one or more Lua scripts that create communication channels (IPC gates), instantiate other L4Re objects, organize capabilities to these objects in sets, and start application processes with access to those objects (or based on those objects).
For starting applications, Ned depends on the services of Moe or another *loader*, which must provide data spaces and region maps. Ned also uses the 'rom' capability as source for Lua scripts and at least the 'l4re' binary (the runtime environment core) running in each application.
Each application Ned starts is equipped with an L4Re::Env environment that provides information about all the initial objects made accessible to this application.

4.3.1 Lua Bindings for L4Re

Ned provides various bindings for L4Re abstractions. These bindings are located in the 'L4' package (`require "L4"`).

4.3.1.1 Tutorial

For a verbose example using the Ned Lua bindings, see tutorial.lua.

4.3.1.2 Capabilities in Lua

Capabilities are handled as normal values in Lua. They can be stored in normal variables or Lua compound structures (tables). A capability in Lua possesses additional information about the access rights that shall be transferred to other tasks when the capability is transferred. To support implementation of the Principle of Least Privilege, minimal rights are assigned by default. Extended rights can be added using the method `mode("...")` (short `m("...")`) that returns a new reference to the capability with the given rights.

Note

It is generally impossible to elevate the real access rights to an object. This means that if Ned has only restricted rights to an object it is not possible to upgrade the access rights with the `mode` method.

The capabilities in Lua also carry dynamic type information about the referenced objects. They thereby provide type-specific operations on the objects, such as the `create` operation on a generic factory or the `query` and `register` operations on a name space.

4.3.1.3 Access to L4Re::Env Capabilities

The initial objects provided to Ned itself are accessible via the table `L4.Env`. The default (usually unnamed) capabilities are accessible as `factory`, `log`, `mem_alloc`, `parent`, `rm`, and `scheduler` in the `L4.Env` table.

4.3.1.4 Constants

Protocols

The protocol constants are defined by default in the L4 package's table `L4.Proto`. The definition is not complete and only covers what is usually needed to configure and start applications. The protocols are for example used as first argument to the `Factory:create` method.

```
Proto = {
  Dataspace = 0x4000,
  Namespace = 0x4001,
  Goos      = 0x4003,
  Mem_alloc = 0x4004,
  Rm        = 0x4005,
  Event     = 0x4006,
  Inhibitor = 0x4007,
  Sigma0    = -6,
  Log       = -13,
  Scheduler = -14,
  Factory   = -15,
  Vm         = -16,
  Dma_space  = -17,
  Irq_sender = -18,
  Semaphore  = -20,
  Iommu      = -22,
  Ipc_gate  = 0,
}
```

Rights

The rights of a Lua capability can be defined in two ways via the `:mode()` interface. Either via a string representation of the rights or via an integer value. An example for the former is `:mode("rsnc")` while the latter equivalent is `:mode(L4.Rights.r | L4.Rights.s | L4.Rights.n | L4.Rights.c)`. The following listing shows the integer constants. The constant names can be used in the string parameter to `:mode()`.

```
Rights = {
  s   = 2,
  w   = 1,
  r   = 4,
  d   = 8,
  n   = 16,
```

```
  c   = 32,
  ro  = 4,
  rw  = 5,
  rws = 7,
}
```

Debugging Flags

Debugging flags used for the applications L4Re core:

```
Dbg = {
  Info       = 1,
  Warn       = 2,
  Boot       = 4,
  Server     = 0x10,
  Exceptions = 0x20,
  Cmd_line   = 0x40,
  Loader     = 0x80,
  Name_space = 0x400,
  All        = 0xffffffff,
}
```

Loader Flags

Flags for configuring the loading process of an application.

```
Ldr_flags = {
  eager_map    = 0x1, -- L4RE_AUX_LDR_FLAG_EAGER_MAP
  all_segs_cow = 0x2, -- L4RE_AUX_LDR_FLAG_ALL_SEGS_COW
  pinned_segs  = 0x4, -- L4RE_AUX_LDR_FLAG_PINNED_SEGS
}
```

4.3.1.5 Application Startup Details

The central facility for starting a new task with Ned is the class `L4.Loader`. This class provides interfaces for conveniently configuring and starting programs. It provides three operations:

- `new_channel()` Returns a new IPC gate that can be used to connect two applications
- `start()` and `startv()` Start a new application process and return a process object

The `new_channel()` call is used to provide a service application with a communication channel to bind its initial service to. The concrete behavior of the object and the number of IPC gates required by a server depends on the server implementation. The channel can the be passed to client applications as well or can be used for operations within the script itself.
`start()` and `startv()` always require at least two arguments. The first one is a table that contains information about the initial objects an application shall get. The second argument is a string, which for `start()` is the program name plus a white-space-separated list of program arguments (argv). For `startv()` the second argument is just the program binary name – which may contain spaces –, and the program arguments are provided as separate string arguments following the binary name (allowing spaces in arguments, too). The last optional argument is a table containing the POSIX environment variables for the program.
The Loader class uses reasonable defaults for most of the initial objects. However, you can override any initial object with some user-defined values. The main elements of the initial object table are:

- `factory` The factory used by the new process to create new kernel objects, such as threads etc. This must be a capability to an object implementing the L4::Factory protocol and defaults to the factory object provided to Ned.
- `mem` The memory allocator provided to the application and used by Ned allocates data spaces for the process. This defaults to Ned's memory allocator object (see L4Re::Mem_alloc).
- `rm_fab` The generic factory object used to allocate the region-map object for the process. (defaults to Ned's memory allocator).
- `log_fab` The generic factory to create the L4Re::Log object for the application's output (defaults to Ned's memory allocator). The `create` method of the `log_fab` object is called with `log_tag` and `log_color`, from this table, as arguments.
- `log` A table with parameters passed to the `log_fab`:
  - The first item is a short string defining the tag used for tagging log output of this process (defaults to the program name).
  - The second item is a string defining the color used for the log tag and the log string (defaults to "white").

  - Further parameters might be evaluated by certain implementations of the L4Re::Log interface.

- `scheduler` The scheduler object used for the process' threads (defaults to Ned's own scheduler).
- `caps` The table with application-specific named capabilities (default is an empty table). If the table does not contain a capability with the name 'rom', the 'rom' capability from Ned's initial caps is inserted into the table.

Less frequently used parameters:

- `l4re_dbg` An integer value overriding the debug level of the ITAS used for this application. Default is 2 (Warn). See *Debugging Flags* above.
- `ldr_flags` An integer value for setting additional flags for attaching regions, see *Loader Flags* above.

The `start()` and `startv()` calls return a task object that supports a number of operations.

- `state()` returns a string with the current task state: "running" or "zombie" if the task has terminated. If the task was already reaped (`wait()` returned) or if `kill()` was called, then the function will return `nil`.
- `exit_code()` returns the exit code if the task has terminated or `nil` if it was either killed or has been reaped.
- `kill()` forcefully terminates the task. Returns "killed" if the task was terminated or the exit code if the task was already gone. Returns `nil` if the task was already reaped.
- `exit_handler(function)` registers a Lua function that is invoked when the task terminates. If the task has already terminated, the function is called immediately. Returns `true` if the callback is pending, otherwise `false`. The callback function gets the exit code (`nil` if killed) of the task as its only parameter. The return value of the function is ignored. Only one callback can be registered.
- `wait()` suspends execution until the task has terminated. It's better to use `exit_handler()` instead. While the Lua code executes `wait()`, no `exit_handler()` will be dispatched.

4.3.1.6 Reacting on task termination

Ned can react on the termination of child tasks. The preferred mechanism is to register an `exit_handler()` for a task:

```
task = L4.default_loader:start(...)
task:exit_handler(function(exit_code)
  if exit_code == nil then
    print("Task was killed")
  else
    print("Task has terminated w/ code [" .. exit_code .. "]")
  end
end)
```

If the task did already terminate then the callback is invoked immediately. It is also possible to suspend execution of the Ned script until a task has terminated:

```
task = L4.default_loader:start(...)
task:wait()
```

This method should be used with caution, though. The Ned script will wait until the child task has terminated. Neither will any of the registered `exit_handler()` be called during this time, nor will the remote command interface be able to execute commands.

4.3.1.7 Control scheduling

Scheduling of L4Re applications is controlled by creating scheduler proxies. The proxy restricts the threads of an application to run on a subset of the available CPUs and to set their minimum and maximum priority. Use the loader factory function to create the proxy and pass it to the application:

```
sched_proxy = L4.default_loader:create_sched_proxy{ cpus=L4.Cpu_set:new("0-3") }
L4.default_loader:start({ scheduler = sched_proxy }, ...)
```

The `create_sched_proxy` function takes the following table arguments. All arguments are optional:
`cpus`: Set of allowed CPUs. Default: all CPUs. `prio_offset`: Base priority of all threads. Default: `0`. `prio_limit`: Maximum priority of all threads. Default `priority + 10`. `fab`: Scheduler proxy factory capability. Default: loader `sched_fab`.
The `Cpu_set` constructor takes any number of CPU numbers or ranges:

```
Cpu_set:new()          -- all CPUs (because no argument was passed)
```

```
Cpu_set:new{}          -- empty CPU set (because an empty table was passed)
Cpu_set:new(42)        -- single CPU: 42
Cpu_set:new("0-3")     -- 4 CPUs: 0..3
Cpu_set:new{"0-3", 42} -- 5 CPUs: 0..3, 42
```

A limited number of operations are defined on CPU sets. To compute the union of two sets (all CPUs of both sets), use the | operator. To compute the intersection of two sets (all CPUs common to both sets), use the & operator.

4.3.1.8 Access to the kernel debugger

Applications can enrich the kernel debugger with information using the API defined in l4/sys/debugger. In order to do so, the developer has to assign access to the kernel debugger kernel object to the application. This can be done like this:

```
L4.default_loader:start({ caps = { jdb = L4.Env.jdb; }}, "rom/example")
```

4.3.1.9 Using the interactive ned prompt

Ned can be used in interactive mode by connecting the small ned-prompt helper tool to the command capability. Add the following code snippet at the end of your ned script:

```
local L4 = require("L4");
local l = L4.default_loader;

cmd = l:new_channel()

l:start({ log = L4.Env.log, caps = { svr = cmd} }, "rom/ned-prompt")

L4.server_loop(cmd)
```

The script hands in ned's own log capability to `ned-prompt`. This ensures that input and output of ned and the prompt appear on the same console.
`ned-prompt` needs to be added to your modules list.

4.3.2 Command Line Options

Ned's command line syntax is:

```
[--exit|--wait-and-exit] [--disable-backtracer-autoload] [--execute|-e STATEMENT] <lua script> [options passed
```

Ned interprets the first non-option argument `<lua script>` as the Lua script which it should load and run. All arguments following the first non-option argument are passed as arguments to the Lua script via Lua's global `arg` table.

- Exit Options: **exit**, **wait-and-exit** (must be first if used)
  - **exit**: terminates the application after the script has run through even if there are still tasks running. `wait` for tasks at the end of the script to ensure they do not die forcefully.
  - **wait-and-exit**: terminates the application after the script has run through and all tasks started by ned have signaled their exit.
- Execute Statement Option: **execute**, **e**

  Execute the Lua statement `STATEMENT`.
- **disable-backtracer-autoload**: Do not load the backtracer automatically.

4.4 Io, the Io Server

The Io server handles all platform devices and resources such as I/O memory, ports (on x86) and interrupts, and grants access to those to clients.
Upon startup Io discovers all platform devices using available means on the system, e.g. on x86 the PCI bus is scanned and the ACPI subsystem initialised. Available I/O resource can also be configured via configuration scripts.
Io's configuration consists of two parts:

- the description of the real hardware

- the description of virtual buses

Both descriptions represent a hierarchical (tree) structure of device nodes. Where each device has a set of resources attached to it. And a device that has child devices can be considered a bus.

Hardware Description

The hardware description represents the devices that are available on the particular platform including their resource descriptions, such as MMIO regions, IO-Port regions, IRQs, bus numbers etc.
The root of the hardware devices is formed by a system bus device (accessible in the configuration via Io.system↩_bus()). As mentioned before, platforms that support methods for device discovery may populate the hardware description automatically, for example from ACPI. On platforms that do not have support for such methods you have to specify the hardware description by hand. A simple example for this is `x86-legacy.devs`.

Virtual Bus Description

Each Io server client is provided with its own virtual bus which it can iterate to find devices. A virtual PCI bus may be a part of this virtual bus.

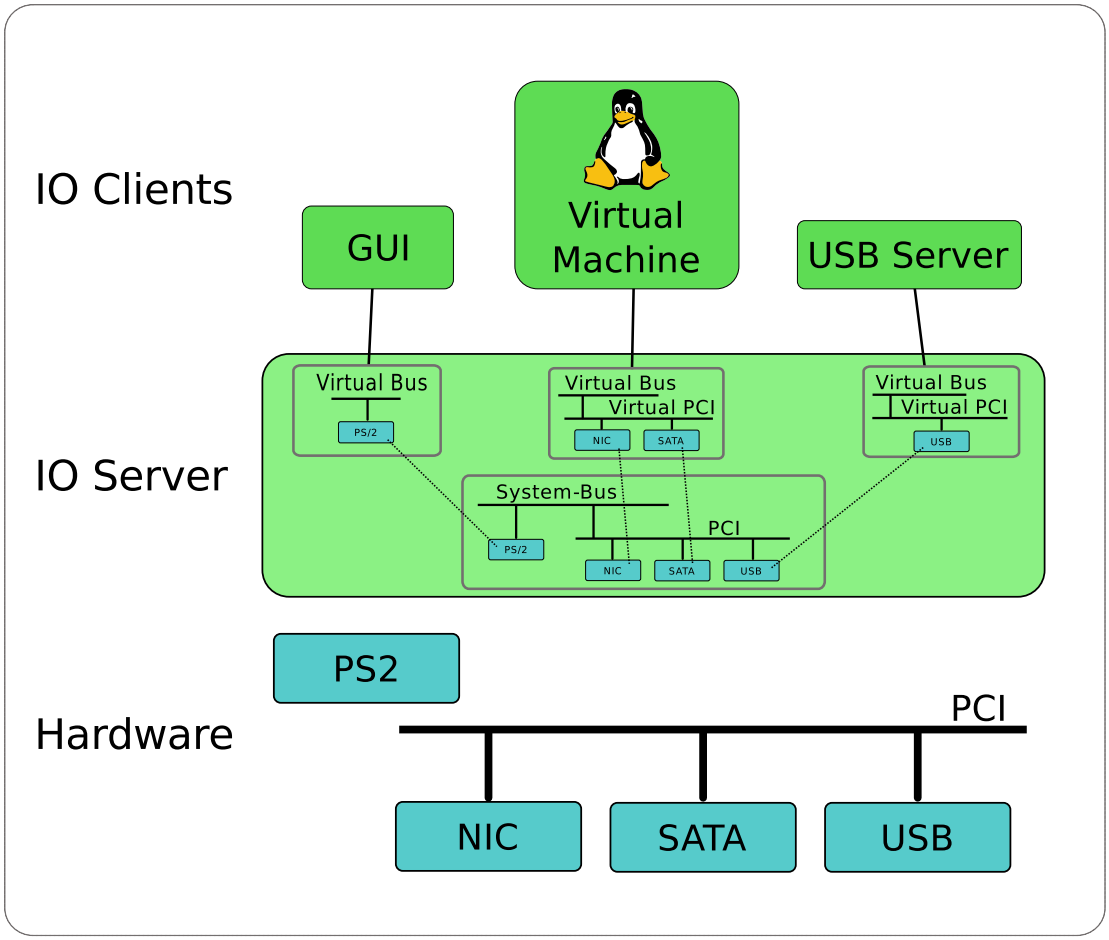


Figure 4.1 IO Service Architecture Overview

The Io server must be configured to create virtual buses for its clients.
This is done with at least one configuration file specifying static resources as well as virtual buses for clients. The configuration may be split across several configuration files passed to Io through the command line.
To allow clients access to available devices, a virtual system bus needs to be created that lists the devices and their resources that should be available to that client. The names of the buses correspond to the capabilities given to Io in its launch configuration.
A very simple configuration for Io could look like this:

```
-- vim:ft=lua
```

```
-- Example configuration for io

-- Configure two platform devices to be known to io
Io.Dt.add_children(Io.system_bus(), function()

  -- create a new hardware device called "FOODEVICE"
  FOODEVICE = Io.Hw.Device(function()
    -- set the compatibility IDs for this device
    -- a client tries to match against these IDs and configures
    -- itself accordingly
    -- the list should be sorted from specific to less specific IDs
    compatible = {"dev-foo,mmio", "dev-foo"};

    -- set the 'hid' property of the device, the hid can also be used
    -- as a compatible ID when matching clients
    Property.hid  = "dev-foo,Example";

    -- note: names for resources are truncated to 4 letters and a client
    -- can determine the name from the ID field of a l4vbus_resource_t
    -- add two resources 'irq0' and 'reg0' to the device
    Resource.irq0 = Io.Res.irq(17);
    Resource.reg0 = Io.Res.mmio(0x6f000000, 0x6f007fff);
  end);

  -- create a new hardware device called "BARDEVICE"
  BARDEVICE = Io.Hw.Device(function()
    -- set the compatibility IDs for this device
    -- a client tries to match against these IDs and configures
    -- itself accordingly
    -- the list should be sorted from specific to less specific IDs
    compatible = {"dev-bar,mmio", "dev-bar"};

    -- set the 'hid' property of the device, the hid can also be used
    -- as a compatible ID when matching clients
    Property.hid  = "dev-bar,Example";

    -- Specify that this device is able to use direct memory access (DMA).
    -- This is needed to allow clients to gain access to DMA addresses
    -- used by this device to directly access memory.
    Property.flags = Io.Hw_device_DF_dma_supported;

    -- note: names for resources are truncated to 4 letters and a client
    -- can determine the name from the ID field of a l4vbus_resource_t
    -- add three resources 'irq0', 'irq1', and 'reg0' to the device
    Resource.irq0 = Io.Res.irq(19);
    Resource.irq1 = Io.Res.irq(20);
    Resource.reg0 = Io.Res.mmio(0x6f100000, 0x6f100fff);
  end);
end);


Io.add_vbusses
{
-- Create a virtual bus for a client and give access to FOODEVICE
  client1 = Io.Vi.System_bus(function ()
    dev = wrap(Io.system_bus():match("dev-foo,mmio"));
  end);

-- Create a virtual bus for another client and give it access to BARDEVICE
  client2 = Io.Vi.System_bus(function ()
    dev = wrap(Io.system_bus():match("dev-bar,Example"));
  end);
}
```

Each device supports a 'compatible' property. It is a list of compatibility strings. A client matches itself against one (or multiple) compatibility IDs and configures itself accordingly. All other device members are handled according to their type. If the type is a resource (Io.Res) it is added as a named resource. Note that resource names are truncated to 4 letters and are stored in the ID field of a l4vbus_resource_t. If the type is a device it is added as a child device to the current one. All other types are treated as a device property which can be used to configure a device driver. Right now, device properties are internal to Io only.

Matching and Assigning PCI Devices

Assigning clients PCI devices could look like this:

```
-- This is a configuration snippet for PCI device selection

local hw = Io.system_bus();

Io.add_vbusses
{
  pciclient = Io.Vi.System_bus(function ()
    PCI = Io.Vi.PCI_bus(function ()
      pci_mm      = wrap(hw:match("PCI/CC_04"));
```

```
      pci_net     = wrap(hw:match("PCI/CC_02"));
      pci_storage = wrap(hw:match("PCI/CC_01"));
    end)
  end)
}
```

The "PCI/" is followed by a bus-specific ID string. The format of the PCI ID string may be one of the following:

- PCI/CC_cc
- PCI/CC_ccss
- PCI/CC_ccsspp
- PCI/VEN_vvvv
- PCI/DEV_dddd
- PCI/SUBSYS_ssssssss
- PCI/REV_rr
- PCI/ADR_xxxx:xx:xx.x

Where:

- `cc` is the hexadecimal representation of the class code byte
- `ss` is the hexadecimal representation of the subclass code byte
- `pp` is the hexadecimal representation of the programming interface byte
- `vvvv` is the hexadecimal representation of the vendor ID
- `dddd` is the hexadecimal representation of the device ID
- `ssssssss` is the hexadecimal representation of the subsystem ID
- `rr` is the hexadecimal representation of the revision byte
- `xxxx:xx:xx.x` is the bus address in PCI nomenclature

As a special extension Io supports replacing the ID string with a human-readable common PCI class name. The following table gives an overview of the names known to Io and their respective PCI class and subclass.

Common Name	Description	PCI ID string
storage	Mass storage controller	CC_01
scsi	SCSI storage controller	CC_0100
ide	IDE interface	CC_0101
floppy	Floppy disk controller	CC_0102
raid	RAID bus controller	CC_0104
ata	ATA controller	CC_0105
sata	SATA controller	CC_0106
sas	Serial attached SCSI controller	CC_0107
nvm	Non-volatile memory controller	CC_0108
-	-	-
network	Network controller	CC_02
ethernet	Ethernet controller	CC_0200
token_ring	Token ring network controller	CC_0201
fddi	FDDI network controller	CC_0202

Common Name	Description	PCI ID string
atm	ATM network controller	CC_0203
isdn	ISDN controller	CC_0204
picmg	PICMG controller	CC_0206
net_infiniband	Infiniband controller	CC_0207
fabric	Fabric controller	CC_0208
network_nw	Network controller e.g. Wifi	CC_0280
-	-	-
display	Display controller	CC_03
vga	VGA compatible controller	CC_0300
xga	XGA compatible controller	CC_0301
-	-	-
media	Multimedia controller	CC_04
mm_video	Multimedia video controller	CC_0400
mm_audio	Multimedia audio controller	CC_0401
telephony	Computer telephony device	CC_0402
audio	Audio device	CC_0403
-	-	-
bridge	Bridge	CC_06
br_host	Host bridge	CC_0600
br_isa	ISA bridge	CC_0601
br_eisa	EISA bridge	CC_0602
br_microchannel	MicroChannel bridge	CC_0603
br_pci	PCI bridge	CC_0604
br_pcmcia	PCMCIA bridge	CC_0605
br_nubus	NuBus bridge	CC_0606
br_cardbus	CardBus bridge	CC_0607
br_raceway	RACEway bridge	CC_0608
br_semi_pci	Semi-transparent PCI-to-PCI bridge	CC_0609
br_infiniband_to_pci	InfiniBand to PCI host bridge	CC_060a
-	-	-
com	Communication controller	CC_07
com_serial	Serial controller	CC_0700
com_parallel	Parallel controller	CC_0701
com_multiport_ser	Multiport serial controller	CC_0702
com_modem	Modem	CC_0703
com_gpib	GPIB controller	CC_0704
com_smart_card	Smart card controller	CC_0705
-	-	-
serial_bus	Serial bus controller	CC_0c
firewire	FireWire (IEEE 1394)	CC_0c00
access_bus	ACCESS bus	CC_0c01

Common Name	Description	PCI ID string
ssa	SSA	CC_0c02
usb	USB controller	CC_0c03
fibre_channel	Fibre channel	CC_0c04
smbus	SMBus	CC_0c05
bus_infiniband	InfiniBand	CC_0c06
ipmi_smic	IPMI SMIC interface	CC_0c07
sercos	SERCOS interface	CC_0c08
canbus	CAN bus	CC_0c09
-	-	-
wireless	Wireless controller	CC_0d
bluetooth	Bluetooth	CC_0d11
w_8021a	802.1a controller	CC_0d20
w_8021b	802.1b controller	CC_0d21

Strong Matching of PCI Devices

If more specific matching of PCI devices is required it is possible to concatenate multiple ID strings using `&`. An example where a specific device from a specific vendor at a fixed bus address is matched would use the string `PCI/VEN_vvvv&DEV_dddd&ADR_xxxx:xx:xx.x`.

Isolation of PCIe devices

PCIe encodes device communication with a network-like protocol with destination headers and packet fragmentation allowing a devices to talk directly to other devices. This potentially works against security boundaries for a system. E.g. two network cards could exchange packets and thereby leak information from one security domain to the other without involvement of the OS.
PCIe introduced an optional capability named PCI Access Control Services (PCI/ACS) to control communication between PCIe devices.
With PCI/ACS it is possible to restrict inter-device communication between PCIe devices.
PCI/ACS is optional and for Intel chipsets, it is usually only implemented on high-end PCI platform controller hubs (PCHs), and is missing on low-end and mobile PCHs. On some Intel-PCHs there exist facilities that allow for similar isolation.
If IO encounters a supported PCH, it will enable those facilities in order to enforce device isolation.

Command Line Options

The Io Server supports the following optional parameters:

```
[--verbose|v] [--transparent-msi] [--trace <trace_mask>] [--acpi-debug-level <debug_level>] [config_files]
```

- **verbose**|**v**

  By default, error debug messages are enabled. This option increments the verboseness level, and can be applied multiple times to reach the desired debug level. The available debug levels are ordered as: `DBG_ERR` (default, level 1), `DBG_WARN`, `DBG_INFO`, `DBG_DEBUG`, `DBG_DEBUG2` and `DBG_ALL` (level 6).

- **transparent-msi**

  Enable MSI on PCI devices which support this feature. This is transparent to clients, as there are no changes in the API used to interact with PCI device via interrupts.

- **acpi-debug-level** <**level_mask**>

  Set the ACPI debug level. The `<level_mask>` is a mask that selects components of interest for debugging. It can be constructed from the ACPI debug constants defined in the linux kernel, see ACPI Debug Output for details. By default, the ACPI debug level is set to `ACPI_LV_INIT | ACPI_LV_TABLES | ACPI_LV_VERBOSE_INFO`.

- **trace <trace_mask>**

  Enable tracing of events matching `trace_mask`. The only supported trace mask is `1` and this matches ACPI events.

- **config_files**

  Space separated list of Lua configuration files specifying real hardware and virtual buses. See example on Virtual Bus Description.

Vbus end points

The IO server provides access to the configured vbus via capabilities

- passed to IO as named capability during startup, the capability names have to match the name of the vbus they are supposed to provide access to.
- created using the factory protocol, which IO provides if a capability name svr is present in IOs capability space, e.g. using

  vbus = L4.cast(L4.Proto.Factory, io):create(0, "vbus=<vbus name>");

  in a ned script.

4.5 Virtio Net P2P, a virtual network point-to-point link

4.5.1 Description

The virtual network point-to-point server (p2p) connects two clients with a virtual network connection. It uses virtio as the transport mechanism. Each virtual network p2p endpoint implements the device-side of a virtio network device. Each client can access its endpoint using the driver-side semantics of a virtio network device.

4.5.2 Capabilities

- `dataspace`

  Trusted dataspaces

  Multiple capability names can be provided by the `-d <cap_name>`, `--register-ds <cap_name>` command line parameter.

- `svr`

  Server Capability of application. Endpoint for IPC calls

  Mandatory capability.

4.5.3 Command Line Options

The following command line options are supported:

- `-p <num_usec>`, `--poll <num_usec>`

  Enable polling mode and set the poll interval. IRQ notification is disabled for queues while in polling mode.

  Numerical value.

  - Must be a positive integer specified in microseconds.

- `-s <num>`, `--size <num>`

  Set the maximum queue size for the device-side virtio queues.

  Numerical value.

  - Must be a power of 2 in the range of 1 to 32768 inclusive.

  Default: `256`

- `-d <cap_name>, --register-ds <cap_name>`

  Register a trusted dataspace capability. If this option is used, it is not possible to communicate with the server via dataspaces other than the registered ones.

  Can be used multiple times.

  This command has the following side effects:

  – A capability with the given name is expected in the capability space of this task.

  String value.

4.5.4 Building and Configuration

The virtual network p2p server can be built using the L4Re build system by placing this project into the `pkg` directory.

4.5.5 Starting the service

The virtual network p2p server can be started with Lua like this:

```
local p2p = L4.default_loader:new_channel();
L4.default_loader:start(
{
  caps = {
    svr = p2p:svr(),
  },
},
"rom/l4vio_net_p2p [<options>]");
```

First an IPC gate (`p2p`) is created which is used between the virtual network p2p server and a client to create new virtual ports. The server-side is assigned to the mandatory `svr` capability of the virtual network p2p server. See the section below on how to create a new virtual port and connect a client to it.

4.5.6 Factory Options

4.5.6.1 Virtual p2p port

Prior to connecting a client to a virtual network p2p server port it has to be created using the following Lua function. It has to be called on the client side of the IPC gate capability whose server side is bound to the virtual network p2p server.
The "key=value" pairs passed to create() can be omitted and their order is not important.
Call: `create(0 [, "ds-max=<max>", "mac=<addr>"])`

- `"ds-max=<max>"`

  Specifies the upper limit of the number of dataspaces the client is allowed to register with the server for virtio DMA.

  Numerical value.

  – Must be in the range of 1 to 80 inclusive.

  Default: `2`

- `"mac=<addr>"`

  Specify the MAC address of the endpoint where `<mac_address>` is of the form xx:xx:xx:xx:xx:xx.

  String value.

  – Must be in the form xx:xx:xx:xx:xx:xx.

If the `create()` call is successful a new capability which references a virtual network p2p server port is returned. A client uses this capability to talk to the virtual network p2p server using the virtio network protocol.

4.5.7 Examples

A couple of examples on how to create ports with different properties are listed below.

```
-- two normal ports with at most 4 data spaces
net0 = p2p:create(0, "ds-max=4")
net1 = p2p:create(0, "ds-max=4")
-- normal port with 4 data spaces and MAC address
net0 = p2p:create(0, "ds-max=4", "mac=11:22:33:44:55:66")
```

4.6 Virtio Net Switch, a virtual network switch

4.6.1 Description

The virtual network switch connects multiple clients with a virtual network connection. It uses Virtio as the transport mechanism. Each virtual switch port implements the host-side of a Virtio network device (virtio-net).

4.6.2 Capabilities

- `dataspace`

  Trusted dataspaces

  Multiple capability names can be provided by the `-d <cap_name>`, `--register-ds <cap_name>` command line parameter.

- `svr`

  Server Capability of application. Endpoint for IPC calls

  Mandatory capability.

4.6.3 Command Line Options

In the example above the virtual network switch is started in its default configuration with a maximum of 5 virtual ports. To customize the configuration the virtual network switch accepts the following command line options:

- `-D <component=level>`, `--debug <component=level>`

  Configure individual debug levels per component. Verbosity increases from `quiet` up to `trace`.

  Can be used multiple times.

  Possible values for component are | `core`, `virtio`, `port`, `request`, `queue`, `packet`.

  Possible values for level are | `quiet`, `warn`, `info`, `debug`, `trace`.

- `-m`, `--mac`

  Ignored. Provided for compatibility with older switch versions.

  Flag. True if provided.

- `-M`, `--no-random-mac`

  Do not assign a random MAC address to ports by default. It is always possible to set an explicit MAC address by passing the `mac=` to the factory call, regardless of this option. If `-M` is passed and no `mac=` address was given, it is the responsibility of the Virtio driver to choose an appropriate address.

  Flag. True if provided.

- `-p <num>`, `--ports <num>`

  Set the maximum number of virtual ports.

  Numerical value.

  Default: `256`

- `-q`, `--quiet`

  Silence all output except for error messages.

  Flag. True if provided.

- `-s <num>`, `--size <num>`

  Set the maximum queue size for the device-side Virtio queues.

  Numerical value.

  – Must be a power of 2 in the range of 1 to 32768 inclusive.

  Default: `256`

- `-v`, `--verbose`

  Increase the global verbosity level. Individual levels per component can be set using the `-D` option.

  Can be used up to 3 times.

  Flag. True if provided.

- `-d <cap_name>`, `--register-ds <cap_name>`

  Register a trusted dataspace capability. If this option gets used, it is not possible to communicate with the server via dataspaces other than the registered ones. Can be used multiple times for multiple dataspaces.

  You need to ensure to add the dataspace capabilities to the named capabilities table with the same access rights as the clients will later register them, e.g.

  ```
  ...
    caps = {
      ...
      <cap_name> = vm_ram:m("rw"),
      ...
    },
  ...
  ```

  Can be used multiple times.

  This command has the following side effects:

  – A capability with the given name is expected in the capability space of this task.

  String value.

The virtual network switch can be setup to feature exactly one monitor port. All traffic passing through the switch is mirrored to the monitor port. The monitor port is read-only, and has no TX capability. An optional packet filter can be configured and implemented to filter data sent to the monitor port.

4.6.4 Configuration

Certain features of the virtual network switch are configurable at compile-time. Configuration is done through the build-time configuration of the L4Re build tree.

4.6.5 Starting the service

The virtual network switch can be started in Ned like this:

```
local switch = L4.default_loader:new_channel();
L4.default_loader:start(
{
  caps = {
    svr = switch:svr(),
  },
},
"rom/l4vio_switch");
```

First a communication channel (`switch`) is created which is used to create virtual network ports. It is connected to the switch component via its mandatory `svr` capability. See the section below on how to create a new virtual port and connect a client to it.

Hardware devices

To plug hardware devices into the switch, provide a Vbus capability with the name `vbus` when starting the switch. To use this feature, you have to enable the `VNS_IXL` config option.

4.6.6 Factory Options

4.6.6.1 Virtual switch port

First, a virtual network port has to be created using the following Ned-Lua function. It has to be called on the communication channel called `switch`, which has been created earlier.
Call: `create(0 [, "ds-max=<max>", "name=<name>", "type=<port type>", "vlan=(access=<vlan id>|trunk=<vlan id>[,<vlan id>]*)", "mac=<addr>"])`

- "ds-max=<max>"

  Specifies the upper limit of the number of dataspaces the client is allowed to register with the virtual network switch for Virtio DMA.

  Numerical value.

  - In the range of 1 to 80 inclusive

- "name=<name>"

  Sets the name of port in debug messages to <name>. A name may consist of at most 19 characters, all other characters are dropped. If there is enough space left, the name will get a postfix of "[<port number>]", e.g. "name=foo" -> foo[1].

  String value.

- "type=<port type>"

  Optionally specify the port type.

  Possible values for <port type> are

  - monitor: Monitor Port
  - none: Normal Port

  Default: none

- "vlan=(access=<vlan id>|trunk=<vlan id>[,<vlan id>]*)"

  Configure the port to participate in an IEEE 802.1Q compatible VLAN. Fundamentally there are two types of ports: access ports and trunk ports.

  The Value for this parameter can be one of the following:

  - "access=<vlan id>"

    Configures the port as access port for VLAN <vlan id> where the id must be a decimal number greater than 0 and less than 4095 in accordance to the standard. Packets on an access port belong to the configured VLAN and are only forwarded to ports that belong to the same VLAN or trunk ports that participate in the particular VLAN. The packets on this port will not have a VLAN tag attached to them so that a guest connected to this port does not see that the port is part of a VLAN.

    An optional monitor port will see packets from an access port as VLAN tagged packets with the <vlan id> given for the port.

    Numerical value.

    * In the range of 0 to 4095 exclusive

  - "trunk=<vlan id>[, <vlan id>]*"

    Configures the port as trunk port. It participates either in all VLANs, if specified by the keyword 'all', or in the list of VLANs given as comma separated list. There must be no whitespace in the list. Each id must be a decimal number greater than 0 and less than 4095 in accordance to the standard. Outgoing packets on this port will be tagged with an IEEE 802.1Q compatible tag. Incoming packets must be tagged with a VLAN tag from the given list. Packets that have no tag or a tag not in the vlan id list are dropped silently. They are not forwarded to the monitor port either. Currently there is no support for IEEE 802.1p. The PCP and DEI sub-fields in the TCI field will be set to zero on outgoing packets and are ignored for incoming packets.

    Numerical value.

- "mac=<addr>"

  Explicitly sets the MAC address of the port. It will be checked that no other port on the switch has the same address. It is the responsibility of the user to ensure the validity of the address and its global uniqueness, though.

  String value.

  - In form xx:xx:xx:xx:xx:xx

If the create() call is successful, a new capability which references a virtual switch port is returned. A client uses this capability to talk to the virtual network switch using the Virtio network protocol.

4.6.6.2 Interface for the switch statistics

The statistics interface is a privileged interface that allows the client to retrieve statistical information about all the virtual network ports of the switch. To create a statistics interface, use the factory interface on the communication channel called `switch`, which has been created earlier.
Call: `create(1)`
If the `create()` call is successful, a new capability which references a statistics interface is returned. A client uses this capability to retrieve statistical information about the switch.

4.6.7 Examples

Here are couple of examples on how to create ports with different properties:

```
-- normal port with at most 4 data spaces
net0 = switch:create(0, "ds-max=4")
-- like the previous but with name foo
net0 = switch:create(0, "ds-max=4", "name=foo")
-- like the previous but the port is a monitor port
net0 = switch:create(0, "ds-max=4", "name=foo", "type=monitor")
-- normal port with 4 data spaces as access port to VLAN 1
net0 = switch:create(0, "ds-max=4", "name=vl1", "vlan=access=1")
-- normal port with 4 data spaces as trunk port participating in VLAN 1 & 2
net0 = switch:create(0, "ds-max=4", "name=vl1", "vlan=trunk=1,2")
```

Here is an example on how to create a statistics interface:

```
-- a statistics interface
stats0 = switch:create(1)
```

4.7 Uvmm, the virtual machine monitor

4.7.1 Description

Uvmm provides a virtual machine for running an unmodified guest in non- privileged mode.

4.7.2 Capabilities

- `ram`

  The memory for the guest provided via a simple dataspace.

- `pfc`

  Uvmm can be instructed to inform a PM manager of PM events through the L4::Platform_control interface. To that end, uvmm may be equipped with a `pfc` cap. On suspend, uvmm will call l4_platform_ctl_system_suspend().

  The `pfc` cap can also be implemented by IO. In that case the guest can start a machine suspend/shutdown/reboot.

4.7.3 Command Line Options

- `--mon <option>`

  Control the handling of guest reads/writes to non-existing memory.

  Possible values for `<option>` are

  - `true`: The monitor interface is enabled but no server implementing the client side of the monitor interface is started. The monitor interface can still be utilized via cons but no readline functionality will be available.
  - `some_binary`: If a string is passed as the value of mon, the monitor interface is enabled and the string is interpreted as the name of a server binary which implements the client side of the monitor interface. This server is automatically started and has access to a vcon capability named mon at startup through which it can make use of the monitor interface. Unless you have written your own server you should specify 'uvmm_cli' which is a server implementing a simple readline interface.
  - `false`: The monitor interface is disabled at runtime.

  Default: `true`

- `-c <guest command line>`, `--cmdline <guest command line>`

  Command line that is passed to the guest on boot.

  String value.

- `-k <kernel image name>`, `--kernel <kernel image name>`

  The name of the guest-kernel image file present in the ROM namespace.

  File path in ROM namespace.

- `-d <DTB overlay>`, `--dtb <DTB overlay>`

  The name of the device tree file present in the ROM namespace. The device tree will be placed in the upmost region of guest memory. Optionally, a user may use an additional parameter in the form of "<DTB overlay>:limit=0xffffffff" to set an upper limit for the device tree location.

  This option can be issued multiple times. uvmm will merge all provided device tree overlays.

  File path in ROM namespace.

- `-r <RAM disk name>`, `--ramdisk <RAM disk name>`

  The name of the RAM disk file present in the ROM namespace

  File path in ROM namespace.

- `-b <Base address of the guest RAM>`, `--rambase <Base address of the guest RAM>`

  Physical start address for the guest RAM. This value is platform specific.

  Numerical value.

- `-D <component=level>`, `--debug <component=level>`

  Control the verbosity level of the uvmm.

  Using the `component` prefix, the verbosity level of each uvmm component is configurable.

  For example, the following command line sets the verbosity of all uvmm components to `info` except for IRQ handling, which is set to `trace`:

  ```
  uvmm -D info -D irq=trace
  ```

  Can be used multiple times.

  Possible values for component are | `core`, `cpu`, `mmio`, `irq`, `dev`, `pm`, `vbus_event`.

  Possible values for level are | `quiet`, `warn`, `info`, `trace`.

  Options `-q, --quiet`, `-v, --verbose` and `-D, --debug` cancel each other out.

- `-f`, `--fault-mode`

  Control the handling of guest reads/writes to non-existing memory.

  Possible values are

  - `ignore`: Invalid writes are ignored. Invalid reads either return 0 or are skipped. The guest may experience undefined behaviour.
  - `halt`: Halt the VM on the first invalid memory access.
  - `inject`: Try to forward the invalid access to the guest. This is not supported on all architectures. Falls back to `halt` if the error could not be forwarded to the guest.

  Default: `ignore`

- `-q`, `--quiet`

  Silence all uvmm output.

  Flag. True if provided.

  Options `-q, --quiet`, `-v, --verbose` and `-D, --debug` cancel each other out.

- `-v`, `--verbose`

  Increase the verbosity of the uvmm. Repeating the option increases the verbosity by another level.

  Can be used multiple times.

  Flag. True if provided.

  Options `-q, --quiet`, `-v, --verbose` and `-D, --debug` cancel each other out.

- `-W`, `--wakeup-on-system-resume`

  When set, the uvmm resumes when the host system resumes after a suspend call.

  Flag. True if provided.

Setting up guest memory

In the most simple setup, memory for the guest can be provided via a simple dataspace. In your ned script, create a new dataspace of the required size and hand it into uvmm as the `ram` capability:

```
local ramds = L4.Env.user_factory:create(L4.Proto.Dataspace, 0x4000000)

L4.default_loader::startv({caps = {ram = ramds:m("rw")}}, "rom/uvmm")
```

The memory will be mapped to the most appropriate place and a memory node added to the device tree, so that the guest can find the memory.
For a more complex setup, the memory can be configured via the device tree. uvmm scans for memory nodes and tries to set up the memory from them. A memory device node should look like this:

```
memory@0 {
  device_type = "memory";
  reg = <0x00000000 0x00100000
         0x00200000 0xffffffff>;
  l4vmm,dscap = "memcap";
  dma-ranges = <>;
};
```

The `device_type` property is mandatory and needs to be set to `memory`.
`l4vmm,dscap` contains the name of the capability containing the dataspace to be used for the RAM. `reg` describe the memory regions to use for the memory. The regions will be filled up to the size of the supplied dataspace. If they are larger, then the remaining area will be cut.
If the optional `dma-ranges` property is given, the host-physical address ranges for the memory regions will be added here. Note that the property is not cleared first, so it should be left empty.
For more details see RAM configuration.

Memory layout

uvmm populates the RAM with the following data:

- kernel binary
- (optional) ramdisk
- (optional) device tree

The kernel binary is put at the predefined address. For ELF binaries, this is an absolute physical address. If the binary supports relative addressing, the binary is put to the requested offset relative to beginning of the first 'memory' region defined in the device tree.
The ramdisk and device tree are placed as far as possible to the end of the regions defined in the first 'memory' node.
If there is a part of RAM that must remain empty, then define an extra memory node for it in the device tree. uvmm only writes to memory in the first memory node it finds.
Warning: uvmm does not touch any unpopulated memory. In particular, it does not ensure that the memory is cleared. It is the responsibility of the provider of the RAM dataspace to make sure that no data leakage can happen. Normally this is not an issue because dataspaces are guaranteed to be cleaned when they are newly created but users should be careful when reusing memory or dataspaces, for example, when restarting the uvmm.

Forwarding hardware resources to the guest

Hardware resources must be specified in two places: the device tree contains the description of all hardware devices the guest could see and the Vbus describes which resources are actually available to the uvmm.
The vbus allows the uvmm access to hardware resources in the same way as any other L4 application. uvmm expects a capability named 'vbus' where it can access its hardware resources. It is possible to leave out the capability for purely virtual guests (Note that this is not actually practical on some architectures. On ARM, for example, the guest needs hardware access to the interrupt controller. Without a 'vbus' capability, interrupts will not work.) For information on how to configure a vbus, see the IO documentation.
The device tree needs to contain the hardware description the guest should see. For hardware devices this usually means to use a device tree that would also be used when running the guest directly on hardware.
On startup, uvmm scans the device tree for any devices that require memory or interrupt resources and compares the required resources with the ones available from its vbus. When all resources are available, it sets up the appropriate forwarding, so that the guest now has direct access to the hardware. If the resources are not available, the device will be marked as 'disabled'. This mechanism allows to work with a standard device tree for all guests in the system while handling the actual resource allocation in a flexible manner via the vbus configuration.
The default mechanism assigns all resources 1:1, i.e. with the same memory address and interrupt number as on hardware. It is also possible to map a hardware device to a different location. In this case, the assignment between vbus device and device tree device must be known in advance and marked in the device tree using the `l4vmm,vbus-dev` property.
The following device will for example be bound with the vbus device with the HID 'l4-test,dev':

```
test@e0000000 {
  compatible = "memdev,bar";
  reg = <0 0xe0000000 0 0x50000>,
        <0 0xe1000000 0 0x50000>;
  l4vmm,vbus-dev = "l4-test,dev";
  interrupts-extended = <&gic 0 139 4>;
};
```

Resources are then matched by name. Memory resources in the vbus must be named `reg0` to `reg9` to match against the address ranges in the device tree `reg` property. Interrupts must be called `irq0` to `irq9` and will be matched against `interrupts` or `interrupts-extended` entries in the device tree. The vbus must expose resources for all resources defined in the device tree entry or the initialisation will fail.
An appropriate IO entry for the above device would thus be:

```
MEM = Io.Hw.Device(function()
  Property.hid = "l4-test,dev"
  Resource.reg0 = Io.Res.mmio(0x41000000, 0x4104ffff)
  Resource.reg1 = Io.Res.mmio(0x42000000, 0x4204ffff)
  Resource.irq0 = Io.Res.irq(134);
end)
```

Please note that HIDs on the vbus are not necessarily unique. If multiple devices with the HID given in `l4vmm,vbus-dev` are available on the vbus, then one device is chosen at random.
If no vbus device with the given HID is available, the device is disabled.

How to enable guest suspend/resume

Note

Currently only supported on ARM. It should work fine with Linux version 4.4 or newer.

Uvmm (partially) implements the power state coordination interface (PSCI), which is the standard ARM power management interface. To make use of this interface, you have to announce its availability to the guest operating system via the device tree like so:

```
psci {
  compatible = "arm,psci-0.2";
  method = "hvc";
};
```

The Linux guest must be configured with at least these options:

```
CONFIG_SUSPEND=y
CONFIG_ARM_PSCI=y
```

How to communicate power management (PM) events

Uvmm can be instructed to inform a PM manager of PM events through the L4::Platform_control interface. To that end, uvmm may be equipped with a `pfc` cap. On suspend, uvmm will call l4_platform_ctl_system_suspend().
The `pfc` cap can also be implemented by IO. In that case the guest can start a machine suspend/shutdown/reboot.

Ram block device support

The example ramdisk works by loading a file system into RAM, which needs RAM block device support to work. In the Linux kernel configuration add: CONFIG_BLK_DEV_RAM=y

Framebuffer support for uvmm/amd64 guests

Uvmm can be instructed to pass along a framebuffer to the Linux guest. To enable this three things need to be done:

1. Configure Linux to support a simple framebuffer by enabling
   ```
   CONFIG_FB_SIMPLE=y
   CONFIG_X86_SYSFB=y
   ```
2. Configure a simple framebuffer device in the device tree (currently only read by uvmm, linearer framebuffer at [0xf0000000 - 0xf1000000])
   ```
   simplefb {
     compatible = "simple-framebuffer";
     reg = <0x0 0xf0000000 0x0 0x1000000>;
     l4vmm,fbcap = "fb";
   };
   ```
3. Start a framebuffer instance and connect it to uvmm e.g.
   ```
   -- Start fb-drv (but only if we need to)
   local fbdrv_fb = L4.Env.vesa;
   if (not fbdrv_fb) then
     fbdrv_fb = l:new_channel();
     l:start({
               caps = {
                 vbus = io_busses.fbdrv,
                 fb   = fbdrv_fb:svr(),
               },
               log = { "fbdrv", "r" },
             },
             "rom/fb-drv");
   end
   vmm.start_vm{
     ext_caps = { fb = fbdrv_fb },
   -- ...
   ```

Requirements on the Fiasco.OC configuration on amd64

The kernel configuration must feature `CONFIG_SYNC_TSC=y` in order for the emulated timers to reach a sufficiently high resolution.

Recommended Linux configuration options for uvmm/amd64 guests

The following options are recommended in additon to the amd64 defaults provided by a `make defconfig`:
Virtio support is required to access virtual devices provided by uvmm:

```
CONFIG_VIRTIO=y
CONFIG_VIRTIO_PCI=y
CONFIG_VIRTIO_BLK=y
CONFIG_BLK_MQ_VIRTIO=y
CONFIG_VIRTIO_CONSOLE=y
CONFIG_VIRTIO_INPUT=y
CONFIG_VIRTIO_NET=y
```

It is highly recommended to use the X2APIC, which needs virtualization awareness to work under uvmm:

```
CONFIG_X86_X2APIC=y
CONFIG_PARAVIRT=y
CONFIG_PARAVIRT_SPINLOCKS=y
```

KVM clock for uvmm/amd64 guests

When executing L4Re + uvmm on QEMU, the PIT as clock source is not reliable. The paravirtualized KVM clock provides the guest with a stable clock source.
A KVM clock device is available to the guest, if the device tree contains the corresponding entry:

```
kvm_clock {
  compatible = "kvm-clock";
  reg = <0x0 0x0 0x0 0x0>;
};
```

To make use of this clock, the Linux guest must be built with the following configuration options:

```
CONFIG_HYPERVISOR_GUEST=y
CONFIG_KVM_GUEST=y
CONFIG_PTP_1588_CLOCK_KVM is not set
```

Note

KVM calls besides the KVM clock are unhandled and lead to failure in the uvmm, e.g. vmcall 0x9 for the PTP_1588_CLOCK_KVM.

This is considered a development feature. The KVM clock is not required when running on physical hardware as TSC calibration via the PIT works as expected.

Development notes for amd64

When you are developing on Linux using QEMU please note that nested virtualization support is necessary on your host system to run uvmm guests. Your host Linux version should be 4.12 or greater, **excluding 4.20**.
Check if your KVM module has nested virtualization enabled via:

```
cat /sys/module/kvm_intel/parameters/nested
Y
```

In case it shows `N` instead of `Y` enable nested virtualization support via:

```
modprobe kvm_intel nested=1
```

On AMD platforms the module name is `kvm_amd`.

QEMU network setup for a uvmm guest on amd64

```
qemu-system-x86_64 -M q35 -cpu host -enable-kvm  -device intel-iommu
                   -device e1000e,netdev=net0 -netdev bridge,id=net0,br=virbr0
```

where 'virbr0' is the name of the host's bridge device. The line 'allow virbr0' needs to be present in `/etc/qemu/bridge.conf`. The bridge can either be created via the network manager or via the command line:

```
brctl addbr virbr0
ip addr add 192.168.124.1/24 dev virbr0
ip link set up dev virbr0
```

In the guest linux with eth0 as network device:

```
ip a a 192.168.124.5/24 dev eth0
ip li se up dev eth0
```

Now the host and guest can ping each other using their respective IPs.
Of course, uvmm needs to be connected to Io and Io needs a vbus configuration for the uvmm client like this:

```
Io.add_vbusses
{
  vm_pci = Io.Vi.System_bus(function ()
    Property.num_msis = 6
    PCI = Io.Vi.PCI_bus(function ()
      pci_net = wrap(Io.system_bus():match("PCI/CC_0200"))
    end)
  end)
}
```

QEMU emulated VirtIO devices and IO-MMU on amd64

QEMU does not route VirtIO devices through the IO-MMU per default. To use QEMU emulated VirtIO devices add the `disable-legacy=on,disable- modern=off,iommu_platform=on` flags to the option list of the device. The e1000e card in the network example above can be replaced with an virtio-net-pci card like this:

```
-device virtio-net-pci,disable-legacy=on,disable-modern=off,
        iommu_platform=on,netdev=net0
```

For more information on VirtIO devices and their options see https://wiki.qemu.org/Features/VT-d.

Using the uvmm monitor interface

Uvmm implements an interface with which parts of the guest's state can be queried and manipulated at runtime. This monitor interface needs to be enabled during compilation as well as during startup of uvmm. This is described in detail below.

Compiling uvmm with monitor interface support

To compile uvmm with monitor interface support pass the `CONFIG_MONITOR=y`, option during the `make` step (or set in in the Makefile.config). This option is available on all architectures but note that the set of available monitor interface features may vary significantly between them. Also note that the monitor interface will always be disabled in release mode, i.e. if `CONFIG_RELEASE_MODE=y`.

Enabling the monitor interface at runtime

When starting a uvmm instance from inside a `ned` script using the `vmm.start_vm` function, the `mon` argument controls whether the monitor interface is enabled at runtime. There are three cases to distinguish:

- `mon=true` (default): The monitor interface is enabled but no server implementing the client side of the monitor interface is started. The monitor interface can still be utilized via `cons` but no readline functionality will be available.
- `mon='some_binary'`: If a string is passed as the value of `mon`, the monitor interface is enabled and the string is interpreted as the name of a server binary which implements the client side of the monitor interface. This server is automatically started and has access to a vcon capability named `mon` at startup through which it can make use of the monitor interface. Unless you have written your own server you should specify `'uvmm_cli'` which is a server implementing a simple readline interface.
- `mon=false`: The monitor interface is disabled at runtime.

Using the monitor interface

If the monitor interface was enabled you can connect to it via `cons` under the name `mon<n>` where `<n>` is a unique integer for every uvmm instance that is started with the monitor interface enabled (numbered starting from one in order of corresponding `vmm.start_vm` calls). If `mon='uvmm_cli'` was specified, readline functionality such as command completion and history will be available. Enter a command followed by enter to run that command. To obtain a list of all available commands issue the `help` command, to obtain usage information for a specific command `foo` issue `help foo`.

Note

Some commands will modify the guests state. Since it should be obvious to which ones this applies this is usually not specifically highlighted. Exercise reasonable caution.

Using the guest debugger

The guest debugger provides monitoring functionality akin to a very bare-bone GDB interface, e.g. guest RAM and page table dumping, breakpointing and single stepping. Additional functionality might be added in the future.

Note

The guest debugger is currently still under development. The guest debugger may also not be available on all architectures. To check whether the guest debugger is available check if `help dbg` returns usage information.

If the guest debugger is available, you have to manually load it at runtime using the monitor interface. This saves resources if the guest debugger is not used. To enable the guest debugger, issue the `dbg on` monitor command. Once enabled, the guest debugger can not be disabled again.
To list available guest debugger subcommands, issue `dbg help` after `dbg on`.

Note

When using SMP, most guest debugger subcommands require you to explicitly specify a guest vcpu using an index starting from zero.

4.7.4 RAM configuration

RAM configuration for uvmm

DMA setup

If the vBus contains DMA capable devices, uvmm maps the guest RAM into a DMA address space so that those devices can access it. The shape of that DMA address space depends on whether the platform provides an IO-↩ MMU:

- with an IO-MMU, the DMA address space is independent of host-physical addresses;
- without an IO-MMU, DMA addresses are the host-physical addresses of the backing dataspace.

If the vBus has no DMA capable devices, no DMA mapping is performed and RAM is placed at the guest-physical address requested by the configuration.
Other components in the system may reserve DMA address ranges. RAM placement within the configured range therefore searches for free DMA addresses and may shift inside the configured range or be split into multiple chunks.

Congruent vs. incongruent placement

Per memory region, uvmm chooses one of two placement modes:

- **Congruent** (default, no `dma-ranges` property): the guest-physical address equals the DMA address. The actual placement is the DMA address found by searching the configured range. On a system without IO-MMU, this is the host-physical address of the backing dataspace, so the guest sees its RAM at its host-physical address.
- **Incongruent** (`dma-ranges` property present): the guest-physical address is honoured as configured, but the corresponding DMA addresses may differ. uvmm fills the `dma-ranges` property with the resulting (DMA address, guest address, size) triplets. Use of this property **requires** modification of guest code so that DMA-capable devices are programmed with the correct DMA addresses.

Without a memory node in the device tree

uvmm uses the dataspace bound to the `ram` capability with congruent placement. The base address defaults to 0x0 or the value of the `-b` command-line option. If a DMA address space is in use, the actual base address may be shifted upwards to the first free DMA address at or above the requested base. On a system without IO-MMU this is the host-physical address of the backing dataspace.
If a device tree is loaded, uvmm adds a synthesized `memory@<addr>` node with the resulting `reg` value. No `dma-ranges` property is added.

With a memory node in the device tree

The memory node needs at least the properties device_type, l4vmm,dscap and reg:

```
memory@0 {
  device_type = "memory";
  l4vmm,dscap = "ram";
  reg = < ... >;
}
```

A memory node without a `reg` property is invalid and uvmm refuses to boot. The given l4vmm,dscap name must be accessible in the capability namespace of the uvmm. If the capability is invalid, the memory node is disabled.
The `reg` property describes the allowable guest-physical placement range(s) for the dataspace. It is mandatory for explicit memory nodes. uvmm fills the listed `reg` ranges in order with chunks of the dataspace, potentially using multiple chunks per `reg` entry if DMA address space reservations require it. A `reg` entry with `size == 0` means "use the remaining dataspace size". After setup, uvmm rewrites the `reg` property to reflect the actual placement(s) used.
If the listed `reg` ranges cannot accommodate the full dataspace, uvmm emits a warning and stops mapping; the guest sees only the portion that fitted.
The optional `dma-ranges` property, if present, switches the memory node to incongruent placement (see above). uvmm fills it with the resulting DMA mappings.
If memory nodes are given, but none provides valid RAM, the configuration is invalid and uvmm refuses to boot.

4.8 RTC driver

The RTC driver can drive various real-time clocks and provides an interface for other components, e.g., uvmm, to read and write the time.
It needs access to the hardware, depending on the clock, either via a vbus or via an I2C device.

Command Line Options

There are no command line options.

Environment

Several capabilities can be used to interact with the environment:

- 'rtc' (server)

  The capability with which clients talk to the service. Note that writing to the RTC is only possible when having the rtc capability with write rights, read-only clients must have the capability with read rights only.

- 'vbus'

  The vbus used to access hardware for port-based clock on X86 and pl031 on arm.

  The vbus is also needed for receiving the inhibitor signal from IO.

- 'ds3231' (optional)

  The capability that provides access to an I2C DS3231 device. The capability needs to be created with type 1 (i2c-device).

- 'pcf85063a' (optional)

  The capability that provides access to an I2C PCF85063A device. The capability needs to be created with type 1 (i2c-device).

4.9 Mag, the GUI Multiplexer

4.9.1 Description

Mag is the default multiplexer for graphics hardware. Mag is a Nitpicker derivate that allows secure multiplexing of the graphics and input hardware among multiple applications and multiple complete windowing environments. It is not, and does not attempt to be, a fully-fledged window manager.

4.9.2 Capabilities

None.

4.9.3 Command Line Options

The following command line options are supported:
`<$FILE.lua | libmag-$LIBNAME.so>`
As Mag's only command line option it supports loading additional plugins via the application's command line.
Can be used multiple times.
File path in ROM namespace.

- Plugins must be either a Lua file or a shared library. Shared libraries must be named libmag-$LIBNAME.so.

4.9.4 Session Factory

As a simple nitpicker clone Mag supports the so-called Xray mode. This mode displays all session labels and draws a colored frame around them. The session that currently has the input focus is highlighted. The Xray mode is activated via the special keys Scroll or NEXTSONG.
Call: `create(0 [, "label|l=<LABEL>", "col=(string|hex)"])`

- "label|l=<LABEL>"

  Set the session's text label to LABEL.

  String value.

  - The label is restricted to a length of 256 characters.

- "col=(string|hex)"

  Set the session's color which is used in Xray mode to tint the session's screen area and the border drawn around it. The argument can be either one of the following letters or a hexadecimal representation of the RGB values.

  The Value for this parameter can be one of the following:

  - string
    Define the color by the given character
    Possible values are
    * r, R: Red color
    * g, G: Green color
    * b, B: Blue color
    * w, W: White color
    * y, Y: Yellow color
    * v, V: Magenta color
  - hex
    Define the color by its RGB values in hexadecimal representation.
    Hexadecimal number without '0x' prefix.

4.9.5 Mag Client Session

A client with a mag client session gets access to the whole screen. The client has to allocate and manage it's own buffers and has to position them on the screen on its own.
Call: create(L4.Proto.Goos [, "default-background|dfl-bg"])

- "default-background|dfl-bg"

  Marks this session as the default background.

  Flag. True if provided.

4.9.6 Mag Client Framebuffer Session

For a client framebuffer session mag allocates a view of the requested size and displays it at the requested coordinates on the screen.
Call: create(L4.Proto.Goos [, "geometry|g=<GEOMETRY>", "focus", "shaded", "fixed", "barheight=<X>"])

- "geometry|g=<GEOMETRY>"

  Set the session's geometry and position on the screen. GEOMETRY is provided in an X11-style format: WIDTHxHEIGHT+X_OFFSET+Y_OFFSET.

  String value.

- "focus"

  Set the focus to this session.

  Flag. True if provided.

- "shaded"

  The window is collapsed and only the title bar is visible. The window can be expanded by clicking into the title bar with the middle mouse button. Collapsing and expanding works also independently of this option.

  Flag. True if provided.

- `"fixed"`

  The window cannot be moved on the screen.

  Flag. True if provided.

- `"barheight=<X>"`

  Set the height of the title bar in pixels.

  Numerical value.

4.9.7 Examples

Creating a session

```
-- set label to "Linux" and use a light blue color
fb = mag_client:create(L4.Proto.Goos, "l=Linux", "col=98d9ff");
```

Requesting a framebuffer via a client framebuffer session

```
-- create a window of 640x480 pixels at position (100,100) on the screen.
fb = mag_fb:create(L4.Proto.Goos, "g=640x480+100+100");
```

4.10 Cons, the Console Multiplexer

`cons` is an interactive multiplexer for console input and output. It buffers the output from different L4 clients and allows to switch between them to redirect input.

Multiplexers and Frontends

cons is able to connect multiple clients to multiple console I/O servers. All clients are connected to all configured multiplexers
Multiplexers and frontends come in pairs where the actual I/O is handled by the frontend. From the point-of-view of cons, a frontend consists of an IPC channel to a server that speaks an appropriate server protocol. By default the L4.Env.log capability is used. Only frontends that speak the L4::Vcon protocol are supported.
A multiplexer handles and routes the I/O of each client to and from its respective frontend.
Each client's console settings (e.g. color, visibility) apply to all multiplexers and cannot be changed individually. A user can connect to all clients through all multiplexers. It is not possible to assign individual clients to distinct multiplexers.

Client sessions

For clients cons implements the L4::Vcon and the Virtio console interface. A client session can be requested through a `create` call to cons' factory. cons binds its factory capability to the `cons` capability. See the example below on how this can be set up.

Starting the service

The cons server can be started with Lua like this:

```
local log_server = L4.default_loader:new_channel()
L4.default_loader:start({
  caps = {
    cons = log_server:svr(),
  },
  log = L4.Env.log,
},
"rom/cons")
```

First an IPC gate (`log_server`) is created which is used between the cons server and a client to request a new session. The server side is assigned to the mandatory `cons` capability of cons. This example explicitly assigns the kernel's log capability (`L4.Env.log`) to cons' `log` capability in order to allow cons to provide input and output for its clients. The default log factory (usually provided by `moe`) doesn't provide input capabilities.

Command Line Options

cons accepts the following command line switches:

- `-a`, `--show-all`

  Initially show output from all clients.

- `-B <size>`, `--defaultbufsize <size>`

  Default buffer size per client in bytes. Default: 40960

- `-c <client>`, `--autoconnect <client>`

  Automatically connect to the client with the given name. That means that output of this client will be visible and input will be routed to it.

- `-f <cap>`, `--frontend <cap>`

  Set the frontend for the current multiplexer. Output for the multiplexer is then sent to the capability with the given name `<cap>`. The server connected to the capability needs to understand the L4::Vcon protocol.

- `-V <cap>`, `--virtio-device-frontend <cap>`

  Set a virtio-console frontend for the current multiplexer. This behaves identical to the `--frontend` option except that this frontend implements a virtio-console device that –for example– can be connected to a virtio proxy in uvmm.

  Example lua:

```
-- use 'cons_svr' to create client sessions
local cons_svr = loader:new_channel()
-- connect 'virtio_device' with a virtio driver (e.g. Uvmm)
local virtio_device = loader:new_channel()
loader:start(
  {
    caps = {
      virtio = virtio_device,
      cons = cons_svr:svr(),
    },
   log = {"cons", "blue"},
  }, "cons -m guests -V virtio")
```

- `-k`, `--keep`

  Keep the console buffer when a client disconnects.

- `-l`, `--no-line-buffering`

  By default, merge the client output to entire lines. If the client writes characters without a final newline, the following client output is merged with the current line content. Specifying this switch disables the line buffered mode by default.

- `--line-buffering-ms <timeout>`

  Timeout in milliseconds before buffered client output is written even without a newline. Default value is 50.

- `-m <prompt name>`, `--mux <prompt name>`

  Add a new multiplexer named `<prompt name>`. This is necessary if output should be sent to different frontends. This option must be used in conjunction with the `-f` frontend option

- `-n`, `--defaultname`

  Default name for the multiplexer prompt. Default: `cons`.

- `-t`, `--timestamp`

  Prefix the output with timestamps.

Connecting a client

```
create(backend_type, ["client_name"], ["color"], ["option"] [,"option"] ...)
```

- `backend_type`

  The type of backend that should be created for the client. The type is a positive integer and currently the following types are supported:

  - `L4.Proto.Log`: L4::Vcon client
  - `1`: Virtio console client

cons accepts the following per-client options:

- `bufsz=n`

  Use a buffer of `n` bytes for this client, deviating from the default buffer size.

- `keep` / `no-keep`

  The console buffer is kept / thrown away when the client disconnects.

- `key=<key>`

  Assign `<key>` as keyboard shortcut to this client.

- `line-buffering` / `no-linux-buffering`

  Line buffering is enabled / disabled for this client.

- `show` / `hide`

  Output from this client is initially shown / hidden.

- `timestamp` / `no-timestamp`

  Do / do not prefix the output of this client with timestamps.

Chapter 5

uvmm_dtg The device tree generator for Uvmm

5.1 Description

A virtual machine in Uvmm is configured with a device tree that contains information about the VMs resources, memory layout, virtual CPUs and peripheral devices.
Uvmm_dtg is a tool to generate such a device tree at runtime according to its command line.

5.2 Capabilities

- `dt`

  The dataspace that the device tree is put into.

5.3 Command Line Options

`<file | -->`
`--` prints to stdout. On L4Re, the string given as `<file>` is interpreted as a named capability which needs to be backed by a sufficiently large Dataspace. On Linux, a file with the given name is created. In both cases, uvmm_dtg will output into the named file.
String value.

- `-h`, `--help`

  Show help.

  Flag. True if provided.

- `--arch <target architecture>`

  Select the target architecture.

  Possible values for `<target architecture>` are `x86`, `x86_64`, `arm32`, `arm64`, `mips32`, `mips64`

- `--format <format>`

  Select the output format.

  Possible values for `<format>` are

  - `txt`: The device tree will be printed as plain text (`dts`).
  - `bin`: The device tree will be output as binary (`dtb`).

- `--mem-base <membase>`

  Configure the start of the memory distribution. `membase` can be defined in both decimal and hex notations. uvmm_dtg rounds the given base up to the platforms page size.

  This value can be overridden by memory devices with fixed addresses.

  Numerical value.

- `--device <devicename:[Option1,Option2=value,Option3=value,...]>`

  This configures a device.

  To get a list of supported devices, use `--device help`.

  To get help for a specific device, use `--device devicename:help`.

  String value.

5.4 Examples

Usage in L4Re

Example lua script for Ned:

```
-- Create DS holding device tree
local dt = L4.Env.user_factory:create(L4.Proto.Dataspace, 4 * 1024):m("rw");

-- Start the generator
L4.default_loader:start(
{
  caps = { dt = dt },
}, "rom/uvmm_dtg dt"):wait();

-- Start uvmm
vmm.start_vm
{
  ...
  ext_caps = { dt = dt },
  fdt = "dt",
  ...
}
```

Please notice the `:wait()` when starting `uvmm_dtg`. This makes Ned pause until uvmm_dtg has exited and put the device tree into the dataspace such that Uvmm can commence.

Chapter 6

Bootstrap, the L4 kernel bootstrapper

Bootstrap Command Line Options

`bootstrap` and the kernel can be configured through command line switches. `bootstrap` is responsible for parsing both command lines: `bootstrap` options are the ones directly given to bootstrap, whereas kernel options are those directly given to the kernel, respectively.
When using Multiboot boot, the first module directly after bootstrap is considered the kernel: An example using GRUB2 might look like this:

```
multiboot /path/to/bootstrap bootstrap -bs-boolean-opt -bs-opt-with-argument=foo
module /path/to/fiasco fiasco -kernel-opt-with-argument=bar -kernel-boolean-opt
```

Note

The exact way to provide the command line to `bootstrap` is platform-dependent. On platforms supporting booting via Multiboot Specification the command line can be specified in the boot configuration (currently x86/amd64 only, e.g. using GRUB) whereas other platforms need the command line to be compiled into the `bootstrap` binary.

Platforms utilising flattened device trees usually also allow specifying a command line through the DT. This mechanism is **not** currently supported in `bootstrap`!

Note

`bootstrap` will ignore options it does not understand. For most cases, this also holds true if an option's arguments cannot be understood.

`bootstrap` options

Command line options directly understood by `bootstrap` itself are as follows (passed via `bootstrap` command line):

- `-comirq=<irqno>` (x86/amd64 only)

  If serial logging is enabled (default on), `<irqno>` defines which IRQ to use for serial port communication. This option is ignored if `-noserial` is also specified (see below).

- `-comport=<portspec>` (x86/amd64 only)

  If serial logging is enabled (default on), `<portspec>` defines which serial port to use, being one of:

  - `<number>`
    Use legacy port `<number>`, e.g. use `-comport=1` for the port commonly known as *COM1*, or
  - `pci:<card>:<port>`
    Use serial port number `<port>` at PCI card number `<card>`, e.g. use `-comport=pci:0:1` for the second port on the first PCI card.
  - `pci:probe`
    Use this to have `bootstrap` autodiscover all PCI serial lines. On each discovered line a message will be displayed, telling the correct `<portspec>` to be given to use the respective line.

Note

`bootstrap` does not support specifying the serial port's baudrate and always uses 115200 bps.

- `-noserial`

  Disable serial logging.

- `-wait`

  Wait for key press at early startup.

  Note

  This is not to be confused with the kernel's `-wait` option, see below.

- `-maxmem=<mbytes>`

  Limit the available memory to at most `<mbytes>` MiB.

- `-mem=<size>@<offset>`

  Add a region of memory of `<size>` at `<offset>` to the system's memory map. Both `<size>` and `<offset>` may be suffixed by either `G`, `M`, or `K` to denote GiB, MiB, or KiB, respectively.

  This option may be specified multiple times. If the option is not given, a platform-specific method for determining the memory layout will be used, if available.

- `-sysalloc=<size>@<offset>`

  Designate a region of memory of `<size>` at `<offset>` for loading the modules. Both `<size>` and `<offset>` may be suffixed by either `G`, `M`, or `K` to denote GiB, MiB, or KiB, respectively.

  This option may be specified multiple times. If the option is not given, all system memory regions are used. If this option is given at least once and there are no intersections with any system memory region, `bootstrap` panics.

- `-presetmem=<intval>`

  Initialise memory regions with `<intval>` before starting the kernel.

- `-modaddr=<paddr>`

  Relocate modules to the physical address `<paddr>`. Use this when utilising a version of GRUB that lacks support for the `modaddr` command.

Kernel Options

Command line options for the kernel (passed on kernel command line, i.e. to first module) `bootstrap` understands are as follows.

Note

Availability of individual options might depend on used platform and/or actual kernel configuration.

- `-wait`

  Enter debugger directly after startup, prior to executing any task.

- `-serial_esc`

  Enable entering the debugger over serial line by pressing `Esc`. This option also activates `-serial_input`.

- `-serial_input`

  Allow the kernel to read from the serial line either triggered by the UART receive interrupt or (if that is not possible) by polling the UART receive register from the kernel timer interrupt handler. This is required for Vlog clients to receive input.

- `-noserial`

  Disable serial logging.

Note

If this is given as kernel command line argument, it does not affect `bootstrap` but only the kernel.

- `-noscreen`

  Disable VGA console.

- `-esc`

  Enable entering the debugger by pressing `Esc` on attached keyboard.

- `-nojdb`

  Disable the kernel debugger.

- `-nohlt`

  Enable quirk for broken HLT instruction.

- `-apic`

  Use Advanced Programmable Interrupt Controller (APIC) if available and known to be well-behaving.

- `-oneshot-timer`

  Use the timer in one-shot mode instead of periodic mode. This can reduce the number of timer interrupts and thus improve performance of user-land applications. Selecting the mode via parameter requires the kernel option CONFIG_PARAM_ONE_SHOT=y.

- `-perf_profile=<profile number>` (x86/amd64 only)

  Define the desired CPU performance profile selected by the kernel. The following profiles are supported:

  - `0` - *low power*
    Prefer low power consumption over performance.
  - `1` - *distributed*
    Prefer evenly distributed power consumption and performance over all cores and limit the maximum single core turbo frequency.
  - `2` - *maximum single core*
    Maximum single core performance.

  If this command line option is not passed, the kernel uses the CPU performance profile according to the "Default CPU performance profile" kernel option, which in turn defaults to the *distributed* performance profile.

- `-loadcnt`

  Use load counter for performance counting.

- `-watchdog`

  Enable watchdog timer.

- `-irq0`

  Allow IRQ 0 to be used by userland. This enables some sanity checks to ensure IRQ 0 is not used by the kernel, e.g. for profiling or scheduling purposes. This only has an effect on x86.

- `-nosfn`

  Disable SFN (special fully nested) mode of interrupt controller. This only has an effect on x86 with PIC8259 interrupt controller.

- `-jdb_never_stop`

  Prevent system from stopping to enter JDB. This only has an effect on x86.

- `-kmemsize=<KB>`

  Reserve `<KB>` KiB of memory for the kernel.

- -kmemarea=<size>@<offset>

  Reserve a region of memory of <size> at <offset> to be used as kernel memory. Both <size> and <offset> may be suffixed by either G, M, or K to denote GiB, MiB, or KiB, respectively. The kernel allocates memory for internal use from this pool. The amount of kernel memory is either defined by -kmemsize= or by the kernel itself.

  This option may be specified multiple times. If the option is not given, there are no address constraints for kernel memory.

- -tbuf_entries=<number>

  Specify the <number> of trace buffer entries.

- -out_buf=<length>

  Specify length of console buffer to be <length> bytes.

- -jdb_cmd=<ctrlseq>

  Execute JDB command sequence <ctrlseq> right after start-up. If -wait is also given, <ctrlseq> is executed right before entering JDB.

Module options

Bootstrap supports module attributes for sigma0 and the roottask. They need to be specified in modules.list, e.g.:

```
sigma0[attr:nodes=4-7] ...
```

Attributes are not supported when using multi-boot on platforms that support it. The following attributes are supported:

- nodes

  This is a colon separated list of AMP node ranges. A range can also be a single number. Examples:

  - nodes=1 – Only node 1
  - nodes=1-3 – Nodes 1 to 3 (inclusive)
  - nodes=0:2-3 – Nodes 0, 2 and 3

  If not present, the sigma0/roottask module is applicable to all AMP nodes.

- reloc

  Normally the sigma0 or roottask images are loaded at the preferred load address if the RAM is available at the desired location. If this is not possible, they will be reloacted to some free RAM region. Setting the "reloc" module attribute to a non-empty string will always request the dynamic relocation.

  This attribute can be used on no-MMU systems to maximize the size of contiguous free RAM regions.

Chapter 7

Deprecated List

Global L4::Rcv_endpoint::bind_thread (Ipc::Cap< Thread > t, l4_umword_t label)

Use bind_snd_destination() instead.

Global L4_CAP_SIZE

Superseded by L4_CAP_OFFSET.

Global l4_fpage_size (l4_fpage_t f) L4_NOTHROW

Use l4_fpage_order() instead.

Global l4_kip_clock_lw (l4_kernel_info_t const *kip) L4_NOTHROW

Use l4_kip_clock() instead.

Global L4Re::Dma_space::Direction

Ignored by the API. Use function overloads without the direction parameter instead.

Global L4Re::Dma_space::map (L4::Ipc::Cap< L4Re::Dataspace > src, L4Re::Dataspace::Offset offset, l4_size_t *size, Attributes attrs, Direction dir, Dma_addr *dma_addr)

Use the other overload without `dir` parameter.

Global L4Re::Dma_space::unmap (Dma_addr dma_addr, Dma_size size, Attributes attrs, Direction dir)

Use the overload without `attrs` and `dir` because they are ignored.

Global L4Re::Util::Registry_server< LOOP_HOOKS >::Registry_server (l4_utcb_t *, L4::Cap< L4::Thread > server, L4::Cap< L4::Factory > factory)

Note that this variant of the constructor is deprecated, please do not supply the UTCB pointer, it's not used.

Global l4util_kip_for_each_feature (s)

Use l4_kip_for_each_feature().

Global l4util_kip_kernel_has_feature (l4_kernel_info_t const *k, char const *str)

Use l4_kip_kernel_has_feature().

Global l4util_micros2l4to (l4_uint64_t us) L4_NOTHROW

Use l4_timeout_from_us().

Global start_virtio_switch (ports, prio, cpus, switch_type, ext_caps)

This function exists for backwards compatiblity reasons and calls start_virtio_switch_tbl with an appropriate `options` table

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Chapter 12

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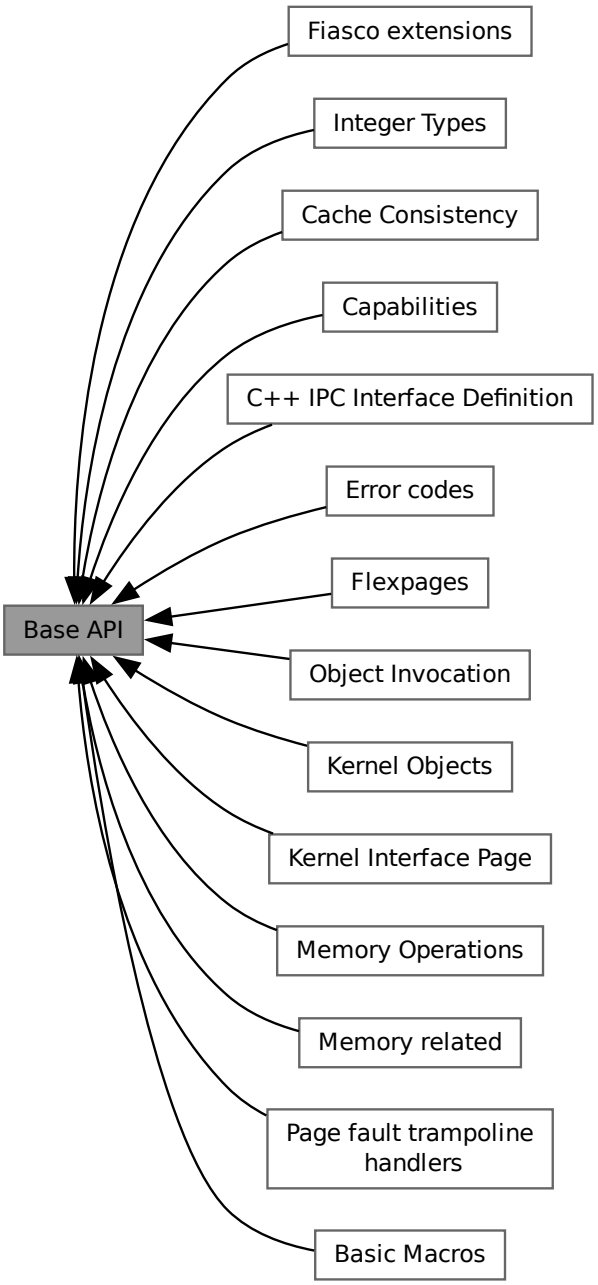
Chapter 13

Topic Documentation

13.1 Base API

Interfaces for all kinds of base functionality.

Collaboration diagram for Base API:



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- file compiler.h
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- file icu
  Interrupt controller.
- file icu.h

Interrupt controller.

- file ipc.h

  Common IPC interface.
- file irq.h

  C Irq interface.
- file kip
- file kip.h

  Kernel Info Page access functions.
- file memdesc.h

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- file semaphore.h

  C semaphore interface.
- file types.h

  Common L4 ABI Data Types.
- file consts.h

  Common L4 constants, arm version.
- file consts.h

  Common L4 constants, arm version.
- file consts.h

  Common L4 constants, AMD64 version.
- file consts.h

  Common L4 constants, x86 version.
- file ipc.h

  L4 IPC System Calls, x86.
- file consts.h

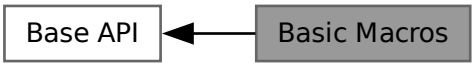
  Common L4 constants, RISC-V version.

13.1.1 Detailed Description

Interfaces for all kinds of base functionality.
Some notes on Inter Process Communication (IPC)
IPC in L4 is always synchronous and unbuffered: a message is transferred from the sender to the recipient if and only if the recipient has invoked a corresponding IPC operation. The sender blocks until this happens or a timeout specified by the sender elapsed without the destination becoming ready to receive.

13.1.2 Basic Macros

L4 standard macros for header files, function definitions, and public APIs etc.
Collaboration diagram for Basic Macros:



Files

- file linkage.h

  Linkage.
- file linkage.h

  Linkage.
- file linkage.h

  Linkage.
- file linkage.h

  Linkage.

Macros

- #define **L4_INLINE**

  L4 Inline function attribute.
- #define **L4_ALWAYS_INLINE**

  Always inline a function.
- #define **L4_BEGIN_DECLS**

  Start section with C types and functions.
- #define **L4_END_DECLS**

  End section with C types and functions.
- #define L4_NOTHROW

  Mark a function declaration and definition as never throwing an exception.
- #define L4_EXPORT

  Attribute to mark functions, variables, and data types as being exported from a library.
- #define L4_HIDDEN

  Attribute to mark functions, variables, and data types as being explicitly hidden from users of a library.
- #define **L4_CONSTEXPR**

  Constexpr function attribute.
- #define **L4_NORETURN**

  Noreturn function attribute.
- #define **L4_NOINSTRUMENT**

  No instrumentation function attribute.
- #define **L4_LIKELY**(x)

  Expression is likely to execute.
- #define **L4_UNLIKELY**(x)

  Expression is unlikely to execute.
- #define **L4_STICKY**(x)

  Mark symbol sticky (even not there).
- #define **L4_DEPRECATED**(s)

  Mark symbol deprecated.
- #define **L4_stringify_helper**(x)

  stringify helper.
- #define **L4_stringify**(x)

  stringify.
- #define **L4_CV**

  Define calling convention.
- #define **L4_CV**

  Define calling convention.
- #define **L4_CV**

  Define calling convention.
- #define **L4_CV**

  Define calling convention.
- #define **L4_CV**

  Define calling convention.

Functions

- unsigned long l4_align_stack_for_direct_fncall (unsigned long stack)

  Specify the desired alignment of the stack pointer.
- void **l4_barrier** (void)

  Memory barrier.
- void **l4_mb** (void)

  Memory barrier.
- void **l4_wmb** (void)

  Write memory barrier.
- L4_NORETURN void l4_infinite_loop (void)

  Infinite loop.

13.1.2.1 Detailed Description

L4 standard macros for header files, function definitions, and public APIs etc.

Include File

```
#include <l4/sys/compiler.h>
```

13.1.2.2 Macro Definition Documentation

13.1.2.2.1 L4_EXPORT

```
#define L4_EXPORT
```

Attribute to mark functions, variables, and data types as being exported from a library.
All data types, functions, and global variables that shall be exported from a library shall be marked with this attribute.
The default may become to hide everything that is not marked as L4_EXPORT from the users of a library and provide the possibility for aggressive optimization of all those internal functionality of a library.
Usage:

```
class L4_EXPORT My_class
{
  ...
};

int L4_EXPORT function(void);

int L4_EXPORT global_data; // global data is not recommended
```

Definition at line 220 of file compiler.h.
Referenced by l4io_iterate_devices(), l4io_lookup_device(), l4io_lookup_resource(), l4io_release_iomem(), l4io_release_ioport(), l4io_request_all_ioports(), l4io_request_icu(), l4io_request_iomem(), l4io_request_iomem_region(), l4io_request_ioport(), l4io_request_resource_iomem(), l4re_inhibitor_acquire(), and l4re_inhibitor_release().

13.1.2.2.2 L4_HIDDEN

```
#define L4_HIDDEN
```

Attribute to mark functions, variables, and data types as being explicitly hidden from users of a library.
This attribute is intended for functions, data, and data types that shall never be visible outside of a library. In particular, for shared libraries this may result in much faster code within the library and short linking times.

```
class L4_HIDDEN My_class
{
  ...
};

int L4_HIDDEN function(void);

int L4_HIDDEN global_data; // global data is not recommended
```

Definition at line 217 of file compiler.h.

13.1.2.2.3 L4_NOTHROW

```
#define L4_NOTHROW
```

Mark a function declaration and definition as never throwing an exception.
(Also for C code).
This macro shall be used to mark C and C++ functions that never throw any exception. Note that also C functions may throw exceptions according to the compilers ABI and shall be marked with L4_NOTHROW if they never do. In C++ this is equivalent to `throw()`.

```
int foo() L4_NOTHROW;
...
int foo() L4_NOTHROW
{
  ...
  return result;
}
```

Definition at line 167 of file compiler.h.
Referenced by __l4_kdebug_3_text(), __l4_kdebug_op(), __l4_kdebug_op_1(), __l4_kdebug_text(), l4_msgtag_t::flags(), l4_msgtag_t::has_error(), l4_msgtag_t::is_exception(), l4_msgtag_t::is_io_page_fault(), l4_msgtag_t::is_page_fault(), l4_msgtag_t::is_sigma0(), l4_msgtag_t::items(), l4_arm_smccc_call(), l4_bdr(), l4_bytes_to_mwords(), l4_cache_clean_data(), l4_cache_coherent(), l4_cache_dma_coherent(), l4_cache_dma_coherent_full(), l4_cache_flush_data(), l4_cache_inv_data(), l4_capability_equal(), l4_capability_next(), l4_debugger_add_image_info(), l4_debugger_get_object_name(), l4_debugger_global_id(), l4_debugger_kobj_to_id(), l4_debugger_query_log_name(), l4_debugger_query_log_typeid(), l4_debugger_query_obj_infos(), l4_debugger_query_object_name(), l4_debugger_set_object_name(), l4_debugger_switch_log(), l4_error(), l4_factory_create(), l4_factory_create_factory(), l4_factory_create_gate(), l4_factory_create_irq(), l4_factory_create_pi_mutex(), l4_factory_create_task(), l4_factory_create_thread(), l4_factory_create_thread_group(), l4_factory_create_vcpu_context(), l4_factory_create_vm(), l4_fpage(), l4_fpage_all(), l4_fpage_contains(), l4_fpage_invalid(), l4_fpage_ioport(), l4_fpage_memaddr(), l4_fpage_obj(), l4_fpage_order(), l4_fpage_page(), l4_fpage_rights(), l4_fpage_set_rights(), l4_fpage_size(), l4_fpage_type(), l4_icu_bind(), l4_icu_bind_u(), l4_icu_info(), l4_icu_info_u(), l4_icu_mask(), l4_icu_mask_u(), l4_icu_msi_info(), l4_icu_msi_info_u(), l4_icu_set_mode(), l4_icu_set_mode_u(), l4_icu_unbind(), l4_icu_unbind_u(), l4_icu_unmask(), l4_icu_unmask_u(), l4_iofpage(), l4_ipc(), l4_ipc(), l4_ipc_call(), l4_ipc_error(), l4_ipc_error_code(), l4_ipc_is_rcv_error(), l4_ipc_is_snd_error(), l4_ipc_receive(), l4_ipc_reply(), l4_ipc_reply_and_wait(), l4_ipc_reply_and_wait_ext(), l4_ipc_send(), l4_ipc_send_and_wait(), l4_ipc_sleep(), l4_ipc_sleep_ms(), l4_ipc_sleep_us(), l4_ipc_timeout(), l4_ipc_to_errno(), l4_ipc_wait(), l4_ipc_wait_ext(), l4_irq_bind_vcpu(), l4_irq_bind_vcpu_u(), l4_irq_detach(), l4_irq_detach_u(), l4_irq_receive(), l4_irq_receive_u(), l4_irq_trigger(), l4_irq_trigger_u(), l4_irq_unmask(), l4_irq_unmask_u(), l4_irq_wait(), l4_irq_wait_u(), l4_is_fpage_valid(), l4_is_fpage_writable(), l4_is_invalid_cap(), l4_is_valid_cap(), l4_kd_enter(), l4_kernel_info_get_mem_desc_end(), l4_kernel_info_get_mem_desc_is_virtual(), l4_kernel_info_get_mem_desc_start(), l4_kernel_info_get_mem_desc_subtype(), l4_kernel_info_get_mem_desc_type(), l4_kernel_info_get_mem_descs(), l4_kernel_info_get_num_mem_descs(), l4_kernel_info_set_mem_desc(), l4_kernel_info_version_offset(), l4_kip(), l4_kip_clock(), l4_kip_clock_lw(), l4_kip_clock_ns(), l4_kip_version(), l4_kip_version_string(), l4_map_control(), l4_map_obj_control(), l4_msgtag(), l4_msgtag_flags(), l4_msgtag_has_error(), l4_msgtag_is_exception(), l4_msgtag_is_io_page_fault(), l4_msgtag_is_page_fault(), l4_msgtag_is_sigma0(), l4_msgtag_items(), l4_msgtag_label(), l4_msgtag_words(), l4_obj_fpage(), l4_pi_mutex_lock(), l4_pi_mutex_unlock(), l4_platform_ctl_cpu_allow_shutdown(), l4_platform_ctl_cpu_disable(), l4_platform_ctl_cpu_enable(), l4_platform_ctl_set_task_asid(), l4_platform_ctl_system_shutdown(), l4_platform_ctl_system_suspend(), l4_rcv_timeout(), l4_round_page(), l4_round_size(), l4_sched_cpu_set(), l4_sched_param(), l4_scheduler_idle_time(), l4_scheduler_info(), l4_scheduler_info_with_classes(), l4_scheduler_is_online(), l4_scheduler_run_thread(), l4_semaphore_down(), l4_semaphore_up(), l4_sleep(), l4_sleep_forever(), l4_snd_timeout(), l4_sndfpage_add(), l4_task_add_ku_mem(), l4_task_cap_equal(), l4_task_cap_valid(), l4_task_delete_obj(), l4_task_map(), l4_task_release_cap(), l4_task_unmap(), l4_task_unmap_batch(), l4_task_vgicc_map(), l4_thread_arm_set_tpidruro(), l4_thread_control_alien(), l4_thread_control_bind(), l4_thread_control_commit(), l4_thread_control_exc_handler(), l4_thread_control_pager(), l4_thread_control_start(), l4_thread_ex_regs(), l4_thread_ex_regs_ret(), l4_thread_ex_regs_ret_u(), l4_thread_ex_regs_u(), l4_thread_group_add(), l4_thread_group_remove(), l4_thread_modify_sender_add(), l4_thread_modify_sender_commit(), l4_thread_modify_sender_start(), l4_thread_pf_trampoline_dis
l4_thread_pf_trampoline_enable(), l4_thread_pf_trampoline_reflect(), l4_thread_pf_trampoline_resume(), l4_thread_pf_trampoline_s
l4_thread_register_del_irq(), l4_thread_register_doorbell_irq(), l4_thread_stats_time(), l4_thread_switch(), l4_thread_vcpu_control(), l4_thread_vcpu_control_ext(), l4_thread_vcpu_control_ext_u(), l4_thread_vcpu_control_u(), l4_thread_vcpu_resume_commit(), l4_thread_vcpu_resume_start(), l4_thread_yield(), l4_timeout(), l4_timeout_abs(), l4_timeout_get(), l4_timeout_is_absolute(), l4_timeout_rel(), l4_timeout_rel_get(), l4_touch_ro(), l4_touch_rw(), l4_trunc_page(), l4_trunc_size(), l4_usleep(), l4_utcb(), l4_utcb_br(), l4_utcb_exc(), l4_utcb_exc_is_ex_regs_exception(), l4_utcb_exc_is_ex_regs_exception(), l4_utcb_exc_is_pf(), l4_utcb_exc_is_pf(), l4_utcb_exc_pc(), l4_utcb_exc_pc(), l4_utcb_exc_pc_set(), l4_utcb_exc_pfa(), l4_utcb_exc_pfa(), l4_utcb_exc_typeval(), l4_utcb_exc_typeval(),

l4_utcb_inherit_fpu(), l4_utcb_mr(), l4_utcb_mr64_idx(), l4_utcb_tcr(), l4_vcon_get_attr(), l4_vcon_get_attr_u(), l4_vcon_read(), l4_vcon_read_u(), l4_vcon_read_with_flags(), l4_vcon_send(), l4_vcon_send_u(), l4_vcon_set_attr(), l4_vcon_set_attr_raw(), l4_vcon_set_attr_u(), l4_vcon_write(), l4_vcon_write_u(), l4_vcpu_check_version(), l4_vm_vmx_clear(), l4_vm_vmx_field_len(), l4_vm_vmx_field_order(), l4_vm_vmx_get_caps(), l4_vm_vmx_get_caps_default1(), l4_vm_vmx_get_cr2_index(), l4_vm_vmx_get_hw_vmcs(), l4_vm_vmx_ptr_load(), l4_vm_vmx_read(), l4_vm_vmx_read_16(), l4_vm_vmx_read_32(), l4_vm_vmx_read_64(), l4_vm_vmx_read_nat(), l4_vm_vmx_set_hw_vmcs(), l4_vm_vmx_write(), l4_vm_vmx_write_16(), l4_vm_vmx_write_32(), l4_vm_vmx_write_64(), l4_vm_vmx_write_nat(), l4re_debug_obj_debug(), l4re_dma_space_map(), l4re_dma_space_mgr_associate(), l4re_dma_space_mgr_associate_phys(), l4re_dma_space_mgr_block_a l4re_dma_space_mgr_disassociate(), l4re_dma_space_mgr_set_limits(), l4re_dma_space_unmap(), l4re_ds_allocate(), l4re_ds_clear(), l4re_ds_copy_in(), l4re_ds_flags(), l4re_ds_info(), l4re_ds_map_info(), l4re_ds_size(), l4re_env(), l4re_env_cap_entry_t::l4re_env_cap_entry_t(), l4re_env_cap_entry_t::l4re_env_cap_entry_t(), l4re_env_get_cap(), l4re_env_get_cap_e(), l4re_env_get_cap_l(), l4re_event_get_axis_info(), l4re_event_get_buffer(), l4re_event_get_num_streams(), l4re_event_get_stream_info(), l4re_event_get_stream_info_for_id(), l4re_kip(), l4re_log_print(), l4re_log_print_srv(), l4re_log_printn(), l4re_log_printn_srv(), l4re_ma_alloc(), l4re_ma_alloc_align(), l4re_ma_alloc_align_srv(), l4re_ns_query_srv(), l4re_ns_query_to_srv(), l4re_ns_register_obj_srv(), l4re_rm_attach(), l4re_rm_attach_srv(), l4re_rm_attach_w_info(), l4re_rm_attach_w_info_srv(), l4re_rm_detach(), l4re_rm_detach_ds(), l4re_rm_detach_ds_unmap(), l4re_rm_detach_srv(), l4re_rm_detach_unmap(), l4re_rm_find(), l4re_rm_find_srv(), l4re_rm_free_area(), l4re_rm_free_area_srv(), l4re_rm_get_info(), l4re_rm_get_info_srv(), l4re_rm_reserve_area(), l4re_rm_reserve_area_srv(), l4re_rm_show_lists(), l4re_rm_show_lists_srv(), l4re_util_cap_alloc(), l4re_util_cap_free(), l4re_util_cap_free_um(), l4re_util_cap_last(), l4re_util_kumem_alloc(), l4re_video_goos_create_buffer(), l4re_video_goos_create_view(), l4re_video_goos_delete_buffer(), l4re_video_goos_delete_view(), l4re_video_goos_get_static_buffer(), l4re_video_goos_get_view(), l4re_video_goos_info(), l4re_video_goos_refresh(), l4re_video_view_get_info(), l4re_video_view_refresh(), l4re_video_view_set_info(), l4re_video_view_set_viewport(), l4re_video_view_stack(), l4util_micros2l4to(), l4vcpu_ext_alloc(), l4vcpu_irq_disable(), l4vcpu_irq_disable_save(), l4vcpu_irq_enable(), l4vcpu_irq_restore(), l4vcpu_is_irq_entry(), l4vcpu_is_page_fault_entry(), l4vcpu_print_state(), l4vcpu_wait_for_event(), l4virtio_config_queue(), l4virtio_device_config_ds(), l4virtio_device_notification_irq(), l4virtio_register_ds(), l4virtio_set_status(), l4_msgtag_t::label(), l4_msgtag_t::label(), umalloc_area_create(), and l4_msgtag_t::words().

13.1.2.3 Function Documentation

13.1.2.3.1 l4_align_stack_for_direct_fncall()

```
unsigned long l4_align_stack_for_direct_fncall (
            unsigned long stack)  [inline]
```

Specify the desired alignment of the stack pointer.

BIGGEST_ALIGNMENT provides the largest alignment ever used for any data type on the target machine. This is normally identical to desired stack alignment. Align stack pointer for directly invoked functions.

The stack needs to be aligned to L4_STACK_ALIGN for being able to access certain data on the stack. On x86/↩ AMD64, a function call is performed using the 'call' instruction decrementing the stack pointer and writing the return address onto the stack. The called function considers this when adapting the stack pointer after function entry. If the called function was not invoked by a 'call' instruction, the stack pointer is actually off by a machine word leading to stack alignment issues when executing SSE instructions.

This function fixes the stack pointer for directly invoked functions. For architectures not automatically pushing the stack pointer during a function call, just enforce the L4_STACK_ALIGN alignment.

Definition at line 284 of file compiler.h.

References L4_INLINE.

13.1.2.3.2 l4_infinite_loop()

```
L4_NORETURN void l4_infinite_loop (
            void )  [inline]
```

Infinite loop.

Will never return. Use l4_sleep_forever() if at all possible.

Definition at line 358 of file compiler.h.

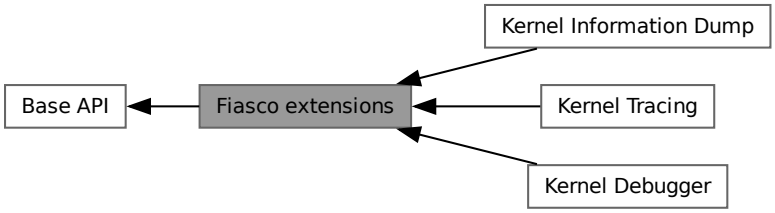
References l4_barrier(), L4_INLINE, and L4_NORETURN.

Here is the call graph for this function:



13.1.3 Fiasco extensions

Extensions of the Fiasco L4 implementation.
Collaboration diagram for Fiasco extensions:



Topics

- Kernel Debugger 156
  Kernel debugger related functionality.
- Kernel Information Dump 163
  Kernel information dumping related functionality.
- Kernel Tracing 164
  Kernel tracing related functionality.

Files

- file __ktrace-impl.h
  L4 kernel event tracing.
- file ktrace.h
  L4 kernel event tracing.
- file obj_info.h
  Debugger related functions.
- file segment.h
  Segment handling (AMD64).
- file segment.h
  Segment handling (x86).

Functions

- long fiasco_ldt_set (l4_cap_idx_t task, void *ldt, unsigned int num_desc, unsigned int entry_number_start, l4_utcb_t *utcb)

  Set LDT segments descriptors.
- long fiasco_gdt_set (l4_cap_idx_t thread, void *desc, unsigned int size, unsigned int entry_number_start, l4_utcb_t *utcb)

  Set GDT segment descriptors.
- unsigned fiasco_gdt_get_entry_offset (l4_cap_idx_t thread, l4_utcb_t *utcb)

  Return the offset of the entry in the GDT.

13.1.3.1 Detailed Description

Extensions of the Fiasco L4 implementation.

13.1.3.2 Function Documentation

13.1.3.2.1 fiasco_gdt_get_entry_offset()

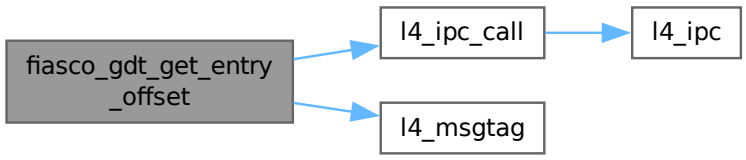
```
unsigned fiasco_gdt_get_entry_offset (
            l4_cap_idx_t thread,
            l4_utcb_t * utcb)  [inline]
```

Return the offset of the entry in the GDT.

Parameters

thread	Thread to get info from.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Definition at line 166 of file segment.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_PROTO_THREAD, and L4_THREAD_X86_GDT_OP.
Here is the call graph for this function:



13.1.3.2.2 fiasco_gdt_set()

```
long fiasco_gdt_set (
            l4_cap_idx_t thread,
            void * desc,
            unsigned int size,
            unsigned int entry_number_start,
            l4_utcb_t * utcb)  [inline]
```

Set GDT segment descriptors.
Fiasco supports 4 consecutive entries, starting at the value returned by fiasco_gdt_get_entry_offset().

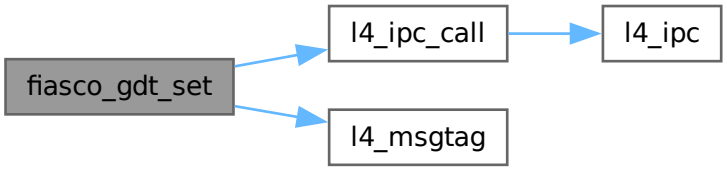
Parameters

thread	Thread to set the GDT entry for.
desc	Pointer to GDT descriptors.
size	Size of the descriptors in bytes (multiple of 8).
entry_number_start	Entry number to start (valid values: 0-3).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

<0	At least one provided GDT descriptor is considered unsafe by the kernel, and not all selected GDT descriptors have been updated.
L4_EOK	Success.

Definition at line 220 of file segment.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_PROTO_THREAD, and L4_THREAD_X86_GDT_OP.
Here is the call graph for this function:



13.1.3.2.3 fiasco_ldt_set()

```
long fiasco_ldt_set (
             l4_cap_idx_t task,
             void * ldt,
             unsigned int num_desc,
             unsigned int entry_number_start,
             l4_utcb_t * utcb)  [inline]
```

Set LDT segments descriptors.

Parameters

task	Task to set the segment for.
ldt	Pointer to LDT hardware descriptors.
num_desc	Number of descriptors.
entry_number_start	Entry number to start.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

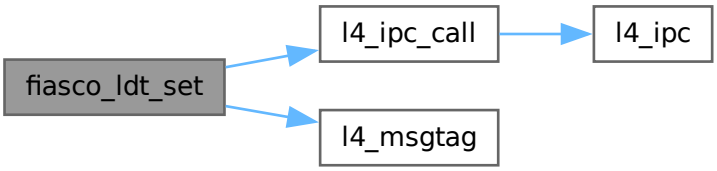
Return values

-L4_ENOSYS	The kernel configuration doesn't support this feature.
-L4_EINVAL	Invalid descriptor or invalid entry number.
L4_EOK	Success.

Note

This feature is not available if the kernel is configured with page table isolation.

Definition at line 153 of file segment.h.
References L4_EINVAL, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_PROTO_TASK, L4_TASK_LDT_SET_X86_OP, L4_TASK_LDT_X86_ENTRY_SIZE, and L4_TASK_LDT_X86_MAX_ENTRIES.
Here is the call graph for this function:



13.1.3.3 Kernel Debugger

Kernel debugger related functionality.
Collaboration diagram for Kernel Debugger:



Files

- file kdebug.h

  Functionality for invoking the kernel debugger.

Functions

- l4_msgtag_t l4_debugger_set_object_name (l4_cap_idx_t cap, const char *name) L4_NOTHROW

  Set the name of a kernel object.
- l4_ret_t l4_debugger_query_object_name (l4_cap_idx_t cap, unsigned id, char *name, unsigned size) L4_NOTHROW

  Get name of the kernel object with Id `id`.
- l4_ret_t l4_debugger_get_object_name (l4_cap_idx_t cap, char *name, unsigned size) L4_NOTHROW

Get name of a kernel object.

- unsigned long l4_debugger_global_id (l4_cap_idx_t cap) L4_NOTHROW

  Get the globally unique ID of the object behind a capability.

- unsigned long l4_debugger_kobj_to_id (l4_cap_idx_t cap, l4_addr_t kobjp) L4_NOTHROW

  Get the globally unique ID of the object behind the kobject pointer.

- l4_ret_t l4_debugger_query_log_typeid (l4_cap_idx_t cap, const char *name, unsigned idx) L4_NOTHROW

  Query the log-id for a log type.

- l4_ret_t l4_debugger_query_log_name (l4_cap_idx_t cap, unsigned idx, char *name, unsigned namelen, char *shortname, unsigned shortnamelen) L4_NOTHROW

  Query the name of a log type given the ID.

- l4_msgtag_t l4_debugger_switch_log (l4_cap_idx_t cap, const char *name, int on_off) L4_NOTHROW

  Set or unset log.

- l4_msgtag_t l4_debugger_add_image_info (l4_cap_idx_t cap, l4_addr_t base, const char *name) L4_NOTHROW

  Add loaded image information for a task.

13.1.3.3.1 Detailed Description

Kernel debugger related functionality.

Attention

This API is subject to change!

This is a debugging facility, any call to any function might be invalid. Do not rely on it in any real code.

Include File

```
#include <l4/sys/debugger.h>
```

13.1.3.3.2 Function Documentation

13.1.3.3.2.1 l4_debugger_add_image_info()

```
l4_msgtag_t l4_debugger_add_image_info (
             l4_cap_idx_t cap,
             l4_addr_t base,
             const char * name)  [inline]
```

Add loaded image information for a task.

Parameters

cap	Capability which refers to the task object.
base	Load base address of image.
name	Image base name.

This is a debugging facility, the call might be invalid.
Definition at line 482 of file debugger.h.
References L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.3.3.2.2 l4_debugger_get_object_name()

```
l4_ret_t l4_debugger_get_object_name (
            l4_cap_idx_t cap,
            char * name,
            unsigned size)  [inline]
```

Get name of a kernel object.

Parameters

	cap	Capability which refers to the kernel object.
out	*name*	Buffer to copy the name into. The buffer must be allocated by the caller.
	size	Length of the name buffer.

Return values

0	Success
<0	Error

Definition at line 475 of file debugger.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.3.3.2.3 l4_debugger_global_id()

```
unsigned long l4_debugger_global_id (
            l4_cap_idx_t cap)  [inline]
```

Get the globally unique ID of the object behind a capability.

Parameters

cap	Capability

Return values

~0UL	Capability is not valid.
otherwise	Global debugger id.

This is a debugging facility, the call might be invalid.
Definition at line 433 of file debugger.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.3.3.2.4 l4_debugger_kobj_to_id()

```
unsigned long l4_debugger_kobj_to_id (
             l4_cap_idx_t cap,
             l4_addr_t kobjp)  [inline]
```

Get the globally unique ID of the object behind the kobject pointer.

Parameters

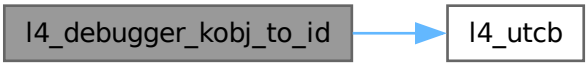
cap	Capability
kobjp	Kobject pointer

Return values

~0UL	The capability or the kobject pointer are invalid.
otherwise	The globally unique id.

This is a debugging facility, the call might be invalid.
Definition at line 439 of file debugger.h.
References L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.3.3.2.5 l4_debugger_query_log_name()

```
l4_ret_t l4_debugger_query_log_name (
             l4_cap_idx_t cap,
             unsigned idx,
             char * name,
             unsigned namelen,
             char * shortname,
             unsigned shortnamelen)  [inline]
```

Query the name of a log type given the ID.

Parameters

cap	Debugger capability.
idx	ID to query.
name	Buffer to copy name to.
namelen	Buffer length of name.
shortname	Buffer to copy `shortname` to.
shortnamelen	Buffer length of `shortname`.

Return values

0	Success
<0	Error

This is a debugging facility, the call might be invalid.
Definition at line 452 of file debugger.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.3.3.2.6 l4_debugger_query_log_typeid()

```
l4_ret_t l4_debugger_query_log_typeid (
             l4_cap_idx_t cap,
             const char * name,
             unsigned idx)  [inline]
```

Query the log-id for a log type.

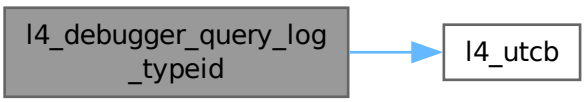
Parameters

cap	Debugger capability
name	Name to query for.
idx	Idx to start searching, start with 0

Returns

positive ID, or negative error code

This is a debugging facility, the call might be invalid.
Definition at line 445 of file debugger.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.3.3.2.7 l4_debugger_query_object_name()

```
l4_ret_t l4_debugger_query_object_name (
             l4_cap_idx_t cap,
             unsigned id,
             char * name,
             unsigned size)  [inline]
```

Get name of the kernel object with Id `id`.

Parameters

	cap	Capability of the debugger object.
	id	Global id of the object whose name is asked.
`out`	*name*	Buffer to copy the name into. The buffer must be allocated by the caller.
	size	Length of the `name` buffer.

Return values

0	Success
<0	Error

Definition at line 468 of file debugger.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.3.3.2.8 l4_debugger_set_object_name()

```
l4_msgtag_t l4_debugger_set_object_name (
            l4_cap_idx_t cap,
            const char * name)  [inline]
```

Set the name of a kernel object.

Parameters

cap	Capability which refers to the kernel object.
name	Name of the kernel object that is e.g. displayed in the kernel debugger.

This is a debugging facility, the call might be invalid.

Examples

examples/libs/shmc/prodcons.c, and examples/sys/aliens/main.c.

Definition at line 426 of file debugger.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.3.3.2.9 l4_debugger_switch_log()

```
l4_msgtag_t l4_debugger_switch_log (
            l4_cap_idx_t cap,
            const char * name,
            int on_off)  [inline]
```

Set or unset log.

Parameters

cap	Debugger object.
name	Name of the log type.
on_off	1: turn log on, 0: turn log off

Returns

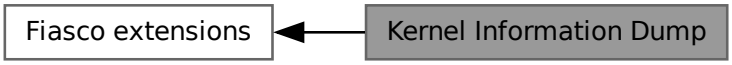
Syscall return tag

Definition at line 461 of file debugger.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.3.4 Kernel Information Dump

Kernel information dumping related functionality.
Collaboration diagram for Kernel Information Dump:



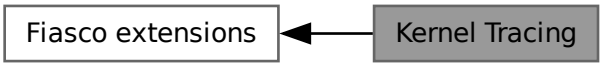
Kernel information dumping related functionality.
Functions that dump various kernel internal information to the console. Probably only present in kernel debug builds.

Include File

```
#include <l4/sys/kdump.h>
```

13.1.3.5 Kernel Tracing

Kernel tracing related functionality.
Collaboration diagram for Kernel Tracing:



Functions

- l4_msgtag_t fiasco_tbuf_validate (void)

  Validate the kernel base debugger capability.
- l4_umword_t fiasco_tbuf_log (const char *text)

  Create new trace-buffer entry with describing <text>.
- l4_umword_t fiasco_tbuf_log_3val (const char *text, l4_umword_t v1, l4_umword_t v2, l4_umword_t v3)

  Create new trace-buffer entry with describing <text> and three additional values.
- l4_umword_t fiasco_tbuf_log_binary (const unsigned char *data)

  Create new trace-buffer entry with binary data.
- void **fiasco_tbuf_clear** (void)

  Clear trace-buffer.
- void **fiasco_tbuf_dump** (void)

  Dump trace-buffer to kernel console.
- l4_msgtag_t fiasco_tbuf_map_status (l4_fpage_t *ku_mem)

  Map kernel trace-buffer status page.
- l4_msgtag_t fiasco_tbuf_map_slots (l4_fpage_t *ku_mem)

  Map kernel trace-buffer slots.

13.1.3.5.1 Detailed Description

Kernel tracing related functionality.

Attention

This API is subject to change!

This is a tracing facility for the Fiasco kernel trace buffer. Any call to any function might be invalid. Do not rely on it in any real code.

Include File

```
#include <l4/sys/ktrace.h>
```

13.1.3.5.2 Function Documentation

13.1.3.5.2.1 fiasco_tbuf_log()

```
l4_umword_t fiasco_tbuf_log (
             const char * text)  [inline]
```

Create new trace-buffer entry with describing <text>.

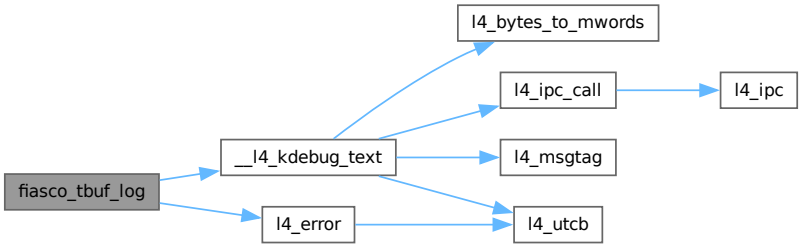
Parameters

text	Logging text

Returns

Pointer to trace-buffer entry

Definition at line 29 of file __ktrace-impl.h.
References __l4_kdebug_text(), and l4_error().
Here is the call graph for this function:



13.1.3.5.2.2 fiasco_tbuf_log_3val()

```
l4_umword_t fiasco_tbuf_log_3val (
             const char * text,
             l4_umword_t v1,
             l4_umword_t v2,
             l4_umword_t v3)  [inline]
```

Create new trace-buffer entry with describing <text> and three additional values.

Parameters

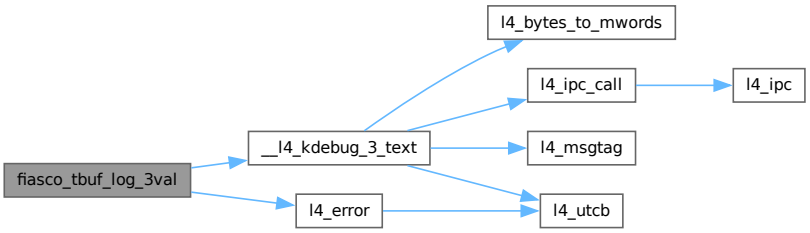
text	Logging text
v1	first value
v2	second value
v3	third value

Returns

Pointer to trace-buffer entry

Definition at line 36 of file __ktrace-impl.h.
References __l4_kdebug_3_text(), and l4_error().

Here is the call graph for this function:



13.1.3.5.2.3 fiasco_tbuf_log_binary()

```
l4_umword_t fiasco_tbuf_log_binary (
            const unsigned char * data)  [inline]
```

Create new trace-buffer entry with binary data.

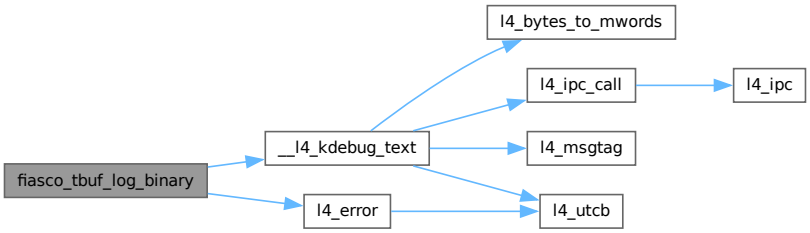
Parameters

data	binary data

Returns

Pointer to trace-buffer entry

Definition at line 59 of file __ktrace-impl.h.
References __l4_kdebug_text(), and l4_error().
Here is the call graph for this function:



13.1.3.5.2.4 fiasco_tbuf_map_slots()

```
l4_msgtag_t fiasco_tbuf_map_slots (
            l4_fpage_t * ku_mem)  [inline]
```

Map kernel trace-buffer slots.

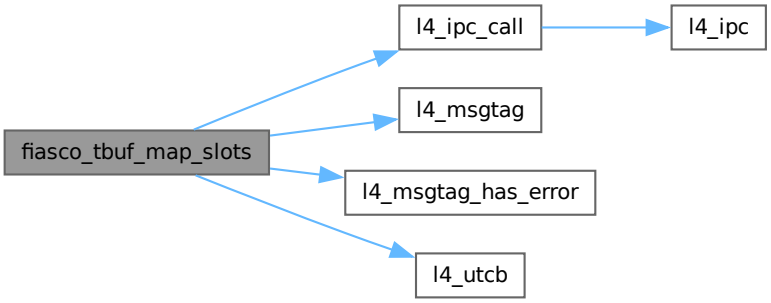
Parameters

ku_mem	Flexpage where to map the trace-buffer slots. Expected to be the exact size as defined by the status page.

Returns

IPC message tag.

Definition at line 85 of file __ktrace-impl.h.
References L4_BASE_DEBUGGER_CAP, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), l4_msgtag_has_error(), L4_PROTO_DEBUGGER, l4_utcb(), l4_msg_regs_t::mr, and l4_fpage_t::raw.
Here is the call graph for this function:



13.1.3.5.2.5 fiasco_tbuf_map_status()

```
l4_msgtag_t fiasco_tbuf_map_status (
            l4_fpage_t * ku_mem)  [inline]
```

Map kernel trace-buffer status page.

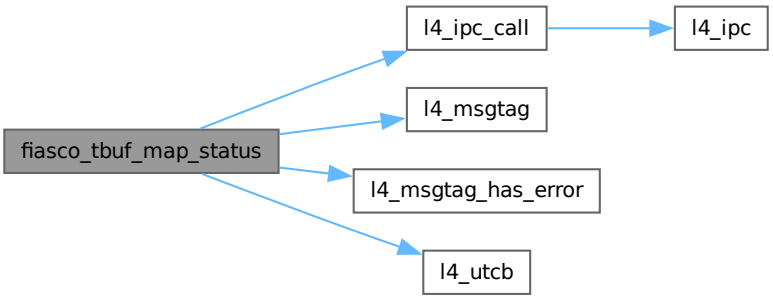
Parameters

ku_mem	Flexpage where to map the trace-buffer status page. Expected to be exactly one page in size.

Returns

IPC message tag.

Definition at line 66 of file __ktrace-impl.h.
References L4_BASE_DEBUGGER_CAP, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), l4_msgtag_has_error(), L4_PROTO_DEBUGGER, l4_utcb(), l4_msg_regs_t::mr, and l4_fpage_t::raw.
Here is the call graph for this function:



13.1.3.5.2.6 fiasco_tbuf_validate()

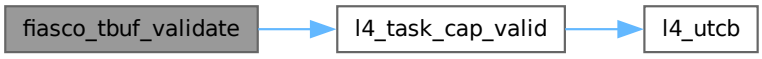
```
l4_msgtag_t fiasco_tbuf_validate (
            void ) [inline]
```

Validate the kernel base debugger capability.

Return values

true	The base debugger capability is valid and accessible.
false	The base debugger capability is not valid or not accessible.

Definition at line 25 of file __ktrace-impl.h.
References L4_BASE_DEBUGGER_CAP, L4_BASE_TASK_CAP, and l4_task_cap_valid().
Here is the call graph for this function:



13.1.4 Flexpages

Flexpage-related API.

Collaboration diagram for Flexpages:



Data Structures

- union l4_fpage_t

  L4 flexpage type.

Enumerations

- enum L4_fpage_consts {
  L4_FPAGE_RIGHTS_SHIFT = 0 , L4_FPAGE_TYPE_SHIFT = 4 , L4_FPAGE_SIZE_SHIFT = 6 , L4_FPAGE_ADDR_SHIFT = 12 ,
  L4_FPAGE_RIGHTS_BITS = 4 , L4_FPAGE_TYPE_BITS = 2 , L4_FPAGE_SIZE_BITS = 6 , L4_FPAGE_ADDR_BITS = L4_MWORD_BITS - L4_FPAGE_ADDR_SHIFT ,
  L4_FPAGE_RIGHTS_MASK , **L4_FPAGE_TYPE_MASK** , **L4_FPAGE_SIZE_MASK** , **L4_FPAGE_ADDR_MASK** = ~0UL << L4_FPAGE_ADDR_SHIFT ,
  L4_FPAGE_RIGHTS_ALL = L4_FPAGE_RIGHTS_MASK }

  L4 flexpage structure.
- enum { L4_WHOLE_ADDRESS_SPACE = 63 }

  Constants for flexpages.
- enum L4_fpage_rights {
  L4_FPAGE_X = 1 , L4_FPAGE_W = 2 , L4_FPAGE_RO = 4 , L4_FPAGE_RW = L4_FPAGE_RO | L4_FPAGE_W ,
  L4_FPAGE_RX = L4_FPAGE_RO | L4_FPAGE_X , L4_FPAGE_RWX = L4_FPAGE_RW | L4_FPAGE_X }

  Memory and IO port flexpage rights.
- enum L4_cap_fpage_rights {
  L4_CAP_FPAGE_W = 0x1 , L4_CAP_FPAGE_S = 0x2 , L4_CAP_FPAGE_R = 0x4 , L4_CAP_FPAGE_RO = 0x4 ,
  L4_CAP_FPAGE_D = 0x8 , L4_CAP_FPAGE_RW = L4_CAP_FPAGE_R | L4_CAP_FPAGE_W ,
  L4_CAP_FPAGE_RS = L4_CAP_FPAGE_R | L4_CAP_FPAGE_S , L4_CAP_FPAGE_RWS = L4_CAP_FPAGE_RW | L4_CAP_FPAGE_S ,
  L4_CAP_FPAGE_RWSD = L4_CAP_FPAGE_RWS | L4_CAP_FPAGE_D , L4_CAP_FPAGE_RWD = L4_CAP_FPAGE_RW | L4_CAP_FPAGE_D , L4_CAP_FPAGE_RSD = L4_CAP_FPAGE_RS | L4_CAP_FPAGE_D }

  Object flexpage rights.
- enum L4_fpage_type { L4_FPAGE_SPECIAL = 0 , L4_FPAGE_MEMORY = 1 , L4_FPAGE_IO = 2 , L4_FPAGE_OBJ = 3 }

  Flexpage type.
- enum L4_fpage_control { L4_FPAGE_CONTROL_OFFSET_SHIFT = 12 , L4_FPAGE_CONTROL_MASK = ~0UL << L4_FPAGE_CONTROL_OFFSET_SHIFT }

  Flexpage map control flags.
- enum { L4_WHOLE_IOADDRESS_SPACE = 16 , L4_IOPORT_MAX = (1L << L4_WHOLE_IOADDRESS_SPACE) }

  Special constants for IO flexpages.

Functions

- L4_CONSTEXPR l4_fpage_t l4_fpage (l4_addr_t address, unsigned int order, unsigned char rights) L4_NOTHROW

  Create a memory flexpage.
- L4_CONSTEXPR l4_fpage_t l4_fpage_all (void) L4_NOTHROW

  Get a flexpage, describing all address spaces at once.
- L4_CONSTEXPR l4_fpage_t l4_fpage_invalid (void) L4_NOTHROW

  Get an invalid flexpage.
- L4_CONSTEXPR l4_fpage_t l4_iofpage (unsigned long port, unsigned int order) L4_NOTHROW

  Create an IO-port flexpage.
- L4_CONSTEXPR l4_fpage_t l4_obj_fpage (l4_cap_idx_t obj, unsigned int order, unsigned char rights) L4_NOTHROW

  Create a kernel-object flexpage.
- L4_CONSTEXPR int l4_is_fpage_writable (l4_fpage_t fp) L4_NOTHROW

  Test if the flexpage is writable.
- L4_CONSTEXPR unsigned l4_fpage_rights (l4_fpage_t f) L4_NOTHROW

  Return rights from a flexpage.
- L4_CONSTEXPR unsigned l4_fpage_type (l4_fpage_t f) L4_NOTHROW

  Return type from a flexpage.
- L4_CONSTEXPR unsigned l4_fpage_size (l4_fpage_t f) L4_NOTHROW

  Return size (log2) from a flexpage.
- L4_CONSTEXPR unsigned l4_fpage_order (l4_fpage_t f) L4_NOTHROW

  Return order (log2(size)) from a flexpage.
- L4_CONSTEXPR unsigned long l4_fpage_page (l4_fpage_t f) L4_NOTHROW

  Return the page part from a flexpage.
- L4_CONSTEXPR l4_addr_t l4_fpage_memaddr (l4_fpage_t f) L4_NOTHROW

  Return the memory address from the memory flexpage.
- L4_CONSTEXPR l4_cap_idx_t l4_fpage_obj (l4_fpage_t f) L4_NOTHROW

  Return the capability index from the object flexpage.
- L4_CONSTEXPR unsigned long l4_fpage_ioport (l4_fpage_t f) L4_NOTHROW

  Return the IO port number from the IO flexpage.
- L4_CONSTEXPR l4_fpage_t l4_fpage_set_rights (l4_fpage_t src, unsigned char new_rights) L4_NOTHROW

  Set new right in a flexpage.
- L4_CONSTEXPR int l4_fpage_contains (l4_fpage_t fpage, l4_addr_t addr, unsigned order) L4_NOTHROW

  Test whether a given range is completely within an fpage.
- L4_CONSTEXPR unsigned char l4_fpage_max_order (unsigned char order, l4_addr_t addr, l4_addr_t min↩ _addr, l4_addr_t max_addr, l4_addr_t hotspot=0)

  Determine maximum flexpage size of a region.
- L4_CONSTEXPR int l4_is_fpage_valid (l4_fpage_t fp) L4_NOTHROW

  Test if the flexpage is valid.

13.1.4.1 Detailed Description

Flexpage-related API.
A flexpage is a page with a variable size, that can describe memory, IO-Ports (IA32 only), and sets of kernel objects. A flexpage describes an always size aligned region of an address space. The size is given in a log2 scale. This means the size in elements (bytes for memory, ports for IO-Ports, and capabilities for kernel objects) is always a power of two.
A flexpage also carries type and access right information for the described region. The type information selects the address space in which the flexpage is valid. Access rights have a meaning depending on the specific address space (type).
There exists a special type for defining *receive windows* or for the l4_task_unmap() method, that can be used to describe all address spaces (all types) with a single flexpage.

Include File

```
#include <l4/sys/types.h>
```

13.1.4.2 Enumeration Type Documentation

13.1.4.2.1 anonymous enum

`anonymous enum`
Constants for flexpages.

Enumerator

L4_WHOLE_ADDRESS_SPACE	Whole address space size. This value does not only specify the log2 size of the biggest possible memory flexpage. It can be also used as size for a special flexpage to define a flexpage which completely covers all spaces.

Definition at line 84 of file __l4_fpage.h.

13.1.4.2.2 anonymous enum

`anonymous enum`
Special constants for IO flexpages.

Enumerator

L4_WHOLE_IOADDRESS_SPACE	Whole I/O address space size. In contrast to L4_WHOLE_ADDRESS_SPACE, this value forms the log2 size of the biggest possible I/O flexpage.
L4_IOPORT_MAX	Maximum I/O port address plus 1.

Definition at line 326 of file __l4_fpage.h.

13.1.4.2.3 L4_cap_fpage_rights

`enum L4_cap_fpage_rights`
Object flexpage rights.
Capabilities are modified or transferred with map and unmap operations. For that, capabilities are wrapped into flexpage objects. The flexpage carries a set of rights the sender wants to hand over to the receiver along with the capability.
For the user only the 'S' and the 'W' right are visible. Other rights such as the 'D' right are internal to the corresponding kernel object and cannot be evaluated by the receiver.
Note that additional object attributes and permissions can be specified in a send item, see Attributes and additional permissions for obj

Note

A thread can also map a capability from its task's capability table with a reduced set of rights into another slot of its own capability table.

Enumerator

L4_CAP_FPAGE_W	Interface specific 'W' right for capability flexpages. The semantics of the 'W' right is defined by the protocol. For example in case of a dataspace cap, the 'W' right is needed to get a writable dataspace.

L4_CAP_FPAGE_S	Interface specific 'S' right for capability flexpages. The semantics of the 'S' right is defined by the interface. When transferring object capabilities via IPC, the kernel masks this right with the 'S' right of the capability used to address the IPC partner. Thus, the 'S' right of sent capabilities is only transferred if both the flexpage and the IPC gate or thread capability specifying the IPC partner have the 'S' right. For L4::Task::map(), the 'S' right is only transferred if the flexpage, the source and destination task capabilities have the 'S' right.
L4_CAP_FPAGE_R	Read right for capability flexpages. This is always required, otherwise no capability is mapped.
L4_CAP_FPAGE_RO	Read right for capability flexpages. This is always required, otherwise no capability is mapped.
L4_CAP_FPAGE_D	Delete right for capability flexpages. This allows the receiver to delete the corresponding kernel object using unmap() regardless of other tasks still holding a capability to the kernel object. Such capabilities are set to an empty capability if the object is deleted.
L4_CAP_FPAGE_RW	Read and interface specific 'W' right for capability flexpages. The semantics of the 'W' right is defined by the interface. **See also** L4_CAP_FPAGE_W
L4_CAP_FPAGE_RS	Read and interface specific 'S' right for capability flexpages. The semantics of the 'S' right is defined by the interface. **See also** L4_CAP_FPAGE_S
L4_CAP_FPAGE_RWS	Read, interface specific 'W', and 'S' rights for capability flexpages. The semantics of the 'W' and 'S' right are defined by the interface. **See also** L4_CAP_FPAGE_R, L4_CAP_FPAGE_W, and L4_CAP_FPAGE_S
L4_CAP_FPAGE_RWSD	Full rights for capability flexpages. **See also** L4_CAP_FPAGE_R, L4_CAP_FPAGE_W, L4_CAP_FPAGE_S, and L4_CAP_FPAGE_D
L4_CAP_FPAGE_RWD	Read, write, and delete right for capability flexpages. **See also** L4_CAP_FPAGE_R, L4_CAP_FPAGE_W, and L4_CAP_FPAGE_D
L4_CAP_FPAGE_RSD	Read, 'S', and delete right for capability flexpages. **See also** L4_CAP_FPAGE_R, L4_CAP_FPAGE_S, and L4_CAP_FPAGE_D

Definition at line 148 of file __l4_fpage.h.

13.1.4.2.4 L4_fpage_consts

enum L4_fpage_consts
L4 flexpage structure.

Enumerator

L4_FPAGE_RIGHTS_SHIFT	Access permissions shift.
L4_FPAGE_TYPE_SHIFT	Flexpage type shift (memory, IO port, obj...).
L4_FPAGE_SIZE_SHIFT	Flexpage size shift (log2-based).
L4_FPAGE_ADDR_SHIFT	Page address shift.
L4_FPAGE_RIGHTS_BITS	Access permissions size.
L4_FPAGE_TYPE_BITS	Flexpage type size (memory, IO port, obj...).
L4_FPAGE_SIZE_BITS	Flexpage size size (log2-based).
L4_FPAGE_ADDR_BITS	Page address size.
L4_FPAGE_RIGHTS_MASK	Mask to get the flexpage rights.
L4_FPAGE_RIGHTS_ALL	Specify as flexpage rights during grant.

Definition at line 48 of file __l4_fpage.h.

13.1.4.2.5 L4_fpage_control

enum L4_fpage_control
Flexpage map control flags.

Enumerator

L4_FPAGE_CONTROL_OFFSET_SHIFT	Number of bits an index must be shifted or an address must be aligned to in the control word.
L4_FPAGE_CONTROL_MASK	Mask for truncating the lower bits of the send base or the index of the control word.

Definition at line 243 of file __l4_fpage.h.

13.1.4.2.6 L4_fpage_rights

enum L4_fpage_rights
Memory and IO port flexpage rights.
For IO flexpages, bit 1 and bit 2 are a combined read/write right. In a map operation, the receiver receives the IO port capability when the sender possesses it and at least one of these bits is present. For an unmap operation, the absence of one of those bits is sufficient to unmap the IO port capability.
Note that more memory attributes can be specified in a send item, see l4_fpage_cacheability_opt_t.

Enumerator

L4_FPAGE_X	Executable flexpage.
L4_FPAGE_W	Writable flexpage.
L4_FPAGE_RO	Read-only flexpage.
L4_FPAGE_RW	Read-write flexpage.
L4_FPAGE_RX	Read-execute flexpage.

L4_FPAGE_RWX	Read-write-execute flexpage.

Definition at line 118 of file __l4_fpage.h.

13.1.4.2.7 L4_fpage_type

```
enum L4_fpage_type
```
Flexpage type.

Enumerator

L4_FPAGE_SPECIAL	Special flexpage, either l4_fpage_invalid() or l4_fpage_all(); only supported by selected interfaces.
L4_FPAGE_MEMORY	Flexpage for memory spaces.
L4_FPAGE_IO	Flexpage for I/O port spaces.
L4_FPAGE_OBJ	Flexpage for object spaces.

Definition at line 230 of file __l4_fpage.h.

13.1.4.3 Function Documentation

13.1.4.3.1 l4_fpage()

```
L4_CONSTEXPR l4_fpage_t l4_fpage (
             l4_addr_t address,
             unsigned int order,
             unsigned char rights)  [inline]
```
Create a memory flexpage.

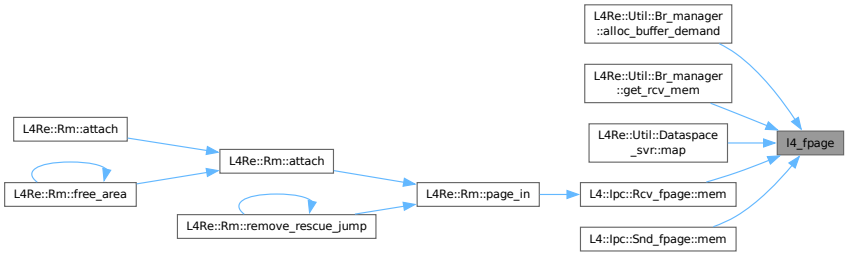
Parameters

address	Flexpage start address
order	Flexpage size (log2), L4_WHOLE_ADDRESS_SPACE to specify the whole address space (with `address` 0). The minimum log2 size of a memory flexpage is defined by L4_LOG2_PAGESIZE according to the size of the smallest virtual page supported by the MMU.
rights	Access rights, see L4_fpage_rights

Returns

Memory flexpage

Definition at line 740 of file __l4_fpage.h.
References L4_FPAGE_MEMORY, and L4_NOTHROW.
Referenced by L4Re::Util::Br_manager::alloc_buffer_demand(), L4Re::Util::Br_manager::get_rcv_mem(), L4Re::Util::Dataspace_svr::
L4::Ipc::Rcv_fpage::mem(), and L4::Ipc::Snd_fpage::mem().
Here is the caller graph for this function:



13.1.4.3.2 l4_fpage_all()

```
L4_CONSTEXPR l4_fpage_t l4_fpage_all (
             void )  [inline]
```

Get a flexpage, describing all address spaces at once.

Returns

Special *all-spaces* flexpage.

Note

This flexpage can be used to define a receive window where the sender can send objects of any type, or for an unmap item completely covering all spaces of the target task. It does not make sense to use this flexpage as send item.

Definition at line 760 of file __l4_fpage.h.
References L4_FPAGE_SPECIAL, L4_NOTHROW, and L4_WHOLE_ADDRESS_SPACE.

13.1.4.3.3 l4_fpage_contains()

```
L4_CONSTEXPR int l4_fpage_contains (
             l4_fpage_t fpage,
             l4_addr_t addr,
             unsigned order)  [inline]
```

Test whether a given range is completely within an fpage.

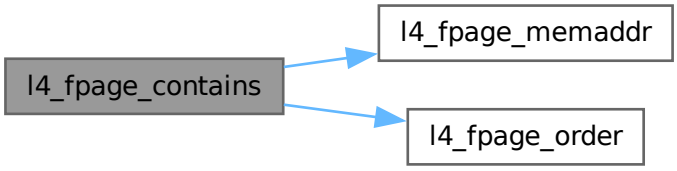
Parameters

fpage	Flexpage
addr	Address
order	Size of range in log2.

Return values

==0	The range is not completely in the fpage.
!=0	The range is within the fpage.

Definition at line 792 of file __l4_fpage.h.
References l4_fpage_memaddr(), l4_fpage_order(), and L4_NOTHROW.
Here is the call graph for this function:



13.1.4.3.4 l4_fpage_invalid()

```
L4_CONSTEXPR l4_fpage_t l4_fpage_invalid (
             void )  [inline]
```

Get an invalid flexpage.

Returns

Special *invalid* flexpage.

Definition at line 766 of file __l4_fpage.h.
References L4_FPAGE_SPECIAL, and L4_NOTHROW.

13.1.4.3.5 l4_fpage_ioport()

```
L4_CONSTEXPR unsigned long l4_fpage_ioport (
             l4_fpage_t f)  [inline]
```

Return the IO port number from the IO flexpage.

Parameters

f	Flexpage

Returns

IO port number from the given IO flexpage.

Precondition

`f` must be an IO flexpage (`l4_fpage_type(f) == L4_FPAGE_IO`) and

The function does not enforce size alignment of the read memory address. The caller must ensure the input fpage is correct.
Definition at line 692 of file __l4_fpage.h.
References L4_FPAGE_ADDR_SHIFT, and L4_NOTHROW.

13.1.4.3.6 l4_fpage_max_order()

```
L4_CONSTEXPR unsigned char l4_fpage_max_order (
             unsigned char order,
             l4_addr_t addr,
             l4_addr_t min_addr,
             l4_addr_t max_addr,
             l4_addr_t hotspot = 0)  [inline]
```

Determine maximum flexpage size of a region.

Parameters

order	Order value to start with (e.g. for memory L4_LOG2_PAGESIZE would be used)
addr	Address to be covered by the flexpage.
min_addr	Start of region / minimal address (including).
max_addr	End of region / maximal address (excluding).
hotspot	(Optional) hot spot.

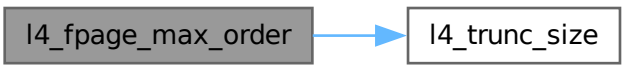
Returns

Maximum order (log2-size) possible.

Note

The start address of the flexpage can be determined with l4_trunc_size(addr, returnvalue)

Definition at line 800 of file __l4_fpage.h.
References l4_trunc_size().
Here is the call graph for this function:



13.1.4.3.7 l4_fpage_memaddr()

```
L4_CONSTEXPR l4_addr_t l4_fpage_memaddr (
             l4_fpage_t f)  [inline]
```

Return the memory address from the memory flexpage.

Parameters

f	Flexpage

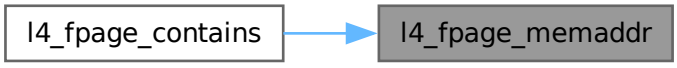
Returns

Page address from the given memory flexpage.

Precondition

`f` must be a memory flexpage (`l4_fpage_type(f) == L4_FPAGE_MEMORY`).

The function does not enforce size alignment of the read memory address. The caller must ensure the input fpage is correct.
Definition at line 698 of file __l4_fpage.h.
References L4_NOTHROW.
Referenced by l4_fpage_contains().
Here is the caller graph for this function:



13.1.4.3.8 l4_fpage_obj()

```
L4_CONSTEXPR l4_cap_idx_t l4_fpage_obj (
             l4_fpage_t f)  [inline]
```

Return the capability index from the object flexpage.

Parameters

f	Flexpage

Returns

Capability index from the given object flexpage.

Precondition

`f` must be an object flexpage (`l4_fpage_type(f) == L4_FPAGE_OBJ`)

The function does not enforce size alignment of the read memory address. The caller must ensure the input fpage is correct.
Definition at line 704 of file __l4_fpage.h.
References L4_NOTHROW.

13.1.4.3.9 l4_fpage_order()

```
L4_CONSTEXPR unsigned l4_fpage_order (
             l4_fpage_t f)  [inline]
```

Return order (log2(size)) from a flexpage.

Parameters

f	Flexpage

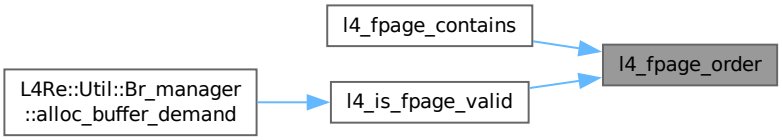
Returns

Order part of the given flexpage.

See also

l4_fpage_memaddr(), l4_fpage_obj(), l4_fpage_ioport()

Definition at line 680 of file __l4_fpage.h.
References L4_FPAGE_SIZE_SHIFT, and L4_NOTHROW.
Referenced by l4_fpage_contains(), and l4_is_fpage_valid().
Here is the caller graph for this function:



13.1.4.3.10 l4_fpage_page()

```
L4_CONSTEXPR unsigned long l4_fpage_page (
             l4_fpage_t f)  [inline]
```

Return the page part from a flexpage.

Parameters

f	Flexpage

Returns

Page part of the given flexpage.

Note

The meaning of the page part depends on the flexpage type.

Definition at line 686 of file __l4_fpage.h.
References L4_FPAGE_ADDR_SHIFT, and L4_NOTHROW.

13.1.4.3.11 l4_fpage_rights()

```
L4_CONSTEXPR unsigned l4_fpage_rights (
             l4_fpage_t f)  [inline]
```

Return rights from a flexpage.

Parameters

f	Flexpage

Returns

Size part of the given flexpage.

Definition at line 662 of file __l4_fpage.h.
References L4_FPAGE_RIGHTS_MASK, L4_FPAGE_RIGHTS_SHIFT, and L4_NOTHROW.
Referenced by l4_is_fpage_writable().
Here is the caller graph for this function:



13.1.4.3.12 l4_fpage_set_rights()

```
L4_CONSTEXPR l4_fpage_t l4_fpage_set_rights (
             l4_fpage_t src,
             unsigned char new_rights)  [inline]
```

Set new right in a flexpage.

Parameters

src	Flexpage
new_rights	New rights

Returns

Modified flexpage with new rights.

Definition at line 729 of file __l4_fpage.h.
References L4_FPAGE_RIGHTS_MASK, L4_FPAGE_RIGHTS_SHIFT, and L4_NOTHROW.
Referenced by L4::Ipc::Snd_fpage::io().
Here is the caller graph for this function:



13.1.4.3.13 l4_fpage_size()

```
L4_CONSTEXPR unsigned l4_fpage_size (
             l4_fpage_t f)  [inline]
```

Return size (log2) from a flexpage.

Parameters

f	Flexpage

Returns

Size part of the given flexpage.

See also

l4_fpage_memaddr(), l4_fpage_obj(), l4_fpage_ioport()

Deprecated Use l4_fpage_order() instead.

Definition at line 674 of file __l4_fpage.h.
References L4_FPAGE_SIZE_SHIFT, and L4_NOTHROW.

13.1.4.3.14 l4_fpage_type()

```
L4_CONSTEXPR unsigned l4_fpage_type (
            l4_fpage_t f)  [inline]
```

Return type from a flexpage.

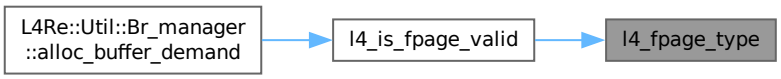
Parameters

f	Flexpage

Returns

Type part of the given flexpage.

Definition at line 668 of file __l4_fpage.h.
References L4_FPAGE_TYPE_SHIFT, and L4_NOTHROW.
Referenced by l4_is_fpage_valid().
Here is the caller graph for this function:



13.1.4.3.15 l4_iofpage()

```
L4_CONSTEXPR l4_fpage_t l4_iofpage (
            unsigned long port,
            unsigned int order)  [inline]
```

Create an IO-port flexpage.

Parameters

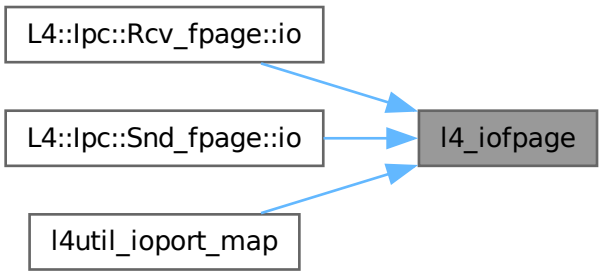
port	I/O-flexpage port base

order	I/O-flexpage size (log2), L4_WHOLE_IOADDRESS_SPACE to specify the whole I/O address space (with `port` 0)

Returns

I/O flexpage

Definition at line 746 of file __l4_fpage.h.
References L4_FPAGE_ADDR_SHIFT, L4_FPAGE_IO, L4_FPAGE_RW, and L4_NOTHROW.
Referenced by L4::Ipc::Rcv_fpage::io(), L4::Ipc::Snd_fpage::io(), and l4util_ioport_map().
Here is the caller graph for this function:



13.1.4.3.16 l4_is_fpage_valid()

```
L4_CONSTEXPR int l4_is_fpage_valid (
             l4_fpage_t fp)  [inline]
```

Test if the flexpage is valid.

Parameters

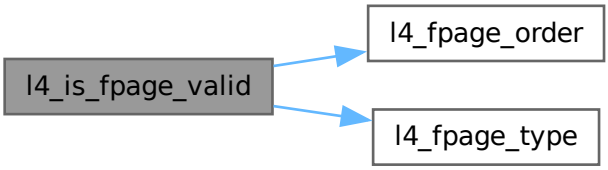
fp	Flexpage.

Return values

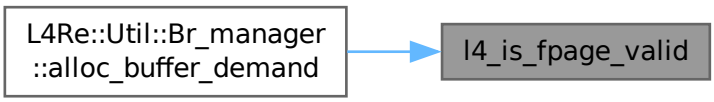
!=0	if flexpage is valid.
==0	if flexpage is not valid.

Definition at line 824 of file __l4_fpage.h.
References l4_fpage_order(), L4_FPAGE_SPECIAL, l4_fpage_type(), and L4_NOTHROW.
Referenced by L4Re::Util::Br_manager::alloc_buffer_demand().

Here is the call graph for this function:



Here is the caller graph for this function:



13.1.4.3.17 l4_is_fpage_writable()

```
L4_CONSTEXPR int l4_is_fpage_writable (
             l4_fpage_t fp)  [inline]
```

Test if the flexpage is writable.

Parameters

fp	Flexpage.

Return values

!=0	if flexpage is writable.
==0	if flexpage is not writable.

Definition at line 773 of file __l4_fpage.h.
References l4_fpage_rights(), L4_FPAGE_W, and L4_NOTHROW.

Here is the call graph for this function:



13.1.4.3.18 l4_obj_fpage()

```
L4_CONSTEXPR l4_fpage_t l4_obj_fpage (
             l4_cap_idx_t obj,
             unsigned int order,
             unsigned char rights)  [inline]
```

Create a kernel-object flexpage.

Parameters

obj	Base capability index.
order	Log2 size (number of capabilities).
rights	Access rights, see L4_cap_fpage_rights

Returns

Flexpage for a set of kernel objects.

Note

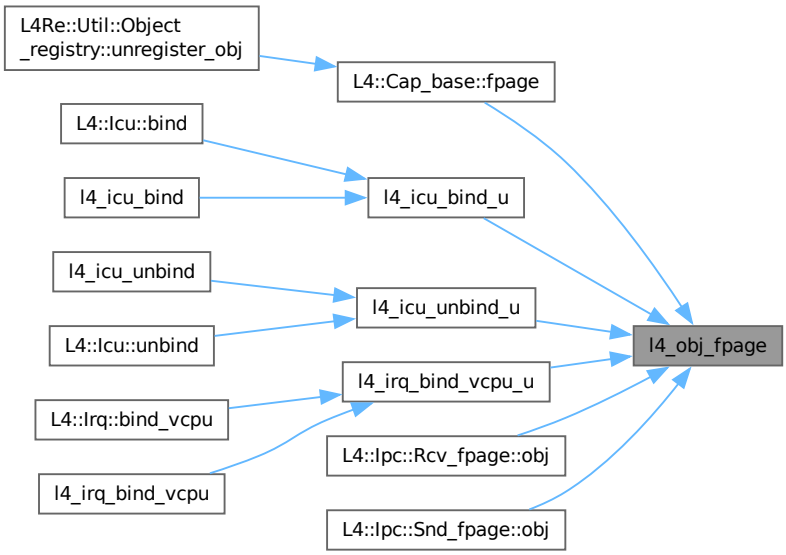
L4_CAP_FPAGE_R is always required, otherwise no capability is mapped.

Examples

examples/sys/utcb-ipc/main.c.

Definition at line 752 of file __l4_fpage.h.
References L4_CAP_SHIFT, L4_FPAGE_ADDR_SHIFT, L4_FPAGE_OBJ, and L4_NOTHROW.
Referenced by L4::Cap_base::fpage(), l4_icu_bind_u(), l4_icu_unbind_u(), l4_irq_bind_vcpu_u(), L4::Ipc::Rcv_fpage::obj(), and L4::Ipc::Snd_fpage::obj().

Here is the caller graph for this function:



13.1.5 C++ IPC Interface Definition

APIs for defining IPC interfaces using C++ as language.
Collaboration diagram for C++ IPC Interface Definition:



Topics

- Internal•Helpers 186

Namespaces

- namespace L4::Typeid

  Definition of interface data-type helpers.

13.1.5.1 Detailed Description

APIs for defining IPC interfaces using C++ as language.

13.1.5.2 Internal Helpers

Collaboration diagram for Internal Helpers:



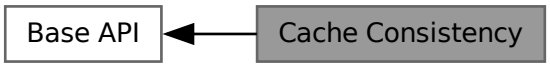
Data Structures

- struct L4::Types::Bool< V >
  Boolean meta type.
- struct L4::Types::False
  False meta value.
- struct L4::Types::True
  True meta value.
- struct L4::Types::Same< A, B >
  Compare two data types for equality.

13.1.5.2.1 Detailed Description

13.1.6 Cache Consistency

Various functions for cache consistency.
Collaboration diagram for Cache Consistency:



Functions

- L4_BEGIN_DECLS int l4_cache_clean_data (unsigned long start, unsigned long end) L4_NOTHROW
  Cache clean a range in D-cache; writes back to PoC.
- int l4_cache_flush_data (unsigned long start, unsigned long end) L4_NOTHROW
  Cache flush a range; writes back to PoC.
- int l4_cache_inv_data (unsigned long start, unsigned long end) L4_NOTHROW
  Cache invalidate a range; might write back to PoC.
- int l4_cache_coherent (unsigned long start, unsigned long end) L4_NOTHROW
  Make memory coherent between I-cache and D-cache; writes back to PoU.
- int l4_cache_dma_coherent (unsigned long start, unsigned long end) L4_NOTHROW
  Make memory coherent for use with external memory; writes back to PoC.
- int **l4_cache_dma_coherent_full** (void) L4_NOTHROW
  Make memory coherent for use with external memory; writes back to PoC.

13.1.6.1 Detailed Description

Various functions for cache consistency.
These functions shall be used to ensure that

- all blocks (e.g. CPU cores, devices, DMA engines) are guaranteed to see the same copy of a memory location (Point of Coherency – PoC),
- instruction and data caches of a core are guaranteed to see the same copy of a memory location (Point of Unification – PoU).

Certain functions are NOPs on certain architectures, for example on Intel it's not necessary to explicitly make caches coherent to PoU.

13.1.6.2 Function Documentation

13.1.6.2.1 l4_cache_clean_data()

```
L4_BEGIN_DECLS int l4_cache_clean_data (
             unsigned long start,
             unsigned long end)  [inline]
```

Cache clean a range in D-cache; writes back to PoC.

Parameters

start	Start of range (inclusive)
end	End of range (exclusive)

Return values

0	on success
-EFAULT	in the case of an unresolved page fault in the given area

Writes back any dirty cache lines in the range but leaves them in the cache and marks the cached copies clean.

Examples

examples/libs/l4re/c++/shared_ds/ds_clnt.cc.

Definition at line 68 of file cache.h.
References L4_NOTHROW.

13.1.6.2.2 l4_cache_coherent()

```
int l4_cache_coherent (
             unsigned long start,
             unsigned long end)  [inline]
```

Make memory coherent between I-cache and D-cache; writes back to PoU.

Parameters

start	Start of range (inclusive)
end	End of range (exclusive)

Return values

0	on success
-EFAULT	in the case of an unresolved page fault in the given area

Definition at line 92 of file cache.h.
References L4_NOTHROW.

13.1.6.2.3 l4_cache_dma_coherent()

```
int l4_cache_dma_coherent (
             unsigned long start,
             unsigned long end)  [inline]
```

Make memory coherent for use with external memory; writes back to PoC.

Parameters

start	Start of range (inclusive)
end	End of range (exclusive)

Return values

0	on success
-EFAULT	in the case of an unresolved page fault in the given area

Definition at line 100 of file cache.h.
References L4_NOTHROW.

13.1.6.2.4 l4_cache_flush_data()

```
int l4_cache_flush_data (
             unsigned long start,
             unsigned long end)  [inline]
```

Cache flush a range; writes back to PoC.

Parameters

start	Start of range (inclusive)
end	End of range (exclusive)

Return values

0	on success
-EFAULT	in the case of an unresolved page fault in the given area

Writes back any dirty cache lines and invalidates all cache entries in the range.
Definition at line 76 of file cache.h.
References L4_NOTHROW.

13.1.6.2.5 l4_cache_inv_data()

```
int l4_cache_inv_data (
            unsigned long start,
            unsigned long end)  [inline]
```

Cache invalidate a range; might write back to PoC.

Parameters

start	Start of range (inclusive)
end	End of range (exclusive)

Return values

0	on success
-EFAULT	in the case of an unresolved page fault in the given area

Invalidates all cache entries in the range but does not necessarily write back dirty cache lines.

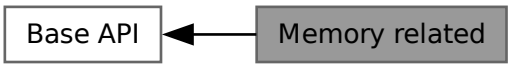
Note

Implementations may choose to write back dirty lines nonetheless if this is more efficient.

Definition at line 84 of file cache.h.
References L4_NOTHROW.

13.1.7 Memory related

Memory related constants, data types and functions.
Collaboration diagram for Memory related:



Macros

- #define **L4_PAGESIZE**

  Minimal page size (in bytes).
- #define L4_PAGEMASK

  Mask for the page number.
- #define L4_LOG2_PAGESIZE

  Number of bits used for page offset.
- #define L4_SUPERPAGESIZE

  Size of a large page.
- #define L4_SUPERPAGEMASK

  Mask for the number of a large page.
- #define L4_LOG2_SUPERPAGESIZE

Number of bits used as offset for a large page.

- #define **L4_INVALID_PTR** ((void *)L4_INVALID_ADDR)

  Invalid address as pointer type.
- #define L4_PAGESHIFT 12

  Size of a page, log2-based.
- #define L4_SUPERPAGESHIFT 21

  Size of a large page, log2-based.
- #define L4_PAGESHIFT 12

  Size of a page, log2-based.
- #define L4_SUPERPAGESHIFT 21

  Size of a large page, log2-based.
- #define L4_PAGESHIFT 12

  Size of a page, log2-based.
- #define L4_SUPERPAGESHIFT 21

  Size of a large page, log2-based.
- #define L4_PAGESHIFT 12

  Size of a page log2-based.
- #define L4_SUPERPAGESHIFT 22

  Size of a large page log2-based.
- #define **L4_PAGESHIFT** 12

  Sizeof a page in log2.
- #define **L4_SUPERPAGESHIFT** 21

  Sizeof a large page in log2.

Enumerations

- enum l4_addr_consts_t { L4_INVALID_ADDR = ~0UL }

  Address related constants.

Functions

- l4_addr_t l4_trunc_page (l4_addr_t address) L4_NOTHROW

  Round an address down to the next lower page boundary.
- l4_addr_t l4_trunc_size (l4_addr_t address, unsigned char bits) L4_NOTHROW

  Round an address down to the next lower flexpage with size bits.
- l4_addr_t l4_round_page (l4_addr_t address) L4_NOTHROW

  Round address up to the next page.
- l4_addr_t l4_round_size (l4_addr_t value, unsigned char bits) L4_NOTHROW

  Round value up to the next alignment with bits size.
- unsigned l4_bytes_to_mwords (unsigned size) L4_NOTHROW

  Determine how many machine words (l4_umword_t) are required to store a buffer of 'size' bytes.

13.1.7.1 Detailed Description

Memory related constants, data types and functions.

13.1.7.2 Macro Definition Documentation

13.1.7.2.1 L4_LOG2_PAGESIZE

```
#define L4_LOG2_PAGESIZE
```

Number of bits used for page offset.
Size of page in log2.
Definition at line 426 of file consts.h.
Referenced by L4Re::Dataspace::map(), L4Re::Dataspace::map_region(), and L4Re::Util::Dataspace_svr::page_shift().

13.1.7.2.2 L4_LOG2_SUPERPAGESIZE

```
#define L4_LOG2_SUPERPAGESIZE
```

Number of bits used as offset for a large page.
Size of large page in log2
Definition at line 452 of file consts.h.

13.1.7.2.3 L4_PAGEMASK

```
#define L4_PAGEMASK
```

Mask for the page number.

Note

The most significant bits are set.

Definition at line 417 of file consts.h.
Referenced by L4virtio::Driver::Device::driver_connect(), l4_round_page(), and l4_trunc_page().

13.1.7.2.4 L4_PAGESHIFT [1/4]

```
#define L4_PAGESHIFT 12
```

Size of a page, log2-based.
Sizeof a page in log2.
Size of a page log2-based.
Definition at line 24 of file consts.h.

13.1.7.2.5 L4_PAGESHIFT [2/4]

```
#define L4_PAGESHIFT 12
```

Size of a page, log2-based.
Sizeof a page in log2.
Size of a page log2-based.

Examples

examples/libs/l4re/c++/mem_alloc/ma+rm.cc, examples/libs/l4re/c/ma+rm.c, examples/libs/l4re/streammap/client.cc, and examples/libs/l4re/streammap/server.cc.

Definition at line 26 of file consts.h.
Referenced by L4Re::Rm::attach(), L4virtio::Driver::Device::driver_connect(), L4Re::Rm::free_area(), L4Re::Util::Dataspace_svr::map L4Re::Rm::reserve_area(), and L4Re::Rm::reserve_area().

13.1.7.2.6 L4_PAGESHIFT [3/4]

```
#define L4_PAGESHIFT 12
```

Size of a page, log2-based.
Sizeof a page in log2.
Size of a page log2-based.
Definition at line 26 of file consts.h.

13.1.7.2.7 L4_PAGESHIFT [4/4]

```
#define L4_PAGESHIFT 12
```

Size of a page log2-based.
Sizeof a page in log2.
Definition at line 24 of file consts.h.

13.1.7.2.8 L4_SUPERPAGEMASK

```
#define L4_SUPERPAGEMASK
```

Mask for the number of a large page.

Note

The most significant bits are set.

Definition at line 444 of file consts.h.

13.1.7.2.9 L4_SUPERPAGESHIFT [1/4]

```
#define L4_SUPERPAGESHIFT 21
```

Size of a large page, log2-based.
Sizeof a large page in log2.
Size of a large page log2-based.
Definition at line 30 of file consts.h.

13.1.7.2.10 L4_SUPERPAGESHIFT [2/4]

```
#define L4_SUPERPAGESHIFT 21
```

Size of a large page, log2-based.
Sizeof a large page in log2.
Size of a large page log2-based.

Examples

examples/libs/l4re/c++/mem_alloc/ma+rm.cc, and examples/libs/l4re/c/ma+rm.c.

Definition at line 31 of file consts.h.
Referenced by L4Re::Dma_space_mgr::block_area(), L4virtio::Svr::Driver_mem_region_t< No_custom_data >::Driver_mem_region_
and L4Re::Dma_space::map().

13.1.7.2.11 L4_SUPERPAGESHIFT [3/4]

```
#define L4_SUPERPAGESHIFT 21
```

Size of a large page, log2-based.
Sizeof a large page in log2.
Size of a large page log2-based.
Definition at line 31 of file consts.h.

13.1.7.2.12 L4_SUPERPAGESHIFT [4/4]

```
#define L4_SUPERPAGESHIFT 22
```

Size of a large page log2-based.
Sizeof a large page in log2.
Definition at line 30 of file consts.h.

13.1.7.2.13 L4_SUPERPAGESIZE

```
#define L4_SUPERPAGESIZE
```

Size of a large page.
A large page is a *super page* on IA32 or a *section* on ARM.
Definition at line 435 of file consts.h.
Referenced by L4virtio::Driver::Device::driver_connect().

13.1.7.3 Enumeration Type Documentation

13.1.7.3.1 l4_addr_consts_t

```
enum l4_addr_consts_t
```

Address related constants.

Enumerator

L4_INVALID_ADDR	Invalid address.

Definition at line 520 of file consts.h.

13.1.7.4 Function Documentation

13.1.7.4.1 l4_bytes_to_mwords()

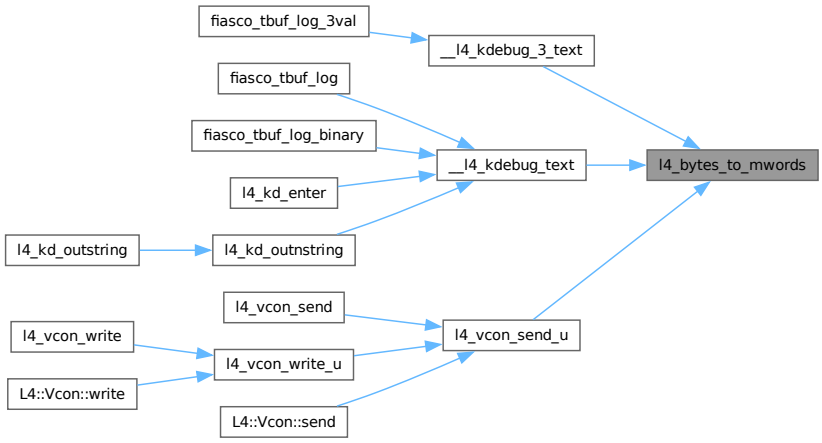
```
unsigned l4_bytes_to_mwords (
            unsigned size)  [inline]
```

Determine how many machine words (l4_umword_t) are required to store a buffer of 'size' bytes.

Parameters

size	The number of bytes to be translated into machine words.

Definition at line 513 of file consts.h.
References L4_INLINE, and L4_NOTHROW.
Referenced by __l4_kdebug_3_text(), __l4_kdebug_text(), and l4_vcon_send_u().
Here is the caller graph for this function:



13.1.7.4.2 l4_round_page()

```
l4_addr_t l4_round_page (
            l4_addr_t address)  [inline]
```

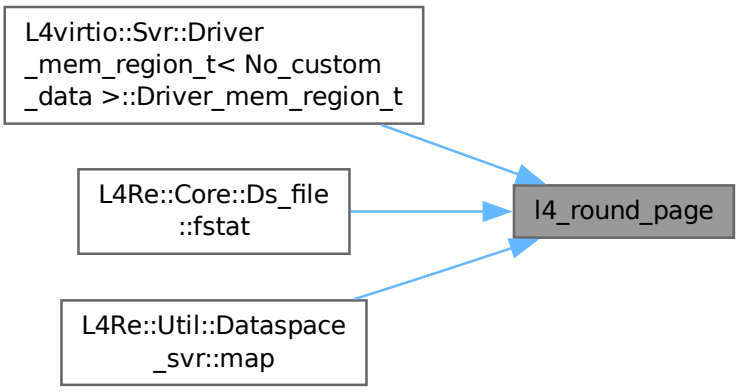
Round address up to the next page.
The address is rounded up to the next minimal page boundary. On most architectures this is a 4k page. Check L4_PAGESIZE for the minimal page size.

Parameters

address	The address to round up.

Definition at line 490 of file consts.h.
References L4_INLINE, L4_NOTHROW, L4_PAGEMASK, and L4_PAGESIZE.
Referenced by L4virtio::Svr::Driver_mem_region_t< No_custom_data >::Driver_mem_region_t(), L4Re::Core::Ds_file::fstat(), and L4Re::Util::Dataspace_svr::map().

Here is the caller graph for this function:



13.1.7.4.3 l4_round_size()

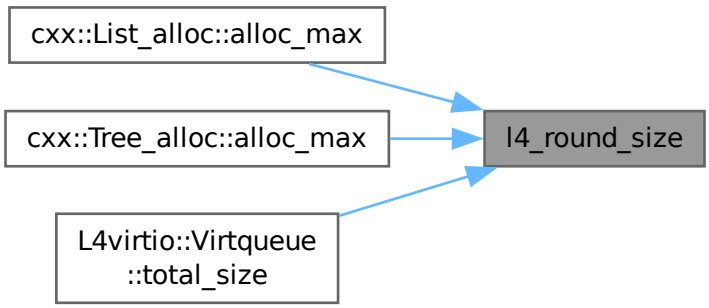
```
l4_addr_t l4_round_size (
             l4_addr_t value,
             unsigned char bits)  [inline]
```

Round value up to the next alignment with *bits* size.

Parameters

value	The value to round up to the next size-alignment.
bits	The size of the alignment (log2).

Definition at line 501 of file consts.h.
References L4_INLINE, and L4_NOTHROW.
Referenced by cxx::List_alloc::alloc_max(), cxx::Tree_alloc::alloc_max(), and L4virtio::Virtqueue::total_size().
Here is the caller graph for this function:



13.1.7.4.4 l4_trunc_page()

```
l4_addr_t l4_trunc_page (
            l4_addr_t address)  [inline]
```

Round an address down to the next lower page boundary.
The address is rounded down to the next lower minimal page boundary. On most architectures this is a 4k page. Check L4_PAGESIZE for the minimal page size.

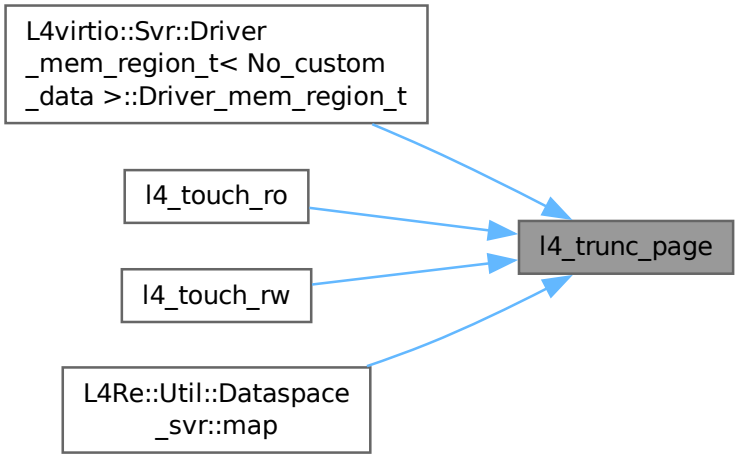
Parameters

address	The address to round.

Examples

examples/libs/l4re/c++/mem_alloc/ma+rm.cc, and examples/libs/l4re/c/ma+rm.c.

Definition at line 465 of file consts.h.
References L4_INLINE, L4_NOTHROW, and L4_PAGEMASK.
Referenced by L4virtio::Svr::Driver_mem_region_t< No_custom_data >::Driver_mem_region_t(), l4_touch_ro(), l4_touch_rw(), and L4Re::Util::Dataspace_svr::map().
Here is the caller graph for this function:



13.1.7.4.5 l4_trunc_size()

```
l4_addr_t l4_trunc_size (
            l4_addr_t address,
            unsigned char bits)  [inline]
```

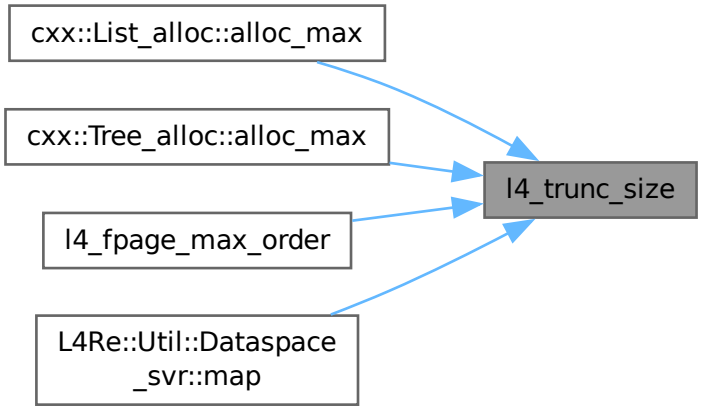
Round an address down to the next lower flexpage with size *bits*.

Parameters

address	The address to round.
bits	The size of the flexpage (log2).

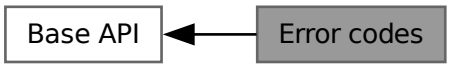
Definition at line 476 of file consts.h.

References L4_INLINE, and L4_NOTHROW.
Referenced by cxx::List_alloc::alloc_max(), cxx::Tree_alloc::alloc_max(), l4_fpage_max_order(), and L4Re::Util::Dataspace_svr::map(
Here is the caller graph for this function:



13.1.8 Error codes

Common error codes.
Collaboration diagram for Error codes:



Enumerations

- enum l4_error_code_t {
  L4_EOK = 0 , L4_EPERM = 1 , L4_ENOENT = 2 , L4_EIO = 5 ,
  L4_ENXIO = 6 , L4_E2BIG = 7 , L4_EAGAIN = 11 , L4_ENOMEM = 12 ,
  L4_EACCESS = 13 , L4_EFAULT = 14 , L4_EBUSY = 16 , L4_EEXIST = 17 ,
  L4_ENODEV = 19 , L4_ENOTDIR = 20 , L4_EINVAL = 22 , L4_ENOSPC = 28 ,
  L4_ERANGE = 34 , L4_EDEADLK = 35 , L4_ENAMETOOLONG = 36 , L4_ENOSYS = 38 ,
  L4_EBADPROTO = 39 , L4_EADDRNOTAVAIL = 99 , L4_ERRNOMAX = 100 , L4_ENOREPLY = 1000 ,
  L4_EMSGTOOSHORT = 1001 , L4_EMSGTOOLONG = 1002 , L4_EMSGMISSARG = 1003 ,
  L4_EMSGERRRANGE = 1004 ,
  L4_EDROPREPLY = 1005 , L4_EIPC_LO = 2000 , L4_EIPC_HI = 2000 + 0x1f }

  L4 error codes.

13.1.8.1 Detailed Description

Common error codes.

Include File

```
#include <l4/sys/err.h>
```

13.1.8.2 Enumeration Type Documentation

13.1.8.2.1 l4_error_code_t

`enum l4_error_code_t`

L4 error codes.

Those error codes are used by both the kernel and the user programs.

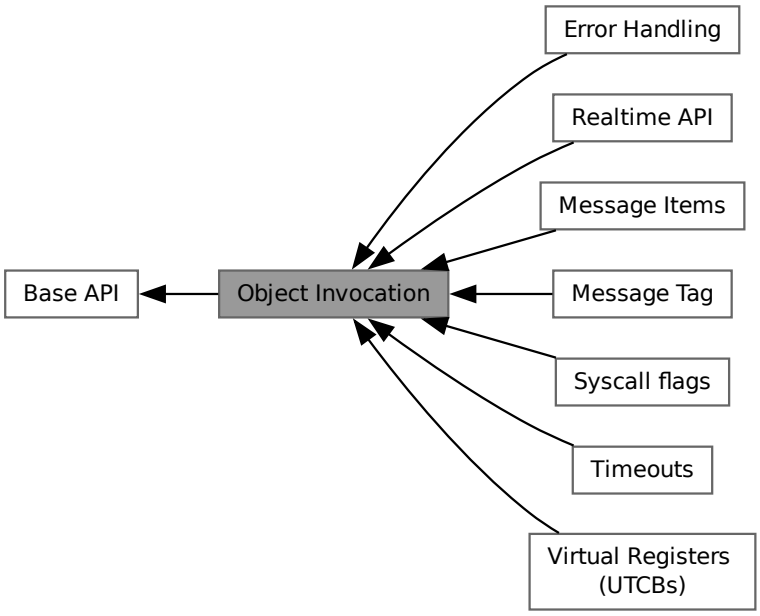
Enumerator

L4_EOK	Ok.
L4_EPERM	No permission.
L4_ENOENT	No such entity.
L4_EIO	I/O error.
L4_ENXIO	No such device or address.
L4_E2BIG	Argument value too big.
L4_EAGAIN	Try again.
L4_ENOMEM	No memory.
L4_EACCESS	Permission denied.
L4_EFAULT	Invalid memory address.
L4_EBUSY	Object currently busy, try later.
L4_EEXIST	Already exists.
L4_ENODEV	No such thing.
L4_ENOTDIR	Not a directory.
L4_EINVAL	Invalid argument.
L4_ENOSPC	No space left on device.
L4_ERANGE	Range error.
L4_EDEADLK	Deadlock would occur.
L4_ENAMETOOLONG	Name too long.
L4_ENOSYS	No sys.
L4_EBADPROTO	Unsupported protocol.
L4_EADDRNOTAVAIL	Address not available.
L4_ERRNOMAX	Maximum error value.
L4_ENOREPLY	No reply.
L4_EMSGTOOSHORT	Message too short.
L4_EMSGTOOLONG	Message too long.
L4_EMSGMISSARG	Message has invalid capability.
L4_EMSGERRRANGE	Error code range error.
L4_EDROPREPLY	Server dropped reply capability.
L4_EIPC_LO	Communication error-range low.
L4_EIPC_HI	Communication error-range high.

Definition at line 31 of file err.h.

13.1.9 Object Invocation

API for L4 object invocation.
Collaboration diagram for Object Invocation:



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- Message Items . . . 213
  Message-item-related functionality.
- Timeouts . . . 220
  All kinds of timeouts and time related functions.
- Syscall flags . . . 228
  These flags determine the concrete operation when a kernel object is invoked.
- Error Handling . . . 230
  Error handling for L4 object invocation.
- Realtime API . . . 235
- Message Tag . . . 235
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  L4 Virtual Registers (UTCB).

Files

- file utcb.h

  UTCB definitions.

Functions

- l4_msgtag_t l4_ipc_send (l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag, l4_timeout_t timeout) L4_NOTHROW

  *Send a message to an object (do **not** wait for a reply).*
- l4_msgtag_t l4_ipc_wait_ext (l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Wait for an incoming message from any possible sender.
- l4_msgtag_t **l4_ipc_wait** (l4_utcb_t *utcb, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Same as l4_ipc_wait_ext() with `reply_cap` set to L4_INVALID_CAP to specify the implicit reply capability.
- l4_msgtag_t l4_ipc_receive (l4_cap_idx_t object, l4_utcb_t *utcb, l4_timeout_t timeout) L4_NOTHROW

  Wait for a message from a specific source.
- l4_msgtag_t l4_ipc_call (l4_cap_idx_t object, l4_utcb_t *utcb, l4_msgtag_t tag, l4_timeout_t timeout) L4_NOTHROW

  Object call (usual invocation).
- l4_msgtag_t l4_ipc_reply (l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_msgtag_t tag, l4_timeout_t timeout) L4_NOTHROW

  Reply operation (uses a reply capability).
- l4_msgtag_t l4_ipc_reply_and_wait_ext (l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_msgtag_t tag, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Reply and wait operation (uses the reply capability).
- l4_msgtag_t **l4_ipc_reply_and_wait** (l4_utcb_t *utcb, l4_msgtag_t tag, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Same as l4_ipc_reply_and_wait_ext() with `reply_cap` set to L4_INVALID_CAP to specify the implicit reply capability.
- l4_msgtag_t l4_ipc_send_and_wait (l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Send a message and do an open wait.
- l4_msgtag_t l4_ipc (l4_cap_idx_t dest, l4_utcb_t *utcb, l4_umword_t flags, l4_umword_t slabel, l4_msgtag_t tag, l4_umword_t *rlabel, l4_timeout_t timeout) L4_NOTHROW

  Generic L4 object invocation.
- l4_msgtag_t l4_ipc_sleep (l4_timeout_t timeout) L4_NOTHROW

  Sleep for an amount of time.
- l4_msgtag_t l4_ipc_sleep_ms (l4_uint32_t ms) L4_NOTHROW

  Sleep for a certain amount of milliseconds.
- l4_msgtag_t l4_ipc_sleep_us (l4_uint64_t us) L4_NOTHROW

  Sleep for a certain amount of microseconds.
- int l4_sndfpage_add (l4_fpage_t const snd_fpage, unsigned long snd_base, l4_msgtag_t *tag) L4_NOTHROW

  Add a flexpage to be sent to the UTCB.

13.1.9.1 Detailed Description

API for L4 object invocation.

Include File

```
#include <l4/sys/ipc.h>
```

General abstractions for L4 object invocation. The basic principle is that all objects are denoted by a capability that is accessed via a capability selector (see Capabilities).
This set of functions is common to all kinds of objects provided by the L4 micro kernel. The concrete semantics of an invocation depends on the object that shall be invoked.
Objects may be invoked in various ways, the most common way is to use a *call* operation (l4_ipc_call()). However, there are a lot more flavours available that have a semantics depending on the object.

See also

IPC-Gate API

L4 Inter-Process Communication (IPC)

13.1.9.2 Timeouts during IPC

IPC operation between two communication partners may consist of up to two phases (send phase and receive phase). For both phases, a timeout may be specified (send timeout and receive timeout).

Note

When IPC communication happens across CPU cores and a timeout is specified, then the counting of the timeout only begins after the target thread has been scheduled at least once. In particular, this means that an IPC timeout, including a timeout of zero, may be delayed depending on the scheduling on the target CPU core. If a higher priority thread on the target core is executing a busy loop, that delay may even be indefinitely.

See also

Timeouts

13.1.9.3 Function Documentation

13.1.9.3.1 l4_ipc()

```
l4_msgtag_t l4_ipc (
             l4_cap_idx_t dest,
             l4_utcb_t * utcb,
             l4_umword_t flags,
             l4_umword_t slabel,
             l4_msgtag_t tag,
             l4_umword_t * rlabel,
             l4_timeout_t timeout)  [inline]
```

Generic L4 object invocation.

Parameters

	dest	Destination object. L4_INVALID_CAP denotes the current thread. An IPC to the current thread will always abort after the specified timeout and can be used for sleeping without busy waiting.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
	flags	Invocation flags (see L4_SYSF_NONE).
	slabel	Send label if applicable (may be seen by the receiver).
	tag	Sending message tag.
out	*rlabel*	Receiving label.
	timeout	Timeout pair (see l4_timeout_t).

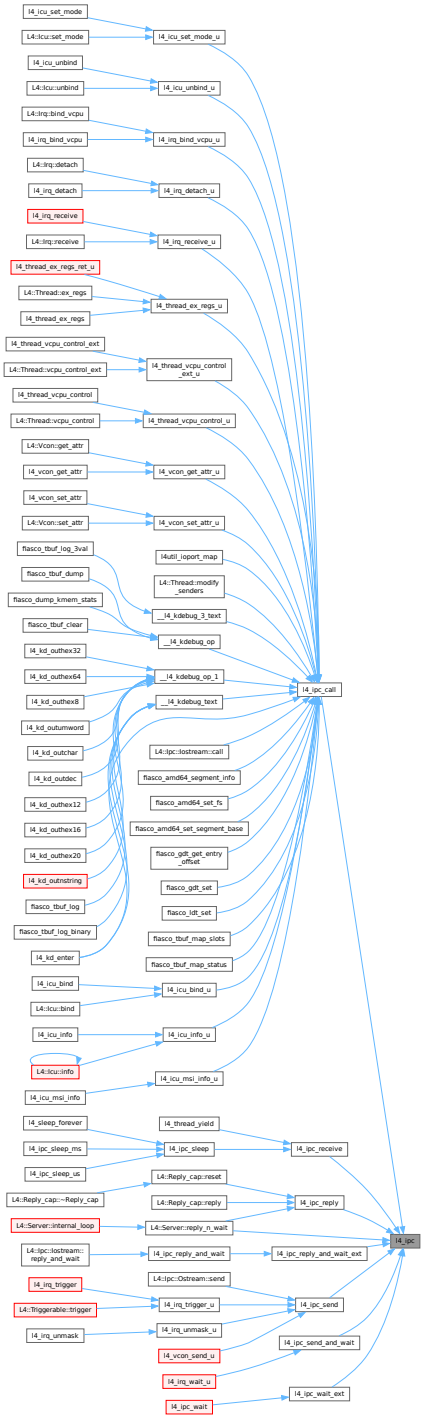
Returns

return tag

See also

L4 Inter-Process Communication (IPC)

Definition at line 19 of file ipc.h.
References L4_NOTHROW.
Referenced by l4_ipc_call(), l4_ipc_receive(), l4_ipc_reply(), l4_ipc_reply_and_wait_ext(), l4_ipc_send(), l4_ipc_send_and_wait(), l4_ipc_wait_ext(), and L4::Server< LOOP_HOOKS >::reply_n_wait().
Here is the caller graph for this function:



13.1.9.3.2 l4_ipc_call()

```
l4_msgtag_t l4_ipc_call (
             l4_cap_idx_t object,
             l4_utcb_t * utcb,
             l4_msgtag_t tag,
             l4_timeout_t timeout)  [inline]
```

Object call (usual invocation).

Parameters

object	Capability selector for the object to call. A value of L4_INVALID_CAP denotes the current thread and will abort the IPC after the time specified in the `snd` part of the `timeout` parameter has expired.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
tag	Message tag to describe the message to be sent.
timeout	Timeout pair for send and receive phase (see l4_timeout_t).

Returns

result tag

A message is sent to the object and the invoker waits for a reply from the object. Messages from other sources are not accepted.

Note

The send-to-receive transition needs no time, the object can reply with a send timeout of zero.

If a finite receive timeout is specified, the IPC receive operation could abort before the partner was able to send the reply message. Under certain circumstances the partner may still have the temporary reply capability to the calling thread and may use this capability to reply to the caller at a later, unexpected time specifying an arbitrary IPC label. This case is relevant for servers which call another, possibly untrusted, server while serving a client request.

See also

L4 Inter-Process Communication (IPC)

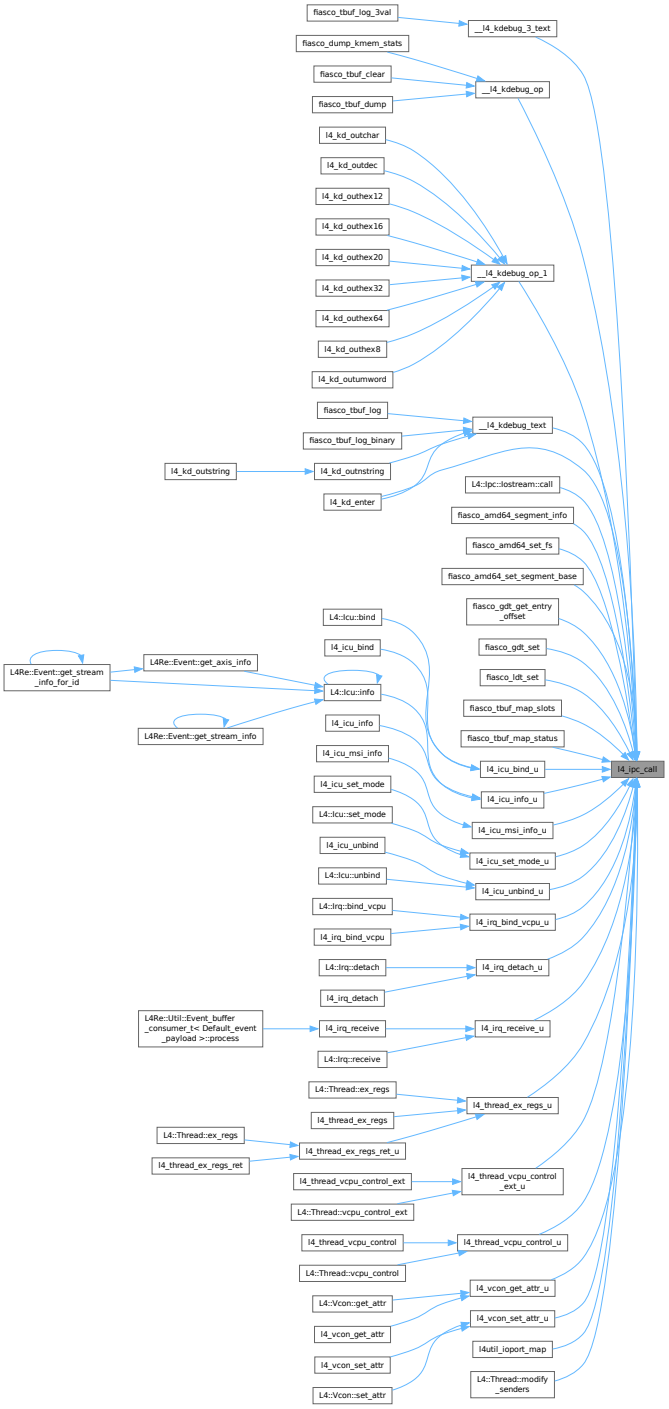
Examples

examples/sys/aliens/main.c, examples/sys/ipc/ipc_example.c, and examples/sys/singlestep/main.c.

Definition at line 625 of file ipc.h.
References l4_ipc(), L4_NOTHROW, and L4_SYSF_CALL.
Referenced by __l4_kdebug_3_text(), __l4_kdebug_op(), __l4_kdebug_op_1(), __l4_kdebug_text(), L4::Ipc::Iostream::call(), fiasco_amd64_segment_info(), fiasco_amd64_set_fs(), fiasco_amd64_set_segment_base(), fiasco_gdt_get_entry_offset(), fiasco_gdt_set(), fiasco_ldt_set(), fiasco_tbuf_map_slots(), fiasco_tbuf_map_status(), l4_icu_bind_u(), l4_icu_info_u(), l4_icu_msi_info_u(), l4_icu_set_mode_u(), l4_icu_unbind_u(), l4_irq_bind_vcpu_u(), l4_irq_detach_u(), l4_irq_receive_u(), l4_kd_enter(), l4_thread_ex_regs_u(), l4_thread_vcpu_control_ext_u(), l4_thread_vcpu_control_u(), l4_vcon_get_attr_u(), l4_vcon_set_attr_u(), l4util_ioport_map(), and L4::Thread::modify_senders().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.3 l4_ipc_receive()

```
l4_msgtag_t l4_ipc_receive (
            l4_cap_idx_t object,
            l4_utcb_t * utcb,
            l4_timeout_t timeout)  [inline]
```

Wait for a message from a specific source.

Parameters

object	Thread or IRQ object to receive a message from. A value of L4_INVALID_CAP denotes the current thread. This can be used for sleeping without busy waiting for the time specified in the `rcv` part of the `timeout` parameter.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
timeout	Timeout pair (see l4_timeout_t, only the receive part matters).

Returns

result tag.

This operation waits for a message from the specified object. Messages from other sources are not accepted by this operation. The operation does not include a send phase, this means no message is sent to the object. See l4_ipc_wait() for general message receiving.

Note

This operation is used to receive messages from a specific IRQ or thread. Receiving from IPC gates or any other objects does not work. It is not common to use the receive-only IPC operation for normal client/server communication.

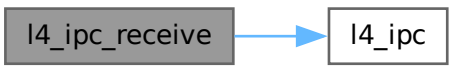
See also

L4 Inter-Process Communication (IPC)

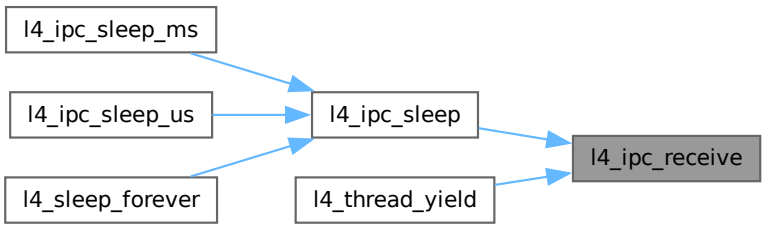
Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 686 of file ipc.h.
References l4_ipc(), L4_NOTHROW, L4_SYSF_RECV, and l4_msgtag_t::raw.
Referenced by l4_ipc_sleep(), and l4_thread_yield().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.4 l4_ipc_reply()

```
l4_msgtag_t l4_ipc_reply (
            l4_cap_idx_t reply_cap,
            l4_utcb_t * utcb,
            l4_msgtag_t tag,
            l4_timeout_t timeout)  [inline]
```

Reply operation (uses a *reply* capability).

Parameters

reply_cap	Reply capability selector. A value of L4_INVALID_CAP denotes the implicit reply capability of the current thread.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
tag	Describes the message to be sent as reply.
timeout	Timeout pair (see l4_timeout_t).

Returns

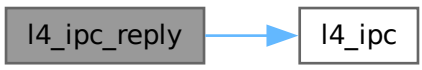
result tag

A message is sent to a previous caller using the given reply capability. The reply capability is always invalidated by the call, even if the IPC operation fails.

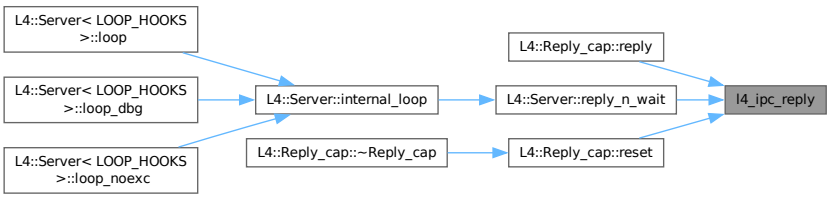
See also

L4 Inter-Process Communication (IPC)

Definition at line 632 of file ipc.h.
References l4_ipc(), L4_NOTHROW, L4_SYSF_REPLY, and L4_SYSF_SEND.
Referenced by L4::Reply_cap::reply(), L4::Server< LOOP_HOOKS >::reply_n_wait(), and L4::Reply_cap::reset().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.5 l4_ipc_reply_and_wait_ext()

```
l4_msgtag_t l4_ipc_reply_and_wait_ext (
             l4_cap_idx_t reply_cap,
             l4_utcb_t * utcb,
             l4_msgtag_t tag,
             l4_umword_t * label,
             l4_timeout_t timeout)  [inline]
```

Reply and wait operation (uses the *reply* capability).

Parameters

	reply_cap	Reply capability selector. A value of L4_INVALID_CAP denotes the implicit reply capability of the current thread.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
	tag	Describes the message to be sent as reply.
out	*label*	Label assigned to the source object of the received message.
	timeout	Timeout pair (see l4_timeout_t).

Returns

result tag

A message is sent to the previous caller using the implicit reply capability. Afterwards the invoking thread waits for a message from any source.

Note

This is the standard server operation: it sends a reply to the actual client and waits for the next incoming request, which may come from any other client.

In case of multiple senders trying to send to the thread performing this system call, the thread receives from a sender with the highest priority. In this respect, IRQ sources have the highest priority 255.

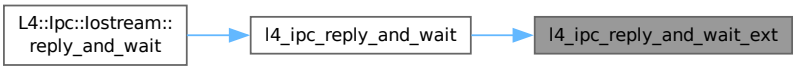
See also

L4 Inter-Process Communication (IPC)

Definition at line 640 of file ipc.h.
References l4_ipc(), L4_NOTHROW, and L4_SYSF_REPLY_AND_WAIT.
Referenced by l4_ipc_reply_and_wait().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.6 l4_ipc_send()

```
l4_msgtag_t l4_ipc_send (
              l4_cap_idx_t dest,
              l4_utcb_t * utcb,
              l4_msgtag_t tag,
              l4_timeout_t timeout)  [inline]
```

Send a message to an object (do **not** wait for a reply).

Parameters

dest	Capability selector for the destination object. A value of L4_INVALID_CAP denotes the current thread and could be used for sleeping without busy waiting for the time specified in the `snd` part of the `timeout` parameter.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
tag	Descriptor for the message to be sent.
timeout	Timeout pair (see l4_timeout_t) only send part is relevant.

Returns

Syscall return tag for the send-only operation, this means there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. Use l4_ipc_error() to check for errors and **do not** use l4_error().

A message is sent to the destination object. There is no receive phase included. The invoker continues working after sending the message.

Note

This is a special-purpose message transfer. Objects usually support only invocation via l4_ipc_call() consisting of a send phase and a receive phase for returning the result of the object invocation. For example, l4_icu_unmask(), l4_icu_mask() and l4_irq_trigger() use send-only IPC operations for object invocation.

See also

L4 Inter-Process Communication (IPC)

Examples

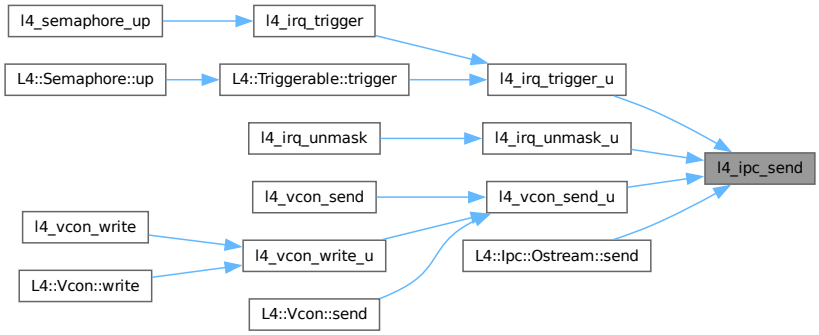
examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 663 of file ipc.h.
References l4_ipc(), L4_NOTHROW, and L4_SYSF_SEND.
Referenced by l4_irq_trigger_u(), l4_irq_unmask_u(), l4_vcon_send_u(), and L4::Ipc::Ostream::send().

Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.7 l4_ipc_send_and_wait()

```
l4_msgtag_t l4_ipc_send_and_wait (
              l4_cap_idx_t dest,
              l4_utcb_t * utcb,
              l4_msgtag_t tag,
              l4_umword_t * label,
              l4_timeout_t timeout)  [inline]
```

Send a message and do an open wait.

Parameters

	dest	Object to send a message to. A value of L4_INVALID_CAP denotes the current thread and will abort the IPC after the time specified in the `snd` part of the `timeout` parameter has expired.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
	tag	Describes the message that shall be sent.
`out`	*label*	Label assigned to the source object of the receive phase.
	timeout	Timeout pair (see l4_timeout_t).

Returns

result tag

A message is sent to the destination object and the invoking thread waits for a reply from any source.

Note

This is a special-purpose operation and shall not be used in general applications.

In case of multiple senders trying to send to the thread performing this system call, the thread receives from a sender with the highest priority. In this respect, IRQ sources have the highest priority 255.

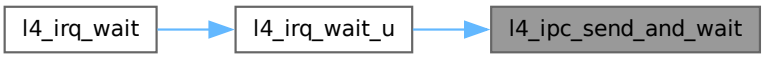
See also

L4 Inter-Process Communication (IPC)

Definition at line 656 of file ipc.h.
References l4_ipc(), L4_NOTHROW, and L4_SYSF_SEND_AND_WAIT.
Referenced by l4_irq_wait_u().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.8 l4_ipc_sleep()

```
l4_msgtag_t l4_ipc_sleep (
             l4_timeout_t timeout)  [inline]
```

Sleep for an amount of time.

Parameters

timeout	Timeout pair (see l4_timeout_t, the receive part matters).

Returns

error code:

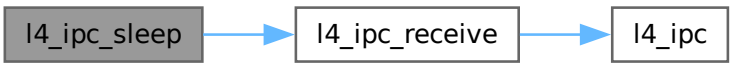
- L4_IPC_RETIMEOUT: success
- L4_IPC_RECANCELED woken up by a different thread (l4_thread_ex_regs()).

The invoking thread waits until the timeout is expired or the wait was aborted by another thread by l4_thread_ex_regs().

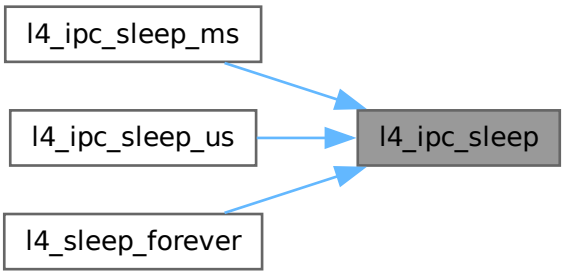
See also

L4 Inter-Process Communication (IPC)

Definition at line 695 of file ipc.h.
References L4_INVALID_CAP, l4_ipc_receive(), and L4_NOTHROW.
Referenced by l4_ipc_sleep_ms(), l4_ipc_sleep_us(), and l4_sleep_forever().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.9 l4_ipc_sleep_ms()

```
l4_msgtag_t l4_ipc_sleep_ms (
            l4_uint32_t ms)  [inline]
```

Sleep for a certain amount of milliseconds.

Parameters

ms	Number of milliseconds to wait.

Returns

error code:

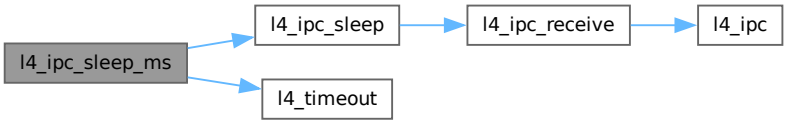
- L4_IPC_RETIMEOUT: success
- L4_IPC_RECANCELED woken up by a different thread (l4_thread_ex_regs()).

The invoking thread waits until the timeout is expired or the wait was aborted by another thread by l4_thread_ex_regs().

See also

L4 Inter-Process Communication (IPC)

Definition at line 699 of file ipc.h.
References l4_ipc_sleep(), L4_IPC_TIMEOUT_NEVER, L4_NOTHROW, and l4_timeout().
Here is the call graph for this function:



13.1.9.3.10 l4_ipc_sleep_us()

```
l4_msgtag_t l4_ipc_sleep_us (
            l4_uint64_t us)  [inline]
```

Sleep for a certain amount of microseconds.

Parameters

us	Number of microseconds to wait.

Returns

error code:

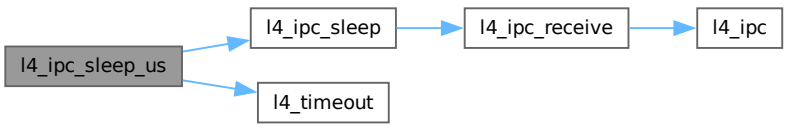
- L4_IPC_RETIMEOUT: success
- L4_IPC_RECANCELED woken up by a different thread (l4_thread_ex_regs()).

The invoking thread waits until the timeout is expired or the wait was aborted by another thread by l4_thread_ex_regs().

See also

L4 Inter-Process Communication (IPC)

Definition at line 706 of file ipc.h.
References l4_ipc_sleep(), L4_IPC_TIMEOUT_NEVER, L4_NOTHROW, and l4_timeout().
Here is the call graph for this function:



13.1.9.3.11 l4_ipc_wait_ext()

```
l4_msgtag_t l4_ipc_wait_ext (
             l4_cap_idx_t reply_cap,
             l4_utcb_t * utcb,
             l4_umword_t * label,
             l4_timeout_t timeout)  [inline]
```

Wait for an incoming message from any possible sender.

Parameters

	reply_cap	Reply capability selector. A value of L4_INVALID_CAP denotes the implicit reply capability of the current thread.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
out	*label*	Label assigned to the source object (IPC gate or IRQ).
	timeout	Timeout pair (see l4_timeout_t, only the receive part is used).

Returns

return tag

This operation does an open wait, and therefore needs no capability to denote the possible source of a message. This means the calling thread waits for an incoming message from any possible source. There is no send phase included in this operation.
The usual usage of this function is to call that function when entering a server loop in a user-level server that implements user-level objects, see also l4_ipc_reply_and_wait().

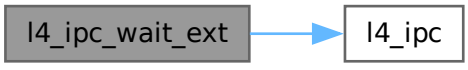
Note

In case of multiple senders trying to send to the thread performing this system call, the thread receives from a sender with the highest priority. In this respect, IRQ sources have the highest priority 255.

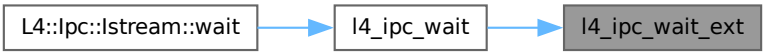
See also

L4 Inter-Process Communication (IPC)

Definition at line 670 of file ipc.h.
References l4_ipc(), L4_NOTHROW, L4_SYSF_WAIT, and l4_msgtag_t::raw.
Referenced by l4_ipc_wait().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.3.12 l4_sndfpage_add()

```
int l4_sndfpage_add (
            l4_fpage_t const snd_fpage,
            unsigned long snd_base,
            l4_msgtag_t * tag)  [inline]
```

Add a flexpage to be sent to the UTCB.

Parameters

	snd_fpage	Flexpage.
	snd_base	Send base.
in,out	*tag*	Tag to be updated. Only the number of items is incremented in the updated tag, all other members remain unmodified.

Returns

0 on success, negative error code otherwise

See also

L4 Inter-Process Communication (IPC)

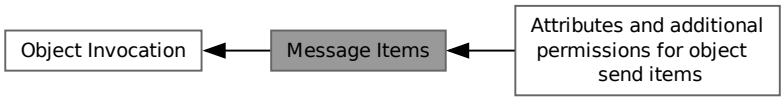
Definition at line 769 of file ipc.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.9.4 Message Items

Message-item-related functionality.

Collaboration diagram for Message Items:



Topics

- Attributes and additional permissions for object send items 219

  These rights need to be added to the snd_base when mapping and control internal behavior.

Data Structures

- struct l4_snd_fpage_t

  Send-flexpage types.

Enumerations

- enum l4_fpage_cacheability_opt_t { L4_FPAGE_CACHE_OPT = 0x1 , L4_FPAGE_CACHEABLE = 0x3 , L4_FPAGE_BUFFERABLE = 0x5 , L4_FPAGE_UNCACHEABLE = 0x1 }

  Cacheability options for memory send items.
- enum l4_msg_item_consts_t { L4_ITEM_MAP = 8 , L4_ITEM_CONT = 1 , L4_MAP_ITEM_GRANT = 2 , L4_MAP_ITEM_MAP = 0 , L4_RCV_ITEM_FORWARD_MAPPINGS = 1 , L4_RCV_ITEM_SINGLE_CAP = L4_ITEM_MAP | 2 , L4_RCV_ITEM_LOCAL_ID = 4 }

  Constants for message items.

Functions

- L4_CONSTEXPR l4_umword_t l4_map_control (l4_umword_t spot, unsigned char cache, unsigned grant) L4_NOTHROW

  Create the first word for a map item that is a send item for the memory space.
- L4_CONSTEXPR l4_umword_t l4_map_obj_control (l4_umword_t spot, unsigned grant) L4_NOTHROW

  Create the first word for a map item that is a send item for the object space.

13.1.9.4.1 Detailed Description

Message-item-related functionality.
Message items are typed items that are used for transferring capabilities during IPC. There are three sub-types of typed message items with variations in the layout:

1. Typed message items set by the sender in its message registers (MRs) of the UTCB for specifying what shall be sent.
2. Typed message items set by the receiver in its buffer registers (BRs) of the UTCB for specifying which types of capabilities may be received at which addresses.
3. Typed message items set by the kernel in the receiver's message registers (MRs) of the UTCB for providing information about the transfer to the receiver.

They are abbreviated by *send item*, *receive item*, and *return item*, respectively.
A typed message item in the message registers (case 1 and case 3) always consists of two words (even if it is a void item). The size of a typed message item in the buffer registers (case 2) is determined by its first word. The size is up to three words (see L4_RCV_ITEM_SINGLE_CAP and L4_RCV_ITEM_FORWARD_MAPPINGS). A void item in the buffer registers consists of a single word.

Include File

```
#include <l4/sys/types.h>
```

13.1.9.4.2 Enumeration Type Documentation

13.1.9.4.2.1 l4_fpage_cacheability_opt_t

`enum l4_fpage_cacheability_opt_t`
Cacheability options for memory send items.
Only the IPC sender and the thread performing the map operation can specify the caching mode of the target mapping. By default, the caching mode of the sender is used as caching mode for the target mapping. If L4_↩ FPAGE_CACHE_OPT is set in the send item, the caching mode is overridden by the respective mode from below.

Enumerator

L4_FPAGE_CACHE_OPT	Enable the cacheability option in a memory send item. Without this flag, the options are copied from the sender.
L4_FPAGE_CACHEABLE	Cacheability option to enable caches for the mapping. Implies L4_FPAGE_CACHE_OPT.
L4_FPAGE_BUFFERABLE	Cacheability option to enable buffered writes for the mapping. Implies L4_FPAGE_CACHE_OPT.
L4_FPAGE_UNCACHEABLE	Cacheability option to disable caching for the mapping. Implies L4_FPAGE_CACHE_OPT.

Definition at line 303 of file __l4_fpage.h.

13.1.9.4.2.2 l4_msg_item_consts_t

`enum l4_msg_item_consts_t`
Constants for message items.

Enumerator

L4_ITEM_MAP	Identify a message item as *map item*.
L4_ITEM_CONT	Denote that the following item shall be put into the same receive item as this one.

L4_MAP_ITEM_GRANT	Flag as *grant* instead of *map* operation. This means, the sender delegates access to the receiver and the kernel removes the rights from the sender (basically a move operation). The mapping in the receiver gets the new parent of any child mappings of the mapping of the sender. Rights revocation via send item/flexpage is *not* guaranteed to be applied to descendant mappings in case of grant. See Spaces and Mappings for more details on map/grant. **Note** The grant operation is not performed if the resulting rights of the receiver mapping would not contain the L4_CAP_FPAGE_R bit (for object capabilities) or none of the L4_FPAGE_RWX bits (memory and IO ports). In that case, the mapping is not created in the receiver space and not removed from the sender space. If the removal of the whole mapping from the sender is not possible because the size of the mapped frame at the sender exceeds the size defined by the send or receive flexpage, the grant operation is turned into a regular map operation and the mapping is *not* removed from the sender. This would happen if, for example, a smaller part of an L4 superpage mapping shall be granted.
L4_MAP_ITEM_MAP	Flag as usual *map* operation.
L4_RCV_ITEM_FORWARD_MAPPINGS	This flag specifies if received capabilities shall be mapped to a particular task instead of the invoking task. This flag may be used only if L4_RCV_ITEM_LOCAL_ID is unset. Setting this flag increases the size of the buffer item by one word. This word is used to specify a capability index for the task that shall receive the mappings.
L4_RCV_ITEM_SINGLE_CAP	Mark the receive buffer to be a small receive item that describes a buffer for a single object capability. A receive item needs to specify a *receive window*. The receive window determines which kind of capabilities (object, memory, I/O ports) may be received where in the respective space. If this flag is unset, the receive window is specified in the second word of the receive item via a flexpage. If this flag is set, the receive window consists of a single capability index in the object space and the capability index is specified in the most significant bits of the first word of the receive item (see L4_CAP_SHIFT).

L4_RCV_ITEM_LOCAL_ID	The receiver requests to receive a local ID instead of a mapping whenever possible. This flag may be used only if L4_RCV_ITEM_SINGLE_CAP is set and L4_RCV_ITEM_FORWARD_MAPPINGS is unset. When this flag is set, then, • when sender and receiver are bound to the same task, then no mapping is done for this item and just the raw flexpage (l4_fpage_t) is transferred, • otherwise, when the sender specified an IPC gate for transfer that is bound to a thread that is bound to the same task as the receiving thread, then no mapping is done for this item and just the bitwise OR (|) of the label and the L4_CAP_FPAGE_W and L4_CAP_FPAGE_S permissions that would have been mapped is transferred, • otherwise a regular mapping is done for this item.

Definition at line 229 of file consts.h.

13.1.9.4.3 Function Documentation

13.1.9.4.3.1 l4_map_control()

```
L4_CONSTEXPR l4_umword_t l4_map_control (
             l4_umword_t spot,
             unsigned char cache,
             unsigned grant)  [inline]
```

Create the first word for a map item that is a send item for the memory space.

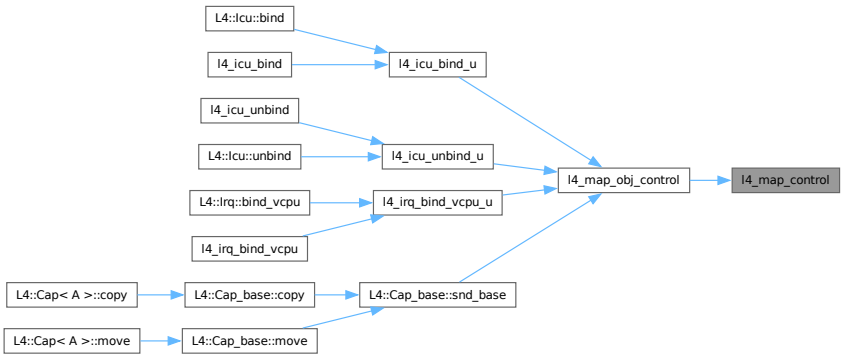
Parameters

spot	Hot spot address, used to determine what is actually mapped when send and receive flexpage have differing sizes.
cache	Cacheability hints for memory flexpages. See Cacheability options.
grant	Indicates if it is a map or a grant item. Allowed values: L4_MAP_ITEM_MAP, L4_MAP_ITEM_GRANT.

Returns

The value to be used as first word in a send item for memory.

Definition at line 779 of file __l4_fpage.h.
References L4_FPAGE_CONTROL_MASK, L4_ITEM_MAP, and L4_NOTHROW.
Referenced by l4_map_obj_control().
Here is the caller graph for this function:



13.1.9.4.3.2 l4_map_obj_control()

```
L4_CONSTEXPR l4_umword_t l4_map_obj_control (
             l4_umword_t spot,
             unsigned grant)  [inline]
```

Create the first word for a map item that is a send item for the object space.

Parameters

spot	Hot spot address, used to determine what is actually mapped when send and receive flexpages have different size.
grant	Indicates if it is a map item or a grant item. Allowed values: L4_MAP_ITEM_MAP, L4_MAP_ITEM_GRANT.

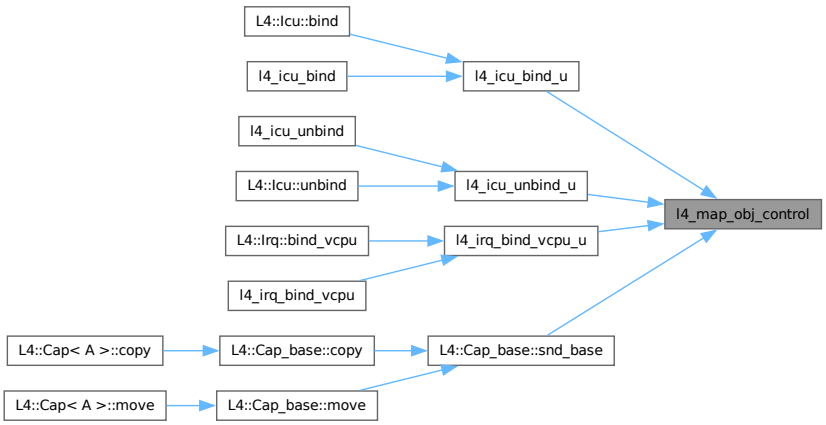
Returns

The value to be used as first word in a send item for kernel objects or IO-ports.

Definition at line 786 of file __l4_fpage.h.
References l4_map_control(), and L4_NOTHROW.
Referenced by l4_icu_bind_u(), l4_icu_unbind_u(), l4_irq_bind_vcpu_u(), and L4::Cap_base::snd_base().
Here is the call graph for this function:

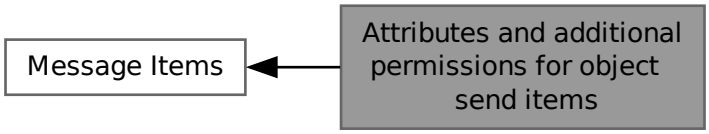


Here is the caller graph for this function:



13.1.9.4.4 Attributes and additional permissions for object send items

These rights need to be added to the snd_base when mapping and control internal behavior.
Collaboration diagram for Attributes and additional permissions for object send items:



Macros

- #define **L4_FPAGE_C_REF_CNT** 0x00

  Mapping is reference-counted (default).
- #define **L4_FPAGE_C_NO_REF_CNT** 0x10

  Don't increase the reference counter.
- #define **L4_FPAGE_C_OBJ_RIGHT1** 0x20

  Object-type specific right.
- #define **L4_FPAGE_C_OBJ_RIGHT2** 0x40

  Object-type specific right.
- #define **L4_FPAGE_C_OBJ_RIGHT3** 0x80

  Object-type specific right.
- #define **L4_FPAGE_C_OBJ_RIGHTS** 0xe0

  All Object-type specific right bits.
- #define L4_FPAGE_C_IPCGATE_SVR L4_FPAGE_C_OBJ_RIGHT1

  The receiver may invoke IPC-gate-specific functions on the capability, for example, bind a thread to the gate and modify the label.

13.1.9.4.4.1 Detailed Description

These rights need to be added to the snd_base when mapping and control internal behavior.
The exact meaning depends on the type of capability (currently used only with IPC gates).

13.1.9.4.4.2 Macro Definition Documentation

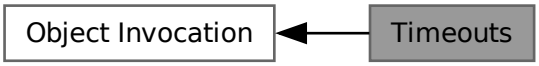
L4_FPAGE_C_IPCGATE_SVR

```
#define L4_FPAGE_C_IPCGATE_SVR L4_FPAGE_C_OBJ_RIGHT1
```

The receiver may invoke IPC-gate-specific functions on the capability, for example, bind a thread to the gate and modify the label.
Needed if the receiver implements the server side of an IPC gate.
Definition at line 288 of file __l4_fpage.h.

13.1.9.5 Timeouts

All kinds of timeouts and time related functions.
Collaboration diagram for Timeouts:



Data Structures

- struct l4_timeout_s
  Basic timeout specification.
- union l4_timeout_t
  Timeout pair.

Macros

- #define L4_IPC_TIMEOUT_0 ((l4_timeout_s){0x0400})
  Timeout constants.
- #define **L4_IPC_TIMEOUT_NEVER** ((l4_timeout_s){0})
  never timeout
- #define **L4_IPC_NEVER_INITIALIZER** {0}
  never timeout, initializer
- #define **L4_IPC_NEVER** ((l4_timeout_t){0})
  never timeout
- #define **L4_IPC_RECV_TIMEOUT_0** ((l4_timeout_t){0x00000400})
  0 receive timeout
- #define **L4_IPC_SEND_TIMEOUT_0** ((l4_timeout_t){0x04000000})
  0 send timeout
- #define **L4_IPC_BOTH_TIMEOUT_0** ((l4_timeout_t){0x04000400})
  0 receive and send timeout
- #define **L4_TIMEOUT_US_NEVER** (~0ULL)
  The waiting period in microseconds which is interpreted as "never" by l4_timeout_from_us().
- #define L4_TIMEOUT_US_MAX ((1ULL << 41) - 1)
  The longest waiting period in microseconds accepted by l4_timeout_from_us().

Typedefs

- typedef struct l4_timeout_s l4_timeout_s

  Basic timeout specification.
- typedef union l4_timeout_t l4_timeout_t

  Timeout pair.

Functions

- L4_CONSTEXPR l4_timeout_s l4_timeout_rel (unsigned man, unsigned exp) L4_NOTHROW

  Get relative timeout consisting of mantissa and exponent.
- L4_CONSTEXPR l4_timeout_t l4_ipc_timeout (unsigned snd_man, unsigned snd_exp, unsigned rcv_man, unsigned rcv_exp) L4_NOTHROW

  Convert explicit timeout values to l4_timeout_t type.
- L4_CONSTEXPR l4_timeout_t l4_timeout (l4_timeout_s snd, l4_timeout_s rcv) L4_NOTHROW

  Combine send and receive timeout in a timeout.
- L4_CONSTEXPR void l4_snd_timeout (l4_timeout_s snd, l4_timeout_t *to) L4_NOTHROW

  Set send timeout in given to timeout.
- L4_CONSTEXPR void l4_rcv_timeout (l4_timeout_s rcv, l4_timeout_t *to) L4_NOTHROW

  Set receive timeout in given to timeout.
- L4_CONSTEXPR l4_kernel_clock_t l4_timeout_rel_get (l4_timeout_s to) L4_NOTHROW

  Get clock value of out timeout.
- L4_CONSTEXPR unsigned l4_timeout_is_absolute (l4_timeout_s to) L4_NOTHROW

  Return whether the given timeout is absolute or not.
- L4_CONSTEXPR l4_kernel_clock_t l4_timeout_get (l4_kernel_clock_t cur, l4_timeout_s to) L4_NOTHROW

  Get clock value for a clock + a timeout.
- l4_timeout_s l4_timeout_abs (l4_kernel_clock_t pint, int br) L4_NOTHROW

  Set an absolute timeout.
- unsigned l4_utcb_mr64_idx (unsigned idx) L4_NOTHROW

  Get index into 64bit message registers alias from native-sized index.

13.1.9.5.1 Detailed Description

All kinds of timeouts and time related functions.

13.1.9.5.2 Macro Definition Documentation

13.1.9.5.2.1 L4_IPC_TIMEOUT_0

```
#define L4_IPC_TIMEOUT_0 ((l4_timeout_s){0x0400})
```

Timeout constants.
0 timeout
Definition at line 73 of file __timeout.h.
Referenced by L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >::timeout().

13.1.9.5.2.2 L4_TIMEOUT_US_MAX

```
#define L4_TIMEOUT_US_MAX ((1ULL << 41) - 1)
```

The longest waiting period in microseconds accepted by l4_timeout_from_us().
See l4_timeout_from_us() for an explanation.
Definition at line 91 of file __timeout.h.

13.1.9.5.3 Typedef Documentation

13.1.9.5.3.1 l4_timeout_s

```
typedef struct l4_timeout_s l4_timeout_s
```

Basic timeout specification.
If bit 15 == 0, basically a floating point number with 10 bits mantissa and 5 bits exponent (t = m∗2^e).
If the mantissa is zero, the exponent encodes special values, see L4_IPC_TIMEOUT_0 and L4_IPC_TIMEOUT_NEVER.
If bit 15 == 1 the timeout is absolute and the lower 6 bits encode the index of the UTCB buffer register(s) holding the absolute 64-bit timeout value. On 32-bit systems, two consecutive UTCB buffer registers are used.

13.1.9.5.3.2 l4_timeout_t

```
typedef union l4_timeout_t l4_timeout_t
```

Timeout pair.
For IPC there are usually a send and a receive timeout. So this structure contains a pair of timeouts.

13.1.9.5.4 Function Documentation

13.1.9.5.4.1 l4_ipc_timeout()

```
L4_CONSTEXPR l4_timeout_t l4_ipc_timeout (
             unsigned snd_man,
             unsigned snd_exp,
             unsigned rcv_man,
             unsigned rcv_exp)  [inline]
```

Convert explicit timeout values to l4_timeout_t type.

Parameters

snd_man	Mantissa of send timeout.
snd_exp	Exponent of send timeout.
rcv_man	Mantissa of receive timeout.
rcv_exp	Exponent of receive timeout.

Definition at line 207 of file __timeout.h.
References L4_NOTHROW, and l4_timeout().
Here is the call graph for this function:



13.1.9.5.4.2 l4_rcv_timeout()

```
L4_CONSTEXPR void l4_rcv_timeout (
             l4_timeout_s rcv,
             l4_timeout_t * to)  [inline]
```

Set receive timeout in given to timeout.

Parameters

	rcv	Receive timeout
out	*to*	L4 timeout

Definition at line 231 of file __timeout.h.
References L4_NOTHROW.

13.1.9.5.4.3 l4_snd_timeout()

```
L4_CONSTEXPR void l4_snd_timeout (
              l4_timeout_s snd,
              l4_timeout_t * to)  [inline]
```

Set send timeout in given to timeout.

Parameters

	snd	Send timeout
out	*to*	L4 timeout

Definition at line 224 of file __timeout.h.
References L4_NOTHROW.

13.1.9.5.4.4 l4_timeout()

```
L4_CONSTEXPR l4_timeout_t l4_timeout (
              l4_timeout_s snd,
              l4_timeout_s rcv)  [inline]
```

Combine send and receive timeout in a timeout.

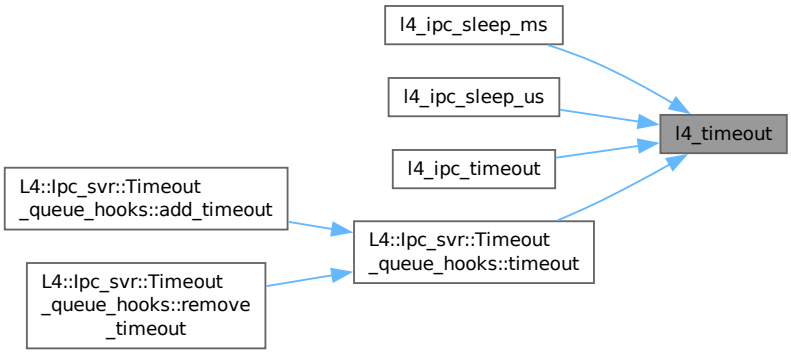
Parameters

snd	Send timeout
rcv	Receive timeout

Returns

L4 timeout

Definition at line 217 of file __timeout.h.
References L4_NOTHROW.
Referenced by l4_ipc_sleep_ms(), l4_ipc_sleep_us(), l4_ipc_timeout(), and L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN
Here is the caller graph for this function:



13.1.9.5.4.5 l4_timeout_abs()

```
l4_timeout_s l4_timeout_abs (
             l4_kernel_clock_t pint,
             int br)  [inline]
```

Set an absolute timeout.

Parameters

pint	Point in time in clocks
br	The buffer register the timeout shall be placed in. (

Note

On 32bit architectures the timeout needs two consecutive buffers.)

The absolute timeout value will be placed into the buffer register *br* of the current thread.

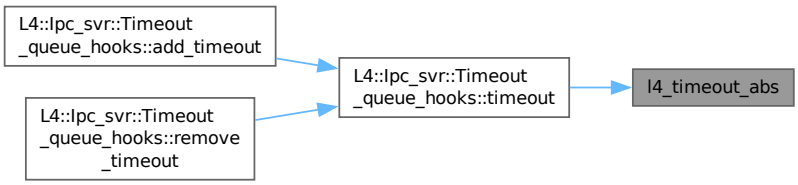
Returns

timeout value

Definition at line 412 of file utcb.h.
References L4_NOTHROW, and l4_utcb().
Referenced by L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >::timeout().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.5.4.6 l4_timeout_get()

```
L4_CONSTEXPR l4_kernel_clock_t l4_timeout_get (
             l4_kernel_clock_t cur,
             l4_timeout_s to)  [inline]
```

Get clock value for a clock + a timeout.

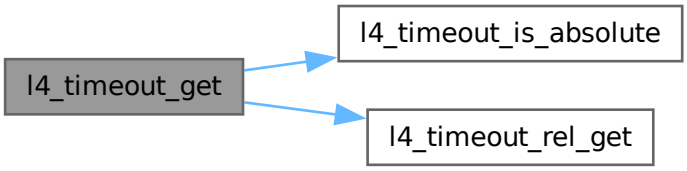
Parameters

cur	Clock value
to	L4 timeout

Returns

Clock sum

Definition at line 261 of file __timeout.h.
References L4_NOTHROW, l4_timeout_is_absolute(), and l4_timeout_rel_get().
Here is the call graph for this function:



13.1.9.5.4.7 l4_timeout_is_absolute()

```
L4_CONSTEXPR unsigned l4_timeout_is_absolute (
            l4_timeout_s to)  [inline]
```

Return whether the given timeout is absolute or not.

Parameters

to	L4 timeout

Returns

!= 0 if absolute, 0 if relative

Definition at line 254 of file __timeout.h.
References L4_NOTHROW.
Referenced by l4_timeout_get().
Here is the caller graph for this function:



13.1.9.5.4.8 l4_timeout_rel()

```
L4_CONSTEXPR l4_timeout_s l4_timeout_rel (
            unsigned man,
            unsigned exp)  [inline]
```

Get relative timeout consisting of mantissa and exponent.

Parameters

man	Mantissa of timeout
exp	Exponent of timeout

Returns

timeout value

Definition at line 238 of file __timeout.h.
References L4_NOTHROW.

13.1.9.5.4.9 l4_timeout_rel_get()

```
L4_CONSTEXPR l4_kernel_clock_t l4_timeout_rel_get (
            l4_timeout_s to)  [inline]
```

Get clock value of out timeout.

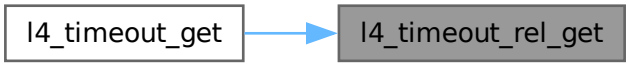
Parameters

to	L4 timeout

Returns

Clock value

Definition at line 245 of file __timeout.h.
References L4_NOTHROW.
Referenced by l4_timeout_get().
Here is the caller graph for this function:



13.1.9.5.4.10 l4_utcb_mr64_idx()

```
unsigned l4_utcb_mr64_idx (
            unsigned idx)  [inline]
```

Get index into 64bit message registers alias from native-sized index.

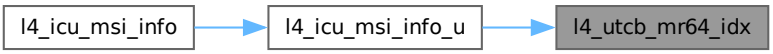
Parameters

idx	Index to native-sized message register

Returns

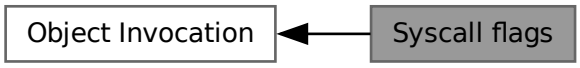
Index to 64bit message register alias

Definition at line 415 of file utcb.h.
References L4_INLINE, and L4_NOTHROW.
Referenced by l4_icu_msi_info_u().
Here is the caller graph for this function:



13.1.9.6 Syscall flags

These flags determine the concrete operation when a kernel object is invoked.
Collaboration diagram for Syscall flags:



Macros

- #define **L4_SYSF_NONE**

  Empty set of flags.
- #define L4_SYSF_SEND

  Send-phase flag.
- #define L4_SYSF_RECV

  Receive-phase flag.
- #define L4_SYSF_OPEN_WAIT

  Open-wait flag.
- #define L4_SYSF_REPLY

  Reply flag.
- #define L4_SYSF_CALL

  Call flags (combines send and receive).
- #define L4_SYSF_WAIT

  Wait flags (combines receive and open wait).
- #define L4_SYSF_SEND_AND_WAIT

  Send-and-wait flags.
- #define L4_SYSF_REPLY_AND_WAIT

  Reply-and-wait flags.

13.1.9.6.1 Detailed Description

These flags determine the concrete operation when a kernel object is invoked.
The following combinations of flags are supported when invoking IPC (see l4_ipc()); with other combinations, behavior is undefined:

- L4_SYSF_SEND: send to specified partner
- L4_SYSF_RECV: receive from specified partner
- L4_SYSF_RECV | L4_SYSF_OPEN_WAIT: receive from any sending partner; see L4_SYSF_WAIT
- L4_SYSF_SEND | L4_SYSF_RECV: call specified partner; see L4_SYSF_CALL
- L4_SYSF_SEND | L4_SYSF_RECV | L4_SYSF_OPEN_WAIT: send to specified partner and receive from any sending partner; see L4_SYSF_SEND_AND_WAIT
- L4_SYSF_REPLY | L4_SYSF_SEND: reply to caller
- L4_SYSF_REPLY | L4_SYSF_SEND | L4_SYSF_RECV: call the caller
- L4_SYSF_REPLY | L4_SYSF_SEND | L4_SYSF_RECV | L4_SYSF_OPEN_WAIT: reply to caller and receive from any sending partner; see L4_SYSF_REPLY_AND_WAIT

13.1.9.6.2 Macro Definition Documentation

13.1.9.6.2.1 L4_SYSF_CALL

```
#define L4_SYSF_CALL
```

Call flags (combines send and receive).
Combines L4_SYSF_SEND and L4_SYSF_RECV.
Definition at line 110 of file consts.h.
Referenced by l4_ipc_call().

13.1.9.6.2.2 L4_SYSF_OPEN_WAIT

```
#define L4_SYSF_OPEN_WAIT
```

Open-wait flag.
This flag indicates that the receive operation (see L4_SYSF_RECV) shall be an *open wait*. *Open wait* means that the invoking thread shall wait for a message from any possible sender and *not* from the sender denoted by the capability.
Definition at line 93 of file consts.h.

13.1.9.6.2.3 L4_SYSF_RECV

```
#define L4_SYSF_RECV
```

Receive-phase flag.
Setting this flag induces a receive phase, this means the invoking thread waits for a message from the object denoted by the capability. For a send phase see L4_SYSF_SEND.
Definition at line 82 of file consts.h.
Referenced by l4_ipc_receive().

13.1.9.6.2.4 L4_SYSF_REPLY

```
#define L4_SYSF_REPLY
```

Reply flag.
This flag indicates that the send phase shall use the in-kernel reply capability instead of the capability denoted by the selector index.
Definition at line 102 of file consts.h.
Referenced by l4_ipc_reply().

13.1.9.6.2.5 L4_SYSF_REPLY_AND_WAIT

```
#define L4_SYSF_REPLY_AND_WAIT
```

Reply-and-wait flags.
Combines L4_SYSF_SEND, L4_SYSF_REPLY, and L4_SYSF_WAIT.
Definition at line 134 of file consts.h.
Referenced by l4_ipc_reply_and_wait_ext(), and L4::Server< LOOP_HOOKS >::reply_n_wait().

13.1.9.6.2.6 L4_SYSF_SEND

```
#define L4_SYSF_SEND
```

Send-phase flag.
Setting this flag induces a send phase, this means a message is sent to the object denoted by the capability. For receive phase see L4_SYSF_RECV.
In l4_vcpu_state_t::user_task this flag means that the kernel has cached the user task capability internally, see l4_thread_vcpu_resume_commit().
Definition at line 71 of file consts.h.
Referenced by l4_ipc_reply(), and l4_ipc_send().

13.1.9.6.2.7 L4_SYSF_SEND_AND_WAIT

```
#define L4_SYSF_SEND_AND_WAIT
```

Send-and-wait flags.
Combines L4_SYSF_SEND and L4_SYSF_WAIT.
Definition at line 126 of file consts.h.
Referenced by l4_ipc_send_and_wait().

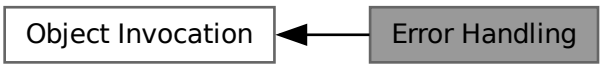
13.1.9.6.2.8 L4_SYSF_WAIT

```
#define L4_SYSF_WAIT
```

Wait flags (combines receive and open wait).
Combines L4_SYSF_RECV and L4_SYSF_OPEN_WAIT.
Definition at line 118 of file consts.h.
Referenced by l4_ipc_wait_ext(), and L4::Server< LOOP_HOOKS >::reply_n_wait().

13.1.9.7 Error Handling

Error handling for L4 object invocation.
Collaboration diagram for Error Handling:



Enumerations

- enum l4_ipc_tcr_error_t {
  L4_IPC_ERROR_MASK = 0x1F , L4_IPC_SND_ERR_MASK = 0x01 , L4_IPC_ENOT_EXISTENT = 0x04 , L4_IPC_RETIMEOUT = 0x03 ,
  L4_IPC_SETIMEOUT = 0x02 , L4_IPC_RECANCELED = 0x07 , L4_IPC_SECANCELED = 0x06 , L4_IPC_REMAPFAILED = 0x11 ,
  L4_IPC_SEMAPFAILED = 0x10 , L4_IPC_RESNDPFTO = 0x0b , L4_IPC_SESNDPFTO = 0x0a , L4_IPC_RERCVPFTO = 0x0d ,

L4_IPC_SERCVPFTO = 0x0c , L4_IPC_REABORTED = 0x0f , L4_IPC_SEABORTED = 0x0e , L4_IPC_REMSGCUT = 0x09 ,
L4_IPC_SEMSGCUT = 0x08 , L4_IPC_NO_REPLY_CAP = 0x13 }

Error codes in the error TCR.

Functions

- l4_umword_t l4_ipc_error (l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW

  Get the IPC error code for an IPC operation.
- l4_ret_t l4_error (l4_msgtag_t tag) L4_NOTHROW

  Get IPC error code if any or message tag label otherwise for an IPC call.
- int l4_ipc_is_snd_error (l4_utcb_t *utcb) L4_NOTHROW

  Returns whether an error occurred in send phase of an invocation.
- int l4_ipc_is_rcv_error (l4_utcb_t *utcb) L4_NOTHROW

  Returns whether an error occurred in receive phase of an invocation.
- int l4_ipc_error_code (l4_utcb_t *utcb) L4_NOTHROW

  Get the error condition of the last invocation from the TCR.

13.1.9.7.1 Detailed Description

Error handling for L4 object invocation.

Include File

```
#include <l4/sys/ipc.h>
```

13.1.9.7.2 Enumeration Type Documentation

13.1.9.7.2.1 l4_ipc_tcr_error_t

```
enum l4_ipc_tcr_error_t
```

Error codes in the *error* TCR.
The error codes are accessible via the *error* TCR, see l4_thread_regs_t.error.

Enumerator

L4_IPC_ERROR_MASK	Mask for error bits.
L4_IPC_SND_ERR_MASK	Send error mask.
L4_IPC_ENOT_EXISTENT	Non-existing destination or source.
L4_IPC_RETIMEOUT	Timeout during receive operation.
L4_IPC_SETIMEOUT	Timeout during send operation.
L4_IPC_RECANCELED	Receive operation canceled.
L4_IPC_SECANCELED	Send operation canceled.
L4_IPC_REMAPFAILED	Map flexpage failed in receive operation.
L4_IPC_SEMAPFAILED	Map flexpage failed in send operation.
L4_IPC_RESNDPFTO	Send-pagefault timeout in receive operation.
L4_IPC_SESNDPFTO	Send-pagefault timeout in send operation.
L4_IPC_RERCVPFTO	Receive-pagefault timeout in receive operation.
L4_IPC_SERCVPFTO	Receive-pagefault timeout in send operation.
L4_IPC_REABORTED	Receive operation aborted.
L4_IPC_SEABORTED	Send operation aborted.

L4_IPC_REMSGCUT	Received message truncated. Usually returned when the typed items to be sent by the IPC partner exceed the buffer registers of the respective types.
L4_IPC_SEMSGCUT	Sent message truncated. Usually returned when the typed items to be sent exceed the IPC partner's buffer registers of the respective types.
L4_IPC_NO_REPLY_CAP	Receive operation using explicit reply capability failed. Either the reply capability index was too large or the callers memory quota was exhausted.

Definition at line 81 of file ipc.h.

13.1.9.7.3 Function Documentation

13.1.9.7.3.1 l4_error()

```
l4_ret_t l4_error (
            l4_msgtag_t tag)  [inline]
```

Get IPC error code if any or message tag label otherwise for an IPC call.
This function shall only be used if the IPC operation includes a receive phase (usually a call operation), otherwise no tag label is received and the return value of this function is undefined.

Parameters

tag	Message tag returned by the IPC call.

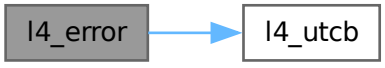
Returns

In case of an IPC error, a negative error code in the range of L4_EIPC_LO to L4_EIPC_HI (see l4_ipc_to_errno() and l4_ipc_tcr_error_t), otherwise the tag label. By convention, the callee can signal errors via a negative tag label (negated value from l4_error_code_t) and success via a non-negative value.

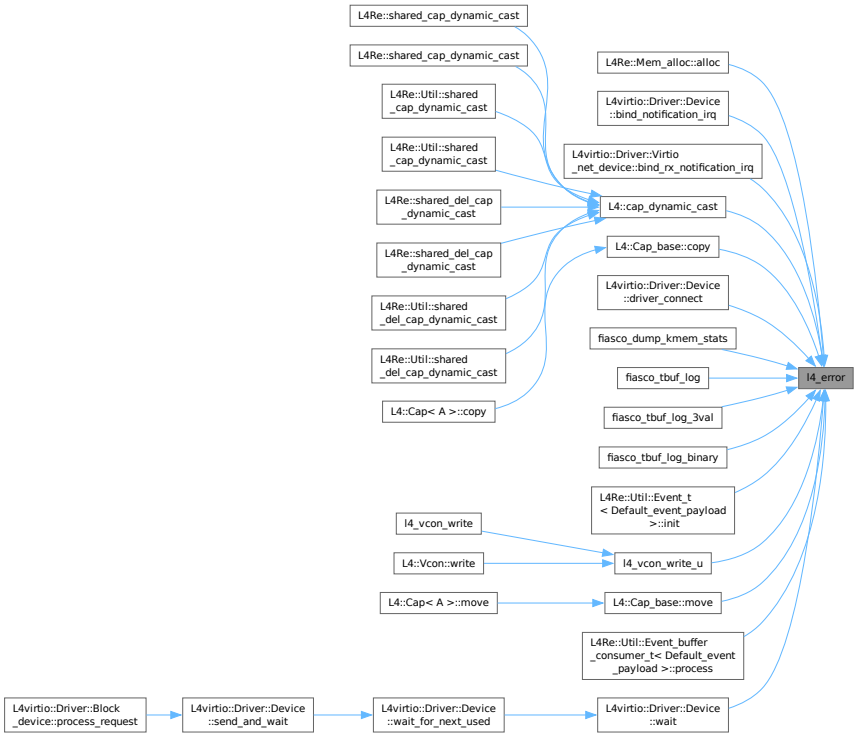
Examples

examples/libs/l4re/streammap/client.cc, examples/sys/aliens/main.c, examples/sys/isr/main.c, examples/sys/migrate/thread_mig examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 730 of file ipc.h.
References L4_NOTHROW, and l4_utcb().
Referenced by L4Re::Mem_alloc::alloc(), L4virtio::Driver::Device::bind_notification_irq(), L4virtio::Driver::Virtio_net_device::bind_rx_n L4::cap_dynamic_cast(), L4::Cap_base::copy(), L4virtio::Driver::Device::driver_connect(), fiasco_dump_kmem_stats(), fiasco_tbuf_log(), fiasco_tbuf_log_3val(), fiasco_tbuf_log_binary(), L4Re::Util::Event_t< Default_event_payload >::init(), l4_vcon_write_u(), L4::Cap_base::move(), L4Re::Util::Event_buffer_consumer_t< Default_event_payload >::process(), and L4virtio::Driver::Device::wait().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.7.3.2 l4_ipc_error()

```
l4_umword_t l4_ipc_error (
            l4_msgtag_t tag,
            l4_utcb_t * utcb)  [inline]
```

Get the IPC error code for an IPC operation.

Parameters

tag	Message tag returned by the IPC operation.
utcb	UTCB that was used for the IPC operation.

Returns

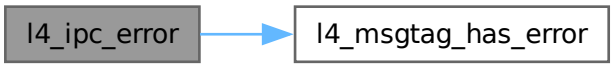
0 if no error condition is set, error code otherwise (see l4_ipc_tcr_error_t).

Examples

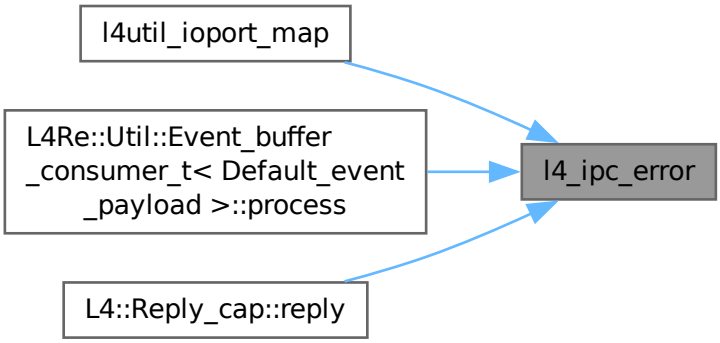
examples/sys/ipc/ipc_example.c, and examples/sys/start-with-exc/main.c.

Definition at line 713 of file ipc.h.
References L4_IPC_ERROR_MASK, L4_LIKELY, l4_msgtag_has_error(), and L4_NOTHROW.
Referenced by l4util_ioport_map(), L4Re::Util::Event_buffer_consumer_t< Default_event_payload >::process(), and L4::Reply_cap::reply().

Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.7.3.3 l4_ipc_error_code()

```
int l4_ipc_error_code (
            l4_utcb_t * utcb)  [inline]
```

Get the error condition of the last invocation from the TCR.

Precondition

l4_msgtag_has_error(tag) == true

Parameters

utcb	UTCB to check.

Returns

Error condition of type l4_ipc_tcr_error_t.

Definition at line 742 of file ipc.h.
References L4_INLINE, L4_IPC_ERROR_MASK, and L4_NOTHROW.

13.1.9.7.3.4 l4_ipc_is_rcv_error()

```
int l4_ipc_is_rcv_error (
            l4_utcb_t * utcb)  [inline]
```

Returns whether an error occurred in receive phase of an invocation.

Precondition

l4_msgtag_has_error(tag) == true

Parameters

utcb	UTCB to check.

Returns

Boolean value.

Definition at line 739 of file ipc.h.
References L4_INLINE, and L4_NOTHROW.

13.1.9.7.3.5 l4_ipc_is_snd_error()

```
int l4_ipc_is_snd_error (
            l4_utcb_t * utcb)  [inline]
```

Returns whether an error occurred in send phase of an invocation.

Precondition

l4_msgtag_has_error(tag) == true

Parameters

utcb	UTCB to check.

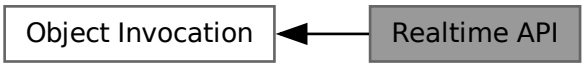
Returns

Boolean value.

Definition at line 736 of file ipc.h.
References L4_INLINE, and L4_NOTHROW.

13.1.9.8 Realtime API

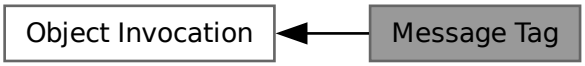
Collaboration diagram for Realtime API:



13.1.9.9 Message Tag

API related to the message tag data type.

Collaboration diagram for Message Tag:



Data Structures

- struct l4_msgtag_t

  Message tag data structure.

Enumerations

- enum L4_msgtag_protocol {
  L4_PROTO_NONE = 0 , L4_PROTO_ALLOW_SYSCALL = 1 , L4_PROTO_PF_EXCEPTION = 1 ,
  L4_PROTO_PLATFORM_CTL = 0L ,
  L4_PROTO_IRQ = -1L , L4_PROTO_PAGE_FAULT = -2L , L4_PROTO_EXCEPTION = -5L , L4_PROTO_SIGMA0 = -6L ,
  L4_PROTO_IO_PAGE_FAULT = -8L , L4_PROTO_THREAD_GROUP = -9L , L4_PROTO_KOBJECT = -10L , L4_PROTO_TASK = -11L ,
  L4_PROTO_THREAD = -12L , L4_PROTO_LOG = -13L , L4_PROTO_SCHEDULER = -14L , L4_PROTO_FACTORY = -15L ,
  L4_PROTO_VM = -16L , L4_PROTO_DMA_SPACE = -17L , L4_PROTO_IRQ_SENDER = -18L , L4_PROTO_SEMAPHORE = -20L ,
  L4_PROTO_META = -21L , L4_PROTO_IOMMU = -22L , L4_PROTO_DEBUGGER = -23L , L4_PROTO_SMCCC = -24L ,
  L4_PROTO_VCPU_CONTEXT = -25L , L4_PROTO_PI_MUTEX = -26L }

  Message tag for IPC operations.
- enum L4_msgtag_flags { L4_MSGTAG_ERROR , L4_MSGTAG_TRANSFER_FPU , L4_MSGTAG_SCHEDULE , **L4_MSGTAG_PROPAGATE** = 0x4000 , L4_MSGTAG_FLAGS }

  Flags for message tags.

Functions

- long l4_msgtag_label (l4_msgtag_t t) L4_NOTHROW

  Get the protocol of tag.
- unsigned l4_msgtag_words (l4_msgtag_t t) L4_NOTHROW

  Get the number of untyped words.
- unsigned l4_msgtag_items (l4_msgtag_t t) L4_NOTHROW

  Get the number of typed items.
- unsigned l4_msgtag_flags (l4_msgtag_t t) L4_NOTHROW

  Get the flags.
- unsigned l4_msgtag_has_error (l4_msgtag_t t) L4_NOTHROW

  Test for error indicator flag.
- unsigned l4_msgtag_is_page_fault (l4_msgtag_t t) L4_NOTHROW

  Test for page-fault protocol.
- unsigned l4_msgtag_is_exception (l4_msgtag_t t) L4_NOTHROW

  Test for exception protocol.
- unsigned l4_msgtag_is_sigma0 (l4_msgtag_t t) L4_NOTHROW

Test for sigma0 protocol.

- unsigned l4_msgtag_is_io_page_fault (l4_msgtag_t t) L4_NOTHROW

  Test for IO-page-fault protocol.

- l4_msgtag_t l4_msgtag (long label, unsigned words, unsigned items, unsigned flags) L4_NOTHROW

  Create a message tag from the specified values.

13.1.9.9.1 Detailed Description

API related to the message tag data type.

Include File

```
#include <l4/sys/types.h>
```

13.1.9.9.2 Enumeration Type Documentation

13.1.9.9.2.1 L4_msgtag_flags

enum L4_msgtag_flags
Flags for message tags.

Enumerator

L4_MSGTAG_ERROR	Error indicator flag.
L4_MSGTAG_TRANSFER_FPU	Enable FPU transfer flag for IPC. By enabling this flag when sending IPC, the sender indicates that the contents of the FPU shall be transferred to the receiving thread. However, the receiver has to indicate its willingness to receive FPU context in its buffer descriptor register (BDR).
L4_MSGTAG_SCHEDULE	Enable schedule in IPC flag. Usually IPC operations donate the remaining time slice of a thread to the called thread. Enabling this flag when sending IPC does a real scheduling decision. However, this flag decreases IPC performance.
L4_MSGTAG_FLAGS	Mask for all flags.

Definition at line 103 of file types.h.

13.1.9.9.2.2 L4_msgtag_protocol

enum L4_msgtag_protocol
Message tag for IPC operations.
All predefined protocols used by the kernel.

Enumerator

L4_PROTO_NONE	Default protocol tag to reply to kernel.
L4_PROTO_ALLOW_SYSCALL	Allow an alien the system call.
L4_PROTO_PF_EXCEPTION	Make an exception out of a page fault.
L4_PROTO_PLATFORM_CTL	Platform control.
L4_PROTO_IRQ	IRQ message.
L4_PROTO_PAGE_FAULT	Page fault message.
L4_PROTO_EXCEPTION	Exception.
L4_PROTO_SIGMA0	Sigma0 protocol.
L4_PROTO_IO_PAGE_FAULT	I/O page fault message.

L4_PROTO_THREAD_GROUP	Protocol for messages to a thread group obj.
L4_PROTO_KOBJECT	Protocol for messages to a generic kobject.
L4_PROTO_TASK	Protocol for messages to a task object.
L4_PROTO_THREAD	Protocol for messages to a thread object.
L4_PROTO_LOG	Protocol for messages to a log object.
L4_PROTO_SCHEDULER	Protocol for messages to a scheduler object.
L4_PROTO_FACTORY	Protocol for messages to a factory object.
L4_PROTO_VM	Protocol for messages to a virtual machine object.
L4_PROTO_DMA_SPACE	Protocol for (creating) kernel DMA space objects.
L4_PROTO_IRQ_SENDER	Protocol for IRQ senders (IRQ -> IPC).
L4_PROTO_SEMAPHORE	Protocol for semaphore objects.
L4_PROTO_META	Meta information protocol.
L4_PROTO_IOMMU	Protocol ID for IO-MMUs.
L4_PROTO_DEBUGGER	Protocol ID for the debugger.
L4_PROTO_SMCCC	Protocol ID for ARM SMCCC calls.
L4_PROTO_VCPU_CONTEXT	Protocol for hardware vCPU contexts.
L4_PROTO_PI_MUTEX	Protocol for priority inheritance mutex.

Definition at line 53 of file types.h.

13.1.9.9.3 Function Documentation

13.1.9.9.3.1 l4_msgtag()

```
l4_msgtag_t l4_msgtag (
             long label,
             unsigned words,
             unsigned items,
             unsigned flags)  [inline]
```

Create a message tag from the specified values.
Message tag functions.

Parameters

label	The user-defined label
words	The number of untyped words within the UTCB
items	The number of typed items (e.g., flexpages) within the UTCB
flags	The IPC flags for realtime and FPU extensions

Returns

Message tag

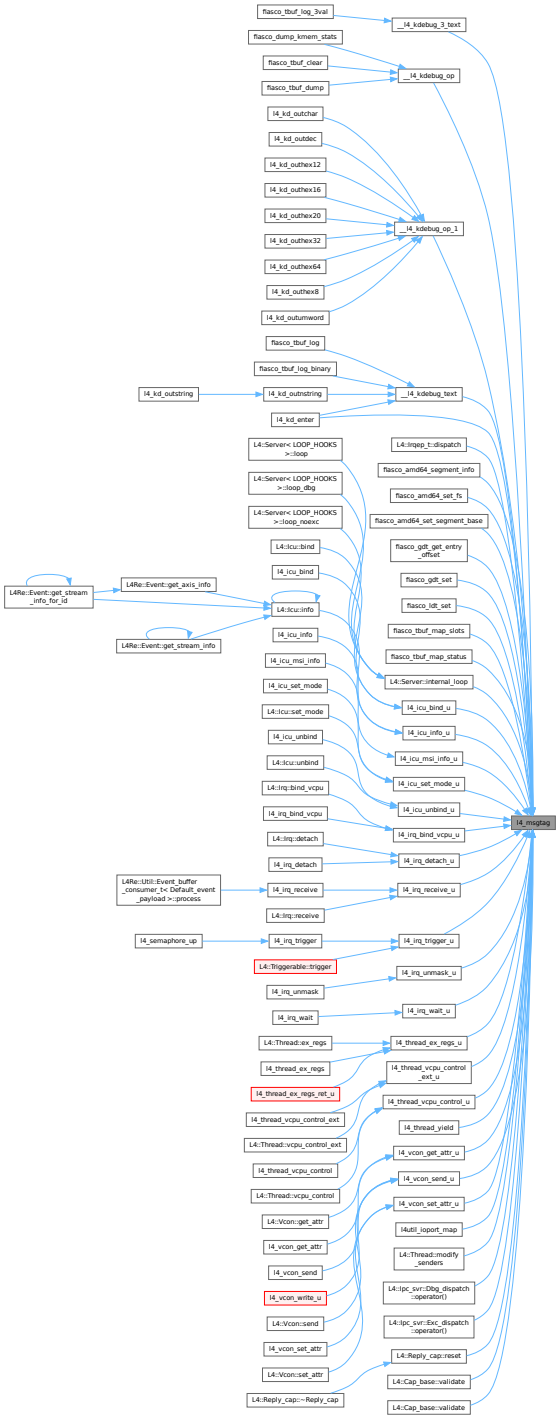
Examples

examples/sys/aliens/main.c, examples/sys/ipc/ipc_example.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/mai
and examples/sys/utcb-ipc/main.c.

Definition at line 444 of file types.h.
References L4_NOTHROW.
Referenced by __l4_kdebug_3_text(), __l4_kdebug_op(), __l4_kdebug_op_1(), __l4_kdebug_text(), L4::Irqep_t< Derived, BASE, boo
fiasco_amd64_segment_info(), fiasco_amd64_set_fs(), fiasco_amd64_set_segment_base(), fiasco_gdt_get_entry_offset(),

fiasco_gdt_set(), fiasco_ldt_set(), fiasco_tbuf_map_slots(), fiasco_tbuf_map_status(), L4::Server< LOOP_HOOKS >::internal_loop(), l4_icu_bind_u(), l4_icu_info_u(), l4_icu_msi_info_u(), l4_icu_set_mode_u(), l4_icu_unbind_u(), l4_irq_bind_vcpu_u(), l4_irq_detach_u(), l4_irq_receive_u(), l4_irq_trigger_u(), l4_irq_unmask_u(), l4_irq_wait_u(), l4_kd_enter(), l4_thread_ex_regs_u(), l4_thread_vcpu_control_ext_u(), l4_thread_vcpu_control_u(), l4_thread_yield(), l4_vcon_get_attr_u(), l4_vcon_send_u(), l4_vcon_set_attr_u(), l4util_ioport_map(), L4::Thread::modify_senders(), L4::Ipc_svr::Dbg_dispatch< R, Exc, Prin L4::Ipc_svr::Exc_dispatch< R, Exc >::operator()(), L4::Reply_cap::reset(), L4::Cap_base::validate(), and L4::Cap_base::validate().

Here is the caller graph for this function:



13.1.9.9.3.2 l4_msgtag_flags()

```
unsigned l4_msgtag_flags (
            l4_msgtag_t t)  [inline]
```

Get the flags.
The flag are defined by L4_msgtag_flags.

Parameters

t	The tag

Returns

Flags

Definition at line 474 of file types.h.
References L4_NOTHROW.
Referenced by l4_msgtag_t::flags().
Here is the caller graph for this function:



13.1.9.9.3.3 l4_msgtag_has_error()

```
unsigned l4_msgtag_has_error (
            l4_msgtag_t t)  [inline]
```

Test for error indicator flag.

Parameters

t	The tag

Returns

>0 for yes, 0 for no

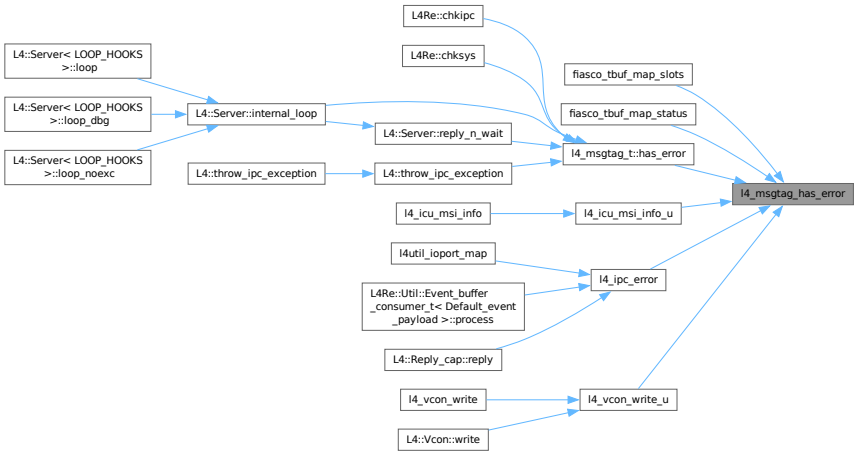
Return whether the kernel operation caused a communication error, e.g. with IPC. if true: utcb->error is valid, otherwise utcb->error is not valid

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 479 of file types.h.
References L4_MSGTAG_ERROR, and L4_NOTHROW.
Referenced by fiasco_tbuf_map_slots(), fiasco_tbuf_map_status(), l4_msgtag_t::has_error(), l4_icu_msi_info_u(), l4_ipc_error(), and l4_vcon_write_u().

Here is the caller graph for this function:



13.1.9.9.3.4 l4_msgtag_is_exception()

```
unsigned l4_msgtag_is_exception (
             l4_msgtag_t t)  [inline]
```

Test for exception protocol.

Parameters

t	The tag

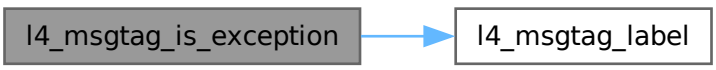
Returns

Boolean value

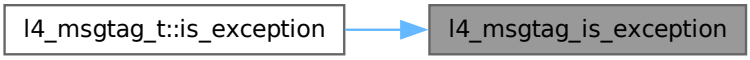
Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, and examples/sys/start-with-exc/main.c.

Definition at line 487 of file types.h.
References L4_INLINE, l4_msgtag_label(), L4_NOTHROW, and L4_PROTO_EXCEPTION.
Referenced by l4_msgtag_t::is_exception().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.9.3.5 l4_msgtag_is_io_page_fault()

```
unsigned l4_msgtag_is_io_page_fault (
            l4_msgtag_t t)  [inline]
```

Test for IO-page-fault protocol.

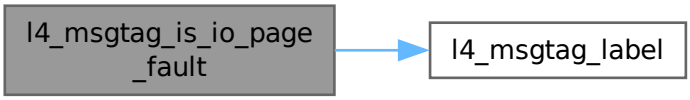
Parameters

t	The tag

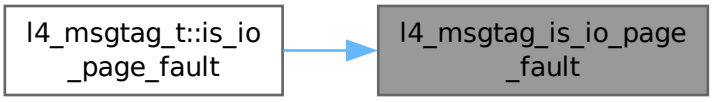
Returns

Boolean value

Definition at line 493 of file types.h.
References L4_INLINE, l4_msgtag_label(), L4_NOTHROW, and L4_PROTO_IO_PAGE_FAULT.
Referenced by l4_msgtag_t::is_io_page_fault().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.9.3.6 l4_msgtag_is_page_fault()

```
unsigned l4_msgtag_is_page_fault (
            l4_msgtag_t t)  [inline]
```

Test for page-fault protocol.

Parameters

t	The tag

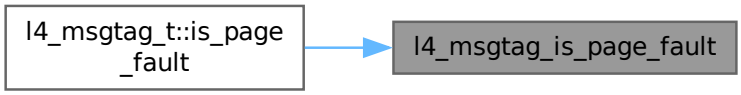
Returns

Boolean value

Definition at line 484 of file types.h.
References L4_INLINE, l4_msgtag_label(), L4_NOTHROW, and L4_PROTO_PAGE_FAULT.
Referenced by l4_msgtag_t::is_page_fault().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.9.3.7 l4_msgtag_is_sigma0()

```
unsigned l4_msgtag_is_sigma0 (
            l4_msgtag_t t)  [inline]
```

Test for sigma0 protocol.

Parameters

t	The tag

Returns

Boolean value

Definition at line 490 of file types.h.
References L4_INLINE, l4_msgtag_label(), L4_NOTHROW, and L4_PROTO_SIGMA0.
Referenced by l4_msgtag_t::is_sigma0().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.9.3.8 l4_msgtag_items()

```
unsigned l4_msgtag_items (
            l4_msgtag_t t)  [inline]
```

Get the number of typed items.

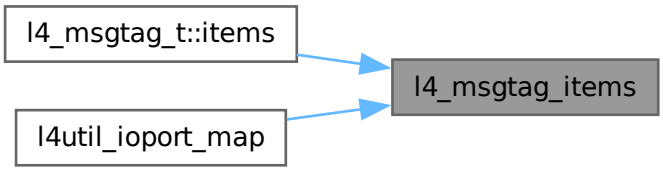
Parameters

t	The tag

Returns

Number of items.

Definition at line 470 of file types.h.
References L4_NOTHROW.
Referenced by l4_msgtag_t::items(), and l4util_ioport_map().
Here is the caller graph for this function:



13.1.9.9.3.9 l4_msgtag_label()

```
long l4_msgtag_label (
              l4_msgtag_t t)  [inline]
```

Get the protocol of tag.

Parameters

t	The tag

Returns

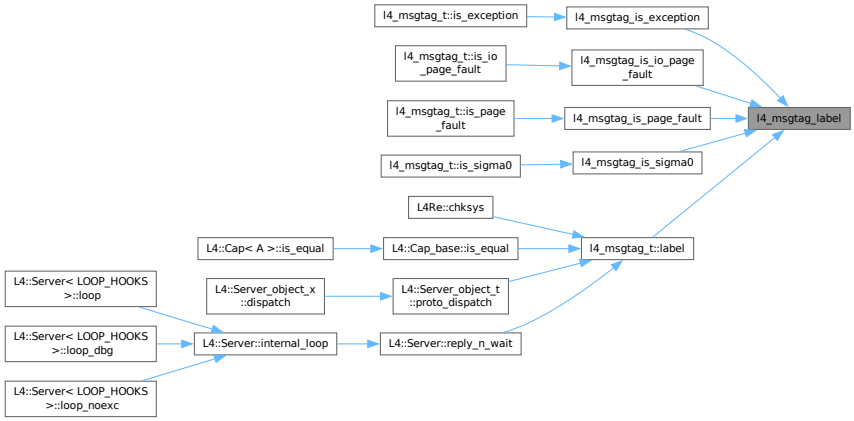
Label

Examples

examples/sys/singlestep/main.c, and examples/sys/start-with-exc/main.c.

Definition at line 456 of file types.h.
References L4_NOTHROW.
Referenced by l4_msgtag_is_exception(), l4_msgtag_is_io_page_fault(), l4_msgtag_is_page_fault(), l4_msgtag_is_sigma0(), and l4_msgtag_t::label().

Here is the caller graph for this function:



13.1.9.9.3.10 l4_msgtag_words()

```
unsigned l4_msgtag_words (
            l4_msgtag_t t)  [inline]
```

Get the number of untyped words.

Parameters

t	The tag

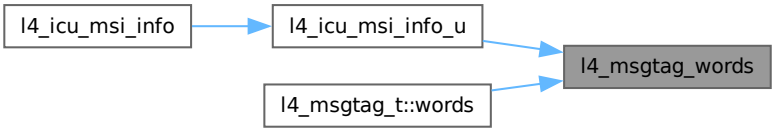
Returns

Number of words

Examples

examples/sys/utcb-ipc/main.c.

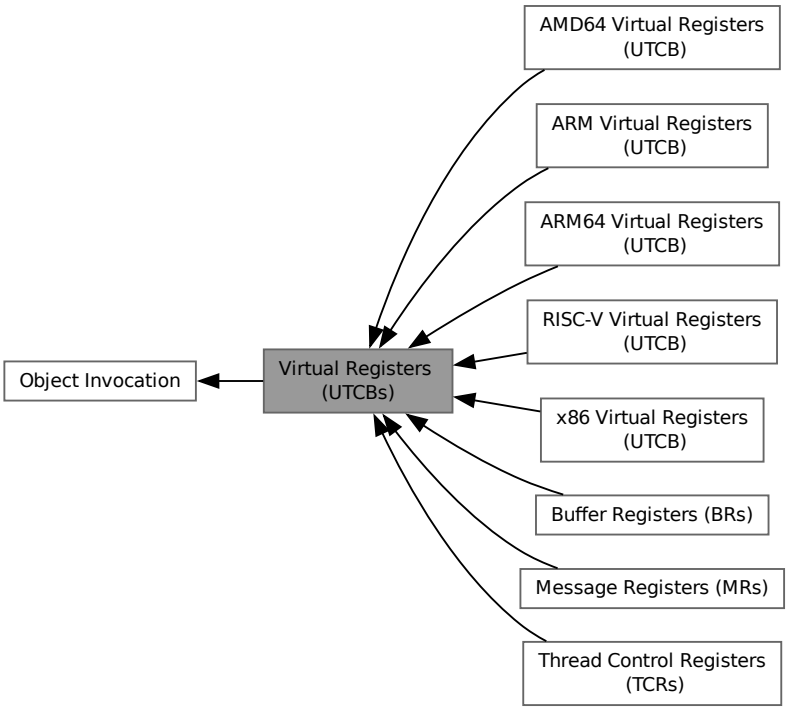
Definition at line 466 of file types.h.
References L4_NOTHROW.
Referenced by l4_icu_msi_info_u(), and l4_msgtag_t::words().
Here is the caller graph for this function:



13.1.9.10 Virtual Registers (UTCBs)

L4 Virtual Registers (UTCB).

Collaboration diagram for Virtual Registers (UTCBs):



Topics

- Message Registers (MRs) . . . 251
- Buffer Registers (BRs) . . . 254
- Thread Control Registers (TCRs) . . . 255
- ARM Virtual Registers (UTCB) . . . 256
- ARM64 Virtual Registers (UTCB) . . . 256
- AMD64 Virtual Registers (UTCB) . . . 257
- x86 Virtual Registers (UTCB) . . . 257
- RISC-V Virtual Registers (UTCB) . . . 258

Files

- file utcb.h

  UTCB definitions for ARM.
- file utcb.h

  UTCB definitions for ARM64.
- file utcb.h

UTCB definitions for AMD64.

- file utcb.h

  UTCB definitions for x86.

- file utcb.h

  UTCB definitions for RISC-V.

Typedefs

- typedef struct l4_utcb_t l4_utcb_t

  Opaque type for the UTCB.

Functions

- l4_utcb_t * **l4_utcb** (void) L4_NOTHROW L4_PURE

  Get the UTCB address.

- l4_msg_regs_t * l4_utcb_mr (void) L4_NOTHROW L4_PURE

  Get the message-register block of a UTCB.

- l4_buf_regs_t * l4_utcb_br (void) L4_NOTHROW L4_PURE

  Get the buffer-register block of a UTCB.

- l4_thread_regs_t * l4_utcb_tcr (void) L4_NOTHROW L4_PURE

  Get the thread-control-register block of a UTCB.

13.1.9.10.1 Detailed Description

L4 Virtual Registers (UTCB).

Include File

```
#include <l4/sys/utcb.h>
```

The virtual registers are part of the micro-kernel API and are located in the user-level thread control block (UTCB). The UTCB is a data structure defined by the micro kernel and located on kernel-provided memory. Each L4 thread gets a unique UTCB assigned when it is bound to a task (see Thread Control , l4_thread_control_bind() for more information).
The UTCB is arranged in three blocks of virtual registers.

- Thread Control Registers (TCRs)
- Message Registers (MRs)
- Buffer Registers (BRs)

To access the contents of the virtual registers the l4_utcb_mr(), l4_utcb_tcr(), and l4_utcb_br() functions must be used.

13.1.9.10.2 Typedef Documentation

13.1.9.10.2.1 l4_utcb_t

```
typedef struct l4_utcb_t l4_utcb_t
```

Opaque type for the UTCB.
To access the contents of the virtual registers the l4_utcb_mr(), l4_utcb_tcr(), and l4_utcb_br() functions must be used.

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 56 of file utcb.h.

13.1.9.10.3 Function Documentation

13.1.9.10.3.1 l4_utcb_br()

```
l4_buf_regs_t * l4_utcb_br (
            void )  [inline]
```

Get the buffer-register block of a UTCB.

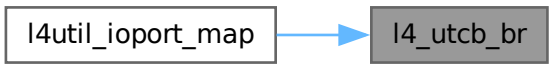
Returns

A pointer to the buffer-register block of `u`.

Definition at line 384 of file utcb.h.
References L4_INLINE, L4_NOTHROW, and l4_utcb().
Referenced by l4util_ioport_map().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.10.3.2 l4_utcb_mr()

```
l4_msg_regs_t * l4_utcb_mr (
            void )  [inline]
```

Get the message-register block of a UTCB.

Returns

A pointer to the message-register block of `u`.

Examples

examples/sys/aliens/main.c, examples/sys/ipc/ipc_example.c, examples/sys/singlestep/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 381 of file utcb.h.
References L4_INLINE, L4_NOTHROW, and l4_utcb().
Referenced by l4util_ioport_map().

Here is the call graph for this function:



Here is the caller graph for this function:



13.1.9.10.3.3 l4_utcb_tcr()

```
l4_thread_regs_t * l4_utcb_tcr (
            void )  [inline]
```

Get the thread-control-register block of a UTCB.

Returns

A pointer to the thread-control-register block of `u`.

Definition at line 387 of file utcb.h.
References L4_INLINE, L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.9.10.4 Message Registers (MRs)

Collaboration diagram for Message Registers (MRs):



Topics

- Exception registers 251
  Overlay definition of the MRs for exception messages.

Data Structures

- union l4_msg_regs_t
  Encapsulation of the message-register block in the UTCB.

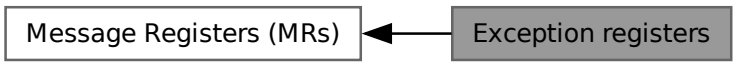
Typedefs

- typedef union l4_msg_regs_t **l4_msg_regs_t**
  Encapsulation of the message-register block in the UTCB.

13.1.9.10.4.1 Detailed Description

13.1.9.10.4.2 Exception registers

Overlay definition of the MRs for exception messages.
Collaboration diagram for Exception registers:



Functions

- l4_umword_t l4_utcb_exc_pc (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE
  Access function to get the program counter of the exception state.
- void l4_utcb_exc_pc_set (l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW
  Set the program counter register in the exception state.
- unsigned long **l4_utcb_exc_typeval** (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE
  Get the value out of an exception UTCB that describes the type of exception.
- int l4_utcb_exc_is_pf (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE
  Check whether an exception IPC is a page fault.
- l4_addr_t **l4_utcb_exc_pfa** (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE
  Function to get the L4 style page fault address out of an exception.

- int l4_utcb_exc_is_ex_regs_exception (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE

  Check whether an exception IPC was triggered via l4_thread_ex_regs().
- l4_exc_regs_t * l4_utcb_exc (void) L4_NOTHROW L4_PURE

  Get the message-register block of a UTCB (for an exception IPC).

Detailed Description

Overlay definition of the MRs for exception messages.

Function Documentation

l4_utcb_exc()

```
l4_exc_regs_t * l4_utcb_exc (
             void )  [inline]
```

Get the message-register block of a UTCB (for an exception IPC).

Returns

A pointer to the exception message in `u`.

Examples

examples/sys/aliens/main.c, and examples/sys/singlestep/main.c.

Definition at line 390 of file utcb.h.
References L4_INLINE, L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



l4_utcb_exc_is_ex_regs_exception()

```
int l4_utcb_exc_is_ex_regs_exception (
             l4_exc_regs_t const * u)  [inline]
```

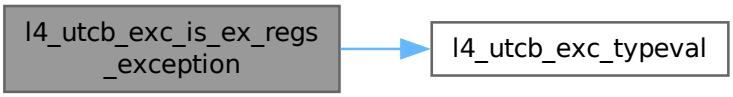
Check whether an exception IPC was triggered via l4_thread_ex_regs().

Return values

0	Exception was not triggered through ex_regs.
!=0	Exception was triggered through ex_regs.

This function checks if the exception was emitted by using the L4_THREAD_EX_REGS_TRIGGER_EXCEPTION flag in an l4_thread_ex_regs() call.
Definition at line 100 of file utcb.h.
References L4_INLINE, L4_NOTHROW, and l4_utcb_exc_typeval().

Here is the call graph for this function:



l4_utcb_exc_is_pf()

```
int l4_utcb_exc_is_pf (
            l4_exc_regs_t const * u)  [inline]
```

Check whether an exception IPC is a page fault.

Returns

0 if not, != 0 if yes

Function to check whether an exception IPC is a page fault, also applies to I/O pagefaults.
Definition at line 90 of file utcb.h.
References L4_INLINE, and L4_NOTHROW.

l4_utcb_exc_pc()

```
l4_umword_t l4_utcb_exc_pc (
            l4_exc_regs_t const * u)  [inline]
```

Access function to get the program counter of the exception state.

Parameters

u	UTCB

Returns

The program counter register out of the exception state.

Examples

examples/sys/aliens/main.c, and examples/sys/singlestep/main.c.

Definition at line 75 of file utcb.h.
References L4_INLINE, and L4_NOTHROW.

l4_utcb_exc_pc_set()

```
void l4_utcb_exc_pc_set (
            l4_exc_regs_t * u,
            l4_addr_t pc)  [inline]
```

Set the program counter register in the exception state.

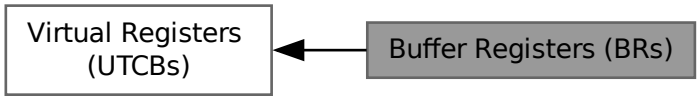
Parameters

u	UTCB
pc	The program counter to set.

Definition at line 80 of file utcb.h.
References L4_INLINE, and L4_NOTHROW.

13.1.9.10.5 Buffer Registers (BRs)

Collaboration diagram for Buffer Registers (BRs):



Data Structures

- struct l4_buf_regs_t

  Encapsulation of the buffer-registers block in the UTCB.

Typedefs

- typedef struct l4_buf_regs_t **l4_buf_regs_t**

  Encapsulation of the buffer-registers block in the UTCB.

Enumerations

- enum l4_buffer_desc_consts_t { L4_BDR_MEM_SHIFT = 0 , L4_BDR_IO_SHIFT = 5 , L4_BDR_OBJ_SHIFT = 10 , **L4_BDR_OFFSET_MASK** = (1UL << 20) - 1 }

  Constants for buffer descriptors.

Functions

- void **l4_utcb_inherit_fpu** (int switch_on) L4_NOTHROW

  Enable or disable inheritance of FPU state to receiver.
- l4_umword_t l4_bdr (l4_umword_t mem, l4_umword_t io, l4_umword_t obj, l4_umword_t flags) L4_NOTHROW

  Create a buffer descriptor.

13.1.9.10.5.1 Detailed Description

13.1.9.10.5.2 Enumeration Type Documentation

l4_buffer_desc_consts_t

`enum l4_buffer_desc_consts_t`
Constants for buffer descriptors.

Enumerator

L4_BDR_MEM_SHIFT	Bit offset for the memory-buffer index.
L4_BDR_IO_SHIFT	Bit offset for the IO-buffer index.
L4_BDR_OBJ_SHIFT	Bit offset for the capability-buffer index.

Definition at line 320 of file consts.h.

13.1.9.10.5.3 Function Documentation

l4_bdr()

```
l4_umword_t l4_bdr (
             l4_umword_t mem,
             l4_umword_t io,
             l4_umword_t obj,
             l4_umword_t flags)  [inline]
```

Create a buffer descriptor.

Parameters

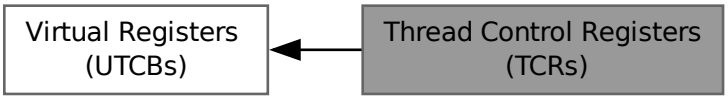
mem	Index of the first memory receive buffer.
io	Index of the first IO-port receive buffer.
obj	Index of the first object receive buffer.
flags	Flags (only L4_UTCB_INHERIT_FPU so far).

Definition at line 362 of file utcb.h.
References L4_INLINE, and L4_NOTHROW.
Referenced by L4Re::Util::Br_manager::setup_wait().
Here is the caller graph for this function:



13.1.9.10.6 Thread Control Registers (TCRs)

Collaboration diagram for Thread Control Registers (TCRs):



Data Structures

- struct l4_thread_regs_t

  Encapsulation of the thread-control-register block of the UTCB.

Typedefs

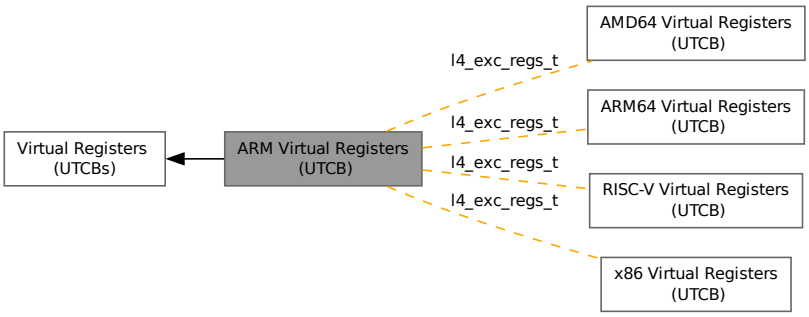
- typedef struct l4_thread_regs_t **l4_thread_regs_t**

  Encapsulation of the thread-control-register block of the UTCB.

13.1.9.10.6.1 Detailed Description

13.1.9.10.7 ARM Virtual Registers (UTCB)

Collaboration diagram for ARM Virtual Registers (UTCB):



Data Structures

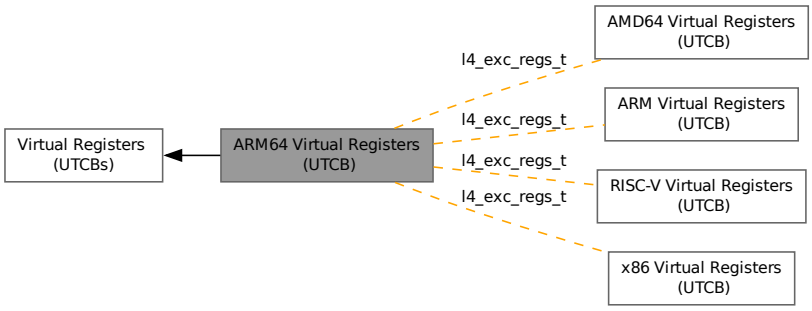
- struct l4_exc_regs_t

  UTCB structure for exceptions.

13.1.9.10.7.1 Detailed Description

13.1.9.10.8 ARM64 Virtual Registers (UTCB)

Collaboration diagram for ARM64 Virtual Registers (UTCB):



Data Structures

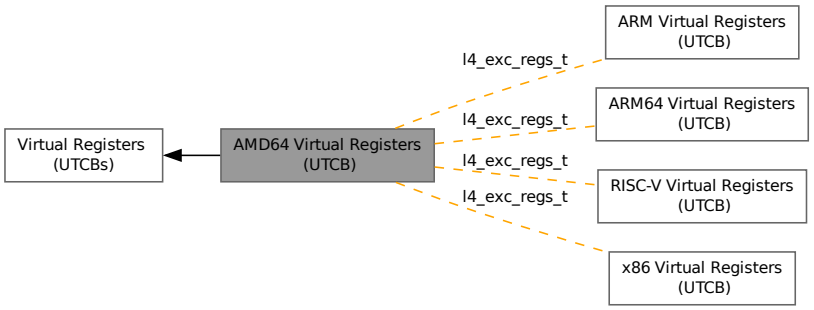
- struct l4_exc_regs_t

  UTCB structure for exceptions.

13.1.9.10.8.1 Detailed Description

13.1.9.10.9 AMD64 Virtual Registers (UTCB)

Collaboration diagram for AMD64 Virtual Registers (UTCB):



Data Structures

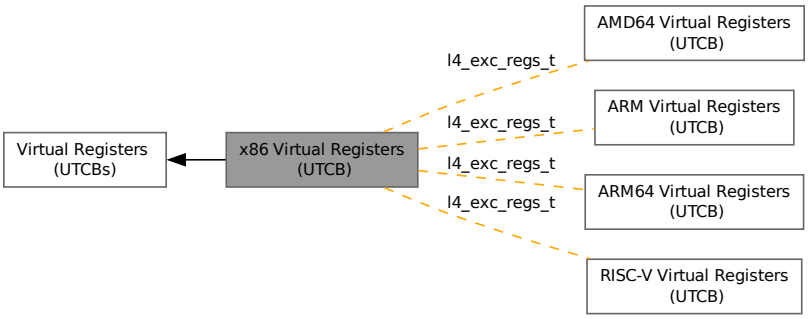
- struct l4_exc_regs_t

  UTCB structure for exceptions.

13.1.9.10.9.1 Detailed Description

13.1.9.10.10 x86 Virtual Registers (UTCB)

Collaboration diagram for x86 Virtual Registers (UTCB):



Data Structures

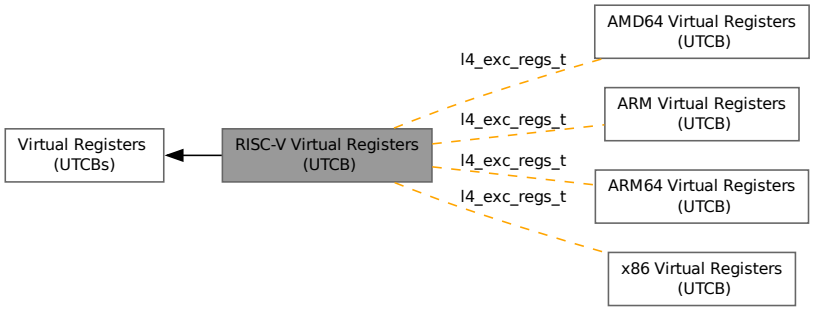
- struct l4_exc_regs_t

  UTCB structure for exceptions.

13.1.9.10.10.1 Detailed Description

13.1.9.10.11 RISC-V Virtual Registers (UTCB)

Collaboration diagram for RISC-V Virtual Registers (UTCB):



Data Structures

- struct l4_exc_regs_t

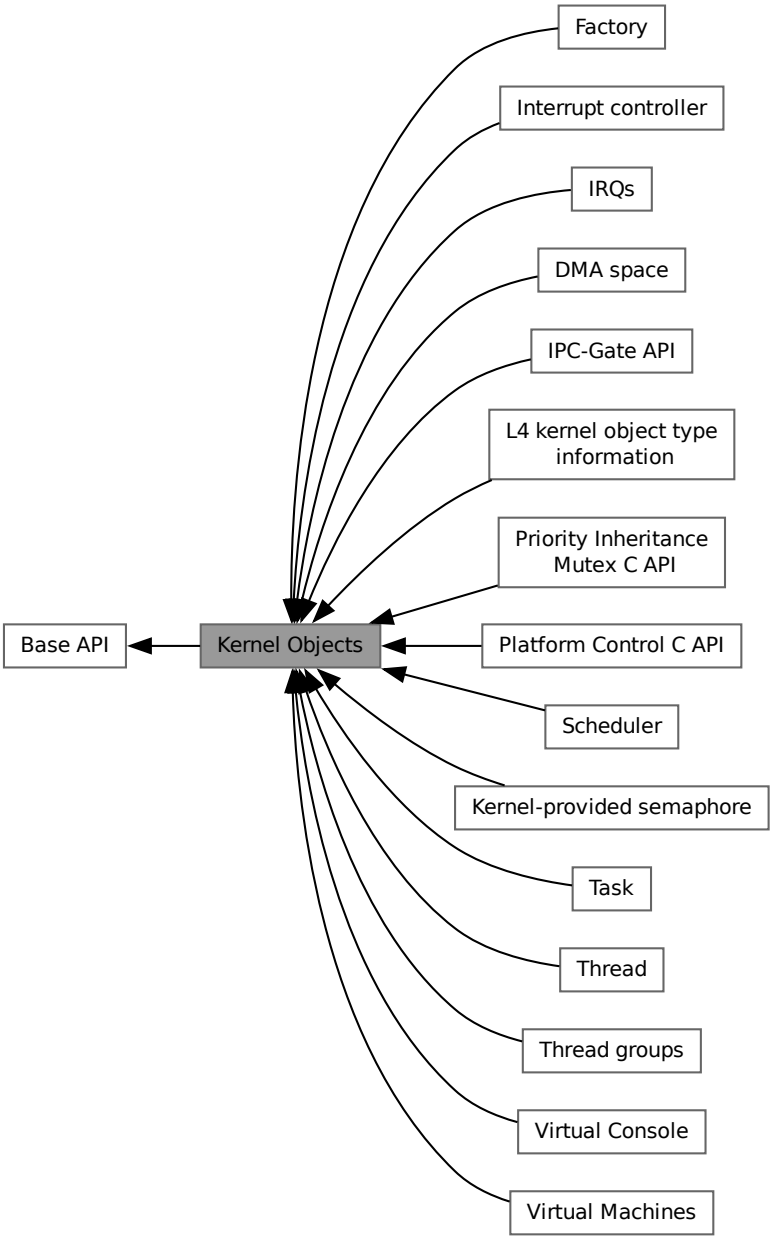
  UTCB structure for exceptions.

13.1.9.10.11.1 Detailed Description

13.1.10 Kernel Objects

API of kernel objects.

Collaboration diagram for Kernel Objects:



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  C Virtual console interface for simple character based input and output, see L4::Vcon for the C++ interface.

Data Structures

- class L4::Kobject
  Base class for all kinds of kernel objects and remote objects, referenced by capabilities.
- class L4::Vm
  Virtual machine host address space.

13.1.10.1 Detailed Description

API of kernel objects.

Include File

```
#include <l4/sys/kernel_object.h>
```

13.1.10.2 IPC-Gate API

The C IPC gate interface, see L4::Ipc_gate for the C++ interface.
Collaboration diagram for IPC-Gate API:



Functions

- l4_msgtag_t l4_ipc_gate_get_infos (l4_cap_idx_t gate, l4_umword_t *label)

  Get information about the IPC-gate.
- l4_msgtag_t l4_rcv_ep_bind_thread (l4_cap_idx_t ep, l4_cap_idx_t thread, l4_umword_t label)

  Bind the IPC receive endpoint to a thread.
- l4_msgtag_t l4_rcv_ep_bind_snd_destination (l4_cap_idx_t ep, l4_cap_idx_t snd_dst, l4_umword_t label)

  Bind the IPC receive endpoint to a send destination (a thread).

13.1.10.2.1 Detailed Description

The C IPC gate interface, see L4::Ipc_gate for the C++ interface.
IPC gates are used to create secure communication channels between protection domains. An IPC gate can be created using the Factory interface.
Depending on the permissions of the capability used, an IPC gate forwards IPC to the Thread the IPC gate is *bound* to (cf. l4_rcv_ep_bind_thread() and l4_rcv_ep_bind_snd_destination()). If the capability has the L4_FPAGE_C_IPCGATE_SVR permission, only IPC using a protocol different from the L4_PROTO_KOBJECT protocol is forwarded. Without the L4_FPAGE_C_IPCGATE_SVR permission, all IPC is forwarded. The latter is the usual case for a client in a client/server scenario. When not bound to a thread or thread group yet, the forwarded IPC blocks until the IPC gate is bound to a thread or thread group, or the IPC times out.
Forwarded IPC is always forwarded to the userland of the thread the IPC gate is bound to, either directly or indirectly using a thread group. That means, the Thread interface of that thread is not accessible via an IPC gate. The IPC-Gate API of an IPC gate is only accessible if the capability used has the L4_FPAGE_C_IPCGATE_SVR permission (cf. previous paragraph). Conversely that means, if the capability used lacks the L4_FPAGE_C_IPCGATE_SVR permission, IPC-Gate API calls are forwarded to the thread or thread group the IPC gate is bound to instead of being processed by the IPC gate itself. In a client/server scenario, a client should only get IPC gate capabilities without L4_FPAGE_C_IPCGATE_SVR permission so the client cannot tamper with the IPC gate.
When binding an IPC gate to a thread or thread group, a user-defined, kernel protected, machine-word sized payload called the IPC gate's *label* is assigned to the IPC gate (note that the two least significant bits of the label must be zero; cf. l4_rcv_ep_bind_thread() and l4_rcv_ep_bind_snd_destination()). When a send-only IPC or call IPC is forwarded via an IPC gate, the label provided by the sender is ignored and replaced by the IPC gate's label where the two least significant bits are set to the L4_CAP_FPAGE_S and L4_CAP_FPAGE_W permissions of the capability used. The replaced label is only visible to the thread the IPC gate is bound to upon receive (or to the selected thread from the thread group the IPC gate is bound to). However, the configured label of an IPC gate can also be queried via l4_ipc_gate_get_infos() if the capability used has the L4_FPAGE_C_IPCGATE_SVR permission.
When deleting an IPC gate or when unbinding it from a thread or thread group, the label of IPC already in flight won't be changed. To ensure that no IPC from this IPC gate is received by a thread with an unexpected label, l4_thread_modify_sender_start() shall be used to change the labels of every pending IPC to that gate. This is also required if the label of an already bound IPC gate is changed. It is not necessary after binding the IPC gate to a thread or thread group for the first time.
When binding a currently bound IPC gate to a new thread or thread group, the same label should be used that was used with the old thread. Otherwise the old and the new thread need to synchronize to avoid IPC messages with unexpected labels.

Include File

```
#include <l4/sys/ipc_gate.h>
```

For the C++ interface refer to the L4::Ipc_gate documentation.

See also

Object Invocation

13.1.10.2.2 Function Documentation

13.1.10.2.2.1 l4_ipc_gate_get_infos()

```
l4_msgtag_t l4_ipc_gate_get_infos (
             l4_cap_idx_t gate,
             l4_umword_t * label)  [inline]
```

Get information about the IPC-gate.

Parameters

	gate	The IPC gate object to get information about.
out	*label*	The label of the IPC gate is returned here.

Returns

System call return tag.

Precondition

If `gate` does not possess the L4_FPAGE_C_IPCGATE_SVR right, the kernel will not perform this operation. Instead, the underlying IPC message will be forwarded to the thread or thread group the IPC gate is bound to, blocking the caller if the IPC gate is not bound yet.

Definition at line 166 of file ipc_gate.h.
References l4_utcb().
Here is the call graph for this function:



13.1.10.2.2.2 l4_rcv_ep_bind_snd_destination()

```
l4_msgtag_t l4_rcv_ep_bind_snd_destination (
             l4_cap_idx_t ep,
             l4_cap_idx_t snd_dst,
             l4_umword_t label)  [inline]
```

Bind the IPC receive endpoint to a send destination (a thread).

Parameters

ep	The IPC receive endpoint object.
snd_dst	The send destination (thread) object `ep` shall be bound to.
label	Label to assign to `ep`. For IPC gates, the two least significant bits must be set to zero.

Returns

Syscall return tag containing one of the following return codes.

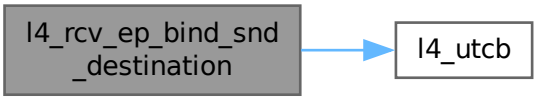
Return values

L4_EOK	Operation successful.
-L4_EINVAL	`snd_dst` is not a thread object or other arguments were malformed.
-L4_EPERM	No L4_CAP_FPAGE_S right on `ep` or `snd_dst`.

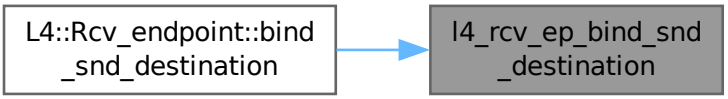
Precondition

If `ep` is an IPC gate capability without the L4_FPAGE_C_IPCGATE_SVR right, the kernel will not perform this operation. Instead, the underlying IPC message will be forwarded to the send destination the IPC gate is bound to, blocking the caller if the IPC gate was not bound yet.

The specified `label` is passed to the receiver of the incoming IPC. It is possible to re-bind a receive endpoint to the same or a different send destination. In this case, IPC already in flight will be delivered with the old label to the previously bound thread unless l4_thread_modify_sender_start() is used to change these labels.
Definition at line 138 of file rcv_endpoint.h.
References l4_utcb().
Referenced by L4::Rcv_endpoint::bind_snd_destination().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.2.2.3 l4_rcv_ep_bind_thread()

```
l4_msgtag_t l4_rcv_ep_bind_thread (
             l4_cap_idx_t ep,
             l4_cap_idx_t thread,
             l4_umword_t label)  [inline]
```

Bind the IPC receive endpoint to a thread.

Parameters

ep	The IPC receive endpoint object.
thread	The thread object `ep` shall be bound to.
label	Label to assign to `ep`. For IPC gates, the two least significant bits must be set to zero.

Returns

Syscall return tag containing one of the following return codes.

Return values

L4_EOK	Operation successful.
-L4_EINVAL	`thread` is not a thread object or other arguments were malformed.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The capabilities `ep` and `thread` both must have the permission L4_CAP_FPAGE_S.

If `ep` is an IPC gate capability without the L4_FPAGE_C_IPCGATE_SVR right, the kernel will not perform this operation. Instead, the underlying IPC message will be forwarded to the thread the IPC gate is bound to, blocking the caller if the IPC gate was not bound yet.

The specified `label` is passed to the receiver of the incoming IPC. It is possible to re-bind a receive endpoint to the same or a different thread. In this case, IPC already in flight will be delivered with the old label to the previously bound thread unless l4_thread_modify_sender_start() is used to change these labels.

Examples

examples/sys/isr/main.c.

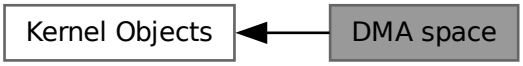
Definition at line 131 of file rcv_endpoint.h.
References l4_utcb().
Here is the call graph for this function:



13.1.10.3 DMA space

A DMA space represents a device memory address space managed by an IOMMU.

Collaboration diagram for DMA space:



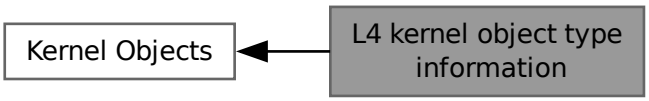
A DMA space represents a device memory address space managed by an IOMMU.
That is, it manages the translation of virtual addresses used by devices to physical addresses. It is accessed via the L4::Task interface, but with the following caveats:

- No threads can be bound to it.
- No objects (and IO ports on IA32) can be mapped to it.
- No kernel-user memory can be added to it.
- It must be constructed by passing the L4_PROTO_DMA_SPACE protocol constant to the kernel factory's L4::Factory.create() call.

A DMA space must be bound to an L4::Iommu to enable the address translation for specific devices.
The kernel factory allows to create DMA spaces only if the kernel has been configured with IOMMU support and if an IOMMU was detected.

13.1.10.4 L4 kernel object type information

Type information for L4 server objects that can be called via IPC.
Collaboration diagram for L4 kernel object type information:



Data Structures

- struct L4::Type_info

  Dynamic Type Information for L4Re Interfaces.
- struct L4::Kobject_typeid< T >

  Meta object for handling access to type information of Kobjects.
- class L4::Kobject_t< Derived, Base, PROTO, S_DEMAND >

  Helper class to create an L4Re interface class that is derived from a single base class.
- class L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >

  Helper class to create an L4Re interface class that is derived from two base classes (see `L4::Kobject_t`).
- struct L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >

  Helper class to create an L4Re interface class that is derived from three base classes (see `L4::Kobject_t`).
- struct L4::Kobject_x< Derived, ARGS >

  Generic Kobject inheritance template.

Functions

- template<typename T>
  Type_info const * L4::kobject_typeid () noexcept

  Get the L4::Type_info for the L4Re interface given in `T`.

13.1.10.4.1 Detailed Description

Type information for L4 server objects that can be called via IPC.
This type information consists of inheritance information, the protocol number assigned to an interface as well as the demand on server-side resources.

13.1.10.4.2 Function Documentation

13.1.10.4.2.1 kobject_typeid()

```
template<typename T>
Type_info const * L4::kobject_typeid ()  [inline], [noexcept]
```

Get the L4::Type_info for the L4Re interface given in `T`.

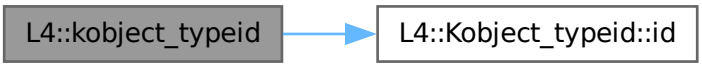
Template Parameters

T	The type (L4Re interface) for which the information shall be returned.

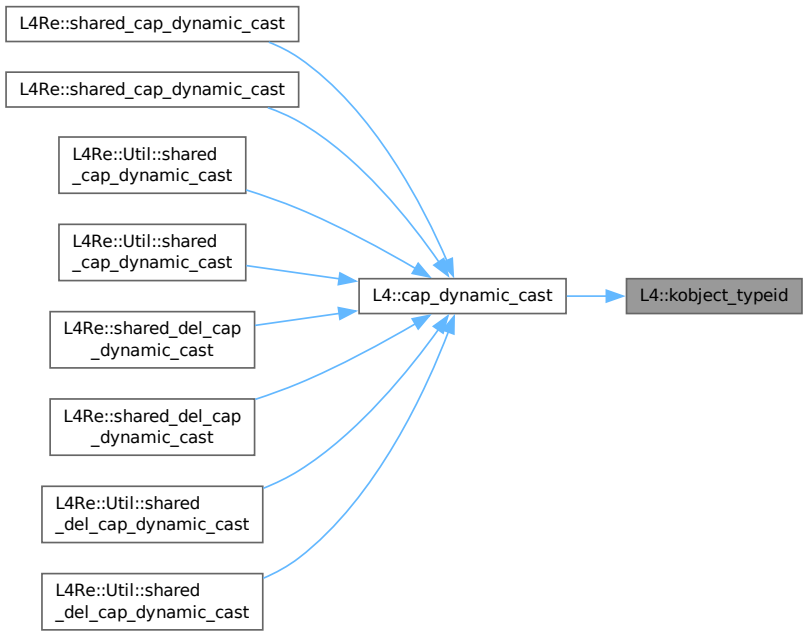
Returns

A pointer to the L4::Type_info structure for `T`.

Definition at line 682 of file __typeinfo.h.
References L4::Kobject_typeid< T >::id().
Referenced by cap_dynamic_cast().
Here is the call graph for this function:

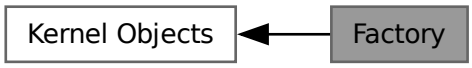


Here is the caller graph for this function:



13.1.10.5 Factory

C factory interface to create objects, see L4::Factory for the C++ interface.
Collaboration diagram for Factory:



Functions

- l4_msgtag_t l4_factory_create_task (l4_cap_idx_t factory, l4_cap_idx_t target_cap, l4_fpage_t *utcb_area) L4_NOTHROW

  Create a new task.
- l4_msgtag_t l4_factory_create_thread (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

  Create a new thread.
- l4_msgtag_t l4_factory_create_factory (l4_cap_idx_t factory, l4_cap_idx_t target_cap, unsigned long limit) L4_NOTHROW

  Create a new factory.
- l4_msgtag_t l4_factory_create_gate (l4_cap_idx_t factory, l4_cap_idx_t target_cap, l4_cap_idx_t snd_dst_↩ cap, l4_umword_t label) L4_NOTHROW

  Create a new IPC gate, optionally bound to a send destination (a thread or thread group).
- l4_msgtag_t l4_factory_create_irq (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

Create a new IRQ sender.

- l4_msgtag_t l4_factory_create_vm (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

  Create a new virtual machine.

- l4_msgtag_t l4_factory_create_vcpu_context (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

  Create a new vCPU context.

- l4_msgtag_t l4_factory_create_thread_group (l4_cap_idx_t factory, l4_cap_idx_t target_cap, unsigned policy) L4_NOTHROW

  Create a new thread group.

- l4_msgtag_t l4_factory_create_pi_mutex (l4_cap_idx_t factory, l4_cap_idx_t target_cap, l4_addr_t ku_status, l4_cap_idx_t task_cap) L4_NOTHROW

  Create a new priority inheritance mutex.

- l4_msgtag_t l4_factory_create (l4_cap_idx_t factory, long obj, l4_cap_idx_t target) L4_NOTHROW

  Create a new object.

13.1.10.5.1 Detailed Description

C factory interface to create objects, see L4::Factory for the C++ interface.
A factory is used to create all kinds of kernel objects:

- Task
- Thread
- Factory
- IPC-Gate API
- IRQs
- Virtual Machines

To create a new kernel object the caller has to specify the factory to use for creation. The caller has to allocate a capability slot where the kernel stores the new object's capability.
The factory is equipped with a limit that limits the amount of kernel memory available for that factory.

Note

The limit does not give any guarantee for the amount of available kernel memory.

Include File

```
#include <l4/sys/factory.h>
```

For the C++ interface refer to L4::Factory.

13.1.10.5.2 Function Documentation

13.1.10.5.2.1 l4_factory_create()

```
l4_msgtag_t l4_factory_create (
             l4_cap_idx_t factory,
             long obj,
             l4_cap_idx_t target)  [inline]
```

Create a new object.

Parameters

	factory	Factory to use for creation.
	obj	Protocol ID to describe the type of the object to create.

out	*target*	The kernel stores the new object's capability into this slot.

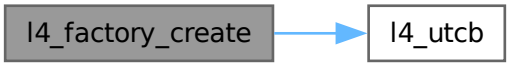
Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

The capability `factory` must have the permission L4_CAP_FPAGE_S.

Definition at line 769 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.5.2.2 l4_factory_create_factory()

```
l4_msgtag_t l4_factory_create_factory (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap,
             unsigned long limit)  [inline]
```

Create a new factory.

Parameters

	factory	Capability index for factory to use for creation.
out	*target_cap*	The kernel stores the new factory's capability into this slot.
	limit	Limit for the new factory in bytes.

Returns

Syscall return tag

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

The capability `factory` must have the permission L4_CAP_FPAGE_S.

Note

The limit of the new factory is subtracted from the available amount of the factory used for creation.

This method is only guaranteed to work with the Kernel Factory. For other services, use the generic L4::Factory::create() method and consult the service documentation for information on the arguments that need to be passed to the create stream.

Definition at line 599 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.5.2.3 l4_factory_create_gate()

```
l4_msgtag_t l4_factory_create_gate (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap,
             l4_cap_idx_t snd_dst_cap,
             l4_umword_t label)  [inline]
```

Create a new IPC gate, optionally bound to a send destination (a thread or thread group).

Parameters

	factory	Capability index for factory to use for creation.
`out`	*target_cap*	The kernel stores the new IPC gate's capability into this slot.
	snd_dst_cap	Optional capability index of a thread or thread group to bind the gate to. Use L4_INVALID_CAP to create an unbound IPC gate.
	label	Optional label of the gate (precisely used if `snd_dst_cap` is valid). If `snd_dst_cap` is valid, `label` must be present.

Returns

Syscall return tag containing one of the following return codes.

Return values

L4_EOK	No error occurred.
-L4_ENOMEM	Out-of-memory during allocation of the lpc_gate object.
-L4_EINVAL	`snd_dst_cap` is void or points to something that is not a thread or thread group.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The capability `factory` must have the permission L4_CAP_FPAGE_S. Also `snd_dst_cap` (if not L4_INVALID_CAP) must have the permission L4_CAP_FPAGE_S.

An unbound IPC gate can be bound to a thread using l4_rcv_ep_bind_thread().

See also

IPC-Gate API

Definition at line 607 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.5.2.4 l4_factory_create_irq()

```
l4_msgtag_t l4_factory_create_irq (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap)  [inline]
```

Create a new IRQ sender.

Parameters

	factory	Factory to use for creation.
`out`	*target_cap*	The kernel stores the new IRQ's capability into this slot.

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

The capability `factory` must have the permission L4_CAP_FPAGE_S.

See also

IRQs

Examples

examples/sys/isr/main.c.

Definition at line 615 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.5.2.5 l4_factory_create_pi_mutex()

```
l4_msgtag_t l4_factory_create_pi_mutex (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap,
             l4_addr_t ku_status,
             l4_cap_idx_t task_cap)  [inline]
```

Create a new priority inheritance mutex.
The priority inheritance mutex is bound to the specified task.

Parameters

	factory	Capability index for factory to use for creation.
out	*target_cap*	The kernel stores the new mutex's capability into this slot.
	ku_status	Address of mutex status field in kernel-user memory of specified task.
	task_cap	Task the mutex gets bound to.

Returns

Syscall return tag

Return values

L4_EOK	No error occurred.
-L4_ENOMEM	Out-of-memory during allocation of the mutex object.
-L4_EINVAL	Invalid ku_status or task_cap parameter.
-L4_EPERM	Insufficient permissions; see precondition.
-L4_ENODEV	Priority inheritance mutexes not supported.

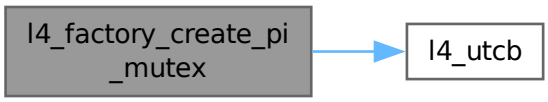
Precondition

The capabilities `factory` and `task_cap` must have the permission L4_CAP_FPAGE_S.

See also

Priority Inheritance Mutex C API

Definition at line 644 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.5.2.6 l4_factory_create_task()

```
l4_msgtag_t l4_factory_create_task (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap,
             l4_fpage_t * utcb_area)  [inline]
```

Create a new task.

Parameters

	factory	Capability index for factory to use for creation.
out	*target_cap*	The kernel stores the new task's capability into this slot.
in,out	*utcb_area*	Pointer to flexpage that describes an area of kernel-user memory that can be used for UTCBs and vCPU state-save-areas of the new task.

On systems without MMU, the flexpage is adjusted to reflect the actually allocated physical address.

Returns

Syscall return tag.

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

The capability `factory` must have the permission L4_CAP_FPAGE_S.

Note

The size of the UTCB area specifies indirectly the number of UTCBs available for this task. Refer to l4_task_add_ku_mem() for adding more of this type of memory.

See also

Task

Definition at line 585 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.5.2.7 l4_factory_create_thread()

```
l4_msgtag_t l4_factory_create_thread (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap)  [inline]
```

Create a new thread.

Parameters

	factory	Capability index for factory to use for creation.
out	*target_cap*	The kernel stores the new thread's capability into this slot.

Returns

Syscall return tag

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

The capability `factory` must have the permission L4_CAP_FPAGE_S.

See also

Thread

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 592 of file factory.h.
References L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.10.5.2.8 l4_factory_create_thread_group()

```
l4_msgtag_t l4_factory_create_thread_group (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap,
             unsigned policy)  [inline]
```

Create a new thread group.

An IPC endpoint can be bound to a thread group. When a message arrives at the IPC endpoint, a specific thread of the thread group is selected to actually receive the message. A thread group is a send destination for an IPC endpoint.

Parameters

	factory	Capability index for factory to use for creation.
out	*target_cap*	The kernel stores the new thread group's capability into this slot.
	policy	Policy parameter for the thread group. See L4_thread_group_policy for a list of supported values.

Returns

Syscall return tag

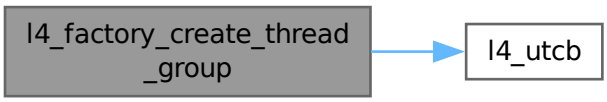
Return values

L4_EOK	No error occurred.
-L4_ENOMEM	Out-of-memory during allocation of the thread group object.
-L4_EINVAL	Invalid policy parameter.
-L4_EPERM	The factory instance requires L4_CAP_FPAGE_S rights on `factory` and L4_CAP_FPAGE_S is not present.
<0	Error code.

See also

Thread groups

Definition at line 636 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.5.2.9 l4_factory_create_vcpu_context()

```
l4_msgtag_t l4_factory_create_vcpu_context (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap)  [inline]
```

Create a new vCPU context.
A vCPU context typically represents a hardware structure that captures the state of a vCPU on a CPU (e.g. VMX VMCS).

Parameters

	factory	Capability index for factory to use for creation.
out	*target_cap*	The kernel stores the new vCPU context's capability into this slot.

Returns

Syscall return tag

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

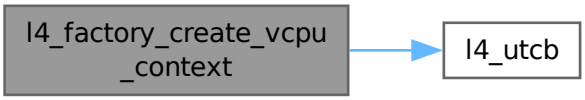
The capability `factory` must have the permission L4_CAP_FPAGE_S.

See also

Virtual Machines

Definition at line 629 of file factory.h.
References L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.10.5.2.10 l4_factory_create_vm()

```
l4_msgtag_t l4_factory_create_vm (
             l4_cap_idx_t factory,
             l4_cap_idx_t target_cap)  [inline]
```

Create a new virtual machine.

Parameters

	factory	Capability index for factory to use for creation.
out	*target_cap*	The kernel stores the new VM's capability into this slot.

Returns

Syscall return tag

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

The capability `factory` must have the permission L4_CAP_FPAGE_S.

See also

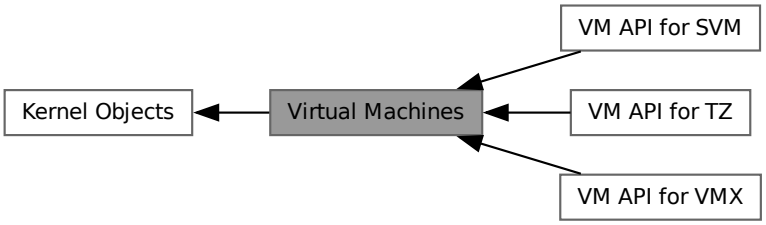
Virtual Machines

Definition at line 622 of file factory.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.6 Virtual Machines

Virtual Machine API.
Collaboration diagram for Virtual Machines:



Topics

- VM API•for SVM 278
  Virtual machine API for SVM.
- VM API•for VMX 279
  Virtual machine API for VMX.
- VM API•for TZ 296
  Virtual Machine API for ARM TrustZone.

13.1.10.6.1 Detailed Description

Virtual Machine API.

13.1.10.6.2 VM API for SVM

Virtual machine API for SVM.

Collaboration diagram for VM API for SVM:



Data Structures

- struct l4_vm_svm_vmcb_control_area

  VMCB structure for SVM VMs.
- struct l4_vm_svm_vmcb_state_save_area_seg

  State save area segment selector struct.
- struct l4_vm_svm_vmcb_state_save_area

  State save area structure for SVM VMs.
- struct l4_vm_svm_vmcb_t

  Control structure for SVM VMs.

Typedefs

- typedef struct l4_vm_svm_vmcb_control_area **l4_vm_svm_vmcb_control_area_t**

  VMCB structure for SVM VMs.
- typedef struct l4_vm_svm_vmcb_state_save_area_seg **l4_vm_svm_vmcb_state_save_area_seg_t**

  State save area segment selector struct.
- typedef struct l4_vm_svm_vmcb_state_save_area **l4_vm_svm_vmcb_state_save_area_t**

  State save area structure for SVM VMs.
- typedef struct l4_vm_svm_vmcb_t **l4_vm_svm_vmcb_t**

  Control structure for SVM VMs.

13.1.10.6.2.1 Detailed Description

Virtual machine API for SVM.

13.1.10.6.3 VM API for VMX

Virtual machine API for VMX.
Collaboration diagram for VM API for VMX:



Data Structures

- struct l4_vmx_offset_table_t

  Software VMCS field offset table.
- struct l4_vm_vmx_vcpu_vmcs_t

  VMX software VMCS.
- struct l4_vm_vmx_vcpu_infos_t

  VMX information members.
- struct l4_vm_vmx_vcpu_state_t

  VMX vCPU state.

Typedefs

- typedef struct l4_vmx_offset_table_t l4_vmx_offset_table_t

  Software VMCS field offset table.
- typedef struct l4_vm_vmx_vcpu_vmcs_t l4_vm_vmx_vcpu_vmcs_t

  VMX software VMCS.
- typedef struct l4_vm_vmx_vcpu_infos_t **l4_vm_vmx_vcpu_infos_t**

  VMX information members.
- typedef struct l4_vm_vmx_vcpu_state_t l4_vm_vmx_vcpu_state_t

  VMX vCPU state.

Enumerations

- enum L4_vm_vmx_caps_regs {
  L4_VM_VMX_BASIC_REG = 0 , L4_VM_VMX_TRUE_PINBASED_CTLS_REG = 1 , L4_VM_VMX_TRUE_PROCBASED_CTL
  = 2 , L4_VM_VMX_TRUE_EXIT_CTLS_REG = 3 ,
  L4_VM_VMX_TRUE_ENTRY_CTLS_REG = 4 , L4_VM_VMX_MISC_REG = 5 , L4_VM_VMX_CR0_FIXED0_REG
  = 6 , L4_VM_VMX_CR0_FIXED1_REG = 7 ,
  L4_VM_VMX_CR4_FIXED0_REG = 8 , L4_VM_VMX_CR4_FIXED1_REG = 9 , L4_VM_VMX_VMCS_ENUM_REG
  = 10 , L4_VM_VMX_PROCBASED_CTLS2_REG = 11 ,
  L4_VM_VMX_EPT_VPID_CAP_REG = 12 , L4_VM_VMX_NESTED_REVISION = 13 , L4_VM_VMX_NUM_CAPS_REGS
  }

  Exported VMX capability registers.
- enum L4_vm_vmx_dfl1_regs {
  L4_VM_VMX_PINBASED_CTLS_DFL1_REG = 0 , L4_VM_VMX_PROCBASED_CTLS_DFL1_REG = 1 ,
  L4_VM_VMX_EXIT_CTLS_DFL1_REG = 2 , L4_VM_VMX_ENTRY_CTLS_DFL1_REG = 3 ,
  L4_VM_VMX_NUM_DFL1_REGS }

  Exported VMX capability registers (default to 1 bits).
- enum L4_vm_vmx_sw_fields {
  L4_VM_VMX_VMCS_CR2 = 0x6880 , L4_VM_VMX_VMCS_NAT_ARG0 = 0x6882 , L4_VM_VMX_VMCS_NAT_ARG1
  = 0x6884 , L4_VM_VMX_VMCS_NAT_ARG2 = 0x6886 ,
  L4_VM_VMX_VMCS_NAT_ARG3 = 0x6888 , L4_VM_VMX_VMCS_XCR0 = 0x2880 , L4_VM_VMX_VMCS_MSR_SYSCALL_M
  = 0x2882 , L4_VM_VMX_VMCS_MSR_LSTAR = 0x2884 ,
  L4_VM_VMX_VMCS_MSR_CSTAR = 0x2886 , L4_VM_VMX_VMCS_MSR_TSC_AUX = 0x2888 ,
  L4_VM_VMX_VMCS_MSR_STAR = 0x288a , L4_VM_VMX_VMCS_MSR_KERNEL_GS_BASE = 0x288c }

  Additional (software-defined) VMCS fields.
- enum L4_vm_vmx_vmcs_sizes { L4_VM_VMX_VMCS_SIZE_VALUES = 2560 , L4_VM_VMX_VMCS_SIZE_DIRTY_BITMAP
  = 320 }

  Sizes of software VMCS members.

Functions

- l4_uint64_t l4_vm_vmx_get_caps (l4_vm_vmx_vcpu_state_t const *vcpu_state, enum L4_vm_vmx_caps_regs caps_reg) L4_NOTHROW

  Get a capability register for VMX.
- l4_uint32_t l4_vm_vmx_get_caps_default1 (l4_vm_vmx_vcpu_state_t const *vcpu_state, enum L4_vm_vmx_dfl1_regs dfl1_reg) L4_NOTHROW

  Get a default to one capability register for VMX.
- unsigned l4_vm_vmx_field_len (unsigned field) L4_NOTHROW

  Return length in bytes of a VMCS field.
- unsigned l4_vm_vmx_field_order (unsigned field) L4_NOTHROW

  Return length in power of two (bytes) of a VMCS field.
- void l4_vm_vmx_clear (l4_vm_vmx_vcpu_vmcs_t *vmcs, l4_vm_vmx_vcpu_vmcs_t *dest_vmcs) L4_NOTHROW

  Save the content from the software VMCS to a different software VMCS.
- void l4_vm_vmx_ptr_load (l4_vm_vmx_vcpu_vmcs_t *vmcs, l4_vm_vmx_vcpu_vmcs_t *src_vmcs) L4_NOTHROW

  Load the content from a different software VMCS to the software VMCS.
- l4_uint32_t l4_vm_vmx_get_cr2_index (l4_vm_vmx_vcpu_vmcs_t const *vmcs) L4_NOTHROW

  Get the software VMCS field index of the virtual CR2 register.
- l4_umword_t l4_vm_vmx_read_nat (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW

  Read a natural-width software VMCS field.
- l4_uint16_t l4_vm_vmx_read_16 (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW

  Read a 16-bit software VMCS field.
- l4_uint32_t l4_vm_vmx_read_32 (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW

  Read a 32-bit software VMCS field.
- l4_uint64_t l4_vm_vmx_read_64 (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW

  Read a 64-bit software VMCS field.
- l4_uint64_t l4_vm_vmx_read (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW

  Read any software VMCS field.
- void l4_vm_vmx_write_nat (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field, l4_umword_t val) L4_NOTHROW

  Write to a natural-width software VMCS field.
- void l4_vm_vmx_write_16 (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field, l4_uint16_t val) L4_NOTHROW

  Write to a 16-bit software VMCS field.
- void l4_vm_vmx_write_32 (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field, l4_uint32_t val) L4_NOTHROW

  Write to a 32-bit software VMCS field.
- void l4_vm_vmx_write_64 (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field, l4_uint64_t val) L4_NOTHROW

  Write to a 64-bit software VMCS field.
- void l4_vm_vmx_write (l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field, l4_uint64_t val) L4_NOTHROW

  Write to an arbitrary software VMCS field.
- void l4_vm_vmx_set_hw_vmcs (l4_vm_vmx_vcpu_vmcs_t *vmcs, l4_cap_idx_t vmcs_cap) L4_NOTHROW

  Associate the software VMCS with a vCPU context, i.e.
- l4_cap_idx_t l4_vm_vmx_get_hw_vmcs (l4_vm_vmx_vcpu_vmcs_t *vmcs) L4_NOTHROW

  Get the vCPU context (i.e.

13.1.10.6.3.1 Detailed Description

Virtual machine API for VMX.

13.1.10.6.3.2 Typedef Documentation

l4_vm_vmx_vcpu_state_t

```
typedef struct l4_vm_vmx_vcpu_state_t l4_vm_vmx_vcpu_state_t
```

VMX vCPU state.
This is a specialization of the generic vCPU state for VMX. This data structure represents the following memory layout:

- 0x000 - 0x1ff: Standard vCPU state (with padding). See l4_vcpu_state_t.
- 0x200 - 0x3ff: VMX information members (with padding). See l4_vm_vmx_vcpu_infos_t.
- 0x400 - 0xfff: VMX software VMCS. See l4_vm_vmx_vcpu_vmcs_t.

Note

The memory layout is documented here for reference purposes. However, the users are strongly discouraged from accessing the data structure directly. The API functions defined in this file are the preferred way of achieving the functionality.

l4_vm_vmx_vcpu_vmcs_t

```
typedef struct l4_vm_vmx_vcpu_vmcs_t l4_vm_vmx_vcpu_vmcs_t
```

VMX software VMCS.
This data structure represents the following memory layout:

- 0x000 - 0x007: Reserved (ignored by the kernel). In the hardware VMCS, the revision identifier and the abort indicator are stored in this area. Hereby we simply ignore these two entries.
- 0x008 - 0x00f: User space data (ignored by the kernel). This currently stores the pointer to a different software VMCS whose content has been loaded to this software VMCS.
- 0x010 - 0x013: VMCS field index of the software-defined CR2 field in the software VMCS.
- 0x014 - 0x017: Reserved.
- 0x018 - 0x01f: Capability of the vCPU context, i.e. the hardware VMCS object (with padding).
- 0x020 - 0x047: Software VMCS field offset table. See l4_vmx_offset_table_t.
- 0x048 - 0x0bf: Reserved.
- 0x0c0 - 0xabf: Software VMCS fields (with padding).
- 0xac0 - 0xbff: Software VMCS fields dirty bitmap (with padding).

Note

The memory layout is documented here for reference purposes. However, the users are strongly discouraged from accessing the data structure directly. The API functions defined in this file are the preferred way of achieving the functionality.

l4_vmx_offset_table_t

```
typedef struct l4_vmx_offset_table_t l4_vmx_offset_table_t
```

Software VMCS field offset table.
This data structure represents the following memory layout:

- 0x00 - 0x02: 3 offsets for 16-bit fields.
- 0x03: Reserved.
- 0x04 - 0x06: 3 offsets for 64-bit fields.

- 0x07: Reserved.
- 0x08 - 0x0a: 3 offsets for 32-bit fields.
- 0x0b: Reserved.
- 0x0c - 0x0e: 3 offsets for natural-width fields.
- 0x0f: Reserved.
- 0x10 - 0x12: 3 limits for 16-bit fields.
- 0x13: Reserved.
- 0x14 - 0x16: 3 limits for 64-bit fields.
- 0x17: Reserved.
- 0x18 - 0x1a: 3 limits for 32-bit fields.
- 0x1b: Reserved.
- 0x1c - 0x1e: 3 limits for natural-width fields.
- 0x1f: Reserved.
- 0x20 - 0x23: 4 index shifts.
- 0x24: Offset of the first software VMCS field.
- 0x25: Size of the software VMCS fields.
- 0x26 - 0x27: Reserved.

The offsets/limits in each size category are in the following order:

- Control fields.
- Read-only fields.
- Guest fields.

The index shifts are in the following order:

- 16-bit.
- 64-bit.
- 32-bit.
- Natural-width.

All offsets/limits/sizes are represented in a 64-byte granule.
The offsets (after being multiplied by 64) are indexes in the values array in l4_vm_vmx_vcpu_vmcs_t and bit indexes in the dirty_bitmap array in l4_vm_vmx_vcpu_vmcs_t.
The limits (after being multiplied by 64) represent the range of the available indexes.

Note

The memory layout is documented here for reference purposes. However, the users are strongly discouraged from accessing the data structure directly. The API functions defined in this file are the preferred way of achieving the functionality.

13.1.10.6.3.3 Enumeration Type Documentation

L4_vm_vmx_caps_regs

enum L4_vm_vmx_caps_regs
Exported VMX capability registers.

Enumerator

L4_VM_VMX_BASIC_REG	Basic VMX capabilities.
L4_VM_VMX_TRUE_PINBASED_CTLS_REG	True pin-based control caps.
L4_VM_VMX_TRUE_PROCBASED_CTLS_REG	True processor based control caps.
L4_VM_VMX_TRUE_EXIT_CTLS_REG	True exit control caps.
L4_VM_VMX_TRUE_ENTRY_CTLS_REG	True entry control caps.
L4_VM_VMX_MISC_REG	Misc caps.
L4_VM_VMX_CR0_FIXED0_REG	Fixed to 0 bits of CR0.
L4_VM_VMX_CR0_FIXED1_REG	Fixed to 1 bits of CR0.
L4_VM_VMX_CR4_FIXED0_REG	Fixed to 0 bits of CR4.
L4_VM_VMX_CR4_FIXED1_REG	Fixed to 1 bits of CR4.
L4_VM_VMX_VMCS_ENUM_REG	VMCS enumeration info.
L4_VM_VMX_PROCBASED_CTLS2_REG	Processor based control 2 caps.
L4_VM_VMX_EPT_VPID_CAP_REG	EPT and VPID caps.
L4_VM_VMX_NESTED_REVISION	Nested VMCS revision.
L4_VM_VMX_NUM_CAPS_REGS	Total number of VMX capability registers.

Definition at line 28 of file __vm-vmx.h.

L4_vm_vmx_dfl1_regs

enum L4_vm_vmx_dfl1_regs
Exported VMX capability registers (default to 1 bits).

Enumerator

L4_VM_VMX_PINBASED_CTLS_DFL1_REG	Default 1 bits in pin-based controls.
L4_VM_VMX_PROCBASED_CTLS_DFL1_REG	Default 1 bits in processor-based controls.
L4_VM_VMX_EXIT_CTLS_DFL1_REG	Default 1 bits in exit controls.
L4_VM_VMX_ENTRY_CTLS_DFL1_REG	Default 1 bits in entry controls.
L4_VM_VMX_NUM_DFL1_REGS	Total number of default on registers.

Definition at line 51 of file __vm-vmx.h.

L4_vm_vmx_sw_fields

enum L4_vm_vmx_sw_fields
Additional (software-defined) VMCS fields.
The VMCS offsets defined here are actually not in the hardware VMCS. However our VMMs run in user mode and need to have access to certain registers available in kernel mode only. So we put them into our software VMCS.

Enumerator

L4_VM_VMX_VMCS_CR2	Software VMCS offset for CR2. **Note** You usually need to check this value against the value you get from l4_vm_vmx_get_cr2_index() to make sure you are running on a compatible kernel.
L4_VM_VMX_VMCS_NAT_ARG0	Custom argument passed from kernel to user space.
L4_VM_VMX_VMCS_NAT_ARG1	Custom argument passed from kernel to user space.
L4_VM_VMX_VMCS_NAT_ARG2	Custom argument passed from kernel to user space.
L4_VM_VMX_VMCS_NAT_ARG3	Custom argument passed from kernel to user space.
L4_VM_VMX_VMCS_XCR0	VMCS offset of extended control register XCR0.
L4_VM_VMX_VMCS_MSR_SYSCALL_MASK	VMCS offset of system call flag mask MSR.
L4_VM_VMX_VMCS_MSR_LSTAR	VMCS offset of IA32e mode system call target address MSR.
L4_VM_VMX_VMCS_MSR_CSTAR	VMCS offset of IA32 mode system call target address MSR.
L4_VM_VMX_VMCS_MSR_TSC_AUX	VMCS offset of auxiliary TSC signature MSR.
L4_VM_VMX_VMCS_MSR_STAR	VMCS offset of system call target address MSR.
L4_VM_VMX_VMCS_MSR_KERNEL_GS_BASE	VMCS offset of GS base address swap target MSR.

Definition at line 69 of file __vm-vmx.h.

L4_vm_vmx_vmcs_sizes

```
enum L4_vm_vmx_vmcs_sizes
```

Sizes of software VMCS members.

Enumerator

L4_VM_VMX_VMCS_SIZE_VALUES	Size of the software VMCS values member.
L4_VM_VMX_VMCS_SIZE_DIRTY_BITMAP	Size of the software VMCS dirty bitmap member.

Definition at line 170 of file __vm-vmx.h.

13.1.10.6.3.4 Function Documentation

l4_vm_vmx_clear()

```
void l4_vm_vmx_clear (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            l4_vm_vmx_vcpu_vmcs_t * dest_vmcs)  [inline]
```

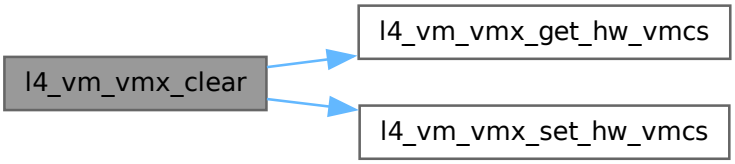
Save the content from the software VMCS to a different software VMCS.

Parameters

vmcs	Pointer to the source software VMCS.
dest_vmcs	Pointer to the destination software VMCS.

This function is comparable to the VMX VMCLEAR instruction.
Definition at line 698 of file __vm-vmx.h.
References L4_NOTHROW, l4_vm_vmx_get_hw_vmcs(), l4_vm_vmx_set_hw_vmcs(), and L4_VM_VMX_VMCS_SIZE_DIRTY_BITM

Referenced by l4_vm_vmx_ptr_load().
Here is the call graph for this function:



Here is the caller graph for this function:



l4_vm_vmx_field_len()

```
unsigned l4_vm_vmx_field_len (
             unsigned field)  [inline]
```

Return length in bytes of a VMCS field.

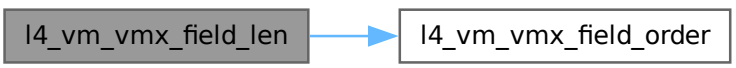
Parameters

field	Field number.

Returns

Width of field in bytes.

Definition at line 593 of file __vm-vmx.h.
References L4_NOTHROW, and l4_vm_vmx_field_order().
Here is the call graph for this function:



l4_vm_vmx_field_order()

```
unsigned l4_vm_vmx_field_order (
             unsigned field)  [inline]
```

Return length in power of two (bytes) of a VMCS field.

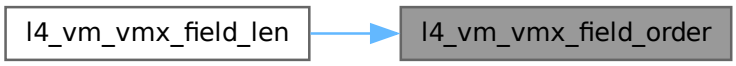
Parameters

field	Field number.

Returns

Width of field in power of two (bytes).

Definition at line 600 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_field_len().
Here is the caller graph for this function:



l4_vm_vmx_get_caps()

```
l4_uint64_t l4_vm_vmx_get_caps (
             l4_vm_vmx_vcpu_state_t const * vcpu_state,
             enum L4_vm_vmx_caps_regs caps_reg)  [inline]
```

Get a capability register for VMX.

Parameters

vcpu_state	Pointer to the vCPU state.
caps_reg	Capability register index (see L4_vm_vmx_caps_regs).

Returns

The value of the capability register.

Definition at line 884 of file __vm-vmx.h.
References L4_NOTHROW.

l4_vm_vmx_get_caps_default1()

```
l4_uint32_t l4_vm_vmx_get_caps_default1 (
             l4_vm_vmx_vcpu_state_t const * vcpu_state,
             enum L4_vm_vmx_dfl1_regs dfl1_reg)  [inline]
```

Get a default to one capability register for VMX.

Parameters

vcpu_state	Pointer to the vCPU state.
dfl1_reg	Default to 1 capability register index (see L4_vm_vmx_dfl1_regs).

Returns

The value of the capability register.

Definition at line 892 of file __vm-vmx.h.
References L4_NOTHROW.

l4_vm_vmx_get_cr2_index()

```
l4_uint32_t l4_vm_vmx_get_cr2_index (
            l4_vm_vmx_vcpu_vmcs_t const * vmcs)  [inline]
```

Get the software VMCS field index of the virtual CR2 register.

Parameters

vmcs	Pointer to the software VMCS.

Returns

The field index used for the virtual CR2 register as used by the current Fiasco interface.

The CR2 register is actually not in the hardware VMCS, however our VMMs run in user mode and need to have access to this register so we put it into our software VMCS.

See also

L4_VM_VMX_VMCS_CR2

Definition at line 900 of file __vm-vmx.h.
References L4_NOTHROW.

l4_vm_vmx_get_hw_vmcs()

```
l4_cap_idx_t l4_vm_vmx_get_hw_vmcs (
             l4_vm_vmx_vcpu_vmcs_t * vmcs)  [inline]
```

Get the vCPU context (i.e.
the hardware VMCS object) associated with the software VMCS.

Parameters

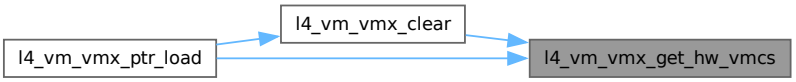
vmcs	Pointer to the software VMCS.

Returns

vCPU context (hardware VMCS object) capability.

Definition at line 915 of file __vm-vmx.h.
References L4_CAP_MASK, and L4_NOTHROW.
Referenced by l4_vm_vmx_clear(), and l4_vm_vmx_ptr_load().

Here is the caller graph for this function:



l4_vm_vmx_ptr_load()

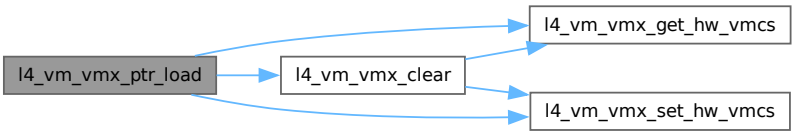
```
void l4_vm_vmx_ptr_load (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            l4_vm_vmx_vcpu_vmcs_t * src_vmcs)  [inline]
```

Load the content from a different software VMCS to the software VMCS.

Parameters

vmcs	Pointer to the destination software VMCS.
src_vmcs	Pointer to the source software VMCS.

This function is comparable to the VMX VMPTRLD instruction.
Definition at line 719 of file __vm-vmx.h.
References L4_NOTHROW, l4_vm_vmx_clear(), l4_vm_vmx_get_hw_vmcs(), l4_vm_vmx_set_hw_vmcs(), and L4_VM_VMX_VMCS_SIZE_DIRTY_BITMAP.
Here is the call graph for this function:



l4_vm_vmx_read()

```
l4_uint64_t l4_vm_vmx_read (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            unsigned field)  [inline]
```

Read any software VMCS field.

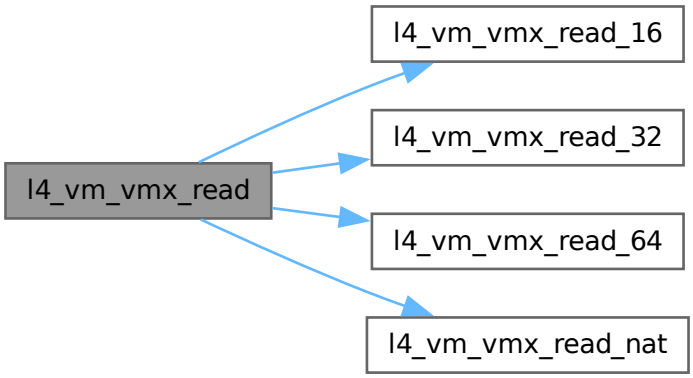
Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.

Returns

The value of the software VMCS field with the given index.

Definition at line 787 of file __vm-vmx.h.
References L4_NOTHROW, l4_vm_vmx_read_16(), l4_vm_vmx_read_32(), l4_vm_vmx_read_64(), and l4_vm_vmx_read_nat().
Here is the call graph for this function:



l4_vm_vmx_read_16()

```
l4_uint16_t l4_vm_vmx_read_16 (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            unsigned field)  [inline]
```

Read a 16-bit software VMCS field.

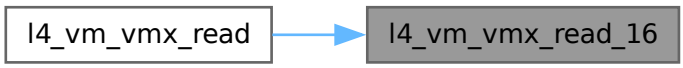
Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.

Returns

The value of the software VMCS field with the given index.

Definition at line 754 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_read().
Here is the caller graph for this function:



l4_vm_vmx_read_32()

```
l4_uint32_t l4_vm_vmx_read_32 (
             l4_vm_vmx_vcpu_vmcs_t * vmcs,
             unsigned field)  [inline]
```

Read a 32-bit software VMCS field.

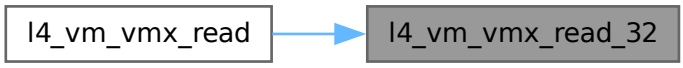
Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.

Returns

The value of the software VMCS field with the given index.

Definition at line 765 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_read().
Here is the caller graph for this function:



l4_vm_vmx_read_64()

```
l4_uint64_t l4_vm_vmx_read_64 (
             l4_vm_vmx_vcpu_vmcs_t * vmcs,
             unsigned field)  [inline]
```

Read a 64-bit software VMCS field.

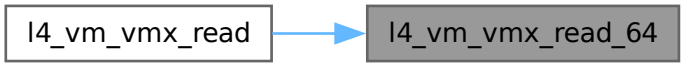
Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.

Returns

The value of the software VMCS field with the given index.

Definition at line 776 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_read().
Here is the caller graph for this function:



l4_vm_vmx_read_nat()

```
l4_umword_t l4_vm_vmx_read_nat (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            unsigned field)  [inline]
```

Read a natural-width software VMCS field.

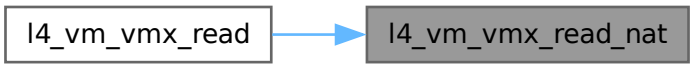
Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.

Returns

The value of the software VMCS field with the given index.

Definition at line 743 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_read().
Here is the caller graph for this function:



l4_vm_vmx_set_hw_vmcs()

```
void l4_vm_vmx_set_hw_vmcs (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            l4_cap_idx_t vmcs_cap)  [inline]
```

Associate the software VMCS with a vCPU context, i.e.
a hardware VMCS object.
The VMX extended vCPU state is unable to be resumed unless it is associated with a vCPU context, i.e. a hardware VMCS object: An L4::Vcpu_context from the user space point of view with its kernel counterpart `Vmx_vmcs`.

Note

When replacing the vCPU context, the dirty bitmap of the software VMCS is not touched, neither by the kernel nor by the API functions. This is on purpose, to enable efficient switching between separate VMs in the common case. If there is a logical discrepancy between the content of the software VMCS and the replaced vCPU context, the user is responsible for explicitly setting the relevant software VMCS fields and/or the relevant software VMCS dirty bitmap bits to ensure that the discrepancy is rectified on the next vCPU resume. This needs to be done regardless of using the API functions (the preferred way) or accessing the data structures directly (the discouraged way).

Replacing the vCPU context while the vCPU is currently running has no immediate effect until the next v↩ CPU resume. In addition to that, the kernel might cache the vCPU context internally (in other words, the capability is not looked up on every vCPU resume). To remove the association of the current vCPU context, simply replace it by an another vCPU context. The reference count of the previous vCPU context will be decremented accordingly on the next vCPU resume.

To remove the association of the current vCPU context without replacing it by an another vCPU context, pass an invalid capability with the bit 3 set and trigger a vCPU resume. The vCPU resume will fail in this case (due to the missing vCPU context), but the reference count of the previous vCPU context will be decremented accordingly.

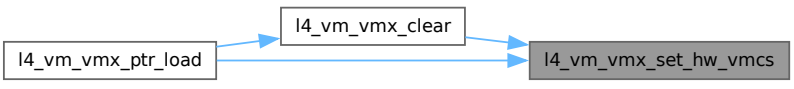
There is no need to explicitly remove the association of the current vCPU context before deleting the software VMCS. Deleting the software VMCS automatically disassociates it from the vCPU context and a vCPU context with a reference count of 0 will be eventually deleted as well.

If the hardware limitations on the usage of the vCPU context are not observed (i.e. no hardware VMCS being active on more than one physical CPU), the vCPU will fail to resume.

Parameters

vmcs	Pointer to the software VMCS.
vmcs_cap	vCPU context (hardware VMCS object) capability.

Definition at line 907 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_clear(), and l4_vm_vmx_ptr_load().
Here is the caller graph for this function:



l4_vm_vmx_write()

```
void l4_vm_vmx_write (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
```

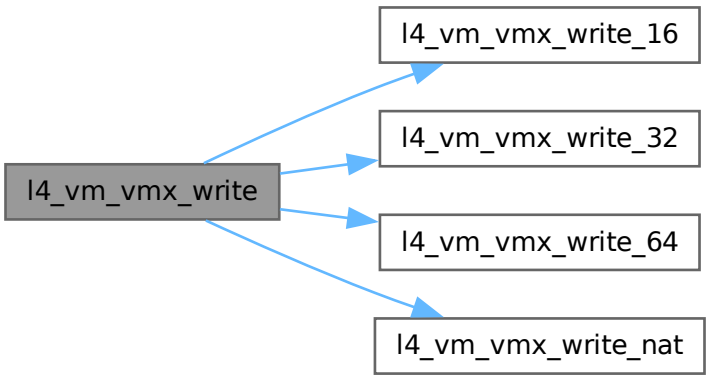
```
unsigned field,
l4_uint64_t val)  [inline]
```

Write to an arbitrary software VMCS field.

Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.
val	The value that shall be written to the given field.

Definition at line 868 of file __vm-vmx.h.
References L4_NOTHROW, l4_vm_vmx_write_16(), l4_vm_vmx_write_32(), l4_vm_vmx_write_64(), and l4_vm_vmx_write_nat().
Here is the call graph for this function:



l4_vm_vmx_write_16()

```
void l4_vm_vmx_write_16 (
l4_vm_vmx_vcpu_vmcs_t * vmcs,
unsigned field,
l4_uint16_t val)  [inline]
```

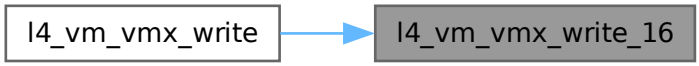
Write to a 16-bit software VMCS field.

Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.
val	The value that shall be written to the given field.

Definition at line 820 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_write().

Here is the caller graph for this function:



l4_vm_vmx_write_32()

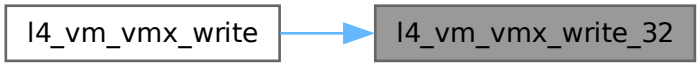
```
void l4_vm_vmx_write_32 (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            unsigned field,
            l4_uint32_t val)  [inline]
```

Write to a 32-bit software VMCS field.

Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.
val	The value that shall be written to the given field.

Definition at line 836 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_write().
Here is the caller graph for this function:



l4_vm_vmx_write_64()

```
void l4_vm_vmx_write_64 (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            unsigned field,
            l4_uint64_t val)  [inline]
```

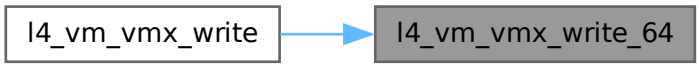
Write to a 64-bit software VMCS field.

Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.

val	The value that shall be written to the given field.

Definition at line 852 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_write().
Here is the caller graph for this function:



l4_vm_vmx_write_nat()

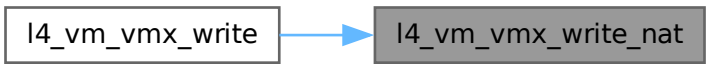
```
void l4_vm_vmx_write_nat (
            l4_vm_vmx_vcpu_vmcs_t * vmcs,
            unsigned field,
            l4_umword_t val)  [inline]
```

Write to a natural-width software VMCS field.

Parameters

vmcs	Pointer to the software VMCS.
field	The VMCS field index as used on VMX hardware.
val	The value that shall be written to the given field.

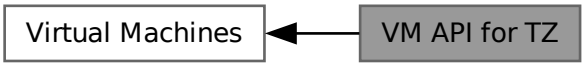
Definition at line 804 of file __vm-vmx.h.
References L4_NOTHROW.
Referenced by l4_vm_vmx_write().
Here is the caller graph for this function:



13.1.10.6.4 VM API for TZ

Virtual Machine API for ARM TrustZone.

Collaboration diagram for VM API for TZ:



Data Structures

- struct l4_vm_tz_state

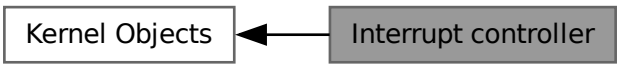
  state structure for TrustZone VMs

13.1.10.6.4.1 Detailed Description

Virtual Machine API for ARM TrustZone.

13.1.10.7 Interrupt controller

The C Icu interface, see L4::Icu for the C++ interface.
Collaboration diagram for Interrupt controller:



Data Structures

- struct l4_icu_info_t

  Info structure for an ICU.

Typedefs

- typedef struct l4_icu_info_t l4_icu_info_t

  Info structure for an ICU.

Enumerations

- enum L4_icu_flags { L4_ICU_FLAG_MSI }

  Flags for IRQ numbers used for the ICU.

Functions

- l4_msgtag_t l4_icu_bind (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW

  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t l4_icu_bind_u (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

Bind an interrupt line of an interrupt controller to an interrupt object.

- l4_msgtag_t l4_icu_unbind (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t l4_icu_unbind_u (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t l4_icu_set_mode (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode) L4_NOTHROW

  Set interrupt mode.
- l4_msgtag_t l4_icu_set_mode_u (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb) L4_NOTHROW

  Set interrupt mode.
- l4_msgtag_t l4_icu_info (l4_cap_idx_t icu, l4_icu_info_t *info) L4_NOTHROW

  Get information about the ICU features.
- l4_msgtag_t l4_icu_info_u (l4_cap_idx_t icu, l4_icu_info_t *info, l4_utcb_t *utcb) L4_NOTHROW

  Get information about the ICU features.
- l4_msgtag_t l4_icu_msi_info (l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info) L4_NOTHROW

  Get MSI info about IRQ.
- l4_msgtag_t l4_icu_msi_info_u (l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info, l4_utcb_t *utcb) L4_NOTHROW

  Get MSI info about IRQ.
- l4_msgtag_t l4_icu_unmask (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to) L4_NOTHROW

  Unmask an IRQ line.
- l4_msgtag_t l4_icu_unmask_u (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW

  Unmask the given interrupt line.
- l4_msgtag_t l4_icu_mask (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to) L4_NOTHROW

  Mask an IRQ line.
- l4_msgtag_t l4_icu_mask_u (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW

  Mask an IRQ line.

13.1.10.7.1 Detailed Description

The C Icu interface, see L4::Icu for the C++ interface.

Note

"ICU" is short for "interrupt control unit".

These functions define the interface for interrupt controllers, for binding IRQ objects to interrupt lines and other interrupt sources, as well as functions for masking and unmasking of interrupts.
To setup an IRQ line the following steps are required:

1. l4_icu_set_mode() (optional if IRQ has a default mode)
2. l4_rcv_ep_bind_thread() or l4_rcv_ep_bind_snd_destination() to attach the IRQ object to a thread object.
3. l4_icu_bind()
4. l4_icu_unmask() to receive the first IRQ

For certain interrupt sources only some of these steps are necessary and supported, see Scheduler and Virtual Console.
At most one IRQs object can be bound to a certain interrupt source and a certain IRQs object can be bound to at most one interrupt source.

Include File

```
#include <l4/sys/icu.h>
```

13.1.10.7.2 Typedef Documentation

13.1.10.7.2.1 l4_icu_info_t

`typedef struct l4_icu_info_t l4_icu_info_t`

Info structure for an ICU.
This structure contains information about the features of an ICU.

See also

l4_icu_info().

13.1.10.7.3 Enumeration Type Documentation

13.1.10.7.3.1 L4_icu_flags

`enum L4_icu_flags`

Flags for IRQ numbers used for the ICU.

Enumerator

L4_ICU_FLAG_MSI	Flag to denote that the IRQ is actually an MSI. This flag may be used for l4_icu_bind() and l4_icu_unbind() functions to denote that the IRQ number is meant to be an MSI.

Definition at line 53 of file icu.h.

13.1.10.7.4 Function Documentation

13.1.10.7.4.1 l4_icu_bind()

```
l4_msgtag_t l4_icu_bind (
             l4_cap_idx_t icu,
             unsigned irqnum,
             l4_cap_idx_t irq)  [inline]
```

Bind an interrupt line of an interrupt controller to an interrupt object.

Parameters

icu	ICU object to bind `irq` to.
irqnum	IRQ line at the ICU.
irq	IRQ object to bind to this ICU.

Returns

Syscall return tag. The caller should check the return value using l4_error() to check for errors and to identify the correct method for unmasking the interrupt. Return values < 0 indicate an error. A return value of 0 means a direct unmask via the IRQ object using l4_irq_unmask(). A return value of 1 means that the interrupt has to be unmasked via the ICU using l4_icu_unmask().

Return values

-L4_EINVAL	`irq` is bound to an interrupt source.

-L4_EPERM	Insufficient permissions; see precondition.

Precondition

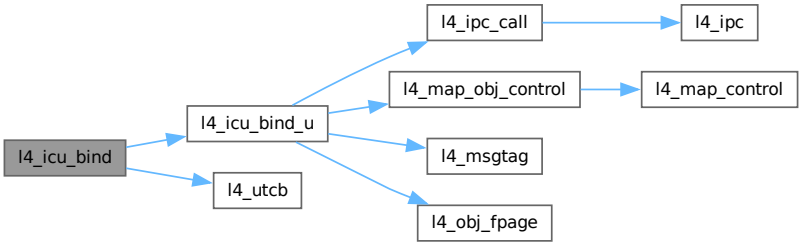
The capability `irq` must have the permission L4_CAP_FPAGE_W.

In case the `irq` is already bound to an interrupt source, it is unbound first. In case the `irq` is bound and the interrupt source is bound to a different IRQ object, only the unbinding happens. An IRQ object that is bound to an interrupt source will get unbound if the IRQ object is deleted.

Examples

examples/sys/isr/main.c.

Definition at line 496 of file icu.h.
References l4_icu_bind_u(), L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.7.4.2 l4_icu_bind_u()

```
l4_msgtag_t l4_icu_bind_u (
             l4_cap_idx_t icu,
             unsigned irqnum,
             l4_cap_idx_t irq,
             l4_utcb_t * utcb)  [inline]
```

Bind an interrupt line of an interrupt controller to an interrupt object.

Parameters

icu	The ICU object to bind `irq` to.
irqnum	IRQ line at the ICU.
irq	IRQ object for the given IRQ line to bind to this ICU.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag. The caller should check the return value using l4_error() to check for errors and to identify the correct method for unmasking the interrupt. Return values < 0 indicate an error. A return value of `0` means a direct unmask via the IRQ object using L4::Irq::unmask. A return value of `1` means that the interrupt has to be unmasked via the ICU using L4::Icu::unmask.

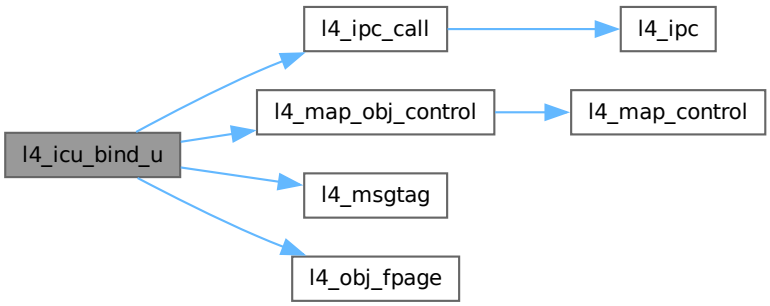
Return values

-L4_EINVAL	`irq` is bound to an interrupt source.
-L4_EPERM	Insufficient permissions; see precondition.

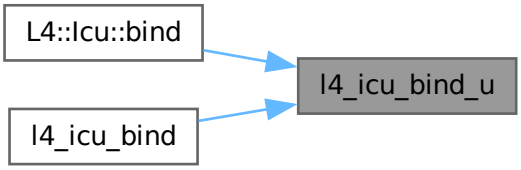
Precondition

The capability `irq` must have the permission L4_CAP_FPAGE_W.

In case the `irq` is already bound to an interrupt source, it is unbound first. In case the `irq` is bound and the interrupt source is bound to a different L4::Irq object, only the unbinding happens. An L4::Irq object that is bound to an interrupt source will get unbound if the L4::Irq object is deleted.
Definition at line 396 of file icu.h.
References L4_CAP_FPAGE_RWS, L4_ICU_OP_BIND, l4_ipc_call(), L4_IPC_NEVER, l4_map_obj_control(), l4_msgtag(), L4_NOTHROW, l4_obj_fpage(), L4_PROTO_IRQ, l4_msg_regs_t::mr, and l4_fpage_t::raw.
Referenced by L4::Icu::bind(), and l4_icu_bind().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.7.4.3 l4_icu_info()

```
l4_msgtag_t l4_icu_info (
            l4_cap_idx_t icu,
            l4_icu_info_t * info)  [inline]
```

Get information about the ICU features.

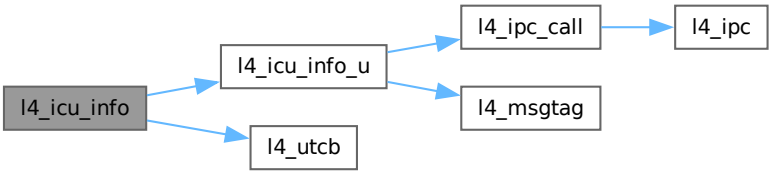
Parameters

	icu	The ICU object from which information shall be retrieved.
out	*info*	Info structure to be filled with information.

Returns

Syscall return tag

Definition at line 504 of file icu.h.
References l4_icu_info_u(), L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.7.4.4 l4_icu_info_u()

```
l4_msgtag_t l4_icu_info_u (
             l4_cap_idx_t icu,
             l4_icu_info_t * info,
             l4_utcb_t * utcb)  [inline]
```

Get information about the ICU features.

Parameters

	icu	The ICU object from which MSI information shall be retrieved.
out	*info*	Info structure to be filled with information.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

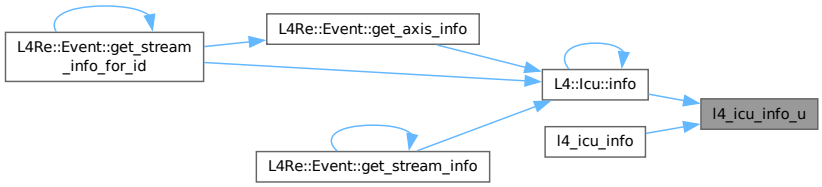
Returns

Syscall return tag

Definition at line 420 of file icu.h.
References L4_ICU_OP_INFO, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_IRQ, and l4_msg_regs_t::mr.
Referenced by L4::Icu::info(), and l4_icu_info().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.7.4.5 l4_icu_mask()

```
l4_msgtag_t l4_icu_mask (
            l4_cap_idx_t icu,
            unsigned irqnum,
            l4_umword_t * label,
            l4_timeout_t to)  [inline]
```

Mask an IRQ line.

Parameters

icu	The ICU object where the IRQ line shall be masked.
irqnum	IRQ line at the ICU.
label	If non-NULL, the function also performs an open wait IPC operation waiting for the next message, and the received label is returned here.
to	IPC timeout, if unsure use L4_IPC_NEVER.

Returns

Syscall return tag. If `label` is NULL, this function performs an IPC send-only operation and there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. In this case use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 518 of file icu.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.7.4.6 l4_icu_mask_u()

```
l4_msgtag_t l4_icu_mask_u (
             l4_cap_idx_t icu,
             unsigned irqnum,
             l4_umword_t * label,
             l4_timeout_t to,
             l4_utcb_t * utcb)  [inline]
```

Mask an IRQ line.

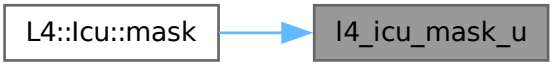
Parameters

icu	The ICU object where the IRQ line shall be masked.
irqnum	IRQ line at the ICU.
label	If NULL, this function is a send-only message to the ICU. If not NULL, this function will enter an open wait after sending the mask message and the received label is returned here.
to	The timeout-pair (send and receive) that shall be used for this operation. The receive timeout is used with a non-NULL `label` only.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag. If `label` is NULL, this function performs an IPC send-only operation and there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. In this case use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 483 of file icu.h.
References L4_NOTHROW.
Referenced by L4::Icu::mask().
Here is the caller graph for this function:



13.1.10.7.4.7 l4_icu_msi_info()

```
l4_msgtag_t l4_icu_msi_info (
              l4_cap_idx_t icu,
              unsigned irqnum,
              l4_uint64_t source,
              l4_icu_msi_info_t * msi_info)  [inline]
```

Get MSI info about IRQ.

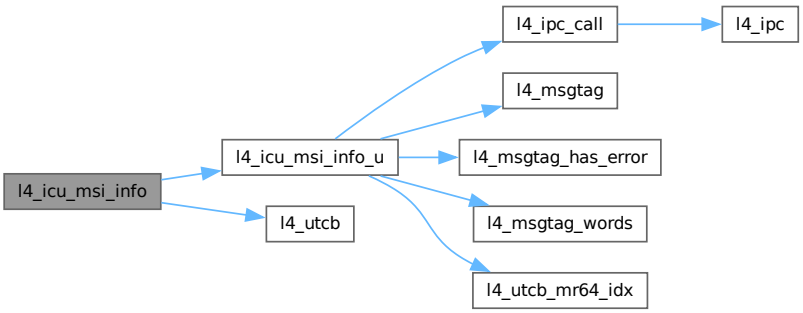
Parameters

	icu	The ICU object from which MSI information shall be retrieved.
	irqnum	IRQ line at the ICU.
	source	Platform dependent requester ID for MSIs. On IA32 we use a 20bit source filter value as described in the Intel IRQ remapping specification.
out	*msi_info*	A l4_icu_msi_info_t structure receiving the address and the data value to trigger this MSI.

Returns

Syscall return tag

Definition at line 508 of file icu.h.
References l4_icu_msi_info_u(), L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.7.4.8 l4_icu_msi_info_u()

```
l4_msgtag_t l4_icu_msi_info_u (
            l4_cap_idx_t icu,
            unsigned irqnum,
            l4_uint64_t source,
            l4_icu_msi_info_t * msi_info,
            l4_utcb_t * utcb)  [inline]
```

Get MSI info about IRQ.

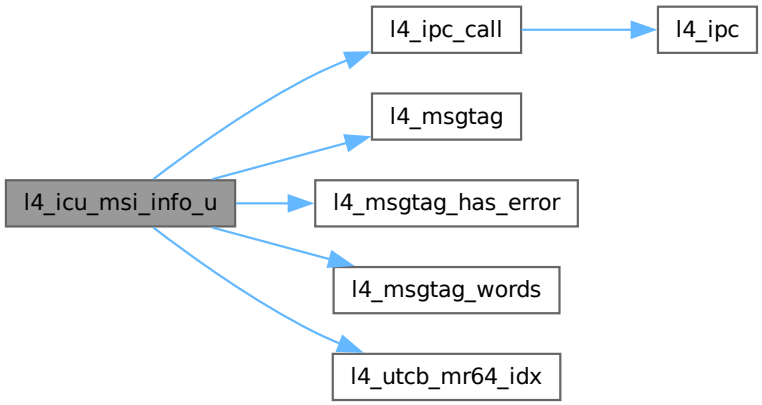
Parameters

	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.
	icu	The ICU object from which MSI information shall be retrieved.
	irqnum	IRQ line at the ICU.
	source	Platform dependent requester ID for MSIs. On IA32 we use a 20bit source filter value as described in the Intel IRQ remapping specification.
out	*msi_info*	A l4_icu_msi_info_t structure receiving the address and the data value to trigger this MSI.

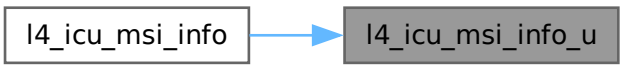
Returns

Syscall return tag

Definition at line 434 of file icu.h.
References L4_ICU_OP_MSI_INFO, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), l4_msgtag_has_error(), l4_msgtag_words(), L4_NOTHROW, L4_PROTO_IRQ, L4_UNLIKELY, l4_utcb_mr64_idx(), l4_msg_regs_t::mr, and l4_msg_regs_t::mr64.
Referenced by l4_icu_msi_info().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.7.4.9 l4_icu_set_mode()

```
l4_msgtag_t l4_icu_set_mode (
            l4_cap_idx_t icu,
            unsigned irqnum,
            l4_umword_t mode)  [inline]
```

Set interrupt mode.

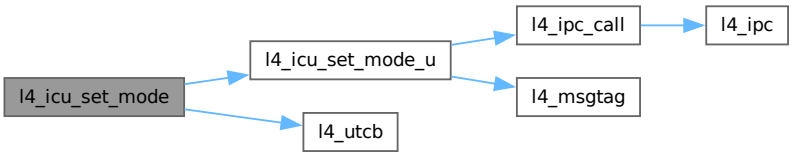
Parameters

icu	The ICU object.
irqnum	IRQ line at the ICU.
mode	Mode, see L4_irq_mode.

Returns

Syscall return tag

Definition at line 523 of file icu.h.
References l4_icu_set_mode_u(), L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.7.4.10 l4_icu_set_mode_u()

```
l4_msgtag_t l4_icu_set_mode_u (
            l4_cap_idx_t icu,
            unsigned irqnum,
            l4_umword_t mode,
            l4_utcb_t * utcb)  [inline]
```

Set interrupt mode.

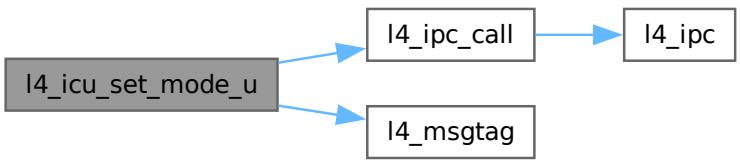
Parameters

icu	The ICU object.
irqnum	IRQ line at the ICU.
mode	Mode, see L4_irq_mode.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

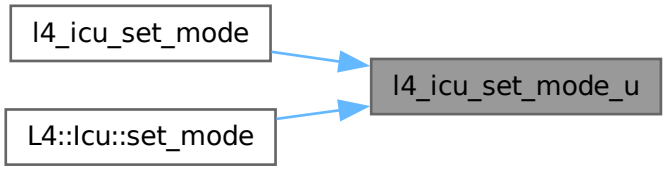
Returns

Syscall return tag

Definition at line 457 of file icu.h.
References L4_ICU_OP_SET_MODE, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_IRQ, and l4_msg_regs_t::mr.
Referenced by l4_icu_set_mode(), and L4::Icu::set_mode().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.7.4.11 l4_icu_unbind()

```
l4_msgtag_t l4_icu_unbind (
             l4_cap_idx_t icu,
             unsigned irqnum,
             l4_cap_idx_t irq)  [inline]
```

Remove binding of an interrupt line from the interrupt controller object.

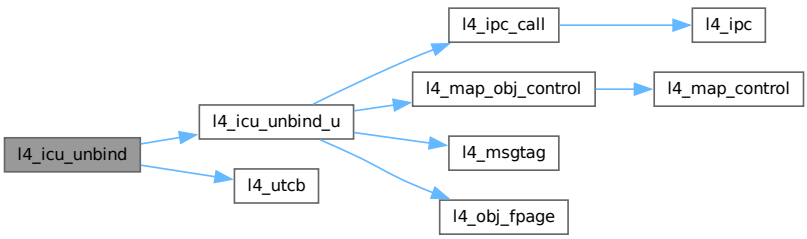
Parameters

icu	The ICU object from where the binding shall be removed.
irqnum	IRQ line at the ICU.
irq	IRQ object to remove from the ICU.

Returns

Syscall return tag

Definition at line 500 of file icu.h.
References l4_icu_unbind_u(), L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.7.4.12 l4_icu_unbind_u()

```
l4_msgtag_t l4_icu_unbind_u (
             l4_cap_idx_t icu,
```

```
            unsigned irqnum,
            l4_cap_idx_t irq,
            l4_utcb_t * utcb)  [inline]
```

Remove binding of an interrupt line from the interrupt controller object.

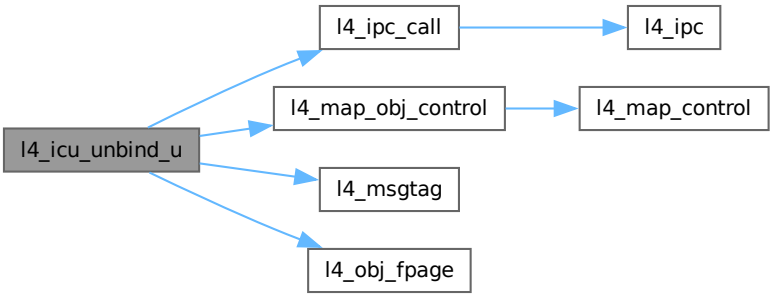
Parameters

icu	The ICU object from where the binding shall be removed.
irqnum	IRQ line at the ICU.
irq	IRQ object to remove from the ICU.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

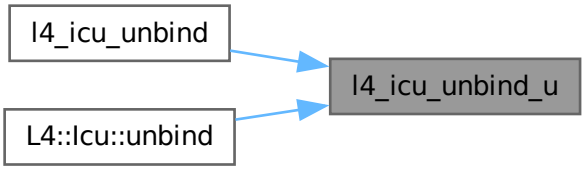
Returns

Syscall return tag

Definition at line 408 of file icu.h.
References L4_CAP_FPAGE_RWS, L4_ICU_OP_UNBIND, l4_ipc_call(), L4_IPC_NEVER, l4_map_obj_control(), l4_msgtag(), L4_NOTHROW, l4_obj_fpage(), L4_PROTO_IRQ, l4_msg_regs_t::mr, and l4_fpage_t::raw.
Referenced by l4_icu_unbind(), and L4::Icu::unbind().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.7.4.13 l4_icu_unmask()

```
l4_msgtag_t l4_icu_unmask (
```

```
                l4_cap_idx_t icu,
                unsigned irqnum,
                l4_umword_t * label,
                l4_timeout_t to)  [inline]
```

Unmask an IRQ line.

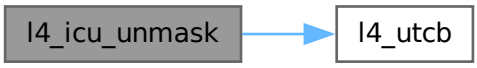
Parameters

icu	The ICU object where the IRQ line shall be unmasked.
irqnum	IRQ line at the ICU.
label	If non-NULL, the function also performs an open wait IPC operation waiting for the next message, and the received label is returned here.
to	IPC timeout, if unsure use L4_IPC_NEVER.

Returns

Syscall return tag. If `label` is NULL, this function performs an IPC send-only operation and there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. In this case use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 513 of file icu.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.7.4.14 l4_icu_unmask_u()

```
l4_msgtag_t l4_icu_unmask_u (
                l4_cap_idx_t icu,
                unsigned irqnum,
                l4_umword_t * label,
                l4_timeout_t to,
                l4_utcb_t * utcb)  [inline]
```

Unmask the given interrupt line.

Parameters

icu	The ICU object where the IRQ line shall be unmasked. When the object is an IRQ, the given interrupt line is ignored and instead the line which the IRQ is bound to (if any) is unmasked.

Its counterpart for explicitly masking an interrupt line is L4::Icu::mask().

Parameters

	irqnum	The interrupt line that shall be unmasked. Ignored if the object is an IRQ.
`out`	*label*	If NULL, this is a send-only unmask. If not NULL, this operation enters an open wait and the *protected label* shall be received here.
	to	The timeout-pair (send and receive) that shall be used for this operation. The receive timeout is used with a non-NULL `label` only.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag. If `label` is NULL, this function performs an IPC send-only operation and there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. In this case use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 488 of file icu.h.
References L4_NOTHROW.

13.1.10.8 IRQs

C IRQ interface, see L4::Irq for the C++ interface.
Collaboration diagram for IRQs:



Enumerations

- enum L4_irq_mode {
  L4_IRQ_F_NONE = 0 , L4_IRQ_F_SET_MODE = 0x1 , L4_IRQ_F_LEVEL = 0x2 , L4_IRQ_F_EDGE = 0x0 ,
  L4_IRQ_F_POS = 0x0 , L4_IRQ_F_NEG = 0x4 , L4_IRQ_F_BOTH = 0x8 , L4_IRQ_F_LEVEL_HIGH = L4_IRQ_F_SET_MODE | L4_IRQ_F_LEVEL | L4_IRQ_F_POS ,
  L4_IRQ_F_LEVEL_LOW = L4_IRQ_F_SET_MODE | L4_IRQ_F_LEVEL | L4_IRQ_F_NEG , L4_IRQ_F_POS_EDGE = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE | L4_IRQ_F_POS , L4_IRQ_F_NEG_EDGE = L4_IRQ_F_↩
  SET_MODE | L4_IRQ_F_EDGE | L4_IRQ_F_NEG , L4_IRQ_F_BOTH_EDGE = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE | L4_IRQ_F_BOTH ,
  L4_IRQ_F_MASK = 0xf , L4_IRQ_F_SET_WAKEUP = 0x10 , L4_IRQ_F_CLEAR_WAKEUP = 0x20 }

  Interrupt attributes.

Functions

- l4_msgtag_t l4_irq_detach (l4_cap_idx_t irq) L4_NOTHROW

  Detach from an interrupt source.
- l4_msgtag_t l4_irq_detach_u (l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Detach from this interrupt.
- l4_msgtag_t l4_irq_bind_vcpu (l4_cap_idx_t irq, l4_cap_idx_t thread, l4_umword_t cfg) L4_NOTHROW

  Bind a thread to this Irq for vCPU interrupt forwarding.
- l4_msgtag_t l4_irq_bind_vcpu_u (l4_cap_idx_t irq, l4_cap_idx_t thread, l4_umword_t cfg, l4_utcb_t *utcb) L4_NOTHROW

  Bind a thread to this Irq for vCPU interrupt forwarding.

- l4_msgtag_t l4_irq_trigger (l4_cap_idx_t irq) L4_NOTHROW

  Trigger an IRQ.
- l4_msgtag_t l4_irq_trigger_u (l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Trigger the object.
- l4_msgtag_t l4_irq_receive (l4_cap_idx_t irq, l4_timeout_t to) L4_NOTHROW

  Unmask and wait for specified IRQ.
- l4_msgtag_t l4_irq_receive_u (l4_cap_idx_t irq, l4_timeout_t timeout, l4_utcb_t *utcb) L4_NOTHROW

  Unmask and wait for this IRQ.
- l4_msgtag_t l4_irq_wait (l4_cap_idx_t irq, l4_umword_t *label, l4_timeout_t to) L4_NOTHROW

  Unmask IRQ and wait for any message.
- l4_msgtag_t l4_irq_wait_u (l4_cap_idx_t irq, l4_umword_t *label, l4_timeout_t timeout, l4_utcb_t *utcb) L4_NOTHROW

  Unmask IRQ and (open) wait for any message.
- l4_msgtag_t l4_irq_unmask (l4_cap_idx_t irq) L4_NOTHROW

  Unmask IRQ.
- l4_msgtag_t l4_irq_unmask_u (l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Unmask this IRQ.

13.1.10.8.1 Detailed Description

C IRQ interface, see L4::Irq for the C++ interface.
The IRQ interface provides access to abstract interrupts provided by the microkernel. Interrupts may be

- hardware interrupts provided by the platform interrupt controller,
- virtual device interrupts provided by the microkernel's virtual devices (virtual serial or trace buffer) or
- virtual interrupts that can be triggered by user programs (IRQs) via l4_irq_trigger().

For hardware and virtual device interrupts the Irq object must be bound to an interrupt source, see Interrupt controller. To receive interrupts, the Irq object must be bound to a thread, see l4_rcv_ep_bind_thread() and l4_rcv_ep_bind_snd_destination().
IRQ objects can be created using a factory, see the Factory API (use l4_factory_create_irq()).

Include File

```
#include <l4/sys/irq.h>
```

For the C++ interface refer to the L4::Irq API for an overview.

13.1.10.8.2 Enumeration Type Documentation

13.1.10.8.2.1 L4_irq_mode

`enum L4_irq_mode`
Interrupt attributes.

Enumerator

L4_IRQ_F_NONE	Flow types. None
L4_IRQ_F_SET_MODE	Valid flag, if not set, the set_mode operation does nothing.
L4_IRQ_F_LEVEL	Level triggered.
L4_IRQ_F_EDGE	Edge triggered.
L4_IRQ_F_POS	Positive trigger.
L4_IRQ_F_NEG	Negative trigger.
L4_IRQ_F_BOTH	Both edges trigger.

L4_IRQ_F_LEVEL_HIGH	Level high trigger.
L4_IRQ_F_LEVEL_LOW	Level low trigger.
L4_IRQ_F_POS_EDGE	Positive edge trigger.
L4_IRQ_F_NEG_EDGE	Negative edge trigger.
L4_IRQ_F_BOTH_EDGE	Both edges trigger.
L4_IRQ_F_MASK	Mask.
L4_IRQ_F_SET_WAKEUP	Wakeup source? Use irq as wakeup source
L4_IRQ_F_CLEAR_WAKEUP	Do not use irq as wakeup source.

Definition at line 70 of file icu.h.

13.1.10.8.3 Function Documentation

13.1.10.8.3.1 l4_irq_bind_vcpu()

```
l4_msgtag_t l4_irq_bind_vcpu (
              l4_cap_idx_t irq,
              l4_cap_idx_t thread,
              l4_umword_t cfg)  [inline]
```

Bind a thread to this Irq for vCPU interrupt forwarding.
If the interrupt is triggered, the kernel will directly inject the interrupt into the guest. This requires that the thread is currently in extended vCPU user mode. Otherwise the interrupt will stay pending and gets injected on the next vCPU user mode transition. Optionally a doorbell Irq can be registered on the thread (see Thread::register_doorbell_irq()) that is triggered in this case.
If a guest has acknowledged the interrupt but has not yet issued an EOI (i.e. the interrupt is in "active" state), it is not possible to bind the Irq to a new thread object. Either wait for the guest to issue the EOI or detach() from the current thread. In this case the interrupt will stay active in the guest and it is the responsibility of the VMM to handle the eventual EOI of the guest.

Parameters

irq	The IRQ object that shall be bound.
thread	Thread object this Irq shall be bound to.
cfg	Architecture specific interrupt configuration.

Returns

Syscall return tag

Return values

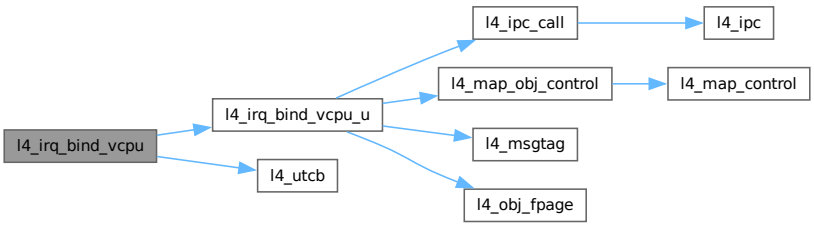
-L4_EPERM	Insufficient permissions; see precondition.
-L4_EBUSY	Cannot bind to new thread because interrupt is active on previous thread and guest has to issue end-of-interrupt first.
-L4_ENOSYS	The kernel does not support direct interrupt forwarding.

Precondition

The capabilities `irq` and `thread` both must have the permission L4_CAP_FPAGE_S.

Definition at line 300 of file irq.h.
References l4_irq_bind_vcpu_u(), L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.10.8.3.2 l4_irq_bind_vcpu_u()

```
l4_msgtag_t l4_irq_bind_vcpu_u (
             l4_cap_idx_t irq,
             l4_cap_idx_t thread,
             l4_umword_t cfg,
             l4_utcb_t * utcb)  [inline]
```

Bind a thread to this Irq for vCPU interrupt forwarding.

Parameters

irq	The IRQ object that shall be bound. If the interrupt is triggered, the kernel will directly inject the interrupt into the guest. This requires that the thread is currently in extended vCPU user mode. Otherwise the interrupt will stay pending and gets injected on the next vCPU user mode transition. Optionally a doorbell Irq can be registered on the thread (see Thread::register_doorbell_irq()) that is triggered in this case.

If a guest has acknowledged the interrupt but has not yet issued an EOI (i.e. the interrupt is in "active" state), it is not possible to bind the Irq to a new thread object. Either wait for the guest to issue the EOI or detach() from the current thread. In this case the interrupt will stay active in the guest and it is the responsibility of the VMM to handle the eventual EOI of the guest.

Parameters

thread	Thread object this Irq shall be bound to.
cfg	Architecture specific interrupt configuration.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

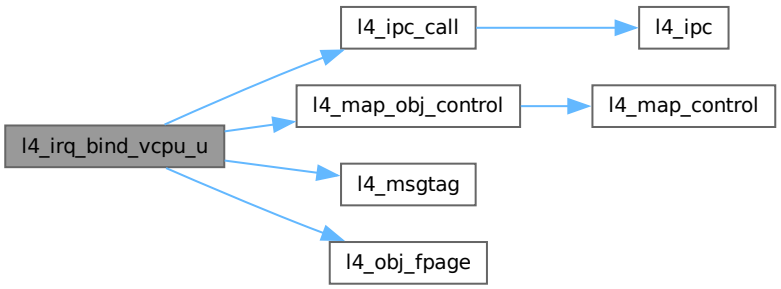
Return values

-L4_EPERM	Insufficient permissions; see precondition.
-L4_EBUSY	Cannot bind to the new thread because interrupt is active on previous thread and guest has to issue end-of-interrupt first.
-L4_ENOSYS	The kernel does not support direct interrupt forwarding.

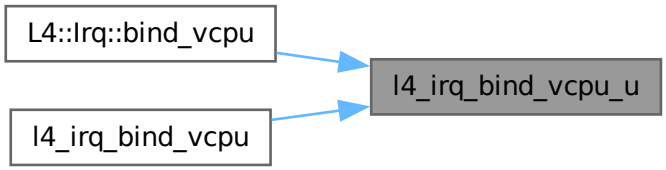
Precondition

The invoked Irq capability and the capability `thread` both must have the permission L4_CAP_FPAGE_S.

Definition at line 250 of file irq.h.
References L4_CAP_FPAGE_RWS, l4_ipc_call(), L4_IPC_NEVER, l4_map_obj_control(), l4_msgtag(), L4_NOTHROW, l4_obj_fpage(), L4_PROTO_IRQ_SENDER, l4_msg_regs_t::mr, and l4_fpage_t::raw.
Referenced by L4::Irq::bind_vcpu(), and l4_irq_bind_vcpu().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.8.3.3 l4_irq_detach()

```
l4_msgtag_t l4_irq_detach (
            l4_cap_idx_t irq)  [inline]
```

Detach from an interrupt source.

Parameters

irq	The IRQ object that shall be detached.

Returns

Syscall return tag

Return values

0	Successfully detached, there was no interrupt pending.
1	Successfully detached, there was an interrupt pending.
2	Successfully detached, an active vIRQ was abandoned.
-L4_EPERM	Insufficient permissions; see precondition.

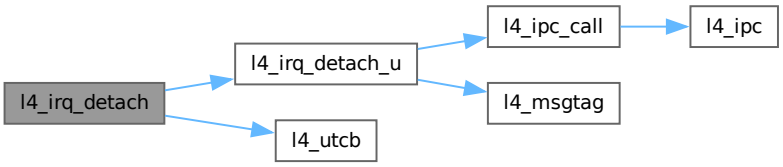
Precondition

The capability `irq` must have the permission L4_CAP_FPAGE_S.

Examples

examples/sys/isr/main.c.

Definition at line 294 of file irq.h.
References l4_irq_detach_u(), L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.8.3.4 l4_irq_detach_u()

```
l4_msgtag_t l4_irq_detach_u (
             l4_cap_idx_t irq,
             l4_utcb_t * utcb)  [inline]
```

Detach from this interrupt.

Parameters

irq	The IRQ object that shall be detached.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

Return values

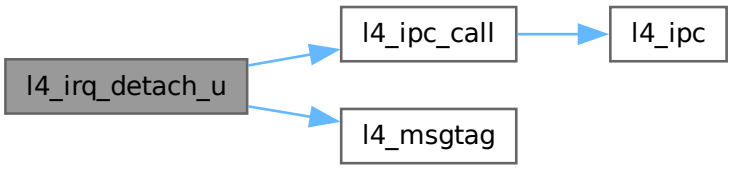
0	Successfully detached, there was no interrupt pending.

1	Successfully detached, there was an interrupt pending.
2	Successfully detached, an active vIRQ was abandoned.
-L4_EPERM	Insufficient permissions; see precondition.

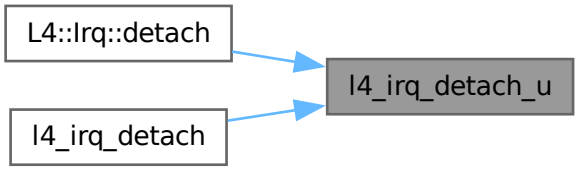
Precondition

The invoked Irq capability must have the permission L4_CAP_FPAGE_S.

Definition at line 242 of file irq.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, and L4_PROTO_IRQ_SENDER.
Referenced by L4::Irq::detach(), and l4_irq_detach().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.8.3.5 l4_irq_receive()

```
l4_msgtag_t l4_irq_receive (
             l4_cap_idx_t irq,
             l4_timeout_t to)  [inline]
```

Unmask and wait for specified IRQ.

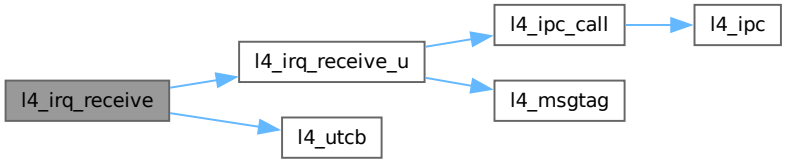
Parameters

irq	The IRQ object that shall be unmasked.
to	Timeout.

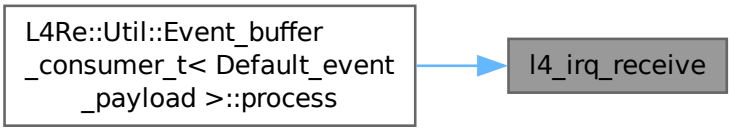
Returns

Syscall return tag

Definition at line 313 of file irq.h.
References l4_irq_receive_u(), L4_NOTHROW, and l4_utcb().
Referenced by L4Re::Util::Event_buffer_consumer_t< Default_event_payload >::process().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.8.3.6 l4_irq_receive_u()

```
l4_msgtag_t l4_irq_receive_u (
              l4_cap_idx_t irq,
              l4_timeout_t timeout,
              l4_utcb_t * utcb)  [inline]
```

Unmask and wait for this IRQ.

Parameters

irq	The IRQ object that shall be unmasked.
timeout	Timeout.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

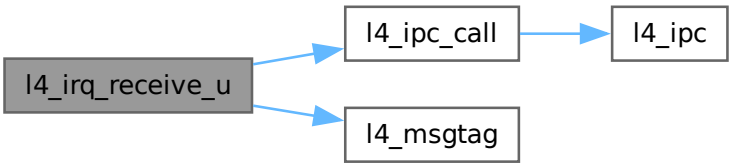
Returns

Syscall return tag

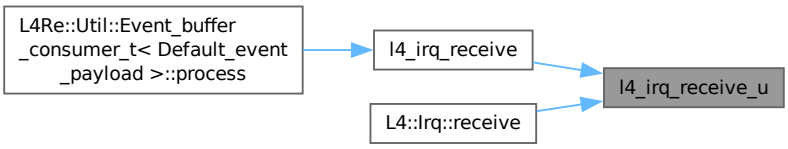
Note

If this is the function normally used for your IRQs consider using L4::Semaphore instead of L4::Irq.

Definition at line 270 of file irq.h.
References l4_ipc_call(), l4_msgtag(), L4_NOTHROW, and L4_PROTO_IRQ.
Referenced by l4_irq_receive(), and L4::Irq::receive().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.8.3.7 l4_irq_trigger()

```
l4_msgtag_t l4_irq_trigger (
            l4_cap_idx_t irq)  [inline]
```

Trigger an IRQ.

Parameters

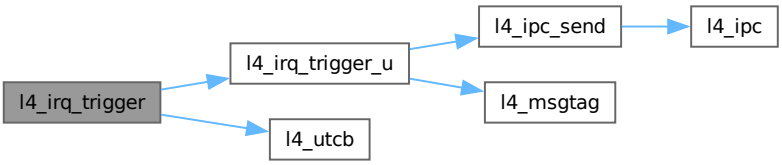
irq	The IRQ object that shall be triggered.

Returns

Syscall return tag.

Note that this function is a send only operation, i.e. there is no return value except for a failed send operation. Especially l4_error() will return an error value from the message tag which still contains the IRQ protocol used for the send operation.
Use l4_ipc_error() to check for (send) errors.
Definition at line 307 of file irq.h.
References l4_irq_trigger_u(), L4_NOTHROW, and l4_utcb().
Referenced by l4_semaphore_up().

Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.8.3.8 l4_irq_trigger_u()

```
l4_msgtag_t l4_irq_trigger_u (
             l4_cap_idx_t irq,
             l4_utcb_t * utcb)  [inline]
```

Trigger the object.

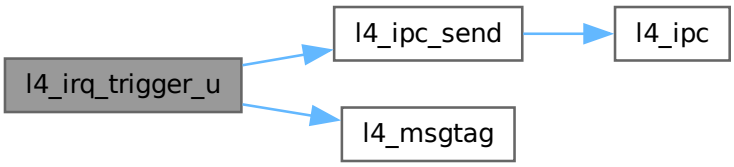
Parameters

irq	The IRQ object that shall be triggered.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

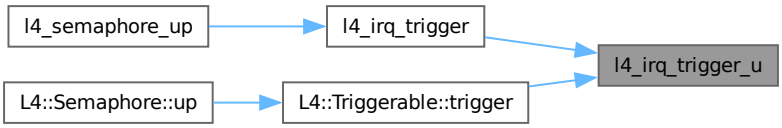
Returns

Syscall return tag for a send-only operation, this means there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. Use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 263 of file irq.h.
References L4_IPC_BOTH_TIMEOUT_0, l4_ipc_send(), l4_msgtag(), L4_NOTHROW, and L4_PROTO_IRQ.
Referenced by l4_irq_trigger(), and L4::Triggerable::trigger().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.8.3.9 l4_irq_unmask()

```
l4_msgtag_t l4_irq_unmask (
            l4_cap_idx_t irq)  [inline]
```

Unmask IRQ.

Parameters

irq	The IRQ object that shall be unmasked.

Returns

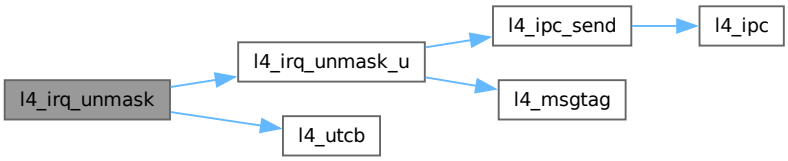
Syscall return tag

Note

l4_irq_wait() and l4_irq_receive() are doing the unmask themselves.

Definition at line 326 of file irq.h.
References l4_irq_unmask_u(), L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.10.8.3.10 l4_irq_unmask_u()

```
l4_msgtag_t l4_irq_unmask_u (
             l4_cap_idx_t irq,
             l4_utcb_t * utcb)  [inline]
```

Unmask this IRQ.

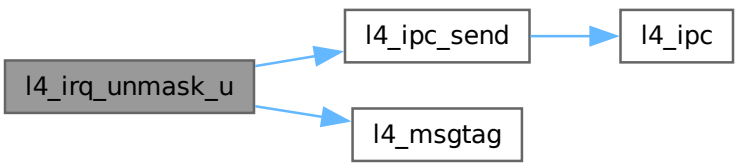
Parameters

irq	The IRQ object that shall be unmasked.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

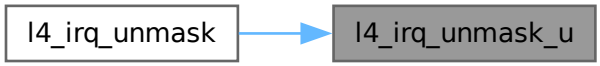
Returns

Syscall return tag for a send-only operation, this means there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. Use l4_ipc_error() to check for errors and **do not** use l4_error().

Irq::wait() and Irq::receive() operations already include an unmask(), do not use an extra unmask() in these cases.
Definition at line 286 of file irq.h.
References L4_IPC_NEVER, l4_ipc_send(), l4_msgtag(), L4_NOTHROW, and L4_PROTO_IRQ.
Referenced by l4_irq_unmask().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.8.3.11 l4_irq_wait()

```
l4_msgtag_t l4_irq_wait (
             l4_cap_idx_t irq,
             l4_umword_t * label,
             l4_timeout_t to)  [inline]
```

Unmask IRQ and wait for any message.

Parameters

irq	The IRQ object that shall be unmasked.
label	Receive label.
to	Timeout.

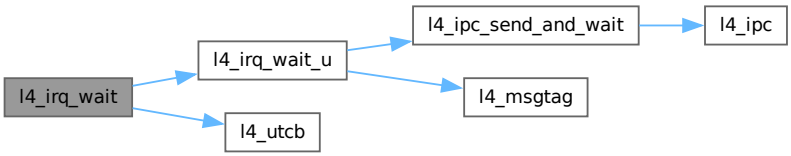
Returns

Syscall return tag

Examples

examples/sys/isr/main.c.

Definition at line 319 of file irq.h.
References l4_irq_wait_u(), L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.8.3.12 l4_irq_wait_u()

```
l4_msgtag_t l4_irq_wait_u (
             l4_cap_idx_t irq,
             l4_umword_t * label,
             l4_timeout_t timeout,
             l4_utcb_t * utcb)  [inline]
```

Unmask IRQ and (open) wait for any message.

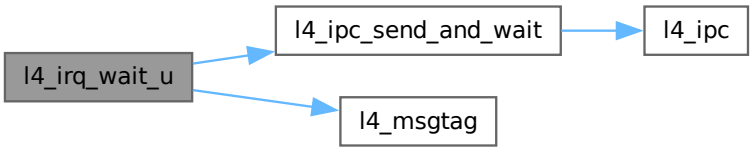
Parameters

irq	The IRQ object that shall be unmasked.
label	The *protected label* shall be received here.
timeout	Timeout.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

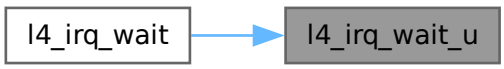
Returns

Syscall return tag

Definition at line 277 of file irq.h.
References l4_ipc_send_and_wait(), l4_msgtag(), L4_NOTHROW, and L4_PROTO_IRQ.
Referenced by l4_irq_wait().
Here is the call graph for this function:

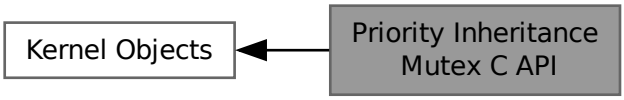


Here is the caller graph for this function:



13.1.10.9 Priority Inheritance Mutex C API

C interface for controlling priority inheritance mutexes.
Collaboration diagram for Priority Inheritance Mutex C API:



Functions

- l4_msgtag_t l4_pi_mutex_lock (l4_cap_idx_t mutex, l4_timeout_t timeout) L4_NOTHROW

  Lock contended priority inheritance mutex on slow path.
- l4_msgtag_t l4_pi_mutex_unlock (l4_cap_idx_t mutex) L4_NOTHROW

  Unlock contended priority inheritance mutex from fast path or slow path.

13.1.10.9.1 Detailed Description

C interface for controlling priority inheritance mutexes.
A priority inheritance mutex (PI mutex) object provides the slow path for a priority-inheritance-aware mutex. User-space implements the fast-path using a compare-and-swap atomic operation, with acquire/release semantics, on a `status` machine-word in kernel-user memory.

[63/31 .. L4_CAP_SHIFT]	...	0
thread cap slot		waiter flag

When a thread wants to acquire a PI mutex, it first tries to do so via the fast path: `cas(&status, 0, self_thread_cap())` If the mutex is uncontended the cas succeeds and the thread becomes the owner of mutex. Otherwise, the thread needs to enter the slow path via `l4_pi_mutex_lock()` and the kernel takes over.
When a thread wants to release a PI mutex, it first tries to do so via the fast path: `cas(&status, self_thread_cap(), 0)` If the mutex is uncontended, i.e. the waiter flag is not set, the cas succeeds. Otherwise, the thread needs to enter the slow path via `l4_pi_mutex_unlock()` and the kernel takes over.

Include File

```
#include <l4/sys/pi_mutex.h>
```

13.1.10.9.2 Function Documentation

13.1.10.9.2.1 l4_pi_mutex_lock()

```
l4_msgtag_t l4_pi_mutex_lock (
             l4_cap_idx_t mutex,
             l4_timeout_t timeout)  [inline]
```

Lock contended priority inheritance mutex on slow path.

Parameters

mutex	Priority inheritance mutex object.
timeout	Timeout for blocking the mutex lock operation. Note: The receive timeout of this timeout-pair is significant for blocking, the send part is usually non-blocking.

Returns

Syscall return tag. Use l4_error() to check for errors.

Return values

0	Success.
-L4_EAGAIN	Lock operation in kernel failed, can happen under certain circumstances, try again.
-L4_EDEADLK	Deadlock condition was detected or the calling thread already owns the mutex.
-L4_EINVAL	Invalid parameter or ku_status in invalid state.

L4_IPC_RETIMEOUT	Timeout expired before mutex could be locked.
L4_IPC_RECANCELED	Thread was cancelled while waiting on the mutex.

Definition at line 145 of file pi_mutex.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.9.2.2 l4_pi_mutex_unlock()

```
l4_msgtag_t l4_pi_mutex_unlock (
            l4_cap_idx_t mutex)  [inline]
```

Unlock contended priority inheritance mutex from fast path or slow path.

Parameters

mutex	Priority inheritance mutex object.

Returns

Syscall return tag. Use l4_error() to check for errors.

Return values

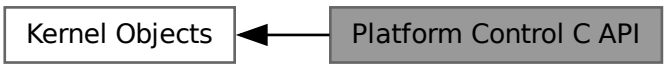
0	Success.
-L4_EINVAL	Invalid parameter or ku_status in invalid state.
-L4_EPERM	Calling thread was not the owner of the mutex.

Definition at line 151 of file pi_mutex.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.10 Platform Control C API

C interface for controlling platform-wide properties, see L4::Platform_control for the C++ interface.
Collaboration diagram for Platform Control C API:



Functions

- l4_msgtag_t l4_platform_ctl_set_task_asid (l4_cap_idx_t pfc, l4_cap_idx_t task, l4_umword_t asid) L4_NOTHROW

  Set ASID of task.
- l4_msgtag_t l4_platform_ctl_system_suspend (l4_cap_idx_t pfc, l4_umword_t extras) L4_NOTHROW

  Enter suspend to RAM.
- l4_msgtag_t l4_platform_ctl_system_shutdown (l4_cap_idx_t pfc, l4_umword_t reboot) L4_NOTHROW

  Shutdown or reboot the system.
- l4_msgtag_t l4_platform_ctl_cpu_allow_shutdown (l4_cap_idx_t pfc, l4_umword_t phys_id, l4_umword_t enable) L4_NOTHROW

  Allow a CPU to be shut down.
- l4_msgtag_t l4_platform_ctl_cpu_enable (l4_cap_idx_t pfc, l4_umword_t phys_id) L4_NOTHROW

  Enable an offline CPU.
- l4_msgtag_t l4_platform_ctl_cpu_disable (l4_cap_idx_t pfc, l4_umword_t phys_id) L4_NOTHROW

  Disable an online CPU.

13.1.10.10.1 Detailed Description

C interface for controlling platform-wide properties, see L4::Platform_control for the C++ interface.

Include File

```
#include <l4/sys/platform_control.h>
```

The API allows a client to suspend, reboot or shutdown the system.
For the C++ interface refer to L4::Platform_control

13.1.10.10.2 Function Documentation

13.1.10.10.2.1 l4_platform_ctl_cpu_allow_shutdown()

```
l4_msgtag_t l4_platform_ctl_cpu_allow_shutdown (
             l4_cap_idx_t pfc,
             l4_umword_t phys_id,
             l4_umword_t enable)  [inline]
```

Allow a CPU to be shut down.

Parameters

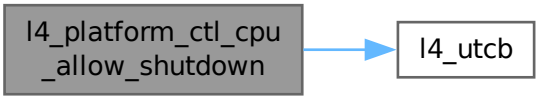
pfc	Capability index for the platform-control object.

phys↩ _id	Physical CPU id of CPU (e.g. local APIC id) to enable.
enable	Allow shutdown when 1, disallow when 0.

Returns

Syscall return tag

Definition at line 228 of file platform_control.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.10.2.2 l4_platform_ctl_cpu_disable()

```
l4_msgtag_t l4_platform_ctl_cpu_disable (
             l4_cap_idx_t pfc,
             l4_umword_t phys_id)  [inline]
```

Disable an online CPU.

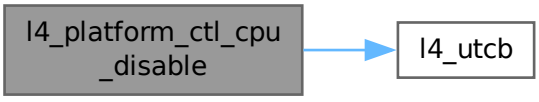
Parameters

pfc	Capability to the platform control object.
phys↩ _id	Physical CPU id of CPU (e.g. local APIC id) to disable.

Returns

System call message tag

This function is currently only supported on the ARM EXYNOS platform.
Definition at line 267 of file platform_control.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.10.2.3 l4_platform_ctl_cpu_enable()

```
l4_msgtag_t l4_platform_ctl_cpu_enable (
            l4_cap_idx_t pfc,
            l4_umword_t phys_id)  [inline]
```

Enable an offline CPU.

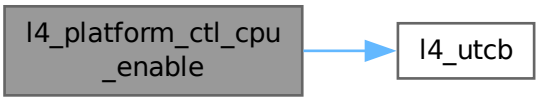
Parameters

pfc	Capability to the platform control object.
phys↩ _id	Physical CPU id of CPU (e.g. local APIC id) to enable.

Returns

System call message tag

This function is currently only supported on the ARM EXYNOS platform.
Definition at line 260 of file platform_control.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.10.2.4 l4_platform_ctl_set_task_asid()

```
l4_msgtag_t l4_platform_ctl_set_task_asid (
            l4_cap_idx_t pfc,
            l4_cap_idx_t task,
            l4_umword_t asid)  [inline]
```

Set ASID of task.
On Cortex-R52 platforms, it might be necessary to control the VMID of a task or virtual machine explicitly. The IOMPU on such platforms will use it for further access control of device memory accesses. A privileged component can use this call to control the value.
The caller must have write permissions to the destination task.

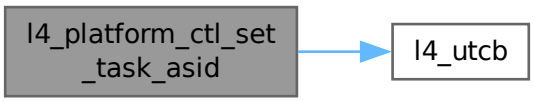
Parameters

pfc	Capability index for the platform-control object.
task	Capability index of destination task
asid	New ASID value

Returns

Syscall return tag

Definition at line 62 of file __platform_control-arm.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.10.2.5 l4_platform_ctl_system_shutdown()

```
l4_msgtag_t l4_platform_ctl_system_shutdown (
             l4_cap_idx_t pfc,
             l4_umword_t reboot)  [inline]
```

Shutdown or reboot the system.

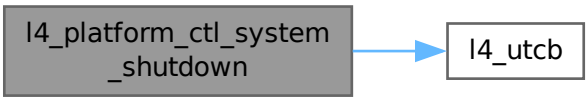
Parameters

pfc	Capability index for the platform-control object.
reboot	Shutdown when 0, or reboot when 1.

Returns

Syscall return tag

Definition at line 207 of file platform_control.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.10.2.6 l4_platform_ctl_system_suspend()

```
l4_msgtag_t l4_platform_ctl_system_suspend (
             l4_cap_idx_t pfc,
             l4_umword_t extras)  [inline]
```

Enter suspend to RAM.

Precondition

Must only be invoked on the boot CPU. Furthermore it must be ensured that the invoking thread is not migrated to a different CPU during the suspend.

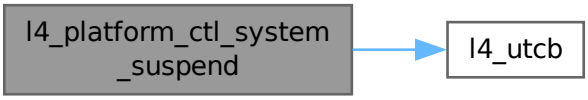
Parameters

pfc	Capability index for the platform-control object.
extras	Some extra platform-specific information needed to enter suspend to RAM. On x86 platforms and when using the Platform_control object provided by Fiasco, the value defines the sleep state. The sleep states are defined in the ACPI table. Other platforms as well as Io's Platform_control object don't make use of this value at the moment.

Returns

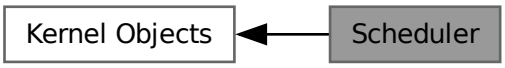
Syscall return tag

Definition at line 200 of file platform_control.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.11 Scheduler

C interface of the Scheduler kernel object, see L4::Scheduler for the C++ interface.
Collaboration diagram for Scheduler:



Data Structures

- struct l4_sched_cpu_set_t

  CPU sets.
- struct l4_sched_param_t

  Scheduler parameter set.

Typedefs

- typedef struct l4_sched_cpu_set_t **l4_sched_cpu_set_t**

  CPU sets.
- typedef struct l4_sched_param_t **l4_sched_param_t**

  Scheduler parameter set.

Enumerations

- enum L4_scheduler_classes { L4_SCHEDULER_CLASS_FIXED_PRIO = 1UL << 1 , L4_SCHEDULER_CLASS_WFQ = 1UL << 2 }

  Supported scheduler classes.
- enum L4_scheduler_ops { L4_SCHEDULER_INFO_OP = 0UL , L4_SCHEDULER_RUN_THREAD_OP = 1UL , L4_SCHEDULER_IDLE_TIME_OP = 2UL }

  Operations on the Scheduler object.

Functions

- l4_sched_cpu_set_t l4_sched_cpu_set (l4_umword_t offset, unsigned char granularity, l4_umword_t map=1) L4_NOTHROW
- l4_msgtag_t l4_scheduler_info (l4_cap_idx_t scheduler, l4_umword_t *cpu_max, l4_sched_cpu_set_t *cpus) L4_NOTHROW))

  Get scheduler information.
- l4_msgtag_t l4_scheduler_info_with_classes (l4_cap_idx_t scheduler, l4_umword_t *cpu_max, l4_sched_cpu_set_t *cpus, l4_umword_t *sched_classes) L4_NOTHROW))

  Get scheduler information.
- l4_sched_param_t l4_sched_param (unsigned prio, l4_umword_t quantum=0) L4_NOTHROW

  Construct scheduler parameter.
- l4_msgtag_t l4_scheduler_run_thread (l4_cap_idx_t scheduler, l4_cap_idx_t thread, l4_sched_param_t const *sp) L4_NOTHROW)

  Run a thread on a Scheduler.
- l4_msgtag_t l4_scheduler_idle_time (l4_cap_idx_t scheduler, l4_sched_cpu_set_t const *cpus, l4_kernel_clock_t *us) L4_NOTHROW)

  Query the idle time (in µs) of a CPU.
- int l4_scheduler_is_online (l4_cap_idx_t scheduler, l4_umword_t cpu) L4_NOTHROW

  Query if a CPU is online.

13.1.10.11.1 Detailed Description

C interface of the Scheduler kernel object, see L4::Scheduler for the C++ interface.
The Scheduler interface allows a client to manage CPU resources. The API provides functions to query scheduler information, check the online state of CPUs, query CPU idle time and to start threads on defined CPU sets.
The scheduler offers a virtual device IRQ which triggers when the number of online cores changes, e.g. due to hotplug events. In contrast to hardware IRQs, this IRQ implements a limited functionality:

- Only IRQ line 0 is supported, no MSI vectors.
- The IRQ is edge-triggered and the IRQ mode cannot be changed.
- As the IRQ is edge-triggered, it does not have to be explicitly unmasked.

It depends on the platform, which hotplug events actually trigger the IRQ. Many platforms only support triggering the IRQ when a CPU core different from the boot CPU goes online.

Include File

```
#include <l4/sys/scheduler.h>
```

13.1.10.11.2 Enumeration Type Documentation

13.1.10.11.2.1 L4_scheduler_classes

```
enum L4_scheduler_classes
```
Supported scheduler classes.

Enumerator

L4_SCHEDULER_CLASS_FIXED_PRIO	Fixed-priority scheduler.
L4_SCHEDULER_CLASS_WFQ	Weighted fair queuing scheduler.

Definition at line 46 of file scheduler.h.

13.1.10.11.2.2 L4_scheduler_ops

```
enum L4_scheduler_ops
```
Operations on the Scheduler object.

Enumerator

L4_SCHEDULER_INFO_OP	Query infos about the scheduler.
L4_SCHEDULER_RUN_THREAD_OP	Run a thread on this scheduler.
L4_SCHEDULER_IDLE_TIME_OP	Query idle time for the scheduler.

Definition at line 269 of file scheduler.h.

13.1.10.11.3 Function Documentation

13.1.10.11.3.1 l4_sched_cpu_set()

```
l4_sched_cpu_set_t l4_sched_cpu_set (
            l4_umword_t offset,
            unsigned char granularity,
            l4_umword_t map = 1)  [inline]
```

Parameters

offset	Offset. Must be a multiple of 2^granularity.
granularity	Granularity in log2 notation.
map	Bitmap of CPUs, defaults to 1 in C++.

Returns

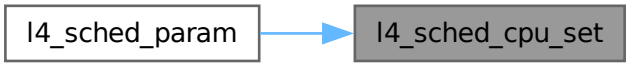
CPU set.

Examples

examples/sys/migrate/thread_migrate.cc.

Definition at line 279 of file scheduler.h.
References l4_sched_cpu_set_t::gran_offset, L4_NOTHROW, and l4_sched_cpu_set_t::map.
Referenced by l4_sched_param().

Here is the caller graph for this function:



13.1.10.11.3.2 l4_sched_param()

```
l4_sched_param_t l4_sched_param (
            unsigned prio,
            l4_umword_t quantum = 0)  [inline]
```

Construct scheduler parameter.

Parameters

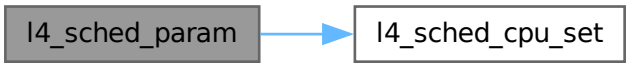
prio	Thread priority (1-255).
quantum	Timeslice in micro seconds.

The l4_sched_param_t::affinity of the returned value contains all CPUs.

Examples

examples/sys/aliens/main.c, examples/sys/migrate/thread_migrate.cc, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 289 of file scheduler.h.
References l4_sched_param_t::affinity, L4_NOTHROW, l4_sched_cpu_set(), l4_sched_param_t::prio, and l4_sched_param_t::quantum.
Here is the call graph for this function:



13.1.10.11.3.3 l4_scheduler_idle_time()

```
l4_msgtag_t l4_scheduler_idle_time (
            l4_cap_idx_t scheduler,
            l4_sched_cpu_set_t const * cpus,
            l4_kernel_clock_t * us)  [inline]
```

Query the idle time (in µs) of a CPU.

Parameters

	scheduler	Scheduler object.
	cpus	Set of CPUs to query. Only the idle time of the first selected CPU in `cpus.map` is queried.
`out`	*us*	Idle time of queried CPU in µs.

Return values

0	Success.
-L4_EINVAL	Invalid CPU requested in cpu set.

This function retrieves the idle time in µs of the first selected CPU in `cpus.map`. The idle time is the accumulated time a CPU has spent in the idle thread since its last reset. To calculate a load estimate `l` one has to retrieve the idle time at the beginning (`i1`) and the end (`i2`) of a known time interval `t`. The load is then calculated as l = 1 - (i2 - i1)/t.
The idle time is only defined for online CPUs. Reading the idle time from offline CPUs is undefined and may result in either getting -L4_EINVAL or calculating an estimated (incorrect) load of 1.

Note

The idle time statistics of remote CPUs is updated on context switch events only, hence may not be up-to-date when requested cross-CPU. To get up-to-date idle time you should use a thread running on the same CPU of which the idle time is requested.

Definition at line 403 of file scheduler.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.11.3.4 l4_scheduler_info()

```
l4_msgtag_t l4_scheduler_info (
             l4_cap_idx_t scheduler,
             l4_umword_t * cpu_max,
             l4_sched_cpu_set_t * cpus)  [inline]
```

Get scheduler information.

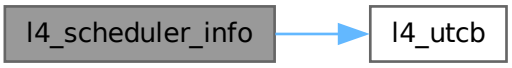
Parameters

	scheduler	Scheduler object.
`out`	*cpu_max*	Maximum number of CPUs ever available. Optional, can be NULL.
`in,out`	*cpus*	*cpus.offset* is first CPU of interest. *cpus.granularity* (see l4_sched_cpu_set_t). *cpus.map* Bitmap of online CPUs. Must not be NULL.

Return values

0	Success.
-L4_ERANGE	The given CPU offset is larger than the maximum number of CPUs.

Definition at line 381 of file scheduler.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.11.3.5 l4_scheduler_info_with_classes()

```
l4_msgtag_t l4_scheduler_info_with_classes (
             l4_cap_idx_t scheduler,
             l4_umword_t * cpu_max,
             l4_sched_cpu_set_t * cpus,
             l4_umword_t * sched_classes)  [inline]
```

Get scheduler information.

Parameters

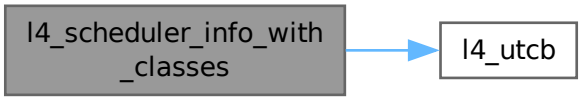
	scheduler	Scheduler object.
out	*cpu_max*	Maximum number of CPUs ever available. Optional, can be NULL.
in,out	*cpus*	*cpus.offset* is first CPU of interest. *cpus.granularity* (see l4_sched_cpu_set_t). *cpus.map* Bitmap of online CPUs. Must not be NULL.
out	*sched_classes*	A bitmap of available scheduling classes (see L4_scheduler_classes). Optional, can be NULL.

Return values

0	Success.
-L4_ERANGE	The given CPU offset is larger than the maximum number of CPUs.

This function delivers the same information as l4_scheduler_info plus the available scheduler classes (see L4_scheduler_classes).
Definition at line 388 of file scheduler.h.
References L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.10.11.3.6 l4_scheduler_is_online()

```
int l4_scheduler_is_online (
            l4_cap_idx_t scheduler,
            l4_umword_t cpu)  [inline]
```

Query if a CPU is online.

Parameters

scheduler	Scheduler object.
cpu	CPU number whose online status should be queried.

Return values

true	The CPU is online.
false	The CPU is offline

Definition at line 410 of file scheduler.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.11.3.7 l4_scheduler_run_thread()

```
l4_msgtag_t l4_scheduler_run_thread (
            l4_cap_idx_t scheduler,
            l4_cap_idx_t thread,
            l4_sched_param_t const * sp)  [inline]
```

Run a thread on a Scheduler.

Parameters

scheduler	Scheduler object.
thread	Capability of the thread to run.
sp	Scheduling parameters.

Return values

0	Success.
-L4_EINVAL	Invalid size of the scheduling parameter.

This function launches a thread on a CPU determined by the scheduling parameter `sp.affinity`. A thread can be intentionally stopped by migrating it on an offline or an invalid CPU. The thread is only guaranteed to run if the CPU it is migrated to is currently online.

Note

If the target CPU is currently not online, there is no guarantee that the thread will ever run, even if the CPU comes online later on.

A scheduler may impose a policy with regard to selecting CPUs. However the scheduler is required to ensure the following two properties:

- Two threads with disjoint CPU sets must be scheduled to different CPUs.
- Two threads with identical CPU sets selecting only a single CPU must be scheduled to the same CPU.

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 396 of file scheduler.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.12 Kernel-provided semaphore

C semaphore interface, see L4::Semaphore for the C++ interface.

Collaboration diagram for Kernel-provided semaphore:



Functions

- l4_msgtag_t l4_semaphore_up (l4_cap_idx_t sem) L4_NOTHROW

  Semaphore up operation (wrapper for trigger()).
- l4_msgtag_t l4_semaphore_down (l4_cap_idx_t sem, l4_timeout_t timeout) L4_NOTHROW

  Semaphore down operation.

13.1.10.12.1 Detailed Description

C semaphore interface, see L4::Semaphore for the C++ interface.

Include File

```
#include <l4/sys/semaphore.h>
```

13.1.10.12.2 Function Documentation

13.1.10.12.2.1 l4_semaphore_down()

```
l4_msgtag_t l4_semaphore_down (
            l4_cap_idx_t sem,
            l4_timeout_t timeout)  [inline]
```

Semaphore down operation.

Parameters

sem	Semaphore object.
timeout	Timeout for blocking the semaphore down operation. Note: The receive timeout of this timeout-pair is significant for blocking, the send part is usually non-blocking.

Returns

Syscall return tag. Use l4_error() to check for errors.

Return values

-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The capability `sem` must have the permission L4_CAP_FPAGE_S.

This method decrements the semaphore counter by one, or blocks if the counter is already zero, until either a timeout or cancel condition hits or the counter is increased by an `up()` operation.
Definition at line 100 of file semaphore.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.12.2.2 l4_semaphore_up()

```
l4_msgtag_t l4_semaphore_up (
            l4_cap_idx_t sem)  [inline]
```

Semaphore up operation (wrapper for trigger()).

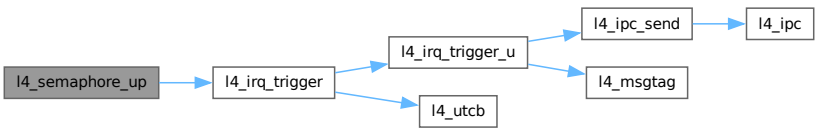
Parameters

sem	Semaphore object.

Returns

Send-only IPC message return tag. Use l4_ipc_error() to check for errors, do **not** use l4_error().

Increases the semaphore counter by one if it is smaller than an unspecified limit. The unspecified limit is guaranteed to be at least 2^31-1.
Definition at line 45 of file semaphore.h.
References l4_irq_trigger(), and L4_NOTHROW.
Here is the call graph for this function:



13.1.10.13 Task

C interface of the Task kernel object, see L4::Task for the C++ interface.

Collaboration diagram for Task:



Enumerations

- enum l4_unmap_flags_t { L4_FP_ALL_SPACES , L4_FP_DELETE_OBJ , L4_FP_OTHER_SPACES }

  Flags for the unmap operation.

Functions

- l4_msgtag_t l4_task_vgicc_map (l4_cap_idx_t task, l4_fpage_t vgicc_fpage) L4_NOTHROW

  Map the GIC virtual CPU interface page to the task in case Fiasco detected a GIC version 2.
- l4_msgtag_t l4_task_map (l4_cap_idx_t dst_task, l4_cap_idx_t src_task, l4_fpage_t snd_fpage, l4_umword_t snd_base) L4_NOTHROW

  Map resources available in the source task to a destination task.
- l4_msgtag_t l4_task_unmap (l4_cap_idx_t task, l4_fpage_t fpage, l4_umword_t map_mask) L4_NOTHROW

  Revoke rights from the task.
- l4_msgtag_t l4_task_unmap_batch (l4_cap_idx_t task, l4_fpage_t const *fpages, unsigned num_fpages, l4_umword_t map_mask) L4_NOTHROW

  Revoke rights from a task.
- l4_msgtag_t l4_task_delete_obj (l4_cap_idx_t task, l4_cap_idx_t obj) L4_NOTHROW

  Release capability and delete object.
- l4_msgtag_t l4_task_release_cap (l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW

  Release object capability.
- l4_msgtag_t l4_task_cap_valid (l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW

  Check whether a capability is present (refers to an object).
- l4_msgtag_t l4_task_cap_equal (l4_cap_idx_t task, l4_cap_idx_t cap_a, l4_cap_idx_t cap_b) L4_NOTHROW

  Test whether two capabilities point to the same object with the same permissions (only considering selected permissions).
- l4_msgtag_t l4_task_add_ku_mem (l4_cap_idx_t task, l4_fpage_t *ku_mem) L4_NOTHROW

  Add kernel-user memory.

13.1.10.13.1 Detailed Description

C interface of the Task kernel object, see L4::Task for the C++ interface.
A task represents a combination of the address spaces provided by the L4Re micro kernel. A task consists of at least a memory address space and an object address space. On IA32 there is also an IO-port address space.
Task objects are created using the Factory interface.

Include File

```
#include <l4/sys/task.h>
```

13.1.10.13.2 Enumeration Type Documentation

13.1.10.13.2.1 l4_unmap_flags_t

enum l4_unmap_flags_t

Flags for the unmap operation.

See also

L4::Task::unmap() and l4_task_unmap()

Enumerator

L4_FP_ALL_SPACES	Flag to tell the unmap operation to revoke permissions from all child mappings including the mapping in the invoked task. **Note** Object capabilities are not hierarchical – they have no children. The result of the map operation on an object capability is a copy of that capability in the object space of the destination task. An unmap operation on object capabilities is a no-op if this flag is not specified. **See also** L4::Task::unmap() l4_task_unmap()
L4_FP_DELETE_OBJ	Flag that indicates that an unmap operation on object capabilities shall try to delete the corresponding objects immediately. This flag implies the L4_FP_ALL_SPACES flag. The concept of deletion is only applicable to kernel objects. Therefore, for memory and I/O port capabilities, this flag has the same effect as L4_FP_ALL_SPACES alone. **See also** L4::Task::unmap() l4_task_unmap() **Note** Specifying L4_FP_DELETE_OBJ ^ L4_FP_ALL_SPACES is treated as L4_FP_OTHER_SPACES.
L4_FP_OTHER_SPACES	Counterpart to L4_FP_ALL_SPACES; revoke permissions from child mappings only. **See also** L4::Task::unmap() l4_task_unmap()

Definition at line 186 of file consts.h.

13.1.10.13.3 Function Documentation

13.1.10.13.3.1 l4_task_add_ku_mem()

```
l4_msgtag_t l4_task_add_ku_mem (
            l4_cap_idx_t task,
            l4_fpage_t * ku_mem)  [inline]
```

Add kernel-user memory.

Parameters

	task	Capability index of the task to add the memory to.
in,out	*ku_mem*	Flexpage describing the virtual area the memory goes to. On systems without MMU, the flexpage is adjusted to reflect the actually allocated physical address.

Returns

Syscall return tag

Kernel-user memory (ku_mem) is memory that is shared between the kernel and user-space. It is needed for the UTCB area of threads (see l4_thread_control_bind()) and for (extended) vCPU state. Note that existing kernel-user memory cannot be unmapped or mapped somewhere else.

Note

The amount of kernel-user memory that can be allocated at once is limited by the used kernel implementation. The minimum allocatable amount is one page (L4_PAGESIZE). A portable implementation should not depend on allocations greater than 16KiB to succeed.

This function is only guaranteed to work on L4::Task objects. It might or might not work on L4::Vm objects or on L4Re::Dma_space objects but there is no practical use for adding kernel-user memory to L4::Vm objects or to L4Re::Dma_space objects.

Definition at line 497 of file task.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.13.3.2 l4_task_cap_equal()

```
l4_msgtag_t l4_task_cap_equal (
             l4_cap_idx_t task,
             l4_cap_idx_t cap_a,
             l4_cap_idx_t cap_b)  [inline]
```

Test whether two capabilities point to the same object with the same permissions (only considering selected permissions).

Parameters

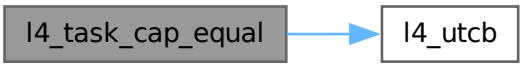
task	Capability index for the destination task to do the lookup in.
cap_a	Capability selector for the first capability to compare.
cap_b	Capability selector for the second capability to compare.

Return values

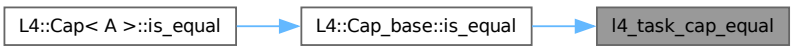
l4_msgtag_t::label() = 1	The compared capabilities point to the same object with same considered permission.
l4_msgtag_t::label() = 0	The compared capabilities do **not** point to the same object or differ in the considered permission.

- For L4::Ipc_gate objects, only the permissions L4_CAP_FPAGE_W, L4_CAP_FPAGE_S, and L4_FPAGE_C_OBJ_RIGHT1 are considered for the comparison. Differences in other permissions are ignored.
- For other objects, only the permissions L4_CAP_FPAGE_W and L4_CAP_FPAGE_S are considered for the comparison. Differences in other permissions are ignored.

Note that having the L4_CAP_FPAGE_R permission is implicit in possessing the capability.
Definition at line 490 of file task.h.
References L4_NOTHROW, and l4_utcb().
Referenced by L4::Cap_base::is_equal().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.13.3.3 l4_task_cap_valid()

```
l4_msgtag_t l4_task_cap_valid (
             l4_cap_idx_t task,
             l4_cap_idx_t cap)  [inline]
```

Check whether a capability is present (refers to an object).

Parameters

task	Task to check the capability in.
cap	Valid capability to check for presence.

Return values

l4_msgtag_t::label() > 0	Capability is present (refers to an object).

l4_msgtag_t::label() == 0	No capability present (void object).

A capability is considered present when it refers to an existing kernel object.

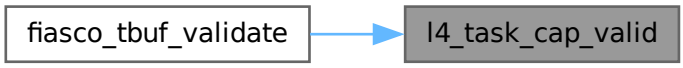
Precondition

`cap` must be a valid capability index (i.e. not L4_INVALID_CAP or the like).

Definition at line 484 of file task.h.
References L4_NOTHROW, and l4_utcb().
Referenced by fiasco_tbuf_validate().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.13.3.4 l4_task_delete_obj()

```
l4_msgtag_t l4_task_delete_obj (
             l4_cap_idx_t task,
             l4_cap_idx_t obj)  [inline]
```

Release capability and delete object.

Parameters

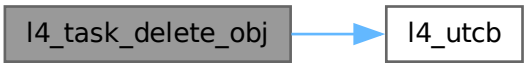
task	Capability index of destination task.
obj	Capability index of the object to delete.

Returns

Syscall return tag

If `obj` has the delete permission, initiates the deletion of the object. This implies that all capabilities for that object are gone afterwards. However, kernel-internally, objects are not destroyed until all other kernel objects holding a reference to it drop the reference. Hence, quota used by that object might not be freed immediately.
If `obj` does not have the delete permission, no error will be reported and only the capability `obj` is removed. (Note that, depending on the object's reference counter, this might still imply initiation of deletion.)

This operation is equivalent to l4_task_unmap() with L4_FP_DELETE_OBJ flag.
Definition at line 463 of file task.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.13.3.5 l4_task_map()

```
l4_msgtag_t l4_task_map (
             l4_cap_idx_t dst_task,
             l4_cap_idx_t src_task,
             l4_fpage_t snd_fpage,
             l4_umword_t snd_base)  [inline]
```

Map resources available in the source task to a destination task.

Parameters

dst_task	Capability index of the destination task.
src_task	Capability index of the source task.
snd_fpage	Send flexpage that describes an area in the address space or object space of the source task.
snd_base	Send base that describes an offset in the receive window of the destination task. The lower bits contain additional map control flags (see l4_fpage_cacheability_opt_t for memory mappings, Attributes and additional permissions for object send items for object mappings, and L4_MAP_ITEM_GRANT; also see l4_map_control() and l4_map_obj_control()).

Returns

Syscall return tag. The function l4_error() shall be used to test if the map operation was successful.

Return values

L4_EOK	Operation successful (but see notes below).
-L4_EPERM	Insufficient permissions; see precondition.
-L4_EINVAL	Invalid source task capability.
-L4_IPC_SEMAPFAILED	The map operation failed due to limited quota.

Precondition

The capability `dst_task` must have the permission L4_CAP_FPAGE_W.

This method allows for asynchronous transfer of capabilities, memory mappings, and IO-port mappings (on IA32) from one task to another. The receive window is the whole address space of `dst_task`. By specifying proper rights in `snd_fpage` and `snd_base`, it is possible to remove rights during transfer.

Note

If the send flexpage is of type L4_FPAGE_OBJ, the L4_CAP_FPAGE_S right is removed from the transferred capability unless both the source and destination task capabilities possess the L4_CAP_FPAGE_S right themselves.

Even with l4_error() returning L4_EOK there might be cases where not all pages of the send flexpage were mapped respectively granted to the destination task, for instance, if the corresponding mapping in the destination task does already exist.

For more information on spaces and mappings, see Spaces and Mappings. The flexpage API is described in more detail at Flexpages.

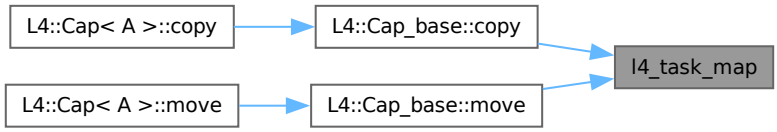
Note

For peculiarities when using grant, see L4_MAP_ITEM_GRANT.

Definition at line 433 of file task.h.
References L4_NOTHROW, and l4_utcb().
Referenced by L4::Cap_base::copy(), and L4::Cap_base::move().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.13.3.6 l4_task_release_cap()

```
l4_msgtag_t l4_task_release_cap (
             l4_cap_idx_t task,
             l4_cap_idx_t cap)  [inline]
```

Release object capability.

Parameters

task	Capability index of destination task
cap	Capability index of object to release

Returns

Syscall return tag

This operation unmaps the capability from the specified task. This operation is equivalent to unmapping a single object capability by specifying all object rights as unmap mask.

Note

If the reference counter of the kernel object referenced by `cap` goes down to zero, deletion of the object is initiated. Objects are not destroyed until all other kernel objects holding a reference to it drop the reference.

Definition at line 478 of file task.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.13.3.7 l4_task_unmap()

```
l4_msgtag_t l4_task_unmap (
             l4_cap_idx_t task,
             l4_fpage_t fpage,
             l4_umword_t map_mask)  [inline]
```

Revoke rights from the task.

Parameters

task	Capability index of destination task
fpage	Flexpage that describes an area in one capability space of the destination task and the rights to revoke.
map_mask	Unmap mask, see l4_unmap_flags_t

Returns

Syscall return tag

This method allows to revoke rights from the destination task. The rights to revoke are specified in the flexpage, see l4_fpage_rights(). For a flexpage describing IO ports or memory, it also revokes rights from all the tasks that got the rights delegated from the destination task (i.e., this operation does a recursive rights revocation). The capability is unmapped if certain rights are specified, see below for details. It is guaranteed that the rights revocation is completed before this function returns.
Note that this function cannot be used to revoke the reference counting permission (see L4_FPAGE_C_REF_CNT) or the IPC-gate server permission (see L4_FPAGE_C_IPCGATE_SVR) from object capabilities.
It depends on the platform and the object type which rights need to be specified in the `rights` field of `fpage` to unmap a capability:

- An object capability is unmapped if and only if the L4_CAP_FPAGE_R right bit is set.
- An IO port is unmapped if and only if any right bit is set.
- Memory is unmapped if and only if the L4_FPAGE_RO right bit is set.

Note

Depending on the page-table features supported by the hardware, revocation of certain rights from a memory capability can be a no-op (i.e., the rights are not revoked). Further, revocation of certain rights may grant other rights which were not present before. For instance, on an architecture without support for NX, revoking X does nothing. For another example, revoking only X from an execute-only page grants read permission (because the mapping remains present in the page table).

If the reference counter of a kernel object referenced in `fpage` goes down to zero (as a result of deleting capabilities), the deletion of the object is initiated. Objects are not destroyed until all other kernel objects holding a reference to it drop the reference.

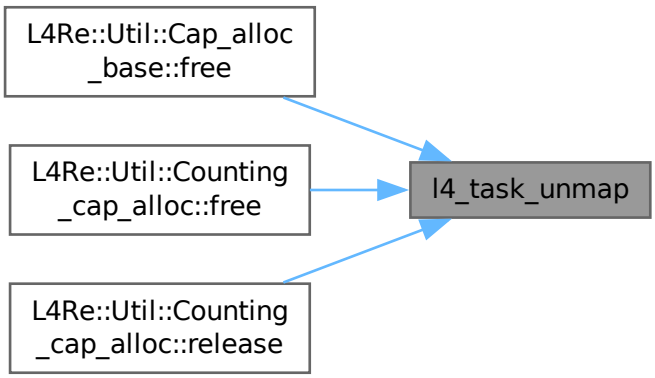
Examples

examples/sys/utcb-ipc/main.c.

Definition at line 440 of file task.h.
References L4_NOTHROW, and l4_utcb().
Referenced by L4Re::Util::Cap_alloc_base::free(), L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::free(), and L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::release().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.13.3.8 l4_task_unmap_batch()

```
l4_msgtag_t l4_task_unmap_batch (
             l4_cap_idx_t task,
             l4_fpage_t const * fpages,
```

```
            unsigned num_fpages,
            l4_umword_t map_mask)  [inline]
```

Revoke rights from a task.

Parameters

task	Capability index of destination task
fpages	An array of flexpages. Each item describes an area in one capability space of the destination task.
num_fpages	The size of the fpages array in elements (number of fpages sent).
map_mask	Unmap mask, see l4_unmap_flags_t

Returns

Syscall return tag

Revoke rights specified in an array of flexpages, see l4_task_unmap for details.

Precondition

The caller needs to take care that num_fpages is not bigger than L4_UTCB_GENERIC_DATA_SIZE - 2.

Definition at line 447 of file task.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.13.3.9 l4_task_vgicc_map()

```
l4_msgtag_t l4_task_vgicc_map (
            l4_cap_idx_t task,
            l4_fpage_t vgicc_fpage)  [inline]
```

Map the GIC virtual CPU interface page to the task in case Fiasco detected a GIC version 2.

Parameters

task	Capability index of destination task
vgicc_fpage	Flexpage that describes an area in the address space of the destination task to map the vGICC page to

Returns

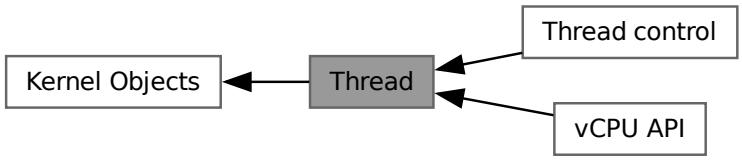
Syscall return tag

Definition at line 46 of file __task-arm.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14 Thread

C Thread object interface, see L4::Thread for the C++ interface.
Collaboration diagram for Thread:



Topics

- Thread control 375
  API for Thread Control method.
- vCPU API 380
  vCPU API.

Enumerations

- enum L4_thread_control_flags { L4_THREAD_CONTROL_SET_PAGER = 0x0010000 , L4_THREAD_CONTROL_BIND_TASK = 0x0200000 , L4_THREAD_CONTROL_ALIEN = 0x0400000 , L4_THREAD_CONTROL_SET_EXC_HANDLER = 0x1000000 }
  Flags for the thread control operation.
- enum L4_thread_control_mr_indices { L4_THREAD_CONTROL_MR_IDX_FLAGS = 0 , L4_THREAD_CONTROL_MR_IDX_PAGER = 1 , L4_THREAD_CONTROL_MR_IDX_EXC_HANDLER = 2 , L4_THREAD_CONTROL_MR_IDX_FLAG_VALS = 4 , L4_THREAD_CONTROL_MR_IDX_BIND_UTCB = 5 , L4_THREAD_CONTROL_MR_IDX_BIND_TASK = 6 }
  Indices for the values in the message register for thread control.

- enum L4_thread_ex_regs_flags { L4_THREAD_EX_REGS_CANCEL = 0x10000UL , L4_THREAD_EX_REGS_TRIGGER_EXC = 0x20000UL , L4_THREAD_EX_REGS_ARCH_MASK = 0xff000000UL }

  Flags for the thread ex-regs operation.
- enum L4_pf_tramp_control_op { L4_THREAD_PF_TRAMP_CONTROL_OP_SETUP = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x00000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_RESUME = (L4_THREAD_PF_TRAMP_↩ CONTROL_OP | 0x10000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_REFLECT = (L4_THREAD_↩ PF_TRAMP_CONTROL_OP | 0x20000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_DISABLE = (L4↩ _THREAD_PF_TRAMP_CONTROL_OP | 0x30000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_ENABLE = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x40000UL) }

  Sub-opcodes for L4_THREAD_PF_TRAMP_CONTROL_OP.
- enum L4_thread_ex_regs_flags_arm { L4_THREAD_EX_REGS_ARM_SET_EL_MASK = 0x3 << 24 , L4_THREAD_EX_REGS_ARM_SET_EL_KEEP = 0x0 << 24 , L4_THREAD_EX_REGS_ARM_SET_EL_EL0 = 0x1 << 24 , L4_THREAD_EX_REGS_ARM_SET_EL_EL1 = 0x2 << 24 }

  Arm specific L4::Thread::ex_regs() flags.
- enum L4_thread_ex_regs_flags_arm64 { L4_THREAD_EX_REGS_ARM64_SET_EL_MASK = 0x3 << 24 , L4_THREAD_EX_REGS_ARM64_SET_EL_KEEP = 0x0 << 24 , L4_THREAD_EX_REGS_ARM64_SET_EL_EL0 = 0x1 << 24 , L4_THREAD_EX_REGS_ARM64_SET_EL_EL1 = 0x2 << 24 }

  Arm64 specific L4::Thread::ex_regs() flags.

Functions

- l4_msgtag_t l4_thread_ex_regs (l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp, l4_umword_t flags) L4_NOTHROW

  Exchange basic thread registers.
- l4_msgtag_t l4_thread_ex_regs_u (l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp, l4_umword_t flags, l4_utcb_t *utcb) L4_NOTHROW

  Exchange basic thread registers.
- l4_msgtag_t l4_thread_ex_regs_ret (l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp, l4_umword_t *flags) L4_NOTHROW

  Exchange basic thread registers and return previous values.
- l4_msgtag_t l4_thread_ex_regs_ret_u (l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp, l4_umword_t *flags, l4_utcb_t *utcb) L4_NOTHROW

  Exchange basic thread registers and return previous values.
- l4_msgtag_t l4_thread_yield (void) L4_NOTHROW

  Yield current time slice.
- l4_msgtag_t l4_thread_switch (l4_cap_idx_t to_thread) L4_NOTHROW

  Switch to another thread (and donate the remaining time slice).
- l4_msgtag_t l4_thread_stats_time (l4_cap_idx_t thread, l4_kernel_clock_t *us) L4_NOTHROW

  Get consumed time of thread in µs.
- l4_msgtag_t l4_thread_vcpu_resume_start (void) L4_NOTHROW

  vCPU return from event handler.
- l4_msgtag_t l4_thread_vcpu_resume_commit (l4_cap_idx_t thread, l4_msgtag_t tag) L4_NOTHROW

  Commit vCPU resume.
- l4_msgtag_t l4_thread_vcpu_control (l4_cap_idx_t thread, l4_addr_t vcpu_state) L4_NOTHROW

  Enable the vCPU feature for the thread.
- l4_msgtag_t l4_thread_vcpu_control_u (l4_cap_idx_t thread, l4_addr_t vcpu_state, l4_utcb_t *utcb) L4_NOTHROW

  Enable the vCPU feature for the thread.
- l4_msgtag_t l4_thread_vcpu_control_ext (l4_cap_idx_t thread, l4_addr_t ext_vcpu_state) L4_NOTHROW

  Enable the extended vCPU feature for the thread.
- l4_msgtag_t l4_thread_vcpu_control_ext_u (l4_cap_idx_t thread, l4_addr_t ext_vcpu_state, l4_utcb_t *utcb) L4_NOTHROW

Enable the extended vCPU feature for the thread.

- l4_msgtag_t l4_thread_register_del_irq (l4_cap_idx_t thread, l4_cap_idx_t irq) L4_NOTHROW

  Register an IRQ that will trigger upon deletion events.
- l4_msgtag_t l4_thread_modify_sender_start (void) L4_NOTHROW

  Start a thread sender modification sequence.
- int l4_thread_modify_sender_add (l4_umword_t match_mask, l4_umword_t match, l4_umword_t del_bits, l4_umword_t add_bits, l4_msgtag_t *tag) L4_NOTHROW

  Add a modification pattern to a sender modification sequence.
- l4_msgtag_t l4_thread_modify_sender_commit (l4_cap_idx_t thread, l4_msgtag_t tag) L4_NOTHROW

  Apply (commit) a sender modification sequence.
- l4_msgtag_t l4_thread_register_doorbell_irq (l4_cap_idx_t thread, l4_cap_idx_t irq) L4_NOTHROW

  Register an IRQ that will trigger when a forwarded virtual interrupt is pending.
- l4_msgtag_t l4_thread_pf_trampoline_setup (l4_cap_idx_t thread, l4_addr_t pf_tramp_state) L4_NOTHROW

  Setup page fault trampoline handler.
- l4_msgtag_t l4_thread_pf_trampoline_resume (l4_cap_idx_t thread) L4_NOTHROW

  Resume from page fault trampoline handler.
- l4_msgtag_t l4_thread_pf_trampoline_reflect (l4_cap_idx_t thread) L4_NOTHROW

  Page fault trampoline handler reflects page fault to exception handler.
- l4_msgtag_t l4_thread_pf_trampoline_disable (l4_cap_idx_t thread, int *was_enabled) L4_NOTHROW

  Disable the page fault trampoline handling for this thread.
- l4_msgtag_t l4_thread_pf_trampoline_enable (l4_cap_idx_t thread) L4_NOTHROW

  Re-enable the page fault trampoline handling for this thread.
- l4_msgtag_t l4_thread_arm_set_tpidruro (l4_cap_idx_t thread, l4_addr_t tpidruro) L4_NOTHROW

  Set the TPIDRURO thread specific register.

13.1.10.14.1 Detailed Description

C Thread object interface, see L4::Thread for the C++ interface.
An L4 thread is a thread of execution in the L4 context. Usually user-level and kernel threads are mapped 1:1 to each other. Thread kernel objects are created using a factory, see Factory (l4_factory_create_thread()).
Amongst other things an L4 thread encapsulates:

- CPU state
  - General-purpose registers
  - Program counter
  - Stack pointer
- FPU state
- Scheduling parameters, see the Scheduler API
- Execution state
  - Blocked, Runnable, Running

Thread objects provide an API for

- Thread configuration and manipulation
- Thread switching.

The thread control functions are used to control various aspects of a thread. See l4_thread_control_start() for more information.
On ARM newly created threads run in EL0 by default and the exception level can be changed there with ex_regs().

Include File

```
#include <l4/sys/thread.h>
```

For the C++ interface refer to L4::Thread.

13.1.10.14.2 Enumeration Type Documentation

13.1.10.14.2.1 L4_pf_tramp_control_op

enum L4_pf_tramp_control_op
Sub-opcodes for L4_THREAD_PF_TRAMP_CONTROL_OP.

Enumerator

L4_THREAD_PF_TRAMP_CONTROL_OP_SETUP	Setup PF trampoline handler.
L4_THREAD_PF_TRAMP_CONTROL_OP_RESUME	Normal resume from PF trampoline handler to user-land.
L4_THREAD_PF_TRAMP_CONTROL_OP_REFLECT	Resume from PF trampoline handler – trigger exception.
L4_THREAD_PF_TRAMP_CONTROL_OP_DISABLE	Disable PF trampoline handler. The ITAS will usually enable PF trampoline handling for all threads. A thread can decide to install its own pager and will disable the PF trampoline handling in that case.
L4_THREAD_PF_TRAMP_CONTROL_OP_ENABLE	Re-enable PF trampoline handler. Re-enable the PF trampoline handling for a thread where the handling was explicitly disabled before.

Definition at line 925 of file thread.h.

13.1.10.14.2.2 L4_thread_control_flags

enum L4_thread_control_flags
Flags for the thread control operation.

Enumerator

L4_THREAD_CONTROL_SET_PAGER	The pager will be given.
L4_THREAD_CONTROL_BIND_TASK	The task to bind the thread to will be given.
L4_THREAD_CONTROL_ALIEN	Alien state of the thread is set.
L4_THREAD_CONTROL_SET_EXC_HANDLER	The exception handler of the thread will be given.

Definition at line 876 of file thread.h.

13.1.10.14.2.3 L4_thread_control_mr_indices

enum L4_thread_control_mr_indices
Indices for the values in the message register for thread control.

Enumerator

L4_THREAD_CONTROL_MR_IDX_FLAGS	**See also** L4_thread_control_flags.
L4_THREAD_CONTROL_MR_IDX_PAGER	Index for pager cap.
L4_THREAD_CONTROL_MR_IDX_EXC_HANDLER	Index for exception handler.
L4_THREAD_CONTROL_MR_IDX_FLAG_VALS	Index for feature values.

L4_THREAD_CONTROL_MR_IDX_BIND_UTCB	Index for UTCB address for bind.
L4_THREAD_CONTROL_MR_IDX_BIND_TASK	Index for task flexpage for bind.

Definition at line 897 of file thread.h.

13.1.10.14.2.4 L4_thread_ex_regs_flags

enum L4_thread_ex_regs_flags
Flags for the thread ex-regs operation.

Enumerator

L4_THREAD_EX_REGS_CANCEL	Cancel ongoing IPC in the thread.
L4_THREAD_EX_REGS_TRIGGER_EXCEPTION	Trigger artificial exception in thread.
L4_THREAD_EX_REGS_ARCH_MASK	Arch specific flags.

Definition at line 912 of file thread.h.

13.1.10.14.2.5 L4_thread_ex_regs_flags_arm

enum L4_thread_ex_regs_flags_arm
Arm specific L4::Thread::ex_regs() flags.
Only one option must be used in calls to L4::Thread::ex_regs(). Using more than one option results in undefined behaviour.

Enumerator

L4_THREAD_EX_REGS_ARM_SET_EL_MASK	Exception level set mask.
L4_THREAD_EX_REGS_ARM_SET_EL_KEEP	Keep current exception level of thread (default).
L4_THREAD_EX_REGS_ARM_SET_EL_EL0	Set exception level of thread to EL0 (usr mode).
L4_THREAD_EX_REGS_ARM_SET_EL_EL1	Set exception level of thread to EL1 (sys mode).

Definition at line 37 of file thread.h.

13.1.10.14.2.6 L4_thread_ex_regs_flags_arm64

enum L4_thread_ex_regs_flags_arm64
Arm64 specific L4::Thread::ex_regs() flags.
Only one option must be used in calls to L4::Thread::ex_regs(). Using more than one option results in undefined behaviour.

Enumerator

L4_THREAD_EX_REGS_ARM64_SET_EL_MASK	Exception level set mask.
L4_THREAD_EX_REGS_ARM64_SET_EL_KEEP	Keep current exception level of thread (default).
L4_THREAD_EX_REGS_ARM64_SET_EL_EL0	Set exception level of thread to EL0.
L4_THREAD_EX_REGS_ARM64_SET_EL_EL1	Set exception level of thread to EL1t.

Definition at line 44 of file thread.h.

13.1.10.14.3 Function Documentation

13.1.10.14.3.1 l4_thread_arm_set_tpidruro()

```
l4_msgtag_t l4_thread_arm_set_tpidruro (
             l4_cap_idx_t thread,
             l4_addr_t tpidruro)  [inline]
```

Set the TPIDRURO thread specific register.

Parameters

thread	Thread to manipulate
tpidruro	The value to be set

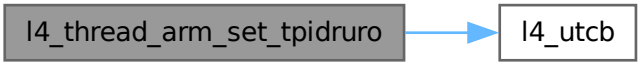
Returns

System call return tag

Note

When this function is invoked for a thread currently executing on a different core, then the changed register content will not be visible to that thread until a thread switch happens on that core.

Definition at line 70 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.2 l4_thread_ex_regs()

```
l4_msgtag_t l4_thread_ex_regs (
             l4_cap_idx_t thread,
             l4_addr_t ip,
             l4_addr_t sp,
             l4_umword_t flags)  [inline]
```

Exchange basic thread registers.

Parameters

thread	Capability selector of the thread to manipulate.
ip	New instruction pointer, use ~0UL to leave the instruction pointer unchanged.
sp	New stack pointer, use ~0UL to leave the stack pointer unchanged.
flags	Ex-regs flags, see L4_thread_ex_regs_flags.

Returns

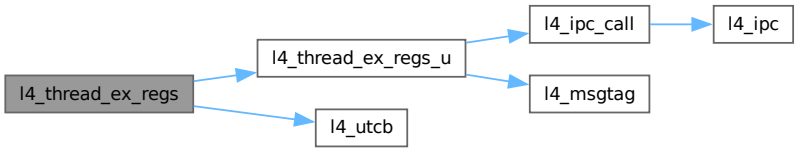
System call return tag

This method allows to manipulate and start a thread. The basic functionality is to set the instruction pointer and the stack pointer of a thread. Additionally, this method allows also to cancel ongoing IPC operations and to force the thread to raise an artificial exception (see `flags`). If the thread is in an IPC operation or if L4_THREAD_EX_REGS_TRIGGER_EXCEPTION forces an IPC then changes in IP and SP take effect directly after returning from this IPC. On ARM this method allows to change the exception level, see L4_thread_ex_regs_flags_arm and L4_thread_ex_regs_flags_arm64.
The thread is started using l4_scheduler_run_thread(). However, if at the time l4_scheduler_run_thread() is called, the instruction pointer of the thread is invalid, a later call to l4_thread_ex_regs() with a valid instruction pointer might start the thread.

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 1086 of file thread.h.
References L4_NOTHROW, l4_thread_ex_regs_u(), and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.3 l4_thread_ex_regs_ret()

```
l4_msgtag_t l4_thread_ex_regs_ret (
            l4_cap_idx_t thread,
            l4_addr_t * ip,
            l4_addr_t * sp,
            l4_umword_t * flags)  [inline]
```

Exchange basic thread registers and return previous values.

Parameters

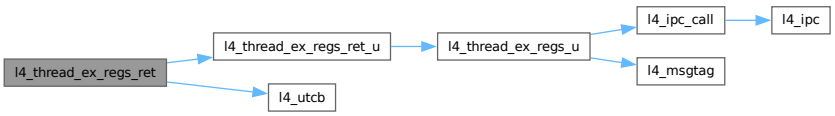
	thread	Capability selector of the thread to manipulate.
`in,out`	*ip*	New instruction pointer, use ~0UL to leave the instruction pointer unchanged, return previous instruction pointer.
`in,out`	*sp*	New stack pointer, use ~0UL to leave the stack pointer unchanged, returns previous stack pointer.
`in,out`	*flags*	Ex-regs flags, see L4_thread_ex_regs_flags, return previous CPU flags of the thread.

Returns

System call return tag

This method allows to manipulate and start a thread. The basic functionality is to set the instruction pointer and the stack pointer of a thread. Additionally, this method allows also to cancel ongoing IPC operations

and to force the thread to raise an artificial exception (see `flags`). If the thread is in an IPC operation or if L4_THREAD_EX_REGS_TRIGGER_EXCEPTION forces an IPC then changes in IP and SP take effect directly after returning from this IPC. On ARM this method allows to change the exception level, see L4_thread_ex_regs_flags_arm and L4_thread_ex_regs_flags_arm64.
The thread is started using l4_scheduler_run_thread(). However, if at the time l4_scheduler_run_thread() is called, the instruction pointer of the thread is invalid, a later call to l4_thread_ex_regs() with a valid instruction pointer might start the thread.
Returned values are valid only if function returns successfully.
Definition at line 1093 of file thread.h.
References L4_NOTHROW, l4_thread_ex_regs_ret_u(), and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.4 l4_thread_ex_regs_ret_u()

```
l4_msgtag_t l4_thread_ex_regs_ret_u (
             l4_cap_idx_t thread,
             l4_addr_t * ip,
             l4_addr_t * sp,
             l4_umword_t * flags,
             l4_utcb_t * utcb)  [inline]
```

Exchange basic thread registers and return previous values.

Parameters

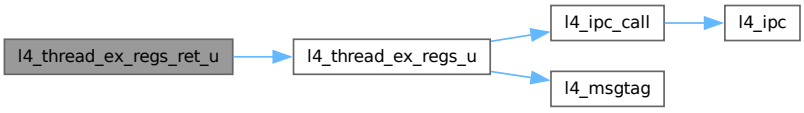
	thread	Capability selector of the thread to manipulate.
in,out	*ip*	New instruction pointer, use ~0UL to leave the instruction pointer unchanged, return previous instruction pointer.
in,out	*sp*	New stack pointer, use ~0UL to leave the stack pointer unchanged, returns previous stack pointer.
in,out	*flags*	Ex-regs flags, see L4_thread_ex_regs_flags, return previous CPU flags of the thread.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

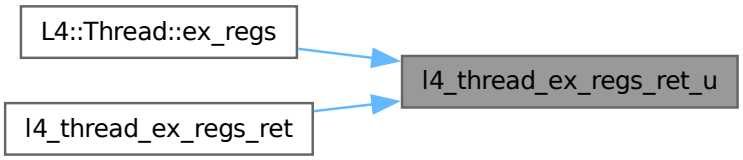
System call return tag. [out] parameters are only valid if the function returns successfully. Use l4_error() to check.

This method allows to manipulate and start a thread. The basic functionality is to set the instruction pointer and the stack pointer of a thread. Additionally, this method allows also to cancel ongoing IPC operations and to force the thread to raise an artificial exception (see `flags`). If the thread is in an IPC operation or if L4_THREAD_EX_REGS_TRIGGER_EXCEPTION forces an IPC then changes in IP and SP take effect directly after returning from this IPC. On ARM this method allows to change the exception level, see L4_thread_ex_regs_flags_arm and L4_thread_ex_regs_flags_arm64.
The thread is started using L4::Scheduler::run_thread(). However, if at the time L4::Scheduler::run_thread() is called, the instruction pointer of the thread is invalid, a later call to ex_regs() with a valid instruction pointer might start the thread.

Definition at line 967 of file thread.h.
References L4_NOTHROW, l4_thread_ex_regs_u(), and l4_msg_regs_t::mr.
Referenced by L4::Thread::ex_regs(), and l4_thread_ex_regs_ret().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.14.3.5 l4_thread_ex_regs_u()

```
l4_msgtag_t l4_thread_ex_regs_u (
             l4_cap_idx_t thread,
             l4_addr_t ip,
             l4_addr_t sp,
             l4_umword_t flags,
             l4_utcb_t * utcb)  [inline]
```

Exchange basic thread registers.

Parameters

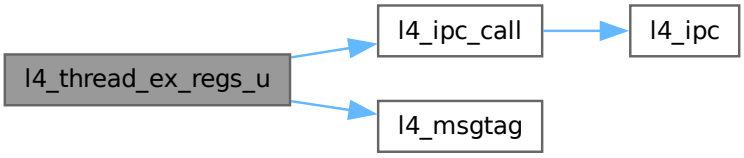
thread	Capability selector of the thread to manipulate.
ip	New instruction pointer, use ~0UL to leave the instruction pointer unchanged.
sp	New stack pointer, use ~0UL to leave the stack pointer unchanged.
flags	Ex-regs flags, see L4_thread_ex_regs_flags.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

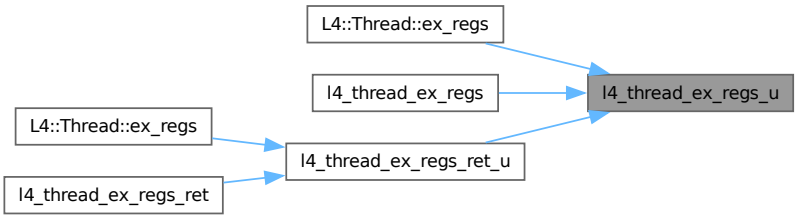
System call return tag.

This method allows to manipulate and start a thread. The basic functionality is to set the instruction pointer and the stack pointer of a thread. Additionally, this method allows also to cancel ongoing IPC operations and to force the thread to raise an artificial exception (see `flags`). If the thread is in an IPC operation or if L4_THREAD_EX_REGS_TRIGGER_EXCEPTION forces an IPC then changes in IP and SP take ef-

fect directly after returning from this IPC. On ARM this method allows to change the exception level, see L4_thread_ex_regs_flags_arm and L4_thread_ex_regs_flags_arm64.
The thread is started using L4::Scheduler::run_thread(). However, if at the time L4::Scheduler::run_thread() is called, the instruction pointer of the thread is invalid, a later call to ex_regs() with a valid instruction pointer might start the thread.
Definition at line 956 of file thread.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_THREAD, L4_THREAD_EX_REGS_OP, and l4_msg_regs_t::mr.
Referenced by L4::Thread::ex_regs(), l4_thread_ex_regs(), and l4_thread_ex_regs_ret_u().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.14.3.6 l4_thread_modify_sender_add()

```
int l4_thread_modify_sender_add (
             l4_umword_t match_mask,
             l4_umword_t match,
             l4_umword_t del_bits,
             l4_umword_t add_bits,
             l4_msgtag_t * tag)  [inline]
```

Add a modification pattern to a sender modification sequence.

Parameters

tag	Tag received from l4_thread_modify_sender_start() or previous l4_thread_modify_sender_add() calls from the same sequence.
match_mask	Bitmask of bits to match the label.
match	Bitmask that must be equal to the label after applying match_mask.
del_bits	Bits to be deleted from the label.

add_bits	Bits to be added to the label.

Returns

0 on success, <0 on error

In pseudo code: if ((sender_label & match_mask) == match) { sender_label = (sender_label & ~del_bits) | add_bits; }
Only the first match is applied.

See also

l4_thread_modify_sender_start

l4_thread_modify_sender_commit

Definition at line 1260 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.7 l4_thread_modify_sender_commit()

```
l4_msgtag_t l4_thread_modify_sender_commit (
             l4_cap_idx_t thread,
             l4_msgtag_t tag)  [inline]
```

Apply (commit) a sender modification sequence.
The modification rules are applied to all IPCs to the thread (whether directly or by IPC gate) that are already in flight, that is that the sender is already blocking on.

Note

Modifying the senders of a thread running on a different CPU core is not supported.

To ensure that no in-flight senders are missed, either the thread itself must execute modify_senders, or the thread executing the modify_senders must synchronize with the target thread. This synchronization must ensure the following:

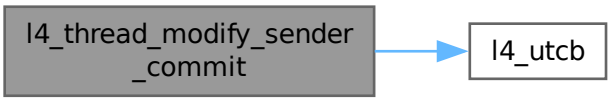
1. Before modify_senders is executed the target thread must execute at least shortly (so that pending DRQs are handled).
2. The target thread must pause its IPC dispatch, until modify_senders is completed. In other words, the target thread must not be receive ready, because otherwise an IPC message with an unmodified label can be transferred to its UTCB or vCPU state.

See also

l4_thread_modify_sender_start

l4_thread_modify_sender_add

Definition at line 1271 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.8 l4_thread_modify_sender_start()

```
l4_msgtag_t l4_thread_modify_sender_start (
            void )  [inline]
```

Start a thread sender modification sequence.
Add modification rules with l4_thread_modify_sender_add() and commit with l4_thread_modify_sender_commit().
Do not touch the UTCB between l4_thread_modify_sender_start() and l4_thread_modify_sender_commit().
This mechanism shall be used to change the source object labels of every pending IPC of an IPC gate or an IRQ if the labels in such pending IPC become invalid for the receiving thread, potentially because:

- an IPC gate / IRQ was unbound from a thread, or
- an IPC gate / IRQ was removed, or
- the label of an IPC gate /IRQ bound to a thread was changed.

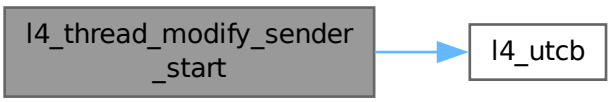
It is not required to perform the modify_sender mechanism after an IPC gate or an IRQ was bound to a thread for the first time.

See also

l4_thread_modify_sender_add

l4_thread_modify_sender_commit

Definition at line 1254 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.9 l4_thread_pf_trampoline_disable()

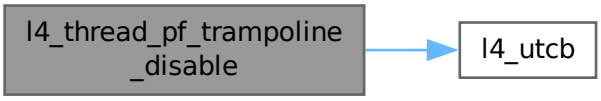
```
l4_msgtag_t l4_thread_pf_trampoline_disable (
            l4_cap_idx_t thread,
            int * was_enabled)  [inline]
```

Disable the page fault trampoline handling for this thread.

Parameters

	thread	Thread to disable page fault trampoline handling.
out	*was_enabled*	!= 0 if page fault trampoline handling was enabled, 0 if not. Optional, can be NULL.

Definition at line 1346 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.10 l4_thread_pf_trampoline_enable()

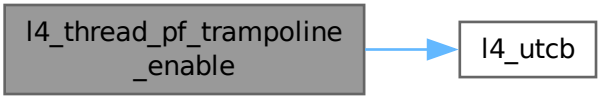
```
l4_msgtag_t l4_thread_pf_trampoline_enable (
            l4_cap_idx_t thread)  [inline]
```

Re-enable the page fault trampoline handling for this thread.

Parameters

thread	Thread to re-enable page fault trampoline handling.

Definition at line 1368 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.11 l4_thread_pf_trampoline_reflect()

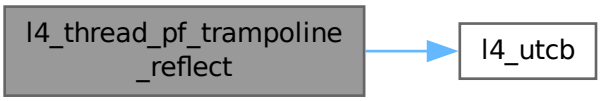
```
l4_msgtag_t l4_thread_pf_trampoline_reflect (
            l4_cap_idx_t thread)  [inline]
```

Page fault trampoline handler reflects page fault to exception handler.

Parameters

thread	Thread to reflect page fault to exception handler.

Called by the trampoline page fault handler in case a page fault could not be resolved. The kernel will reflect the page fault as exception IPC to the exception handler of the faulting thread.
Definition at line 1331 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.12 l4_thread_pf_trampoline_resume()

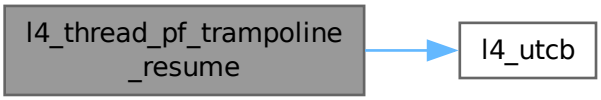
```
l4_msgtag_t l4_thread_pf_trampoline_resume (
            l4_cap_idx_t thread)  [inline]
```

Resume from page fault trampoline handler.

Parameters

thread	Thread to resume after handling page fault.

Called by the trampoline page fault handler after successfully resolving the page fault.
Definition at line 1316 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.13 l4_thread_pf_trampoline_setup()

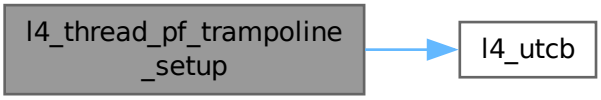
```
l4_msgtag_t l4_thread_pf_trampoline_setup (
            l4_cap_idx_t thread,
            l4_addr_t pf_tramp_state)  [inline]
```

Setup page fault trampoline handler.

Parameters

thread	Thread to setup page fault trampoline for.
pf_tramp_state	State of the faulting thread at entry of page fault handler, see l4_pf_trampoline_t. Instead of sending a page fault IPC to the pager, the kernel makes a single attempt to handle the page fault in the context of the faulting thread. For that purpose, the kernel saves the state of the faulting thread to the preallocated kernel-user memory `pf_tramp_state` and returns directly to the address of the page fault trampoline handler which is specified in l4_pf_trampoline_t::handler_ip. The page fault trampoline handler uses the stack and the stack pointer of the preempted context.

If the handler was able to resolve the page fault, it finishes using pf_trampoline_resume to resume to the preempted context.
If the page fault couldn't be resolved, the handler calls pf_trampoline_reflect which reflects the page fault to the exception handler of the thread.
If any page fault is triggered while the trampoline page fault handler is executed, a page fault IPC to the pager is generated.
Definition at line 1298 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.14 l4_thread_register_del_irq()

```
l4_msgtag_t l4_thread_register_del_irq (
             l4_cap_idx_t thread,
             l4_cap_idx_t irq)  [inline]
```

Register an IRQ that will trigger upon deletion events.

Parameters

thread	Thread to register IRQ for.
irq	Capability index for the IRQ object to be triggered.

Returns

System call return tag containing the return code.

Return values

-L4_EPERM	Insufficient permissions; see precondition.

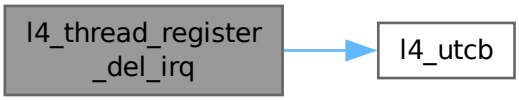
Precondition

The capability `irq` must have the permission L4_CAP_FPAGE_W.

In case the `irq` is already bound to an interrupt source, it is unbound first. When `irq` is deleted, it will be deregistered first. A registered deletion Irq can only be deregistered by deleting the Irq or the thread.
List of deletion events:

- deletion of one or several IPC gates bound to this thread.

When the deletion event is delivered, there is no indication about which IPC gate was deleted.
Definition at line 1181 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.15 l4_thread_register_doorbell_irq()

```
l4_msgtag_t l4_thread_register_doorbell_irq (
             l4_cap_idx_t thread,
             l4_cap_idx_t irq)  [inline]
```

Register an IRQ that will trigger when a forwarded virtual interrupt is pending.

Parameters

thread	Thread to register IRQ for.
irq	Capability index for the IRQ object to be triggered.

Returns

System call return tag containing the return code.

Return values

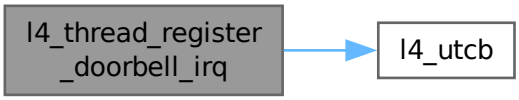
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The capability `irq` must have the permission L4_CAP_FPAGE_W.

See l4_irq_bind_vcpu() for more details about how interrupts can be forwarded directly by the kernel to extended vCPU user mode.
In case the `irq` is already bound to an interrupt source, it is unbound first. When `irq` is deleted, it will be deregistered first. A registered deletion Irq can only be deregistered by deleting the Irq or the thread.
Definition at line 1290 of file thread.h.
References L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.10.14.3.16 l4_thread_stats_time()

```
l4_msgtag_t l4_thread_stats_time (
            l4_cap_idx_t thread,
            l4_kernel_clock_t * us)  [inline]
```

Get consumed time of thread in µs.

Parameters

	thread	Thread to get the consumed time from.
out	*us*	Consumed time in µs.

Returns

system call return tag

Definition at line 1149 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.17 l4_thread_switch()

```
l4_msgtag_t l4_thread_switch (
            l4_cap_idx_t to_thread)  [inline]
```

Switch to another thread (and donate the remaining time slice).

Parameters

to_thread	The thread to switch to.

Returns

system call return tag

Definition at line 1140 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.18 l4_thread_vcpu_control()

```
l4_msgtag_t l4_thread_vcpu_control (
             l4_cap_idx_t thread,
             l4_addr_t vcpu_state)  [inline]
```

Enable the vCPU feature for the thread.

Parameters

thread	Capability selector of the thread for which the vCPU feature shall be enabled.
vcpu_state	The virtual address where the kernel shall store the vCPU state in case of vCPU exits. The address must be a valid kernel-user-memory address (see l4_task_add_ku_mem()).

Returns

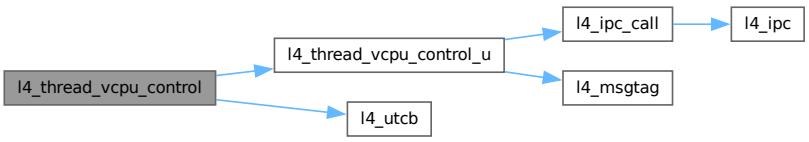
Syscall return tag.

This function enables the vCPU feature of the `thread`.
The kernel-user memory area starting at `vcpu_state` must be at least 128-byte aligned and must cover the size of l4_vcpu_state_t.

Note

Disabling of the vCPU feature is optional and currently not supported.

Definition at line 1198 of file thread.h.
References L4_NOTHROW, l4_thread_vcpu_control_u(), and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.19 l4_thread_vcpu_control_ext()

```
l4_msgtag_t l4_thread_vcpu_control_ext (
            l4_cap_idx_t thread,
            l4_addr_t ext_vcpu_state)  [inline]
```

Enable the extended vCPU feature for the thread.

Parameters

thread	Capability selector of the thread for which the extended vCPU feature shall be enabled.
ext_vcpu_state	The virtual address where the kernel shall store the vCPU state in case of vCPU exits. The address must be a valid kernel-user-memory address (see l4_task_add_ku_mem()).

Returns

Syscall return tag.

The extended vCPU feature allows the use of hardware-virtualization features such as Intel's VT or AMD's SVM. This function enables the extended vCPU feature of the `thread`. Enabling the extended vCPU feature also enables the vCPU feature.
The kernel-user memory area starting at `ext_vcpu_state` must be at least 4 KiB aligned and must cover a size of L4_PAGESIZE. It includes the data of l4_vcpu_state_t at offset 0, the extended vCPU state at offset L4_VCPU↩ _OFFSET_EXT_STATE, and, on some platforms, the extended vCPU information at offset L4_VCPU_OFFSET_↩ EXT_INFOS.

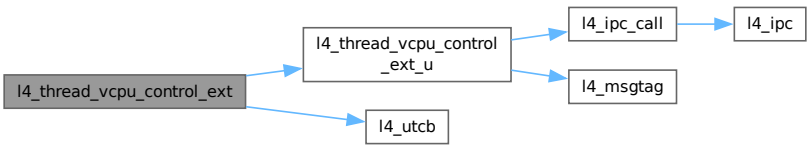
Note

Enabling the extended vCPU feature for a thread running on a different CPU core is currently not supported.

Disabling of the extended vCPU feature is currently not supported.

Upgrading from non-extended vCPU feature to extended vCPU feature is currently not supported.

Definition at line 1213 of file thread.h.
References L4_NOTHROW, l4_thread_vcpu_control_ext_u(), and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.20 l4_thread_vcpu_control_ext_u()

```
l4_msgtag_t l4_thread_vcpu_control_ext_u (
            l4_cap_idx_t thread,
            l4_addr_t ext_vcpu_state,
            l4_utcb_t * utcb)  [inline]
```

Enable the extended vCPU feature for the thread.

Parameters

thread	Capability selector of the thread for which the extended vCPU feature shall be enabled.

ext_vcpu_state	The virtual address where the kernel shall store the vCPU state in case of vCPU exits. The address must be a valid kernel-user-memory address (see L4::Task::add_ku_mem()).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag.

The extended vCPU feature allows the use of hardware-virtualization features such as Intel's VT-x (VMX) or AMD's AMD-V (SVM).
This function enables the extended vCPU feature of `this` thread. Enabling the extended vCPU feature also enables the vCPU feature.
The kernel-user memory area starting at `ext_vcpu_state` must be at least 4 KiB aligned and must cover a size of L4_PAGESIZE. It includes the data of l4_vcpu_state_t at offset 0, the extended vCPU state at offset L4_VCPU↩_OFFSET_EXT_STATE, and, on some platforms, the extended vCPU information at offset L4_VCPU_OFFSET_↩EXT_INFOS.
On Intel's VT-x (VMX), the extended vCPU state is l4_vm_vmx_vcpu_vmcs_t and the extended vCPU information is l4_vm_vmx_vcpu_infos_t. Furthermore, the extended vCPU state needs to be associated with a vCPU context (see l4_vm_vmx_set_hw_vmcs()).
On AMD's AMD-V (SVM), the extended vCPU state is l4_vm_svm_vmcb_t.

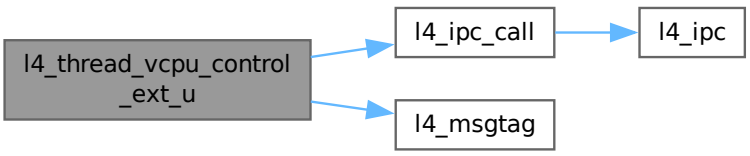
Note

Enabling the extended vCPU feature for a thread running on a different CPU core is currently not supported.

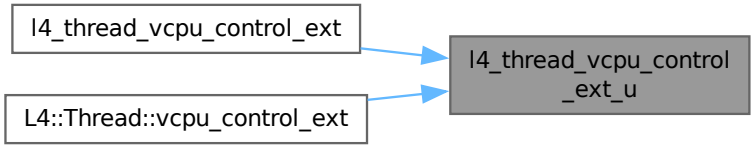
Disabling of the extended vCPU feature is currently not supported.

Upgrading from non-extended vCPU feature to extended vCPU feature is currently not supported.

Definition at line 1203 of file thread.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_THREAD, and l4_msg_regs_t::mr.
Referenced by l4_thread_vcpu_control_ext(), and L4::Thread::vcpu_control_ext().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.14.3.21 l4_thread_vcpu_control_u()

```
l4_msgtag_t l4_thread_vcpu_control_u (
             l4_cap_idx_t thread,
             l4_addr_t vcpu_state,
             l4_utcb_t * utcb)  [inline]
```

Enable the vCPU feature for the thread.

Parameters

thread	Capability selector of the thread for which the vCPU feature shall be enabled.
vcpu_state	A virtual address pointing to a l4_vcpu_state_t. It must be a valid kernel-user-memory address (see L4::Task::add_ku_mem()).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

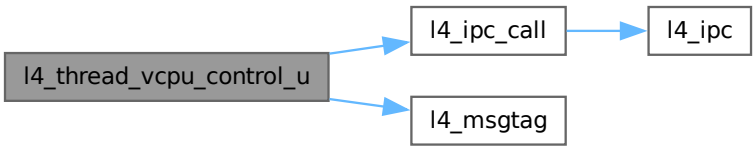
Syscall return tag.

This function enables the vCPU feature of `this` thread
The kernel-user memory starting at `vcpu_state` must be at least 128-byte aligned and must cover the size of l4_vcpu_state_t.
The asynchronous IPC handling is described at vCPU API.

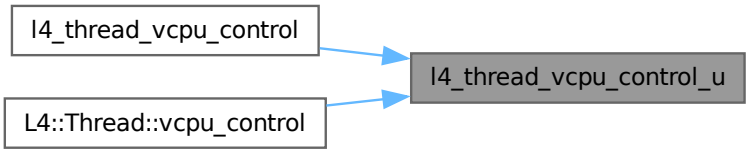
Note

Disabling of the vCPU feature is optional and currently not supported.

Definition at line 1188 of file thread.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_THREAD, L4_THREAD_VCPU_CONTROL_OP and l4_msg_regs_t::mr.
Referenced by l4_thread_vcpu_control(), and L4::Thread::vcpu_control().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.14.3.22 l4_thread_vcpu_resume_commit()

```
l4_msgtag_t l4_thread_vcpu_resume_commit (
             l4_cap_idx_t thread,
             l4_msgtag_t tag)  [inline]
```

Commit vCPU resume.

Parameters

thread	Thread to be resumed, the invalid cap can be used for the current thread.
tag	Tag to use, returned by l4_thread_vcpu_resume_start()

Returns

Syscall return tag containing one of the following return codes.

Return values

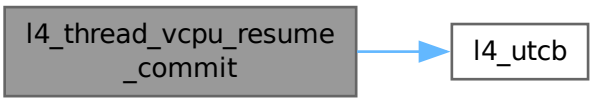
0	Indicates a VM exit, provided that `thread` is in extended vCPU mode with virtual interrupts cleared.
1	Indicates an incoming IPC message, provided that the `thread` is in extended vCPU mode with virtual interrupts cleared.
-L4_EPERM	The user task capability set in the vCPU state is missing the L4_CAP_FPAGE_S right. On Intel's VT-x (VMX): The vCPU context capability set in the extended vCPU state is missing the L4_CAP_FPAGE_S right.
-L4_ENOENT	The user task capability set in the vCPU state is invalid.
-L4_EINVAL	`thread` is not the current running thread, or does not have the vCPU feature enabled. On Intel's VT-x (VMX): No vCPU context associated with the extended vCPU state.
-L4_EBUSY	On Intel's VT-x (VMX): The vCPU context associated with the extended vCPU state is already active on a different CPU.
-L4_ENODEV	On Intel's VT-x (VMX): The vCPU context associated with the extended vCPU state cannot be initialized or activated.
<0	A supplied mapping failed.

All flexpages in the UTCB (added with l4_sndfpage_add() after l4_thread_vcpu_resume_start()) are unconditionally mapped into the user task configured in the vCPU state.
To resume into another address space, the capability to the target Task (or L4::Vm) must be set in l4_vcpu_state_t::user_task together with L4_VCPU_F_USER_MODE. The capability selector must have all lower bits clear (see L4_CAP_MASK). The kernel adds the L4_SYSF_SEND flag there to indicate that the capability has been referenced in the kernel. Consecutive resumes will not reference the task capability again until all lower bits are cleared again. To release a task use a different task capability or use an invalid capability with the L4_SYSF_REPLY flag set.

See also

l4_vcpu_state_t

Definition at line 1161 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.23 l4_thread_vcpu_resume_start()

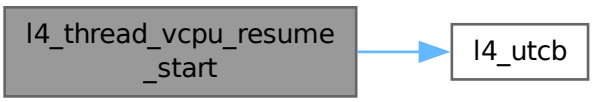
```
l4_msgtag_t l4_thread_vcpu_resume_start (
            void )  [inline]
```

vCPU return from event handler.

Returns

Message tag to be used for l4_sndfpage_add() and l4_thread_vcpu_resume_commit()

The vCPU resume functionality is split in multiple functions to allow the specification of additional send-flexpages using l4_sndfpage_add().
Definition at line 1155 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.3.24 l4_thread_yield()

```
l4_msgtag_t l4_thread_yield (
            void )  [inline]
```

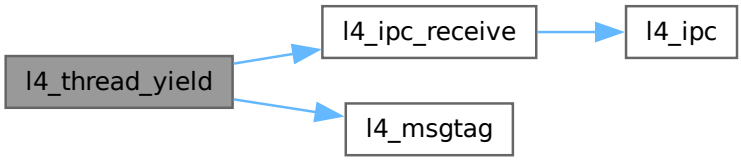
Yield current time slice.

Returns

system call return tag

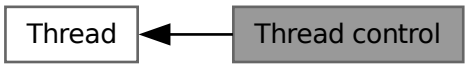
Definition at line 1035 of file thread.h.
References L4_INVALID_CAP, L4_IPC_BOTH_TIMEOUT_0, l4_ipc_receive(), l4_msgtag(), and L4_NOTHROW.

Here is the call graph for this function:



13.1.10.14.4 Thread control

API for Thread Control method.
Collaboration diagram for Thread control:



Functions

- void l4_thread_control_start (void) L4_NOTHROW

  Start a thread control API sequence.
- void l4_thread_control_pager (l4_cap_idx_t pager) L4_NOTHROW

  Set the pager.
- void l4_thread_control_exc_handler (l4_cap_idx_t exc_handler) L4_NOTHROW

  Set the exception handler.
- void l4_thread_control_bind (l4_utcb_t *thread_utcb, l4_cap_idx_t task) L4_NOTHROW

  Bind the thread to a task.
- void l4_thread_control_alien (int on) L4_NOTHROW

  Enable alien mode.
- l4_msgtag_t l4_thread_control_commit (l4_cap_idx_t thread) L4_NOTHROW

  Commit the thread control parameters.

13.1.10.14.4.1 Detailed Description

API for Thread Control method.
The thread control API provides access to almost any parameter of a thread object. The API is based on a single invocation of the thread object. However, because of the huge amount of parameters, the API provides a set of functions to set specific parameters of a thread and a commit function to commit the thread control call (see l4_thread_control_commit()).
A thread control operation must always start with l4_thread_control_start() and be committed with l4_thread_control_commit(). All other thread control parameter setter functions must be called between these two functions.
An example for a sequence of thread control API calls can be found below.
l4_thread_control_start();
l4_thread_control_pager(pager_cap);

l4_thread_control_bind (thread_utcb, task);
l4_thread_control_commit(thread_cap);

13.1.10.14.4.2 Function Documentation

l4_thread_control_alien()

```
void l4_thread_control_alien (
             int on)  [inline]
```

Enable alien mode.

Parameters

on	Boolean value defining the state of the feature.

For a thread in alien mode the kernel produces just an exception IPC for each IPC and exception caused by the alien thread instead of handling these events regularly. (Page faults of alien threads and interrupts occurring while the alien thread is running are always handled regularly.) While the alien thread is blocking, the exception handler can inspect and modify the state of the alien thread and potentially also the system call arguments. If the exception handler replies with L4_PROTO_ALLOW_SYSCALL as message tag, the kernel handles the next IPC or exception of the alien thread in a regular way. If the exception handler leaves certain thread state unchanged (in particular the instruction pointer), this will be the IPC or exception that caused the call of the exception handler. For a regularly processed IPC or exception of the alien thread the kernel also performs an exception IPC on kernel exit.
This feature can be used to attach a debugger to a thread and trace all object invocations and their results. It could also be used to handle other systems that use the same syscall instruction as L4Re.

Examples

examples/sys/aliens/main.c, and examples/sys/singlestep/main.c.

Definition at line 1125 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



l4_thread_control_bind()

```
void l4_thread_control_bind (
             l4_utcb_t * thread_utcb,
             l4_cap_idx_t task)  [inline]
```

Bind the thread to a task.

Parameters

thread_utcb	The thread's UTCB address within the task it shall be bound to. The address must be aligned (architecture dependent; at least word aligned) and it must point to at least L4_UTCB_OFFSET bytes of kernel-user memory.

task	The task the thread shall be bound to.

Precondition

The thread must not be bound to a task yet.

The capability `task` must have the permission L4_CAP_FPAGE_S, otherwise the later call to l4_thread_control_commit() will fail with L4_EPERM.

A thread may execute code in the context of a task if and only if the thread is bound to the task. To actually start execution, l4_thread_ex_regs() needs to be used. Execution in the context of the task means that the code has access to all the task's resources (and only those). The executed code itself must be one of those resources. A thread can be bound at most once to a task.

Note

The UTCBs of different threads in the same task should not overlap in order to prevent data corruption.

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 1119 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



l4_thread_control_commit()

```
l4_msgtag_t l4_thread_control_commit (
             l4_cap_idx_t thread)  [inline]
```

Commit the thread control parameters.

Parameters

thread	Capability selector of target thread to commit to.

Returns

Syscall return tag containing one of the following return codes.

Return values

L4_EOK	Operation successful.
-L4_EPERM	Insufficient permissions; see precondition.

-L4_EINVAL	Malformed thread control parameters.

Precondition

The capability `thread` must have the permission L4_CAP_FPAGE_S. When using l4_thread_control_bind(), also the respective task capability must have the permission L4_CAP_FPAGE_S.

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 1131 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



l4_thread_control_exc_handler()

```
void l4_thread_control_exc_handler (
             l4_cap_idx_t exc_handler)  [inline]
```

Set the exception handler.

Parameters

exc_handler	Capability index invoked to send an exception IPC.

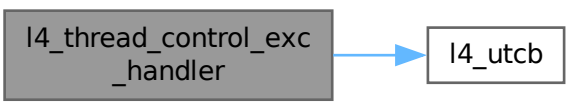
Note

The exception-handler capability index is interpreted in the task the thread is bound to (executes in).

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 1112 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



l4_thread_control_pager()

```
void l4_thread_control_pager (
             l4_cap_idx_t pager)  [inline]
```

Set the pager.

Parameters

pager	Capability index invoked to send a page-fault IPC.

Note

The pager capability index is interpreted in the task the thread is bound to (executes in).

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 1106 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



l4_thread_control_start()

```
void l4_thread_control_start (
             void )  [inline]
```

Start a thread control API sequence.
This function starts a sequence of thread control API functions. After this functions any of following functions may be called in any order.

- l4_thread_control_pager()
- l4_thread_control_exc_handler()
- l4_thread_control_bind()
- l4_thread_control_alien()

To commit the changes to the thread l4_thread_control_commit() must be called in the end.

Note

The thread control API calls store the parameters for the thread in the UTCB of the caller (see l4_utcb()), this means between l4_thread_control_start() and l4_thread_control_commit() no functions that modify the UTCB contents must be called.

Examples

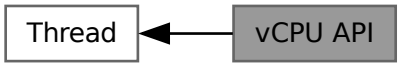
examples/sys/aliens/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 1100 of file thread.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.14.5 vCPU API

vCPU API.
Collaboration diagram for vCPU API:



Data Structures

- struct l4_vcpu_state_t
  State of a vCPU.
- struct l4_vcpu_regs_t
  vCPU registers.
- struct l4_vcpu_ipc_regs_t
  vCPU message registers.

Typedefs

- typedef struct l4_vcpu_state_t **l4_vcpu_state_t**
  State of a vCPU.
- typedef struct l4_vcpu_regs_t **l4_vcpu_regs_t**
  vCPU registers.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**
  vCPU message registers.
- typedef l4_exc_regs_t **l4_vcpu_regs_t**
  vCPU registers.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**
  vCPU message registers.
- typedef struct l4_vcpu_regs_t **l4_vcpu_regs_t**
  vCPU registers.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**
  vCPU message registers.
- typedef struct l4_vcpu_regs_t **l4_vcpu_regs_t**

vCPU registers.

- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**

  vCPU message registers.

- typedef l4_exc_regs_t **l4_vcpu_regs_t**

  vCPU registers.

- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**

  vCPU message registers.

Enumerations

- enum L4_vcpu_state_flags {
  L4_VCPU_F_IRQ = 0x01 , L4_VCPU_F_PAGE_FAULTS = 0x02 , L4_VCPU_F_EXCEPTIONS = 0x04 ,
  L4_VCPU_F_USER_MODE = 0x20 ,
  L4_VCPU_F_FPU_ENABLED = 0x80 }

  State flags of a vCPU.

- enum L4_vcpu_sticky_flags { L4_VCPU_SF_IRQ_PENDING = 0x01 }

  Sticky flags of a vCPU.

- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x180 , L4_VCPU_OFFSET_EXT_INFOS = 0x100 }

  Offsets for vCPU state layouts.

- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x280 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.

- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x400 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.

- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x400 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.

- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x400 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.

13.1.10.14.5.1 Detailed Description

vCPU API.
The vCPU API in L4Re implements virtual processors (vCPUs) on top of L4::Thread. This API can be used for user level threading, operating system rehosting (see L4Linux) and virtualization.
You switch a thread into `vCPU` operation with L4::Thread::vcpu_control.
In vCPU mode, incoming IPC can be redirected to a handler function. If an IPC is sent to the vCPU, the thread's normal execution is interrupted and the handler called. Which kind of IPC is redirected is specified by the L4_vcpu_state_flags set in the l4_vcpu_state_t::state field of `vcpu_state`. All events enabled in the `vcpu_state` field are redirected to the handler. The handler is set via l4_vcpu_state_t::entry_ip and l4_vcpu_state_t::entry_sp. IPC redirection works independent of "kernel" and "user" mode, but see l4_vcpu_state_t::entry_sp. When the entry handler is called, the UTCB contains the result of the IPC and content normally found in CPU registers is in l4_vcpu_state_t::i.
Furthermore, the thread can execute in the context of different tasks, called the "kernel" and the "user" mode. The kernel task is the one to which the thread was originally bound via L4::Thread::control(). Execution starts in the kernel task and it is always switched to when the asynchronous IPC handler is invoked. When returning from the handler via l4_thread_vcpu_resume_start() and l4_thread_vcpu_resume_commit(), a different user task can be specified by setting l4_vcpu_state_t::user_task and enabling the L4_VCPU_F_USER_MODE flag in l4_vcpu_state_t::state. Note that the kernel may cache the user task internally, see l4_thread_vcpu_resume_commit().
If the L4_VCPU_F_USER_MODE flag is enabled, the following flags will be automatically enabled in l4_vcpu_state_t::state on L4::Thread::vcpu_resume_commit():

- L4_VCPU_F_IRQ

- L4_VCPU_F_PAGE_FAULTS
- L4_VCPU_F_EXCEPTIONS

When the kernel mode is entered, the following flags will be automatically disabled in l4_vcpu_state_t::state:

- L4_VCPU_F_IRQ
- L4_VCPU_F_PAGE_FAULTS
- L4_VCPU_F_USER_MODE

Extended vCPU operation is used for hardware CPU virtualization. It can be enabled with L4::Thread::vcpu_control_ext(). vCPU Support Library defines a convenience API for working with vCPUs.

See also

vCPU Support Library

13.1.10.14.5.2 Enumeration Type Documentation

L4_vcpu_state_flags

`enum L4_vcpu_state_flags`
State flags of a vCPU.

Enumerator

L4_VCPU_F_IRQ	Receiving of IRQs and IPC enabled. While this flag is not set, the corresponding vCPU thread will not receive any IPC and threads attempting to send an IPC to this thread will block (according to the selected send timeout). **Note** On L4::Thread::vcpu_resume_commit() this flag is automatically enabled in l4_vcpu_state_t::state if L4_VCPU_F_USER_MODE is enabled. When the kernel mode is entered, this flag is automatically disabled in l4_vcpu_state_t::state.
L4_VCPU_F_PAGE_FAULTS	Page faults enabled. If this flag is set, a page fault switches to kernel mode (potentially causing a VM exit) and calls the entry handler. If this flag is not set, a page fault generates a page fault IPC to the pager of the vCPU thread. **Note** IPC redirection for page faults controlled by this flag works independent of "kernel" and "user" mode. On L4::Thread::vcpu_resume_commit() this flag is automatically enabled in l4_vcpu_state_t::state if L4_VCPU_F_USER_MODE is enabled. When the kernel mode is entered, this flag is automatically disabled in l4_vcpu_state_t::state.

L4_VCPU_F_EXCEPTIONS	Exceptions enabled. If this flag is set, then, on the event of an exception, the vCPU switches to kernel mode (potentially causing a VM exit) and calls the entry handler. If this flag is not set, an exception generates an exception IPC to the exception handler of the vCPU thread. **Note** IPC redirection for exceptions controlled by this flag works independent of "kernel" and "user" mode. On L4::Thread::vcpu_resume_commit() this flag is automatically enabled in l4_vcpu_state_t::state if L4_VCPU_F_USER_MODE is enabled.
L4_VCPU_F_USER_MODE	User task will be used. If set, the vCPU switches to user mode on next L4::Thread::vcpu_resume_commit(). If clear, the vCPU stays in "kernel" mode. **Note** When the kernel mode is entered, this flag is automatically disabled in l4_vcpu_state_t::state.
L4_VCPU_F_FPU_ENABLED	FPU enabled. This flag is only relevant if L4_VCPU_F_USER_MODE is set. Setting this flag allows code in vCPU mode to use the FPU. If this flag is not set, any FPU operation will trigger a corresponding exception (FPU fault).

Definition at line 101 of file vcpu.h.

L4_vcpu_state_offset [1/5]

enum L4_vcpu_state_offset
Offsets for vCPU state layouts.

Enumerator

L4_VCPU_OFFSET_EXT_STATE	Offset where extended state begins.
L4_VCPU_OFFSET_EXT_INFOS	Offset where extended infos begin.

Definition at line 34 of file __vcpu-arch.h.

L4_vcpu_state_offset [2/5]

enum L4_vcpu_state_offset
Offsets for vCPU state layouts.

Enumerator

L4_VCPU_OFFSET_EXT_STATE	Offset where extended state begins.
L4_VCPU_OFFSET_EXT_INFOS	Offset where extended infos begin.

Definition at line 35 of file __vcpu-arch.h.

L4_vcpu_state_offset [3/5]

enum L4_vcpu_state_offset
Offsets for vCPU state layouts.

Enumerator

L4_VCPU_OFFSET_EXT_STATE	Offset where extended state begins.
L4_VCPU_OFFSET_EXT_INFOS	Offset where extended infos begin.

Definition at line 36 of file __vcpu-arch.h.

L4_vcpu_state_offset [4/5]

enum L4_vcpu_state_offset
Offsets for vCPU state layouts.

Enumerator

L4_VCPU_OFFSET_EXT_STATE	Offset where extended state begins.
L4_VCPU_OFFSET_EXT_INFOS	Offset where extended infos begin.

Definition at line 34 of file __vcpu-arch.h.

L4_vcpu_state_offset [5/5]

enum L4_vcpu_state_offset
Offsets for vCPU state layouts.

Enumerator

L4_VCPU_OFFSET_EXT_STATE	Offset where extended state begins.
L4_VCPU_OFFSET_EXT_INFOS	Offset where extended infos begin.

Definition at line 34 of file __vcpu-arch.h.

L4_vcpu_sticky_flags

enum L4_vcpu_sticky_flags
Sticky flags of a vCPU.

Enumerator

L4_VCPU_SF_IRQ_PENDING	An event is pending: Either an IRQ or another thread attempts to send an IPC to this vCPU thread.

Definition at line 167 of file vcpu.h.

13.1.10.15 Thread groups

C thread group interface, see L4::Thread_group for the C++ interface.

Collaboration diagram for Thread groups:



Enumerations

- enum L4_thread_group_ops { L4_THREAD_GROUP_ADD_OP = 2UL , L4_THREAD_GROUP_REMOVE_OP = 3UL }

  Operations on the Thread_group object.
- enum L4_thread_group_policy { L4_THREAD_GROUP_POLICY_STRICT_CORE_LOCAL = 0 , L4_THREAD_GROUP_POLIC = 1 }

  Thread group policy.

Functions

- l4_msgtag_t l4_thread_group_add (l4_cap_idx_t tg, l4_cap_idx_t thread) L4_NOTHROW

  Add thread to a thread group.
- l4_msgtag_t l4_thread_group_remove (l4_cap_idx_t tg, l4_cap_idx_t thread) L4_NOTHROW

  Remove thread from a thread group.

13.1.10.15.1 Detailed Description

C thread group interface, see L4::Thread_group for the C++ interface.
An L4 thread group is a collection of threads used as indirection for IPC gate and IRQ objects such that these objects can have multiple receivers, from which the kernel selects one according to a policy.
The primary use case for thread groups are multi-threaded servers and CPU core local IRQ / IPC delivery.
A thread can be bound to at most one thread group. Before binding a thread to a thread group, the thread must be bound to a task. All threads bound to the same thread group must belong to the same task.

13.1.10.15.2 Enumeration Type Documentation

13.1.10.15.2.1 L4_thread_group_ops

`enum L4_thread_group_ops`
Operations on the Thread_group object.

Enumerator

L4_THREAD_GROUP_ADD_OP	Add thread to thread group.
L4_THREAD_GROUP_REMOVE_OP	Remove thread from thread group.

Definition at line 40 of file thread_group.h.

13.1.10.15.2.2 L4_thread_group_policy

`enum L4_thread_group_policy`
Thread group policy.
Define how to select a suitable thread from the thread group.

Enumerator

L4_THREAD_GROUP_POLICY_STRICT_CORE_LOCAL	Use a thread on the same CPU core. Fail if no such thread is available.
L4_THREAD_GROUP_POLICY_SOFT_CORE_LOCAL	Prefer a thread on the same CPU core. Fall-back to another thread of the group if no such thread is available.

Definition at line 52 of file thread_group.h.

13.1.10.15.3 Function Documentation

13.1.10.15.3.1 l4_thread_group_add()

```
l4_msgtag_t l4_thread_group_add (
             l4_cap_idx_t tg,
             l4_cap_idx_t thread)  [inline]
```

Add thread to a thread group.

Parameters

tg	Thread group object.
thread	Thread to add to the thread group.

Definition at line 135 of file thread_group.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.15.3.2 l4_thread_group_remove()

```
l4_msgtag_t l4_thread_group_remove (
             l4_cap_idx_t tg,
             l4_cap_idx_t thread)  [inline]
```

Remove thread from a thread group.

Parameters

tg	Thread group object.
thread	Thread to remove from the thread group.

Definition at line 142 of file thread_group.h.
References L4_NOTHROW, and l4_utcb().

Here is the call graph for this function:



13.1.10.16 Virtual Console

C Virtual console interface for simple character based input and output, see L4::Vcon for the C++ interface.
Collaboration diagram for Virtual Console:



Data Structures

- struct l4_vcon_attr_t

  Vcon attribute structure.

Typedefs

- typedef struct l4_vcon_attr_t l4_vcon_attr_t

  Vcon attribute structure.

Enumerations

- enum L4_vcon_size_consts { L4_VCON_WRITE_SIZE = (L4_UTCB_GENERIC_DATA_SIZE - 2) * sizeof(l4_umword_t) , L4_VCON_READ_SIZE = (L4_UTCB_GENERIC_DATA_SIZE - 1) * sizeof(l4_↩ umword_t) }

  Size constants.
- enum L4_vcon_i_flags { L4_VCON_INLCR = 000100 , L4_VCON_IGNCR = 000200 , L4_VCON_ICRNL = 000400 }

  Input flags.
- enum L4_vcon_o_flags { L4_VCON_ONLCR = 000004 , L4_VCON_OCRNL = 000010 , L4_VCON_ONLRET = 000040 }

  Output flags.
- enum L4_vcon_l_flags { L4_VCON_ICANON = 000002 , L4_VCON_ECHO = 000010 }

  Local flags.

Functions

- l4_msgtag_t l4_vcon_send (l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW

  Send data to virtual console.

- l4_msgtag_t l4_vcon_send_u (l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW

  Send data to `this` virtual console.
- long l4_vcon_write (l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW

  Write data to virtual console.
- long l4_vcon_write_u (l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW

  Write data to `this` virtual console.
- int l4_vcon_read (l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW

  Read data from virtual console.
- int l4_vcon_read_u (l4_cap_idx_t vcon, char *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW

  Read data from `this` virtual console.
- int l4_vcon_read_with_flags (l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW

  Read data from virtual console, extended version including flags.
- l4_msgtag_t l4_vcon_set_attr (l4_cap_idx_t vcon, l4_vcon_attr_t const *attr) L4_NOTHROW

  Set attributes of a Vcon.
- l4_msgtag_t l4_vcon_set_attr_u (l4_cap_idx_t vcon, l4_vcon_attr_t const *attr, l4_utcb_t *utcb) L4_NOTHROW

  Set the attributes of `this` virtual console.
- l4_msgtag_t l4_vcon_get_attr (l4_cap_idx_t vcon, l4_vcon_attr_t *attr) L4_NOTHROW

  Get attributes of a Vcon.
- l4_msgtag_t l4_vcon_get_attr_u (l4_cap_idx_t vcon, l4_vcon_attr_t *attr, l4_utcb_t *utcb) L4_NOTHROW

  Get attributes of `this` virtual console.
- void l4_vcon_set_attr_raw (l4_vcon_attr_t *attr) L4_NOTHROW

  Set terminal attributes to disable all special processing.

13.1.10.16.1 Detailed Description

C Virtual console interface for simple character based input and output, see L4::Vcon for the C++ interface.
The interrupt for read events is provided by the virtual key interrupt which, in contrast to hardware IRQs, implements a limited functionality:

- Only IRQ line 0 is supported, no MSI vectors.
- The IRQ is edge-triggered and the IRQ mode cannot be changed.
- As the IRQ is edge-triggered, it does not have to be explicitly unmasked.

A server implementing the virtual console protocol has a queue for input events. When the first input event is added to the empty queue, the virtual key interrupt is triggered. Further events are added to the queue without generating further interrupts. The queue is emptied when a client reads all queued input events.

Include File

```
#include <l4/sys/vcon.h>
```

See L4::Vcon for the C++ interface.

13.1.10.16.2 Typedef Documentation

13.1.10.16.2.1 l4_vcon_attr_t

`typedef struct l4_vcon_attr_t l4_vcon_attr_t`

Vcon attribute structure.
The flags members can be a combination of their respective enums.

See also

L4_vcon_i_flags
L4_vcon_o_flags
L4_vcon_l_flags

13.1.10.16.3 Enumeration Type Documentation

13.1.10.16.3.1 L4_vcon_i_flags

`enum L4_vcon_i_flags`
Input flags.

Enumerator

L4_VCON_INLCR	Translate NL to CR.
L4_VCON_IGNCR	Ignore CR.
L4_VCON_ICRNL	Translate CR to NL if L4_VCON_IGNCR is not set.

Definition at line 208 of file vcon.h.

13.1.10.16.3.2 L4_vcon_l_flags

`enum L4_vcon_l_flags`
Local flags.

Enumerator

L4_VCON_ICANON	Canonical mode.
L4_VCON_ECHO	Echo input.

Definition at line 230 of file vcon.h.

13.1.10.16.3.3 L4_vcon_o_flags

`enum L4_vcon_o_flags`
Output flags.

Enumerator

L4_VCON_ONLCR	Translate NL to CR-NL.
L4_VCON_OCRNL	Translate CR to NL.
L4_VCON_ONLRET	Do not output CR.

Definition at line 219 of file vcon.h.

13.1.10.16.3.4 L4_vcon_size_consts

`enum L4_vcon_size_consts`
Size constants.

Enumerator

L4_VCON_WRITE_SIZE	Maximum size that can be written with one l4_vcon_write call.
L4_VCON_READ_SIZE	Maximum size that can be read with one l4_vcon_read* call.

Definition at line 95 of file vcon.h.

13.1.10.16.4 Function Documentation

13.1.10.16.4.1 l4_vcon_get_attr()

```
l4_msgtag_t l4_vcon_get_attr (
             l4_cap_idx_t vcon,
             l4_vcon_attr_t * attr)  [inline]
```

Get attributes of a Vcon.

Parameters

	vcon	Vcon object.
out	*attr*	Attribute structure.

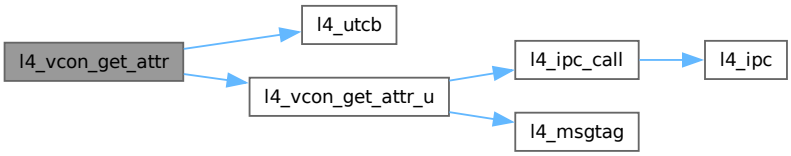
Returns

Syscall return tag

Examples

examples/sys/isr/main.c.

Definition at line 435 of file vcon.h.
References L4_NOTHROW, l4_utcb(), and l4_vcon_get_attr_u().
Here is the call graph for this function:



13.1.10.16.4.2 l4_vcon_get_attr_u()

```
l4_msgtag_t l4_vcon_get_attr_u (
             l4_cap_idx_t vcon,
             l4_vcon_attr_t * attr,
             l4_utcb_t * utcb)  [inline]
```

Get attributes of `this` virtual console.

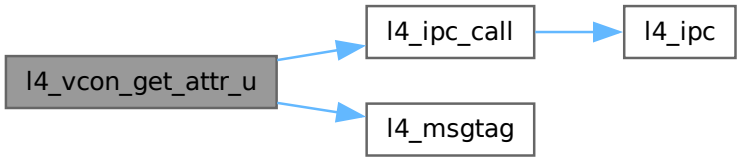
Parameters

	vcon	Capability index of the vcon object.
out	*attr*	Attribute structure. Contains the attributes after a successful call of this function.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

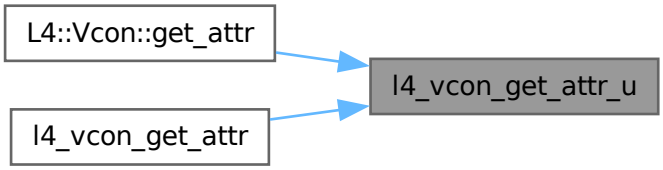
Returns

Syscall return tag.

Definition at line 417 of file vcon.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_LOG, L4_VCON_GET_ATTR_OP, and l4_msg_regs_t::mr.
Referenced by L4::Vcon::get_attr(), and l4_vcon_get_attr().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.16.4.3 l4_vcon_read()

```
int l4_vcon_read (
              l4_cap_idx_t vcon,
              char * buf,
              unsigned size)  [inline]
```

Read data from virtual console.

Parameters

	vcon	Vcon object.
out	*buf*	Pointer to data buffer.
	size	Size of buffer in bytes.

Return values

-L4_EPERM	Insufficient permissions; see precondition.
>size	More bytes to read, `size` bytes are in the buffer `buf`.
<=size	Number of bytes read.

Precondition

The capability `vcon` must have the permission L4_CAP_FPAGE_W.

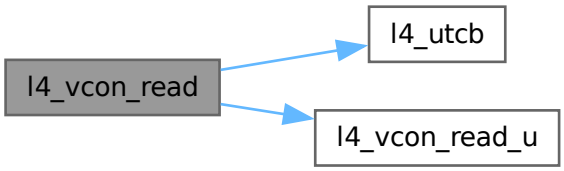
Note

Size must not exceed L4_VCON_READ_SIZE.

Examples

examples/sys/isr/main.c.

Definition at line 391 of file vcon.h.
References L4_NOTHROW, l4_utcb(), and l4_vcon_read_u().
Here is the call graph for this function:



13.1.10.16.4.4 l4_vcon_read_u()

```
int l4_vcon_read_u (
            l4_cap_idx_t vcon,
            char * buf,
            unsigned size,
            l4_utcb_t * utcb)  [inline]
```

Read data from `this` virtual console.

Parameters

	vcon	Capability index of the vcon object.
`out`	*buf*	Pointer to data buffer.
	size	Size of the data buffer in bytes.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

-L4_EPERM	Insufficient permissions; see precondition.

>*size*	More bytes to read, `size` bytes are in the buffer `buf`.
<=*size*	Number of bytes read.

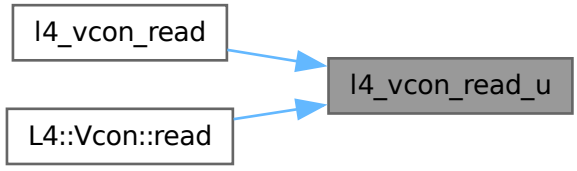
Precondition

The invoked Vcon capability must have the permission L4_CAP_FPAGE_W.

Note

Size must not exceed L4_VCON_READ_SIZE.

Definition at line 381 of file vcon.h.
References L4_NOTHROW, and L4_VCON_READ_SIZE_MASK.
Referenced by l4_vcon_read(), and L4::Vcon::read().
Here is the caller graph for this function:



13.1.10.16.4.5 l4_vcon_read_with_flags()

```
int l4_vcon_read_with_flags (
            l4_cap_idx_t vcon,
            char * buf,
            unsigned size)  [inline]
```

Read data from virtual console, extended version including flags.

Parameters

	vcon	Vcon object.
out	*buf*	Pointer to data buffer.
	size	Size of buffer in bytes.

If this function returns a positive value the caller can check the L4_VCON_READ_STAT_BREAK flag bit for a break condition. The bytes read can be obtained by masking the return value with L4_VCON_READ_SIZE_MASK.
If a break condition is signaled, it is always the first event in the transmitted content, i.e. all characters supplied by this read call follow the break condition.
`buf` might be a `NULL`, in this case the input data will be dropped.

Note

Size must not exceed L4_VCON_READ_SIZE.

Return values

-L4_EPERM	Insufficient permissions; see precondition.
>size	More bytes to read, `size` bytes are in the buffer `buf`.
<=size	Number of bytes read.

Precondition

The capability `vcon` must have the permission L4_CAP_FPAGE_W.

Definition at line 375 of file vcon.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



13.1.10.16.4.6 l4_vcon_send()

```
l4_msgtag_t l4_vcon_send (
             l4_cap_idx_t vcon,
             char const * buf,
             unsigned size)  [inline]
```

Send data to virtual console.

Parameters

vcon	Vcon object.
buf	Pointer to data buffer.
size	Size of buffer in bytes.

Returns

Syscall return tag

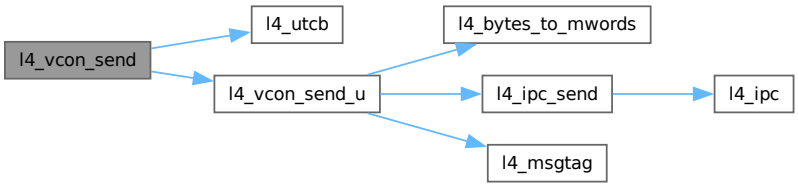
Note

Size must not exceed L4_VCON_WRITE_SIZE, a proper value of the `size` parameter is NOT checked. Also, this function is a send only operation, this means there is no return value except for a failed send operation. Use l4_ipc_error() to check for send errors, and **do not** use l4_error().

Examples

examples/sys/utcb-ipc/main.c.

Definition at line 315 of file vcon.h.
References L4_NOTHROW, l4_utcb(), and l4_vcon_send_u().
Here is the call graph for this function:



13.1.10.16.4.7 l4_vcon_send_u()

```
l4_msgtag_t l4_vcon_send_u (
            l4_cap_idx_t vcon,
            char const * buf,
            unsigned size,
            l4_utcb_t * utcb)  [inline]
```

Send data to `this` virtual console.

Parameters

vcon	Capability index of the Vcon object.
buf	Pointer to the data buffer.
size	Size of the data buffer in bytes.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

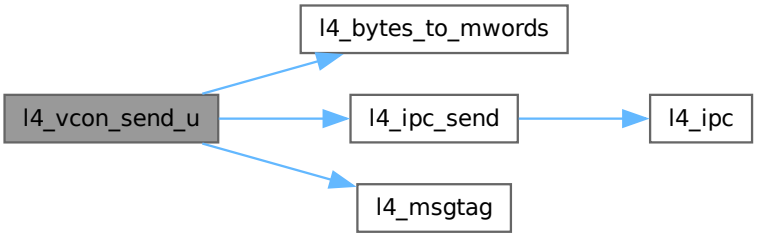
Returns

Syscall return tag

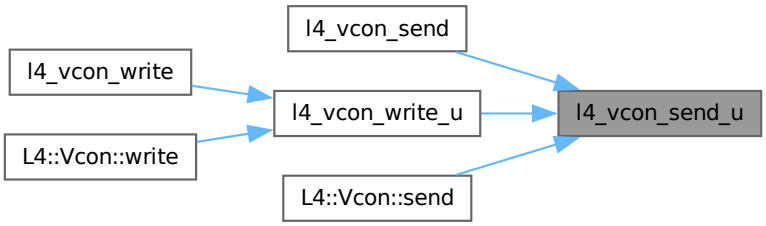
Note

Size must not exceed L4_VCON_WRITE_SIZE, a proper value of the `size` parameter is NOT checked. Also, this function is a send only operation, this means there is no return value except for a failed send operation. Use l4_ipc_error() to check for send errors, do not use l4_error(), as l4_error() will always return an error.

Definition at line 302 of file vcon.h.
References l4_bytes_to_mwords(), L4_IPC_NEVER, l4_ipc_send(), l4_msgtag(), L4_MSGTAG_SCHEDULE, L4_NOTHROW, L4_PROTO_LOG, L4_VCON_WRITE_OP, and l4_msg_regs_t::mr.
Referenced by l4_vcon_send(), l4_vcon_write_u(), and L4::Vcon::send().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.16.4.8 l4_vcon_set_attr()

```
l4_msgtag_t l4_vcon_set_attr (
            l4_cap_idx_t vcon,
            l4_vcon_attr_t const * attr)  [inline]
```

Set attributes of a Vcon.

Parameters

vcon	Vcon object.
attr	Attribute structure.

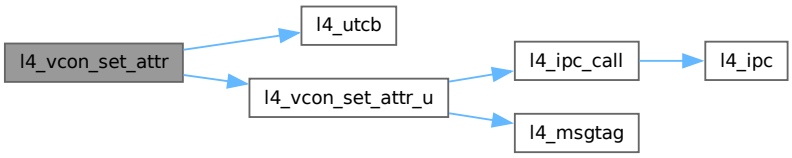
Returns

Syscall return tag

Examples

examples/sys/isr/main.c.

Definition at line 411 of file vcon.h.
References L4_NOTHROW, l4_utcb(), and l4_vcon_set_attr_u().
Here is the call graph for this function:



13.1.10.16.4.9 l4_vcon_set_attr_raw()

```
void l4_vcon_set_attr_raw (
            l4_vcon_attr_t * attr)  [inline]
```

Set terminal attributes to disable all special processing.
Removes all flags that would mangle the read or written characters. Also disables echoing and any special processing of characters.

Parameters

in,out	*attr*	Attribute structure to update.

Definition at line 441 of file vcon.h.
References L4_NOTHROW.
Referenced by l4_vcon_attr_t::set_raw().
Here is the caller graph for this function:



13.1.10.16.4.10 l4_vcon_set_attr_u()

```
l4_msgtag_t l4_vcon_set_attr_u (
            l4_cap_idx_t vcon,
            l4_vcon_attr_t const * attr,
            l4_utcb_t * utcb)  [inline]
```

Set the attributes of `this` virtual console.

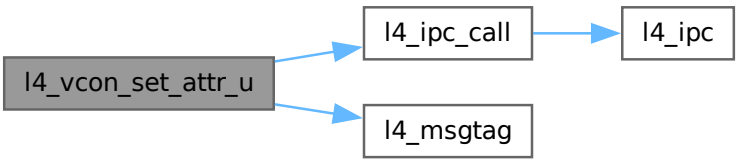
Parameters

vcon	Capability index of the vcon object.
attr	Attribute structure with the attributes for the virtual console.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

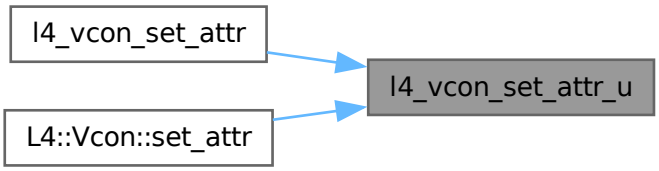
Returns

Syscall return tag.

Definition at line 397 of file vcon.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_LOG, L4_VCON_SET_ATTR_OP, and l4_msg_regs_t::mr.
Referenced by l4_vcon_set_attr(), and L4::Vcon::set_attr().
Here is the call graph for this function:



Here is the caller graph for this function:



13.1.10.16.4.11 l4_vcon_write()

```
long l4_vcon_write (
             l4_cap_idx_t vcon,
             char const * buf,
             unsigned size)  [inline]
```

Write data to virtual console.

Parameters

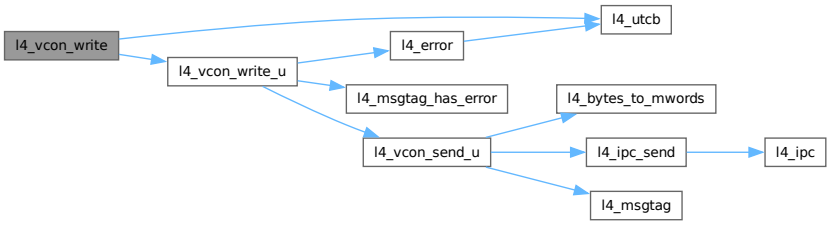
vcon	Vcon object.

buf	Pointer to data buffer.
size	Size of buffer in bytes.

Return values

<0	Error.
>=0	Number of bytes written to the virtual console

Definition at line 336 of file vcon.h.
References L4_NOTHROW, l4_utcb(), and l4_vcon_write_u().
Here is the call graph for this function:



13.1.10.16.4.12 l4_vcon_write_u()

```
long l4_vcon_write_u (
            l4_cap_idx_t vcon,
            char const * buf,
            unsigned size,
            l4_utcb_t * utcb)  [inline]
```

Write data to `this` virtual console.

Parameters

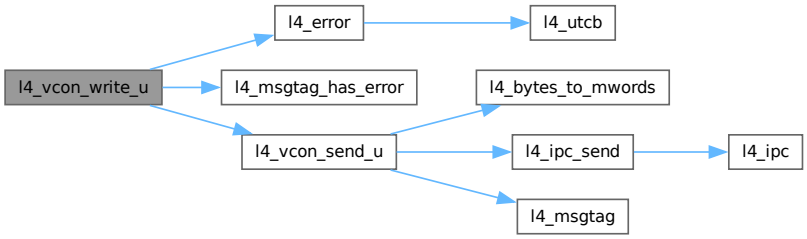
vcon	Capability index of the vcon object.
buf	Pointer to the data buffer.
size	Size of the data buffer in bytes.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

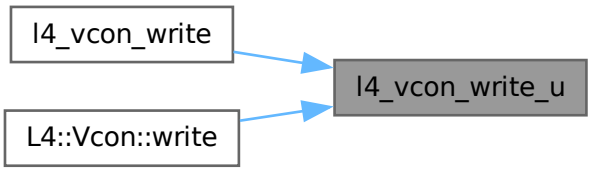
<0	Error.
>=0	Number of bytes written to the virtual console.

Definition at line 321 of file vcon.h.
References l4_error(), l4_msgtag_has_error(), L4_NOTHROW, l4_vcon_send_u(), and L4_VCON_WRITE_SIZE.
Referenced by l4_vcon_write(), and L4::Vcon::write().

Here is the call graph for this function:



Here is the caller graph for this function:



13.1.11 Kernel Interface Page

Kernel Interface Page.
Collaboration diagram for Kernel Interface Page:



Topics

- Memory descriptors (C version) 406
  C Interface for KIP memory descriptors.

Data Structures

- class L4::Kip::Mem_desc
  Memory descriptors stored in the kernel interface page.
- struct l4_kernel_info_t
  L4 Kernel Interface Page.

Macros

- #define **L4_KERNEL_INFO_MAGIC** (0x4BE6344CL) /* "L4µK" */

  Kernel Info Page identifier ("L4µK").

Typedefs

- typedef struct l4_kernel_info_t l4_kernel_info_t

  L4 Kernel Interface Page.

Enumerations

- enum { L4_KIP_OFFS_READ_US = 0x900 , L4_KIP_OFFS_READ_NS = 0x980 }

Functions

- l4_kernel_info_t const * l4_kip (void) L4_NOTHROW

  Get Kernel Info Page.
- l4_umword_t l4_kip_version (l4_kernel_info_t const *kip) L4_NOTHROW

  Get the kernel version.
- const char * l4_kip_version_string (l4_kernel_info_t const *kip) L4_NOTHROW

  Get the kernel version string.
- int l4_kernel_info_version_offset (l4_kernel_info_t const *kip) L4_NOTHROW

  Return offset in bytes of version_strings relative to the KIP base.
- l4_cpu_time_t l4_kip_clock (l4_kernel_info_t const *kip) L4_NOTHROW

  Return clock value from the KIP.
- l4_umword_t l4_kip_clock_lw (l4_kernel_info_t const *kip) L4_NOTHROW

  Return least significant machine word of clock value from the KIP.
- l4_uint64_t l4_kip_clock_ns (l4_kernel_info_t const *kip) L4_NOTHROW

  Return current clock using the KIP in nanoseconds.

13.1.11.1 Detailed Description

Kernel Interface Page.
C interface for the Kernel Interface Page:

C++ interface for the Kernel Interface Page:

Include File

```
#include <l4/sys/kip>
```

Include File

```
#include <l4/sys/kip.h>
```

13.1.11.2 Typedef Documentation

13.1.11.2.1 l4_kernel_info_t

```
typedef struct l4_kernel_info_t l4_kernel_info_t
```

L4 Kernel Interface Page.
32-bit architecture may assume that the upper 32 bits of addresses is 0

13.1.11.3 Enumeration Type Documentation

13.1.11.3.1 anonymous enum

```
anonymous enum
```

Enumerator

L4_KIP_OFFS_READ_US	Offset of KIP code (provided by the kernel) for reading the KIP clock in microseconds. If the kernel is configured for a fine-grained KIP clock (CONFIG_SYNC_↩ TSC enabled for IA32, ARM_SYNC_CLOCK for ARM), this code provides the KIP clock with microseconds granularity and accuracy by reading the hardware clock used by the kernel and transforming this value into microseconds. Otherwise this code just reads the KIP clock value.
L4_KIP_OFFS_READ_NS	Offset of KIP code (provided by the kernel) for reading the time stamp counter and transforming this value into nanoseconds. If the kernel is configured for fine-grained KIP clock (CONFIG_SYNC enabled for IA32, ARM_SYNC_CLOCK for ARM), this code provides the KIP clock with nanoseconds granularity and accuracy by reading the hardware clock used by the kernel and transforming this value into nanoseconds. Otherwise this code just reads the KIP clock value and multiplies it by 1000.

Definition at line 95 of file kip.h.

13.1.11.4 Function Documentation

13.1.11.4.1 l4_kernel_info_version_offset()

```
int l4_kernel_info_version_offset (
            l4_kernel_info_t const * kip)  [inline]
```

Return offset in bytes of version_strings relative to the KIP base.

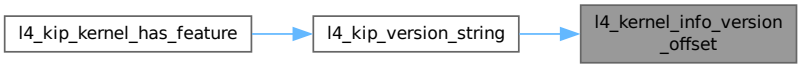
Parameters

kip	Pointer to the kernel info page (KIP).

Returns

offset of version_strings relative to the KIP base address, in bytes.

Definition at line 238 of file kip.h.
References L4_NOTHROW.
Referenced by l4_kip_version_string().
Here is the caller graph for this function:



13.1.11.4.2 l4_kip()

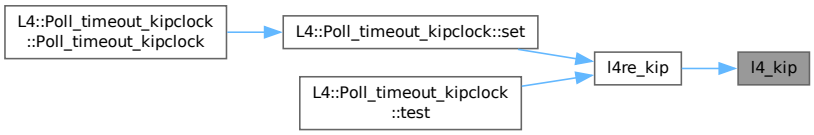
```
l4_kernel_info_t const * l4_kip (
            void )  [inline]
```

Get Kernel Info Page.

Returns

Pointer to Kernel Info Page (KIP) structure.

Definition at line 226 of file kip.h.
References L4_NOTHROW.
Referenced by l4re_kip().
Here is the caller graph for this function:



13.1.11.4.3 l4_kip_clock()

```
l4_cpu_time_t l4_kip_clock (
            l4_kernel_info_t const * kip)  [inline]
```

Return clock value from the KIP.

Parameters

kip	Pointer to the kernel info page (KIP).

Returns

Value of the clock field in the KIP.

The KIP clock always contains the current (relative) time in micro seconds independently of the CPU frequency. The clock is only guaranteed to be accurate within the scheduling granularity announced in the KIP.
This function basically calls the KIP code for reading the KIP clock with microseconds resolution. The accuracy depends on the platform and the kernel configuration.

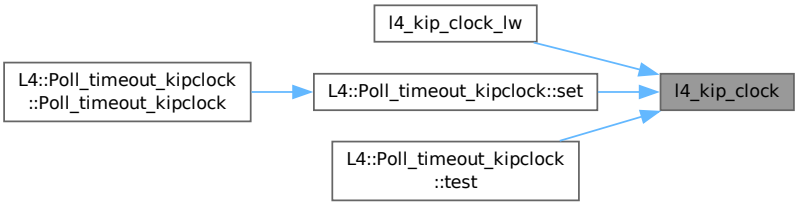
See also

L4_KIP_OFFS_READ_US.

Examples

examples/libs/shmc/prodcons.c.

Definition at line 242 of file kip.h.
References L4_KIP_OFFS_READ_US, and L4_NOTHROW.
Referenced by l4_kip_clock_lw(), L4::Poll_timeout_kipclock::set(), and L4::Poll_timeout_kipclock::test().
Here is the caller graph for this function:



13.1.11.4.4 l4_kip_clock_lw()

```
l4_umword_t l4_kip_clock_lw (
            l4_kernel_info_t const * kip)  [inline]
```

Return least significant machine word of clock value from the KIP.

Parameters

kip	Pointer to the kernel info page (KIP).

Returns

Lower machine word of clock value from the KIP.

Deprecated Use l4_kip_clock() instead.

This function will always provide the least significant machine word of the clock value from the KIP, regardless of the kernel configuration.
Definition at line 261 of file kip.h.
References l4_kip_clock(), and L4_NOTHROW.
Here is the call graph for this function:



13.1.11.4.5 l4_kip_clock_ns()

```
l4_cpu_time_t l4_kip_clock_ns (
            l4_kernel_info_t const * kip)  [inline]
```

Return current clock using the KIP in nanoseconds.

Parameters

kip	Pointer to the kernel info page (KIP).

Returns

Value of the current clock in nanoseconds.

This function basically calls the KIP code for reading the KIP clock with nanoseconds resolution. The accuracy depends on the platform and the kernel configuration.

See also

L4_KIP_OFFS_READ_NS.

Definition at line 252 of file kip.h.
References L4_KIP_OFFS_READ_NS, and L4_NOTHROW.

13.1.11.4.6 l4_kip_version()

```
l4_umword_t l4_kip_version (
            l4_kernel_info_t const * kip)  [inline]
```

Get the kernel version.

Parameters

kip	Kernel Info Page.

Returns

Kernel version.

Definition at line 230 of file kip.h.
References L4_NOTHROW.

13.1.11.4.7 l4_kip_version_string()

```
const char * l4_kip_version_string (
            l4_kernel_info_t const * kip)  [inline]
```

Get the kernel version string.

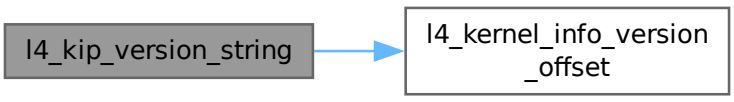
Parameters

kip	Kernel Info Page.

Returns

Kernel version string.

Definition at line 234 of file kip.h.
References l4_kernel_info_version_offset(), and L4_NOTHROW.
Referenced by l4_kip_kernel_has_feature().
Here is the call graph for this function:

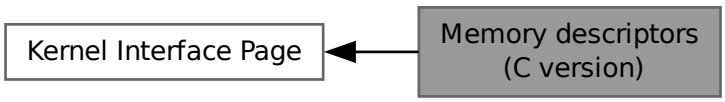


Here is the caller graph for this function:



13.1.11.5 Memory descriptors (C version)

C Interface for KIP memory descriptors.
Collaboration diagram for Memory descriptors (C version):



Data Structures

- struct l4_kernel_info_mem_desc_t

  Memory descriptor data structure.

Typedefs

- typedef struct l4_kernel_info_mem_desc_t l4_kernel_info_mem_desc_t

  Memory descriptor data structure.

Enumerations

- enum l4_mem_type_t {
  l4_mem_type_undefined = 0x0 , l4_mem_type_conventional = 0x1 , l4_mem_type_reserved = 0x2 , l4_mem_type_dedicated = 0x3 ,
  l4_mem_type_shared = 0x4 , l4_mem_type_kmem = 0x5 , l4_mem_type_info = 0xd , l4_mem_type_bootloader = 0xe ,
  l4_mem_type_archspecific = 0xf }

  Type of a memory descriptor.
- enum l4_mem_info_sub_type_t { l4_mem_info_acpi_rsdp = 0 , l4_mem_reserved_kernel = 0 , l4_mem_reserved_heap = 1 , l4_mem_reserved_mmio = 2 }

  Memory sub types for l4_mem_type_info descriptors.
- enum l4_mem_archspecific_sub_type_common_t { l4_mem_archspecific_acpi_tables = 3 , l4_mem_archspecific_acpi_nvs = 4 , l4_mem_archspecific_cpu_fw = 5 }

  Memory sub types for l4_mem_type_archspecific descriptors.

Functions

- l4_kernel_info_mem_desc_t * **l4_kernel_info_get_mem_descs** (l4_kernel_info_t *kip) L4_NOTHROW

  Get pointer to memory descriptors from KIP.
- unsigned l4_kernel_info_get_num_mem_descs (l4_kernel_info_t *kip) L4_NOTHROW

  Get number of memory descriptors in KIP.
- void l4_kernel_info_set_mem_desc (l4_kernel_info_mem_desc_t *md, l4_addr_t start, l4_addr_t end, unsigned type, unsigned virt, unsigned sub_type) L4_NOTHROW

  Populate a memory descriptor.
- l4_umword_t l4_kernel_info_get_mem_desc_start (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get start address of the region described by the memory descriptor.
- l4_umword_t l4_kernel_info_get_mem_desc_end (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get end address of the region described by the memory descriptor.
- l4_umword_t l4_kernel_info_get_mem_desc_type (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

Get type of the memory region.

- l4_umword_t l4_kernel_info_get_mem_desc_subtype (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get sub-type of memory region.

- l4_umword_t l4_kernel_info_get_mem_desc_is_virtual (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get virtual flag of the memory descriptor.

13.1.11.5.1 Detailed Description

C Interface for KIP memory descriptors.

Include File

```
#include <l4/sys/memdesc.h>
```

This module contains the C functions to access the memory descriptor in the kernel interface page (KIP).

13.1.11.5.2 Typedef Documentation

13.1.11.5.2.1 l4_kernel_info_mem_desc_t

`typedef struct l4_kernel_info_mem_desc_t l4_kernel_info_mem_desc_t`
Memory descriptor data structure.

Note

This data type is opaque, and must be accessed by the accessor functions defined in this module.

13.1.11.5.3 Enumeration Type Documentation

13.1.11.5.3.1 l4_mem_archspecific_sub_type_common_t

`enum l4_mem_archspecific_sub_type_common_t`
Memory sub types for l4_mem_type_archspecific descriptors.

Enumerator

l4_mem_archspecific_acpi_tables	Firmware ACPI tables.
l4_mem_archspecific_acpi_nvs	Firmware reserved address space.
l4_mem_archspecific_cpu_fw	CPU firmware.

Definition at line 66 of file memdesc.h.

13.1.11.5.3.2 l4_mem_info_sub_type_t

`enum l4_mem_info_sub_type_t`
Memory sub types for l4_mem_type_info descriptors.

Enumerator

l4_mem_info_acpi_rsdp	Physical address of the ACPI root pointer.
l4_mem_reserved_kernel	Kernel image.
l4_mem_reserved_heap	Kernel heap.
l4_mem_reserved_mmio	MMIO range reserved by kernel.

Definition at line 53 of file memdesc.h.

13.1.11.5.3.3 l4_mem_type_t

enum l4_mem_type_t
Type of a memory descriptor.

Enumerator

l4_mem_type_undefined	Undefined, unused descriptor.
l4_mem_type_conventional	Conventional memory.
l4_mem_type_reserved	Reserved memory for kernel etc.
l4_mem_type_dedicated	Dedicated memory (some device memory).
l4_mem_type_shared	Shared memory (not implemented).
l4_mem_type_kmem	Kernel memory.
l4_mem_type_info	Info from the boot loader.
l4_mem_type_bootloader	Memory owned by the boot loader.
l4_mem_type_archspecific	Architecture specific memory (e.g., ACPI memory).

Definition at line 33 of file memdesc.h.

13.1.11.5.4 Function Documentation

13.1.11.5.4.1 l4_kernel_info_get_mem_desc_end()

```
l4_umword_t l4_kernel_info_get_mem_desc_end (
            l4_kernel_info_mem_desc_t * md)  [inline]
```

Get end address of the region described by the memory descriptor.

Returns

End address.

Definition at line 223 of file memdesc.h.
References L4_NOTHROW.

13.1.11.5.4.2 l4_kernel_info_get_mem_desc_is_virtual()

```
l4_umword_t l4_kernel_info_get_mem_desc_is_virtual (
            l4_kernel_info_mem_desc_t * md)  [inline]
```

Get virtual flag of the memory descriptor.

Returns

1 if region is virtual memory, 0 if region is physical memory

Definition at line 244 of file memdesc.h.
References L4_NOTHROW.

13.1.11.5.4.3 l4_kernel_info_get_mem_desc_start()

```
l4_umword_t l4_kernel_info_get_mem_desc_start (
            l4_kernel_info_mem_desc_t * md)  [inline]
```

Get start address of the region described by the memory descriptor.

Returns

Start address.

Definition at line 216 of file memdesc.h.
References L4_NOTHROW.

13.1.11.5.4.4 l4_kernel_info_get_mem_desc_subtype()

```
l4_umword_t l4_kernel_info_get_mem_desc_subtype (
             l4_kernel_info_mem_desc_t * md)  [inline]
```

Get sub-type of memory region.

Returns

Sub-type.

The sub type is defined for architecture specific memory descriptors (see l4_mem_type_archspecific) and has architecture specific meaning.
Definition at line 237 of file memdesc.h.
References L4_NOTHROW.

13.1.11.5.4.5 l4_kernel_info_get_mem_desc_type()

```
l4_umword_t l4_kernel_info_get_mem_desc_type (
             l4_kernel_info_mem_desc_t * md)  [inline]
```

Get type of the memory region.

Returns

Type of the region (see l4_mem_type_t).

Definition at line 230 of file memdesc.h.
References L4_NOTHROW.

13.1.11.5.4.6 l4_kernel_info_get_num_mem_descs()

```
unsigned l4_kernel_info_get_num_mem_descs (
             l4_kernel_info_t * kip)  [inline]
```

Get number of memory descriptors in KIP.

Returns

Number of memory descriptors.

Definition at line 194 of file memdesc.h.
References L4_NOTHROW.

13.1.11.5.4.7 l4_kernel_info_set_mem_desc()

```
void l4_kernel_info_set_mem_desc (
             l4_kernel_info_mem_desc_t * md,
             l4_addr_t start,
             l4_addr_t end,
             unsigned type,
             unsigned virt,
             unsigned sub_type)  [inline]
```

Populate a memory descriptor.

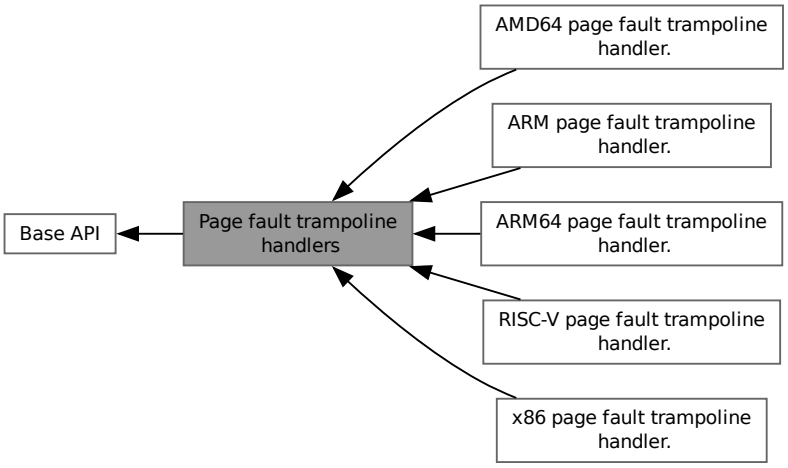
Parameters

md	Pointer to memory descriptor
start	Start of region
end	End of region
type	Type of region
virt	1 if virtual region, 0 if physical region
sub_type	Sub type.

Definition at line 201 of file memdesc.h.
References L4_NOTHROW.

13.1.12 Page fault trampoline handlers

A page fault trampoline handler is an alternative mechanism to handle page faults.
Collaboration diagram for Page fault trampoline handlers:



Topics

- ARM page fault trampoline handler. . . . 412
- ARM64 page fault trampoline handler. . . . 412
- AMD64 page fault trampoline handler. . . . 413
- x86 page fault trampoline handler. . . . 413
- RISC-V page fault trampoline handler. . . . 414

Data Structures

- struct l4_pf_trampoline_t

  State for page fault trampoline handler.

Typedefs

- typedef struct l4_pf_trampoline_regs_t **l4_pf_trampoline_regs_t**

  Opaque type for the page fault trampoline register state.
- typedef struct l4_pf_trampoline_t l4_pf_trampoline_t

  Opaque type for the page fault trampoline state.

Enumerations

- enum L4_pf_trampoline_flags { Page_fault_in_progress = 1 << 0 , Trigger_exception_after_resume = 1 << 1 }

  Definitions for l4_pf_trampoline_t::flags.

13.1.12.1 Detailed Description

A page fault trampoline handler is an alternative mechanism to handle page faults.
Instead of sending a page fault IPC to the pager of the faulting thread, a dedicated page fault handler is directly called by the kernel in the context of the faulting thread.
The handler has access to the instruction pointer and the page fault address. The l4_pf_trampoline_t state contains this information plus additional information saved by the kernel on entering the kernel page fault handler and restored before leaving the kernel page fault handler.

Include File

```
#include <l4/sys/pf_trampoline.h>
```

13.1.12.2 Typedef Documentation

13.1.12.2.1 l4_pf_trampoline_t

```
typedef struct l4_pf_trampoline_t l4_pf_trampoline_t
```

Opaque type for the page fault trampoline state.
State for page fault trampoline handler.
Definition at line 75 of file pf_trampoline.h.

13.1.12.3 Enumeration Type Documentation

13.1.12.3.1 L4_pf_trampoline_flags

```
enum L4_pf_trampoline_flags
```

Definitions for l4_pf_trampoline_t::flags.

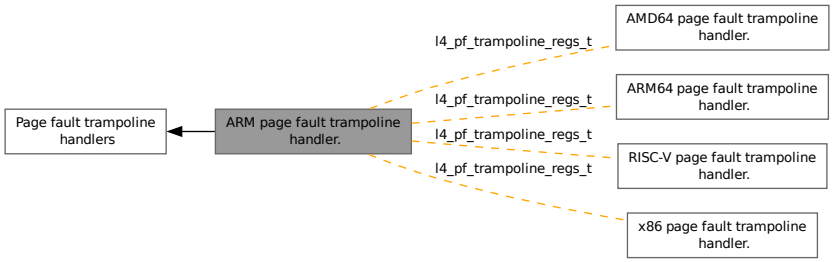
Enumerator

Page_fault_in_progress	The corresponding thread is currently handling a page fault using the trampoline handler. The thread must not be ex-regs'd during that time!
Trigger_exception_after_resume	Trigger an exception at the corresponding thread when the thread resumes execution after returning from a page fault trampoline handler. Used for deferred triggering of an artificial exception, for example, for signal handling↩ : If a thread resolving a page fault using a trampoline page fault handler is being ex_regs'd(L4_THREAD_EX_REGS_TRIGGER_EXCEPTION), the thread must not longjmp before the trampoline page fault handler resumed. Instead, the signal handler just sets Trigger_exception_after_resume and returns. Once the trampoline page fault handler resumes, the kernel resets this flags and triggers the artificial exception which is again handled by the signal handler.

Definition at line 40 of file pf_trampoline.h.

13.1.12.4 ARM page fault trampoline handler.

Collaboration diagram for ARM page fault trampoline handler.:



Data Structures

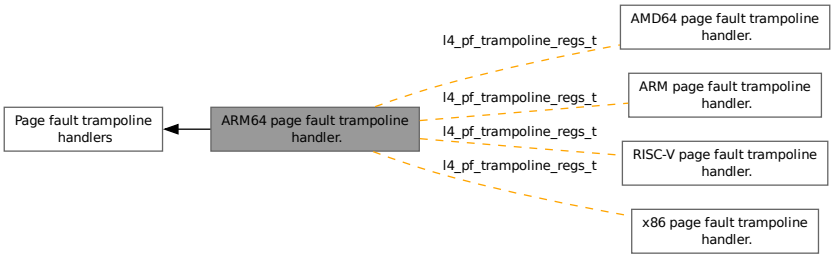
- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

13.1.12.4.1 Detailed Description

13.1.12.5 ARM64 page fault trampoline handler.

Collaboration diagram for ARM64 page fault trampoline handler.:



Data Structures

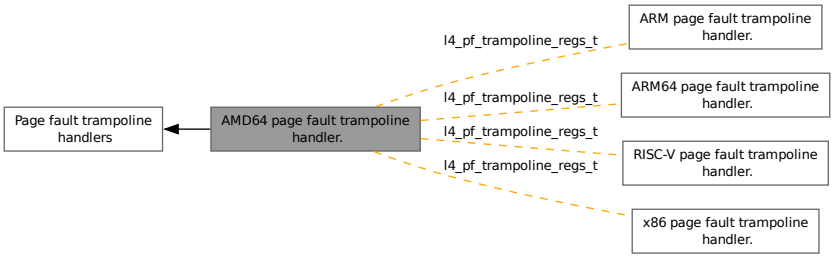
- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

13.1.12.5.1 Detailed Description

13.1.12.6 AMD64 page fault trampoline handler.

Collaboration diagram for AMD64 page fault trampoline handler.:



Data Structures

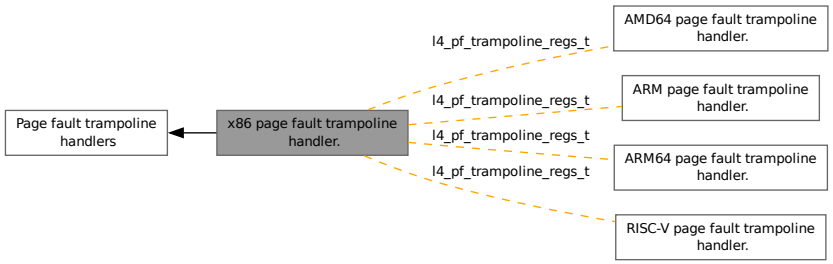
- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

13.1.12.6.1 Detailed Description

13.1.12.7 x86 page fault trampoline handler.

Collaboration diagram for x86 page fault trampoline handler.:



Data Structures

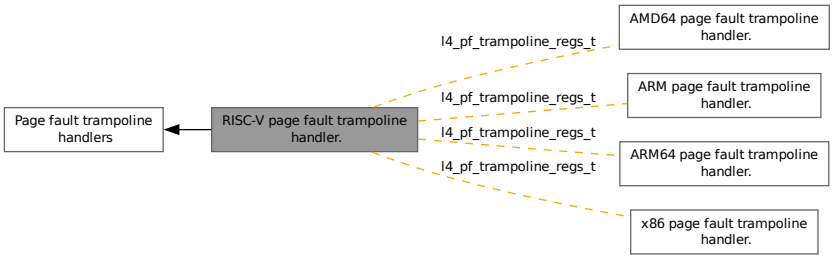
- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

13.1.12.7.1 Detailed Description

13.1.12.8 RISC-V page fault trampoline handler.

Collaboration diagram for RISC-V page fault trampoline handler.:



Data Structures

- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

13.1.12.8.1 Detailed Description

13.1.13 Capabilities

C interface for capabilities.
Collaboration diagram for Capabilities:



Macros

- #define **L4_CAP_SHIFT**

  Capability index shift; see l4_cap_idx_t.
- #define L4_CAP_SIZE

  Deprecated.
- #define **L4_CAP_OFFSET**

  Offset of two consecutive capability indices.
- #define **L4_CAP_MASK**

  Mask to get only the relevant bits of an l4_cap_idx_t.
- #define **L4_INVALID_CAP**

  Invalid capability selector; see l4_cap_idx_t.
- #define L4_INVALID_CAP_BIT

  Bit indicating if a capability selector is invalid.

Typedefs

- typedef unsigned long l4_cap_idx_t

  Capability selector type.

Enumerations

- enum l4_default_caps_t {
  L4_BASE_TASK_CAP , L4_BASE_FACTORY_CAP , L4_BASE_THREAD_CAP , L4_BASE_PAGER_CAP ,
  L4_BASE_LOG_CAP , L4_BASE_ICU_CAP , L4_BASE_SCHEDULER_CAP , L4_BASE_IOMMU_CAP ,
  L4_BASE_DEBUGGER_CAP , L4_BASE_ARM_SMCCC_CAP , **L4_BASE_CAPS_LAST_P1** , L4_BASE_CAPS_LAST
  = L4_BASE_CAPS_LAST_P1 - 1 }

  Default capabilities setup for the initial tasks.

Functions

- unsigned l4_is_invalid_cap (l4_cap_idx_t c) L4_NOTHROW

  Test if a capability selector is invalid (i.e., L4_INVALID_CAP_BIT is set).
- unsigned l4_is_valid_cap (l4_cap_idx_t c) L4_NOTHROW

  Test if a capability selector is valid (i.e., L4_INVALID_CAP_BIT is not set).
- unsigned l4_capability_equal (l4_cap_idx_t c1, l4_cap_idx_t c2) L4_NOTHROW

  Test if the capability indices of two capability selectors are equal.

13.1.13.1 Detailed Description

C interface for capabilities.
Add

```
#include <l4/sys/types.h>
#include <l4/sys/consts.h>
```

to your code to use the functions and definitions explained here.

13.1.13.2 Macro Definition Documentation

13.1.13.2.1 L4_CAP_SIZE

```
#define L4_CAP_SIZE
```

Deprecated.

Deprecated Superseded by L4_CAP_OFFSET.

Definition at line 149 of file consts.h.

13.1.13.2.2 L4_INVALID_CAP_BIT

```
#define L4_INVALID_CAP_BIT
```

Bit indicating if a capability selector is invalid.
If the bit is set, the capability selector is considered invalid.
Definition at line 173 of file consts.h.
Referenced by L4::Cap_base::invalid_cap_error(), L4::Cap_base::is_valid(), L4::Ipc::Cap< A >::is_valid(), l4_is_invalid_cap(), and l4_is_valid_cap().

13.1.13.3 Typedef Documentation

13.1.13.3.1 l4_cap_idx_t

```
typedef unsigned long l4_cap_idx_t
```

Capability selector type.
A capability selector is either a (shifted) capability index, a (shifted) reply capability index or the invalid capability selector L4_INVALID_CAP.

An alternative, synonymous term for capability index is capability slot.
When an interface expects an argument of type l4_cap_idx_t and the documentation does not state any specifics, it is assumed that the argument is an object capability index, i.e., `idx` << L4_CAP_SHIFT for arbitrary `idx`. The behavior for other values is then undefined.
Some interfaces allow use of L4_INVALID_CAP for indicating the absence of a capability index.
When invoking IPC (see Object Invocation), all types of capability selectors are relevant. The particular type is determined by the IPC operation.

- When the operation is a reply (with or without a receive phase) or an open wait without a send, then the selector refers to a reply capability.
- Otherwise, the selector refers to an object capability.

When not L4_INVALID_CAP, the selector contains a capability index for the respective space (reply capability space or object capability space) of the current task. When the selector is L4_INVALID_CAP, the meaning depends on the type of capability:

- When the operation needs a reply capability, the implicit reply capability of the invoking thread is used.
- When the operation needs an object capability, an implicit object capability for the current thread with full permissions is used.

Examples

examples/libs/shmc/prodcons.c, examples/sys/aliens/main.c, examples/sys/isr/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 374 of file types.h.

13.1.13.4 Enumeration Type Documentation

13.1.13.4.1 l4_default_caps_t

`enum l4_default_caps_t`
Default capabilities setup for the initial tasks.
These capability indices are setup per default by the micro kernel for the two initial tasks, the Root-Pager (Sigma0) and the Root-Task (Moe).

Attention

These constants do not have any particular meaning for applications started by Moe, see Initial Environment for this kind of information.

See also

Initial Environment for information useful for normal user applications.

Enumerator

L4_BASE_TASK_CAP	Capability index for the current task.
L4_BASE_FACTORY_CAP	Capability index for the factory.
L4_BASE_THREAD_CAP	Capability index for the first thread.
L4_BASE_PAGER_CAP	Capability index for the pager gate. For Sigma0, the pager is not present since it never raises page faults. For Moe, the pager is set to Sigma0.
L4_BASE_LOG_CAP	Capability index for the log object. Present if the corresponding feature is turned on in the microkernel configuration.
L4_BASE_ICU_CAP	Capability index for the base icu object.
L4_BASE_SCHEDULER_CAP	Capability index for the scheduler cap.

L4_BASE_IOMMU_CAP	Capability index for the IO-MMU cap. Present if the microkernel detected an IO-MMU.
L4_BASE_DEBUGGER_CAP	Capability index for the debugger cap. Present if the corresponding feature is turned on in the microkernel configuration.
L4_BASE_ARM_SMCCC_CAP	Capability index for the ARM SMCCC cap. Present if the microkernel detected an ARM SMC capable trusted execution environment.
L4_BASE_CAPS_LAST	Last capability index used for base capabilities.

Definition at line 341 of file consts.h.

13.1.13.5 Function Documentation

13.1.13.5.1 l4_capability_equal()

```
unsigned l4_capability_equal (
             l4_cap_idx_t c1,
             l4_cap_idx_t c2)  [inline]
```

Test if the capability indices of two capability selectors are equal.

Parameters

c1	Capability selector.
c2	Capability selector.

Return values

0	The index parts of the capability selectors differ.
1	The index parts of the capability selectors are equal.

Precondition

Both capability selectors must be valid (cf. l4_is_valid_cap()) otherwise the return value is undefined.

Definition at line 436 of file types.h.
References L4_CAP_SHIFT, and L4_NOTHROW.

13.1.13.5.2 l4_is_invalid_cap()

```
unsigned l4_is_invalid_cap (
             l4_cap_idx_t c)  [inline]
```

Test if a capability selector is invalid (i.e., L4_INVALID_CAP_BIT is set).

Parameters

c	Capability selector

Return values

0	The capability selector is not the invalid capability.
>0	The capability selector is the invalid capability.

Examples

examples/libs/l4re/c/ma+rm.c, examples/sys/aliens/main.c, examples/sys/isr/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 428 of file types.h.
References L4_INVALID_CAP_BIT, and L4_NOTHROW.

13.1.13.5.3 l4_is_valid_cap()

```
unsigned l4_is_valid_cap (
            l4_cap_idx_t c)  [inline]
```

Test if a capability selector is valid (i.e., L4_INVALID_CAP_BIT is not set).

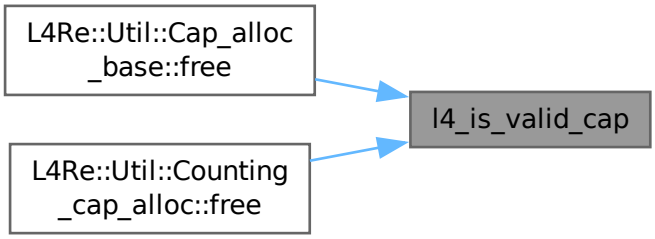
Parameters

c	Capability selector

Return values

0	The capability selector is not valid.
>0	The capability selector is valid.

Definition at line 432 of file types.h.
References L4_INVALID_CAP_BIT, and L4_NOTHROW.
Referenced by L4Re::Util::Cap_alloc_base::free(), and L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::free().
Here is the caller graph for this function:



13.1.14 Memory Operations

Operations for memory access.

Collaboration diagram for Memory Operations:



Enumerations

- enum L4_mem_op_widths { L4_MEM_WIDTH_1BYTE = 0 , L4_MEM_WIDTH_2BYTE = 1 , L4_MEM_WIDTH_4BYTE = 2 }

  Memory access width definitions.

Functions

- unsigned long l4_mem_read (unsigned long virtaddress, unsigned width)

  Read user task memory from kernel privilege level.
- void l4_mem_write (unsigned long virtaddress, unsigned width, unsigned long value)

  Write user task memory from kernel privilege level.

13.1.14.1 Detailed Description

Operations for memory access.
This module provides functionality to access user task memory from the kernel. This is needed for some devices that are only accessible from privileged processor mode. Only use this when absolutely required. This functionality is only available on the ARM architecture.
`#include <l4/sys/mem_op.h>`

13.1.14.2 Enumeration Type Documentation

13.1.14.2.1 L4_mem_op_widths

`enum L4_mem_op_widths`
Memory access width definitions.

Enumerator

L4_MEM_WIDTH_1BYTE	Access one byte (8-bit width).
L4_MEM_WIDTH_2BYTE	Access two bytes (16-bit width).
L4_MEM_WIDTH_4BYTE	Access four bytes (32-bit width).

Definition at line 40 of file mem_op.h.

13.1.14.3 Function Documentation

13.1.14.3.1 l4_mem_read()

```
unsigned long l4_mem_read (
            unsigned long virtaddress,
            unsigned width)  [inline]
```

Read user task memory from kernel privilege level.

Parameters

virtaddress	Virtual address in the calling task.
width	Width of access in bytes in log2,

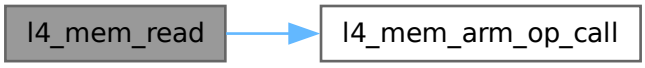
See also

L4_mem_op_widths

Returns

Read value.

Upon a given invalid address or invalid width value the function does nothing.
Definition at line 130 of file mem_op.h.
References l4_mem_arm_op_call().
Here is the call graph for this function:



13.1.14.3.2 l4_mem_write()

```
void l4_mem_write (
             unsigned long virtaddress,
             unsigned width,
             unsigned long value)  [inline]
```

Write user task memory from kernel privilege level.

Parameters

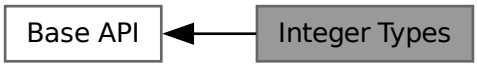
virtaddress	Virtual address in the calling task.
width	Width of access in bytes in log2 (i.e. allowed values: 0, 1, 2)
value	Value to write.

Upon a given invalid address or invalid width value the function does nothing.
Definition at line 136 of file mem_op.h.
References l4_mem_arm_op_call().
Here is the call graph for this function:



13.1.15 Integer Types

Collaboration diagram for Integer Types:



Files

- file l4int.h

  Fixed sized integer types, generic version.
- file l4int.h

  Fixed sized integer types, arm version.
- file l4int.h

  Fixed sized integer types, arm version.
- file l4int.h

  Fixed sized integer types, AMD64 version.
- file l4int.h

  Fixed sized integer types, x86 version.
- file l4int.h

  Fixed sized integer types, RISC-V version.

Macros

- #define **L4_MWORD_BITS** 32

  Size of machine words in bits.
- #define **L4_MWORD_BITS** 64

  Size of machine words in bits.
- #define **L4_MWORD_BITS** 64

  Size of machine words in bits.
- #define **L4_MWORD_BITS** 32

  Size of machine words in bits.
- #define **L4_MWORD_BITS** __riscv_xlen

  Size of machine words in bits.

Typedefs

- typedef signed char **l4_int8_t**

  Signed 8bit value.
- typedef unsigned char **l4_uint8_t**

  Unsigned 8bit value.
- typedef signed short int **l4_int16_t**

  Signed 16bit value.
- typedef unsigned short int **l4_uint16_t**

  Unsigned 16bit value.
- typedef signed int **l4_int32_t**

  Signed 32bit value.

- typedef unsigned int **l4_uint32_t**

  Unsigned 32bit value.
- typedef signed long long **l4_int64_t**

  Signed 64bit value.
- typedef unsigned long long **l4_uint64_t**

  Unsigned 64bit value.
- typedef unsigned long **l4_addr_t**

  Address type.
- typedef signed long **l4_mword_t**

  Signed machine word.
- typedef unsigned long **l4_umword_t**

  Unsigned machine word.
- typedef l4_uint64_t **l4_cpu_time_t**

  CPU clock type.
- typedef l4_uint64_t **l4_kernel_clock_t**

  Kernel clock type.
- typedef unsigned int **l4_size_t**

  Unsigned size type.
- typedef signed int **l4_ssize_t**

  Signed size type.
- typedef unsigned long **l4_size_t**

  Unsigned size type.
- typedef signed long **l4_ssize_t**

  Signed size type.
- typedef unsigned long **l4_size_t**

  Unsigned size type.
- typedef signed long **l4_ssize_t**

  Signed size type.
- typedef unsigned int **l4_size_t**

  Unsigned size type.
- typedef signed int **l4_ssize_t**

  Signed size type.
- typedef unsigned int **l4_size_t**

  Unsigned size type.
- typedef signed int **l4_ssize_t**

  Signed size type.

13.1.15.1 Detailed Description

Include File

```
#include <l4/sys/l4int.h>
```

13.2 EDID parsing functionality

Enumerations

- enum Libedid_consts { Libedid_block_size = 128 }

  EDID constants.

Functions

- int libedid_check_header (const unsigned char *edid)
  Check for valid EDID header.
- int libedid_checksum (const unsigned char *edid)
  Calculates the EDID checksum.
- unsigned libedid_version (const unsigned char *edid)
  Returns the EDID version number.
- unsigned libedid_revision (const unsigned char *edid)
  Returns the EDID revision number.
- void libedid_pnp_id (const unsigned char *edid, unsigned char *id)
  Extracts the display's PnP ID.
- void libedid_prefered_resolution (const unsigned char *edid, unsigned *w, unsigned *h)
  Extract the display's prefered mode.
- unsigned libedid_num_ext_blocks (const unsigned char *edid)
  Get the number of EDID extension blocks.
- unsigned libedid_dump_standard_timings (const unsigned char *edid)
  Dump the standard timings to stdout.
- void libedid_dump (const unsigned char *edid)
  Dump raw EDID data to stdout.

13.2.1 Detailed Description

13.2.2 Enumeration Type Documentation

13.2.2.1 Libedid_consts

```
enum Libedid_consts
```

EDID constants.

Enumerator

Libedid_block_size	Size of one EDID block in bytes.

Definition at line 23 of file edid.h.

13.2.3 Function Documentation

13.2.3.1 libedid_check_header()

```
int libedid_check_header (
            const unsigned char * edid)
```

Check for valid EDID header.

Parameters

edid	Pointer to a 128byte EDID block

Returns

0 if the header is correct, -EINVAL otherwise

13.2.3.2 libedid_checksum()

```
int libedid_checksum (
            const unsigned char * edid)
```

Calculates the EDID checksum.

Parameters

edid	Pointer to a 128byte EDID block

Returns

0 if checksum is correct, -EINVAL otherwise

13.2.3.3 libedid_dump()

```
void libedid_dump (
            const unsigned char * edid)
```

Dump raw EDID data to stdout.

Parameters

edid	Pointer to a 128byte EDID block

13.2.3.4 libedid_dump_standard_timings()

```
unsigned libedid_dump_standard_timings (
            const unsigned char * edid)
```

Dump the standard timings to stdout.

Parameters

edid	Pointer to a 128byte EDID block

Returns

Number of standard timings stored in EDID

13.2.3.5 libedid_num_ext_blocks()

```
unsigned libedid_num_ext_blocks (
            const unsigned char * edid)
```

Get the number of EDID extension blocks.

Parameters

edid	Pointer to a 128byte EDID block

Returns

Number of EDID extension blocks

13.2.3.6 libedid_pnp_id()

```
void libedid_pnp_id (
            const unsigned char * edid,
            unsigned char * id)
```

Extracts the display's PnP ID.

Parameters

	edid	Pointer to a 128byte EDID block
out	*id*	Return the PnP id. Must point to 4 bytes.

13.2.3.7 libedid_prefered_resolution()

```
void libedid_prefered_resolution (
            const unsigned char * edid,
            unsigned * w,
            unsigned * h)
```

Extract the display's prefered mode.

Parameters

	edid	Pointer to a 128byte EDID block
out	*w*	X resolution of prefered video mode in pixels.
out	*h*	Y resolution of prefered video mode in pixels.

13.2.3.8 libedid_revision()

```
unsigned libedid_revision (
            const unsigned char * edid)
```

Returns the EDID revision number.

Parameters

edid	Pointer to a 128 EDID block

Returns

Revision number

13.2.3.9 libedid_version()

```
unsigned libedid_version (
            const unsigned char * edid)
```

Returns the EDID version number.

Parameters

edid	Pointer to a 128byte EDID block

Returns

Version number

13.3 IO interface

Typedefs

- typedef l4vbus_resource_t l4io_resource_t

  Resource descriptor.
- typedef l4vbus_device_t **l4io_device_t**

  Device descriptor.

Enumerations

- enum l4io_iomem_flags_t {
  L4IO_MEM_NONCACHED = 0 , L4IO_MEM_CACHED = 1 , L4IO_MEM_USE_MTRR = 2 , **L4IO_MEM_ATTR_MASK** = 0xf ,
  L4IO_MEM_WRITE_COMBINED = L4IO_MEM_USE_MTRR | L4IO_MEM_CACHED , L4IO_MEM_USE_RESERVED_AREA = 0x40 << 8 , L4IO_MEM_EAGER_MAP = 0x80 << 8 }

  Flags for IO memory.
- enum l4io_device_types_t {
  L4IO_DEVICE_INVALID = 0 , L4IO_DEVICE_PCI , L4IO_DEVICE_USB , L4IO_DEVICE_OTHER ,
  L4IO_DEVICE_ANY = ~0 }

  Device types.
- enum l4io_resource_types_t {
  L4IO_RESOURCE_INVALID = L4VBUS_RESOURCE_INVALID , L4IO_RESOURCE_IRQ = L4VBUS_RESOURCE_IRQ , L4IO_RESOURCE_MEM = L4VBUS_RESOURCE_MEM , L4IO_RESOURCE_PORT = L4VBUS_RESOURCE_PORT ,
  L4IO_RESOURCE_ANY = ~0 }

  Resource types.

Functions

- long l4io_request_iomem (l4_addr_t phys, unsigned long size, int flags, l4_addr_t *virt)

  Request an IO memory region.
- long l4io_request_iomem_region (l4_addr_t phys, l4_addr_t virt, unsigned long size, int flags)

  Request an IO memory region and map it to a specified region.
- long l4io_release_iomem (l4_addr_t virt, unsigned long size)

  Release an IO memory region.
- long l4io_request_ioport (unsigned portnum, unsigned len)

  Request an IO port region.
- long l4io_release_ioport (unsigned portnum, unsigned len)

  Release an IO port region.
- int l4io_lookup_device (const char *devname, l4io_device_handle_t *dev_handle, l4io_device_t *dev, l4io_resource_handle_t *res_handle)

  Find a device by name.
- int l4io_lookup_resource (l4io_device_handle_t devhandle, enum l4io_resource_types_t type, l4io_resource_handle_t *reshandle, l4io_resource_t *res)

  Request a specific resource from a device description.
- l4_addr_t l4io_request_resource_iomem (l4io_device_handle_t devhandle, l4io_resource_handle_t *reshandle)

  Request IO memory.
- int l4io_has_resource (enum l4io_resource_types_t type, l4vbus_paddr_t start, l4vbus_paddr_t end)

  Check if a resource is available.

13.3.1 Detailed Description

13.3.2 Typedef Documentation

13.3.2.1 l4io_resource_t

`typedef l4vbus_resource_t l4io_resource_t`
Resource descriptor.
For IRQ types, the end field is not used, i.e. only a single interrupt can be described with a l4io_resource_t
Definition at line 67 of file types.h.

13.3.3 Enumeration Type Documentation

13.3.3.1 l4io_device_types_t

`enum l4io_device_types_t`
Device types.

Enumerator

L4IO_DEVICE_INVALID	Invalid type.
L4IO_DEVICE_PCI	PCI device.
L4IO_DEVICE_USB	USB device.
L4IO_DEVICE_OTHER	Any other device without unique IDs.
L4IO_DEVICE_ANY	any type

Definition at line 36 of file types.h.

13.3.3.2 l4io_iomem_flags_t

`enum l4io_iomem_flags_t`
Flags for IO memory.

Enumerator

L4IO_MEM_NONCACHED	Non-cache memory.
L4IO_MEM_CACHED	Cache memory.
L4IO_MEM_USE_MTRR	Use MTRR.
L4IO_MEM_USE_RESERVED_AREA	Use reserved area for mapping I/O memory. Flag only valid for l4io_request_iomem_region()
L4IO_MEM_EAGER_MAP	Eagerly map the I/O memory. Passthrough to the l4re-rm.

Definition at line 14 of file types.h.

13.3.3.3 l4io_resource_types_t

`enum l4io_resource_types_t`
Resource types.

Enumerator

L4IO_RESOURCE_INVALID	Invalid type.
L4IO_RESOURCE_IRQ	Interrupt resource.
L4IO_RESOURCE_MEM	I/O memory resource.

L4IO_RESOURCE_PORT	I/O port resource (x86 only).
L4IO_RESOURCE_ANY	any type

Definition at line 48 of file types.h.

13.3.4 Function Documentation

13.3.4.1 l4io_has_resource()

```
int l4io_has_resource (
            enum l4io_resource_types_t type,
            l4vbus_paddr_t start,
            l4vbus_paddr_t end)
```

Check if a resource is available.

Parameters

type	Type of resource
start	Minimal value.
end	Maximum value.

References L4_INLINE.

13.3.4.2 l4io_lookup_device()

```
int l4io_lookup_device (
            const char * devname,
            l4io_device_handle_t * dev_handle,
            l4io_device_t * dev,
            l4io_resource_handle_t * res_handle)
```

Find a device by name.

Parameters

	devname	Name of device.
out	*dev_handle*	Device handle for found device, can be NULL.
out	*dev*	Device information, filled by the function, can be NULL.
out	*res_handle*	Resource handle, can be NULL.

Returns

0 on success, error code otherwise

References L4_CV, and L4_EXPORT.

13.3.4.3 l4io_lookup_resource()

```
int l4io_lookup_resource (
            l4io_device_handle_t devhandle,
            enum l4io_resource_types_t type,
            l4io_resource_handle_t * reshandle,
            l4io_resource_t * res)
```

Request a specific resource from a device description.

Parameters

	devhandle	Device handle.
	type	Type of resource to request (see l4io_resource_types_t).
in,out	*reshandle*	Resource handle, start with handle returned by device functions. The next resource handle is returned here.
out	*res*	Device descriptor.

Returns

0 on success, error code otherwise, esp. -L4_ENOENT if no more resources found

References L4_CV, and L4_EXPORT.

13.3.4.4 l4io_release_iomem()

```
long l4io_release_iomem (
             l4_addr_t virt,
             unsigned long size)
```

Release an IO memory region.

Parameters

virt	Virtual address of region to free, see l4io_request_iomem
size	Size of the region to release.

Returns

0 on success, <0 on error

References L4_CV, and L4_EXPORT.

13.3.4.5 l4io_release_ioport()

```
long l4io_release_ioport (
             unsigned portnum,
             unsigned len)
```

Release an IO port region.

Parameters

portnum	Start of port range to release
len	Length of range to request

Returns

0 on success, <0 on error

Note

X86 architecture only

References L4_CV, L4_EXPORT, and L4_INLINE.

13.3.4.6 l4io_request_iomem()

```
long l4io_request_iomem (
             l4_addr_t phys,
             unsigned long size,
             int flags,
             l4_addr_t * virt)
```

Request an IO memory region.

Parameters

	phys	Physical address of the I/O memory region
	size	Size of the region in Bytes, granularity pages.
	flags	See l4io_iomem_flags_t
in,out	*virt*	Virtual address where the IO memory region should be mapped to. If the caller passes '0' a region in the caller's address space is searched and the virtual address is returned.

Return values

0	Success.
-L4_ENOENT	No area in the caller's address space could be found to map the IO memory region.
-L4_EPERM	Operation not allowed.
-L4_EINVAL	Invalid value.
-L4_EADDRNOTAVAIL	The requested virtual address is not available.
-L4_ENOMEM	The requested IO memory region could not be allocated.
<0	IPC errors.

Note

This function uses L4Re functionality to reserve a part of the virtual address space of the caller.

References L4_CV, and L4_EXPORT.

13.3.4.7 l4io_request_iomem_region()

```
long l4io_request_iomem_region (
             l4_addr_t phys,
             l4_addr_t virt,
             unsigned long size,
             int flags)
```

Request an IO memory region and map it to a specified region.

Parameters

phys	Physical address of the I/O memory region
virt	Virtual address.
size	Size of the region in Bytes, granularity pages.
flags	See l4io_iomem_flags_t

Return values

0	Success.
-L4_ENOENT	No area could be found to map the IO memory region.
-L4_EPERM	Operation not allowed.
-L4_EINVAL	Invalid value.
-L4_EADDRNOTAVAIL	The requested virtual address is not available.
-L4_ENOMEM	The requested IO memory region could not be allocated.
<0	IPC errors.

Note

This function uses L4Re functionality to reserve a part of the virtual address space of the caller.

References L4_CV, and L4_EXPORT.

13.3.4.8 l4io_request_ioport()

```
long l4io_request_ioport (
            unsigned portnum,
            unsigned len)
```

Request an IO port region.

Parameters

portnum	Start of port range to request
len	Length of range to request

Returns

0 on success, <0 on error

Note

X86 architecture only

References L4_CV, and L4_EXPORT.

13.3.4.9 l4io_request_resource_iomem()

```
l4_addr_t l4io_request_resource_iomem (
            l4io_device_handle_t devhandle,
            l4io_resource_handle_t * reshandle)
```

Request IO memory.

Parameters

	devhandle	Device handle.
in,out	*reshandle*	Resource handle from which IO memory should be requested. Upon successfull completion 'reshandle' points to the device's next resource.

Return values

0	An error occured. The value of 'reshandle' is undefined.
>0	The virtual address of the IO memory mapping.

References L4_CV, and L4_EXPORT.

13.4 IPC Helpers

Functions

- void L4::throw_ipc_exception (L4::Cap< void > const &o, l4_msgtag_t const &err, l4_utcb_t *utcb)

  Throw an L4 IPC error as exception.
- void L4::throw_ipc_exception (void const *o, l4_msgtag_t const &err, l4_utcb_t *utcb)

  Throw an L4 IPC error as exception.

13.4.1 Detailed Description

13.4.2 Function Documentation

13.4.2.1 throw_ipc_exception() [1/2]

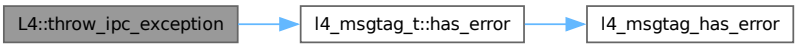
```
void L4::throw_ipc_exception (
            L4::Cap< void > const & o,
            l4_msgtag_t const & err,
            l4_utcb_t * utcb)  [inline]
```

Throw an L4 IPC error as exception.

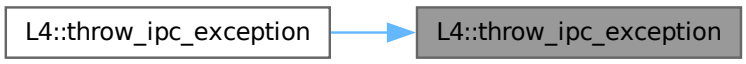
Parameters

o	The client side object, for which the IPC was invoked.
err	The IPC result code (error code).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Definition at line 34 of file ipc_helper.
References l4_msgtag_t::has_error().
Referenced by throw_ipc_exception().
Here is the call graph for this function:



Here is the caller graph for this function:



13.4.2.2 throw_ipc_exception() [2/2]

```
void L4::throw_ipc_exception (
            void const * o,
            l4_msgtag_t const & err,
            l4_utcb_t * utcb)  [inline]
```

Throw an L4 IPC error as exception.

Parameters

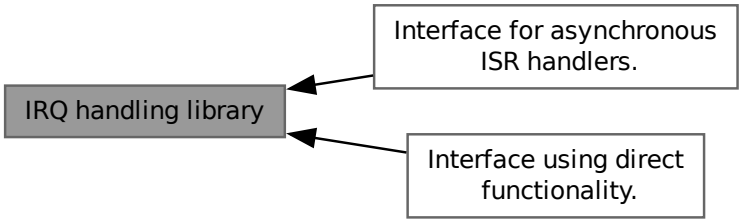
o	The client side object, for which the IPC was invoked.
err	The IPC result code (error code).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Definition at line 50 of file ipc_helper.
References throw_ipc_exception().
Here is the call graph for this function:



13.5 IRQ handling library

Collaboration diagram for IRQ handling library:



Topics

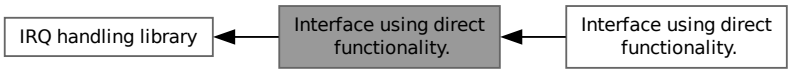
- Interface using direct functionality. 434
- Interface for asynchronous ISR handlers. 440

  This interface has just two (main) functions.

13.5.1 Detailed Description

13.5.2 Interface using direct functionality.

Collaboration diagram for Interface using direct functionality.:



Topics

- Interface using direct functionality. 438

Functions

- l4irq_t ∗ l4irq_attach (int irqnum)

  Attach/connect to IRQ.
- l4irq_t ∗ l4irq_attach_ft (int irqnum, unsigned mode)

  Attach/connect to IRQ using given type.
- l4irq_t ∗ l4irq_attach_thread (int irqnum, l4_cap_idx_t to_thread)

  Attach/connect to IRQ.
- l4irq_t ∗ l4irq_attach_thread_ft (int irqnum, l4_cap_idx_t to_thread, unsigned mode)

  Attach/connect to IRQ using given type.
- long l4irq_wait (l4irq_t ∗irq)

  Wait for specified IRQ.
- long l4irq_unmask_and_wait_any (l4irq_t ∗unmask_irq, l4irq_t ∗∗ret_irq)

  Unmask a specific IRQ and wait for any attached IRQ.
- long l4irq_wait_any (l4irq_t ∗∗irq)

  Wait for any attached IRQ.
- long l4irq_unmask (l4irq_t ∗irq)

  Unmask a specific IRQ.
- long l4irq_detach (l4irq_t ∗irq)

  Detach from IRQ.

13.5.2.1 Detailed Description

13.5.2.2 Function Documentation

13.5.2.2.1 l4irq_attach()

```
l4irq_t * l4irq_attach (
             int irqnum)
```

Attach/connect to IRQ.

Parameters

irqnum	IRQ number to request

Returns

Pointer to l4irq_t structure, 0 on error

This l4irq_attach has to be called in the same thread as l4irq_wait and caller has to be a pthread thread.

Examples

examples/libs/libirq/loop.c.

References L4_CV.

13.5.2.2.2 l4irq_attach_ft()

```
l4irq_t * l4irq_attach_ft (
             int irqnum,
             unsigned mode)
```

Attach/connect to IRQ using given type.

Parameters

irqnum	IRQ number to request
mode	Interrupt type,

See also

L4_irq_mode

Returns

Pointer to l4irq_t structure, 0 on error

This l4irq_attach has to be called in the same thread as l4irq_wait and caller has to be a pthread thread.
References L4_CV.

13.5.2.2.3 l4irq_attach_thread()

```
l4irq_t * l4irq_attach_thread (
             int irqnum,
             l4_cap_idx_t to_thread)
```

Attach/connect to IRQ.

Parameters

irqnum	IRQ number to request
to_thread	Attach IRQ to this specified thread.

Returns

Pointer to l4irq_t structure, 0 on error

The pointer to the IRQ structure is used as a label in the IRQ object.
References L4_CV.

13.5.2.2.4 l4irq_attach_thread_ft()

```
l4irq_t * l4irq_attach_thread_ft (
            int irqnum,
            l4_cap_idx_t to_thread,
            unsigned mode)
```

Attach/connect to IRQ using given type.

Parameters

irqnum	IRQ number to request
to_thread	Attach IRQ to this specified thread.
mode	Interrupt type,

See also

L4_irq_mode

Returns

Pointer to l4irq_t structure, 0 on error

The pointer to the IRQ structure is used as a label in the IRQ object.
References L4_CV.

13.5.2.2.5 l4irq_detach()

```
long l4irq_detach (
            l4irq_t * irq)
```

Detach from IRQ.

Parameters

irq	IRQ data structure

Returns

0 on success, != 0 on error

References L4_CV.

13.5.2.2.6 l4irq_unmask()

```
long l4irq_unmask (
            l4irq_t * irq)
```

Unmask a specific IRQ.

Parameters

irq	IRQ data structure

Returns

0 on success, != 0 on error

This function is useful if a thread wants to wait for multiple IRQs using l4_ipc_wait.
References L4_CV.

13.5.2.2.7 l4irq_unmask_and_wait_any()

```
long l4irq_unmask_and_wait_any (
             l4irq_t * unmask_irq,
             l4irq_t ** ret_irq)
```

Unmask a specific IRQ and wait for any attached IRQ.

Parameters

	unmask_irq	IRQ data structure for unmask.
out	*ret_irq*	Received interrupt.

Returns

0 on success, != 0 on error

References L4_CV.

13.5.2.2.8 l4irq_wait()

```
long l4irq_wait (
             l4irq_t * irq)
```

Wait for specified IRQ.

Parameters

irq	IRQ data structure

Returns

0 on success, != 0 on error

Examples

examples/libs/libirq/loop.c.

References L4_CV.

13.5.2.2.9 l4irq_wait_any()

```
long l4irq_wait_any (
             l4irq_t ** irq)
```

Wait for any attached IRQ.

Return values

irq	Received interrupt.

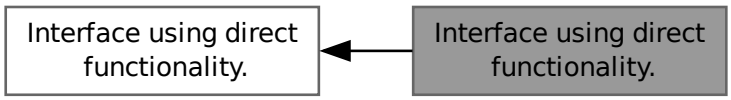
Returns

0 on success, != 0 on error

References L4_CV.

13.5.2.3 Interface using direct functionality.

Collaboration diagram for Interface using direct functionality.:



Functions

- l4irq_t * l4irq_attach_cap (l4_cap_idx_t irqcap)

  Attach/connect to IRQ.
- l4irq_t * l4irq_attach_cap_ft (l4_cap_idx_t irqcap, unsigned mode)

  Attach/connect to IRQ using given type.
- l4irq_t * l4irq_attach_thread_cap (l4_cap_idx_t irqcap, l4_cap_idx_t to_thread)

  Attach/connect to IRQ.
- l4irq_t * l4irq_attach_thread_cap_ft (l4_cap_idx_t irqcap, l4_cap_idx_t to_thread, unsigned mode)

  Attach/connect to IRQ using given type.

13.5.2.3.1 Detailed Description

13.5.2.3.2 Function Documentation

13.5.2.3.2.1 l4irq_attach_cap()

```
l4irq_t * l4irq_attach_cap (
             l4_cap_idx_t irqcap)
```

Attach/connect to IRQ.

Parameters

irqcap	IRQ capability

Returns

Pointer to l4irq_t structure, 0 on error

This l4irq_attach has to be called in the same thread as l4irq_wait and caller has to be a pthread thread.
References L4_CV.

13.5.2.3.2.2 l4irq_attach_cap_ft()

```
l4irq_t * l4irq_attach_cap_ft (
             l4_cap_idx_t irqcap,
             unsigned mode)
```

Attach/connect to IRQ using given type.

Parameters

irqcap	IRQ capability
mode	Interrupt type,

See also

L4_irq_mode

Returns

Pointer to l4irq_t structure, 0 on error

This l4irq_attach has to be called in the same thread as l4irq_wait and caller has to be a pthread thread.
References L4_CV.

13.5.2.3.2.3 l4irq_attach_thread_cap()

```
l4irq_t * l4irq_attach_thread_cap (
             l4_cap_idx_t irqcap,
             l4_cap_idx_t to_thread)
```

Attach/connect to IRQ.

Parameters

irqcap	IRQ capability
to_thread	Attach IRQ to this thread.

Returns

Pointer to l4irq_t structure, 0 on error

The pointer to the IRQ structure is used as a label in the IRQ object.
References L4_CV.

13.5.2.3.2.4 l4irq_attach_thread_cap_ft()

```
l4irq_t * l4irq_attach_thread_cap_ft (
             l4_cap_idx_t irqcap,
             l4_cap_idx_t to_thread,
             unsigned mode)
```

Attach/connect to IRQ using given type.

Parameters

irqcap	IRQ capability
to_thread	Attach IRQ to this thread.
mode	Interrupt type,

See also

L4_irq_mode

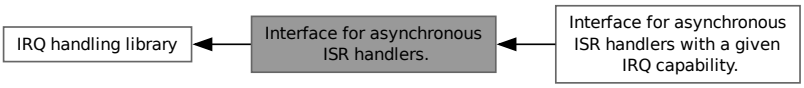
Returns

Pointer to l4irq_t structure, 0 on error

The pointer to the IRQ structure is used as a label in the IRQ object.
References L4_CV.

13.5.3 Interface for asynchronous ISR handlers.

This interface has just two (main) functions.
Collaboration diagram for Interface for asynchronous ISR handlers.:



Topics

- Interface for asynchronous ISR handlers with a given IRQ capability. 441
  This group is just an enhanced version to l4irq_request() which takes a capability object instead of a plain number.

Functions

- l4irq_t * l4irq_request (int irqnum, void(*isr_handler)(void *), void *isr_data, int irq_thread_prio, unsigned mode)
  Attach asychronous ISR handler to IRQ.
- long l4irq_release (l4irq_t *irq)
  Release asynchronous ISR handler and free resources.

13.5.3.1 Detailed Description

This interface has just two (main) functions.
l4irq_request to install a handler for an interrupt and l4irq_release to uninstall the handler again and release all resources associated with it.

13.5.3.2 Function Documentation

13.5.3.2.1 l4irq_release()

```
long l4irq_release (
             l4irq_t * irq)
```

Release asynchronous ISR handler and free resources.

Parameters

irq	IRQ data structure

Returns

0 sucess, != 0 failure

Examples

examples/libs/libirq/async_isr.c.

References L4_CV.

13.5.3.2.2 l4irq_request()

```
l4irq_t * l4irq_request (
             int irqnum,
             void(* isr_handler )(void *),
             void * isr_data,
             int irq_thread_prio,
             unsigned mode)
```

Attach asychronous ISR handler to IRQ.

Parameters

irqnum	IRQ number to request
isr_handler	Handler routine that is called when an interrupt triggers
isr_data	Pointer given as argument to isr_handler
irq_thread_prio	L4 thread priority of the ISR handler. Give -1 for same priority as creator.
mode	Interrupt type,

See also

L4_irq_mode

Returns

Pointer to l4irq_t structure, 0 on error

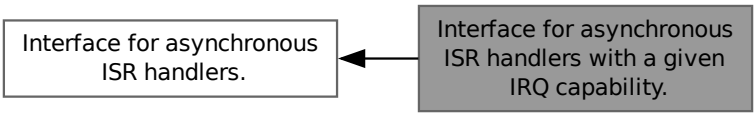
Examples

examples/libs/libirq/async_isr.c.

References L4_CV.

13.5.3.3 Interface for asynchronous ISR handlers with a given IRQ capability.

This group is just an enhanced version to l4irq_request() which takes a capability object instead of a plain number.
Collaboration diagram for Interface for asynchronous ISR handlers with a given IRQ capability.:



Functions

- l4irq_t * l4irq_request_cap (l4_cap_idx_t irqcap, void(*isr_handler)(void *), void *isr_data, int irq_thread_↩ prio, unsigned mode)

  Attach asychronous ISR handler to IRQ.

13.5.3.3.1 Detailed Description

This group is just an enhanced version to l4irq_request() which takes a capability object instead of a plain number.

13.5.3.3.2 Function Documentation

13.5.3.3.2.1 l4irq_request_cap()

```
l4irq_t * l4irq_request_cap (
            l4_cap_idx_t irqcap,
            void(* isr_handler )(void *),
            void * isr_data,
            int irq_thread_prio,
            unsigned mode)
```

Attach asychronous ISR handler to IRQ.

Parameters

irqcap	IRQ capability
isr_handler	Handler routine that is called when an interrupt triggers
isr_data	Pointer given as argument to isr_handler
irq_thread_prio	L4 thread priority of the ISR handler. Give -1 for same priority as creator.
mode	Interrupt type,

See also

L4_irq_mode

Returns

Pointer to l4irq_t structure, 0 on error

13.6 L4 IPC Opcodes

List of protocol specific opcodes used for communication with L4Re and Kernel objects.

Enumerations

- enum L4_icu_opcode {
  L4_ICU_OP_BIND , L4_ICU_OP_UNBIND , L4_ICU_OP_INFO , L4_ICU_OP_MSI_INFO ,
  L4_ICU_OP_UNMASK , L4_ICU_OP_MASK , L4_ICU_OP_SET_MODE }

  Opcodes to the ICU interface.
- enum L4_ipc_gate_ops { L4_IPC_GATE_BIND_OP = 0x10 , L4_IPC_GATE_GET_INFO_OP = 0x11 }

  Operations on the IPC-gate.
- enum L4_pi_mutex_ops { L4_PI_MUTEX_LOCK_OP = 0UL , L4_PI_MUTEX_UNLOCK_OP = 1UL }

  Operations on priority inheritance mutex objects.
- enum L4_platform_ctl_ops {
  L4_PLATFORM_CTL_SYS_SUSPEND_OP = 0UL , L4_PLATFORM_CTL_SYS_SHUTDOWN_OP = 1UL ,
  L4_PLATFORM_CTL_CPU_ALLOW_SHUTDOWN_OP = 2UL , L4_PLATFORM_CTL_CPU_ENABLE_OP =
  3UL ,
  L4_PLATFORM_CTL_CPU_DISABLE_OP = 4UL , L4_PLATFORM_CTL_SET_TASK_ASID_OP = 0x10UL }

  Operations on platform-control objects.
- enum L4_task_ops {
  L4_TASK_MAP_OP = 0UL , L4_TASK_UNMAP_OP = 1UL , L4_TASK_CAP_INFO_OP = 2UL ,
  L4_TASK_ADD_KU_MEM_OP = 3UL ,
  L4_TASK_LDT_SET_X86_OP = 0x11UL , L4_TASK_MAP_VGICC_ARM_OP = 0x12UL }

  Operations on task objects.

- enum L4_thread_ops { L4_THREAD_CONTROL_OP = 0UL , L4_THREAD_EX_REGS_OP = 1UL , L4_THREAD_SWITCH_OP = 2UL , L4_THREAD_STATS_OP = 3UL , L4_THREAD_VCPU_RESUME_OP = 4UL , L4_THREAD_REGISTER_DELETE_IRQ_OP = 5UL , L4_THREAD_MODIFY_SENDER_OP = 6UL , L4_THREAD_VCPU_CONTROL_OP = 7UL , **L4_THREAD_VCPU_CONTROL_EXT_OP** = L4_THREAD_VCPU_CONTROL_OP | 0x10000 , L4_THREAD_REGISTER_DO = 8UL , L4_THREAD_PF_TRAMP_CONTROL_OP = 9UL , L4_THREAD_X86_GDT_OP = 0x10UL , L4_THREAD_ARM_TPIDRURO_OP = 0x10UL , L4_THREAD_AMD64_SET_SEGMENT_BASE_OP = 0x12UL , L4_THREAD_AMD64_GET_SEGMENT_INFO_OP = 0x13UL , L4_THREAD_OPCODE_MASK = 0xffff }

  Operations on thread objects.
- enum L4_vcon_ops { L4_VCON_WRITE_OP = 0UL , L4_VCON_READ_OP = 1UL , L4_VCON_SET_ATTR_OP = 2UL , L4_VCON_GET_ATTR_OP = 3UL }

  Operations on vcon objects.

13.6.1 Detailed Description

List of protocol specific opcodes used for communication with L4Re and Kernel objects.

13.6.2 Enumeration Type Documentation

13.6.2.1 L4_icu_opcode

`enum L4_icu_opcode`

Opcodes to the ICU interface.

Enumerator

L4_ICU_OP_BIND	Bind opcode. **See also** l4_icu_bind()
L4_ICU_OP_UNBIND	Unbind opcode. **See also** l4_icu_unbind()
L4_ICU_OP_INFO	Info opcode. **See also** l4_icu_info()
L4_ICU_OP_MSI_INFO	Msi-info opcode. **See also** l4_icu_msi_info()
L4_ICU_OP_UNMASK	Unmask opcode. **See also** l4_icu_unmask()

L4_ICU_OP_MASK	Mask opcode. **See also** l4_icu_mask()
L4_ICU_OP_SET_MODE	Set-mode opcode. **See also** l4_icu_set_mode()

Definition at line 97 of file icu.h.

13.6.2.2 L4_ipc_gate_ops

`enum L4_ipc_gate_ops`
Operations on the IPC-gate.

Enumerator

L4_IPC_GATE_BIND_OP	Bind operation.
L4_IPC_GATE_GET_INFO_OP	Info operation.

Definition at line 108 of file ipc_gate.h.

13.6.2.3 L4_pi_mutex_ops

`enum L4_pi_mutex_ops`
Operations on priority inheritance mutex objects.
See L4_PROTO_PI_MUTEX for the protocol type to use for messages to priority inheritance mutex objects.

Enumerator

L4_PI_MUTEX_LOCK_OP	Lock mutex.
L4_PI_MUTEX_UNLOCK_OP	Unlock mutex.

Definition at line 114 of file pi_mutex.h.

13.6.2.4 L4_platform_ctl_ops

`enum L4_platform_ctl_ops`
Operations on platform-control objects.
See L4_PROTO_PLATFORM_CTL for the protocol type to use for messages to platform-control objects.

Enumerator

L4_PLATFORM_CTL_SYS_SUSPEND_OP	Suspend.
L4_PLATFORM_CTL_SYS_SHUTDOWN_OP	shutdown/reboot
L4_PLATFORM_CTL_CPU_ALLOW_SHUTDOWN_OP	allow CPU shutdown
L4_PLATFORM_CTL_CPU_ENABLE_OP	enable an offline CPU
L4_PLATFORM_CTL_CPU_DISABLE_OP	disable an online CPU
L4_PLATFORM_CTL_SET_TASK_ASID_OP	Arm: set task ASID.

Definition at line 159 of file platform_control.h.

13.6.2.5 L4_task_ops

enum L4_task_ops
Operations on task objects.

Enumerator

L4_TASK_MAP_OP	Map.
L4_TASK_UNMAP_OP	Unmap.
L4_TASK_CAP_INFO_OP	Cap info.
L4_TASK_ADD_KU_MEM_OP	Add kernel-user memory.
L4_TASK_LDT_SET_X86_OP	x86: LDT set
L4_TASK_MAP_VGICC_ARM_OP	Arm: Map virtual GICC area.

Definition at line 341 of file task.h.

13.6.2.6 L4_thread_ops

enum L4_thread_ops
Operations on thread objects.

Enumerator

L4_THREAD_CONTROL_OP	Control operation.
L4_THREAD_EX_REGS_OP	Exchange registers operation.
L4_THREAD_SWITCH_OP	Do a thread switch.
L4_THREAD_STATS_OP	Thread statistics.
L4_THREAD_VCPU_RESUME_OP	VCPU resume.
L4_THREAD_REGISTER_DELETE_IRQ_OP	Register an IPC-gate deletion IRQ.
L4_THREAD_MODIFY_SENDER_OP	Modify all senders IDs that match the given pattern.
L4_THREAD_VCPU_CONTROL_OP	Enable / disable VCPU feature.
L4_THREAD_REGISTER_DOORBELL_IRQ_OP	Register direct IRQ injection doorbell IRQ.
L4_THREAD_PF_TRAMP_CONTROL_OP	Page fault trampoline control operation.
L4_THREAD_X86_GDT_OP	Gdt.
L4_THREAD_ARM_TPIDRURO_OP	Set TPIDRURO register.
L4_THREAD_AMD64_SET_SEGMENT_BASE_OP	Set segment base.
L4_THREAD_AMD64_GET_SEGMENT_INFO_OP	Get segment information.
L4_THREAD_OPCODE_MASK	Mask for opcodes.

Definition at line 846 of file thread.h.

13.6.2.7 L4_vcon_ops

enum L4_vcon_ops
Operations on vcon objects.

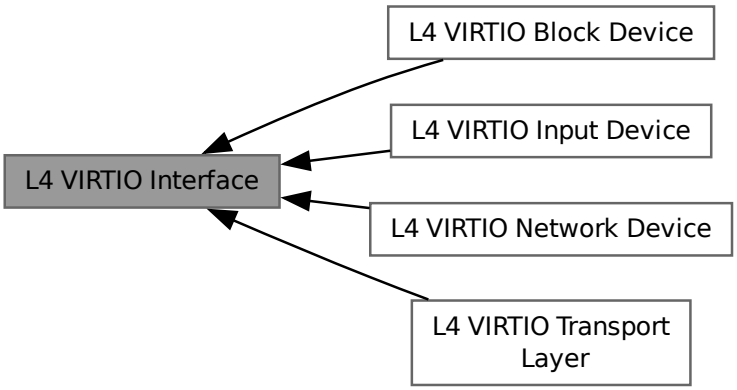
Enumerator

L4_VCON_WRITE_OP	Write.
L4_VCON_READ_OP	Read.
L4_VCON_SET_ATTR_OP	Get console attributes.
L4_VCON_GET_ATTR_OP	Set console attributes.

Definition at line 291 of file vcon.h.

13.7 L4 VIRTIO Interface

Collaboration diagram for L4 VIRTIO Interface:



Topics

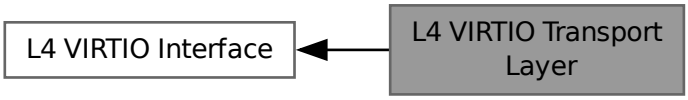
- L4 VIRTIO Transport Layer 446
  L4 specific VIRTIO Transport layer.
- L4 VIRTIO Block Device 454
- L4 VIRTIO Input Device 456
- L4 VIRTIO Network Device 456

13.7.1 Detailed Description

13.7.2 L4 VIRTIO Transport Layer

L4 specific VIRTIO Transport layer.

Collaboration diagram for L4 VIRTIO Transport Layer:



Namespaces

- namespace L4virtio

  L4-VIRTIO Transport C++ API.

Data Structures

- struct l4virtio_config_hdr_t

  L4-VIRTIO config header, provided in shared data space.
- struct l4virtio_config_queue_t

  Queue configuration entry.

Typedefs

- typedef struct l4virtio_config_hdr_t **l4virtio_config_hdr_t**

  L4-VIRTIO config header, provided in shared data space.
- typedef struct l4virtio_config_queue_t l4virtio_config_queue_t

  Queue configuration entry.

Enumerations

- enum L4_virtio_protocol

  L4-VIRTIO protocol number.
- enum L4_virtio_opcodes {
  L4VIRTIO_OP_SET_STATUS = 0 , L4VIRTIO_OP_CONFIG_QUEUE = 1 , L4VIRTIO_OP_REGISTER_DS = 3 , L4VIRTIO_OP_DEVICE_CONFIG = 4 ,
  L4VIRTIO_OP_GET_DEVICE_IRQ = 5 }

  Opcodes to setup and configure a device.
- enum L4virtio_device_ids {
  L4VIRTIO_ID_NET = 1 , L4VIRTIO_ID_BLOCK = 2 , L4VIRTIO_ID_CONSOLE = 3 , L4VIRTIO_ID_RNG = 4 ,
  L4VIRTIO_ID_BALLOON = 5 , L4VIRTIO_ID_RPMSG = 7 , L4VIRTIO_ID_SCSI = 8 , L4VIRTIO_ID_9P = 9 ,
  L4VIRTIO_ID_RPROC_SERIAL = 11 , L4VIRTIO_ID_CAIF = 12 , L4VIRTIO_ID_GPU = 16 , L4VIRTIO_ID_INPUT = 18 ,
  L4VIRTIO_ID_VSOCK = 19 , L4VIRTIO_ID_CRYPTO = 20 , L4VIRTIO_ID_SOUND = 25 , L4VIRTIO_ID_FS = 26 ,
  L4VIRTIO_ID_SCMI = 32 , L4VIRTIO_ID_I2C = 34 , L4VIRTIO_ID_WATCHDOG = 35 , L4VIRTIO_ID_CAN = 36 ,
  L4VIRTIO_ID_GPIO = 41 , L4VIRTIO_ID_SPI = 45 , L4VIRTIO_ID_SOCK = 0x9999 }

  Virtio device IDs as reported in the driver's config space.
- enum L4virtio_device_status {
  L4VIRTIO_STATUS_ACKNOWLEDGE = 1 , L4VIRTIO_STATUS_DRIVER = 2 , L4VIRTIO_STATUS_DRIVER_OK = 4 , L4VIRTIO_STATUS_FEATURES_OK = 8 ,
  L4VIRTIO_STATUS_DEVICE_NEEDS_RESET = 0x40 , L4VIRTIO_STATUS_FAILED = 0x80 }

Virtio device status bits.

- enum L4virtio_feature_bits { L4VIRTIO_FEATURE_VERSION_1 = 32 , L4VIRTIO_FEATURE_CMD_CONFIG = 160 }

  L4virtio-specific feature bits.
- enum L4_virtio_irq_status { L4VIRTIO_IRQ_STATUS_VRING = 1 , L4VIRTIO_IRQ_STATUS_CONFIG = 2 }

  VIRTIO IRQ status codes (l4virtio_config_hdr_t::irq_status).
- enum L4_virtio_cmd {
  L4VIRTIO_CMD_NONE = 0x00000000 , L4VIRTIO_CMD_SET_STATUS = 0x01000000 , L4VIRTIO_CMD_CFG_QUEUE = 0x02000000 , L4VIRTIO_CMD_CFG_CHANGED = 0x04000000 ,
  L4VIRTIO_CMD_NOTIFY_QUEUE = 0x08000000 , L4VIRTIO_CMD_MASK = 0xff000000 }

  Virtio commands for device configuration.

Functions

- L4_BEGIN_DECLS l4virtio_config_queue_t ∗ l4virtio_config_queues (l4virtio_config_hdr_t const ∗cfg)

  Get the pointer to the first queue config.
- void ∗ l4virtio_device_config (l4virtio_config_hdr_t const ∗cfg)

  Get the pointer to the device configuration.
- void **l4virtio_set_feature** (l4_uint32_t ∗feature_map, unsigned feat)

  Set the given feature bit in a feature map.
- void **l4virtio_clear_feature** (l4_uint32_t ∗feature_map, unsigned feat)

  Clear the given feature bit in a feature map.
- unsigned **l4virtio_get_feature** (l4_uint32_t ∗feature_map, unsigned feat)

  Check if the given bit in a feature map is set.
- int l4virtio_set_status (l4_cap_idx_t cap, unsigned status) L4_NOTHROW
- int l4virtio_config_queue (l4_cap_idx_t cap, unsigned queue) L4_NOTHROW
- int l4virtio_register_ds (l4_cap_idx_t cap, l4_cap_idx_t ds_cap, l4_uint64_t base, l4_umword_t offset, l4_umword_t size) L4_NOTHROW
- int l4virtio_device_config_ds (l4_cap_idx_t cap, l4_cap_idx_t config_ds, l4_addr_t ∗ds_offset) L4_NOTHROW
- int l4virtio_device_notification_irq (l4_cap_idx_t cap, unsigned index, l4_cap_idx_t irq) L4_NOTHROW

13.7.2.1 Detailed Description

L4 specific VIRTIO Transport layer.
The L4 specific VIRTIO Transport layer is based on L4Re::Dataspace as shared memory and L4::Irq for signaling. The VIRTIO configuration space is mostly based on a shared memory implementation too and accompanied by two IPC functions to synchronize the configuration between device and driver.

13.7.2.2 Typedef Documentation

13.7.2.2.1 l4virtio_config_queue_t

```
typedef struct l4virtio_config_queue_t l4virtio_config_queue_t
```

Queue configuration entry.
An array of such entries is available at the l4virtio_config_hdr_t::queues_offset in the config data space.
Consistency rules for the queue config are:

- A driver might read `num_max` at any time.
- A driver must write to `num`, `desc_addr`, `avail_addr`, and `used_addr` only when `ready` is zero (0). Values in these fields are validated and used by the device only after successfully setting `ready` to one (1), either by the IPC or by L4VIRTIO_CMD_CFG_QUEUE.
- The value of `device_notify_index` is valid only when `ready` is one.
- The driver might write to `device_notify_index` at any time, however the change is guaranteed to take effect after a successful L4VIRTIO_CMD_CFG_QUEUE or after a config_queue IPC. Note, the change might also have immediate effect, depending on the device implementation.

13.7.2.3 Enumeration Type Documentation

13.7.2.3.1 L4_virtio_cmd

enum L4_virtio_cmd
Virtio commands for device configuration.

Enumerator

L4VIRTIO_CMD_NONE	No command pending.
L4VIRTIO_CMD_SET_STATUS	Set the status register.
L4VIRTIO_CMD_CFG_QUEUE	Configure a queue.
L4VIRTIO_CMD_CFG_CHANGED	Device config changed.
L4VIRTIO_CMD_NOTIFY_QUEUE	Configure a queue.
L4VIRTIO_CMD_MASK	Mask to get command bits.

Definition at line 128 of file virtio.h.

13.7.2.3.2 L4_virtio_irq_status

enum L4_virtio_irq_status
VIRTIO IRQ status codes (l4virtio_config_hdr_t::irq_status).

Note

l4virtio_config_hdr_t::irq_status is currently unused.

Enumerator

L4VIRTIO_IRQ_STATUS_VRING	VRING IRQ pending flag.
L4VIRTIO_IRQ_STATUS_CONFIG	CONFIG IRQ pending flag.

Definition at line 119 of file virtio.h.

13.7.2.3.3 L4_virtio_opcodes

enum L4_virtio_opcodes
Opcodes to setup and configure a device.

Enumerator

L4VIRTIO_OP_SET_STATUS	Write device status register.
L4VIRTIO_OP_CONFIG_QUEUE	Configure queue.
L4VIRTIO_OP_REGISTER_DS	Register shared memory with device.
L4VIRTIO_OP_DEVICE_CONFIG	Get device config page.
L4VIRTIO_OP_GET_DEVICE_IRQ	Retrieve device notification IRQ.

Definition at line 52 of file virtio.h.

13.7.2.3.4 L4virtio_device_ids

enum L4virtio_device_ids
Virtio device IDs as reported in the driver's config space.

Enumerator

L4VIRTIO_ID_NET	Virtual ethernet card.
L4VIRTIO_ID_BLOCK	General block device.
L4VIRTIO_ID_CONSOLE	Simple device for data IO via ports.
L4VIRTIO_ID_RNG	Entropy source.
L4VIRTIO_ID_BALLOON	Memory ballooning device.
L4VIRTIO_ID_RPMSG	Device using rpmsg protocol.
L4VIRTIO_ID_SCSI	SCSI host device.
L4VIRTIO_ID_9P	Device using 9P transport protocol.
L4VIRTIO_ID_RPROC_SERIAL	Rproc serial device.
L4VIRTIO_ID_CAIF	Device using CAIF network protocol.
L4VIRTIO_ID_GPU	GPU.
L4VIRTIO_ID_INPUT	Input.
L4VIRTIO_ID_VSOCK	Vsock transport.
L4VIRTIO_ID_CRYPTO	Crypto.
L4VIRTIO_ID_SOUND	Sound device.
L4VIRTIO_ID_FS	FS.
L4VIRTIO_ID_SCMI	Scmi device.
L4VIRTIO_ID_I2C	I2C device.
L4VIRTIO_ID_WATCHDOG	Watchdog device.
L4VIRTIO_ID_CAN	CAN device.
L4VIRTIO_ID_GPIO	Gpio device.
L4VIRTIO_ID_SPI	SPI device.
L4VIRTIO_ID_SOCK	Unofficial socket device.

Definition at line 62 of file virtio.h.

13.7.2.3.5 L4virtio_device_status

`enum L4virtio_device_status`
Virtio device status bits.

Enumerator

L4VIRTIO_STATUS_ACKNOWLEDGE	Guest OS has found device.
L4VIRTIO_STATUS_DRIVER	Guest OS knows how to drive device.
L4VIRTIO_STATUS_DRIVER_OK	Driver is set up.
L4VIRTIO_STATUS_FEATURES_OK	Driver has acknowledged feature set.
L4VIRTIO_STATUS_DEVICE_NEEDS_RESET	Device detected fatal error.
L4VIRTIO_STATUS_FAILED	Driver detected fatal error.

Definition at line 91 of file virtio.h.

13.7.2.3.6 L4virtio_feature_bits

`enum L4virtio_feature_bits`
L4virtio-specific feature bits.

Enumerator

L4VIRTIO_FEATURE_VERSION_1	Virtio protocol version 1 supported. Must be 1 for L4virtio.
L4VIRTIO_FEATURE_CMD_CONFIG	Status and queue config are set via cmd field instead of via IPC.

Definition at line 107 of file virtio.h.

13.7.2.4 Function Documentation

13.7.2.4.1 l4virtio_config_queue()

```
int l4virtio_config_queue (
             l4_cap_idx_t cap,
             unsigned queue)
```

Parameters

cap	Capability to the VIRTIO host.

Trigger queue configuration of the given queue.
Usually all queues are configured when the status is written to running. However, in some cases queues shall be disabled or enabled dynamically, in this case this function triggers a reconfiguration from the shared memory register of the queue config.

Parameters

queue	Queue index for the queue to be configured.

Return values

0	on success.
-L4_EIO	The queue's status is invalid.
-L4_ERANGE	The queue index exceeds the number of queues.
-L4_EINVAL	Otherwise.

References L4_CV, and L4_NOTHROW.

13.7.2.4.2 l4virtio_config_queues()

```
L4_BEGIN_DECLS l4virtio_config_queue_t * l4virtio_config_queues (
             l4virtio_config_hdr_t const * cfg)  [inline]
```

Get the pointer to the first queue config.

Parameters

cfg	Pointer to the config header.

Returns

pointer to queue config of queue 0.

Definition at line 261 of file virtio.h.
References l4virtio_config_hdr_t::queues_offset.

13.7.2.4.3 l4virtio_device_config()

```
void * l4virtio_device_config (
            l4virtio_config_hdr_t const * cfg)  [inline]
```

Get the pointer to the device configuration.

Parameters

cfg	Pointer to the config header.

Returns

pointer to device configuration structure.

Definition at line 272 of file virtio.h.

13.7.2.4.4 l4virtio_device_config_ds()

```
int l4virtio_device_config_ds (
            l4_cap_idx_t cap,
            l4_cap_idx_t config_ds,
            l4_addr_t * ds_offset)
```

Parameters

cap	Capability to the L4-VIRTIO host

Get the dataspace with the L4virtio configuration page.

Parameters

config_ds	Capability for receiving the dataspace capability for the shared L4-VIRTIO config data space.
ds_offset	Offset into the dataspace where the device configuration structure starts.

References L4_CV, and L4_NOTHROW.

13.7.2.4.5 l4virtio_device_notification_irq()

```
int l4virtio_device_notification_irq (
            l4_cap_idx_t cap,
            unsigned index,
            l4_cap_idx_t irq)
```

Parameters

cap	Capability to the L4-VIRTIO host

Get the notification interrupt corresponding to the given index.

Parameters

	index	Index of the interrupt.
out	*irq*	Triggerable for the given index.

Return values

L4_EOK	Success.
L4_ENOSYS	IRQ notification not supported by device.
<0	Other error.

An index is only guaranteed to return an IRQ object when the index is set in one of the device notify index fields. The device must return the same interrupt for a given index as long as the index is in use. If an index disappears as a result of a configuration change and then is reused later, the interrupt is not guaranteed to be the same.
Interrupts must always be rerequested after a device reset.
References L4_END_DECLS, and L4_NOTHROW.

13.7.2.4.6 l4virtio_register_ds()

```
int l4virtio_register_ds (
              l4_cap_idx_t cap,
              l4_cap_idx_t ds_cap,
              l4_uint64_t base,
              l4_umword_t offset,
              l4_umword_t size)
```

Parameters

cap	Capability to the VIRTIO host

Register a shared data space with VIRTIO host.

Parameters

ds_cap	Dataspace capability to register. The lower 8 bits determine the rights mask with which the guest's rights are masked during the registration of the dataspace at the VIRTIO host.
base	VIRTIO guest physical start address of shared memory region
offset	Offset within the data space that is attached to the given `base` in the guest physical memory.
size	Size of the memory region in the guest

Return values

L4_EOK	Operation successful.
-L4_EINVAL	The `ds_cap` capability is invalid, does not refer to a valid dataspace, is not a trusted dataspace if trusted dataspace validation is enabled, or `size` and `offset` specify an invalid region.
-L4_ENOMEM	The limit of dataspaces that can be registered has been reached or no capability slot could be allocated.
-L4_ERANGE	`offset` is lager than the size of the dataspace.

<0	Any error returned by the dataspace when queried for information during setup or any error returned by the region manager from attaching the dataspace.

References L4_CV, and L4_NOTHROW.

13.7.2.4.7 l4virtio_set_status()

```
int l4virtio_set_status (
             l4_cap_idx_t cap,
             unsigned status)
```

Parameters

cap	Capability to the VIRTIO host

Write the VIRTIO status register.

Parameters

status	Status word to write to the VIRTIO status.

Return values

0	on success.

Note

All other registers are accessed via shared memory.

References L4_CV, and L4_NOTHROW.

13.7.3 L4 VIRTIO Block Device

Collaboration diagram for L4 VIRTIO Block Device:



Data Structures

- struct l4virtio_block_header_t

  Header structure of a request for a block device.
- struct l4virtio_block_discard_t

  Structure used for the write zeroes and discard commands.
- struct l4virtio_block_config_t

  Device configuration for block devices.

Typedefs

- typedef struct l4virtio_block_header_t **l4virtio_block_header_t**

  Header structure of a request for a block device.
- typedef struct l4virtio_block_discard_t **l4virtio_block_discard_t**

  Structure used for the write zeroes and discard commands.
- typedef struct l4virtio_block_config_t **l4virtio_block_config_t**

  Device configuration for block devices.

Enumerations

- enum L4virtio_block_operations {
  L4VIRTIO_BLOCK_T_IN = 0 , L4VIRTIO_BLOCK_T_OUT = 1 , L4VIRTIO_BLOCK_T_FLUSH = 4 ,
  L4VIRTIO_BLOCK_T_GET_ID = 8 ,
  L4VIRTIO_BLOCK_T_DISCARD = 11 , L4VIRTIO_BLOCK_T_WRITE_ZEROES = 13 }

  Kinds of operation over a block device.
- enum L4virtio_block_status { L4VIRTIO_BLOCK_S_OK = 0 , L4VIRTIO_BLOCK_S_IOERR = 1 ,
  L4VIRTIO_BLOCK_S_UNSUPP = 2 }

  Status of a finished block request.
- enum L4virtio_block_feature_bits

  Block device feature bits.

13.7.3.1 Detailed Description

13.7.3.2 Enumeration Type Documentation

13.7.3.2.1 L4virtio_block_operations

`enum L4virtio_block_operations`
Kinds of operation over a block device.

Enumerator

L4VIRTIO_BLOCK_T_IN	Read from device.
L4VIRTIO_BLOCK_T_OUT	Write to device.
L4VIRTIO_BLOCK_T_FLUSH	Flush data to disk.
L4VIRTIO_BLOCK_T_GET_ID	Get device ID.
L4VIRTIO_BLOCK_T_DISCARD	Discard a range of sectors.
L4VIRTIO_BLOCK_T_WRITE_ZEROES	Write zeroes to a range of sectors.

Definition at line 19 of file virtio_block.h.

13.7.3.2.2 L4virtio_block_status

`enum L4virtio_block_status`
Status of a finished block request.

Enumerator

L4VIRTIO_BLOCK_S_OK	Request finished successfully.
L4VIRTIO_BLOCK_S_IOERR	IO error on device.
L4VIRTIO_BLOCK_S_UNSUPP	Operation is not supported.

Definition at line 32 of file virtio_block.h.

13.7.4 L4 VIRTIO Input Device

Collaboration diagram for L4 VIRTIO Input Device:



Data Structures

- struct l4virtio_input_absinfo_t

  Information about the absolute axis in the underlying evdev implementation.
- struct l4virtio_input_devids_t

  Device ID information for the device.
- struct l4virtio_input_config_t

  Device configuration for input devices.
- struct l4virtio_input_event_t

  Single event in event or status queue.

Typedefs

- typedef struct l4virtio_input_absinfo_t **l4virtio_absinfo_t**

  Information about the absolute axis in the underlying evdev implementation.
- typedef struct l4virtio_input_devids_t **l4virtio_input_devids_t**

  Device ID information for the device.
- typedef struct l4virtio_input_config_t **l4virtio_input_config_t**

  Device configuration for input devices.
- typedef struct l4virtio_input_event_t **l4virtio_input_event_t**

  Single event in event or status queue.

Enumerations

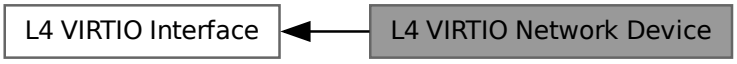
- enum L4virtio_input_config_select

  Device information selectors.

13.7.4.1 Detailed Description

13.7.5 L4 VIRTIO Network Device

Collaboration diagram for L4 VIRTIO Network Device:



Data Structures

- struct l4virtio_net_header_t

  Header structure of a request for a network device.
- struct l4virtio_net_config_t

  Device configuration for network devices.

Typedefs

- typedef struct l4virtio_net_header_t **l4virtio_net_header_t**

  Header structure of a request for a network device.
- typedef struct l4virtio_net_config_t **l4virtio_net_config_t**

  Device configuration for network devices.

Enumerations

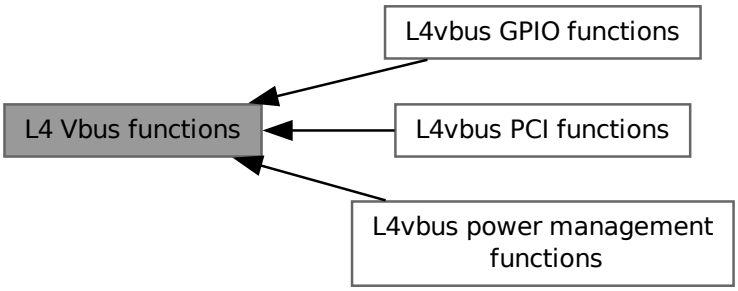
- enum L4virtio_net_feature_bits

  Network device feature bits.

13.7.5.1 Detailed Description

13.8 L4 Vbus functions

C interface of the Vbus API.
Collaboration diagram for L4 Vbus functions:



Topics

- L4vbus GPIO functions 466
- L4vbus PCI functions 475
- L4vbus power management functions 480

Enumerations

- enum L4vbus_dma_domain_assign_flags { L4VBUS_DMAD_UNBIND = 0 , L4VBUS_DMAD_BIND = 1 , L4VBUS_DMAD_L4RE_DMA_SPACE = 0 }

  Flags for l4vbus_assign_dma_domain().

Functions

- L4_BEGIN_DECLS int l4vbus_get_device_by_hid (l4_cap_idx_t vbus, l4vbus_device_handle_t parent, l4vbus_device_handle_t *child, char const *hid, int depth, l4vbus_device_t *devinfo)

  Find a device by the hardware interface identifier (HID).
- int l4vbus_get_next_device (l4_cap_idx_t vbus, l4vbus_device_handle_t parent, l4vbus_device_handle_t *child, int depth, l4vbus_device_t *devinfo)

  Find next child following `child`.
- int l4vbus_get_device (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, l4vbus_device_t *devinfo)

  Obtain detailed information about a Vbus device.
- int l4vbus_get_resource (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, unsigned res_idx, l4vbus_resource_t *res)

  Obtain the resource description of an individual device resource.
- int l4vbus_is_compatible (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, char const *cid)

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- int l4vbus_get_hid (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, char *hid, unsigned long max_len)

  Get the HID (hardware identifier) of a device.
- int l4vbus_get_adr (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, l4_uint32_t *adr)

  Get the bus-specific address of a device.
- int l4vbus_request_ioport (l4_cap_idx_t vbus, l4vbus_resource_t const *res)

  Request an IO port resource.
- int l4vbus_assign_dma_domain (l4_cap_idx_t vbus, unsigned domain_id, unsigned flags, l4_cap_idx_t dma_space)

  Bind or unbind a kernel DMA space or a L4Re::Dma_space to a DMA domain.
- int l4vbus_release_ioport (l4_cap_idx_t vbus, l4vbus_resource_t const *res)

  Release a previously requested IO port resource.
- int l4vbus_vicu_get_cap (l4_cap_idx_t vbus, l4vbus_device_handle_t icu, l4_cap_idx_t cap)

  Get capability of ICU.

13.8.1 Detailed Description

C interface of the Vbus API.
The virtual bus (Vbus) is a hierarchical (tree) structure of device nodes where each device has a set of resources attached to it. Each virtual bus provides an Icu (Interrupt controller) for interrupt handling.
The Vbus interface allows a client to find and query devices present on his virtual bus. After obtaining a device handle for a specific device the client can enumerate its resources.

Include File

```
#include <l4/vbus/vbus.h>
```

Refer to L4vbus for the C++ API.

13.8.2 Enumeration Type Documentation

13.8.2.1 L4vbus_dma_domain_assign_flags

`enum L4vbus_dma_domain_assign_flags`
Flags for l4vbus_assign_dma_domain().

Enumerator

L4VBUS_DMAD_UNBIND	Unbind the given DMA space from the DMA domain.
L4VBUS_DMAD_BIND	Bind the given DMA space to the DMA domain.
L4VBUS_DMAD_L4RE_DMA_SPACE	The given DMA space is an L4Re::Dma_space.

Definition at line 174 of file vbus.h.

13.8.3 Function Documentation

13.8.3.1 l4vbus_assign_dma_domain()

```
int l4vbus_assign_dma_domain (
             l4_cap_idx_t vbus,
             unsigned domain_id,
             unsigned flags,
             l4_cap_idx_t dma_space)
```

Bind or unbind a kernel DMA space or a L4Re::Dma_space to a DMA domain.

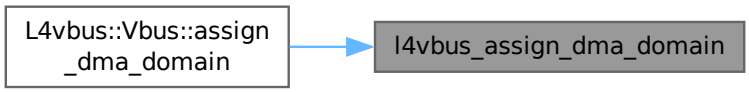
Parameters

vbus	Capability of the system bus
domain_id	DMA domain ID (resource address of DMA domain found on the vBUS). If the value is ~0U the DMA space of the whole vBUS is used.
flags	A combination of L4vbus_dma_domain_assign_flags.
dma_space	The DMA space capability to bind, this must be an L4Re::Dma_space. For unbind the `dma_space` is ignored and should be L4_INVALID_CAP.

Return values

0	Operation completed successfully.
-L4_ENOENT	The vbus does not support a global DMA domain or no DMA domain could be found.
-L4_EINVAL	Invalid argument used.
-L4_EBUSY	DMA domain is already active, this means another DMA space is already assigned.

References L4_CV.
Referenced by L4vbus::Vbus::assign_dma_domain().
Here is the caller graph for this function:



13.8.3.2 l4vbus_get_adr()

```
int l4vbus_get_adr (
             l4_cap_idx_t vbus,
             l4vbus_device_handle_t dev,
             l4_uint32_t * adr)
```

Get the bus-specific address of a device.

Parameters

	vbus	Capability of the system bus

	dev	Handle of the device
out	*adr*	Address

Return values

L4_EOK	Success.
-L4_ENOSYS	Device has no valid address.

References L4_CV.

13.8.3.3 l4vbus_get_device()

```
int l4vbus_get_device (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t dev,
              l4vbus_device_t * devinfo)
```

Obtain detailed information about a Vbus device.

Parameters

	vbus	Capability of the vbus to which the device is connected.
	dev	Device handle of the device from which to retrieve the details.
out	*devinfo*	Information structure which contains details about the device. The pointer might be NULL.

Return values

0	Success.
-L4_ENODEV	No device with the given device handle `dev` could be found.

References L4_CV.
Referenced by L4vbus::Device::device().
Here is the caller graph for this function:



13.8.3.4 l4vbus_get_device_by_hid()

```
L4_BEGIN_DECLS int l4vbus_get_device_by_hid (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t parent,
              l4vbus_device_handle_t * child,
              char const * hid,
```

```
            int depth,
            l4vbus_device_t * devinfo)
```

Find a device by the hardware interface identifier (HID).

Parameters

vbus	Capability of the system bus
parent	Handle to the parent to start the search

This function searches the vbus for a device with the given HID and returns a handle to the first matching device. The HID usually conforms to an ACPI HID or a Linux device tree compatible identifier.
It is possible to have multiple devices with the same HID on a vbus. In order to find all matching devices this function has to be called repeatedly with `child` pointing to the device found in the previous iteration. The iteration starts at `child` that might be any device node in the tree.

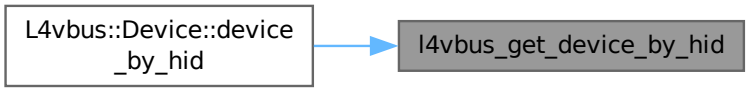
Parameters

`in,out`	*child*	Handle of the device from where in the device tree the search should start. To start searching from the beginning `child` must be initialized using the default (L4VBUS_NULL). If a matching device is found, its handle is returned through this parameter.
	hid	HID of the device
	depth	Maximum depth for the recursive lookup
`out`	*devinfo*	Device information structure (might be NULL)

Return values

>=0	A device with the given HID was found.
-L4_ENOENT	No device with the given HID could be found on the vbus.
-L4_EINVAL	Invalid or no HID provided.
-L4_ENODEV	Function called on a non-existing device.

References L4_CV.
Referenced by L4vbus::Device::device_by_hid().
Here is the caller graph for this function:



13.8.3.5 l4vbus_get_hid()

```
int l4vbus_get_hid (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t dev,
```

```
            char * hid,
            unsigned long max_len)
```

Get the HID (hardware identifier) of a device.

Parameters

vbus	Capability of the system bus
dev	Handle of the device
hid	Pointer to a buffer for the HID string
max_len	The size of the buffer (*hid*)

Returns

the length of the HID string on success, else failure

References L4_CV.

13.8.3.6 l4vbus_get_next_device()

```
int l4vbus_get_next_device (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t parent,
            l4vbus_device_handle_t * child,
            int depth,
            l4vbus_device_t * devinfo)
```

Find next child following `child`.

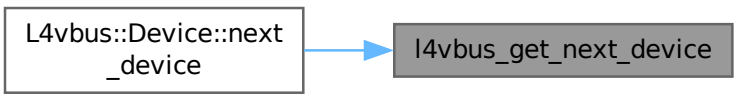
Parameters

	vbus	Capability of the system bus
	parent	Handle to the parent device (use L4VBUS_ROOT_BUS for the system bus)
`in,out`	*child*	Handle of the device that precedes the device that shall be returned. To start from the beginning, `child` must be initialized with L4VBUS_NULL. If a device is found, its handle is returned through this parameter.
	depth	Depth to look for
`out`	*devinfo*	Device information (might be NULL)

Returns

0 on success, else failure

References L4_CV.
Referenced by L4vbus::Device::next_device().
Here is the caller graph for this function:



13.8.3.7 l4vbus_get_resource()

```
int l4vbus_get_resource (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t dev,
            unsigned res_idx,
            l4vbus_resource_t * res)
```

Obtain the resource description of an individual device resource.

Parameters

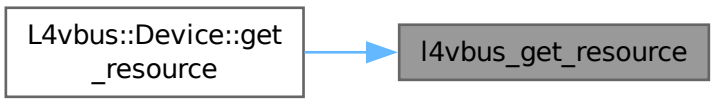
	vbus	Capability of the vbus to which the device is connected.
	dev	Device handle of the device on the vbus. The device handle can be obtained by using the l4vbus_get_device_by_hid() and l4vbus_get_next_device() functions.
	res_idx	Index of the resource for which the resource description should be returned. The total number of resources for a device is available in the l4vbus_device_t structure that is returned by L4vbus::Device::device_by_hid() and L4vbus::Device::next_device().
out	*res*	Descriptor of the resource.

This function returns the resource descriptor of an individual device resource selected by the `res_idx` parameter.

Return values

0	Success.
-L4_ENOENT	Invalid resource index `res_idx`.

References L4_CV.
Referenced by L4vbus::Device::get_resource().
Here is the caller graph for this function:



13.8.3.8 l4vbus_is_compatible()

```
int l4vbus_is_compatible (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t dev,
            char const * cid)
```

Check if the given device has a compatibility ID (CID) or HID that matches *cid*.

Parameters

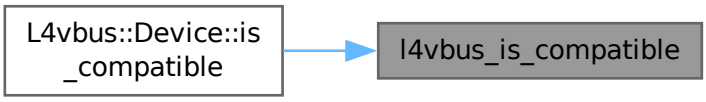
vbus	Capability of the system bus
dev	device handle for which the CID shall be tested

cid	the compatibility ID to test

Returns

1 when the given ID (*cid*) matches this device, 0 when the given ID does not match, <0 on error.

References L4_CV.
Referenced by L4vbus::Device::is_compatible().
Here is the caller graph for this function:



13.8.3.9 l4vbus_release_ioport()

```
int l4vbus_release_ioport (
            l4_cap_idx_t vbus,
            l4vbus_resource_t const * res)
```

Release a previously requested IO port resource.

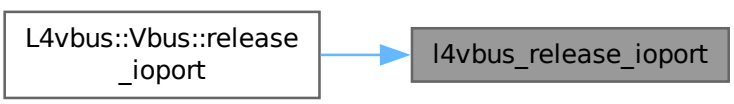
Parameters

	vbus	Capability of the system bus.
in	*res*	The IO port resource to be released from the bus.

Returns

>=0 on success, <0 on error.

References L4_CV.
Referenced by L4vbus::Vbus::release_ioport().
Here is the caller graph for this function:



13.8.3.10 l4vbus_request_ioport()

```
int l4vbus_request_ioport (
             l4_cap_idx_t vbus,
             l4vbus_resource_t const * res)
```

Request an IO port resource.

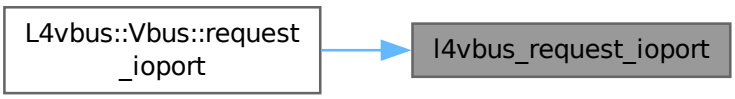
Parameters

	vbus	Capability of the system bus.
in	*res*	The IO port resource to be requested from the bus.

Return values

0	Success.
-L4_EINVAL	Resource is not an IO port resource.
-L4_ENOENT	No matching IO port resource found.

If any IO port resource is found that contains the requested IO port range the IO ports are obtained.
Referenced by L4vbus::Vbus::request_ioport().
Here is the caller graph for this function:



13.8.3.11 l4vbus_vicu_get_cap()

```
int l4vbus_vicu_get_cap (
             l4_cap_idx_t vbus,
             l4vbus_device_handle_t icu,
             l4_cap_idx_t cap)
```

Get capability of ICU.

Parameters

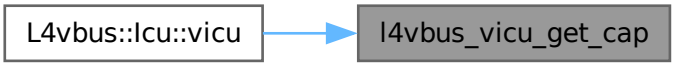
vbus	Capability of the system bus.
icu	ICU device handle.
cap	Capability slot for the capability.

Returns

0 on success, else failure

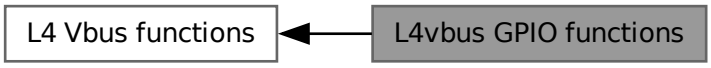
References L4_END_DECLS.

Referenced by L4vbus::Icu::vicu().
Here is the caller graph for this function:



13.8.4 L4vbus GPIO functions

Collaboration diagram for L4vbus GPIO functions:



Enumerations

- enum L4vbus_gpio_generic_func { L4VBUS_GPIO_SETUP_INPUT = 0x100 , L4VBUS_GPIO_SETUP_OUTPUT = 0x200 , L4VBUS_GPIO_SETUP_IRQ = 0x300 }

  Constants for generic GPIO functions.
- enum L4vbus_gpio_pull_modes { L4VBUS_GPIO_PIN_PULL_NONE = 0x100 , L4VBUS_GPIO_PIN_PULL_UP = 0x200 , L4VBUS_GPIO_PIN_PULL_DOWN = 0x300 }

  Constants for generic GPIO pull up/down resistor configuration.

Functions

- int l4vbus_gpio_setup (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned pin, unsigned mode, int value)

  Configure the function of a GPIO pin.
- int l4vbus_gpio_config_pull (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned pin, unsigned mode)

  Generic function to set pull up/down mode.
- int l4vbus_gpio_config_pad (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned pin, unsigned func, unsigned value)

  Hardware specific configuration function.
- int l4vbus_gpio_config_get (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned pin, unsigned func, unsigned *value)

  Read hardware specific configuration.
- int l4vbus_gpio_get (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned pin)

  Read value of GPIO input pin.
- int l4vbus_gpio_set (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned pin, int value)

  Set GPIO output pin.

- int l4vbus_gpio_multi_setup (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned offset, unsigned mask, unsigned mode, unsigned value)

  Configure function of multiple GPIO pins at once.
- int l4vbus_gpio_multi_config_pad (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned offset, unsigned mask, unsigned func, unsigned value)

  Hardware specific configuration function for multiple GPIO pins.
- int l4vbus_gpio_multi_get (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned offset, unsigned *data)

  Read values of multiple GPIO pins at once.
- int l4vbus_gpio_multi_set (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned offset, unsigned mask, unsigned data)

  Set multiple GPIO output pins at once.
- int l4vbus_gpio_to_irq (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned pin)

  Create IRQ for GPIO pin.

13.8.4.1 Detailed Description

13.8.4.2 Enumeration Type Documentation

13.8.4.2.1 L4vbus_gpio_generic_func

`enum L4vbus_gpio_generic_func`
Constants for generic GPIO functions.

Enumerator

L4VBUS_GPIO_SETUP_INPUT	Set GPIO pin to input.
L4VBUS_GPIO_SETUP_OUTPUT	Set GPIO pin to output.
L4VBUS_GPIO_SETUP_IRQ	Set GPIO pin to IRQ.

Definition at line 24 of file vbus_gpio.h.

13.8.4.2.2 L4vbus_gpio_pull_modes

`enum L4vbus_gpio_pull_modes`
Constants for generic GPIO pull up/down resistor configuration.

Enumerator

L4VBUS_GPIO_PIN_PULL_NONE	No pull up or pull down resistors.
L4VBUS_GPIO_PIN_PULL_UP	enable pull up resistor
L4VBUS_GPIO_PIN_PULL_DOWN	enable pull down resistor

Definition at line 34 of file vbus_gpio.h.

13.8.4.3 Function Documentation

13.8.4.3.1 l4vbus_gpio_config_get()

```
int l4vbus_gpio_config_get (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t handle,
            unsigned pin,
            unsigned func,
            unsigned * value)
```

Read hardware specific configuration.

Parameters

	vbus	V-BUS capability
	handle	Device handle for the GPIO chip
	pin	GPIO pin number
	func	Hardware specific configuration register to read from. Usually this is an offset to the GPIO chip's base address.
out	*value*	The configuration value.

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_pin::config_get().
Here is the caller graph for this function:



13.8.4.3.2 l4vbus_gpio_config_pad()

```
int l4vbus_gpio_config_pad (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t handle,
            unsigned pin,
            unsigned func,
            unsigned value)
```

Hardware specific configuration function.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
pin	GPIO pin number
func	Hardware specific configuration register, usually offset to the GPIO chip's base address
value	Value which is written into the hardware specific configuration register for the specified pin

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_pin::config_pad().

Here is the caller graph for this function:



13.8.4.3.3 l4vbus_gpio_config_pull()

```
int l4vbus_gpio_config_pull (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t handle,
              unsigned pin,
              unsigned mode)
```

Generic function to set pull up/down mode.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
pin	GPIO pin number
mode	mode for pull up/down resistors, see L4vbus_gpio_pull_modes

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_pin::config_pull().
Here is the caller graph for this function:



13.8.4.3.4 l4vbus_gpio_get()

```
int l4vbus_gpio_get (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t handle,
              unsigned pin)
```

Read value of GPIO input pin.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
pin	GPIO pin number to read from

Returns

Value of GPIO pin (usually 0 or 1), negative error code otherwise.

References L4_CV.
Referenced by L4vbus::Gpio_pin::get().
Here is the caller graph for this function:



13.8.4.3.5 l4vbus_gpio_multi_config_pad()

```
int l4vbus_gpio_multi_config_pad (
             l4_cap_idx_t vbus,
             l4vbus_device_handle_t handle,
             unsigned offset,
             unsigned mask,
             unsigned func,
             unsigned value)
```

Hardware specific configuration function for multiple GPIO pins.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
offset	Pin corresponding to the LSB in *mask*. Note: allowed may be hardware specific.
mask	Mask of GPIO pins to configure. A bit set to 1 configures this pin. A maximum of 32 pins can be configured at once. The real number depends on the hardware and the driver implementation.
func	Hardware specific configuration register, usually offset to the GPIO chip's base address.
value	Value which is written into the hardware specific configuration register for the specified pins

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_module::config_pad().

Here is the caller graph for this function:



13.8.4.3.6 l4vbus_gpio_multi_get()

```
int l4vbus_gpio_multi_get (
             l4_cap_idx_t vbus,
             l4vbus_device_handle_t handle,
             unsigned offset,
             unsigned * data)
```

Read values of multiple GPIO pins at once.

Parameters

	vbus	V-BUS capability
	handle	Device handle for the GPIO chip
	offset	Pin corresponding to the LSB in *data*. Note: allowed may be hardware specific.
out	*data*	Each bit returns the value (0 or 1) for the corresponding GPIO pin. The value of pins that are not accessible is undefined.

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_module::get().
Here is the caller graph for this function:



13.8.4.3.7 l4vbus_gpio_multi_set()

```
int l4vbus_gpio_multi_set (
             l4_cap_idx_t vbus,
             l4vbus_device_handle_t handle,
             unsigned offset,
             unsigned mask,
             unsigned data)
```

Set multiple GPIO output pins at once.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
offset	Pin corresponding to the LSB in *data*. Note: allowed may be hardware specific.
mask	Mask of GPIO pins to set. A bit set to 1 selects this pin. A maximum of 32 pins can be set at once. The real number depends on the hardware and the driver implementation.
data	Each bit corresponds to the GPIO pin in *mask*. The value of each bit is written to the GPIO pin if its bit in *mask* is set.

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_module::set().
Here is the caller graph for this function:



13.8.4.3.8 l4vbus_gpio_multi_setup()

```
int l4vbus_gpio_multi_setup (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t handle,
              unsigned offset,
              unsigned mask,
              unsigned mode,
              unsigned value)
```

Configure function of multiple GPIO pins at once.

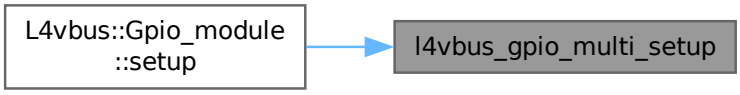
Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
offset	Pin corresponding to the LSB in *mask*. Note: allowed may be hardware specific.
mask	Mask of GPIO pins to configure. A bit set to 1 configures this pin. A maximum of 32 pins can be configured at once. The real number depends on the hardware and the driver implementation.
mode	GPIO function, see L4vbus_gpio_generic_func for generic functions. Hardware specific functions must be provided in the lower 8 bits.
value	Optional value to set the GPIO pins to if they are configured as output pins

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_module::setup().
Here is the caller graph for this function:



13.8.4.3.9 l4vbus_gpio_set()

```
int l4vbus_gpio_set (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t handle,
              unsigned pin,
              int value)
```

Set GPIO output pin.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
pin	GPIO pin number to write to
value	Value to write to the GPIO pin (usually 0 or 1)

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_pin::set().
Here is the caller graph for this function:



13.8.4.3.10 l4vbus_gpio_setup()

```
int l4vbus_gpio_setup (
              l4_cap_idx_t vbus,
```

```
                l4vbus_device_handle_t handle,
                unsigned pin,
                unsigned mode,
                int value)
```

Configure the function of a GPIO pin.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
pin	GPIO pin number
mode	GPIO function, see L4vbus_gpio_generic_func for generic functions. Hardware specific functions must be provided in the lower 8 bits.
value	Optional value to set the GPIO pin to if it is configured as an output pin

Returns

0 if OK, error code otherwise

References L4_CV.
Referenced by L4vbus::Gpio_pin::setup().
Here is the caller graph for this function:



13.8.4.3.11 l4vbus_gpio_to_irq()

```
int l4vbus_gpio_to_irq (
                l4_cap_idx_t vbus,
                l4vbus_device_handle_t handle,
                unsigned pin)
```

Create IRQ for GPIO pin.

Parameters

vbus	V-BUS capability
handle	Device handle for the GPIO chip
pin	GPIO pin to create an IRQ for.

Returns

IRQ number if OK, negative error code otherwise

References L4_END_DECLS.
Referenced by L4vbus::Gpio_pin::to_irq().

Here is the caller graph for this function:



13.8.5 L4vbus PCI functions

Collaboration diagram for L4vbus PCI functions:



Functions

- L4_BEGIN_DECLS int l4vbus_pci_cfg_read (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, l4_uint32_t bus, l4_uint32_t devfn, l4_uint32_t reg, l4_uint32_t *value, l4_uint32_t width)

  Read from the vPCI configuration space using the PCI root bridge.
- int l4vbus_pci_cfg_write (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, l4_uint32_t bus, l4_uint32_t devfn, l4_uint32_t reg, l4_uint32_t value, l4_uint32_t width)

  Write to the vPCI configuration space using the PCI root bridge.
- int l4vbus_pci_irq_enable (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, l4_uint32_t bus, l4_uint32_t devfn, int pin, unsigned char *trigger, unsigned char *polarity)

  Enable PCI interrupt for a specific device using the PCI root bridge.
- int l4vbus_pcidev_cfg_read (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, l4_uint32_t reg, l4_uint32_t *value, l4_uint32_t width)

  Read from the device's vPCI configuration space.
- int l4vbus_pcidev_cfg_write (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, l4_uint32_t reg, l4_uint32_t value, l4_uint32_t width)

  Write to the device's vPCI configuration space.
- int l4vbus_pcidev_irq_enable (l4_cap_idx_t vbus, l4vbus_device_handle_t handle, unsigned char *trigger, unsigned char *polarity)

  Enable the device's PCI interrupt.

13.8.5.1 Detailed Description

13.8.5.2 Function Documentation

13.8.5.2.1 l4vbus_pci_cfg_read()

```
L4_BEGIN_DECLS int l4vbus_pci_cfg_read (
             l4_cap_idx_t vbus,
             l4vbus_device_handle_t handle,
             l4_uint32_t bus,
```

```
                l4_uint32_t devfn,
                l4_uint32_t reg,
                l4_uint32_t * value,
                l4_uint32_t width)
```

Read from the vPCI configuration space using the PCI root bridge.

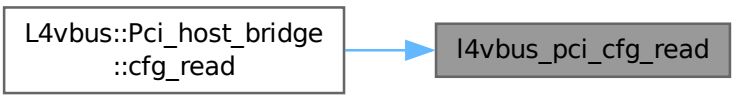
Parameters

	vbus	Capability of the system bus
	handle	Device handle of the PCI root bridge
	bus	Bus number
	devfn	Device id (upper 16bit) and function (lower 16bit)
	reg	Register in configuration space to read
out	*value*	Value that has been read
	width	Width to read in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

References L4_CV.
Referenced by L4vbus::Pci_host_bridge::cfg_read().
Here is the caller graph for this function:



13.8.5.2.2 l4vbus_pci_cfg_write()

```
int l4vbus_pci_cfg_write (
                l4_cap_idx_t vbus,
                l4vbus_device_handle_t handle,
                l4_uint32_t bus,
                l4_uint32_t devfn,
                l4_uint32_t reg,
                l4_uint32_t value,
                l4_uint32_t width)
```

Write to the vPCI configuration space using the PCI root bridge.

Parameters

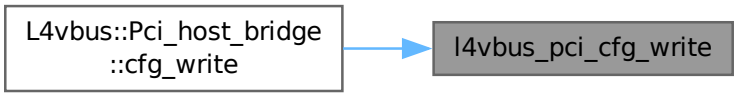
vbus	Capability of the system bus
handle	Device handle of the PCI root bridge
bus	Bus number

devfn	Device id (upper 16bit) and function (lower 16bit)
reg	Register in configuration space to write
value	Value to write
width	Width to write in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

References L4_CV.
Referenced by L4vbus::Pci_host_bridge::cfg_write().
Here is the caller graph for this function:



13.8.5.2.3 l4vbus_pci_irq_enable()

```
int l4vbus_pci_irq_enable (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t handle,
              l4_uint32_t bus,
              l4_uint32_t devfn,
              int pin,
              unsigned char * trigger,
              unsigned char * polarity)
```

Enable PCI interrupt for a specific device using the PCI root bridge.

Parameters

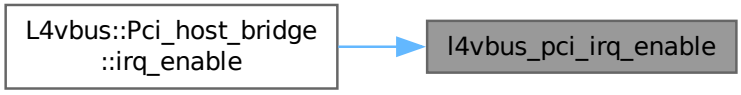
	vbus	Capability of the system bus
	handle	Device handle of the PCI root bridge
	bus	Bus number
	devfn	Device id (upper 16bit) and function (lower 16bit)
	pin	Interrupt pin (normally as reported in configuration register INTR)
out	*trigger*	False if interrupt is level-triggered
out	*polarity*	True if interrupt is of low polarity

Returns

On success: Interrupt line to be used, else failure

References L4_CV.
Referenced by L4vbus::Pci_host_bridge::irq_enable().

Here is the caller graph for this function:



13.8.5.2.4 l4vbus_pcidev_cfg_read()

```
int l4vbus_pcidev_cfg_read (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t handle,
              l4_uint32_t reg,
              l4_uint32_t * value,
              l4_uint32_t width)
```

Read from the device's vPCI configuration space.

Parameters

	vbus	Capability of the system bus
	handle	Device handle of the PCI device
	reg	Register in configuration space to read
out	*value*	Value that has been read
	width	Width to read in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

References L4_CV.
Referenced by L4vbus::Pci_dev::cfg_read().
Here is the caller graph for this function:



13.8.5.2.5 l4vbus_pcidev_cfg_write()

```
int l4vbus_pcidev_cfg_write (
              l4_cap_idx_t vbus,
              l4vbus_device_handle_t handle,
              l4_uint32_t reg,
```

```
                l4_uint32_t value,
                l4_uint32_t width)
```

Write to the device's vPCI configuration space.

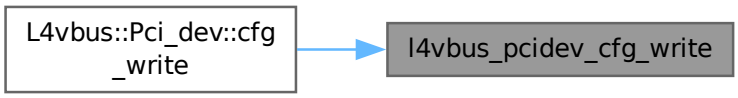
Parameters

vbus	Capability of the system bus
handle	Device handle of the PCI device
reg	Register in configuration space to write
value	Value to write
width	Width to write in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

References L4_CV.
Referenced by L4vbus::Pci_dev::cfg_write().
Here is the caller graph for this function:



13.8.5.2.6 l4vbus_pcidev_irq_enable()

```
int l4vbus_pcidev_irq_enable (
                l4_cap_idx_t vbus,
                l4vbus_device_handle_t handle,
                unsigned char * trigger,
                unsigned char * polarity)
```

Enable the device's PCI interrupt.

Parameters

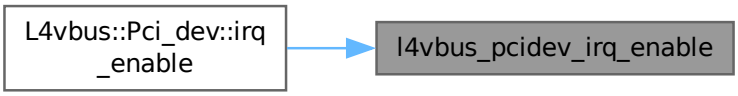
	vbus	Capability of the system bus
	handle	Device handle of the PCI device
out	*trigger*	False if interrupt is level-triggered
out	*polarity*	True if interrupt is of low polarity

Returns

On success: Interrupt line to be used, else failure

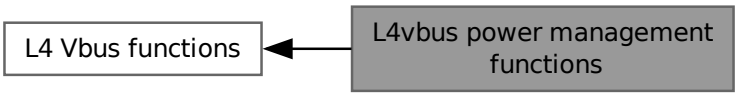
References L4_END_DECLS.
Referenced by L4vbus::Pci_dev::irq_enable().

Here is the caller graph for this function:



13.8.6 L4vbus power management functions

Collaboration diagram for L4vbus power management functions:



Functions

- L4_BEGIN_DECLS int l4vbus_pm_suspend (l4_cap_idx_t vbus, l4vbus_device_handle_t handle)

  Suspend the device.
- int l4vbus_pm_resume (l4_cap_idx_t vbus, l4vbus_device_handle_t handle)

  Resume the device.

13.8.6.1 Detailed Description

13.8.6.2 Function Documentation

13.8.6.2.1 l4vbus_pm_resume()

```
int l4vbus_pm_resume (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t handle)
```

Resume the device.

Parameters

vbus	V-BUS capability
handle	Handle for the device to be resumed Switches the device from low-power mode to normal operation and restores the saved state.

Return values

0	Success.

References L4_END_DECLS.
Referenced by L4vbus::Pm< DEC >::pm_resume().
Here is the caller graph for this function:



13.8.6.2.2 l4vbus_pm_suspend()

```
L4_BEGIN_DECLS int l4vbus_pm_suspend (
            l4_cap_idx_t vbus,
            l4vbus_device_handle_t handle)
```

Suspend the device.

Parameters

vbus	V-BUS capability
handle	Handle for the device to be suspended Saves the state of the device and puts it into a low-power mode.

Return values

0	Success.

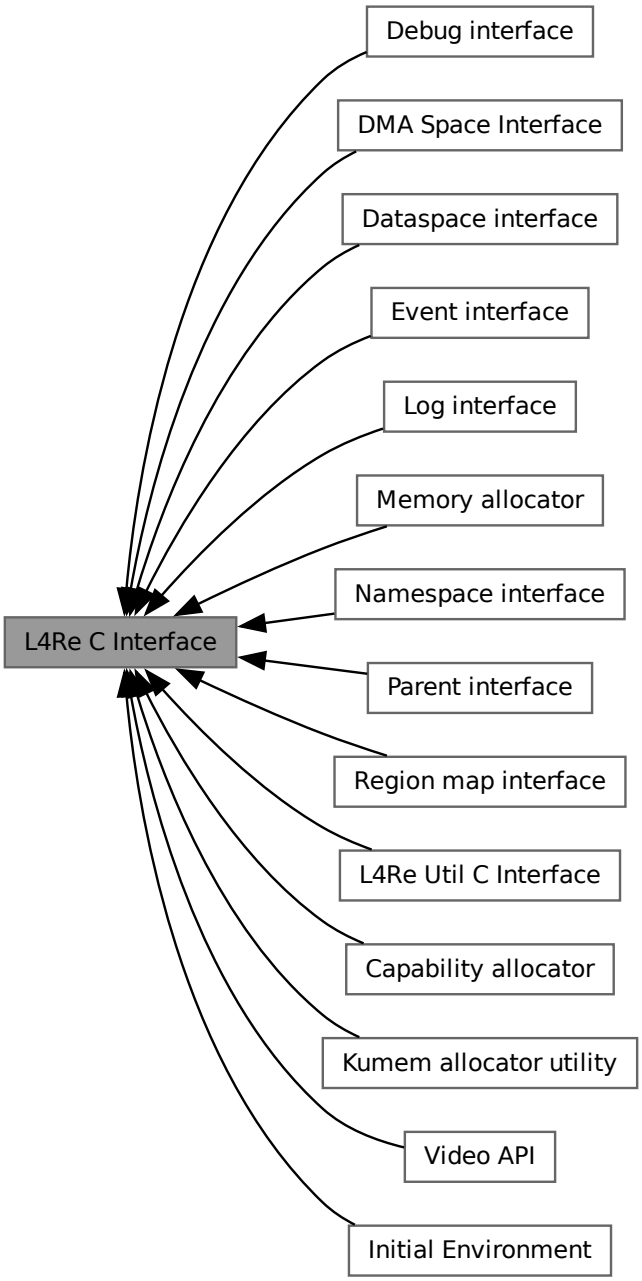
References L4_CV.
Referenced by L4vbus::Pm< DEC >::pm_suspend().
Here is the caller graph for this function:



13.9 L4Re C Interface

Documentation for the L4Re C Interface.

Collaboration diagram for L4Re C Interface:



Topics

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  Dataspace C interface.

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  Event C interface.
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  C interface of the initial environment that is provided to an L4 task.

Files

- file inhibitor.h
  Inhibitor C interface.

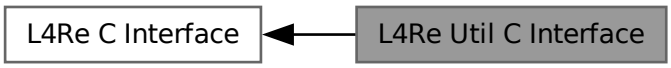
13.9.1 Detailed Description

Documentation for the L4Re C Interface.
The interface functions closely align with the C++ functions and add no further functionalities.
For new programs it is advised to use the C++ interface.

13.9.2 L4Re Util C Interface

Documentation of the L4 Runtime Environment utility functionality in C.

Collaboration diagram for L4Re Util C Interface:



Documentation of the L4 Runtime Environment utility functionality in C.
The interface functions closely align with the C++ functions and add no further functionalities.
For new programs it is advised to use the C++ interface.

13.9.3 Dataspace interface

Dataspace C interface.
Collaboration diagram for Dataspace interface:



Data Structures

- struct l4re_ds_stats_t

  Information about the data space.

Enumerations

- enum l4re_ds_map_flags { }

  Flags to specify the memory mapping type of a request.

Functions

- l4_ret_t l4re_ds_clear (l4re_ds_t ds, l4re_ds_offset_t offset, l4re_ds_size_t size) L4_NOTHROW

  Clear parts of a dataspace.
- l4_ret_t l4re_ds_allocate (l4re_ds_t ds, l4re_ds_offset_t offset, l4re_ds_size_t size) L4_NOTHROW

  Allocate a range in the dataspace.
- l4_ret_t l4re_ds_copy_in (l4re_ds_t ds, l4re_ds_offset_t dst_offs, l4re_ds_t src, l4re_ds_offset_t src_offs, l4re_ds_size_t size) L4_NOTHROW

  Copy contents from another dataspace.
- l4re_ds_size_t l4re_ds_size (l4re_ds_t ds) L4_NOTHROW

  Get size of a dataspace.
- l4re_ds_flags_t l4re_ds_flags (l4re_ds_t ds) L4_NOTHROW

  Get flags of the dataspace.
- l4_ret_t l4re_ds_info (l4re_ds_t ds, l4re_ds_stats_t *stats) L4_NOTHROW

  Get information on the dataspace.

- l4_ret_t l4re_ds_map_info (l4re_ds_t ds, l4_addr_t *start_addr, l4_addr_t *end_addr) L4_NOTHROW

  Get mapping range of dataspace.

Variables

- L4_BEGIN_DECLS typedef l4_cap_idx_t **l4re_ds_t**

  Dataspace type.

13.9.3.1 Detailed Description

Dataspace C interface.

13.9.3.2 Enumeration Type Documentation

13.9.3.2.1 l4re_ds_map_flags

```
enum l4re_ds_map_flags
```

Flags to specify the memory mapping type of a request.

Enumerator

L4RE_DS_F_NORMAL	request normal memory mapping
L4RE_DS_F_CACHEABLE	request normal memory mapping
L4RE_DS_F_BUFFERABLE	request bufferable (write buffered) mappings
L4RE_DS_F_UNCACHEABLE	request uncacheable memory mappings
L4RE_DS_F_CACHING_MASK	mask for caching flags
L4RE_DS_F_CACHING_SHIFT	shift value for caching flags

Definition at line 48 of file dataspace.h.

13.9.3.3 Function Documentation

13.9.3.3.1 l4re_ds_allocate()

```
l4_ret_t l4re_ds_allocate (
             l4re_ds_t ds,
             l4re_ds_offset_t offset,
             l4re_ds_size_t size)
```

Allocate a range in the dataspace.

Parameters

ds	Dataspace capability.
offset	Offset in the dataspace, in bytes.
size	Size of the range, in bytes.

Return values

L4_EOK	Success
-L4_ERANGE	Given range is outside the dataspace. (A dataspace provider may also silently ignore areas outside the dataspace.)
-L4_ENOMEM	Not enough memory available.

<0	IPC errors

On success, at least the given range is guaranteed to be allocated. The dataspace manager may also allocate more memory due to page granularity.
The memory is allocated with the same rights as the dataspace capability.
References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.3.3.2 l4re_ds_clear()

```
l4_ret_t l4re_ds_clear (
             l4re_ds_t ds,
             l4re_ds_offset_t offset,
             l4re_ds_size_t size)
```

Clear parts of a dataspace.

Parameters

ds	Dataspace capability.
offset	Offset within dataspace (in bytes).
size	Size of region to clear (in bytes).

Return values

>=0	Success.
-L4_ERANGE	Given range is outside the dataspace. (A dataspace provider may also silently ignore areas outside the dataspace.)
-L4_EACCESS	No L4_CAP_FPAGE_W right on dataspace capability.
<0	IPC errors

Zeroes out the memory. Depending on the type of memory the memory could also be deallocated and replaced by a shared zero-page.
References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.3.3.3 l4re_ds_copy_in()

```
l4_ret_t l4re_ds_copy_in (
             l4re_ds_t ds,
             l4re_ds_offset_t dst_offs,
             l4re_ds_t src,
             l4re_ds_offset_t src_offs,
             l4re_ds_size_t size)
```

Copy contents from another dataspace.

Parameters

ds	Destination dataspace.
dst_offs	Offset in destination dataspace.
src	Source dataspace to copy from.
src_offs	Offset in the source dataspace.
size	Size to copy (in bytes).

Return values

L4_EOK	Success
-L4_EACCESS	No L4_CAP_FPAGE_W right on the destination dataspace.
-L4_EINVAL	Invalid parameter supplied.
<0	IPC errors

The copy operation may use copy-on-write mechanisms. The operation may also fail if both dataspaces are not from the same dataspace manager or the dataspace managers do not cooperate.
References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.3.3.4 l4re_ds_flags()

```
l4re_ds_flags_t l4re_ds_flags (
            l4re_ds_t ds)
```

Get flags of the dataspace.

Parameters

ds	Dataspace capability.

Return values

>=0	Flags of the dataspace
<0	IPC errors

See also

L4Re::Dataspace::F::Flags

References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.3.3.5 l4re_ds_info()

```
l4_ret_t l4re_ds_info (
            l4re_ds_t ds,
            l4re_ds_stats_t * stats)
```

Get information on the dataspace.

Parameters

	ds	Dataspace capability.
out	*stats*	Dataspace information

Return values

0	Success
<0	IPC errors

References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.3.3.6 l4re_ds_map_info()

```
l4_ret_t l4re_ds_map_info (
             l4re_ds_t ds,
             l4_addr_t * start_addr,
             l4_addr_t * end_addr)
```

Get mapping range of dataspace.

Parameters

ds	Dataspace capability. In case of a MMU-less system, the dataspace must be mapped at the correct address in the task because virtual and physical address must match. This method returns the start and end address of the physically contiguous buffer backing the dataspace.

On MMU-enabled system any page aligned address is permissible. On such systems the method is just a stub.

Parameters

out	*start_addr*	Start address of dataspace.
out	*end_addr*	End address (inclusive) of dataspace.

Return values

>0	Start/end address have been set and need to be obeyed.
0	No constraint of mapping address.
-L4_EPERM	Cannot infer mapping address. Dataspace not mappable.
<0	IPC errors.

References L4_END_DECLS, L4_NOTHROW, and l4re_ds_t.

13.9.3.3.7 l4re_ds_size()

```
l4re_ds_size_t l4re_ds_size (
             l4re_ds_t ds)
```

Get size of a dataspace.

Parameters

ds	Dataspace capability.

Returns

Size of the dataspace in bytes.

References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.4 Debug interface

Collaboration diagram for Debug interface:



Functions

- L4_BEGIN_DECLS l4_ret_t l4re_debug_obj_debug (l4_cap_idx_t srv, unsigned long function) L4_NOTHROW
  Call debug function of L4Re service.

13.9.4.1 Detailed Description

13.9.4.2 Function Documentation

13.9.4.2.1 l4re_debug_obj_debug()

```
L4_BEGIN_DECLS l4_ret_t l4re_debug_obj_debug (
             l4_cap_idx_t srv,
             unsigned long function)
```

Call debug function of L4Re service.

Parameters

srv	Object to call.
function	Function to call.

See also

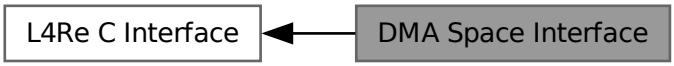
L4Re::Debug_obj::debug

References L4_END_DECLS, and L4_NOTHROW.

13.9.5 DMA Space Interface

DMA Space C interface.

Collaboration diagram for DMA Space Interface:



Typedefs

- typedef l4_cap_idx_t l4re_dma_space_t

  DMA space capability type.
- typedef l4_cap_idx_t l4re_dma_space_mgr_t

  DMA space manager capability type.

Functions

- l4_ret_t l4re_dma_space_map (l4re_dma_space_t dma, l4re_ds_t src, l4re_ds_offset_t offset, l4_size_t *size, unsigned long attrs, enum l4re_dma_space_direction dir, l4re_dma_space_dma_addr_t *dma_addr) L4_NOTHROW

  Map the given part of this data space into the DMA address space.
- l4_ret_t l4re_dma_space_unmap (l4re_dma_space_t dma, l4re_dma_space_dma_addr_t dma_addr, l4_size_t size, unsigned long attrs, enum l4re_dma_space_direction dir) L4_NOTHROW

  Unmap the given part of this data space from the DMA address space.
- l4_ret_t l4re_dma_space_mgr_associate (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, l4_cap_idx_t dma_task, enum l4re_dma_space_mgr_space_attribs attr) L4_NOTHROW

  Associate a (kernel) DMA space for a device to a Dma_space.
- l4_ret_t l4re_dma_space_mgr_associate_phys (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, enum l4re_dma_space_mgr_space_attribs attr) L4_NOTHROW

  Register a Dma_space to use for DMA.
- l4_ret_t l4re_dma_space_mgr_disassociate (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space) L4_NOTHROW
- l4_ret_t l4re_dma_space_mgr_block_area (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, l4re_dma_space_dma_addr_t *addr, l4re_dma_space_dma_size_t size, l4re_dma_space_dma_addr_t max_addr, enum l4re_dma_space_mgr_block_flags flags, unsigned char align) L4_NOTHROW
- l4_ret_t l4re_dma_space_mgr_set_limits (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, l4re_dma_space_dma_addr_t min_addr, l4re_dma_space_dma_addr_t max_addr) L4_NOTHROW

13.9.5.1 Detailed Description

DMA Space C interface.

13.9.5.2 Typedef Documentation

13.9.5.2.1 l4re_dma_space_mgr_t

```
typedef l4_cap_idx_t l4re_dma_space_mgr_t
```

DMA space manager capability type.
A privileged interface to manage Dma_space associations for the clients.
This interface is provided as a singleton by Moe.
Definition at line 76 of file dma_space.h.

13.9.5.2.2 l4re_dma_space_t

```
typedef l4_cap_idx_t l4re_dma_space_t
```

DMA space capability type.
Managed DMA Address Space.
A managed Dma_space represents the L4Re abstraction of an DMA address space of one or several devices. Devices are assigned to a managed Dma_space by binding the Dma_space to the respective DMA domain (see L4vbus::Vbus::assign_dma_domain()), which might link the Dma_space with a kernel DMA space. Note that several DMA domains can be bound to the same Dma_space. Whenever a device needs direct access to parts of an L4Re::Dataspace, that part of the data space must be mapped to the managed Dma_space that is assigned to that device. Binding to DMA domains must happen before mapping. After the DMA accesses to the memory are finished the memory must be unmapped from the device's DMA address space.
Mapping to a managed DMA address space, using map(), makes the given parts of the data space visible to the associated device at the returned DMA address. As long as the memory is mapped into a DMA space it is 'pinned' and cannot be subject to dynamic memory management such as swapping.
unmap() is the reverse operation to map() and unmaps the given data-space part for the DMA address space.
Definition at line 69 of file dma_space.h.

13.9.5.3 Function Documentation

13.9.5.3.1 l4re_dma_space_map()

```
l4_ret_t l4re_dma_space_map (
             l4re_dma_space_t dma,
             l4re_ds_t src,
             l4re_ds_offset_t offset,
             l4_size_t * size,
             unsigned long attrs,
             enum l4re_dma_space_direction dir,
             l4re_dma_space_dma_addr_t * dma_addr)
```

Map the given part of this data space into the DMA address space.

Parameters

	dma	DMA space capability A suitable address in the DMA task will be chosen automatically.
in	*src*	Source data space (that describes the memory).
in	*offset*	The offset (bytes) within src.
in,out	*size*	The size (bytes) of the region to be mapped for DMA, after successful mapping the size returned is the size mapped for DMA as a single block. This size might be smaller than the original input size, in this case the caller might call map() again with a new offset and the remaining size.
in	*attrs*	The attributes used for this DMA mapping (a combination of Dma_space::Attribute values). The Search_addr attribute is forced by this overload!
in	*dir*	The direction of the DMA transfer issued with this mapping. The same value must later be passed to unmap(). (ignored)
out	*dma_addr*	The DMA address to use for DMA with the associated device.

Return values

L4_EOK	Operation successful.
-L4_EADDRNOTAVAIL	The specified region overlaps an existing mapping.
-L4_EINVAL	The capability src is invalid or does not refer to a valid dataspace.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.

-L4_ERANGE	`offset` is larger than the size of the dataspace.

The DMA mapping is created writable if capability `src` has the permission L4_CAP_FPAGE_W. Otherwise, a read-only DMA mapping is established.

Note

Dma_space_mgr::associate() or Dma_space_mgr::associate_phys() must be called prior to mapping memory. Usually this is done implicitly when binding the managed Dma_space to a DMA domain (see L4vbus::Vbus::assign_dma_domain()).

Deprecated Use the other overload without `dir` parameter.

References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.5.3.2 l4re_dma_space_mgr_associate()

```
l4_ret_t l4re_dma_space_mgr_associate (
             l4re_dma_space_mgr_t dma_mgr,
             l4re_dma_space_t dma_space,
             l4_cap_idx_t dma_task,
             enum l4re_dma_space_mgr_space_attribs attr)
```

Associate a (kernel) DMA space for a device to a Dma_space.

Parameters

	dma_mgr	DMA space manager capability
`in`	*dma_space*	The Dma_space to associate the (kernel) DMA space with.
`in`	*dma_task*	The (kernel) DMA space used for the device that shall be associated with this DMA space.
`in`	*attr*	Attributes for this DMA space. See L4Re::Dma_space::Space_attrib.

Return values

L4_EOK	Operation successful.
-L4_EBUSY	The Dma_space is already associated.
-L4_EINVAL	Invalid arguments, e.g. no `dma_task` capability passed. In particular, when Space_attrib↩ ::Identity_map is requested, the Dma_space must not have any pre-existing blockings (see Dma_space_mgr::block_area()) and must not have custom address limits set (see Dma_↩ space_mgr::set_limits()).
-L4_ENOENT	Invalid `dma_space` was passed.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The `dma_space` and `dma_task` capabilities must have the permission L4_CAP_FPAGE_W.

References L4_CV, and L4_NOTHROW.

13.9.5.3.3 l4re_dma_space_mgr_associate_phys()

```
l4_ret_t l4re_dma_space_mgr_associate_phys (
             l4re_dma_space_mgr_t dma_mgr,
```

```
            l4re_dma_space_t dma_space,
            enum l4re_dma_space_mgr_space_attribs attr)
```

Register a Dma_space to use for DMA.

Parameters

	dma_mgr	DMA space manager capability This function should be used, in case no IOMMU is present or configured. The CPU's physical memory is used as DMA address space.
in	*dma_space*	The Dma_space to register.
in	*attr*	Attributes for the provided DMA space. Currently not used; must be the default-constructed Space_attribs() value.

Return values

L4_EOK	Operation successful.
-L4_EBUSY	The Dma_space is already associated.
-L4_EINVAL	Invalid arguments, for example a non-zero `attr`, pre-existing blockings on `dma_space` (see Dma_space_mgr::block_area()), or custom address limits set on `dma_space` (see Dma_↩ space_mgr::set_limits()).
-L4_ENOENT	Invalid `dma_space` was passed.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The `dma_space` capability must have the permission L4_CAP_FPAGE_W.

References L4_CV, and L4_NOTHROW.

13.9.5.3.4 l4re_dma_space_mgr_block_area()

```
l4_ret_t l4re_dma_space_mgr_block_area (
            l4re_dma_space_mgr_t dma_mgr,
            l4re_dma_space_t dma_space,
            l4re_dma_space_dma_addr_t * addr,
            l4re_dma_space_dma_size_t size,
            l4re_dma_space_dma_addr_t max_addr,
            enum l4re_dma_space_mgr_block_flags flags,
            unsigned char align)
```

Parameters

dma_mgr	DMA space manager capability Block an area in a Dma_space.

The blocked area cannot be used for mappings in the given `dma_space` after the call. The call will fail if there are already mappings in the requested range. It is allowed to add block areas before associate() or associate_phys() has been called.
Blocked areas are allowed to overlap.

Parameters

in	*dma_space*	The Dma_space to add blocked areas.
in,out	*addr*	The DMA address of the blocked area. Either taken literally (in which case it must be page aligned) or as start address if Block_flag::Search_addr is passed.
in	*size*	Size of the blocked region. Must be page aligned.
in	*max_addr*	Highest allowed DMA address of the region (inclusive).
in	*flags*	The attributes used for this blocking (a combination of Dma_space_mgr::Block_flag values).
in	*align*	The log2 alignment of the blocked area. Only used if Block_flag::Search_addr is passed.

Return values

L4_EOK	Operation successful.
-L4_EADDRNOTAVAIL	The specified region overlaps an existing mapping or no space left for the blocking.
-L4_EINVAL	Invalid address, alignment or flag passed. Block_flag::Search_addr passed but dma_space is not associated yet.
-L4_EPERM	Dma_space is associated with physical DMA domain or insufficient permissions; see precondition.
-L4_ENOMEM	There is not enough memory to allocate internal data structures.

Precondition

The dma_space capability must have the permission L4_CAP_FPAGE_W.

References L4_CV, and L4_NOTHROW.

13.9.5.3.5 l4re_dma_space_mgr_disassociate()

```
l4_ret_t l4re_dma_space_mgr_disassociate (
             l4re_dma_space_mgr_t dma_mgr,
             l4re_dma_space_t dma_space)
```

Parameters

	dma_mgr	DMA space manager capability Disassociate the (kernel) DMA space from this Dma_space.
in	*dma_space*	The Dma_space to de-register.

Return values

L4_EOK	Operation successful.
-L4_ENOENT	Invalid dma_space was passed or disassociate() called without prior calling associate()/associate_phys().
-L4_EPERM	Insufficient permissions; see precondition.

Attention

This will remove all mappings, reservations and blockings from dma_space.

Precondition

The dma_space capability must have the permission L4_CAP_FPAGE_W.

References L4_CV, and L4_NOTHROW.

13.9.5.3.6 l4re_dma_space_mgr_set_limits()

```
l4_ret_t l4re_dma_space_mgr_set_limits (
             l4re_dma_space_mgr_t dma_mgr,
             l4re_dma_space_t dma_space,
             l4re_dma_space_dma_addr_t min_addr,
             l4re_dma_space_dma_addr_t max_addr)
```

Parameters

dma_mgr	DMA space manager capability Set lower and upper bound of DMA addresses.

Mappings and blockings are only allowed in the given range.
If multiple Dma_spaces share the same kernel DMA space (i.e., were associated by passing the same dma_task to associate()), all DMA address allocations, reservations and blockings performed through any of these Dma↩ _spaces use the intersection of all their individual limits. Tightening the limits on one Dma_space therefore also constrains all other Dma_spaces sharing the same DMA task; loosening the limits on one Dma_space has no effect beyond what the most-restrictive peer Dma_space allows.

Parameters

in	*dma_space*	The Dma_space whose limits shall be changed.
in	*min_addr*	The lowest usable address in the Dma_space.
in	*max_addr*	The highest usable address in the Dma_space (inclusive).

Return values

L4_EOK	Operation successful.
-L4_EADDRNOTAVAIL	There are existing mappings or blocking outside the bounds.
-L4_EPERM	Dma_space is associated with physical DMA domain or insufficient permissions; see precondition.
-L4_EINVAL	Invalid address passed.

Precondition

The dma_space capability must have the permission L4_CAP_FPAGE_W.

References L4_END_DECLS, and L4_NOTHROW.

13.9.5.3.7 l4re_dma_space_unmap()

```
l4_ret_t l4re_dma_space_unmap (
             l4re_dma_space_t dma,
             l4re_dma_space_dma_addr_t dma_addr,
             l4_size_t size,
             unsigned long attrs,
             enum l4re_dma_space_direction dir)
```

Unmap the given part of this data space from the DMA address space.

Parameters

dma	DMA space capability The calls to map() and unmap() must be balanced. That is, each page of a mapping that was established by `map()` previously must be unmapped exactly once.

Sub-ranges that do not currently hold a mapping are silently skipped. That is, unmapping the same region too often, is not treated as an error.

Parameters

dma_addr	The DMA address (returned by Dma_space::map()).
size	The size (bytes) of the memory region to unmap.
attrs	The attributes for the unmap (currently none, ignored).
dir	The direction of the finished DMA operation (ignored).

Return values

L4_EOK	Operation successful.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.

Deprecated Use the overload without `attrs` and `dir` because they are ignored.

References L4_CV, and L4_NOTHROW.

13.9.6 Event interface

Event C interface.
Collaboration diagram for Event interface:



Functions

- l4_ret_t l4re_event_get_buffer (const l4_cap_idx_t server, const l4re_ds_t ds) L4_NOTHROW

  Get an event signal buffer.
- l4_ret_t l4re_event_get_num_streams (const l4_cap_idx_t server) L4_NOTHROW

  Get number of streams.
- l4_ret_t l4re_event_get_stream_info (const l4_cap_idx_t server, int idx, l4re_event_stream_info_t *info) L4_NOTHROW

  Get information on a stream.
- l4_ret_t l4re_event_get_stream_info_for_id (const l4_cap_idx_t server, l4_umword_t stream_id, l4re_event↩ _stream_info_t *info) L4_NOTHROW

  Get info for a stream given a stream id.
- l4_ret_t l4re_event_get_axis_info (const l4_cap_idx_t server, l4_umword_t id, unsigned naxes, unsigned const *axis, l4re_event_absinfo_t *info) L4_NOTHROW

Get Axis information for a stream.

13.9.6.1 Detailed Description

Event C interface.

13.9.6.2 Function Documentation

13.9.6.2.1 l4re_event_get_axis_info()

```
l4_ret_t l4re_event_get_axis_info (
             const l4_cap_idx_t server,
             l4_umword_t id,
             unsigned naxes,
             unsigned const * axis,
             l4re_event_absinfo_t * info)
```

Get Axis information for a stream.

Parameters

	server	Server to talk to.
	id	Id of the stream to get information from.
	naxes	Number of axes in `axis` array.
`in`	*axis*	Array of axis IDs whose information should be retrieved.
`out`	*info*	Information buffer to store the retrieved axis infos.

Return values

0	Success
<0	Error

See also

L4Re::Event::get_axis_info

References L4_END_DECLS, and L4_NOTHROW.

13.9.6.2.2 l4re_event_get_buffer()

```
l4_ret_t l4re_event_get_buffer (
             const l4_cap_idx_t server,
             const l4re_ds_t ds)
```

Get an event signal buffer.

Parameters

server	Server to talk to.
ds	Buffer to event data.

Returns

0 for success, <0 on error

See also

L4Re::Event::get_buffer

References L4_CV, L4_NOTHROW, and l4re_ds_t.

13.9.6.2.3 l4re_event_get_num_streams()

```
l4_ret_t l4re_event_get_num_streams (
            const l4_cap_idx_t server)
```

Get number of streams.

Parameters

server	Server to talk to.

Returns

0 for success, <0 on error

See also

L4Re::Event::get_num_streams

References L4_CV, and L4_NOTHROW.

13.9.6.2.4 l4re_event_get_stream_info()

```
l4_ret_t l4re_event_get_stream_info (
            const l4_cap_idx_t server,
            int idx,
            l4re_event_stream_info_t * info)
```

Get information on a stream.

Parameters

	server	Server to talk to.
	idx	Index value.
out	*info*	Information buffer.

Returns

0 for success, <0 on error

See also

L4Re::Event::get_stream_info

References L4_CV, and L4_NOTHROW.

13.9.6.2.5 l4re_event_get_stream_info_for_id()

```
l4_ret_t l4re_event_get_stream_info_for_id (
            const l4_cap_idx_t server,
            l4_umword_t stream_id,
            l4re_event_stream_info_t * info)
```

Get info for a stream given a stream id.

Parameters

	server	Server to talk to.
	stream↩ _id	Stream ID.
out	*info*	Information buffer.

Returns

0 for success, <0 on error

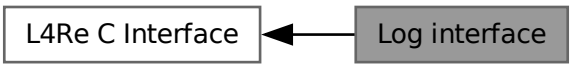
See also

L4Re::Event::get_stream_info_for_id

References L4_CV, and L4_NOTHROW.

13.9.7 Log interface

Log C interface.
Collaboration diagram for Log interface:



Functions

- L4_BEGIN_DECLS void l4re_log_print (char const *string) L4_NOTHROW
  Write a null terminated string to the default log.
- void l4re_log_printn (char const *string, int len) L4_NOTHROW
  Write a string of a given length to the default log.
- void l4re_log_print_srv (const l4_cap_idx_t logcap, char const *string) L4_NOTHROW
  Write a null terminated string to a log.
- void l4re_log_printn_srv (const l4_cap_idx_t logcap, char const *string, int len) L4_NOTHROW
  Write a string of a given length to a log.

13.9.7.1 Detailed Description

Log C interface.

13.9.7.2 Function Documentation

13.9.7.2.1 l4re_log_print()

```
void l4re_log_print (
            char const * string)  [inline]
```

Write a null terminated string to the default log.

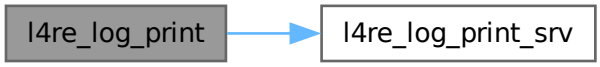
Parameters

string	Text to print, null terminated.

See also

L4Re::Log::print

Definition at line 81 of file log.h.
References L4_NOTHROW, and l4re_log_print_srv().
Here is the call graph for this function:



13.9.7.2.2 l4re_log_print_srv()

```
void l4re_log_print_srv (
             const l4_cap_idx_t logcap,
             char const * string)
```

Write a null terminated string to a log.

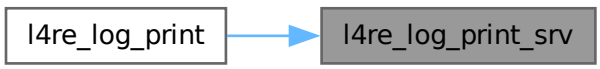
Parameters

logcap	Log capability (service).
string	Text to print, null terminated.

See also

L4Re::Log::print

References L4_CV, and L4_NOTHROW.
Referenced by l4re_log_print().
Here is the caller graph for this function:



13.9.7.2.3 l4re_log_printn()

```
void l4re_log_printn (
             char const * string,
             int len)  [inline]
```

Write a string of a given length to the default log.

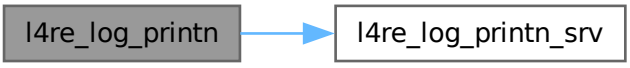
Parameters

string	Text to print, null terminated.
len	Length of string in bytes.

See also

L4Re::Log::printn

Definition at line 87 of file log.h.
References L4_NOTHROW, and l4re_log_printn_srv().
Here is the call graph for this function:



13.9.7.2.4 l4re_log_printn_srv()

```
void l4re_log_printn_srv (
             const l4_cap_idx_t logcap,
             char const * string,
             int len)
```

Write a string of a given length to a log.

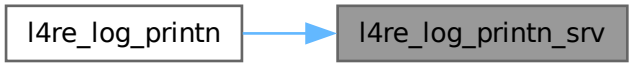
Parameters

logcap	Log capability (service).
string	Text to print, null terminated.
len	Length of string in bytes.

See also

L4Re::Log::printn

References L4_CV, L4_INLINE, and L4_NOTHROW.
Referenced by l4re_log_printn().
Here is the caller graph for this function:



13.9.8 Memory allocator

Memory allocator C interface.
Collaboration diagram for Memory allocator:



Enumerations

- enum l4re_ma_flags

  Flags for requesting memory at the memory allocator.

Functions

- l4_ret_t l4re_ma_alloc (long size, l4re_ds_t const mem, unsigned long flags) L4_NOTHROW

  Allocate memory.
- l4_ret_t l4re_ma_alloc_align (long size, l4re_ds_t const mem, unsigned long flags, unsigned long align) L4_NOTHROW

  Allocate memory.
- l4_ret_t l4re_ma_alloc_align_srv (l4_cap_idx_t srv, long size, l4re_ds_t const mem, unsigned long flags, unsigned long align) L4_NOTHROW

  Allocate memory.

13.9.8.1 Detailed Description

Memory allocator C interface.

13.9.8.2 Enumeration Type Documentation

13.9.8.2.1 l4re_ma_flags

`enum l4re_ma_flags`
Flags for requesting memory at the memory allocator.

See also

L4Re::Mem_alloc::Mem_alloc_flags

Definition at line 32 of file mem_alloc.h.

13.9.8.3 Function Documentation

13.9.8.3.1 l4re_ma_alloc()

```
l4_ret_t l4re_ma_alloc (
            long size,
            l4re_ds_t const mem,
            unsigned long flags)  [inline]
```

Allocate memory.

Parameters

size	Size in bytes to be requested. Allocation granularity is (super)pages, however, the allocator will store the byte-granular given size as the size of the dataspace and consecutively will use this byte-granular size for servicing the dataspace. Allocators may optionally also implement a maximum allocation strategy: if `size` is a negative value and `flags` set the Mem_alloc_flags::Continuous bit, the allocator tries to allocate as much memory as possible leaving an amount of at least `-size` bytes within the associated quota.
mem	Capability slot where the capability to the dataspace is received.
flags	Special dataspace properties, see l4re_ma_flags

Return values

0	Success
-L4_ERANGE	Given size not supported.
-L4_ENOMEM	Not enough memory available.
<0	IPC error

See also

L4Re::Mem_alloc::alloc

The memory allocator returns a dataspace.

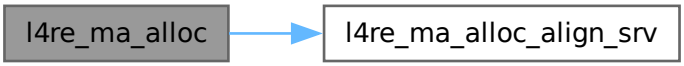
Note

This function is using the L4Re::Env::env()->mem_alloc() service.

Examples

examples/libs/l4re/c/ma+rm.c.

Definition at line 136 of file mem_alloc.h.
References L4_NOTHROW, l4re_ds_t, and l4re_ma_alloc_align_srv().
Here is the call graph for this function:



13.9.8.3.2 l4re_ma_alloc_align()

```
l4_ret_t l4re_ma_alloc_align (
             long size,
             l4re_ds_t const mem,
             unsigned long flags,
             unsigned long align)  [inline]
```

Allocate memory.

Parameters

size	Size in bytes to be requested. Allocation granularity is (super)pages, however, the allocator will store the byte-granular given size as the size of the dataspace and consecutively will use this byte-granular size for servicing the dataspace. Allocators may optionally also implement a maximum allocation strategy: if `size` is a negative value and `flags` set the Mem_alloc_flags::Continuous bit, the allocator tries to allocate as much memory as possible leaving an amount of at least `-size` bytes within the associated quota.
mem	Capability slot where the capability to the dataspace is received.
flags	Special dataspace properties, see l4re_ma_flags
align	Log2 alignment of dataspace if supported by allocator, will be at least L4_PAGESHIFT, with Super_↩ pages flag set at least L4_SUPERPAGESHIFT

Return values

0	Success
-L4_ERANGE	Given size not supported.
-L4_ENOMEM	Not enough memory available.
<0	IPC error

See also

L4Re::Mem_alloc::alloc and

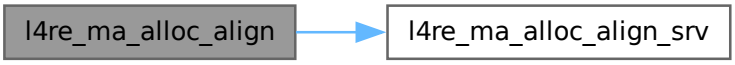
l4re_ma_alloc

The memory allocator returns a dataspace.

Note

This function is using the L4Re::Env::env()->mem_alloc() service.

Definition at line 144 of file mem_alloc.h.
References L4_NOTHROW, l4re_ds_t, and l4re_ma_alloc_align_srv().
Here is the call graph for this function:



13.9.8.3.3 l4re_ma_alloc_align_srv()

```
l4_ret_t l4re_ma_alloc_align_srv (
             l4_cap_idx_t srv,
             long size,
             l4re_ds_t const mem,
             unsigned long flags,
             unsigned long align)
```

Allocate memory.

Parameters

srv	Memory allocator service.
size	Size to be requested.
mem	Capability slot to put the requested dataspace in
flags	Flags, see l4re_ma_flags
align	Log2 alignment of dataspace if supported by allocator, will be at least L4_PAGESHIFT, with Super_↩ pages flag set at least L4_SUPERPAGESHIFT, default 0

Returns

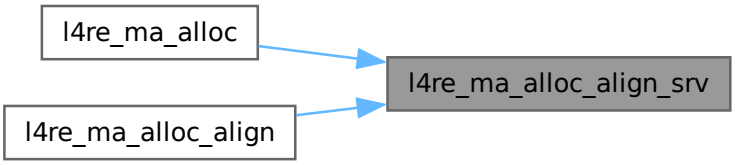
0 on success, <0 on error

See also

L4Re::Mem_alloc::alloc

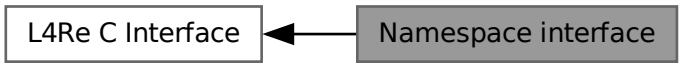
The memory allocator returns a dataspace.
References L4_CV, L4_INLINE, L4_NOTHROW, and l4re_ds_t.
Referenced by l4re_ma_alloc(), and l4re_ma_alloc_align().

Here is the caller graph for this function:



13.9.9 Namespace interface

Namespace C interface.
Collaboration diagram for Namespace interface:



Enumerations

- enum l4re_ns_register_flags

  Namespace register flags.

Functions

- l4_ret_t l4re_ns_query_to_srv (l4re_namespace_t srv, char const ∗name, l4_cap_idx_t const cap, int timeout) L4_NOTHROW

  Query the name space for the object named by `name`.
- l4_ret_t l4re_ns_query_srv (l4re_namespace_t srv, char const ∗name, l4_cap_idx_t const cap) L4_NOTHROW

  Query the name space for the object named by `name`.
- l4_ret_t l4re_ns_register_obj_srv (l4re_namespace_t srv, char const ∗name, l4_cap_idx_t const obj, unsigned flags) L4_NOTHROW

  Register an object with a name.

Variables

- L4_BEGIN_DECLS typedef l4_cap_idx_t **l4re_namespace_t**

  Namespace type.

13.9.9.1 Detailed Description

Namespace C interface.

13.9.9.2 Enumeration Type Documentation

13.9.9.2.1 l4re_ns_register_flags

```
enum l4re_ns_register_flags
```

Namespace register flags.

See also

L4Re::Namespace::Register_flags

Definition at line 29 of file namespace.h.

13.9.9.3 Function Documentation

13.9.9.3.1 l4re_ns_query_srv()

```
l4_ret_t l4re_ns_query_srv (
            l4re_namespace_t srv,
            char const * name,
            l4_cap_idx_t const cap)  [inline]
```

Query the name space for the object named by `name`.

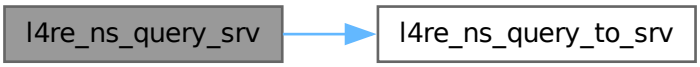
Parameters

srv	Name space server to use for the query.
name	String to query.
cap	Capability slot where the received capability will be stored.

Return values

0	Name could be fully resolved.
>0	Name could only be partly resolved. The number of remaining characters is returned.
-L4_ENOENT	Entry could not be found.
-L4_EAGAIN	Entry exists but no object is yet attached. Try again later.
<0	IPC errors, see l4_error_code_t.

Definition at line 95 of file namespace.h.
References L4_NOTHROW, l4re_namespace_t, and l4re_ns_query_to_srv().
Here is the call graph for this function:



13.9.9.3.2 l4re_ns_query_to_srv()

```
l4_ret_t l4re_ns_query_to_srv (
            l4re_namespace_t srv,
```

```
            char const * name,
            l4_cap_idx_t const cap,
            int timeout)
```

Query the name space for the object named by `name`.

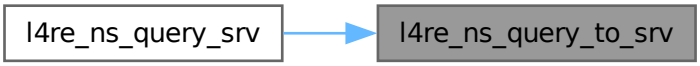
Parameters

timeout	Timeout of query in milliseconds. The client will only wait if a name already has been registered with the server but no object has been attached yet.
srv	Name space server to use for the query.
name	String to query.
cap	Capability slot where the received capability will be stored.

Return values

0	Name could be fully resolved.
>0	Name could only be partly resolved. The number of remaining characters is returned.
-L4_ENOENT	Entry could not be found.
-L4_EAGAIN	Entry exists but no object is yet attached. Try again later.
<0	IPC errors, see l4_error_code_t.

References L4_CV, L4_INLINE, L4_NOTHROW, and l4re_namespace_t.
Referenced by l4re_ns_query_srv().
Here is the caller graph for this function:



13.9.9.3.3 l4re_ns_register_obj_srv()

```
l4_ret_t l4re_ns_register_obj_srv (
            l4re_namespace_t srv,
            char const * name,
            l4_cap_idx_t const obj,
            unsigned flags)
```

Register an object with a name.

Parameters

srv	Name space server to use for the query.
name	Name under which the object should be registered.
obj	Capability to object to register. An invalid capability may be given to only reserve the name for later use.

flags	Flags to assign to the entry, see L4Re::Namespace::Register_flags. Note that the rights that are assigned to a capability are not only determined by the rights given in these flags but also by the rights with which the `obj` capability was mapped to the name space.

Return values

0	Object was successfully registered with *name*.
-L4_EEXIST	Name already registered.
-L4_EPERM	Insufficient permissions; see precondition.
-L4_ENOMEM	Server has insufficient resources.
-L4_EINVAL	Invalid parameter.
<0	IPC errors, see l4_error_code_t.

Precondition

The invoked Namespace capability must have the permission L4_CAP_FPAGE_W.

References L4_CV, L4_INLINE, L4_NOTHROW, and l4re_namespace_t.

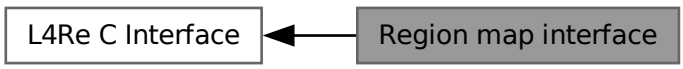
13.9.10 Parent interface

Collaboration diagram for Parent interface:



13.9.11 Region map interface

Region map C interface.
Collaboration diagram for Region map interface:



Enumerations

- enum l4re_rm_flags_values {
  L4RE_RM_F_R = L4RE_DS_F_R , **L4RE_RM_F_W** = L4RE_DS_F_W , **L4RE_RM_F_X** = L4RE_DS_F_X , **L4RE_RM_F_RX** = L4RE_DS_F_RX ,

L4RE_RM_F_RW = L4RE_DS_F_RW , **L4RE_RM_F_RWX** = L4RE_DS_F_RWX , L4RE_RM_F_KERNEL = 0x100 , L4RE_RM_F_DETACH_FREE = 0x200 , L4RE_RM_F_PAGER = 0x400 , L4RE_RM_F_RESERVED = 0x800 , L4RE_RM_CACHING_SHIFT = 4 , L4RE_RM_F_CACHING = L4RE_DS_F_CACHING_MASK , L4RE_RM_REGION_FLAGS = 0xffff , L4RE_RM_F_CACHE_NORMAL = L4RE_DS_F_NORMAL , L4RE_RM_F_CACHE_BUFFERED = L4RE_DS_F_BUFFERABLE , L4RE_RM_F_CACHE_UNCACHED = L4RE_DS_F_UNCACHEABLE , L4RE_RM_F_SEARCH_ADDR = 0x020000 , L4RE_RM_F_IN_AREA = 0x040000 , L4RE_RM_F_EAGER_MAP = 0x080000 , L4RE_RM_F_NO_EAGER_MAP = 0x100000 , L4RE_RM_F_ATTACH_FLAGS = 0x1f0000 }

Flags for region operations.

Functions

- int l4re_rm_reserve_area (l4_addr_t *start, unsigned long size, l4re_rm_flags_t flags, unsigned char align) L4_NOTHROW

  Reserve the given area in the region map.
- int l4re_rm_free_area (l4_addr_t addr) L4_NOTHROW

  Free an area from the region map.
- int l4re_rm_attach (void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm_offset_t offs, unsigned char align) L4_NOTHROW

  Attach a data space to a region.
- int l4re_rm_attach_w_info (void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm_offset_t offs, unsigned char align, char const *name, l4re_ds_offset_t backing_offset) L4_NOTHROW

  Attach a data space to a region.
- int l4re_rm_detach (void *addr) L4_NOTHROW

  Detach and unmap a region from the address space in the current task.
- int l4re_rm_detach_ds (void *addr, l4re_ds_t *ds) L4_NOTHROW

  Detach and unmap a region and return affected dataspace in the current task.
- int l4re_rm_detach_unmap (l4_addr_t addr, l4_cap_idx_t task) L4_NOTHROW

  Detach and unmap in specified task.
- int l4re_rm_detach_ds_unmap (void *addr, l4re_ds_t *ds, l4_cap_idx_t task) L4_NOTHROW

  Detach and unmap in specified task.
- int l4re_rm_find (l4_addr_t *addr, unsigned long *size, l4re_rm_offset_t *offset, l4re_rm_flags_t *flags, l4re_ds_t *m) L4_NOTHROW

  Find a region given an address and size.
- int l4re_rm_get_info (l4_addr_t addr, char *name, unsigned int len, l4re_rm_offset_t *backing_offset) L4_NOTHROW

  Return auxiliary information of a region.
- void l4re_rm_show_lists (void) L4_NOTHROW

  Dump region map internal data structures.
- int l4re_rm_reserve_area_srv (l4_cap_idx_t rm, l4_addr_t *start, unsigned long size, l4re_rm_flags_t flags, unsigned char align) L4_NOTHROW
- int l4re_rm_free_area_srv (l4_cap_idx_t rm, l4_addr_t addr) L4_NOTHROW
- int l4re_rm_attach_srv (l4_cap_idx_t rm, void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm_offset_t offs, unsigned char align) L4_NOTHROW
- int l4re_rm_attach_w_info_srv (l4_cap_idx_t rm, void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm_offset_t offs, unsigned char align, char const *name, l4re_ds_offset_t backing_offset) L4_NOTHROW
- int l4re_rm_detach_srv (l4_cap_idx_t rm, l4_addr_t addr, l4re_ds_t *ds, l4_cap_idx_t task) L4_NOTHROW
- int l4re_rm_find_srv (l4_cap_idx_t rm, l4_addr_t *addr, unsigned long *size, l4re_rm_offset_t *offset, l4re_rm_flags_t *flags, l4re_ds_t *m) L4_NOTHROW
- int l4re_rm_get_info_srv (l4_cap_idx_t rm, l4_addr_t addr, char *name, unsigned int len, l4re_rm_offset_t *backing_offset) L4_NOTHROW
- void **l4re_rm_show_lists_srv** (l4_cap_idx_t rm) L4_NOTHROW

  Dump region map internal data structures.

13.9.11.1 Detailed Description

Region map C interface.

13.9.11.2 Enumeration Type Documentation

13.9.11.2.1 l4re_rm_flags_values

`enum l4re_rm_flags_values`
Flags for region operations.

Enumerator

L4RE_RM_F_R	Region is read-only.
L4RE_RM_F_KERNEL	Kernel-provided memory (KUMEM).
L4RE_RM_F_DETACH_FREE	Free the portion of the data space after detach.
L4RE_RM_F_PAGER	Region has a pager.
L4RE_RM_F_RESERVED	Region is reserved (blocked).
L4RE_RM_CACHING_SHIFT	Start of region mapper cache bits.
L4RE_RM_F_CACHING	Mask of all region manager cache bits.
L4RE_RM_REGION_FLAGS	Mask of all region flags.
L4RE_RM_F_CACHE_NORMAL	Cache bits for normal cacheable memory.
L4RE_RM_F_CACHE_BUFFERED	Cache bits for buffered (write combining) memory.
L4RE_RM_F_CACHE_UNCACHED	Cache bits for uncached memory.
L4RE_RM_F_SEARCH_ADDR	Search for a suitable address range.
L4RE_RM_F_IN_AREA	Search only in area, or map into area.
L4RE_RM_F_EAGER_MAP	Eagerly map the attached data space in.
L4RE_RM_F_NO_EAGER_MAP	Prevent eager mapping of the attached data space.
L4RE_RM_F_ATTACH_FLAGS	Mask of all attach flags.

Definition at line 30 of file rm.h.

13.9.11.3 Function Documentation

13.9.11.3.1 l4re_rm_attach()

```
int l4re_rm_attach (
             void ** start,
             unsigned long size,
             l4re_rm_flags_t flags,
             l4re_ds_t mem,
             l4re_rm_offset_t offs,
             unsigned char align)  [inline]
```

Attach a data space to a region.

Parameters

in,out	*start*	Virtual start address where the region manager shall attach the data space. Will be rounded down to the nearest start of a page. If L4Re::Rm::F::Search_addr is given this value is used as the start address to search for a free virtual memory region and the resulting address is returned here. If L4Re::Rm::F::In_area is given the value is used as a selector for the area (see L4Re::Rm::reserve_area) to attach the data space to.

	size	Size of the data space to attach (in bytes). Will be rounded up to the nearest multiple of the page size.
	flags	The flags control how and with which rights the dataspace is attached to the region. See L4Re::Rm::F::Attach_flags and L4Re::Rm::F::Region_flags. The caller must specify the desired rights of the attached region explicitly. The default set of rights is empty. If the `F::Eager_map` flag is set this function may also return L4Re::Dataspace::map error codes if the mapping fails.
	mem	Data space.
	offs	Offset into the data space to use.
	align	Alignment of the virtual region, log2-size, default: a page (L4_PAGESHIFT). This is only meaningful if the L4Re::Rm::F::Search_addr flag is used.

Return values

0	Success
-L4_ENOENT	No area could be found (see L4Re::Rm::F::In_area)
-L4_EPERM	Operation not allowed.
-L4_EINVAL	
-L4_EADDRNOTAVAIL	The given address is not available.
<0	IPC errors

Makes the whole or parts of a data space visible in the virtual memory of the corresponding task. The corresponding region in the virtual address space is backed with the contents of the dataspace.

Note

When searching for a free place in the virtual address space, the space between *start* and the end of the virtual address space is

See also

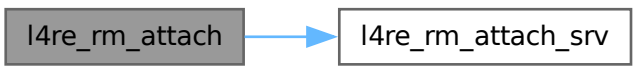
L4Re::Rm::attach

This function is using the L4::Env::env()->rm() service.

Examples

examples/libs/l4re/c/ma+rm.c.

Definition at line 417 of file rm.h.
References L4_NOTHROW, l4re_ds_t, and l4re_rm_attach_srv().
Here is the call graph for this function:



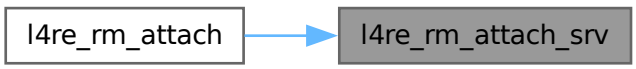
13.9.11.3.2 l4re_rm_attach_srv()

```
int l4re_rm_attach_srv (
             l4_cap_idx_t rm,
             void ** start,
             unsigned long size,
             l4re_rm_flags_t flags,
             l4re_ds_t mem,
             l4re_rm_offset_t offs,
             unsigned char align)
```

See also

L4Re::Rm::attach

References L4_CV, L4_NOTHROW, and l4re_ds_t.
Referenced by l4re_rm_attach().
Here is the caller graph for this function:



13.9.11.3.3 l4re_rm_attach_w_info()

```
int l4re_rm_attach_w_info (
             void ** start,
             unsigned long size,
             l4re_rm_flags_t flags,
             l4re_ds_t mem,
             l4re_rm_offset_t offs,
             unsigned char align,
             char const * name,
             l4re_ds_offset_t backing_offset)  [inline]
```

Attach a data space to a region.

Parameters

in,out	*start*	Virtual start address where the region manager shall attach the data space. Will be rounded down to the nearest start of a page. If L4Re::Rm::F::Search_addr is given this value is used as the start address to search for a free virtual memory region and the resulting address is returned here. If L4Re::Rm::F::In_area is given the value is used as a selector for the area (see L4Re::Rm::reserve_area) to attach the data space to.
	size	Size of the data space to attach (in bytes). Will be rounded up to the nearest multiple of the page size.
	flags	The flags control how and with which rights the dataspace is attached to the region. See L4Re::Rm::F::Attach_flags and L4Re::Rm::F::Region_flags. The caller must specify the desired rights of the attached region explicitly. The default set of rights is empty. If the `F::Eager_map` flag is set this function may also return L4Re::Dataspace::map error codes if the mapping fails.

	mem	Data space.
	offs	Offset into the data space to use.
	align	Alignment of the virtual region, log2-size, default: a page (L4_PAGESHIFT). This is only meaningful if the L4Re::Rm::F::Search_addr flag is used.
	name	Optional name of the region.
	backing_offset	Optional value describing an offset into the backing store of this region.

Return values

0	Success
-L4_ENOENT	No area could be found (see L4Re::Rm::F::In_area)
-L4_EPERM	Operation not allowed.
-L4_EINVAL	
-L4_EADDRNOTAVAIL	The given address is not available.
<0	IPC errors

Makes the whole or parts of a data space visible in the virtual memory of the corresponding task. The corresponding region in the virtual address space is backed with the contents of the dataspace.

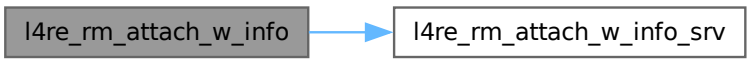
Note

When searching for a free place in the virtual address space, the space between *start* and the end of the virtual address space is

See also

L4Re::Rm::attach

This function is using the L4::Env::env()->rm() service.
Definition at line 426 of file rm.h.
References L4_NOTHROW, l4re_ds_t, and l4re_rm_attach_w_info_srv().
Here is the call graph for this function:



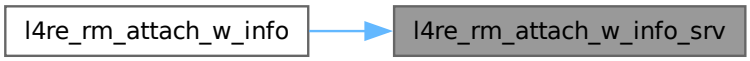
13.9.11.3.4 l4re_rm_attach_w_info_srv()

```
int l4re_rm_attach_w_info_srv (
            l4_cap_idx_t rm,
            void ** start,
            unsigned long size,
            l4re_rm_flags_t flags,
            l4re_ds_t mem,
            l4re_rm_offset_t offs,
            unsigned char align,
            char const * name,
            l4re_ds_offset_t backing_offset)
```

See also

L4Re::Rm::attach

References L4_CV, L4_NOTHROW, and l4re_ds_t.
Referenced by l4re_rm_attach_w_info().
Here is the caller graph for this function:



13.9.11.3.5 l4re_rm_detach()

```
int l4re_rm_detach (
            void * addr)  [inline]
```

Detach and unmap a region from the address space in the current task.

Parameters

addr	Address of the region to detach.

Return values

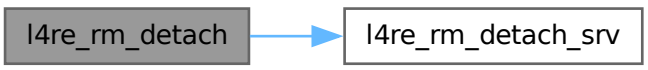
L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees a region in the virtual address space given by addr. The corresponding part of the address space is now available again.
Also

See also

L4Re::Rm::detach

This function is using the L4::Env::env()->rm() service.
Definition at line 439 of file rm.h.
References L4_BASE_TASK_CAP, L4_NOTHROW, and l4re_rm_detach_srv().
Here is the call graph for this function:



13.9.11.3.6 l4re_rm_detach_ds()

```
int l4re_rm_detach_ds (
            void * addr,
            l4re_ds_t * ds)  [inline]
```

Detach and unmap a region and return affected dataspace in the current task.

Parameters

	addr	Address of the region to detach.
out	*ds*	Returns dataspace that is affected.

Return values

L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees a region in the virtual address space given by addr. The corresponding part of the address space is now available again.
Also

See also

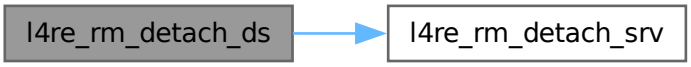
L4Re::Rm::detach

This function is using the L4::Env::env()->rm() service.

Examples

examples/libs/l4re/c/ma+rm.c.

Definition at line 452 of file rm.h.
References L4_BASE_TASK_CAP, L4_NOTHROW, l4re_ds_t, and l4re_rm_detach_srv().
Here is the call graph for this function:



13.9.11.3.7 l4re_rm_detach_ds_unmap()

```
int l4re_rm_detach_ds_unmap (
            void * addr,
            l4re_ds_t * ds,
            l4_cap_idx_t task)  [inline]
```

Detach and unmap in specified task.

Parameters

	addr	Address of the region to detach.
out	*ds*	Returns dataspace that is affected.
	task	Task to unmap pages from, specify L4_INVALID_CAP to not unmap

Returns

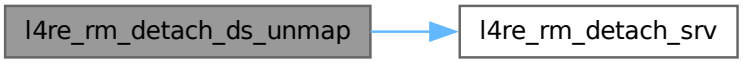
0 on success, <0 on error

Also

See also

L4Re::Rm::detach

This function is using the L4::Env::env()->rm() service.
Definition at line 459 of file rm.h.
References L4_NOTHROW, l4re_ds_t, and l4re_rm_detach_srv().
Here is the call graph for this function:



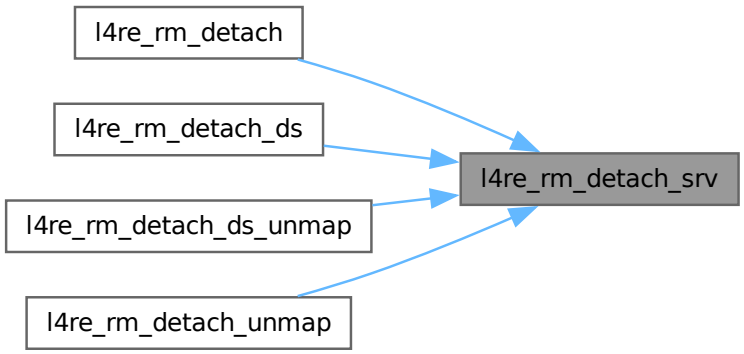
13.9.11.3.8 l4re_rm_detach_srv()

```
int l4re_rm_detach_srv (
              l4_cap_idx_t rm,
              l4_addr_t addr,
              l4re_ds_t * ds,
              l4_cap_idx_t task)
```

See also

L4Re::Rm::detach

References L4_CV, L4_NOTHROW, and l4re_ds_t.
Referenced by l4re_rm_detach(), l4re_rm_detach_ds(), l4re_rm_detach_ds_unmap(), and l4re_rm_detach_unmap().
Here is the caller graph for this function:



13.9.11.3.9 l4re_rm_detach_unmap()

```
int l4re_rm_detach_unmap (
            l4_addr_t addr,
            l4_cap_idx_t task)  [inline]
```

Detach and unmap in specified task.

Parameters

addr	Address of the region to detach.
task	Task to unmap pages from, specify L4_INVALID_CAP to not unmap

Returns

0 on success, <0 on error

Also

See also

L4Re::Rm::detach

This function is using the L4::Env::env()->rm() service.
Definition at line 446 of file rm.h.
References L4_NOTHROW, and l4re_rm_detach_srv().
Here is the call graph for this function:



13.9.11.3.10 l4re_rm_find()

```
int l4re_rm_find (
            l4_addr_t * addr,
            unsigned long * size,
            l4re_rm_offset_t * offset,
            l4re_rm_flags_t * flags,
            l4re_ds_t * m)  [inline]
```

Find a region given an address and size.

Parameters

in,out	*addr*	Address to look for. Returns the start address of the found region.
in,out	*size*	Size of the area to look for (in bytes). Returns the size of the found region (in bytes).
out	*offset*	Offset at the beginning of the region within the associated dataspace.
out	*flags*	Region flags, see F::Region_flags (and F::In_area).
out	*m*	Associated dataspace or paging service. May be an invalid capability, see below.

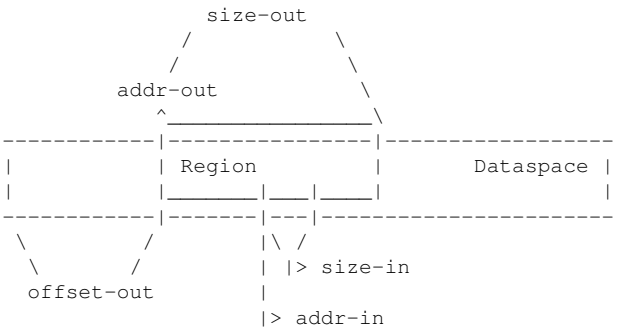
Return values

0	Success
-L4_EPERM	Operation not allowed.
-L4_ENOENT	No region found.
<0	IPC errors

This function returns the properties of the region that contains the area described by the addr and size parameter. If no such region is found but a reserved area, the area is returned and F::In_area is set in `flags`. Note, in the case of an area the `offset` and `m` return values are invalid.

Note

`m` is the dataspace that was passed when the region was attached. It is L4_INVALID_CAP whenever the region has no such dataspace, which is the case for regions attached with F::Anonymous because the memory is provided by the region manager itself. Additionally, the capability slot may have been reused by the application in the meantime. Thus, callers must be careful when using `m` of regions that have been created or manipulated by other code.



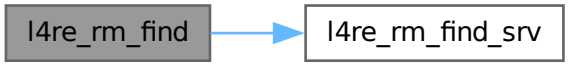
Note

The value of the size input parameter should be 1 to assure that a region can be determined unambiguously.

See also

L4Re::Rm::find

Definition at line 466 of file rm.h.
References L4_NOTHROW, l4re_ds_t, and l4re_rm_find_srv().
Here is the call graph for this function:



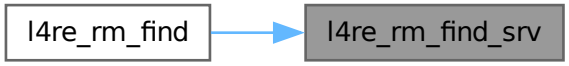
13.9.11.3.11 l4re_rm_find_srv()

```
int l4re_rm_find_srv (
              l4_cap_idx_t rm,
              l4_addr_t * addr,
              unsigned long * size,
              l4re_rm_offset_t * offset,
              l4re_rm_flags_t * flags,
              l4re_ds_t * m)
```

See also

L4Re::Rm::find

References L4_CV, L4_NOTHROW, and l4re_ds_t.
Referenced by l4re_rm_find().
Here is the caller graph for this function:



13.9.11.3.12 l4re_rm_free_area()

```
int l4re_rm_free_area (
            l4_addr_t addr)  [inline]
```

Free an area from the region map.

Parameters

addr	An address within the area to free.

Return values

0	Success
-L4_ENOENT	No area found.
<0	IPC errors

Note

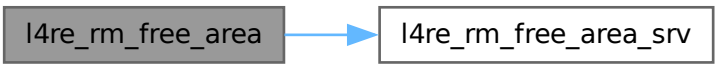
The data spaces that are attached to that area are not detached by this operation.

See also

reserve_area() for more information about areas.

L4Re::Rm::free_area

This function is using the L4::Env::env()->rm() service.
Definition at line 411 of file rm.h.
References L4_NOTHROW, and l4re_rm_free_area_srv().
Here is the call graph for this function:



13.9.11.3.13 l4re_rm_free_area_srv()

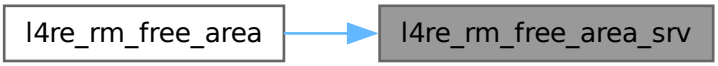
```
int l4re_rm_free_area_srv (
            l4_cap_idx_t rm,
            l4_addr_t addr)
```

See also

L4Re::Rm::free_area

References L4_CV, and L4_NOTHROW.
Referenced by l4re_rm_free_area().

Here is the caller graph for this function:



13.9.11.3.14 l4re_rm_get_info()

```
int l4re_rm_get_info (
            l4_addr_t addr,
            char * name,
            unsigned int len,
            l4re_rm_offset_t * backing_offset)  [inline]
```

Return auxiliary information of a region.
This is a debugging feature and might not be available.

Parameters

	addr	Virtual address of the region.
out	*name*	Name of the region.
out	*backing_offset*	Backing offset information.

Return values

0	Success
-L4_ENOENT	Region not found.
-L4_ENOSYS	Function not available.
<0	IPC errors

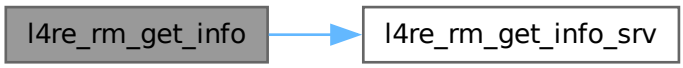
Parameters

len	Length of the name given in name argument, in bytes.

See also

L4Re::Rm::get_info

Definition at line 482 of file rm.h.
References L4_NOTHROW, and l4re_rm_get_info_srv().
Here is the call graph for this function:



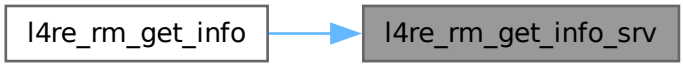
13.9.11.3.15 l4re_rm_get_info_srv()

```
int l4re_rm_get_info_srv (
             l4_cap_idx_t rm,
             l4_addr_t addr,
             char * name,
             unsigned int len,
             l4re_rm_offset_t * backing_offset)
```

See also

L4Re::Rm::get_info

References L4_CV, and L4_NOTHROW.
Referenced by l4re_rm_get_info().
Here is the caller graph for this function:



13.9.11.3.16 l4re_rm_reserve_area()

```
int l4re_rm_reserve_area (
             l4_addr_t * start,
             unsigned long size,
             l4re_rm_flags_t flags,
             unsigned char align)  [inline]
```

Reserve the given area in the region map.

Parameters

in,out	*start*	The virtual start address of the area to reserve. Returns the start address of the area.

	size	The size of the area to reserve (in bytes).
	flags	Flags for the reserved area (see F::Search_addr, F::Kernel and F::Reserved).
	align	Alignment of area if searched as bits (log2 value).

Return values

0	Success
-L4_EADDRNOTAVAIL	The given area cannot be reserved.
-L4_EINVAL	Invalid parameters
<0	IPC errors

This function reserves an area within the virtual address space managed by the region map. There are two kinds of areas available:

- Reserved areas (*flags* = L4Re::Rm::F::Reserved), where no data spaces can be attached
- Special purpose areas (*flags* = 0), where data spaces can be attached to the area via the L4Re::Rm::F::In_area flag and a start address within the area itself.

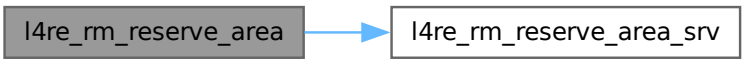
Note

When searching for a free place in the virtual address space (with *flags* = L4Re::Rm::F::Search_addr), the space between *start* and the end of the virtual address space is searched.

See also

L4Re::Rm::reserve_area

This function is using the L4::Env::env()->rm() service.
Definition at line 403 of file rm.h.
References L4_NOTHROW, and l4re_rm_reserve_area_srv().
Here is the call graph for this function:



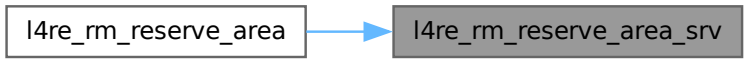
13.9.11.3.17 l4re_rm_reserve_area_srv()

```
int l4re_rm_reserve_area_srv (
              l4_cap_idx_t rm,
              l4_addr_t * start,
              unsigned long size,
              l4re_rm_flags_t flags,
              unsigned char align)
```

See also

L4Re::Rm::reserve_area

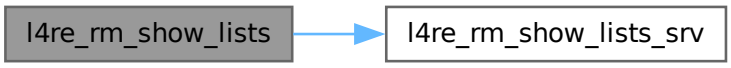
References L4_CV, and L4_NOTHROW.
Referenced by l4re_rm_reserve_area().
Here is the caller graph for this function:



13.9.11.3.18 l4re_rm_show_lists()

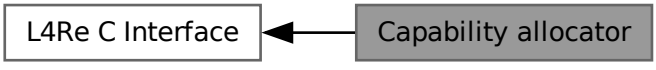
```
void l4re_rm_show_lists (
            void )  [inline]
```

Dump region map internal data structures.
This function is using the L4::Env::env()->rm() service.
Definition at line 474 of file rm.h.
References L4_NOTHROW, and l4re_rm_show_lists_srv().
Here is the call graph for this function:



13.9.12 Capability allocator

Capability allocator C interface.
Collaboration diagram for Capability allocator:



Functions

- L4_BEGIN_DECLS l4_cap_idx_t **l4re_util_cap_alloc** (void) L4_NOTHROW

  Get free capability index at capability allocator.
- void **l4re_util_cap_free** (l4_cap_idx_t cap) L4_NOTHROW

Return capability index to capability allocator.

- void **l4re_util_cap_free_um** (l4_cap_idx_t cap) L4_NOTHROW

  Return capability index to capability allocator, and unmaps the object.

- long l4re_util_cap_last (void) L4_NOTHROW

  Return last capability index the allocator can return.

13.9.12.1 Detailed Description

Capability allocator C interface.

13.9.12.2 Function Documentation

13.9.12.2.1 l4re_util_cap_last()

```
long l4re_util_cap_last (
            void )
```

Return last capability index the allocator can return.

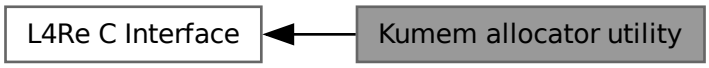
Returns

last/biggest capability index the allocator can return

References L4_END_DECLS, and L4_NOTHROW.

13.9.13 Kumem allocator utility

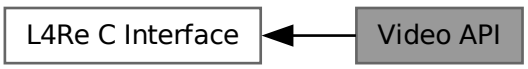
Kumem allocator utility C interface.
Collaboration diagram for Kumem allocator utility:



Kumem allocator utility C interface.

13.9.14 Video API

Collaboration diagram for Video API:



Data Structures

- struct l4re_video_color_component_t

  Color component structure.
- struct l4re_video_pixel_info_t

  Pixel_info structure.
- struct l4re_video_goos_info_t

  Goos information structure.
- struct l4re_video_view_info_t

  View information structure.
- struct l4re_video_view_t

  C representation of a goos view.

Typedefs

- typedef struct l4re_video_color_component_t **l4re_video_color_component_t**

  Color component structure.
- typedef struct l4re_video_pixel_info_t **l4re_video_pixel_info_t**

  Pixel_info structure.
- typedef l4_cap_idx_t **l4re_video_goos_t**

  Goos object type.
- typedef struct l4re_video_view_info_t **l4re_video_view_info_t**

  View information structure.
- typedef struct l4re_video_view_t l4re_video_view_t

  C representation of a goos view.

Enumerations

- enum l4re_video_goos_info_flags_t { F_l4re_video_goos_auto_refresh = 0x01 , F_l4re_video_goos_pointer = 0x02 , F_l4re_video_goos_dynamic_views = 0x04 , F_l4re_video_goos_dynamic_buffers = 0x08 }

  Flags of information on the goos.
- enum l4re_video_view_info_flags_t { F_l4re_video_view_none = 0x00 , F_l4re_video_view_set_buffer = 0x01 , F_l4re_video_view_set_buffer_offset = 0x02 , F_l4re_video_view_set_bytes_per_line = 0x04 , F_l4re_video_view_set_pixel = 0x08 , F_l4re_video_view_set_position = 0x10 , F_l4re_video_view_dyn_allocated = 0x20 , F_l4re_video_view_set_background = 0x40 , F_l4re_video_view_set_flags = 0x80 , **F_l4re_video_view_fully_dynamic** , F_l4re_video_view_above = 0x01000 , F_l4re_video_view_flags_mask = 0xff000 }

  Flags of information on a view.

Functions

- L4_BEGIN_DECLS int l4re_video_goos_info (l4re_video_goos_t goos, l4re_video_goos_info_t *ginfo) L4_NOTHROW

  Get information on a goos.
- int l4re_video_goos_refresh (l4re_video_goos_t goos, int x, int y, int w, int h) L4_NOTHROW

  Flush a rectangle of pixels of the goos screen.
- int l4re_video_goos_create_buffer (l4re_video_goos_t goos, unsigned long size, l4_cap_idx_t buffer) L4_NOTHROW

  Create a new buffer (memory buffer) for pixel data.
- int l4re_video_goos_delete_buffer (l4re_video_goos_t goos, unsigned idx) L4_NOTHROW

  Delete a pixel buffer.
- int l4re_video_goos_get_static_buffer (l4re_video_goos_t goos, unsigned idx, l4_cap_idx_t buffer) L4_NOTHROW

Get the data-space capability of the static pixel buffer.

- int l4re_video_goos_create_view (l4re_video_goos_t goos, l4re_video_view_t *view) L4_NOTHROW

  Create a new view (.

- int l4re_video_goos_delete_view (l4re_video_goos_t goos, l4re_video_view_t *view) L4_NOTHROW

  Delete a view.

- int l4re_video_goos_get_view (l4re_video_goos_t goos, unsigned idx, l4re_video_view_t *view) L4_NOTHROW

  Get a view for the given index.

- L4_BEGIN_DECLS int l4re_video_view_refresh (l4re_video_view_t *view, int x, int y, int w, int h) L4_NOTHROW

  Flush the given rectangle of pixels of the given view.

- int l4re_video_view_get_info (l4re_video_view_t *view, l4re_video_view_info_t *info) L4_NOTHROW

  Retrieve information about the given view.

- int l4re_video_view_set_info (l4re_video_view_t *view, l4re_video_view_info_t *info) L4_NOTHROW

  Set properties of the view.

- int l4re_video_view_set_viewport (l4re_video_view_t *view, int x, int y, int w, int h, unsigned long bofs) L4_NOTHROW

  Set the viewport parameters of a view.

- int l4re_video_view_stack (l4re_video_view_t *view, l4re_video_view_t *pivot, int behind) L4_NOTHROW

  Change the stacking order in the stack of visible views.

13.9.14.1 Detailed Description

13.9.14.2 Typedef Documentation

13.9.14.2.1 l4re_video_view_t

```
typedef struct l4re_video_view_t l4re_video_view_t
```

C representation of a goos view.
A view is a visible rectangle that provides a view to the contents of a buffer (frame buffer) memory object and is placed on a real screen.

13.9.14.3 Enumeration Type Documentation

13.9.14.3.1 l4re_video_goos_info_flags_t

```
enum l4re_video_goos_info_flags_t
```

Flags of information on the goos.

Enumerator

F_l4re_video_goos_auto_refresh	The graphics display is automatically refreshed.
F_l4re_video_goos_pointer	We have a mouse pointer.
F_l4re_video_goos_dynamic_views	Supports dynamically allocated views.
F_l4re_video_goos_dynamic_buffers	Supports dynamically allocated buffers.

Definition at line 29 of file goos.h.

13.9.14.3.2 l4re_video_view_info_flags_t

```
enum l4re_video_view_info_flags_t
```

Flags of information on a view.

Enumerator

F_l4re_video_view_none	everything for this view is static (the BOOT-FB case)
F_l4re_video_view_set_buffer	buffer object for this view can be changed
F_l4re_video_view_set_buffer_offset	buffer offset can be set
F_l4re_video_view_set_bytes_per_line	bytes per line can be set
F_l4re_video_view_set_pixel	pixel type can be set
F_l4re_video_view_set_position	position on screen can be set
F_l4re_video_view_dyn_allocated	View is dynamically allocated.
F_l4re_video_view_set_background	Set view as background for session.
F_l4re_video_view_set_flags	Set view property flags.
F_l4re_video_view_above	Flag the view as stay on top.
F_l4re_video_view_flags_mask	Mask containing all possible property flags.

Definition at line 23 of file view.h.

13.9.14.4 Function Documentation

13.9.14.4.1 l4re_video_goos_create_buffer()

```
int l4re_video_goos_create_buffer (
             l4re_video_goos_t goos,
             unsigned long size,
             l4_cap_idx_t buffer)
```

Create a new buffer (memory buffer) for pixel data.

Parameters

goos	the target object for the operation.
size	the size in bytes for the pixel buffer.
buffer	a capability index to receive the data-space capability for the buffer.

Returns

>=0: The index of the created buffer (used to assign views and for deletion). < 0: on error

References L4_CV, and L4_NOTHROW.

13.9.14.4.2 l4re_video_goos_create_view()

```
int l4re_video_goos_create_view (
             l4re_video_goos_t goos,
             l4re_video_view_t * view)
```

Create a new view (.

See also

l4re_video_view_t)

Parameters

	goos	the goos session to use.
out	*view*	structure initialized to the new view.

References L4_CV, and L4_NOTHROW.

13.9.14.4.3 l4re_video_goos_delete_buffer()

```
int l4re_video_goos_delete_buffer (
            l4re_video_goos_t goos,
            unsigned idx)
```

Delete a pixel buffer.

Parameters

goos	the target goos object.
idx	the buffer index of the buffer to delete (the return value of l4re_video_goos_create_buffer())

References L4_CV, and L4_NOTHROW.

13.9.14.4.4 l4re_video_goos_delete_view()

```
int l4re_video_goos_delete_view (
            l4re_video_goos_t goos,
            l4re_video_view_t * view)
```

Delete a view.

Parameters

goos	the goos session to use.
view	the view to delete, the given data-structure is invalid afterwards.

References L4_CV, and L4_NOTHROW.

13.9.14.4.5 l4re_video_goos_get_static_buffer()

```
int l4re_video_goos_get_static_buffer (
            l4re_video_goos_t goos,
            unsigned idx,
            l4_cap_idx_t buffer)
```

Get the data-space capability of the static pixel buffer.

Parameters

goos	The target goos object.
idx	Index of the static buffer.
buffer	A capability index to receive the data-space capability.

This function allows access to static, preexisting pixel buffers. Such static buffers exist for static configurations, such as the bootloader's framebuffer.
References L4_CV, and L4_NOTHROW.

13.9.14.4.6 l4re_video_goos_get_view()

```
int l4re_video_goos_get_view (
            l4re_video_goos_t goos,
            unsigned idx,
            l4re_video_view_t * view)
```

Get a view for the given index.

Parameters

	goos	the target goos session.
	idx	the index of the view to retrieve.
out	*view*	structure initialized to the view with the given index.

This function allows to access static views as provided, for example, by the bootloader's framebuffer. However, it also allows to access dynamic views created with l4re_video_goos_create_view().
References L4_END_DECLS, and L4_NOTHROW.

13.9.14.4.7 l4re_video_goos_info()

```
L4_BEGIN_DECLS int l4re_video_goos_info (
            l4re_video_goos_t goos,
            l4re_video_goos_info_t * ginfo)
```

Get information on a goos.

Parameters

	goos	Goos object
out	*ginfo*	Pointer to goos information structure.

Returns

0 for success, <0 on error

- -L4_ENODEV
- IPC errors

References L4_CV, and L4_NOTHROW.

13.9.14.4.8 l4re_video_goos_refresh()

```
int l4re_video_goos_refresh (
            l4re_video_goos_t goos,
            int x,
            int y,
            int w,
            int h)
```

Flush a rectangle of pixels of the goos screen.

Parameters

goos	the target object of the operation.
x	the x-coordinate of the upper left corner of the rectangle
y	the y-coordinate of the upper left corner of the rectangle
w	the width of the rectangle to be flushed
h	the height of the rectangle

References L4_CV, and L4_NOTHROW.

13.9.14.4.9 l4re_video_view_get_info()

```
int l4re_video_view_get_info (
```

```
            l4re_video_view_t * view,
            l4re_video_view_info_t * info)
```

Retrieve information about the given *view*.

Parameters

	view	the target view for the operation.
out	*info*	a buffer receiving the information about the view.

References L4_CV, and L4_NOTHROW.

13.9.14.4.10 l4re_video_view_refresh()

```
L4_BEGIN_DECLS int l4re_video_view_refresh (
            l4re_video_view_t * view,
            int x,
            int y,
            int w,
            int h)
```

Flush the given rectangle of pixels of the given *view*.

Parameters

view	the target view of the operation.
x	x-coordinate of the upper left corner
y	y-coordinate of the upper left corner
w	the width of the rectangle
h	the height of the rectangle

References L4_CV, and L4_NOTHROW.

13.9.14.4.11 l4re_video_view_set_info()

```
int l4re_video_view_set_info (
            l4re_video_view_t * view,
            l4re_video_view_info_t * info)
```

Set properties of the view.

Parameters

view	the target view of the operation.
info	the parameters to be set on the view.

Which parameters can be manipulated on a given view can be figured out with l4re_video_view_get_info() and this depends on the concrete instance the view object.
References L4_CV, and L4_NOTHROW.

13.9.14.4.12 l4re_video_view_set_viewport()

```
int l4re_video_view_set_viewport (
            l4re_video_view_t * view,
            int x,
            int y,
            int w,
```

```
            int h,
            unsigned long bofs)
```

Set the viewport parameters of a view.

Parameters

view	the target view of the operation.
x	the x-coordinate of the upper left corner on the screen.
y	the y-coordinate of the upper left corner on the screen.
w	the width of the view.
h	the height of the view.
bofs	the offset (in bytes) of the upper left pixel in the memory buffer

This function is a convenience wrapper for l4re_video_view_set_info(), just setting the often changed parameters of a dynamic view. With this function a view can be placed on the real screen and at the same time on its backing buffer.
References L4_CV, and L4_NOTHROW.

13.9.14.4.13 l4re_video_view_stack()

```
int l4re_video_view_stack (
            l4re_video_view_t * view,
            l4re_video_view_t * pivot,
            int behind)
```

Change the stacking order in the stack of visible views.

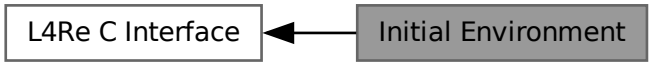
Parameters

view	the target view for the operation.
pivot	the neighbor view, relative to which *view* shall be stacked. a NULL value allows top (*behind* = 1) and bottom (*behind* = 0) placement of the view.
behind	describes the placement of the view relative to the *pivot* view.

References L4_END_DECLS, and L4_NOTHROW.

13.9.15 Initial Environment

C interface of the initial environment that is provided to an L4 task.
Collaboration diagram for Initial Environment:



Data Structures

- struct l4re_env_cap_entry_t

  Entry in the L4Re environment array for the named initial objects.

Typedefs

- typedef struct l4re_env_cap_entry_t **l4re_env_cap_entry_t**

  Entry in the L4Re environment array for the named initial objects.

Functions

- l4re_env_t * l4re_env (void) L4_NOTHROW

  Get L4Re initial environment.
- l4_kernel_info_t const * l4re_kip (void) L4_NOTHROW

  Get Kernel Info Page.
- l4_cap_idx_t l4re_env_get_cap (char const *name) L4_NOTHROW

  Get the capability index for the object named name.
- l4_cap_idx_t l4re_env_get_cap_e (char const *name, l4re_env_t const *e) L4_NOTHROW

  Get the capability index for the object named name.
- l4re_env_cap_entry_t const * l4re_env_get_cap_l (char const *name, unsigned l, l4re_env_t const *e) L4_NOTHROW

  Get the full l4re_env_cap_entry_t for the object named name.

13.9.15.1 Detailed Description

C interface of the initial environment that is provided to an L4 task.

Include File

```
#include <l4/re/env.h>
```

For an explanation of the default task capabilities see l4_default_caps_t.
For the C++ interface refer to L4Re::Env.

13.9.15.2 Function Documentation

13.9.15.2.1 l4re_env()

```
l4re_env_t * l4re_env (
            void )  [inline]
```

Get L4Re initial environment.

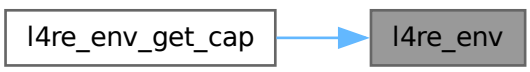
Returns

Pointer to L4Re initial environment.

Examples

examples/sys/aliens/main.c, examples/sys/isr/main.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 202 of file env.h.
References L4_NOTHROW.
Referenced by l4re_env_get_cap().
Here is the caller graph for this function:



13.9.15.2.2 l4re_env_get_cap()

```
l4_cap_idx_t l4re_env_get_cap (
             char const * name)  [inline]
```

Get the capability index for the object named *name*.

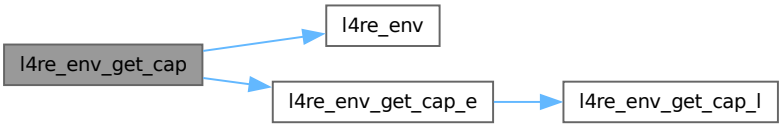
Parameters

name	is the name of the object to lookup in the initial objects.

Returns

A capability index if the object exists or an invalid capability selector if not (see l4_is_invalid_cap()).

Definition at line 241 of file env.h.
References L4_NOTHROW, l4re_env(), and l4re_env_get_cap_e().
Here is the call graph for this function:



13.9.15.2.3 l4re_env_get_cap_e()

```
l4_cap_idx_t l4re_env_get_cap_e (
             char const * name,
             l4re_env_t const * e)  [inline]
```

Get the capability index for the object named *name*.

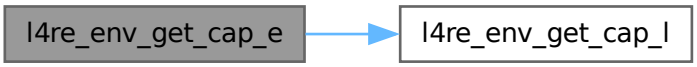
Parameters

name	is the name of the object to lookup in the initial objects.
e	is the environment structure to use for the operation.

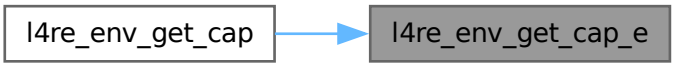
Returns

A capability index if the object exists or an invalid capability selector if not (see l4_is_invalid_cap()).

Definition at line 228 of file env.h.
References l4re_env_cap_entry_t::cap, L4_INVALID_CAP, L4_NOTHROW, and l4re_env_get_cap_l().
Referenced by l4re_env_get_cap().
Here is the call graph for this function:



Here is the caller graph for this function:



13.9.15.2.4 l4re_env_get_cap_l()

```
l4re_env_cap_entry_t const * l4re_env_get_cap_l (
            char const * name,
            unsigned l,
            l4re_env_t const * e)  [inline]
```

Get the full l4re_env_cap_entry_t for the object named *name*.

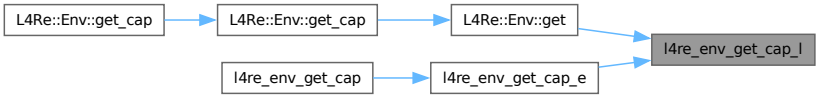
Parameters

name	is the name of the object to lookup in the initial objects.
l	is the length of the name string, thus *name* might not be zero terminated.
e	is the environment structure to use for the operation.

Returns

A pointer to an l4re_env_cap_entry_t if the object exists or NULL if not.

Definition at line 210 of file env.h.
References l4re_env_cap_entry_t::flags, L4_NOTHROW, and l4re_env_cap_entry_t::name.
Referenced by L4Re::Env::get(), and l4re_env_get_cap_e().
Here is the caller graph for this function:



13.9.15.2.5 l4re_kip()

```
l4_kernel_info_t const * l4re_kip (
            void )  [inline]
```

Get Kernel Info Page.

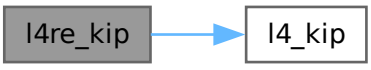
Returns

Pointer to Kernel Info Page (KIP) structure.

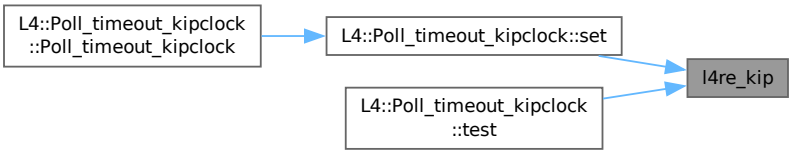
Examples

examples/libs/shmc/prodcons.c, and examples/sys/aliens/main.c.

Definition at line 206 of file env.h.
References l4_kip(), and L4_NOTHROW.
Referenced by L4::Poll_timeout_kipclock::set(), and L4::Poll_timeout_kipclock::test().
Here is the call graph for this function:

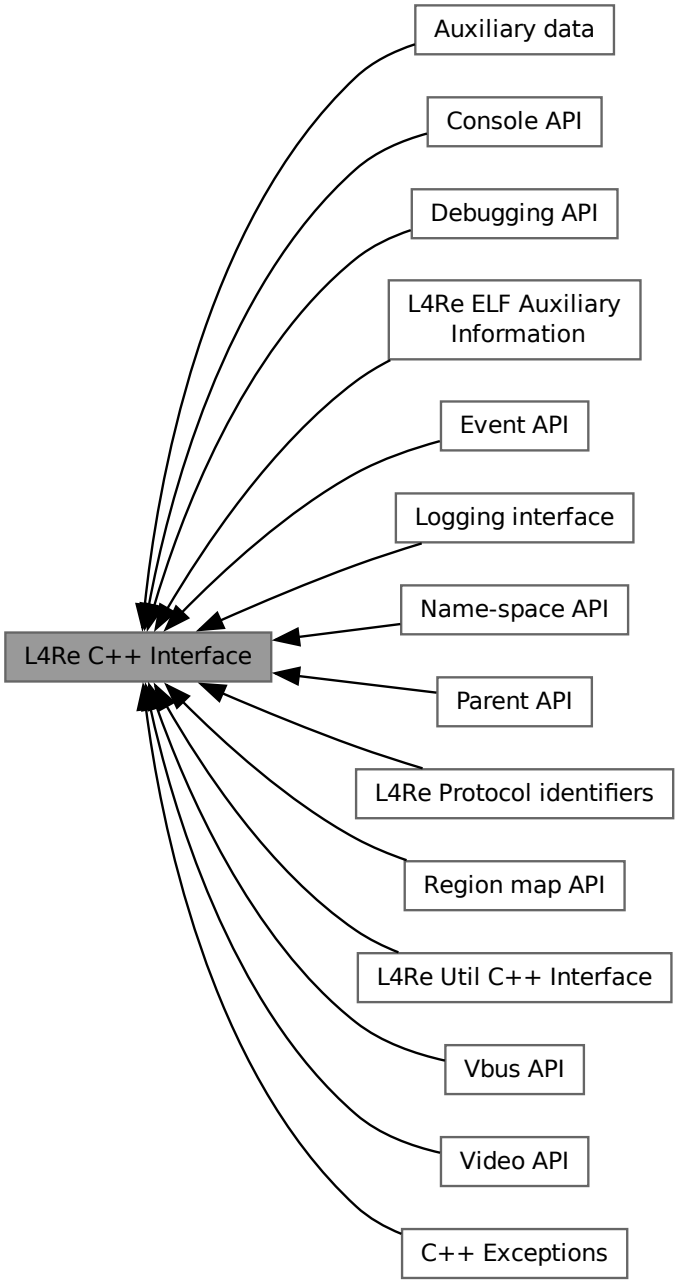


Here is the caller graph for this function:



13.10 L4Re C++ Interface

Documentation of the L4 Runtime Environment C++ API.
Collaboration diagram for L4Re C++ Interface:



Topics

- L4Re Util C++ Interface 539
  Documentation of the L4 Runtime Environment utility functionality in C++.

- Console API . . . 543
  Console interface.
- Debugging API . . . 543
  Debugging Interface.
- L4Re ELF Auxiliary Information . . . 544
  API for embedding auxiliary information into binary programs.
- Event API . . . 546
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- Name-space API . . . 548
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- Parent API . . . 548
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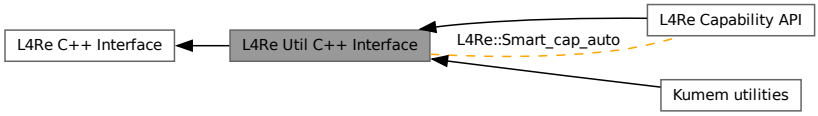
13.10.1 Detailed Description

Documentation of the L4 Runtime Environment C++ API.

13.10.2 L4Re Util C++ Interface

Documentation of the L4 Runtime Environment utility functionality in C++.
Collaboration diagram for L4Re Util C++ Interface:



Topics

- L4Re Capability API 540
- Kumem utilities 542

Data Structures

- class L4Re::Smart_cap_auto< Unmap_flags >
  Helper for Unique_cap and Unique_del_cap.
- class L4Re::Util::Cap_alloc_base
  Capability allocator.
- class L4Re::Util::Br_manager
  Buffer-register (BR) manager for L4::Server.
- class L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >
  Internal reference-counting cap allocator.
- class L4Re::Util::Event_buffer_t< PAYLOAD >
  Event_buffer utility class.
- class L4Re::Util::Event_buffer_consumer_t< PAYLOAD >
  An event buffer consumer.
- class L4Re::Util::Vcon_svr< SVR >
  Console server template class.
- class L4Re::Util::Video::Goos_svr
  Goos server class.

13.10.2.1 Detailed Description

Documentation of the L4 Runtime Environment utility functionality in C++.

13.10.2.2 L4Re Capability API

Collaboration diagram for L4Re Capability API:



Data Structures

- class L4Re::Cap_alloc
  Capability allocator interface.
- class L4Re::Smart_cap_auto< Unmap_flags >
  Helper for Unique_cap and Unique_del_cap.
- class L4Re::Smart_count_cap< Unmap_flags >
  Helper for Ref_cap and Ref_del_cap.
- class L4Re::Util::Smart_cap_auto< Unmap_flags >
  Helper for Unique_cap and Unique_del_cap.
- class L4Re::Util::Smart_count_cap< Unmap_flags >

Helper for Ref_cap and Ref_del_cap.

- struct L4Re::Util::Ref_cap< T >

  Automatic capability that implements automatic free and unmap of the capability slot.

- struct L4Re::Util::Ref_del_cap< T >

  Automatic capability that implements automatic free and unmap+delete of the capability slot.

Functions

- template<typename T>
  Ref_cap< T >::Cap L4Re::Util::make_ref_cap ()

  Allocate a capability slot and wrap it in a Ref_cap.

- template<typename T>
  Ref_del_cap< T >::Cap L4Re::Util::make_ref_del_cap ()

  Allocate a capability slot and wrap it in a Ref_del_cap.

Variables

- _Cap_alloc L4Re::Util::cap_alloc

  Capability allocator.

- Def_reply_cap_alloc L4Re::Util::reply_cap_alloc

  Reply capability allocator.

13.10.2.2.1 Detailed Description

13.10.2.2.2 Function Documentation

13.10.2.2.2.1 make_ref_cap()

```
template<typename T>
Ref_cap< T >::Cap L4Re::Util::make_ref_cap ()
```

Allocate a capability slot and wrap it in a Ref_cap.

Template Parameters

T	Type of capability the slot is used for.

Definition at line 237 of file cap_alloc.
References cap_alloc.

13.10.2.2.2.2 make_ref_del_cap()

```
template<typename T>
Ref_del_cap< T >::Cap L4Re::Util::make_ref_del_cap ()
```

Allocate a capability slot and wrap it in a Ref_del_cap.

Template Parameters

T	Type of capability the slot is used for.

Definition at line 246 of file cap_alloc.
References cap_alloc.

13.10.2.2.3 Variable Documentation

13.10.2.2.3.1 cap_alloc

```
_Cap_alloc L4Re::Util::cap_alloc  [extern]
```

Capability allocator.
This is the instance of the capability allocator that is used by usual applications.
The capability allocator uses the Counting_cap_alloc, a reference-counting thread-safe capability allocator, that keeps a reference counter for each managed capability slot.

Examples

examples/libs/l4re/c++/mem_alloc/ma+rm.cc, examples/libs/l4re/c++/shared_ds/ds_clnt.cc, examples/libs/l4re/c++/shared_ds/d and examples/libs/l4re/streammap/client.cc.

Referenced by L4Re::Util::Br_manager::alloc_buffer_demand(), L4Re::Util::Smart_count_cap< Unmap_flags >::copy(), L4Re::Util::Smart_cap_auto< Unmap_flags >::free(), L4Re::Util::Smart_count_cap< Unmap_flags >::free(), L4Re::Util::Event_t< Default_event_payload >::init(), L4Re::Util::Event_t< Default_event_payload >::init_poll(), make_ref_cap(), make_ref_del_cap(), make_shared_cap(), make_shared_del_cap(), make_unique_cap(), make_unique_del_cap(), L4Re::Util::Br_manager::realloc_rcv_cap(), and L4Re::Util::Object_registry::unregister_obj().

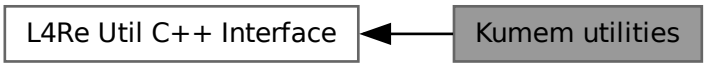
13.10.2.2.3.2 reply_cap_alloc

```
Def_reply_cap_alloc L4Re::Util::reply_cap_alloc  [extern]
```

Reply capability allocator.
This is the default reply capability allocator that is used by usual applications.

13.10.2.3 Kumem utilities

Collaboration diagram for Kumem utilities:



Functions

- int L4Re::Util::kumem_alloc (l4_addr_t *mem, unsigned pages_order, L4::Cap< L4::Task > task=L4Re::Env::env() ->task(), L4::Cap< L4Re::Rm > rm=L4Re::Env::env() ->rm()) noexcept

  Allocate state area.

13.10.2.3.1 Detailed Description

13.10.2.3.2 Function Documentation

13.10.2.3.2.1 kumem_alloc()

```
int L4Re::Util::kumem_alloc (
             l4_addr_t * mem,
             unsigned pages_order,
             L4::Cap< L4::Task > task = L4Re::Env::env() ->task(),
             L4::Cap< L4Re::Rm > rm = L4Re::Env::env() ->rm())  [noexcept]
```

Allocate state area.

Parameters

out	*mem*	Pointer to memory that has been allocated.
	pages_order	Size to allocate, in log2 pages.

	task	Task to use for allocation.
	rm	Region manager to use for allocation.

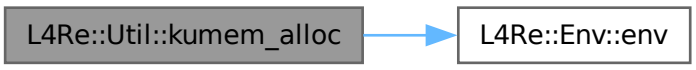
Return values

0	for success
<0	error code on failure

Note

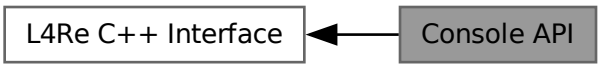
The amount of kernel-user memory that can be allocated at once is limited by the used kernel implementation. The minimum allocatable amount is one page. A portable implementation should not depend on allocations greater than 16KiB to succeed.

References L4Re::Env::env().
Here is the call graph for this function:



13.10.3 Console API

Console interface.
Collaboration diagram for Console API:



Data Structures

- class L4Re::Console
  Console class.

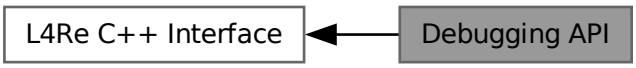
13.10.3.1 Detailed Description

Console interface.

13.10.4 Debugging API

Debugging Interface.

Collaboration diagram for Debugging API:



Data Structures

- class L4Re::Debug_obj
  Debug interface.

13.10.4.1 Detailed Description

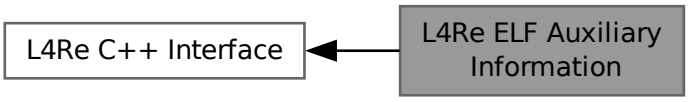
Debugging Interface.
The debugging interface can be provided to retrieve, or log debugging information for an object. Each class may realize the debug interface to provide debugging functionality. For example, the region map objects provide a facility to dump the currently established memory regions.

See also

L4::Debug_obj for more information.

13.10.5 L4Re ELF Auxiliary Information

API for embedding auxiliary information into binary programs.
Collaboration diagram for L4Re ELF Auxiliary Information:



Data Structures

- struct l4re_elf_aux_t
  Generic header for each auxiliary vector element.
- struct l4re_elf_aux_vma_t
  Auxiliary vector element for a reserved virtual memory area.
- struct l4re_elf_aux_mword_t
  Auxiliary vector element for a single unsigned data word.

Macros

- #define L4RE_ELF_AUX_ELEM const __attribute__((used, section(".rol4re_elf_aux"), aligned(sizeof(l4_umword_t))))
  Define an auxiliary vector element.
- #define L4RE_ELF_AUX_ELEM_T(type, id, tag, val...)
  Define an auxiliary vector element.

Typedefs

- typedef struct l4re_elf_aux_t **l4re_elf_aux_t**

  Generic header for each auxiliary vector element.
- typedef struct l4re_elf_aux_vma_t **l4re_elf_aux_vma_t**

  Auxiliary vector element for a reserved virtual memory area.
- typedef struct l4re_elf_aux_mword_t **l4re_elf_aux_mword_t**

  Auxiliary vector element for a single unsigned data word.

Enumerations

- enum {
  L4RE_ELF_AUX_T_NONE = 0 , L4RE_ELF_AUX_T_VMA , L4RE_ELF_AUX_T_STACK_SIZE ,
  L4RE_ELF_AUX_T_STACK_ADDR ,
  L4RE_ELF_AUX_T_KIP_ADDR , L4RE_ELF_AUX_T_EX_REGS_FLAGS }

13.10.5.1 Detailed Description

API for embedding auxiliary information into binary programs.
This API allows information for the binary loader to be embedded into a binary application. This information can be reserved areas in the virtual memory of an application and things such as the stack size to be allocated for the first application thread.

13.10.5.2 Macro Definition Documentation

13.10.5.2.1 L4RE_ELF_AUX_ELEM

```
#define L4RE_ELF_AUX_ELEM const __attribute__((used, section(".rol4re_elf_aux"), aligned(sizeof(l4_umword_t))))
```

Define an auxiliary vector element.
This is the generic method for defining auxiliary vector elements. A more convenient way is to use L4RE_ELF_↩ AUX_ELEM_T.
Usage:

```
L4RE_ELF_AUX_ELEM l4re_elf_aux_vma_t decl_name =
  { L4RE_ELF_AUX_T_VMA, sizeof(l4re_elf_aux_vma_t), 0x2000, 0x4000 };
```

Definition at line 41 of file elf_aux.h.

13.10.5.2.2 L4RE_ELF_AUX_ELEM_T

```
#define L4RE_ELF_AUX_ELEM_T(
              type,
              id,
              tag,
              val...)
```

Value:

```
  static L4RE_ELF_AUX_ELEM type id = {tag, sizeof(type), val}
```

Define an auxiliary vector element.

Parameters

type	is the data type for the element (e.g., l4re_elf_aux_vma_t)
id	is the identifier (variable name) for the declaration (the variable is defined with `static` storage class)
tag	is the tag value for the element e.g., L4RE_ELF_AUX_T_VMA
val	are the values to be set in the descriptor

Usage:

```
L4RE_ELF_AUX_ELEM_T(l4re_elf_aux_vma_t, decl_name, L4RE_ELF_AUX_T_VMA, 0x2000, 0x4000 };
```

Definition at line 56 of file elf_aux.h.

13.10.5.3 Enumeration Type Documentation

13.10.5.3.1 anonymous enum

```
anonymous enum
```

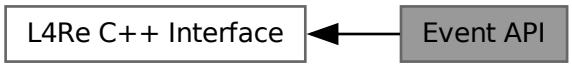
Enumerator

L4RE_ELF_AUX_T_NONE	Tag for an invalid element in the auxiliary vector.
L4RE_ELF_AUX_T_VMA	Tag for descriptor for a reserved virtual memory area.
L4RE_ELF_AUX_T_STACK_SIZE	Tag for descriptor that defines the stack size for the first application thread.
L4RE_ELF_AUX_T_STACK_ADDR	Tag for descriptor that defines the stack address for the first application thread.
L4RE_ELF_AUX_T_KIP_ADDR	Tag for descriptor that defines the KIP address for the binary's address space.
L4RE_ELF_AUX_T_EX_REGS_FLAGS	Tag for descriptor to override ex_regs() flags.

Definition at line 59 of file elf_aux.h.

13.10.6 Event API

Event API.
Collaboration diagram for Event API:



Data Structures

- class L4Re::Event

  Event class.
- struct L4Re::Default_event_payload

  Default event stream payload.
- class L4Re::Event_buffer_t< PAYLOAD >

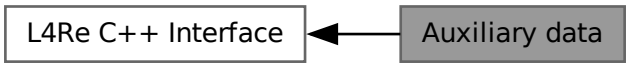
  Event buffer class.

13.10.6.1 Detailed Description

Event API.
On top of a shared L4Re::Dataspace (and optionally using L4::Triggerable), the event API implements asynchronous event transmission from an event provider (server) to an event receiver (client). Events are put into an Event_buffer_t residing on the shared L4Re::Dataspace.
This interface is usually not used directly. Instead use L4Re::Util::Event_t for clients. An example server portion is implemented in L4Re::Util::Event_svr.
This interface is usually used with L4Re::Default_event_payload which delivers HID events modeled on the Linux evdev API, and the interface's methods allow further querying of information about the HID event streams.

13.10.7 Auxiliary data

Collaboration diagram for Auxiliary data:



Data Structures

- struct l4re_aux_t

  Auxiliary descriptor.

Typedefs

- typedef struct l4re_aux_t **l4re_aux_t**

  Auxiliary descriptor.

Enumerations

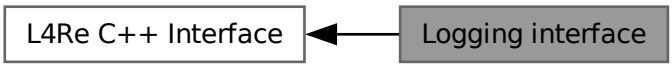
- enum l4re_aux_ldr_flags_t

  Flags for program loading.

13.10.7.1 Detailed Description

13.10.8 Logging interface

Interface for log output.
Collaboration diagram for Logging interface:



Data Structures

- class L4Re::Log

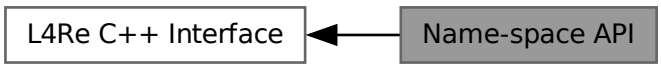
  Log interface class.

13.10.8.1 Detailed Description

Interface for log output.
The logging interface provides a facility sending log output. One purpose of the interface is to serialize the output and provide the possibility to tag output sent to a specific log object.

13.10.9 Name-space API

API for name spaces that store capabilities.
Collaboration diagram for Name-space API:



Data Structures

- class L4Re::Namespace

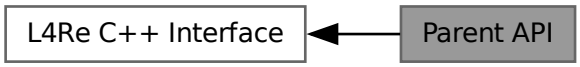
  Name-space interface.

13.10.9.1 Detailed Description

API for name spaces that store capabilities.
This is a basic abstraction for managing a mapping from human-readable names to capabilities. In particular, a name can also be mapped to a capability that refers to another name space object. By this means name spaces can be constructed hierarchically.
Name spaces play a central role in L4Re, because the implementation of the name space objects determines the policy which capabilities (which objects) are accessible to a client of a name space.

13.10.10 Parent API

Parent interface.
Collaboration diagram for Parent API:



Data Structures

- class L4Re::Parent

  Parent interface.

13.10.10.1 Detailed Description

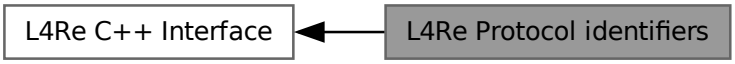
Parent interface.
The parent interface provides means for an L4 task to signal changes in its execution state. The main purpose is to signal program termination to the program that started it, so that its resources can be reclaimed. In a typical L4Re system, this program will be Moe or Ned.

See also

L4Re::Parent for information about the concrete interface.

13.10.11 L4Re Protocol identifiers

Fix L4Re Protocol Constants.
Collaboration diagram for L4Re Protocol identifiers:



Enumerations

- enum L4re_protocols {
  L4RE_PROTO_DATASPACE = 0x4000 , L4RE_PROTO_NAMESPACE , L4RE_PROTO_PARENT ,
  L4RE_PROTO_GOOS ,
  L4RE_PROTO_RSVD_1 , L4RE_PROTO_RM , L4RE_PROTO_EVENT , L4RE_PROTO_INHIBITOR ,
  L4RE_PROTO_DMA_SPACE , L4RE_PROTO_MMIO_SPACE , L4RE_PROTO_ITAS , L4RE_PROTO_MEM_ALLOC
  ,
  L4RE_PROTO_REMOTE_ACCESS , L4RE_PROTO_DEBUG = ∼0x7fffL }

  Common L4Re Protocol Constants.
- enum L4Re::Video::Goos_::Opcodes

  Frame buffer communication-protocol opcodes.

13.10.11.1 Detailed Description

Fix L4Re Protocol Constants.

13.10.11.2 Enumeration Type Documentation

13.10.11.2.1 L4re_protocols

`enum L4re_protocols`
Common L4Re Protocol Constants.

Enumerator

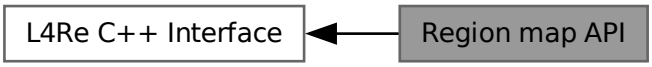
L4RE_PROTO_DATASPACE	ID for L4Re::Dataspace RPCs.
L4RE_PROTO_NAMESPACE	ID for L4Re::Namespace RPCs.
L4RE_PROTO_PARENT	ID for L4Re::Parent RPCs.
L4RE_PROTO_GOOS	ID for L4Re::Video::Goos RPCs.
L4RE_PROTO_RSVD_1	Reserved ID.
L4RE_PROTO_RM	ID for L4Re::Rm RPCs.
L4RE_PROTO_EVENT	ID for L4Re::Event RPCs.
L4RE_PROTO_INHIBITOR	ID for L4Re::Inhibitor RPCs.
L4RE_PROTO_DMA_SPACE	ID for L4Re::Dma_space RPCs.

L4RE_PROTO_MMIO_SPACE	ID for L4Re::Mmio_space.
L4RE_PROTO_ITAS	ID for L4Re::Itas.
L4RE_PROTO_MEM_ALLOC	ID for L4Re::Mem_alloc.
L4RE_PROTO_REMOTE_ACCESS	ID for L4Re::Remote_access.
L4RE_PROTO_DEBUG	ID for debugging RPCs.

Definition at line 24 of file protocols.h.

13.10.12 Region map API

Virtual address-space management.
Collaboration diagram for Region map API:



Data Structures

- class L4Re::Rm

  Region map.

13.10.12.1 Detailed Description

Virtual address-space management.
A region map object implements two protocols. The first protocol is the kernel page-fault protocol, to resolve page faults for threads running in an L4 task. The second protocol is the region map protocol itself, which allows managing the virtual memory address space of an L4 task.
There are two basic concepts provided by the region map abstraction:

- **Areas** are reserved ranges in the virtual memory address space.
- **Regions** are ranges that are backed by (part of) a dataspace, i.e. accessing them results in access to the physical memory the dataspace manages.

Note that regions may live outside of areas and that an area does not necessarily contain any region.
Areas can be reserved for special use or for attaching a dataspace at a later time. When attaching a dataspace, the user can instruct the region map to search for an appropriate range to attach to. Regions are skipped in this search since they already have dataspaces attached to them, and, depending on L4Re::Rm::F::In_area, areas are skipped because they are reserved. Amongst others, areas can be used to attach several dataspaces inside a certain range of addresses without interference from other threads.
When a region map receives a page fault IPC, the region map will check if the faulting virtual address lies in a region. If yes, it will answer the page fault IPC with a mapping from the backing dataspace. If not, an error is returned.
Depending on the system type, an attached dataspace might or might not be mapped eagerly. MMU-based systems resort to lazy mapping while systems without MMU do eager mappings by default. The L4Re::Rm::F::Eager_map and L4Re::Rm::F::No_eager_map flags can be used to force the respective behaviour, independent of the underlying system. In case both flags are given, the L4Re::Rm::F::No_eager_map flag wins.

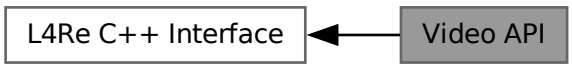
See also

L4Re::Dataspace, L4Re::Rm,

Memory management - Data Spaces and the Region Map

13.10.13 Video API

API for framebuffer based graphics.
Collaboration diagram for Video API:



Data Structures

- class L4Re::Video::Color_component

  A color component.
- class L4Re::Video::Pixel_info

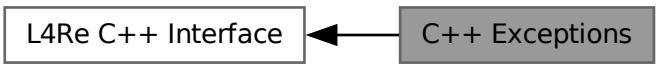
  Pixel information.

13.10.13.1 Detailed Description

API for framebuffer based graphics.
Contains the basic APIs that abstract framebuffers and views into them for L4Re applications.

13.10.14 C++ Exceptions

Collaboration diagram for C++ Exceptions:



Files

- file exceptions

  Base exceptions.

Data Structures

- class L4::Exception_tracer

  Back-trace support for exceptions.
- class L4::Base_exception

  Base class for all exceptions, thrown by the L4Re framework.
- class L4::Runtime_error

  Exception for an abstract runtime error.
- class L4::Out_of_memory

  Exception signalling insufficient memory.

- class L4::Element_already_exists

  Exception for duplicate element insertions.
- class L4::Unknown_error

  Exception for an unknown condition.
- class L4::Element_not_found

  Exception for a failed lookup (element not found).
- class L4::Invalid_capability

  Indicates that an invalid object was invoked.
- class L4::Com_error

  Error conditions during IPC.
- class L4::Bounds_error

  Access out of bounds.

Macros

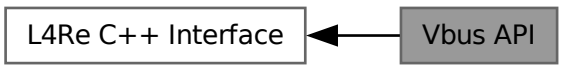
- #define **L4_CXX_EXCEPTION_BACKTRACE** 20

  Number of instruction pointers in backtrace.

13.10.14.1 Detailed Description

13.10.15 Vbus API

C++ interface of the Vbus API.
Collaboration diagram for Vbus API:



Data Structures

- class L4vbus::Pm< DEC >

  Power-management API mixin.
- class L4vbus::Device

  Device on a L4vbus::Vbus.
- class L4vbus::Icu

  Vbus Interrupt controller API.
- class L4vbus::Vbus

  The virtual bus (Vbus) interface.
- class L4vbus::Gpio_pin

  A GPIO pin.
- class L4vbus::Gpio_module

  A Gpio_module groups multiple GPIO pins together.
- class L4vbus::Pci_host_bridge

  A Pci host bridge.
- class L4vbus::Pci_dev

  A PCI device.

13.10.15.1 Detailed Description

C++ interface of the Vbus API.
The virtual bus (Vbus) is a hierarchical (tree) structure of device nodes where each device has a set of resources attached to it. Each virtual bus provides an Icu (Interrupt controller) for interrupt handling.
The Vbus interface allows a client to find and query devices present on his virtual bus. After obtaining a device handle for a specific device the client can enumerate its resources.
Refer to L4 Vbus functions for the C API.

Include File

```
#include <l4/vbus/vbus>
```

Include File

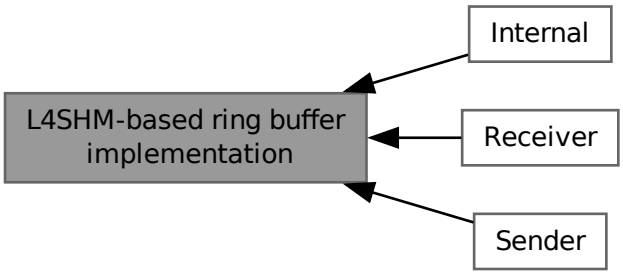
```
#include <l4/vbus/vbus_gpio>
```

Include File

```
#include <l4/vbus/vbus_pci>
```

13.11 L4SHM-based ring buffer implementation

The library provides a non-locking (strictly 1:1) shared-memory-based ring buffer implementation based on the L4SHM library.
Collaboration diagram for L4SHM-based ring buffer implementation:



Topics

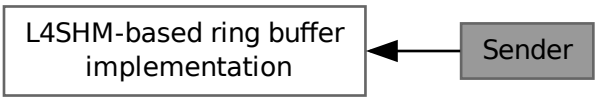
- Sender • 554
- Receiver 554
- Internal • 554

13.11.1 Detailed Description

The library provides a non-locking (strictly 1:1) shared-memory-based ring buffer implementation based on the L4SHM library.
It requires an already allocated L4SHM area to be attached to sender and receiver. It will allocate an SHM chunk within this area and provides functions to produce data and consume data in FIFO order from the ring buffer.
The sender side of the buffer needs to be initialized *before* the receiver side, because allocation of the SHM chunk and the necessary signals is done on the sender side and the receiver initialization tries to attach to these objects.

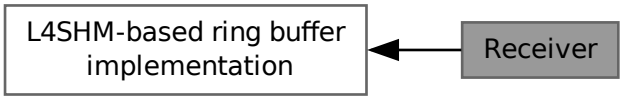
13.11.2 Sender

Collaboration diagram for Sender:



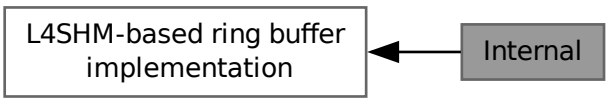
13.11.3 Receiver

Collaboration diagram for Receiver:



13.11.4 Internal

Collaboration diagram for Internal:



Data Structures

- struct l4shmc_ringbuf_head_t

  Head field of a ring buffer.
- struct l4shmc_ringbuf_t

  Ring buffer.

Macros

- #define L4SHMC_RINGBUF_HEAD(ringbuf)

  Get ring buffer head pointer.

- #define L4SHMC_RINGBUF_DATA(ringbuf)

  Get ring buffer data pointer.
- #define L4SHMC_RINGBUF_DATA_SIZE(ringbuf)

  Get size of data area.

13.11.4.1 Detailed Description

13.11.4.2 Macro Definition Documentation

13.11.4.2.1 L4SHMC_RINGBUF_DATA

```
#define L4SHMC_RINGBUF_DATA(
              ringbuf)
```

Value:

```
(L4SHMC_RINGBUF_HEAD(ringbuf)->data)
```

Get ring buffer data pointer.

Parameters

ringbuf	l4shmc_ringbuf_t struct

Definition at line 114 of file ringbuf.h.

13.11.4.2.2 L4SHMC_RINGBUF_DATA_SIZE

```
#define L4SHMC_RINGBUF_DATA_SIZE(
              ringbuf)
```

Value:

```
((ringbuf)->_size - sizeof(l4shmc_ringbuf_head_t))
```

Get size of data area.

Parameters

ringbuf	l4shmc_ringbuf_t struct

Definition at line 123 of file ringbuf.h.

13.11.4.2.3 L4SHMC_RINGBUF_HEAD

```
#define L4SHMC_RINGBUF_HEAD(
              ringbuf)
```

Value:

```
((l4shmc_ringbuf_head_t*)((ringbuf)->_addr))
```

Get ring buffer head pointer.

Parameters

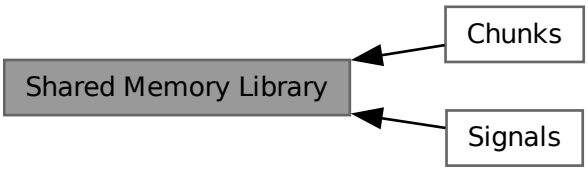
ringbuf	l4shmc_ringbuf_t struct

Definition at line 105 of file ringbuf.h.

13.12 Shared Memory Library

L4SHM provides a shared memory infrastructure that establishes a shared memory area between multiple parties and uses a fast notification mechanism.

Collaboration diagram for Shared Memory Library:



Topics

- Chunks• 561
- Signals• 571

Functions

- L4_BEGIN_DECLS long l4shmc_create (char const ∗shmc_name)

  Create a shared memory area.
- long l4shmc_attach (char const ∗shmc_name, l4shmc_area_t ∗shmarea)

  Attach to a shared memory area.
- long l4shmc_get_client_nr (l4shmc_area_t const ∗shmarea)

  Determine the client number of the shared memory region.
- long l4shmc_mark_client_initialized (l4shmc_area_t ∗shmarea)

  Mark this shared memory client as 'initialized'.
- long l4shmc_get_initialized_clients (l4shmc_area_t ∗shmarea, l4_umword_t ∗bitmask)

  Fetch the `_clients_init_done` bitmask of the shared memory area.
- long l4shmc_connect_chunk_signal (l4shmc_chunk_t ∗chunk, l4shmc_signal_t ∗signal)

  Connect a signal with a chunk.
- long l4shmc_area_size (l4shmc_area_t const ∗shmarea)

  Get size of shared memory area.
- long l4shmc_area_size_free (l4shmc_area_t const ∗shmarea)

  Get free size of shared memory area.
- long l4shmc_area_overhead (void)

  Get memory overhead per area that is not available for chunks.
- long l4shmc_chunk_overhead (void)

  Get memory overhead required in addition to the chunk capacity for adding one chunk.

13.12.1 Detailed Description

L4SHM provides a shared memory infrastructure that establishes a shared memory area between multiple parties and uses a fast notification mechanism.
A shared memory area consists of chunks and signals. A chunk is a defined chunk of memory within the memory area with a maximum size. A chunk is filled (written) by a producer and read by a consumer. When a producer has finished writing to the chunk it signals a data ready notification to the consumer.
A consumer attaches to a chunk and waits for the producer to fill the chunk. After reading out the chunk it marks the chunk free again.
A shared memory area can have multiple chunks.
The interface is divided in three roles.

- The master role, responsible for setting up a shared memory area.
- A producer, generating data into a chunk
- A consumer, receiving data.

A signal can be connected with a chunk or can be used independently (e.g. for multiple chunks).

13.12.2 Function Documentation

13.12.2.1 l4shmc_area_overhead()

```
long l4shmc_area_overhead (
            void )
```

Get memory overhead per area that is not available for chunks.

Returns

Size of the overhead in bytes.

References L4_CV.

13.12.2.2 l4shmc_area_size()

```
long l4shmc_area_size (
            l4shmc_area_t const * shmarea)
```

Get size of shared memory area.

Parameters

shmarea	Shared memory area.

Return values

>0	Size of the shared memory area.
<0	Error.

References L4_CV.

13.12.2.3 l4shmc_area_size_free()

```
long l4shmc_area_size_free (
            l4shmc_area_t const * shmarea)
```

Get free size of shared memory area.
To get the max size to pass to l4shmc_add_chunk, subtract l4shmc_chunk_overhead().

Parameters

shmarea	Shared memory area.

Returns

Size of the shared memory area.

References L4_CV.

13.12.2.4 l4shmc_attach()

```
long l4shmc_attach (
            char const * shmc_name,
            l4shmc_area_t * shmarea)
```

Attach to a shared memory area.

Parameters

	shmc_name	Name of the shared memory area.
out	*shmarea*	Pointer to shared memory area descriptor to be filled with information for the shared memory area.

On success, the data in 'shmarea' contains a client number which can be used to mutual agree about client initialization:

- l4shmc_get_client_nr() returns the client number stored in 'shmarea'. The first attached client will get 0 and this number is increased for each attached client.
- l4shmc_mark_client_initialized() tells other clients that this client has finished its initialization.
- l4shmc_get_initialized_clients() returns the bitmap of initialized clients attached to this shared memory.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.2.5 l4shmc_chunk_overhead()

```
long l4shmc_chunk_overhead (
            void )
```

Get memory overhead required in addition to the chunk capacity for adding one chunk.

Returns

Size of the overhead in bytes.

References L4_END_DECLS.

13.12.2.6 l4shmc_connect_chunk_signal()

```
long l4shmc_connect_chunk_signal (
            l4shmc_chunk_t * chunk,
            l4shmc_signal_t * signal)
```

Connect a signal with a chunk.

Parameters

chunk	Chunk to attach the signal to.
signal	Signal to attach.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV, and L4_INLINE.

13.12.2.7 l4shmc_create()

```
L4_BEGIN_DECLS long l4shmc_create (
            char const * shmc_name)
```

Create a shared memory area.

Parameters

shmc_name	Name of the shared memory area.

Return values

0	Success.
-L4_ENOMEM	The requested size is too big.
-L4_ENOENT	No valid capability with the name of the shared memory area found.
<0	Errors from l4re_rm_attach or l4re_ns_register_obj_srv.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.2.8 l4shmc_get_client_nr()

```
long l4shmc_get_client_nr (
            l4shmc_area_t const * shmarea)
```

Determine the client number of the shared memory region.

Parameters

shmarea	The shared memory area.

Returns

client number.

References L4_CV.

13.12.2.9 l4shmc_get_initialized_clients()

```
long l4shmc_get_initialized_clients (
            l4shmc_area_t * shmarea,
            l4_umword_t * bitmask)
```

Fetch the _clients_init_done bitmask of the shared memory area.

Parameters

	shmarea	The shared memory area.
out	*bitmask*	The bitmask describing which clients are initialized.

Return values

0	Success.
<0	Error.

See also

l4shmc_mark_client_initialized(), l4shmc_get_client_nr()

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.2.10 l4shmc_mark_client_initialized()

```
long l4shmc_mark_client_initialized (
            l4shmc_area_t * shmarea)
```

Mark this shared memory client as 'initialized'.
The corresponding bit is set in the _clients_init_done bitmask. The bitmask can be fetched with l4shmc_get_initialized_clients().

Parameters

shmarea	The shared memory area.

Return values

0	Success.
<0	Error.

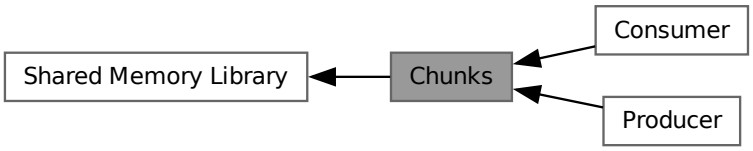
Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.3 Chunks

Collaboration diagram for Chunks:



Topics

- Producer 564
- Consumer 567

Functions

- long l4shmc_add_chunk (l4shmc_area_t ∗shmarea, char const ∗chunk_name, l4_umword_t chunk_capacity, l4shmc_chunk_t ∗chunk)

  Add a chunk in the shared memory area.
- long l4shmc_get_chunk (l4shmc_area_t ∗shmarea, char const ∗chunk_name, l4shmc_chunk_t ∗chunk)

  Get chunk out of shared memory area.
- long l4shmc_get_chunk_to (l4shmc_area_t ∗shmarea, char const ∗chunk_name, l4_umword_t timeout_ms, l4shmc_chunk_t ∗chunk)

  Get chunk out of shared memory area, with timeout.
- long l4shmc_iterate_chunk (l4shmc_area_t const ∗shmarea, char const ∗∗chunk_name, long offs)

  Iterate over names of all existing chunks.
- void ∗ l4shmc_chunk_ptr (l4shmc_chunk_t const ∗chunk)

  Get data pointer to chunk.
- long l4shmc_chunk_capacity (l4shmc_chunk_t const ∗chunk)

  Get capacity of a chunk.
- l4shmc_signal_t ∗ l4shmc_chunk_signal (l4shmc_chunk_t const ∗chunk)

  Get the registered signal of a chunk.

13.12.3.1 Detailed Description

13.12.3.2 Function Documentation

13.12.3.2.1 l4shmc_add_chunk()

```
long l4shmc_add_chunk (
             l4shmc_area_t * shmarea,
             char const * chunk_name,
             l4_umword_t chunk_capacity,
             l4shmc_chunk_t * chunk)
```

Add a chunk in the shared memory area.

Parameters

	shmarea	The shared memory area to put the chunk in.
	chunk_name	Name of the chunk.
	chunk_capacity	Capacity for payload of the chunk in bytes.
out	*chunk*	Chunk structure to fill in.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.3.2.2 l4shmc_chunk_capacity()

```
long l4shmc_chunk_capacity (
            l4shmc_chunk_t const * chunk)  [inline]
```

Get capacity of a chunk.

Parameters

chunk	Chunk.

Returns

Capacity of the chunk in bytes.

References L4_CV, and L4_INLINE.

13.12.3.2.3 l4shmc_chunk_ptr()

```
void * l4shmc_chunk_ptr (
            l4shmc_chunk_t const * chunk)  [inline]
```

Get data pointer to chunk.

Parameters

chunk	Chunk.

Returns

Chunk pointer.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV, and L4_INLINE.

13.12.3.2.4 l4shmc_chunk_signal()

```
l4shmc_signal_t * l4shmc_chunk_signal (
            l4shmc_chunk_t const * chunk)  [inline]
```

Get the registered signal of a chunk.

Parameters

chunk	Chunk.

Return values

0	No signal has been registered with this chunk.
!=0	Pointer to signal otherwise.

References L4_CV, and L4_INLINE.

13.12.3.2.5 l4shmc_get_chunk()

```
long l4shmc_get_chunk (
            l4shmc_area_t * shmarea,
            char const * chunk_name,
            l4shmc_chunk_t * chunk)  [inline]
```

Get chunk out of shared memory area.

Parameters

	shmarea	Shared memory area.
	chunk_name	Name of the chunk.
out	*chunk*	Chunk data structure to fill.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.3.2.6 l4shmc_get_chunk_to()

```
long l4shmc_get_chunk_to (
            l4shmc_area_t * shmarea,
            char const * chunk_name,
            l4_umword_t timeout_ms,
            l4shmc_chunk_t * chunk)
```

Get chunk out of shared memory area, with timeout.

Parameters

	shmarea	Shared memory area.
	chunk_name	Name of the chunk.
	timeout_ms	Timeout in milliseconds to wait for the chunk to appear in the shared memory area.
out	*chunk*	Chunk data structure to fill.

Return values

0	Success.
<0	Error.

References L4_CV.

13.12.3.2.7 l4shmc_iterate_chunk()

```
long l4shmc_iterate_chunk (
             l4shmc_area_t const * shmarea,
             char const ** chunk_name,
             long offs)
```

Iterate over names of all existing chunks.

Parameters

shmarea	Shared memory area.
chunk_name	Where the name of the current chunk will be stored
offs	0 to start iteration, return value of previous call to l4shmc_iterate_chunk() to get next chunk

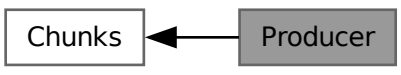
Return values

0	No more chunks available.
<0	Error.
>0	Iterator value for the next call.

References L4_CV.

13.12.3.3 Producer

Collaboration diagram for Producer:



Functions

- long l4shmc_chunk_try_to_take (l4shmc_chunk_t ∗chunk)

  Try to mark chunk busy.
- long l4shmc_chunk_try_to_take_for_writing (l4shmc_chunk_t ∗chunk)

  Try to mark chunk busy writing.
- long l4shmc_chunk_try_to_take_for_overwriting (l4shmc_chunk_t ∗chunk)

  Try to mark the chunk busy writing after it was ready for reading.
- long l4shmc_chunk_ready (l4shmc_chunk_t ∗chunk, l4_umword_t size)

  Mark chunk as filled (ready).
- long l4shmc_chunk_ready_sig (l4shmc_chunk_t ∗chunk, l4_umword_t size)

  Mark chunk as filled (ready) and signal consumer.
- long l4shmc_is_chunk_clear (l4shmc_chunk_t const ∗chunk)

  Check whether chunk is free.

13.12.3.3.1 Detailed Description

13.12.3.3.2 Function Documentation

13.12.3.3.2.1 l4shmc_chunk_ready()

```
long l4shmc_chunk_ready (
             l4shmc_chunk_t * chunk,
             l4_umword_t size)  [inline]
```

Mark chunk as filled (ready).

Parameters

chunk	chunk.
size	Size of data in the chunk, in bytes.

Return values

0	Success.
<0	Error.

References L4_CV, and L4_INLINE.

13.12.3.3.2.2 l4shmc_chunk_ready_sig()

```
long l4shmc_chunk_ready_sig (
             l4shmc_chunk_t * chunk,
             l4_umword_t size)  [inline]
```

Mark chunk as filled (ready) and signal consumer.

Parameters

chunk	chunk.
size	Size of data in the chunk, in bytes.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV, and L4_INLINE.

13.12.3.3.2.3 l4shmc_chunk_try_to_take()

```
long l4shmc_chunk_try_to_take (
            l4shmc_chunk_t * chunk)  [inline]
```

Try to mark chunk busy.

Parameters

chunk	chunk to mark.

Return values

0	Chunk could be taken.
<0	Chunk could not be taken, try again.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV, and L4_INLINE.

13.12.3.3.2.4 l4shmc_chunk_try_to_take_for_overwriting()

```
long l4shmc_chunk_try_to_take_for_overwriting (
            l4shmc_chunk_t * chunk)  [inline]
```

Try to mark the chunk busy writing after it was ready for reading.

Parameters

chunk	chunk to mark busy writing.

This function is used by the producer to overwrite a message if the consumer did not read the message within an expected time. This function can only be used if the consumer uses l4shmc_chunk_try_to_take_for_reading() before reading the chunk.

Return values

0	Chunk could be taken and can be written.
<0	Chunk could not be taken, try again.

References L4_CV, and L4_INLINE.

13.12.3.3.2.5 l4shmc_chunk_try_to_take_for_writing()

```
long l4shmc_chunk_try_to_take_for_writing (
            l4shmc_chunk_t * chunk)  [inline]
```

Try to mark chunk busy writing.
This function is actually an alias for l4shmc_chunk_try_to_take().

Parameters

chunk	chunk to mark busy writing.

Return values

0	Chunk could be taken and can be written.
<0	Chunk could not be taken, try again.

References L4_CV, and L4_INLINE.

13.12.3.3.2.6 l4shmc_is_chunk_clear()

```
long l4shmc_is_chunk_clear (
            l4shmc_chunk_t const * chunk)  [inline]
```

Check whether chunk is free.

Parameters

chunk	Chunk to check.

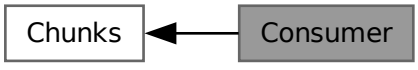
Return values

!=0	Chunk is clear.
0	Chunk is not clear.

References L4_CV, and L4_INLINE.

13.12.3.4 Consumer

Collaboration diagram for Consumer:



Functions

- long l4shmc_chunk_try_to_take_for_reading (l4shmc_chunk_t ∗chunk)

Try to mark chunk busy reading.

- long l4shmc_enable_chunk (l4shmc_chunk_t ∗chunk)

  Enable a signal connected with a chunk.
- long l4shmc_wait_chunk (l4shmc_chunk_t ∗chunk)

  Wait on a specific chunk.
- long l4shmc_wait_chunk_to (l4shmc_chunk_t ∗chunk, l4_timeout_t timeout)

  Check whether a specific chunk has an event pending, with timeout.
- long l4shmc_wait_chunk_try (l4shmc_chunk_t ∗chunk)

  Check whether a specific chunk has an event pending.
- long l4shmc_chunk_consumed (l4shmc_chunk_t ∗chunk)

  Mark a chunk as free.
- long l4shmc_is_chunk_ready (l4shmc_chunk_t const ∗chunk)

  Check whether data is available.
- long l4shmc_chunk_size (l4shmc_chunk_t const ∗chunk)

  Get current size of a chunk.

13.12.3.4.1 Detailed Description

13.12.3.4.2 Function Documentation

13.12.3.4.2.1 l4shmc_chunk_consumed()

```
long l4shmc_chunk_consumed (
            l4shmc_chunk_t * chunk)  [inline]
```

Mark a chunk as free.

Parameters

chunk	Chunk to mark as free.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.3.4.2.2 l4shmc_chunk_size()

```
long l4shmc_chunk_size (
            l4shmc_chunk_t const * chunk)  [inline]
```

Get current size of a chunk.

Parameters

chunk	Chunk.

Returns

Current size of the chunk in bytes.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV, and L4_INLINE.

13.12.3.4.2.3 l4shmc_chunk_try_to_take_for_reading()

```
long l4shmc_chunk_try_to_take_for_reading (
             l4shmc_chunk_t * chunk)  [inline]
```

Try to mark chunk busy reading.

Parameters

chunk	chunk to mark busy reading.

Return values

0	Chunk could be taken and can be read.
<0	Chunk could not be taken, try again.

References L4_CV, and L4_INLINE.

13.12.3.4.2.4 l4shmc_enable_chunk()

```
long l4shmc_enable_chunk (
             l4shmc_chunk_t * chunk)
```

Enable a signal connected with a chunk.

Parameters

chunk	Chunk to enable.

Return values

0	Success.
<0	Error.

A signal must be enabled before waiting when the consumer waits on any signal. Enabling is not needed if the consumer waits for a specific signal or chunk.
References L4_CV, and L4_INLINE.

13.12.3.4.2.5 l4shmc_is_chunk_ready()

```
long l4shmc_is_chunk_ready (
             l4shmc_chunk_t const * chunk)  [inline]
```

Check whether data is available.

Parameters

chunk	Chunk to check.

Return values

!=0	Data is available.
0	No data available.

References L4_CV, and L4_INLINE.

13.12.3.4.2.6 l4shmc_wait_chunk()

```
long l4shmc_wait_chunk (
            l4shmc_chunk_t * chunk)  [inline]
```

Wait on a specific chunk.

Parameters

chunk	Chunk to wait for.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.3.4.2.7 l4shmc_wait_chunk_to()

```
long l4shmc_wait_chunk_to (
            l4shmc_chunk_t * chunk,
            l4_timeout_t timeout)
```

Check whether a specific chunk has an event pending, with timeout.

Parameters

chunk	Chunk to check.
timeout	Timeout.

Return values

0	Success.
<0	Error.

The return code indicates whether an event was pending or not. Success means an event was pending, if an receive timeout error is returned no event was pending.
References L4_CV, and L4_INLINE.

13.12.3.4.2.8 l4shmc_wait_chunk_try()

```
long l4shmc_wait_chunk_try (
             l4shmc_chunk_t * chunk)  [inline]
```

Check whether a specific chunk has an event pending.

Parameters

chunk	Chunk to check.

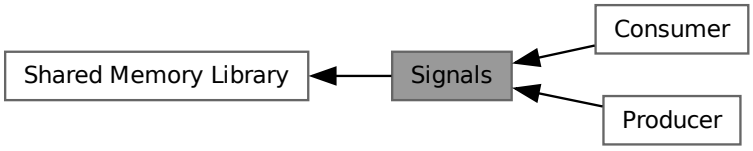
Return values

0	Success.
<0	Error.

The return code indicates whether an event was pending or not. Success means an event was pending, if an receive timeout error is returned no event was pending.
References L4_CV, and L4_INLINE.

13.12.4 Signals

Collaboration diagram for Signals:



Topics

- Producer 574
- Consumer 575

Functions

- long l4shmc_add_signal (l4shmc_area_t *shmarea, char const *signal_name, l4shmc_signal_t *signal)

  Add a signal for the shared memory area.
- long l4shmc_attach_signal (l4shmc_area_t *shmarea, char const *signal_name, l4_cap_idx_t thread, l4shmc_signal_t *signal)

  Attach to signal.
- long l4shmc_get_signal (l4shmc_area_t *shmarea, char const *signal_name, l4shmc_signal_t *signal)

Get signal object from the shared memory area.

- l4_cap_idx_t l4shmc_signal_cap (l4shmc_signal_t const *signal)

  Get the signal capability of a signal.

- long l4shmc_check_magic (l4shmc_chunk_t const *chunk)

  Check magic value of a chunk.

13.12.4.1 Detailed Description

13.12.4.2 Function Documentation

13.12.4.2.1 l4shmc_add_signal()

```
long l4shmc_add_signal (
             l4shmc_area_t * shmarea,
             char const * signal_name,
             l4shmc_signal_t * signal)
```

Add a signal for the shared memory area.

Parameters

	shmarea	The shared memory area.
	signal_name	Name of the signal.
out	*signal*	Signal structure to fill in.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV, and L4_INLINE.

13.12.4.2.2 l4shmc_attach_signal()

```
long l4shmc_attach_signal (
             l4shmc_area_t * shmarea,
             char const * signal_name,
             l4_cap_idx_t thread,
             l4shmc_signal_t * signal)
```

Attach to signal.

Parameters

	shmarea	Shared memory area.
	signal_name	Name of the signal.
	thread	Thread capability index to attach the signal to.
out	*signal*	Signal data structure to fill.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.4.2.3 l4shmc_check_magic()

```
long l4shmc_check_magic (
            l4shmc_chunk_t const * chunk)  [inline]
```

Check magic value of a chunk.

Parameters

chunk	Chunk.

Return values

0	Magic value is not valid.
>0	Chunk is OK, the magic value is valid.

References L4_CV.

13.12.4.2.4 l4shmc_get_signal()

```
long l4shmc_get_signal (
            l4shmc_area_t * shmarea,
            char const * signal_name,
            l4shmc_signal_t * signal)
```

Get signal object from the shared memory area.

Parameters

	shmarea	Shared memory area.
	signal_name	Name of the signal.
out	*signal*	Signal data structure to fill.

Return values

0	Success.
<0	Error.

References L4_CV.

13.12.4.2.5 l4shmc_signal_cap()

```
l4_cap_idx_t l4shmc_signal_cap (
```

```
            l4shmc_signal_t const * signal)  [inline]
```

Get the signal capability of a signal.

Parameters

signal	Signal.

Returns

Capability of the signal object.

References L4_CV, and L4_INLINE.

13.12.4.3 Producer

Collaboration diagram for Producer:



Functions

- long l4shmc_trigger (l4shmc_signal_t *signal)

  Trigger a signal.

13.12.4.3.1 Detailed Description

13.12.4.3.2 Function Documentation

13.12.4.3.2.1 l4shmc_trigger()

```
long l4shmc_trigger (
            l4shmc_signal_t * signal)  [inline]
```

Trigger a signal.

Parameters

signal	Signal to trigger.

Return values

0	Success.
<0	Error.

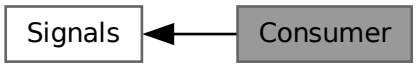
Examples

examples/libs/shmc/prodcons.c.

References L4_CV, and L4_INLINE.

13.12.4.4 Consumer

Collaboration diagram for Consumer:



Functions

- long l4shmc_enable_signal (l4shmc_signal_t ∗signal)

  Enable a signal.
- long l4shmc_wait_any (l4shmc_signal_t ∗∗retsignal)

  Wait on any signal.
- long l4shmc_wait_any_try (l4shmc_signal_t ∗∗retsignal)

  Check whether any waited signal has an event pending.
- long l4shmc_wait_any_to (l4_timeout_t timeout, l4shmc_signal_t ∗∗retsignal)

  Wait for any signal with timeout.
- long l4shmc_wait_signal (l4shmc_signal_t ∗signal)

  Wait on a specific signal.
- long l4shmc_wait_signal_to (l4shmc_signal_t ∗signal, l4_timeout_t timeout)

  Wait on a specific signal, with timeout.
- long l4shmc_wait_signal_try (l4shmc_signal_t ∗signal)

  Check whether a specific signal has an event pending.

13.12.4.4.1 Detailed Description

13.12.4.4.2 Function Documentation

13.12.4.4.2.1 l4shmc_enable_signal()

```
long l4shmc_enable_signal (
            l4shmc_signal_t * signal)
```

Enable a signal.

Parameters

signal	Signal to enable.

Return values

0	Success.
<0	Error.

A signal must be enabled before waiting when the consumer waits on any signal. Enabling is not needed if the consumer waits for a specific signal or chunk.
References L4_CV.

13.12.4.4.2.2 l4shmc_wait_any()

```
long l4shmc_wait_any (
            l4shmc_signal_t ** retsignal)  [inline]
```

Wait on any signal.

Parameters

out	*retsignal*	Signal received.

Return values

0	Success.
<0	Error.

References L4_CV, and L4_INLINE.

13.12.4.4.2.3 l4shmc_wait_any_to()

```
long l4shmc_wait_any_to (
            l4_timeout_t timeout,
            l4shmc_signal_t ** retsignal)
```

Wait for any signal with timeout.

Parameters

	timeout	Timeout.
out	*retsignal*	Signal that has the event pending if any.

Return values

0	Success.
<0	Error.

The return code indicates whether an event was pending or not. Success means an event was pending, if an receive timeout error is returned no event was pending.
References L4_CV, and L4_INLINE.

13.12.4.4.2.4 l4shmc_wait_any_try()

```
long l4shmc_wait_any_try (
            l4shmc_signal_t ** retsignal)  [inline]
```

Check whether any waited signal has an event pending.

Parameters

out	*retsignal*	Signal that has the event pending if any.

Return values

0	Success.
<0	Error.

The return code indicates whether an event was pending or not. Success means an event was pending, if an receive timeout error is returned no event was pending.
References L4_CV.

13.12.4.4.2.5 l4shmc_wait_signal()

```
long l4shmc_wait_signal (
            l4shmc_signal_t * signal)  [inline]
```

Wait on a specific signal.

Parameters

signal	Signal to wait for.

Return values

0	Success.
<0	Error.

Examples

examples/libs/shmc/prodcons.c.

References L4_CV.

13.12.4.4.2.6 l4shmc_wait_signal_to()

```
long l4shmc_wait_signal_to (
            l4shmc_signal_t * signal,
            l4_timeout_t timeout)
```

Wait on a specific signal, with timeout.

Parameters

signal	Signal to wait for.
timeout	Timeout.

Return values

0	Success.
<0	Error.

References L4_CV, and L4_INLINE.

13.12.4.4.2.7 l4shmc_wait_signal_try()

```
long l4shmc_wait_signal_try (
```

```
l4shmc_signal_t * signal)  [inline]
```

Check whether a specific signal has an event pending.

Parameters

signal	Signal to check.

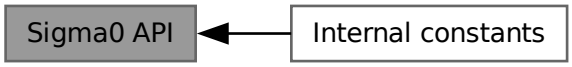
Return values

0	Success.
<0	Error.

The return code indicates whether an event was pending or not. Success means an event was pending, if an receive timeout error is returned no event was pending.
References L4_CV, and L4_INLINE.

13.13 Sigma0 API

Sigma0 API bindings.
Collaboration diagram for Sigma0 API:



Topics

- Internal•constants 582
  Internal sigma0 definitions.

Files

- file sigma0.h
  Sigma0 interface.

Enumerations

- enum l4sigma0_return_flags_t { L4SIGMA0_OK , L4SIGMA0_NOTALIGNED , L4SIGMA0_IPCERROR , L4SIGMA0_NOFPAGE , **L4SIGMA0_4** , **L4SIGMA0_5** , L4SIGMA0_SMALLERFPAGE }
  Return flags of libsigma0 functions.

Functions

- L4_BEGIN_DECLS l4_kernel_info_t ∗ l4sigma0_map_kip (l4_cap_idx_t sigma0, void ∗addr, unsigned log2↩ _size)

Map the kernel info page from sigma0 to addr.

- int l4sigma0_map_mem (l4_cap_idx_t sigma0, l4_addr_t phys, l4_addr_t virt, l4_addr_t size)

  Request a memory mapping from sigma0.
- int l4sigma0_map_iomem (l4_cap_idx_t sigma0, l4_addr_t phys, l4_addr_t virt, l4_addr_t size, int cached)

  Request IO memory from sigma0.
- int l4sigma0_map_anypage (l4_cap_idx_t sigma0, l4_addr_t map_area, unsigned log2_map_size, l4_addr_t *base, unsigned sz)

  Request an arbitrary free page of RAM.
- void l4sigma0_debug_dump (l4_cap_idx_t sigma0)

  Request sigma0 to dump internal debug information.
- char const * l4sigma0_map_errstr (int err)

  Get user readable error messages for the return codes.

13.13.1 Detailed Description

Sigma0 API bindings.
Convenience bindings for the Sigma0 protocol.

13.13.2 Enumeration Type Documentation

13.13.2.1 l4sigma0_return_flags_t

```
enum l4sigma0_return_flags_t
```

Return flags of libsigma0 functions.

Enumerator

L4SIGMA0_OK	Ok.
L4SIGMA0_NOTALIGNED	Phys, virt or size not aligned.
L4SIGMA0_IPCERROR	IPC error.
L4SIGMA0_NOFPAGE	No fpage received.
L4SIGMA0_SMALLERFPAGE	Superpage requested but smaller flexpage received.

Definition at line 76 of file sigma0.h.

13.13.3 Function Documentation

13.13.3.1 l4sigma0_debug_dump()

```
void l4sigma0_debug_dump (
            l4_cap_idx_t sigma0)
```

Request sigma0 to dump internal debug information.

Parameters

sigma0	Capability index for the sigma0 gate.

The debug information, such as internal memory maps, as well as statistics about the internal allocators is dumped to the kernel debugger.
References L4_CV, and L4_INLINE.

13.13.3.2 l4sigma0_map_anypage()

```
int l4sigma0_map_anypage (
            l4_cap_idx_t sigma0,
            l4_addr_t map_area,
            unsigned log2_map_size,
            l4_addr_t * base,
            unsigned sz)
```

Request an arbitrary free page of RAM.

Parameters

	sigma0	Capability index for the sigma0 gate.
	map_area	The base address of the local virtual memory area where the page should be mapped.
	log2_map_size	The size of the requested page log 2 (the size in bytes is 2^log2_map_size). This must be at least the minimal page size. By specifing larger sizes the largest possible hardware page size will be used.
out	*base*	Physical address of the page received (i.e. the send base of the received mapping if any).
	sz	Size to map by the server in 2^sz bytes.

Return values

0	Success.
-L4SIGMA0_IPCERROR	IPC error.
-L4SIGMA0_NOFPAGE	No fpage received.

This function requests arbitrary free memory from sigma0. It should be used whenever spare memory is needed, instead of requesting specific physical memory with l4sigma0_map_mem().
See l4sigma0_map_errstr() to get a description of the return value.
References L4_CV.

13.13.3.3 l4sigma0_map_errstr()

```
char const * l4sigma0_map_errstr (
            int err)  [inline]
```

Get user readable error messages for the return codes.

Parameters

err	The error code reported by the *map* functions.

Returns

A string containing the error message.

Definition at line 213 of file sigma0.h.
References L4_INLINE.

13.13.3.4 l4sigma0_map_iomem()

```
int l4sigma0_map_iomem (
            l4_cap_idx_t sigma0,
```

```
              l4_addr_t phys,
              l4_addr_t virt,
              l4_addr_t size,
              int cached)
```

Request IO memory from sigma0.

Parameters

sigma0	Capability index for the sigma0 gate.
phys	The physical address to be requested (page aligned).
virt	The virtual address where the memory should be mapped to (page aligned).
size	The size of the IO memory area to be mapped (multiple of page size)
cached	Requests cacheable IO memory if 1 and uncached if 0.

Return values

0	Success.
-L4SIGMA0_NOTALIGNED	`phys`, `virt`, or `size` are not aligned.
-L4SIGMA0_IPCERROR	IPC error.
-L4SIGMA0_NOFPAGE	No fpage received.

This function is similar to l4sigma0_map_mem(), the difference is that it requests IO memory. IO memory is everything that is not known to be normal RAM. Also ACPI tables or the BIOS memory is treated as IO memory.
See l4sigma0_map_errstr() to get a description of the return value.
References L4_CV.

13.13.3.5 l4sigma0_map_kip()

```
L4_BEGIN_DECLS l4_kernel_info_t * l4sigma0_map_kip (
              l4_cap_idx_t sigma0,
              void * addr,
              unsigned log2_size)
```

Map the kernel info page from sigma0 to addr.

Parameters

sigma0	Capability index for the sigma0 gate.
addr	Start of the receive window to receive KIP in.
log2_size	Size of the receive window to receive KIP in.

Returns

Address KIP was mapped to, 0 indicates an error.

Note

On systems without MMU, the parameters `addr` and `log2_size` are ignored.

13.13.3.6 l4sigma0_map_mem()

```
int l4sigma0_map_mem (
              l4_cap_idx_t sigma0,
```

```
l4_addr_t phys,
l4_addr_t virt,
l4_addr_t size)
```

Request a memory mapping from sigma0.

Parameters

sigma0	Capability index for the sigma0 gate.
phys	The physical address of the requested page (must be at least aligned to the minimum page size).
virt	The virtual address where the paged should be mapped in the local address space (must be at least aligned to the minimum page size).
size	The size of the requested page, this must be a multiple of the minimum page size.

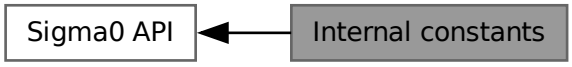
Return values

0	Success.
-L4SIGMA0_NOTALIGNED	`phys`, `virt`, or `size` are not aligned.
-L4SIGMA0_IPCERROR	IPC error.
-L4SIGMA0_NOFPAGE	No fpage received.

This function only maps normal RAM. To map other memory, use l4sigma0_map_iomem(). See also there for the distinction between both memory types.
This is the direct method to request memory from sigma0. There is also the indirect method where sigma0 will answer page faults with a mapping that is one-to-one between the faulting virtual page and the backing physical page. See L4::Pager::page_fault(). For an overview of the memory hierarchy, see Memory management - Data Spaces and the Region Map.
See l4sigma0_map_errstr() to get a description of the return value.
References L4_CV.

13.13.4 Internal constants

Internal sigma0 definitions.
Collaboration diagram for Internal constants:



Macros

- #define **SIGMA0_REQ_MAGIC** ~0xFFUL

  Request magic.
- #define **SIGMA0_REQ_MASK** ~0xFFUL

  Request mask.
- #define **SIGMA0_REQ_ID_MASK** 0xF0

  ID mask.

- #define **SIGMA0_REQ_ID_FPAGE_RAM** 0x60

  RAM.
- #define **SIGMA0_REQ_ID_FPAGE_IOMEM** 0x70

  I/O memory.
- #define **SIGMA0_REQ_ID_FPAGE_IOMEM_CACHED** 0x80

  Cached I/O memory.
- #define **SIGMA0_REQ_ID_FPAGE_ANY** 0x90

  Any.
- #define **SIGMA0_REQ_ID_KIP** 0xA0

  KIP.
- #define **SIGMA0_REQ_ID_DEBUG_DUMP** 0xC0

  Debug dump.
- #define **SIGMA0_REQ_ID_COV** 0xE0

  Trigger cov dump.
- #define **SIGMA0_IS_MAGIC_REQ**(d1)

  Check if magic.
- #define **SIGMA0_REQ**(x)

  Construct.
- #define **SIGMA0_REQ_FPAGE_RAM** (SIGMA0_REQ(FPAGE_RAM))

  RAM.
- #define **SIGMA0_REQ_FPAGE_IOMEM** (SIGMA0_REQ(FPAGE_IOMEM))

  I/O memory.
- #define **SIGMA0_REQ_FPAGE_IOMEM_CACHED** (SIGMA0_REQ(FPAGE_IOMEM_CACHED))

  Cache I/O memory.
- #define **SIGMA0_REQ_FPAGE_ANY** (SIGMA0_REQ(FPAGE_ANY))

  Any.
- #define **SIGMA0_REQ_KIP** (SIGMA0_REQ(KIP))

  KIP.
- #define **SIGMA0_REQ_DEBUG_DUMP** (SIGMA0_REQ(DEBUG_DUMP))

  Debug dump.
- #define **SIGMA0_REQ_COV** (SIGMA0_REQ(COV))

  Cov.

13.13.4.1 Detailed Description

Internal sigma0 definitions.

13.14 Small C++ Template Library

Namespaces

- namespace cxx

  Our C++ library.

Data Structures

- class L4::Alloc_list

  A simple list-based allocator.
- class cxx::List_item

  Basic list item.
- struct cxx::Pair< First, Second >

  Pair of two values.

- class cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >

  Basic slab allocator.
- class cxx::Slab< Type, Slab_size, Max_free, Alloc >

  Slab allocator for object of type `Type`.
- class cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >

  Merged slab allocator (allocators for objects of the same size are merged together).
- class cxx::Slab_static< Type, Slab_size, Max_free, Alloc >

  Merged slab allocator (allocators for objects of the same size are merged together).
- class cxx::Nothrow

  Helper type to distinguish the `operator new` version that does not throw exceptions.
- class cxx::New_allocator< _Type >

  Standard allocator based on `operator new ()` .
- class L4::String

  A null-terminated string container class.

Functions

- template<typename A, typename ... ARGS>
  constexpr A const & cxx::min (A const &a1, A const &a2, ARGS const &...a)

  Get the minimum of `a1` and `a2` upt to `aN`.
- template<typename A, typename ... ARGS>
  constexpr A const & cxx::min (cxx::identity_t< A > const &a1, cxx::identity_t< A > const &a2, ARGS const &...a)

  Get the minimum of `a1` and `a2` upt to `aN`.
- template<typename A, typename ... ARGS>
  constexpr A const & cxx::max (A const &a1, A const &a2, ARGS const &...a)

  Get the maximum of `a1` and `a2` upt to `aN`.
- template<typename A, typename ... ARGS>
  constexpr A const & cxx::max (cxx::identity_t< A > const &a1, cxx::identity_t< A > const &a2, ARGS const &...a)

  Get the maximum of `a1` and `a2` upt to `aN`.
- template<typename T1>
  T1 cxx::clamp (T1 v, T1 lo, T1 hi)

  Limit v to the range given by lo and hi.
- void * operator new (size_t, void *mem, cxx::Nothrow const &) noexcept

  Simple placement new operator.
- void * **operator new** (size_t, cxx::Nothrow const &) noexcept

  New operator that does not throw exceptions.
- void **operator delete** (void *, cxx::Nothrow const &) noexcept

  Delete operator complementing the new operator not throwing exceptions.

13.14.1 Detailed Description

13.14.2 Function Documentation

13.14.2.1 clamp()

```
template<typename T1>
T1 cxx::clamp (
            T1 v,
            T1 lo,
            T1 hi)  [inline]
```

Limit *v* to the range given by *lo* and *hi*.

Parameters

v	The value to clamp.
lo	The lower boundary to clamp *v* to.
hi	The upper boundary to clamp *v* to.

Definition at line 109 of file minmax.

13.14.2.2 max() [1/2]

```
template<typename A, typename ...  ARGS>
A const & cxx::max (
             A const & a1,
             A const & a2,
             ARGS const &...  a)  [constexpr]
```

Get the maximum of `a1` and `a2` upt to `aN`.

Parameters

a1	The first value.
a2	The second value.
...↩ a	Arbitrary number of additional parameters.

Matches with automatic argument type deduction.
Definition at line 78 of file minmax.

13.14.2.3 max() [2/2]

```
template<typename A, typename ...  ARGS>
A const & cxx::max (
             cxx::identity_t< A > const & a1,
             cxx::identity_t< A > const & a2,
             ARGS const &...  a)  [constexpr]
```

Get the maximum of `a1` and `a2` upt to `aN`.

Parameters

a1	The first value.
a2	The second value.
...↩ a	Arbitrary number of additional parameters.

Matches with explicit template type A.
Definition at line 93 of file minmax.

13.14.2.4 min() [1/2]

```
template<typename A, typename ...  ARGS>
A const & cxx::min (
             A const & a1,
             A const & a2,
             ARGS const &...  a)  [constexpr]
```

Get the minimum of `a1` and `a2` upt to `aN`.

Parameters

a1	The first value.
a2	The second value.
...↩ a	Arbitrary number of additional parameters.

Matches with automatic argument type deduction.
Definition at line 36 of file minmax.

13.14.2.5 min() [2/2]

```
template<typename A, typename ...  ARGS>
A const & cxx::min (
             cxx::identity_t< A > const & a1,
             cxx::identity_t< A > const & a2,
             ARGS const &...  a)  [constexpr]
```

Get the minimum of `a1` and `a2` upt to `aN`.

Parameters

a1	The first value.
a2	The second value.
...↩ a	Arbitrary number of additional parameters.

Matches with explicit template type A.
Definition at line 53 of file minmax.

13.14.2.6 operator new()

```
void * operator new (
             size_t ,
             void * mem,
             cxx::Nothrow const & )  [inline], [noexcept]
```

Simple placement new operator.

Parameters

mem	the address of the memory block to place the new object.

Returns

the address given by *mem*.

Definition at line 28 of file std_alloc.

13.15 The L4Re IPC Framework

The mechanisms for IPC communication between L4Re applications.

Collaboration diagram for The L4Re IPC Framework:



Topics

- Server-Side IPC framework 587
  Server-Side framework for implementing object-oriented servers.

13.15.1 Detailed Description

The mechanisms for IPC communication between L4Re applications.

13.15.2 Server-Side IPC framework

Server-Side framework for implementing object-oriented servers.
Collaboration diagram for Server-Side IPC framework:



Namespaces

- namespace L4::Ipc_svr
  Helper classes for L4::Server instantiation.

Data Structures

- class L4::Ipc_svr::Server_iface
  Interface for server-loop related functions.
- class L4::Basic_registry
  This registry returns the corresponding server object based on the label of an Ipc_gate.
- struct L4::Ipc_svr::Ignore_errors
  Mix in for LOOP_HOOKS to ignore IPC errors.
- struct L4::Ipc_svr::Default_timeout
  Mix in for LOOP_HOOKS to use a 0 send and an infinite receive timeout.
- struct L4::Ipc_svr::Compound_reply
  Mix in for LOOP_HOOKS to always use compound reply and wait.
- struct L4::Ipc_svr::Default_setup_wait
  Mix in for LOOP_HOOKS for setup_wait no op.
- class L4::Ipc_svr::Br_manager_no_buffers

Empty implementation of Server_iface.

- struct L4::Ipc_svr::Default_loop_hooks

  Default LOOP_HOOKS.
- class L4::Server< LOOP_HOOKS >

  Basic server loop for handling client requests.
- class L4::Server_object

  Abstract server object to be used with L4::Server and L4::Basic_registry.
- struct L4::Server_object_t< IFACE, BASE >

  Base class (template) for server implementing server objects.
- struct L4::Server_object_x< Derived, IFACE, BASE >

  Helper class to implement p_dispatch based server objects.
- struct L4::Irq_handler_object

  Server object base class for handling IRQ messages.
- class L4::Ipc_svr::Timeout

  Callback interface for Timeout_queue.
- class L4::Ipc_svr::Timeout_queue

  Timeout queue to be used in l4re server loop.
- class L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >

  Loop hooks mixin for integrating a timeout queue into the server loop.

Enumerations

- enum L4::Ipc_svr::Reply_mode { L4::Ipc_svr::Reply_compound , L4::Ipc_svr::Reply_separate }

  Reply mode for server loop.

13.15.2.1 Detailed Description

Server-Side framework for implementing object-oriented servers.

13.15.2.2 Enumeration Type Documentation

13.15.2.2.1 Reply_mode

`enum L4::Ipc_svr::Reply_mode`

Reply mode for server loop.

The reply mode specifies if the server loop shall do a compound reply and wait operation (Reply_compound), which is the most performant method. Note, setup_wait() is called before the reply. The other way is to call reply and wait separately and call setup_wait in between.

The actual mode is determined by the return value of the before_reply() hook in the LOOP_HOOKS of L4::Server.

Enumerator

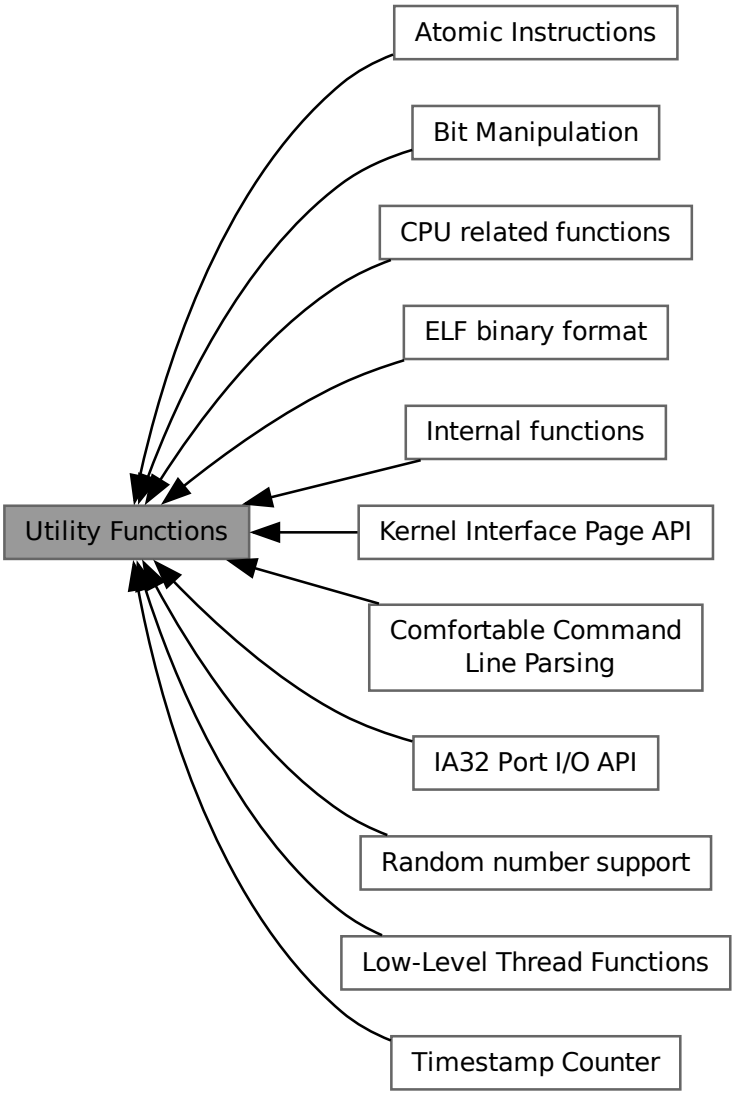
Reply_compound	Server shall use a compound reply and wait (fast).
Reply_separate	Server shall call reply and wait separately.

Definition at line 46 of file ipc_server_loop.

13.16 Utility Functions

Utilities, generic file.

Collaboration diagram for Utility Functions:



Topics

- CPU related functions 594
- IA32 Port I/O API 596
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- Atomic Instructions 608

- Internal functions . . . 623
- Bit Manipulation . . . 624
- ELF binary format . . . 630

  Functions and types related to ELF binaries.
- Kernel Interface Page API . . . 651
- Comfortable Command Line Parsing . . . 653
- Random number support . . . 655
- Low-Level Thread Functions . . . 656

Files

- file rand.h

  Simple Pseudo-Random Number Generator.

Functions

- L4_BEGIN_DECLS long l4util_splitlog2_hdl (l4_addr_t start, l4_addr_t end, long(*handler)(l4_addr_t s, l4_addr_t e, int log2size))

  Split a range into log2 base and size aligned chunks.
- l4_addr_t l4util_splitlog2_size (l4_addr_t start, l4_addr_t end)

  Return log2 base and size aligned length of a range.
- L4_BEGIN_DECLS l4_timeout_s l4util_micros2l4to (l4_uint64_t us) L4_NOTHROW

  Calculate l4 timeouts.
- void l4_sleep (l4_uint32_t ms) L4_NOTHROW

  Suspend thread for a period of ms milliseconds.
- void l4_usleep (l4_uint64_t us) L4_NOTHROW

  Suspend thread for a period of us microseconds.
- void **l4_sleep_forever** (void) L4_NOTHROW L4_NORETURN

  Go sleep and never wake up.
- void l4_touch_ro (const void *addr, unsigned size) L4_NOTHROW

  Touch data area to force mapping (read-only).
- void l4_touch_rw (const void *addr, unsigned size) L4_NOTHROW

  Touch data areas to force mapping (read-write).

13.16.1 Detailed Description

Utilities, generic file.

13.16.2 Function Documentation

13.16.2.1 l4_sleep()

```
void l4_sleep (
            l4_uint32_t ms)
```

Suspend thread for a period of *ms* milliseconds.

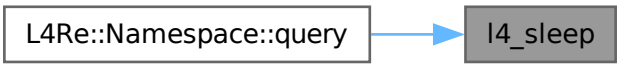
Parameters

ms	Time in milliseconds

Examples

examples/libs/libirq/async_isr.c, examples/sys/aliens/main.c, examples/sys/singlestep/main.c, and examples/sys/start-with-exc/r

References L4_CV, and L4_NOTHROW.
Referenced by L4Re::Namespace::query().
Here is the caller graph for this function:



13.16.2.2 l4_touch_ro()

```
void l4_touch_ro (
            const void * addr,
            unsigned size)  [inline]
```

Touch data area to force mapping (read-only).

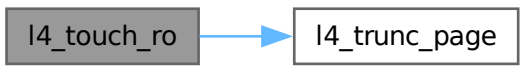
Parameters

addr	Start of memory area to touch.
size	Size of area to touch.

Examples

examples/sys/singlestep/main.c.

Definition at line 92 of file util.h.
References L4_NOTHROW, L4_PAGESIZE, and l4_trunc_page().
Here is the call graph for this function:



13.16.2.3 l4_touch_rw()

```
void l4_touch_rw (
            const void * addr,
            unsigned size)  [inline]
```

Touch data areas to force mapping (read-write).

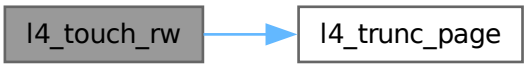
Parameters

addr	Start of memory area to touch.
size	Size of area to touch.

Examples

examples/sys/aliens/main.c, and examples/sys/singlestep/main.c.

Definition at line 105 of file util.h.
References L4_NOTHROW, L4_PAGESIZE, and l4_trunc_page().
Here is the call graph for this function:



13.16.2.4 l4_usleep()

```
void l4_usleep (
            l4_uint64_t us)
```

Suspend thread for a period of *us* microseconds.

Parameters

us	Time in microseconds

Note

The timer resolution of L4 kernels is usually 1ms.

References L4_CV, L4_INLINE, L4_NORETURN, and L4_NOTHROW.

13.16.2.5 l4util_micros2l4to()

```
L4_BEGIN_DECLS l4_timeout_s l4util_micros2l4to (
            l4_uint64_t us)
```

Calculate l4 timeouts.

Parameters

us	time in microseconds. Special cases: • 0 - > timeout 0 • ~0U -> timeout NEVER

Returns

the corresponding l4_timeout value

Deprecated Use l4_timeout_from_us().

References L4_CV, and L4_NOTHROW.

13.16.2.6 l4util_splitlog2_hdl()

```
L4_END_DECLS long l4util_splitlog2_hdl (
              l4_addr_t start,
              l4_addr_t end,
              long(* handler )(l4_addr_t s, l4_addr_t e, int log2size))  [inline]
```

Split a range into log2 base and size aligned chunks.

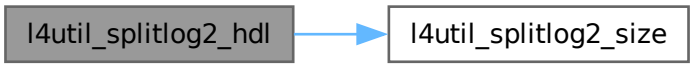
Parameters

start	Start of range
end	End of range (inclusive) (e.g. 2-4 is len 3)
handler	Handler function that is called with start and end (both inclusive) of the chunk. On success, the handler must return 0, if it returns !=0 the function will immediately return with the return code of the handler.

Returns

0 on success, != 0 otherwise

Definition at line 51 of file splitlog2.h.
References L4_EINVAL, and l4util_splitlog2_size().
Here is the call graph for this function:



13.16.2.7 l4util_splitlog2_size()

```
l4_addr_t l4util_splitlog2_size (
              l4_addr_t start,
              l4_addr_t end)  [inline]
```

Return log2 base and size aligned length of a range.

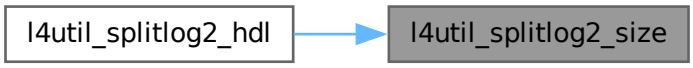
Parameters

start	Start of range
end	End of range (inclusive) (e.g. 2-4 is len 3)

Returns

length of elements in log2size (length is 1 << log2size)

Definition at line 72 of file splitlog2.h.
Referenced by l4util_splitlog2_hdl().
Here is the caller graph for this function:



13.16.3 CPU related functions

Collaboration diagram for CPU related functions:



Functions

- int l4util_cpu_has_cpuid (void)

  Check whether the CPU supports the "cpuid" instruction.
- unsigned int l4util_cpu_capabilities (void)

  Returns the CPU capabilities if the "cpuid" instruction is available.
- unsigned int l4util_cpu_capabilities_nocheck (void)

  Returns the CPU capabilities.
- void **l4util_cpu_cpuid** (unsigned long mode, unsigned long *eax, unsigned long *ebx, unsigned long *ecx, unsigned long *edx)

  Generic CPUID access function.

13.16.3.1 Detailed Description

13.16.3.2 Function Documentation

13.16.3.2.1 l4util_cpu_capabilities()

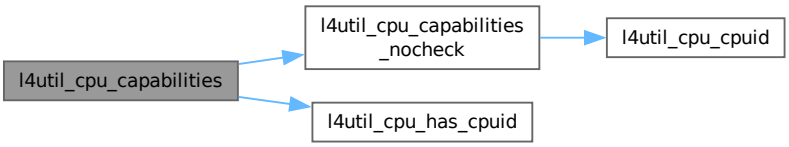
```
unsigned int l4util_cpu_capabilities (
             void )  [inline]
```

Returns the CPU capabilities if the "cpuid" instruction is available.

Returns

CPU capabilities if the "cpuid" instruction is available, 0 if the "cpuid" instruction is not supported.

Definition at line 95 of file cpu.h.
References l4util_cpu_capabilities_nocheck(), and l4util_cpu_has_cpuid().
Here is the call graph for this function:



13.16.3.2.2 l4util_cpu_capabilities_nocheck()

```
unsigned int l4util_cpu_capabilities_nocheck (
            void )  [inline]
```

Returns the CPU capabilities.

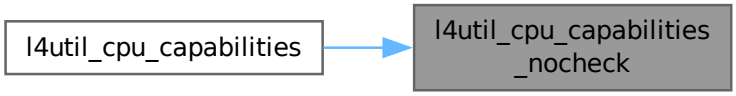
Returns

CPU capabilities.

Definition at line 84 of file cpu.h.
References l4util_cpu_cpuid().
Referenced by l4util_cpu_capabilities().
Here is the call graph for this function:



Here is the caller graph for this function:



13.16.3.2.3 l4util_cpu_has_cpuid()

```
int l4util_cpu_has_cpuid (
            void )  [inline]
```

Check whether the CPU supports the "cpuid" instruction.

Returns

1 if it has, 0 if it has not

Definition at line 64 of file cpu.h.
Referenced by l4util_cpu_capabilities().
Here is the caller graph for this function:



13.16.4 IA32 Port I/O API

Collaboration diagram for IA32 Port I/O API:



Functions

- l4_uint8_t l4util_in8 (l4_uint16_t port)
  Read byte from I/O port.
- l4_uint16_t l4util_in16 (l4_uint16_t port)
  Read 16-bit-value from I/O port.
- l4_uint32_t l4util_in32 (l4_uint16_t port)
  Read 32-bit-value from I/O port.
- void l4util_ins8 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
  Read a block of 8-bit-values from I/O ports.
- void l4util_ins16 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
  Read a block of 16-bit-values from I/O ports.
- void l4util_ins32 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
  Read a block of 32-bit-values from I/O ports.
- void l4util_out8 (l4_uint8_t value, l4_uint16_t port)
  Write byte to I/O port.
- void l4util_out16 (l4_uint16_t value, l4_uint16_t port)
  Write 16-bit-value to I/O port.
- void l4util_out32 (l4_uint32_t value, l4_uint16_t port)

Write 32-bit-value to I/O port.

- void l4util_outs8 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write a block of bytes to I/O port.
- void l4util_outs16 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write a block of 16-bit-values to I/O port.
- void l4util_outs32 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write block of 32-bit-values to I/O port.
- void **l4util_iodelay** (void)

  delay I/O port access by writing to port 0x80
- int l4util_ioport_map (l4_cap_idx_t sigma0id, unsigned port_start, unsigned log2size)

  Map a range of I/O ports.

13.16.4.1 Detailed Description

13.16.4.2 Function Documentation

13.16.4.2.1 l4util_in16()

```
l4_uint16_t l4util_in16 (
            l4_uint16_t port)  [inline]
```

Read 16-bit-value from I/O port.

Parameters

port	I/O port address

Returns

value

Definition at line 195 of file port_io.h.

13.16.4.2.2 l4util_in32()

```
l4_uint32_t l4util_in32 (
            l4_uint16_t port)  [inline]
```

Read 32-bit-value from I/O port.

Parameters

port	I/O port address

Returns

value

Definition at line 203 of file port_io.h.

13.16.4.2.3 l4util_in8()

```
l4_uint8_t l4util_in8 (
            l4_uint16_t port)  [inline]
```

Read byte from I/O port.

Parameters

port	I/O port address

Returns

value

Definition at line 187 of file port_io.h.

13.16.4.2.4 l4util_ins16()

```
void l4util_ins16 (
              l4_uint16_t port,
              l4_umword_t addr,
              l4_umword_t count)  [inline]
```

Read a block of 16-bit-values from I/O ports.

Parameters

port	I/O port address
addr	address of buffer
count	number of I/O operations

Definition at line 220 of file port_io.h.

13.16.4.2.5 l4util_ins32()

```
void l4util_ins32 (
              l4_uint16_t port,
              l4_umword_t addr,
              l4_umword_t count)  [inline]
```

Read a block of 32-bit-values from I/O ports.

Parameters

port	I/O port address
addr	address of buffer
count	number of I/O operations

Definition at line 229 of file port_io.h.

13.16.4.2.6 l4util_ins8()

```
void l4util_ins8 (
              l4_uint16_t port,
              l4_umword_t addr,
              l4_umword_t count)  [inline]
```

Read a block of 8-bit-values from I/O ports.

Parameters

port	I/O port address
addr	address of buffer

count	number of I/O operations

Definition at line 211 of file port_io.h.

13.16.4.2.7 l4util_ioport_map()

```
int l4util_ioport_map (
            l4_cap_idx_t sigma0id,
            unsigned port_start,
            unsigned log2size)  [inline]
```

Map a range of I/O ports.

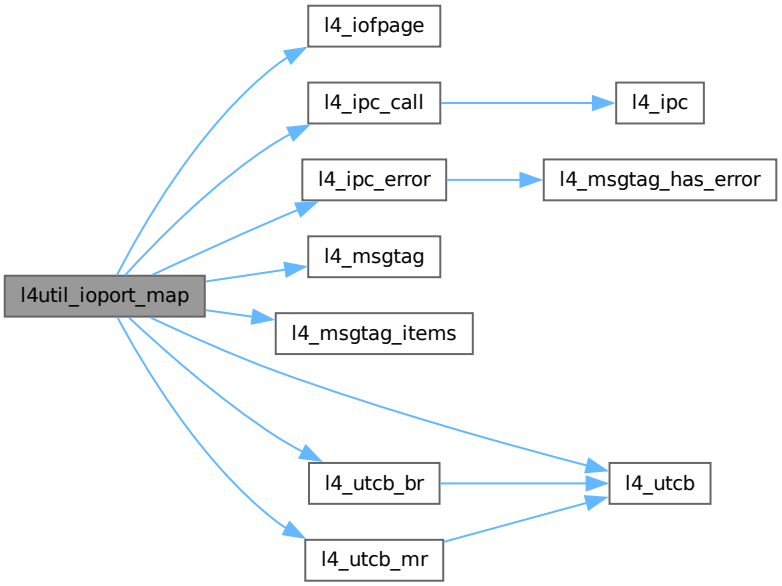
Parameters

sigma0id	I/O port service (sigma0).
port_start	(Start) Port to request.
log2size	Log2size of range to request.

Returns

IPC result: 0 if the range could be successfully mapped on error: IPC failure, or -L4_ENOENT if nothing mapped

Definition at line 289 of file port_io.h.
References l4_buf_regs_t::bdr, l4_buf_regs_t::br, L4_ENOENT, l4_iofpage(), l4_ipc_call(), l4_ipc_error(), L4_IPC_NEVER, L4_ITEM_MAP, l4_msgtag(), l4_msgtag_items(), L4_PROTO_IO_PAGE_FAULT, l4_utcb(), l4_utcb_br(), l4_utcb_mr(), l4_msg_regs_t::mr, and l4_fpage_t::raw.
Here is the call graph for this function:



13.16.4.2.8 l4util_out16()

```
void l4util_out16 (
             l4_uint16_t value,
             l4_uint16_t port)  [inline]
```

Write 16-bit-value to I/O port.

Parameters

port	I/O port address
value	value to write

Definition at line 244 of file port_io.h.

13.16.4.2.9 l4util_out32()

```
void l4util_out32 (
             l4_uint32_t value,
             l4_uint16_t port)  [inline]
```

Write 32-bit-value to I/O port.

Parameters

port	I/O port address
value	value to write

Definition at line 250 of file port_io.h.

13.16.4.2.10 l4util_out8()

```
void l4util_out8 (
             l4_uint8_t value,
             l4_uint16_t port)  [inline]
```

Write byte to I/O port.

Parameters

port	I/O port address
value	value to write

Definition at line 238 of file port_io.h.

13.16.4.2.11 l4util_outs16()

```
void l4util_outs16 (
             l4_uint16_t port,
             l4_umword_t addr,
             l4_umword_t count)  [inline]
```

Write a block of 16-bit-values to I/O port.

Parameters

port	I/O port address
addr	address of buffer

count	number of I/O operations

Definition at line 265 of file port_io.h.

13.16.4.2.12 l4util_outs32()

```
void l4util_outs32 (
              l4_uint16_t port,
              l4_umword_t addr,
              l4_umword_t count)  [inline]
```

Write block of 32-bit-values to I/O port.

Parameters

port	I/O port address
addr	address of buffer
count	number of I/O operations

Definition at line 274 of file port_io.h.

13.16.4.2.13 l4util_outs8()

```
void l4util_outs8 (
              l4_uint16_t port,
              l4_umword_t addr,
              l4_umword_t count)  [inline]
```

Write a block of bytes to I/O port.

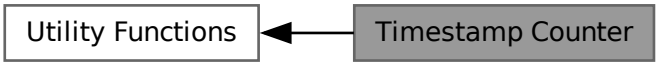
Parameters

port	I/O port address
addr	address of buffer
count	number of I/O operations

Definition at line 256 of file port_io.h.

13.16.5 Timestamp Counter

Collaboration diagram for Timestamp Counter:



Files

- file rdtsc.h

  Timestamp counter related functions.

- file rdtsc.h

  Timestamp counter related functions.

Functions

- l4_cpu_time_t l4_rdtsc (void)

  Read current value of CPU-internal timestamp counter.
- l4_uint32_t l4_rdtsc_32 (void)

  Read the lest significant 32 bit of the TSC.
- l4_uint64_t l4_rdpmc (int ecx)

  Return current value of CPU-internal performance measurement counter.
- l4_uint32_t l4_rdpmc_32 (int ecx)

  Return the least significant 32 bit of a performance counter.
- l4_uint64_t l4_tsc_to_ns (l4_cpu_time_t tsc)

  Convert timestamp to ns value.
- l4_uint64_t l4_tsc_to_us (l4_cpu_time_t tsc)

  Convert timestamp into micro seconds value.
- void l4_tsc_to_s_and_ns (l4_cpu_time_t tsc, l4_uint32_t *s, l4_uint32_t *ns)

  Convert timestamp to s.ns value.
- l4_cpu_time_t l4_ns_to_tsc (l4_uint64_t ns)

  Convert nano seconds into CPU ticks.
- void l4_busy_wait_ns (l4_uint64_t ns)

  Wait busy for a small amount of time.
- void l4_busy_wait_us (l4_uint64_t us)

  Wait busy for a small amount of time.
- l4_uint32_t l4_calibrate_tsc (l4_kernel_info_t const *kip)

  Determine scalers for timestamp calculations.
- l4_uint32_t l4_tsc_init (l4_kernel_info_t const *kip)

  Initialize scaler for TSC calibrations from the kernel.
- l4_uint32_t l4_get_hz (void)

  Get CPU frequency in Hz.

13.16.5.1 Detailed Description

13.16.5.2 Function Documentation

13.16.5.2.1 l4_busy_wait_ns()

```
void l4_busy_wait_ns (
             l4_uint64_t ns)  [inline]
```

Wait busy for a small amount of time.

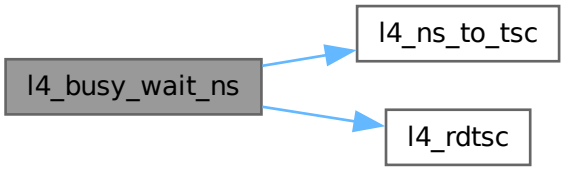
Parameters

ns	nano seconds to wait

Attention

Not intended for any use!

Definition at line 262 of file rdtsc.h.
References l4_ns_to_tsc(), and l4_rdtsc().
Here is the call graph for this function:



13.16.5.2.2 l4_busy_wait_us()

```
void l4_busy_wait_us (
             l4_uint64_t us)  [inline]
```

Wait busy for a small amount of time.

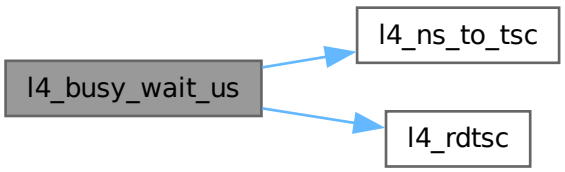
Parameters

us	micro seconds to wait

Attention

Not intended for any use!

Definition at line 272 of file rdtsc.h.
References l4_ns_to_tsc(), and l4_rdtsc().
Here is the call graph for this function:



13.16.5.2.3 l4_calibrate_tsc()

```
l4_uint32_t l4_calibrate_tsc (
             l4_kernel_info_t const * kip)  [inline]
```

Determine scalers for timestamp calculations.
Determine some scalers to be able to convert between real time and CPU ticks. Just calls l4_tsc_init().

Examples

examples/sys/aliens/main.c.

Definition at line 159 of file rdtsc.h.
References l4_tsc_init().
Here is the call graph for this function:



13.16.5.2.4 l4_get_hz()

```
l4_uint32_t l4_get_hz (
            void )
```

Get CPU frequency in Hz.

Returns

frequency in Hz

References L4_END_DECLS, and L4_INLINE.

13.16.5.2.5 l4_ns_to_tsc()

```
l4_cpu_time_t l4_ns_to_tsc (
            l4_uint64_t ns)  [inline]
```

Convert nano seconds into CPU ticks.

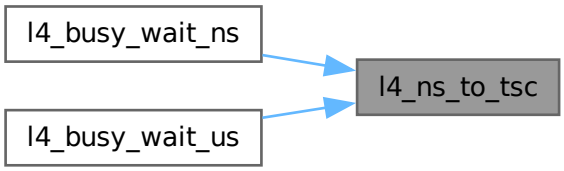
Parameters

ns	nano seconds

Returns

CPU ticks

Definition at line 248 of file rdtsc.h.
Referenced by l4_busy_wait_ns(), and l4_busy_wait_us().
Here is the caller graph for this function:



13.16.5.2.6 l4_rdpmc()

```
l4_uint64_t l4_rdpmc (
             int ecx)  [inline]
```

Return current value of CPU-internal performance measurement counter.

Parameters

ecx	ECX value for the rdpmc instruction. For details see the Intel IA-32 Architectures Software Developer's Manual.

Returns

64-bit PMC

Definition at line 175 of file rdtsc.h.

13.16.5.2.7 l4_rdpmc_32()

```
l4_uint32_t l4_rdpmc_32 (
             int ecx)  [inline]
```

Return the least significant 32 bit of a performance counter.
Useful for smaller differences, needs less cycles.
Definition at line 195 of file rdtsc.h.

13.16.5.2.8 l4_rdtsc()

```
l4_cpu_time_t l4_rdtsc (
             void )  [inline]
```

Read current value of CPU-internal timestamp counter.

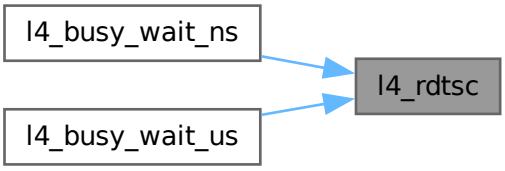
Returns

64-bit timestamp

Examples

examples/sys/aliens/main.c.

Definition at line 165 of file rdtsc.h.
Referenced by l4_busy_wait_ns(), and l4_busy_wait_us().
Here is the caller graph for this function:



13.16.5.2.9 l4_rdtsc_32()

```
l4_uint32_t l4_rdtsc_32 (
            void )  [inline]
```

Read the lest significant 32 bit of the TSC.
Useful for smaller differences, needs less cycles.
Definition at line 185 of file rdtsc.h.

13.16.5.2.10 l4_tsc_init()

```
l4_uint32_t l4_tsc_init (
            l4_kernel_info_t const * kip)
```

Initialize scaler for TSC calibrations from the kernel.
Initialize the scalers needed by l4_tsc_to_ns()/l4_ns_to_tsc() and so on. Use the kernel-provided frequency.

Parameters

kip	KIP pointer

Returns

0 on error (no scalers exported by kernel) otherwise returns (2^32 / (tsc per µsec)). This value has the same semantics as the value returned by the calibrate_delay_loop() function of the Linux kernel.

References L4_CV.
Referenced by l4_calibrate_tsc().
Here is the caller graph for this function:



13.16.5.2.11 l4_tsc_to_ns()

```
l4_uint64_t l4_tsc_to_ns (
            l4_cpu_time_t tsc)  [inline]
```

Convert timestamp to ns value.

Parameters

tsc	time value in CPU ticks

Returns

time value in ns

Examples

examples/sys/aliens/main.c.

Definition at line 205 of file rdtsc.h.

13.16.5.2.12 l4_tsc_to_s_and_ns()

```
void l4_tsc_to_s_and_ns (
            l4_cpu_time_t tsc,
            l4_uint32_t * s,
            l4_uint32_t * ns)  [inline]
```

Convert timestamp to s.ns value.

Parameters

	tsc	time value in CPU ticks
out	*s*	seconds
out	*ns*	nano seconds

Definition at line 233 of file rdtsc.h.

13.16.5.2.13 l4_tsc_to_us()

```
l4_uint64_t l4_tsc_to_us (
            l4_cpu_time_t tsc)  [inline]
```

Convert timestamp into micro seconds value.

Parameters

tsc	time value in CPU ticks

Returns

time value in micro seconds

Definition at line 219 of file rdtsc.h.

13.16.6 Atomic Instructions

Collaboration diagram for Atomic Instructions:



Files

- file atomic.h

  atomic operations header and generic implementations

Functions

- int l4util_cmpxchg32 (volatile l4_uint32_t *dest, l4_uint32_t cmp_val, l4_uint32_t new_val)

  Atomic compare and exchange (32 bit version).
- int l4util_cmpxchg16 (volatile l4_uint16_t *dest, l4_uint16_t cmp_val, l4_uint16_t new_val)

  Atomic compare and exchange (16 bit version).
- int l4util_cmpxchg8 (volatile l4_uint8_t *dest, l4_uint8_t cmp_val, l4_uint8_t new_val)

  Atomic compare and exchange (8 bit version).
- int l4util_cmpxchg (volatile l4_umword_t *dest, l4_umword_t cmp_val, l4_umword_t new_val)

  Atomic compare and exchange (machine wide fields).
- l4_uint32_t l4util_xchg32 (volatile l4_uint32_t *dest, l4_uint32_t val)

  Atomic exchange (32 bit version).
- l4_uint16_t l4util_xchg16 (volatile l4_uint16_t *dest, l4_uint16_t val)

  Atomic exchange (16 bit version).
- l4_uint8_t l4util_xchg8 (volatile l4_uint8_t *dest, l4_uint8_t val)

  Atomic exchange (8 bit version).
- l4_umword_t l4util_xchg (volatile l4_umword_t *dest, l4_umword_t val)

  Atomic exchange (machine wide fields).
- void l4util_atomic_add (volatile long *dest, long val)

  Atomic add.
- void l4util_atomic_inc (volatile long *dest)

  Atomic increment.

Atomic add/sub/and/or (8,16,32 bit version) without result

- void l4util_add8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_add16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_add32 (volatile l4_uint32_t *dest, l4_uint32_t val)
- void l4util_sub8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_sub16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_sub32 (volatile l4_uint32_t *dest, l4_uint32_t val)

- void l4util_and8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_and16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_and32 (volatile l4_uint32_t *dest, l4_uint32_t val)
- void l4util_or8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_or16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_or32 (volatile l4_uint32_t *dest, l4_uint32_t val)

Atomic add/sub/and/or operations (8,16,32 bit) with result

- l4_uint8_t l4util_add8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_add16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_add32_res (volatile l4_uint32_t *dest, l4_uint32_t val)
- l4_uint8_t l4util_sub8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_sub16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_sub32_res (volatile l4_uint32_t *dest, l4_uint32_t val)
- l4_uint8_t l4util_and8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_and16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_and32_res (volatile l4_uint32_t *dest, l4_uint32_t val)
- l4_uint8_t l4util_or8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_or16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_or32_res (volatile l4_uint32_t *dest, l4_uint32_t val)

Atomic inc/dec (8,16,32 bit) without result

- void l4util_inc8 (volatile l4_uint8_t *dest)
- void l4util_inc16 (volatile l4_uint16_t *dest)
- void l4util_inc32 (volatile l4_uint32_t *dest)
- void l4util_dec8 (volatile l4_uint8_t *dest)
- void l4util_dec16 (volatile l4_uint16_t *dest)
- void l4util_dec32 (volatile l4_uint32_t *dest)

Atomic inc/dec (8,16,32 bit) with result

- l4_uint8_t l4util_inc8_res (volatile l4_uint8_t *dest)
- l4_uint16_t l4util_inc16_res (volatile l4_uint16_t *dest)
- l4_uint32_t l4util_inc32_res (volatile l4_uint32_t *dest)
- l4_uint8_t l4util_dec8_res (volatile l4_uint8_t *dest)
- l4_uint16_t l4util_dec16_res (volatile l4_uint16_t *dest)
- l4_uint32_t l4util_dec32_res (volatile l4_uint32_t *dest)

13.16.6.1 Detailed Description

13.16.6.2 Function Documentation

13.16.6.2.1 l4util_add16()

```
void l4util_add16 (
             volatile l4_uint16_t * dest,
             l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 472 of file atomic.h.

13.16.6.2.2 l4util_add16_res()

```
l4_uint16_t l4util_add16_res (
             volatile l4_uint16_t * dest,
             l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 524 of file atomic.h.

13.16.6.2.3 l4util_add32()

```
void l4util_add32 (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 476 of file atomic.h.

13.16.6.2.4 l4util_add32_res()

```
l4_uint32_t l4util_add32_res (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 528 of file atomic.h.

13.16.6.2.5 l4util_add8()

```
void l4util_add8 (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 468 of file atomic.h.

13.16.6.2.6 l4util_add8_res()

```
l4_uint8_t l4util_add8_res (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 520 of file atomic.h.

13.16.6.2.7 l4util_and16()

```
void l4util_and16 (
             volatile l4_uint16_t * dest,
             l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 500 of file atomic.h.

13.16.6.2.8 l4util_and16_res()

```
l4_uint16_t l4util_and16_res (
             volatile l4_uint16_t * dest,
             l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 548 of file atomic.h.

13.16.6.2.9 l4util_and32()

```
void l4util_and32 (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 504 of file atomic.h.

13.16.6.2.10 l4util_and32_res()

```
l4_uint32_t l4util_and32_res (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 552 of file atomic.h.

13.16.6.2.11 l4util_and8()

```
void l4util_and8 (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 496 of file atomic.h.

13.16.6.2.12 l4util_and8_res()

```
l4_uint8_t l4util_and8_res (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 544 of file atomic.h.

13.16.6.2.13 l4util_atomic_add()

```
void l4util_atomic_add (
             volatile long * dest,
             long val)  [inline]
```

Atomic add.

Parameters

dest	destination operand
val	value to add

Definition at line 480 of file atomic.h.

13.16.6.2.14 l4util_atomic_inc()

```
void l4util_atomic_inc (
             volatile long * dest)  [inline]
```

Atomic increment.

Parameters

dest	destination operand

Definition at line 423 of file atomic.h.

13.16.6.2.15 l4util_cmpxchg()

```
int l4util_cmpxchg (
             volatile l4_umword_t * dest,
             l4_umword_t cmp_val,
             l4_umword_t new_val)  [inline]
```

Atomic compare and exchange (machine wide fields).

Parameters

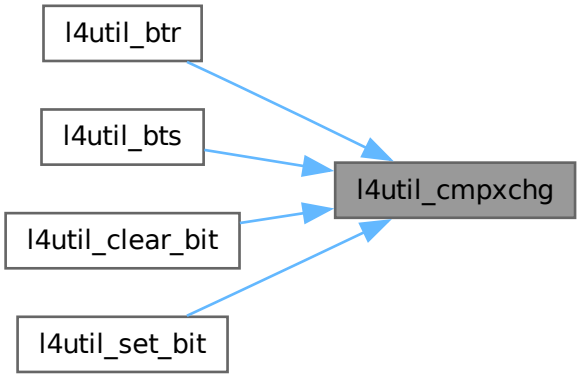
dest	destination operand
cmp_val	compare value
new_val	new value for dest

Returns

0 if comparison failed, 1 otherwise

Compare the value in *dest* with *cmp_val*, if equal set *dest* to *new_val*
Definition at line 379 of file atomic.h.
Referenced by l4util_btr(), l4util_bts(), l4util_clear_bit(), and l4util_set_bit().

Here is the caller graph for this function:



13.16.6.2.16 l4util_cmpxchg16()

```
int l4util_cmpxchg16 (
             volatile l4_uint16_t * dest,
             l4_uint16_t cmp_val,
             l4_uint16_t new_val)  [inline]
```

Atomic compare and exchange (16 bit version).

Parameters

dest	destination operand
cmp_val	compare value
new_val	new value for dest

Returns

0 if comparison failed, !=0 otherwise

Compare the value in *dest* with *cmp_val*, if equal set *dest* to *new_val*
Definition at line 363 of file atomic.h.

13.16.6.2.17 l4util_cmpxchg32()

```
L4_END_DECLS int l4util_cmpxchg32 (
             volatile l4_uint32_t * dest,
             l4_uint32_t cmp_val,
             l4_uint32_t new_val)  [inline]
```

Atomic compare and exchange (32 bit version).

Parameters

dest	destination operand

cmp_val	compare value
new_val	new value for dest

Returns

0 if comparison failed, !=0 otherwise

Compare the value in *dest* with *cmp_val*, if equal set *dest* to *new_val*
Definition at line 355 of file atomic.h.

13.16.6.2.18 l4util_cmpxchg8()

```
int l4util_cmpxchg8 (
             volatile l4_uint8_t * dest,
             l4_uint8_t cmp_val,
             l4_uint8_t new_val)  [inline]
```

Atomic compare and exchange (8 bit version).

Parameters

dest	destination operand
cmp_val	compare value
new_val	new value for dest

Returns

0 if comparison failed, !=0 otherwise

Compare the value in *dest* with *cmp_val*, if equal set *dest* to *new_val*
Definition at line 371 of file atomic.h.

13.16.6.2.19 l4util_dec16()

```
void l4util_dec16 (
             volatile l4_uint16_t * dest)  [inline]
```

Parameters

dest	destination operand

Definition at line 431 of file atomic.h.

13.16.6.2.20 l4util_dec16_res()

```
l4_uint16_t l4util_dec16_res (
             volatile l4_uint16_t * dest)  [inline]
```

Parameters

dest	destination operand

Returns

res

Definition at line 456 of file atomic.h.

13.16.6.2.21 l4util_dec32()

```
void l4util_dec32 (
            volatile l4_uint32_t * dest)  [inline]
```

Parameters

dest	destination operand

Definition at line 435 of file atomic.h.

13.16.6.2.22 l4util_dec32_res()

```
l4_uint32_t l4util_dec32_res (
            volatile l4_uint32_t * dest)  [inline]
```

Parameters

dest	destination operand

Returns

res

Definition at line 460 of file atomic.h.

13.16.6.2.23 l4util_dec8()

```
void l4util_dec8 (
            volatile l4_uint8_t * dest)  [inline]
```

Parameters

dest	destination operand

Definition at line 427 of file atomic.h.

13.16.6.2.24 l4util_dec8_res()

```
l4_uint8_t l4util_dec8_res (
            volatile l4_uint8_t * dest)  [inline]
```

Parameters

dest	destination operand

Returns

res

Definition at line 452 of file atomic.h.

13.16.6.2.25 l4util_inc16()

```
void l4util_inc16 (
            volatile l4_uint16_t * dest)  [inline]
```

Parameters

dest	destination operand

Definition at line 415 of file atomic.h.

13.16.6.2.26 l4util_inc16_res()

```
l4_uint16_t l4util_inc16_res (
             volatile l4_uint16_t * dest)  [inline]
```

Parameters

dest	destination operand

Returns

res

Definition at line 444 of file atomic.h.

13.16.6.2.27 l4util_inc32()

```
void l4util_inc32 (
             volatile l4_uint32_t * dest)  [inline]
```

Parameters

dest	destination operand

Definition at line 419 of file atomic.h.

13.16.6.2.28 l4util_inc32_res()

```
l4_uint32_t l4util_inc32_res (
             volatile l4_uint32_t * dest)  [inline]
```

Parameters

dest	destination operand

Returns

res

Definition at line 448 of file atomic.h.

13.16.6.2.29 l4util_inc8()

```
void l4util_inc8 (
             volatile l4_uint8_t * dest)  [inline]
```

Parameters

dest	destination operand

Definition at line 411 of file atomic.h.

13.16.6.2.30 l4util_inc8_res()

```
l4_uint8_t l4util_inc8_res (
            volatile l4_uint8_t * dest)  [inline]
```

Parameters

dest	destination operand

Returns

res

Definition at line 440 of file atomic.h.

13.16.6.2.31 l4util_or16()

```
void l4util_or16 (
            volatile l4_uint16_t * dest,
            l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 512 of file atomic.h.

13.16.6.2.32 l4util_or16_res()

```
l4_uint16_t l4util_or16_res (
            volatile l4_uint16_t * dest,
            l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 560 of file atomic.h.

13.16.6.2.33 l4util_or32()

```
void l4util_or32 (
            volatile l4_uint32_t * dest,
            l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 516 of file atomic.h.

13.16.6.2.34 l4util_or32_res()

```
l4_uint32_t l4util_or32_res (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 564 of file atomic.h.

13.16.6.2.35 l4util_or8()

```
void l4util_or8 (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 508 of file atomic.h.

13.16.6.2.36 l4util_or8_res()

```
l4_uint8_t l4util_or8_res (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 556 of file atomic.h.

13.16.6.2.37 l4util_sub16()

```
void l4util_sub16 (
             volatile l4_uint16_t * dest,
             l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 488 of file atomic.h.

13.16.6.2.38 l4util_sub16_res()

```
l4_uint16_t l4util_sub16_res (
             volatile l4_uint16_t * dest,
             l4_uint16_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 536 of file atomic.h.

13.16.6.2.39 l4util_sub32()

```
void l4util_sub32 (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 492 of file atomic.h.

13.16.6.2.40 l4util_sub32_res()

```
l4_uint32_t l4util_sub32_res (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 540 of file atomic.h.

13.16.6.2.41 l4util_sub8()

```
void l4util_sub8 (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Definition at line 484 of file atomic.h.

13.16.6.2.42 l4util_sub8_res()

```
l4_uint8_t l4util_sub8_res (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Parameters

dest	destination operand
val	value to add/sub/and/or

Returns

res

Definition at line 532 of file atomic.h.

13.16.6.2.43 l4util_xchg()

```
l4_umword_t l4util_xchg (
             volatile l4_umword_t * dest,
             l4_umword_t val)  [inline]
```

Atomic exchange (machine wide fields).

Parameters

dest	destination operand
val	new value for dest

Returns

old value at destination

Definition at line 405 of file atomic.h.

13.16.6.2.44 l4util_xchg16()

```
l4_uint16_t l4util_xchg16 (
             volatile l4_uint16_t * dest,
             l4_uint16_t val)  [inline]
```

Atomic exchange (16 bit version).

Parameters

dest	destination operand
val	new value for dest

Returns

old value at destination

Definition at line 393 of file atomic.h.

13.16.6.2.45 l4util_xchg32()

```
l4_uint32_t l4util_xchg32 (
             volatile l4_uint32_t * dest,
             l4_uint32_t val)  [inline]
```

Atomic exchange (32 bit version).

Parameters

dest	destination operand
val	new value for dest

Returns

old value at destination

Definition at line 387 of file atomic.h.

13.16.6.2.46 l4util_xchg8()

```
l4_uint8_t l4util_xchg8 (
             volatile l4_uint8_t * dest,
             l4_uint8_t val)  [inline]
```

Atomic exchange (8 bit version).

Parameters

dest	destination operand
val	new value for dest

Returns

old value at destination

Definition at line 399 of file atomic.h.

13.16.7 Internal functions

Collaboration diagram for Internal functions:



Functions

- void base64_encode (char const *in_data, size_t in_size, char **out_data, size_t *out_size)
- void base64_decode (char const *in_data, size_t in_size, char **out_data, size_t *out_size)

13.16.7.1 Detailed Description

13.16.7.2 Function Documentation

13.16.7.2.1 base64_decode()

```
void base64_decode (
            char const * in_data,
            size_t in_size,
            char ** out_data,
            size_t * out_size)
```

decode base-64-encoded string *in_data*.
References L4_CV, and L4_END_DECLS.

13.16.7.2.2 base64_encode()

```
void base64_encode (
            char const * in_data,
            size_t in_size,
            char ** out_data,
            size_t * out_size)
```

base-64-encode string *in_data*.
References L4_CV.

13.16.8 Bit Manipulation

Collaboration diagram for Bit Manipulation:



Files

- file bitops_arch.h

  amd64 bit manipulation functions
- file bitops.h

  bit manipulation functions
- file bitops_arch.h

  x86 bit manipulation functions

Functions

- void l4util_set_bit (int b, volatile l4_umword_t *dest)

  Set bit in memory.
- void l4util_clear_bit (int b, volatile l4_umword_t *dest)

  Clear bit in memory.
- void l4util_complement_bit (int b, volatile l4_umword_t *dest)

  Complement bit in memory.
- int l4util_test_bit (int b, const volatile l4_umword_t *dest)

  Test bit (return value of bit).
- int l4util_bts (int b, volatile l4_umword_t *dest)

  Bit test and set.
- int l4util_btr (int b, volatile l4_umword_t *dest)

  Bit test and reset.
- int l4util_btc (int b, volatile l4_umword_t *dest)

  Bit test and complement.
- int l4util_bsr (l4_umword_t word)

  Bit scan reverse.
- int l4util_bsf (l4_umword_t word)

  Bit scan forward.
- int l4util_find_first_set_bit (const void *dest, l4_size_t size)

  Find the first set bit in a memory region.
- int l4util_find_first_zero_bit (const void *dest, l4_size_t size)

  Find the first zero bit in a memory region.
- unsigned long l4util_next_power2 (unsigned long val)

  Find the next power of 2 for a given number.

13.16.8.1 Detailed Description

13.16.8.2 Function Documentation

13.16.8.2.1 l4util_bsf()

```
int l4util_bsf (
            l4_umword_t word)  [inline]
```

Bit scan forward.

Parameters

word	value (machine size)

Returns

index of least significant bit set in word, -1 if no bit is set (word == 0)

"bit scan forward", find least significant bit set in word.
Definition at line 316 of file bitops.h.

13.16.8.2.2 l4util_bsr()

```
int l4util_bsr (
            l4_umword_t word)  [inline]
```

Bit scan reverse.

Parameters

word	value (machine size)

Returns

index of most significant set bit in word, -1 if no bit is set (word == 0)

"bit scan reverse", find most significant set bit in word (-> LOG2(word))
Definition at line 299 of file bitops.h.

13.16.8.2.3 l4util_btc()

```
int l4util_btc (
            int b,
            volatile l4_umword_t * dest)  [inline]
```

Bit test and complement.

Parameters

b	bit position
dest	destination operand

Returns

Old value of bit *b*.

Complement bit *b* and return old value.
Definition at line 394 of file bitops.h.

13.16.8.2.4 l4util_btr()

```
int l4util_btr (
            int b,
            volatile l4_umword_t * dest)  [inline]
```

Bit test and reset.

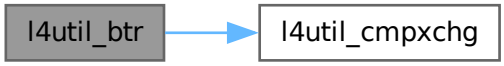
Parameters

b	bit position
dest	destination operand

Returns

Old value of bit *b*.

Reset bit *b* and return old value.
Definition at line 278 of file bitops.h.
References l4util_cmpxchg().
Here is the call graph for this function:



13.16.8.2.5 l4util_bts()

```
int l4util_bts (
            int b,
            volatile l4_umword_t * dest)  [inline]
```

Bit test and set.

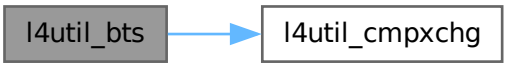
Parameters

b	bit position
dest	destination operand

Returns

Old value of bit *b*.

Set the *b* bit of *dest* to 1 and return the old value.
Definition at line 256 of file bitops.h.
References l4util_cmpxchg().
Here is the call graph for this function:



13.16.8.2.6 l4util_clear_bit()

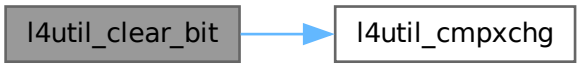
```
void l4util_clear_bit (
            int b,
            volatile l4_umword_t * dest)  [inline]
```

Clear bit in memory.

Parameters

b	bit position
dest	destination operand

Definition at line 226 of file bitops.h.
References l4util_cmpxchg().
Here is the call graph for this function:



13.16.8.2.7 l4util_complement_bit()

```
void l4util_complement_bit (
            int b,
            volatile l4_umword_t * dest)  [inline]
```

Complement bit in memory.

Parameters

b	bit position
dest	destination operand

Definition at line 359 of file bitops.h.

13.16.8.2.8 l4util_find_first_set_bit()

```
int l4util_find_first_set_bit (
            const void * dest,
            l4_size_t size)  [inline]
```

Find the first set bit in a memory region.

Parameters

dest	bit string
size	size of string in bits (must be a multiple of L4_MWORD_BITS!)

Returns

number of the first set bit, >= size if no bit is set

Definition at line 400 of file bitops.h.

13.16.8.2.9 l4util_find_first_zero_bit()

```
int l4util_find_first_zero_bit (
            const void * dest,
            l4_size_t size)  [inline]
```

Find the first zero bit in a memory region.

Parameters

dest	bit string
size	size of string in bits (must be a multiple of L4_MWORD_BITS!)

Returns

number of the first zero bit, >= size if no bit is set

Definition at line 333 of file bitops.h.

13.16.8.2.10 l4util_next_power2()

```
unsigned long l4util_next_power2 (
            unsigned long val)  [inline]
```

Find the next power of 2 for a given number.

Parameters

val	initial value

Returns

next-highest power of 2

Definition at line 373 of file bitops.h.

13.16.8.2.11 l4util_set_bit()

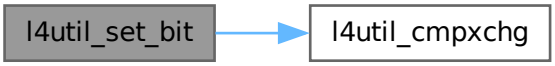
```
void l4util_set_bit (
             int b,
             volatile l4_umword_t * dest)  [inline]
```

Set bit in memory.

Parameters

b	bit position
dest	destination operand

Definition at line 207 of file bitops.h.
References l4util_cmpxchg().
Here is the call graph for this function:



13.16.8.2.12 l4util_test_bit()

```
int l4util_test_bit (
             int b,
             const volatile l4_umword_t * dest)  [inline]
```

Test bit (return value of bit).

Parameters

b	bit position
dest	destination operand

Returns

Value of bit *b*.

Definition at line 244 of file bitops.h.

13.16.9 ELF binary format

Functions and types related to ELF binaries.
Collaboration diagram for ELF binary format:



Files

- file elf.h

  ELF definition.

Data Structures

- struct Elf32_Ehdr

  ELF32 header.
- struct Elf64_Ehdr

  ELF64 header.
- struct Elf32_Shdr

  ELF32 section header.
- struct Elf64_Shdr

  ELF64 section header.
- struct Elf32_Phdr

  ELF32 program header.
- struct Elf64_Phdr

  ELF64 program header.
- struct Elf32_Dyn

  ELF32 dynamic entry.
- struct Elf64_Dyn

  ELF64 dynamic entry.
- struct Elf32_Rel

  ELF32 relocation entry w/o addend.
- struct Elf32_Rela

  ELF32 relocation entry w/ addend.
- struct Elf64_Rel

  ELF64 relocation entry w/o addend.
- struct Elf64_Rela

  ELF64 relocation entry w/ addend.
- struct Elf32_Sym

  ELF32 symbol table entry.
- struct Elf64_Sym

ELF64 symbol table entry.

- struct Elf32_Auxv

  Auxiliary vector (32-bit).

- struct Elf64_Auxv

  Auxiliary vector (64-bit).

Macros

- #define **ElfW**(type)

  Use 64 or 32 bits types depending on the target architecture.

- #define **ELF32_R_SYM**(i)

  Symbol table index.

- #define ELF32_R_TYPE(i)
- #define **ELF32_R_INFO**(s, t)

  Create info from symbol table index + type.

- #define **ELF64_R_SYM**(i)

  Symbol table index.

- #define ELF64_R_TYPE(i)
- #define **ELF64_R_INFO**(s, t)

  Create info from symbol table index + type.

- #define ELF32_ST_BIND(i)
- #define ELF32_ST_TYPE(i)
- #define **ELF32_ST_INFO**(b, t)

  Make info from bind + type.

- #define ELF64_ST_BIND(i)
- #define ELF64_ST_TYPE(i)
- #define **ELF64_ST_INFO**(b, t)

  Make info from bind + type.

Typedefs

- typedef struct Elf32_Auxv **Elf32_Auxv**

  Auxiliary vector (32-bit).

- typedef struct Elf64_Auxv **Elf64_Auxv**

  Auxiliary vector (64-bit).

Enumerations

- enum { EI_NIDENT = 16 }
- enum Elf_ETs {
  ET_NONE = 0 , ET_REL = 1 , ET_EXEC = 2 , ET_DYN = 3 ,
  ET_CORE = 4 , ET_LOPROC = 0xff00 , ET_HIPROC = 0xffff }

  Object file type.

- enum Elf_EMs {
  EM_NONE = 0 , EM_M32 = 1 , EM_SPARC = 2 , EM_386 = 3 ,
  EM_68K = 4 , EM_88K = 5 , EM_860 = 7 , EM_MIPS = 8 ,
  EM_MIPS_RS4_BE = 10 , EM_SPARC64 = 11 , EM_PARISC = 15 , EM_VPP500 = 17 ,
  EM_SPARC32PLUS = 18 , EM_960 = 19 , EM_PPC = 20 , EM_V800 = 36 ,
  EM_FR20 = 37 , EM_RH32 = 38 , EM_RCE = 39 , EM_ARM = 40 ,
  EM_ALPHA = 41 , EM_SH = 42 , EM_SPARCV9 = 43 , EM_TRICORE = 44 ,
  EM_ARC = 45 , EM_H8_300 = 46 , EM_H8_300H = 47 , EM_H8S = 48 ,
  EM_H8_500 = 49 , EM_IA_64 = 50 , EM_MIPS_X = 51 , EM_COLDFIRE = 52 ,
  EM_68HC12 = 53 , EM_X86_64 = 62 , EM_PDSP = 63 , EM_FX66 = 66 ,
  EM_ST9PLUS = 67 , EM_ST7 = 68 , EM_68HC16 = 69 , EM_68HC11 = 70 ,
  EM_68HC08 = 71 , EM_68HC05 = 72 , EM_SVX = 73 , EM_ST19 = 74 ,

EM_VAX = 75 , EM_CRIS = 76 , EM_JAVELIN = 77 , EM_FIREPATH = 78 ,
EM_ZSP = 79 , EM_MMIX = 80 , EM_HUANY = 81 , EM_PRISM = 82 ,
EM_AVR = 83 , EM_FR30 = 84 , EM_D10V = 85 , EM_D30V = 86 ,
EM_V850 = 87 , EM_M32R = 88 , EM_MN10300 = 89 , EM_MN10200 = 90 ,
EM_PJ = 91 , EM_OPENRISC = 92 , EM_ARC_A5 = 93 , EM_XTENSA = 94 ,
EM_ALTERA_NIOS2 = 113 , EM_AARCH64 = 183 , EM_TILEPRO = 188 , EM_MICROBLAZE = 189 ,
EM_TILEGX = 191 , EM_RISCV = 243 , **EM_NUM** = 244 }

Required architecture.

- enum Elf_EVs { EV_NONE = 0 , EV_CURRENT = 1 }

  Object file version.

- enum Elf_EIs {
  EI_MAG0 = 0 , EI_MAG1 = 1 , EI_MAG2 = 2 , EI_MAG3 = 3 ,
  EI_CLASS = 4 , EI_DATA = 5 , EI_VERSION = 6 , EI_OSABI = 7 ,
  EI_ABIVERSION = 8 , EI_PAD = 9 }

  Identification Indices.

- enum Elf_MAGs { ELFMAG0 = 0x7f , ELFMAG1 = 'E' , ELFMAG2 = 'L' , ELFMAG3 = 'F' }

  Magic number.

- enum Elf_ClASSs { ELFCLASSNONE = 0 , ELFCLASS32 = 1 , ELFCLASS64 = 2 , ELFCLASSNUM = 3 }

  File class or capacity.

- enum Elf_DATAs { ELFDATANONE = 0 , ELFDATA2LSB = 1 , ELFDATA2MSB = 2 , ELFDATANUM = 3 }

  Data encoding.

- enum Elf_OSABIs {
  ELFOSABI_NONE = 0 , ELFOSABI_SYSV = 0 , ELFOSABI_HPUX = 1 , ELFOSABI_NETBSD = 2 ,
  ELFOSABI_LINUX = 3 , ELFOSABI_SOLARIS = 6 , ELFOSABI_AIX = 7 , ELFOSABI_IRIX = 8 ,
  ELFOSABI_FREEBSD = 9 , ELFOSABI_TRU64 = 10 , ELFOSABI_MODESTO = 11 , ELFOSABI_OPENBSD
  = 12 ,
  ELFOSABI_ARM = 97 , ELFOSABI_STANDALONE = 255 }

  Identify operating system and ABI to which the object is targeted.

- enum Elf_SHNs {
  SHN_UNDEF = 0 , SHN_LORESERVE = 0xff00 , SHN_LOPROC = 0xff00 , SHN_HIPROC = 0xff1f ,
  SHN_ABS = 0xfff1 , SHN_COMMON = 0xfff2 , SHN_HIRESERVE = 0xffff }

  Special section indexes.

- enum Elf_SHTs {
  SHT_NULL = 0 , SHT_PROGBITS = 1 , SHT_SYMTAB = 2 , SHT_STRTAB = 3 ,
  SHT_RELA = 4 , SHT_HASH = 5 , SHT_DYNAMIC = 6 , SHT_NOTE = 7 ,
  SHT_NOBITS = 8 , SHT_REL = 9 , SHT_SHLIB = 10 , SHT_DYNSYM = 11 ,
  SHT_INIT_ARRAY = 14 , SHT_FINI_ARRAY = 15 , SHT_PREINIT_ARRAY = 16 , SHT_GROUP = 17 ,
  SHT_SYMTAB_SHNDX = 18 , SHT_NUM = 19 , SHT_LOOS = 0x60000000 , SHT_HIOS = 0x6fffffff ,
  SHT_LOPROC = 0x70000000 , SHT_HIPROC = 0x7fffffff , SHT_LOUSER = 0x80000000 , SHT_HIUSER =
  0xffffffff }

  Section type.

- enum Elf_SHFs {
  SHF_WRITE = 0x1 , SHF_ALLOC = 0x2 , SHF_EXECINSTR = 0x4 , SHF_MERGE = 0x10 ,
  SHF_STRINGS = 0x20 , SHF_INFO_LINK = 0x40 , SHF_LINK_ORDER = 0x80 , SHF_OS_NONCONFORMING
  = 0x100 ,
  SHF_GROUP = 0x200 , SHF_TLS = 0x400 , SHF_MASKOS = 0x0ff00000 , SHF_MASKPROC = 0xf0000000
  }

  Section attribute flags.

- enum Elf_PTs {
  PT_NULL = 0 , PT_LOAD = 1 , PT_DYNAMIC = 2 , PT_INTERP = 3 ,
  PT_NOTE = 4 , PT_SHLIB = 5 , PT_PHDR = 6 , PT_TLS = 7 ,
  PT_NUM = 8 , PT_LOOS = 0x60000000 , PT_HIOS = 0x6fffffff , PT_LOPROC = 0x70000000 ,
  PT_HIPROC = 0x7fffffff , PT_GNU_EH_FRAME = PT_LOOS + 0x474e550 , PT_GNU_STACK = PT_LOOS
  + 0x474e551 , PT_GNU_RELRO = PT_LOOS + 0x474e552 ,
  PT_L4_STACK = PT_LOOS + 0x12 , PT_L4_AUX = PT_LOOS + 0x14 }

Segment types.

- enum ELF_PFs {
  PF_X = 0x1 , PF_W = 0x2 , PF_R = 0x4 , PF_MASKOS = 0x0ff00000 ,
  PF_MASKPROC = 0x7fffffff }

  Segment permissions.
- enum Elf_NTs_core {
  NT_PRSTATUS = 1 , NT_FPREGSET = 2 , NT_PRPSINFO = 3 , NT_PRXREG = 4 ,
  NT_TASKSTRUCT = 4 , NT_PLATFORM = 5 , NT_AUXV = 6 , NT_GWINDOWS = 7 ,
  NT_ASRS = 8 , NT_PSTATUS = 10 , NT_PSINFO = 13 , NT_PRCRED = 14 ,
  NT_UTSNAME = 15 , NT_LWPSTATUS = 16 , NT_LWPSINFO = 17 , NT_PRFPXREG = 20 }

  Legal values for note segment descriptor types for core files.
- enum Elf_NTs_obj { NT_VERSION = 1 }

  Legal values for the note segment descriptor types for object files.
- enum Elf_DTs {
  DT_NULL = 0 , DT_NEEDED = 1 , DT_PLTRELSZ = 2 , DT_PLTGOT = 3 ,
  DT_HASH = 4 , DT_STRTAB = 5 , DT_SYMTAB = 6 , DT_RELA = 7 ,
  DT_RELASZ = 8 , DT_RELAENT = 9 , DT_STRSZ = 10 , DT_SYMENT = 11 ,
  DT_INIT = 12 , DT_FINI = 13 , DT_SONAME = 14 , DT_RPATH = 15 ,
  DT_SYMBOLIC = 16 , DT_REL = 17 , DT_RELSZ = 18 , DT_RELENT = 19 ,
  DT_PTRREL = 20 , DT_DEBUG = 21 , DT_TEXTREL = 22 , DT_JMPREL = 23 ,
  DT_BIND_NOW = 24 , DT_INIT_ARRAY = 25 , DT_FINI_ARRAY = 26 , DT_INIT_ARRAYSZ = 27 ,
  DT_FINI_ARRAYSZ = 28 , DT_RUNPATH = 29 , DT_FLAGS = 30 , DT_ENCODING = 32 ,
  DT_PREINIT_ARRAY = 32 , DT_PREINIT_ARRAYSZ = 33 , DT_NUM = 34 , DT_LOOS = 0x6000000d ,
  DT_HIOS = 0x6ffff000 , DT_LOPROC = 0x70000000 , DT_HIPROC = 0x7fffffff }

  Dynamic Array Tags.
- enum Elf_DFs {
  DF_ORIGIN = 0x00000001 , DF_SYMBOLIC = 0x00000002 , DF_TEXTREL = 0x00000004 ,
  DF_BIND_NOW = 0x00000008 ,
  DF_STATIC_TLS = 0x00000010 }

  Values of Elf32_Dyn.d_un.d_val, Elf64_Dyn.d_un.d_val in the DT_FLAGS entry.
- enum Elf_DF_1s {
  DF_1_NOW = 0x00000001 , DF_1_GLOBAL = 0x00000002 , DF_1_GROUP = 0x00000004 ,
  DF_1_NODELETE = 0x00000008 ,
  DF_1_LOADFLTR = 0x00000010 , DF_1_INITFIRST = 0x00000020 , DF_1_NOOPEN = 0x00000040 ,
  DF_1_ORIGIN = 0x00000080 ,
  DF_1_DIRECT = 0x00000100 , **DF_1_TRANS** = 0x00000200 , DF_1_INTERPOSE = 0x00000400 ,
  DF_1_NODEFLIB = 0x00000800 ,
  DF_1_NODUMP = 0x00001000 , DF_1_CONFALT = 0x00002000 , DF_1_ENDFILTEE = 0x00004000 ,
  DF_1_DISPRELDNE = 0x00008000 ,
  DF_1_DISPRELPND = 0x00010000 }

  State flags selectable in the Elf32_Dyn.d_un.d_val / Elf64_Dyn.d_un.d_val element of the DT_FLAGS_1 entry in the dynamic section.
- enum Elf_DTF_1s

  Flags for the feature selection in DT_FEATURE_1.
- enum Elf_DF_P1s { DF_P1_LAZYLOAD = 0x00000001 , DF_P1_GROUPPERM = 0x00000002 }

  Flags in the DT_POSFLAG_1 entry effecting only the next DT_∗ entry.
- enum Elf_R_386_s {
  R_386_NONE = 0 , R_386_32 = 1 , R_386_PC32 = 2 , R_386_GOT32 = 3 ,
  R_386_PLT32 = 4 , R_386_COPY = 5 , R_386_GLOB_DAT = 6 , R_386_JMP_SLOT = 7 ,
  R_386_RELATIVE = 8 , R_386_GOTOFF = 9 , R_386_GOTPC = 10 , **R_386_32PLT** = 11 ,
  R_386_TLS_TPOFF = 14 , R_386_TLS_IE = 15 , R_386_TLS_GOTIE = 16 , R_386_TLS_LE = 17 ,
  R_386_TLS_GD = 18 , R_386_TLS_LDM = 19 , **R_386_16** = 20 , **R_386_PC16** = 21 ,
  R_386_8 = 22 , **R_386_PC8** = 23 , R_386_TLS_GD_32 = 24 , R_386_TLS_GD_PUSH = 25 ,
  R_386_TLS_GD_CALL = 26 , R_386_TLS_GD_POP = 27 , R_386_TLS_LDM_32 = 28 , R_386_TLS_LDM_PUSH
  = 29 ,
  R_386_TLS_LDM_CALL = 30 , R_386_TLS_LDM_POP = 31 , R_386_TLS_LDO_32 = 32 , R_386_TLS_IE_32

= 33 ,
R_386_TLS_LE_32 = 34 , R_386_TLS_DTPMOD32 = 35 , R_386_TLS_DTPOFF32 = 36 , R_386_TLS_TPOFF32 = 37 ,
R_386_NUM = 38 }

Relocation types (processor specific).

- enum Elf_EF_ARM_s { }

  ARM specific declarations.
- enum Elf_STT_ARM_s

  Additional symbol types for Thumb.
- enum Elf_SHF_s_ARM { SHF_ARM_ENTRYSECT = 0x10000000 , SHF_ARM_COMDEF = 0x80000000 }

  ARM-specific values for Elf32_Shdr.sh_flags / Elf64_Shdr.sh_flags.
- enum Elf_ARM_SBs { PF_ARM_SB = 0x10000000 }

  ARM-specific program header flags.
- enum Elf_R_ARM_s {
  R_ARM_NONE = 0 , R_ARM_PC24 = 1 , R_ARM_ABS32 = 2 , R_ARM_REL32 = 3 ,
  R_ARM_PC13 = 4 , R_ARM_ABS16 = 5 , R_ARM_ABS12 = 6 , **R_ARM_THM_ABS5** = 7 ,
  R_ARM_ABS8 = 8 , **R_ARM_SBREL32** = 9 , **R_ARM_THM_PC22** = 10 , **R_ARM_THM_PC8** = 11 ,
  R_ARM_AMP_VCALL9 = 12 , **R_ARM_SWI24** = 13 , **R_ARM_THM_SWI8** = 14 , **R_ARM_XPC25** = 15 ,
  R_ARM_THM_XPC22 = 16 , R_ARM_COPY = 20 , R_ARM_GLOB_DAT = 21 , R_ARM_JUMP_SLOT = 22 ,
  R_ARM_RELATIVE = 23 , R_ARM_GOTOFF = 24 , R_ARM_GOTPC = 25 , R_ARM_GOT32 = 26 ,
  R_ARM_PLT32 = 27 , **R_ARM_ALU_PCREL_7_0** = 32 , **R_ARM_ALU_PCREL_15_8** = 33 , **R_ARM_↩ ALU_PCREL_23_15** = 34 ,
  R_ARM_LDR_SBREL_11_0 = 35 , **R_ARM_ALU_SBREL_19_12** = 36 , **R_ARM_ALU_SBREL_27_20** = 37 , **R_ARM_GNU_VTENTRY** = 100 ,
  R_ARM_GNU_VTINHERIT = 101 , R_ARM_THM_PC11 = 102 , R_ARM_THM_PC9 = 103 , **R_ARM_↩ RXPC25** = 249 ,
  R_ARM_RSBREL32 = 250 , **R_ARM_THM_RPC22** = 251 , **R_ARM_RREL32** = 252 , **R_ARM_RABS22** = 253 ,
  R_ARM_RPC24 = 254 , **R_ARM_RBASE** = 255 , R_ARM_NUM = 256 }

  ARM relocations.
- enum Elf_R_AARCH64_s { R_AARCH64_NONE = 0 , **R_AARCH64_RELATIVE** = 1027 }

  AARCH64 relocations.
- enum Elf_R_X86_64_s {
  R_X86_64_NONE = 0 , R_X86_64_64 = 1 , R_X86_64_PC32 = 2 , R_X86_64_GOT32 = 3 ,
  R_X86_64_PLT32 = 4 , R_X86_64_COPY = 5 , R_X86_64_GLOB_DAT = 6 , R_X86_64_JUMP_SLOT = 7 ,
  R_X86_64_RELATIVE = 8 , R_X86_64_GOTPCREL = 9 , R_X86_64_32 = 10 , R_X86_64_32S = 11 ,
  R_X86_64_16 = 12 , R_X86_64_PC16 = 13 , R_X86_64_8 = 14 , R_X86_64_PC8 = 15 ,
  R_X86_64_DTPMOD64 = 16 , R_X86_64_DTPOFF64 = 17 , R_X86_64_TPOFF64 = 18 , R_X86_64_TLSGD = 19 ,
  R_X86_64_TLSLD = 20 , R_X86_64_DTPOFF32 = 21 , R_X86_64_GOTTPOFF = 22 , R_X86_64_TPOFF32 = 23 ,
  R_X86_64_NUM = 24 }

  AMD x86-64 relocations.
- enum Elf_STNs

  Symbol Table Entry.
- enum Elf_STBs {
  STB_LOCAL = 0 , STB_GLOBAL = 1 , STB_WEAK = 2 , STB_LOOS = 10 ,
  STB_HIOS = 12 , STB_LOPROC = 13 , STB_HIPROC = 15 }

  Symbol Binding.
- enum Elf_STTs {
  STT_NOTYPE = 0 , STT_OBJECT = 1 , STT_FUNC = 2 , STT_SECTION = 3 ,
  STT_FILE = 4 , STT_LOOS = 10 , STT_HIOS = 12 , STT_LOPROC = 13 ,
  STT_HIPROC = 15 }

  Symbol Types.

- enum Elf_ATs {
  AT_NULL = 0 , AT_IGNORE = 1 , AT_EXECFD = 2 , AT_PHDR = 3 ,
  AT_PHENT = 4 , AT_PHNUM = 5 , AT_PAGESZ = 6 , AT_BASE = 7 ,
  AT_FLAGS = 8 , AT_ENTRY = 9 , AT_NOTELF = 10 , AT_UID = 11 ,
  AT_EUID = 12 , AT_GID = 13 , AT_EGID = 14 , AT_L4_AUX = 0xf0 ,
  AT_L4_ENV = 0xf1 , AT_L4_KIP = 0xf2 }

  Legal values for Elf32_Auxv.atype / Elf64_Auxv.atype.

ELF types

- typedef l4_uint32_t **Elf32_Addr**

  size 4 align 4
- typedef l4_uint32_t **Elf32_Off**

  size 4 align 4
- typedef l4_uint16_t **Elf32_Half**

  size 2 align 2
- typedef l4_uint32_t **Elf32_Word**

  size 4 align 4
- typedef l4_int32_t **Elf32_Sword**

  size 4 align 4
- typedef l4_uint64_t **Elf64_Addr**

  size 8 align 8
- typedef l4_uint64_t **Elf64_Off**

  size 8 align 8
- typedef l4_uint16_t **Elf64_Half**

  size 2 align 2
- typedef l4_uint32_t **Elf64_Word**

  size 4 align 4
- typedef l4_int32_t **Elf64_Sword**

  size 4 align 4
- typedef l4_uint64_t **Elf64_Xword**

  size 8 align 8
- typedef l4_int64_t **Elf64_Sxword**

  size 8 align 8

13.16.9.1 Detailed Description

Functions and types related to ELF binaries.

13.16.9.2 Macro Definition Documentation

13.16.9.2.1 ELF32_R_TYPE

```
#define ELF32_R_TYPE(
              i)
```

Value:

```
((unsigned char)(i))
```

See also

Elf_R_386s.

Definition at line 663 of file elf.h.

13.16.9.2.2 ELF32_ST_BIND

```
#define ELF32_ST_BIND(
              i)
```

Value:

```
((i)»4)
```

See also

Elf_STBs.

Definition at line 893 of file elf.h.

13.16.9.2.3 ELF32_ST_TYPE

```
#define ELF32_ST_TYPE(
              i)
```

Value:

```
((i)&0xf)
```

See also

Elf_STTs.

Definition at line 896 of file elf.h.

13.16.9.2.4 ELF64_R_TYPE

```
#define ELF64_R_TYPE(
              i)
```

Value:

```
((i)&0xffffffffL)
```

See also

Elf_R_386s.

Definition at line 671 of file elf.h.

13.16.9.2.5 ELF64_ST_BIND

```
#define ELF64_ST_BIND(
              i)
```

Value:

```
((i)»4)
```

See also

Elf_STBs

Definition at line 902 of file elf.h.

13.16.9.2.6 ELF64_ST_TYPE

```
#define ELF64_ST_TYPE(
              i)
```

Value:

```
((i)&0xf)
```

See also

Elf_STTs

Definition at line 905 of file elf.h.

13.16.9.3 Enumeration Type Documentation

13.16.9.3.1 anonymous enum

```
anonymous enum
```

Enumerator

EI_NIDENT	Number of characters.

Definition at line 117 of file elf.h.

13.16.9.3.2 Elf_ARM_SBs

```
enum Elf_ARM_SBs
```

ARM-specific program header flags.

Enumerator

PF_ARM_SB	Segment contains the location addressed by the static base.

Definition at line 770 of file elf.h.

13.16.9.3.3 Elf_ATs

```
enum Elf_ATs
```

Legal values for Elf32_Auxv.atype / Elf64_Auxv.atype.

Enumerator

AT_NULL	End of vector.
AT_IGNORE	Entry should be ignored.
AT_EXECFD	File descriptor of program.
AT_PHDR	Program headers for program.
AT_PHENT	Size of program header entry.
AT_PHNUM	Number of program headers.
AT_PAGESZ	System page size.
AT_BASE	Base address of interpreter.
AT_FLAGS	Flags.
AT_ENTRY	Entry point of program.
AT_NOTELF	Program is not ELF.
AT_UID	Real UID.
AT_EUID	Effective UID.
AT_GID	Real GID.
AT_EGID	Effective GID.
AT_L4_AUX	L4Re AUX section.
AT_L4_ENV	L4Re ENV section.
AT_L4_KIP	L4Re KIP section.

Definition at line 939 of file elf.h.

13.16.9.3.4 Elf_ClASSs

enum Elf_ClASSs
File class or capacity.

Enumerator

ELFCLASSNONE	Invalid class.
ELFCLASS32	32-bit object
ELFCLASS64	64-bit object
ELFCLASSNUM	Mask for 32-bit or 64-bit class.

Definition at line 298 of file elf.h.

13.16.9.3.5 Elf_DATAs

enum Elf_DATAs
Data encoding.

Enumerator

ELFDATANONE	invalid data encoding
ELFDATA2LSB	0x01020304 => [0x04|0x03|0x02|0x01]
ELFDATA2MSB	0x01020304 => [0x01|0x02|0x03|0x04]
ELFDATANUM	Mask for valid data encoding.

Definition at line 307 of file elf.h.

13.16.9.3.6 Elf_DF_1s

enum Elf_DF_1s
State flags selectable in the Elf32_Dyn.d_un.d_val / Elf64_Dyn.d_un.d_val element of the DT_FLAGS_1 entry in the dynamic section.

Enumerator

DF_1_NOW	Set RTLD_NOW for this object.
DF_1_GLOBAL	Set RTLD_GLOBAL for this object.
DF_1_GROUP	Set RTLD_GROUP for this object.
DF_1_NODELETE	Set RTLD_NODELETE for this object.
DF_1_LOADFLTR	Trigger filtee loading at runtime.
DF_1_INITFIRST	Set RTLD_INITFIRST for this object.
DF_1_NOOPEN	Set RTLD_NOOPEN for this object.
DF_1_ORIGIN	$ORIGIN must be handled.
DF_1_DIRECT	Direct binding enabled.
DF_1_INTERPOSE	Object is used to interpose.
DF_1_NODEFLIB	Ignore default lib search path.
DF_1_NODUMP	Object can't be dldump'ed.
DF_1_CONFALT	Configuration alternative created.

DF_1_ENDFILTEE	Filtee terminates filters search.
DF_1_DISPRELDNE	Disp reloc applied at build time.
DF_1_DISPRELPND	Disp reloc applied at run-time.

Definition at line 594 of file elf.h.

13.16.9.3.7 Elf_DF_P1s

`enum Elf_DF_P1s`
Flags in the DT_POSFLAG_1 entry effecting only the next DT_∗ entry.

Enumerator

DF_P1_LAZYLOAD	Lazyload following object.
DF_P1_GROUPPERM	Symbols from next object are not generally available.

Definition at line 623 of file elf.h.

13.16.9.3.8 Elf_DFs

`enum Elf_DFs`
Values of Elf32_Dyn.d_un.d_val, Elf64_Dyn.d_un.d_val in the DT_FLAGS entry.

Enumerator

DF_ORIGIN	Object may use DF_ORIGIN.
DF_SYMBOLIC	Symbol resolutions starts here.
DF_TEXTREL	Object contains text relocations.
DF_BIND_NOW	No lazy binding for this object.
DF_STATIC_TLS	Module uses the static TLS model.

Definition at line 581 of file elf.h.

13.16.9.3.9 Elf_DTs

`enum Elf_DTs`
Dynamic Array Tags.

See also

Elf32_Dyn.d_tag, Elf64_Dyn.d_tag.

Enumerator

DT_NULL	end of _DYNAMIC array
DT_NEEDED	name of a needed library
DT_PLTRELSZ	total size of relocation entry
DT_PLTGOT	address assoc with prog link table
DT_HASH	address of symbol hash table
DT_STRTAB	address of string table
DT_SYMTAB	address of symbol table

DT_RELA	address of relocation table
DT_RELASZ	total size of relocation table
DT_RELAENT	size of DT_RELA relocation entry
DT_STRSZ	size of the string table
DT_SYMENT	size of a symbol table entry
DT_INIT	address of initialization function
DT_FINI	address of termination function
DT_SONAME	name of the shared object
DT_RPATH	search library path
DT_SYMBOLIC	alter symbol resolution algorithm
DT_REL	address of relocation table
DT_RELSZ	total size of DT_REL relocation table
DT_RELENT	size of the DT_REL relocation entry
DT_PTRREL	type of relocation entry
DT_DEBUG	for debugging purposes
DT_TEXTREL	at least on entry changes r/o section
DT_JMPREL	address of relocation entries
DT_BIND_NOW	Process relocations of object.
DT_INIT_ARRAY	Array with addresses of init fct.
DT_FINI_ARRAY	Array with addresses of fini fct.
DT_INIT_ARRAYSZ	Size in bytes of DT_INIT_ARRAY.
DT_FINI_ARRAYSZ	Size in bytes of DT_FINI_ARRAY.
DT_RUNPATH	Library search path.
DT_FLAGS	Flags for the object being loaded.
DT_ENCODING	Start of encoded range.
DT_PREINIT_ARRAY	Array with addresses of preinit fct.
DT_PREINIT_ARRAYSZ	size in bytes of DT_PREINIT_ARRAY
DT_NUM	Number used.
DT_LOOS	Start of OS-specific.
DT_HIOS	End of OS-specific.
DT_LOPROC	processor-specific
DT_HIPROC	processor-specific

Definition at line 535 of file elf.h.

13.16.9.3.10 Elf_EF_ARM_s

`enum Elf_EF_ARM_s`

ARM specific declarations.
Processor specific flags for the ELF header e_flags field.

Enumerator

EF_ARM_ALIGN8	8-bit structure alignment is in use

Definition at line 730 of file elf.h.

13.16.9.3.11 Elf_EIs

enum Elf_EIs
Identification Indices.

See also

Elf32_Ehdr.e_ident, Elf64_Ehdr.e_ident

Enumerator

EI_MAG0	file id 0
EI_MAG1	file id 1
EI_MAG2	file id 2
EI_MAG3	file id 3
EI_CLASS	file class
EI_DATA	data encoding
EI_VERSION	file version
EI_OSABI	Operating system / ABI identification.
EI_ABIVERSION	ABI version.
EI_PAD	start of padding bytes

Definition at line 274 of file elf.h.

13.16.9.3.12 Elf_EMs

enum Elf_EMs
Required architecture.

See also

Elf32_Ehdr.e_machine, Elf64_Ehdr.e_machine

Enumerator

EM_NONE	no machine
EM_M32	AT&T WE 32100.
EM_SPARC	SPARC.
EM_386	Intel 80386.
EM_68K	Motorola 68000.
EM_88K	Motorola 88000.
EM_860	Intel 80860.
EM_MIPS	MIPS RS3000 big-endian.
EM_MIPS_RS4_BE	MIPS RS4000 big-endian.
EM_SPARC64	SPARC 64-bit.
EM_PARISC	HP PA-RISC.
EM_VPP500	Fujitsu VPP500.
EM_SPARC32PLUS	Sun's V8plus.
EM_960	Intel 80960.

EM_PPC	PowerPC.
EM_V800	NEC V800.
EM_FR20	Fujitsu FR20.
EM_RH32	TRW RH-32.
EM_RCE	Motorola RCE.
EM_ARM	Advanced RISC Machines ARM.
EM_ALPHA	Digital Alpha.
EM_SH	Hitachi SuperH.
EM_SPARCV9	SPARC v9 64-bit.
EM_TRICORE	Siemens Tricore embedded processor.
EM_ARC	Argonaut RISC Core, Argonaut Techn Inc.
EM_H8_300	Hitachi H8/300.
EM_H8_300H	Hitachi H8/300H.
EM_H8S	Hitachi H8/S.
EM_H8_500	Hitachi H8/500.
EM_IA_64	HP/Intel IA-64.
EM_MIPS_X	Stanford MIPS-X.
EM_COLDFIRE	Motorola Coldfire.
EM_68HC12	Motorola M68HC12.
EM_X86_64	Advanced Micro Devices x86-64.
EM_PDSP	Sony DSP Processor.
EM_FX66	Siemens FX66 microcontroller.
EM_ST9PLUS	STMicroelectronics ST9+ 8/16 mc.
EM_ST7	STmicroelectronics ST7 8 bit mc.
EM_68HC16	Motorola MC68HC16 microcontroller.
EM_68HC11	Motorola MC68HC11 microcontroller.
EM_68HC08	Motorola MC68HC08 microcontroller.
EM_68HC05	Motorola MC68HC05 microcontroller.
EM_SVX	Silicon Graphics SVx.
EM_ST19	STMicroelectronics ST19 8 bit mc.
EM_VAX	Digital VAX.
EM_CRIS	Axis Communications 32-bit embedded processor.
EM_JAVELIN	Infineon Technologies 32-bit embedded processor.
EM_FIREPATH	Element 14 64-bit DSP Processor.
EM_ZSP	LSI Logic 16-bit DSP Processor.
EM_MMIX	Donald Knuth's educational 64-bit processor.
EM_HUANY	Harvard University machine-independent object files.
EM_PRISM	SiTera Prism.
EM_AVR	Atmel AVR 8-bit microcontroller.
EM_FR30	Fujitsu FR30.
EM_D10V	Mitsubishi D10V.
EM_D30V	Mitsubishi D30V.

EM_V850	NEC v850.
EM_M32R	Mitsubishi M32R.
EM_MN10300	Matsushita MN10300.
EM_MN10200	Matsushita MN10200.
EM_PJ	picoJava
EM_OPENRISC	OpenRISC 32-bit embedded processor.
EM_ARC_A5	ARC Cores Tangent-A5.
EM_XTENSA	Tensilica Xtensa Architecture.
EM_ALTERA_NIOS2	Altera Nios II.
EM_AARCH64	ARM AARCH64.
EM_TILEPRO	Tilera TILEPro.
EM_MICROBLAZE	Xilinx MicroBlaze.
EM_TILEGX	Tilera TILE-Gx.
EM_RISCV	RISC-V.

Definition at line 183 of file elf.h.

13.16.9.3.13 Elf_ETs

`enum Elf_ETs`
Object file type.

See also

Elf32_Ehdr.e_type, Elf64_Ehdr.e_type

Enumerator

ET_NONE	no file type
ET_REL	relocatable file
ET_EXEC	executable file
ET_DYN	shared object file
ET_CORE	core file
ET_LOPROC	processor-specific
ET_HIPROC	processor-specific

Definition at line 168 of file elf.h.

13.16.9.3.14 Elf_EVs

`enum Elf_EVs`
Object file version.

See also

Elf32_Ehdr.e_version, Elf64_Ehdr.e_version

Enumerator

EV_NONE	Invalid version.
EV_CURRENT	Current version.

Definition at line 266 of file elf.h.

13.16.9.3.15 Elf_MAGs

`enum Elf_MAGs`
Magic number.

Enumerator

ELFMAG0	e_ident[EI_MAG0]
ELFMAG1	e_ident[EI_MAG1]
ELFMAG2	e_ident[EI_MAG2]
ELFMAG3	e_ident[EI_MAG3]

Definition at line 289 of file elf.h.

13.16.9.3.16 Elf_NTs_core

`enum Elf_NTs_core`
Legal values for note segment descriptor types for core files.

Enumerator

NT_PRSTATUS	Contains copy of prstatus struct.
NT_FPREGSET	Contains copy of fpregset struct.
NT_PRPSINFO	Contains copy of prpsinfo struct.
NT_PRXREG	Contains copy of prxregset struct.
NT_TASKSTRUCT	Contains copy of task structure.
NT_PLATFORM	String from sysinfo(SI_PLATFORM).
NT_AUXV	Contains copy of auxv array.
NT_GWINDOWS	Contains copy of gwindows struct.
NT_ASRS	Contains copy of asrset struct.
NT_PSTATUS	Contains copy of pstatus struct.
NT_PSINFO	Contains copy of psinfo struct.
NT_PRCRED	Contains copy of prcred struct.
NT_UTSNAME	Contains copy of utsname struct.
NT_LWPSTATUS	Contains copy of lwpstatus struct.
NT_LWPSINFO	Contains copy of lwpinfo struct.
NT_PRFPXREG	Contains copy of fprxregset struct.

Definition at line 486 of file elf.h.

13.16.9.3.17 Elf_NTs_obj

`enum Elf_NTs_obj`
Legal values for the note segment descriptor types for object files.

Enumerator

NT_VERSION	Contains a version string.

Definition at line 507 of file elf.h.

13.16.9.3.18 Elf_OSABIs

`enum Elf_OSABIs`
Identify operating system and ABI to which the object is targeted.

Enumerator

ELFOSABI_NONE	UNIX System V ABI.
ELFOSABI_SYSV	Alias.
ELFOSABI_HPUX	HP-UX.
ELFOSABI_NETBSD	NetBSD.
ELFOSABI_LINUX	Linux.
ELFOSABI_SOLARIS	Sun Solaris.
ELFOSABI_AIX	IBM AIX.
ELFOSABI_IRIX	SGI Irix.
ELFOSABI_FREEBSD	FreeBSD.
ELFOSABI_TRU64	Compaq TRU64 UNIX.
ELFOSABI_MODESTO	Novell Modesto.
ELFOSABI_OPENBSD	OpenBSD.
ELFOSABI_ARM	ARM.
ELFOSABI_STANDALONE	Standalone (embedded) application.

Definition at line 316 of file elf.h.

13.16.9.3.19 ELF_PFs

`enum ELF_PFs`
Segment permissions.

Enumerator

PF_X	Executable.
PF_W	Write.
PF_R	Read.
PF_MASKOS	OS-specific.
PF_MASKPROC	Processor-specific.

Definition at line 476 of file elf.h.

13.16.9.3.20 Elf_PTs

`enum Elf_PTs`

Segment types.

Enumerator

PT_NULL	array is unused
PT_LOAD	loadable
PT_DYNAMIC	dynamic linking information
PT_INTERP	path to interpreter
PT_NOTE	auxiliary information
PT_SHLIB	reserved
PT_PHDR	location of the pht itself
PT_TLS	Thread-local storage segment.
PT_NUM	Number of defined types.
PT_LOOS	OS-specific.
PT_HIOS	OS-specific.
PT_LOPROC	processor-specific
PT_HIPROC	processor-specific
PT_GNU_EH_FRAME	EH frame information.
PT_GNU_STACK	Flags for stack.
PT_GNU_RELRO	Read only after reloc.
PT_L4_STACK	Address of the stack.
PT_L4_AUX	Address of the AUX structures.

Definition at line 451 of file elf.h.

13.16.9.3.21 Elf_R_386_s

`enum Elf_R_386_s`

Relocation types (processor specific).

Enumerator

R_386_NONE	none
R_386_32	S + A.
R_386_PC32	S + A - P.
R_386_GOT32	G + A - P.
R_386_PLT32	L + A - P.
R_386_COPY	none
R_386_GLOB_DAT	S.
R_386_JMP_SLOT	S.
R_386_RELATIVE	B + A.
R_386_GOTOFF	S + A - GOT.
R_386_GOTPC	GOT + A - P.
R_386_TLS_TPOFF	Offset in static TLS block.
R_386_TLS_IE	Address of GOT entry for static TLS block offset.
R_386_TLS_GOTIE	GOT entry for static TLS block offset.

R_386_TLS_LE	Offset relative to static TLS block.
R_386_TLS_GD	Direct 32 bit for GNU version of general dynamic thread local data.
R_386_TLS_LDM	Direct 32 bit for GNU version of local dynamic thread local data in LE code.
R_386_TLS_GD_32	Direct 32 bit for general dynamic thread local data.
R_386_TLS_GD_PUSH	Tag for pushl in GD TLS code.
R_386_TLS_GD_CALL	Relocation for call to __tls_get_addr().
R_386_TLS_GD_POP	Tag for popl in GD TLS code.
R_386_TLS_LDM_32	Direct 32 bit for local dynamic thread local data in LE code.
R_386_TLS_LDM_PUSH	Tag for pushl in LDM TLS code.
R_386_TLS_LDM_CALL	Relocation for call to __tls_get_addr() in LDM code.
R_386_TLS_LDM_POP	Tag for popl in LDM TLS code.
R_386_TLS_LDO_32	Offset relative to TLS block.
R_386_TLS_IE_32	GOT entry for negated static TLS block offset.
R_386_TLS_LE_32	Negated offset relative to static TLS block.
R_386_TLS_DTPMOD32	ID of module containing symbol.
R_386_TLS_DTPOFF32	Offset in TLS block.
R_386_TLS_TPOFF32	Negated offset in static TLS block.
R_386_NUM	Keep this the last entry.

Definition at line 677 of file elf.h.

13.16.9.3.22 Elf_R_AARCH64_s

`enum Elf_R_AARCH64_s`
AARCH64 relocations.

Enumerator

R_AARCH64_NONE	No reloc.

Definition at line 825 of file elf.h.

13.16.9.3.23 Elf_R_ARM_s

`enum Elf_R_ARM_s`
ARM relocations.

Enumerator

R_ARM_NONE	No reloc.
R_ARM_PC24	PC relative 26 bit branch.
R_ARM_ABS32	Direct 32 bit.
R_ARM_REL32	PC relative 32 bit.
R_ARM_ABS16	Direct 16 bit.
R_ARM_ABS12	Direct 12 bit.
R_ARM_ABS8	Direct 8 bit.
R_ARM_COPY	Copy symbol at runtime.

R_ARM_GLOB_DAT	Create GOT entry.
R_ARM_JUMP_SLOT	Create PLT entry.
R_ARM_RELATIVE	Adjust by program base.
R_ARM_GOTOFF	32 bit offset to GOT
R_ARM_GOTPC	32 bit PC relative offset to GOT
R_ARM_GOT32	32 bit GOT entry
R_ARM_PLT32	32 bit PLT address
R_ARM_THM_PC11	thumb unconditional branch
R_ARM_THM_PC9	thumb conditional branch
R_ARM_NUM	Keep this the last entry.

Definition at line 777 of file elf.h.

13.16.9.3.24 Elf_R_X86_64_s

`enum Elf_R_X86_64_s`
AMD x86-64 relocations.

Enumerator

R_X86_64_NONE	No reloc.
R_X86_64_64	Direct 64 bit.
R_X86_64_PC32	PC relative 32 bit signed.
R_X86_64_GOT32	32 bit GOT entry
R_X86_64_PLT32	32 bit PLT address
R_X86_64_COPY	Copy symbol at runtime.
R_X86_64_GLOB_DAT	Create GOT entry.
R_X86_64_JUMP_SLOT	Create PLT entry.
R_X86_64_RELATIVE	Adjust by program base.
R_X86_64_GOTPCREL	32 bit signed PC relative offset to GOT
R_X86_64_32	Direct 32 bit zero extended.
R_X86_64_32S	Direct 32 bit sign extended.
R_X86_64_16	Direct 16 bit zero extended.
R_X86_64_PC16	16 bit sign extended pc relative
R_X86_64_8	Direct 8 bit sign extended.
R_X86_64_PC8	8 bit sign extended pc relative
R_X86_64_DTPMOD64	ID of module containing symbol.
R_X86_64_DTPOFF64	Offset in module's TLS block.
R_X86_64_TPOFF64	Offset in initial TLS block.
R_X86_64_TLSGD	32 bit signed PC relative offset to two GOT entries for GD symbol
R_X86_64_TLSLD	32 bit signed PC relative offset to two GOT entries for LD symbol
R_X86_64_DTPOFF32	Offset in TLS block.
R_X86_64_GOTTPOFF	32 bit signed PC relative offset to GOT entry for IE symbol
R_X86_64_TPOFF32	Offset in initial TLS block.

Definition at line 832 of file elf.h.

13.16.9.3.25 Elf_SHF_s_ARM

`enum Elf_SHF_s_ARM`
ARM-specific values for Elf32_Shdr.sh_flags / Elf64_Shdr.sh_flags.

Enumerator

SHF_ARM_ENTRYSECT	Section contains an entry point.
SHF_ARM_COMDEF	Section may be multiply defined in the input to a link step.

Definition at line 762 of file elf.h.

13.16.9.3.26 Elf_SHFs

`enum Elf_SHFs`
Section attribute flags.

Enumerator

SHF_WRITE	writeable during execution
SHF_ALLOC	section occupies virt memory
SHF_EXECINSTR	code section
SHF_MERGE	Might be merged.
SHF_STRINGS	Contains nul-terminated strings.
SHF_INFO_LINK	'sh_info' contains SHT index
SHF_LINK_ORDER	Preserve order after combining.
SHF_OS_NONCONFORMING	Non-standard OS-specific handling required.
SHF_GROUP	Section is member of a group.
SHF_TLS	Section hold thread-local data.
SHF_MASKOS	OS-specific.
SHF_MASKPROC	processor-specific mask

Definition at line 406 of file elf.h.

13.16.9.3.27 Elf_SHNs

`enum Elf_SHNs`
Special section indexes.

Enumerator

SHN_UNDEF	undefined section header entry
SHN_LORESERVE	lower bound of reserved indexes
SHN_LOPROC	lower bound of proc spec entr
SHN_HIPROC	upper bound of proc spec entr
SHN_ABS	absolute values for ref
SHN_COMMON	common symbols
SHN_HIRESERVE	upper bound of reserved indexes

Definition at line 335 of file elf.h.

13.16.9.3.28 Elf_SHTs

enum Elf_SHTs
Section type.

Enumerator

SHT_NULL	inactive section header
SHT_PROGBITS	information defined by program
SHT_SYMTAB	symbol table
SHT_STRTAB	string table
SHT_RELA	reloc entries w/ explicit addens
SHT_HASH	symbol hash table
SHT_DYNAMIC	information for dynamic linking
SHT_NOTE	information that marks the file
SHT_NOBITS	occupies no space in the file
SHT_REL	reloc entries w/o explicit addens
SHT_SHLIB	reserved + unspecified semantics
SHT_DYNSYM	symbol table (dynamic
SHT_INIT_ARRAY	Array of constructors.
SHT_FINI_ARRAY	Array of destructors.
SHT_PREINIT_ARRAY	Array of pre-constructors.
SHT_GROUP	Section group.
SHT_SYMTAB_SHNDX	Extended section indices.
SHT_NUM	Number of defined types.
SHT_LOOS	Start OS-specific.
SHT_HIOS	End OS-specific.
SHT_LOPROC	Start processor-specific.
SHT_HIPROC	End processor-specific.
SHT_LOUSER	Start application-specific.
SHT_HIUSER	End application-specific.

Definition at line 377 of file elf.h.

13.16.9.3.29 Elf_STBs

enum Elf_STBs
Symbol Binding.

See also

ELF32_ST_BIND, ELF64_ST_BIND

Enumerator

STB_LOCAL	not visible outside object file

STB_GLOBAL	visible to all objects being combined
STB_WEAK	resemble global symbols
STB_LOOS	OS-specific.
STB_HIOS	OS-specific.
STB_LOPROC	Processor-specific.
STB_HIPROC	Processor-specific.

Definition at line 912 of file elf.h.

13.16.9.3.30 Elf_STTs

`enum Elf_STTs`
Symbol Types.

See also

ELF32_ST_TYPE, ELF64_ST_TYPE

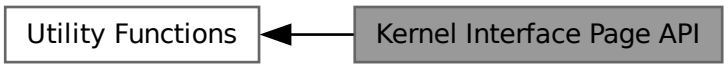
Enumerator

STT_NOTYPE	symbol's type not specified
STT_OBJECT	associated with a data object
STT_FUNC	associated with a function or other code
STT_SECTION	associated with a section
STT_FILE	source file name associated with object
STT_LOOS	OS-specific.
STT_HIOS	OS-specific.
STT_LOPROC	processor-specific
STT_HIPROC	processor-specific

Definition at line 925 of file elf.h.

13.16.10 Kernel Interface Page API

Collaboration diagram for Kernel Interface Page API:



Files

- file kip.h

Macros

- #define l4util_kip_for_each_feature(s)

Cycle through kernel features given in the KIP.

Functions

- L4_BEGIN_DECLS int l4util_kip_kernel_has_feature (l4_kernel_info_t const *k, char const *str)

  Check if kernel supports a feature.
- unsigned long l4util_kip_kernel_abi_version (l4_kernel_info_t const *k)

  Return kernel ABI version.

13.16.10.1 Detailed Description

13.16.10.2 Macro Definition Documentation

13.16.10.2.1 l4util_kip_for_each_feature

```
#define l4util_kip_for_each_feature(
            s)
```

Value:

```
l4_kip_for_each_feature(s)
```

Cycle through kernel features given in the KIP.
Cycles through all KIP kernel feature strings. s must be a character pointer (char const *) initialized with l4_kip_version_string().

Deprecated Use l4_kip_for_each_feature().

Definition at line 58 of file kip.h.

13.16.10.3 Function Documentation

13.16.10.3.1 l4util_kip_kernel_abi_version()

```
unsigned long l4util_kip_kernel_abi_version (
            l4_kernel_info_t const * k)
```

Return kernel ABI version.

Parameters

k	Pointer to the kernel info page (KIP).

Returns

Kernel ABI version.

References L4_CV, and L4_END_DECLS.

13.16.10.3.2 l4util_kip_kernel_has_feature()

```
L4_BEGIN_DECLS int l4util_kip_kernel_has_feature (
            l4_kernel_info_t const * k,
            char const * str)
```

Check if kernel supports a feature.

Parameters

k	Pointer to the kernel info page (KIP).
str	Feature name to check.

Returns

1 if the kernel supports the feature, 0 if not.

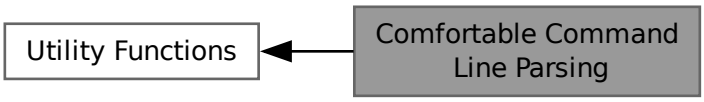
Checks the feature field in the KIP for the given string.

Deprecated Use l4_kip_kernel_has_feature().

References L4_CV.

13.16.11 Comfortable Command Line Parsing

Collaboration diagram for Comfortable Command Line Parsing:



Typedefs

- typedef void(∗ **parse_cmd_fn_t**) (int)
  Function type for PARSE_CMD_FN.
- typedef void(∗ **parse_cmd_fn_arg_t**) (int, const char ∗, int)
  Function type for PARSE_CMD_FN_ARG.

Enumerations

- enum parse_cmd_type
  Types for parsing.

Functions

- L4_BEGIN_DECLS int parse_cmdline (int ∗argc, const char ∗∗∗argv, int arg0,...)
  Parse the command-line for specified arguments and store the values into variables.

13.16.11.1 Detailed Description

13.16.11.2 Function Documentation

13.16.11.2.1 parse_cmdline()

```
L4_BEGIN_DECLS int parse_cmdline (
             int * argc,
             const char *** argv,
             int arg0,
              ...)
```

Parse the command-line for specified arguments and store the values into variables.
This Functions gets the command-line, and a list of command-descriptors. Then, the command-line is parsed according to the given descriptors, storing strings, switches and numeric arguments at given addresses, and possibly calling specified functions. A default help descriptor is added. Its purpose is to present a short command overview in the case the given command-line does not fit to the descriptors.
Each command-descriptor has the following form:
short option char, *long option name*, *comment*, *type*, *val*, *addr*.

The *short option char* specifies the short form of the described option. The short form will be recognized after a single dash, or in a group of short options preceeded by a single dash. Specify ' ' if no short form should be used.
The *long option name* specifies the long form of the described option. The long form will be recognized after two dashes. Specify 0 if no long form should be used for this option.
The *comment* is a string that will be used when presenting the short command-line help.
The *type* specifies, if the option should be recognized as

- a number (`PARSE_CMD_INT`),
- a switch (`PARSE_CMD_SWITCH`),
- a string (`PARSE_CMD_STRING`),
- a function call (`PARSE_CMD_FN`, `PARSE_CMD_FN_ARG`),
- an increment/decrement operator (`PARSE_CMD_INC`, `PARSE_CMD_DEC`).

If type is `PARSE_CMD_INT`, the option requires a second argument on the command-line after the option. This argument is parsed as a number. It can be preceeded by 0x to present a hex-value or by 0 to present an octal form. *addr* is interpreted as an int-pointer. The scanned argument from the command-line is stored in this pointer.
If *type* is `PARSE_CMD_SWITCH`, *addr* must be a pointer to int, and the value from *val* is stored at this pointer.
With `PARSE_CMD_STRING`, an additional argument is expected at the cmdline. *addr* must be a pointer to const char*, and a pointer to the argument on the command line is stored at this pointer. The value in *val* is a default value, which is stored at *addr* if the corresponding option is not given on the command line.
With `PARSE_CMD_FN_ARG`, *addr* is interpreted as a function pointer of type parse_cmd_fn_t. It will be called with *val* as argument if the corresponding option is found.
If *type* is `PARSE_CMD_FN_ARG`, *addr* is as a function pointer of type parse_cmd_fn_arg_t, and handled similar to `PARSE_CMD_FN`. An additional argument is expected at the command line, however. It is given to the called function as 2nd argument, and parsed as an integer as with `PARSE_CMD_INT` as a third argument.
If *type* is `PARSE_CMD_INC` or `PARSE_CMD_DEC`, *addr* is interpreted as an int-pointer. The value of *val* is stored to this pointer first. For every occurence of the option in the command line, the integer referenced by *addr* is incremented or decremented, respectively.
The list of command-descriptors is terminated by specifying a binary 0 for the short option char.
Note: The short option char 'h' and the long option name "help" must not be specified. They are used for the default help descriptor and produce a short command-options help when specified on the command-line.

Parameters

argc	pointer to number of command line parameters as passed to main
argv	pointer to array of command line parameters as passed to main
arg0	format list describing the command line options to parse for

Returns

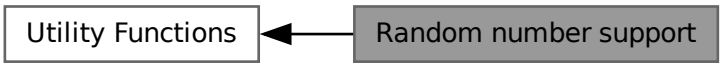
0 if the command-line was successfully parsed, otherwise:

- -1 if the given descriptors are somehow wrong.
- -2 if not enough memory was available to hold temporary structs.
- -3 if the given command-line args did not meet the specified set.
- -4 if the help-option was given.

Upon return, argc and argv point to a list of arguments that were not scanned as arguments. See `getoptlong` for details on scanning.
References L4_CV, and L4_END_DECLS.

13.16.12 Random number support

Collaboration diagram for Random number support:



Functions

- l4_uint32_t l4util_rand (void)

  Deliver next random number.
- void l4util_srand (l4_uint32_t seed)

  Initialize random number generator.

13.16.12.1 Detailed Description

13.16.12.2 Function Documentation

13.16.12.2.1 l4util_rand()

```
l4_uint32_t l4util_rand (
            void )
```

Deliver next random number.

Returns

A new random number

References L4_CV.

13.16.12.2.2 l4util_srand()

```
void l4util_srand (
            l4_uint32_t seed)
```

Initialize random number generator.

Parameters

seed	Value to initialize

References L4_END_DECLS.

13.16.13 Low-Level Thread Functions

Collaboration diagram for Low-Level Thread Functions:



13.17 Virtio Net Switch

A virtual network switch that can be used as defined in the virtio protocol.

Files

- file stats.h

  Client interface for port statistics.

Data Structures

- class Mac_addr

  A wrapper class around the value of a MAC address.
- class Mac_table< Size >

  Mac_table manages a 1:n association between ports and MAC addresses.
- class Switch_factory

  The IPC interface for creating ports.
- class L4virtio_port

  A Port on the Virtio Net Switch.
- class Net_transfer

  A network request to only a single destination.
- class Virtio_net_request

  Abstraction for a network request.
- class Virtio_switch

  The Virtio switch contains all ports and processes network requests.
- struct Buffer

  Data buffer used to transfer packets.
- class Virtio_vlan_mangle

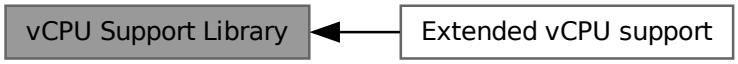
  Class for VLAN packet rewriting.

13.17.1 Detailed Description

A virtual network switch that can be used as defined in the virtio protocol.
The abstraction of a single connection with a network device (also called client) from the switch's perspective is a port. A client can register multiple ports on the switch. The communication between a client and the switch happens via IRQs, MMIO and shared memory as defined by the Virtio protocol. The switch supports VLANs and ports can be either 'access' or 'trunk' ports. The optionally available monitor port receives network traffic from all ports, and the monitor can not send.

13.18 vCPU Support Library

vCPU handling functionality.
Collaboration diagram for vCPU Support Library:



Topics

- Extended vCPU support 663
  Extended vCPU handling functionality.

Data Structures

- class L4vcpu::State
  C++ implementation of state word in the vCPU area.
- class L4vcpu::Vcpu
  C++ implementation of the vCPU save state area.

Functions

- void l4vcpu_irq_disable (l4_vcpu_state_t *vcpu) L4_NOTHROW
  Disable a vCPU for event delivery.
- unsigned l4vcpu_irq_disable_save (l4_vcpu_state_t *vcpu) L4_NOTHROW
  Disable a vCPU for event delivery and return previous state.
- void l4vcpu_irq_enable (l4_vcpu_state_t *vcpu, l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb, l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW
  Enable a vCPU for event delivery.
- void l4vcpu_irq_restore (l4_vcpu_state_t *vcpu, unsigned s, l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb, l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW
  Restore a previously saved IRQ/event state.
- void l4vcpu_wait_for_event (l4_vcpu_state_t *vcpu, l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb, l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW
  Wait for event.
- void l4vcpu_print_state (const l4_vcpu_state_t *vcpu, const char *prefix) L4_NOTHROW
  Print the state of a vCPU.
- int l4vcpu_is_irq_entry (l4_vcpu_state_t const *vcpu) L4_NOTHROW
  Return whether the entry reason was an IRQ/IPC message.
- int l4vcpu_is_page_fault_entry (l4_vcpu_state_t const *vcpu) L4_NOTHROW
  Return whether the entry reason was a page fault.

13.18.1 Detailed Description

vCPU handling functionality.
This library provides convenience functionality on top of the l4sys vCPU interface to ease programming. It wraps commonly used code and abstracts architecture depends parts as far as reasonable.

13.18.2 Function Documentation

13.18.2.1 l4vcpu_irq_disable()

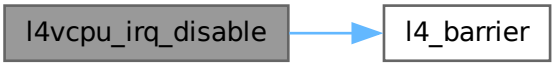
```
void l4vcpu_irq_disable (
            l4_vcpu_state_t * vcpu)  [inline]
```

Disable a vCPU for event delivery.

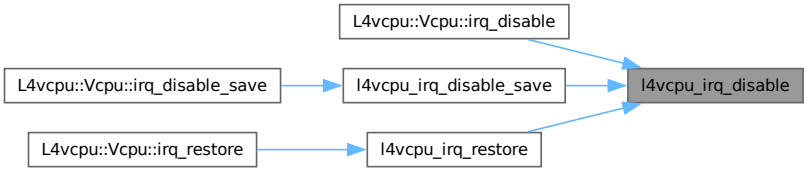
Parameters

vcpu	Pointer to vCPU area.

Definition at line 201 of file vcpu.h.
References l4_barrier(), L4_NOTHROW, and L4_VCPU_F_IRQ.
Referenced by L4vcpu::Vcpu::irq_disable(), l4vcpu_irq_disable_save(), and l4vcpu_irq_restore().
Here is the call graph for this function:



Here is the caller graph for this function:



13.18.2.2 l4vcpu_irq_disable_save()

```
unsigned l4vcpu_irq_disable_save (
            l4_vcpu_state_t * vcpu)  [inline]
```

Disable a vCPU for event delivery and return previous state.

Parameters

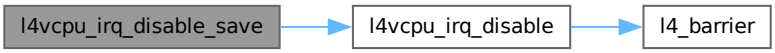
vcpu	Pointer to vCPU area.

Returns

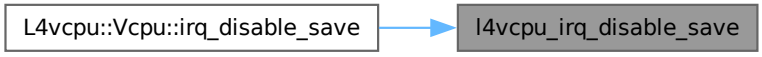
IRQ state before disabling IRQs.

Definition at line 209 of file vcpu.h.
References L4_NOTHROW, and l4vcpu_irq_disable().

Referenced by L4vcpu::Vcpu::irq_disable_save().
Here is the call graph for this function:



Here is the caller graph for this function:



13.18.2.3 l4vcpu_irq_enable()

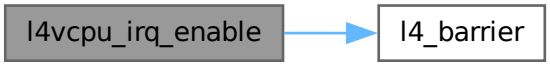
```
void l4vcpu_irq_enable (
             l4_vcpu_state_t * vcpu,
             l4_utcb_t * utcb,
             l4vcpu_event_hndl_t do_event_work_cb,
             l4vcpu_setup_ipc_t setup_ipc)  [inline]
```

Enable a vCPU for event delivery.

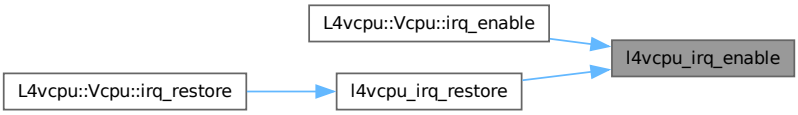
Parameters

vcpu	Pointer to vCPU area.
utcb	Utcb pointer of the calling vCPU.
do_event_work_cb	Call-back function that is called in case an event (such as an interrupt) is pending.
setup_ipc	Function call-back that is called right before any IPC operation, and before event delivery is enabled.

Definition at line 232 of file vcpu.h.
References l4_barrier(), L4_IPC_BOTH_TIMEOUT_0, L4_LIKELY, L4_NOTHROW, L4_VCPU_F_IRQ, and L4_VCPU_SF_IRQ_PENDING.
Referenced by L4vcpu::Vcpu::irq_enable(), and l4vcpu_irq_restore().
Here is the call graph for this function:



Here is the caller graph for this function:



13.18.2.4 l4vcpu_irq_restore()

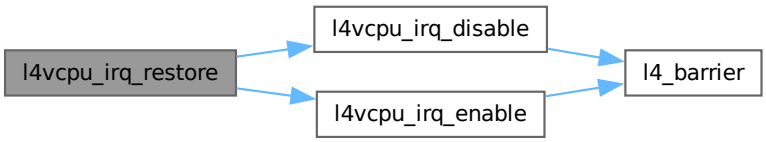
```
void l4vcpu_irq_restore (
            l4_vcpu_state_t * vcpu,
            unsigned s,
            l4_utcb_t * utcb,
            l4vcpu_event_hndl_t do_event_work_cb,
            l4vcpu_setup_ipc_t setup_ipc)  [inline]
```

Restore a previously saved IRQ/event state.

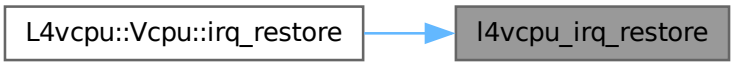
Parameters

vcpu	Pointer to vCPU area.
s	IRQ state to be restored.
utcb	Utcb pointer of the calling vCPU.
do_event_work_cb	Call-back function that is called in case an event (such as an interrupt) is pending after enabling.
setup_ipc	Function call-back that is called right before any IPC operation, and before event delivery is enabled.

Definition at line 257 of file vcpu.h.
References L4_NOTHROW, L4_VCPU_F_IRQ, l4vcpu_irq_disable(), and l4vcpu_irq_enable().
Referenced by L4vcpu::Vcpu::irq_restore().
Here is the call graph for this function:



Here is the caller graph for this function:



13.18.2.5 l4vcpu_is_irq_entry()

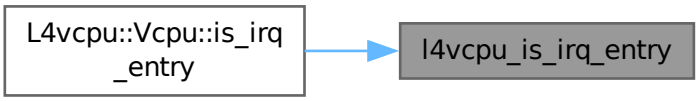
```
int l4vcpu_is_irq_entry (
            l4_vcpu_state_t const * vcpu)  [inline]
```

Return whether the entry reason was an IRQ/IPC message.

Parameters

vcpu	Pointer to vCPU area.

return 0 if not, !=0 otherwise.
References L4_CV, L4_INLINE, and L4_NOTHROW.
Referenced by L4vcpu::Vcpu::is_irq_entry().
Here is the caller graph for this function:



13.18.2.6 l4vcpu_is_page_fault_entry()

```
int l4vcpu_is_page_fault_entry (
            l4_vcpu_state_t const * vcpu)  [inline]
```

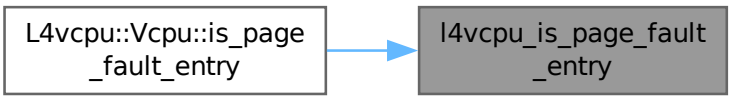
Return whether the entry reason was a page fault.

Parameters

vcpu	Pointer to vCPU area.

return 0 if not, !=0 otherwise.
References L4_CV, and L4_NOTHROW.
Referenced by L4vcpu::Vcpu::is_page_fault_entry().

Here is the caller graph for this function:



13.18.2.7 l4vcpu_print_state()

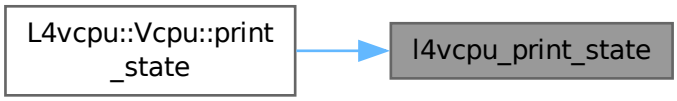
```
void l4vcpu_print_state (
            const l4_vcpu_state_t * vcpu,
            const char * prefix)
```

Print the state of a vCPU.

Parameters

vcpu	Pointer to vCPU area.
prefix	A prefix for each line printed.

References L4_CV, L4_INLINE, and L4_NOTHROW.
Referenced by L4vcpu::Vcpu::print_state().
Here is the caller graph for this function:



13.18.2.8 l4vcpu_wait_for_event()

```
void l4vcpu_wait_for_event (
            l4_vcpu_state_t * vcpu,
            l4_utcb_t * utcb,
            l4vcpu_event_hndl_t do_event_work_cb,
            l4vcpu_setup_ipc_t setup_ipc)  [inline]
```

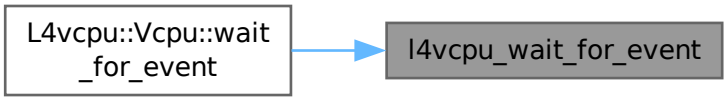
Wait for event.

Parameters

vcpu	Pointer to vCPU area.
utcb	Utcb pointer of the calling vCPU.

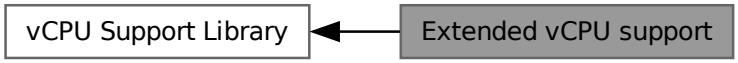
do_event_work_cb	Call-back function that is called when the vCPU awakes and needs to handle an event/↩ IRQ.
setup_ipc	Function call-back that is called right before any IPC operation.

Note that event delivery remains disabled after this function returns.
Definition at line 270 of file vcpu.h.
References L4_IPC_NEVER, and L4_NOTHROW.
Referenced by L4vcpu::Vcpu::wait_for_event().
Here is the caller graph for this function:



13.18.3 Extended vCPU support

Extended vCPU handling functionality.
Collaboration diagram for Extended vCPU support:



Functions

- int l4vcpu_ext_alloc (l4_vcpu_state_t **vcpu, l4_addr_t *ext_state, l4_cap_idx_t task, l4_cap_idx_t regmgr) L4_NOTHROW

  Allocate state area for an extended vCPU.

13.18.3.1 Detailed Description

Extended vCPU handling functionality.

13.18.3.2 Function Documentation

13.18.3.2.1 l4vcpu_ext_alloc()

```
int l4vcpu_ext_alloc (
             l4_vcpu_state_t ** vcpu,
             l4_addr_t * ext_state,
             l4_cap_idx_t task,
             l4_cap_idx_t regmgr)
```

Allocate state area for an extended vCPU.

Parameters

out	*vcpu*	Allocated vcpu-state area.
out	*ext_state*	Allocated extended vcpu-state area.
	task	Task to use for allocation.
	regmgr	Region manager to use for allocation.

Returns

0 for success, error code otherwise

References L4_CV, L4_INLINE, and L4_NOTHROW.

Chapter 14

Namespace Documentation

14.1 cxx Namespace Reference

Our C++ library.

Namespaces

- namespace Bits

  Internal helpers for the cxx package.

Data Structures

- class Avl_map

  AVL tree based associative container.
- class Avl_set

  AVL set for simple comparable items.
- class Avl_tree_node

  Node of an AVL tree.
- class Avl_tree

  A generic AVL tree.
- class Bitfield

  Definition for a member (part) of a bit field.
- class Bitmap_base

  Basic bitmap abstraction.
- class Bitmap

  A static bitmap.
- class Buddy_alloc

  Buddy allocator backed by a perfect binary tree.
- class Elide_dtor

  Wrapper class to remove destructor calls.
- class H_list_item_t

  Basic element type for a double-linked H_list.
- class H_list

  General double-linked list of unspecified cxx::H_list_item elements.
- struct H_list_t

  Double-linked list of typed H_list_item_t elements.
- class List_item

  Basic list item.
- class List

  Doubly linked list, with internal allocation.

- class List_alloc

  Standard list-based allocator.
- struct Pair

  Pair of two values.
- class Pair_first_compare

  Comparison functor for Pair.
- class Ref_ptr

  A reference-counting pointer with automatic cleanup.
- struct Ref_obj_list_item

  Item for list linked via cxx::Ref_ptr with default refence counting.
- class Error

  Error value.
- class Result

  A result of a function call.
- class Base_slab

  Basic slab allocator.
- class Slab

  Slab allocator for object of type `Type`.
- class Base_slab_static

  Merged slab allocator (allocators for objects of the same size are merged together).
- class Slab_static

  Merged slab allocator (allocators for objects of the same size are merged together).
- class S_list

  Simple single-linked list.
- class static_vector

  Simple encapsulation for a dynamically allocated array.
- class Nothrow

  Helper type to distinguish the `operator new` version that does not throw exceptions.
- class New_allocator

  Standard allocator based on `operator new ()` .
- struct Lt_functor

  Generic comparator class that defaults to the less-than operator.
- class String

  Allocation free string class with explicit length field.
- class Tree_alloc

  Standard tree-based allocator.
- class Weak_ref_base

  Generic (base) weak reference to some object.
- class Weak_ref

  Typed weak reference to an object of type `T`.

Typedefs

- typedef H_list_item_t< void > **H_list_item**

  Untyped list item.
- template<typename T>
  using **Ref_ptr_list_item** = Bits::Smart_ptr_list_item<T, cxx::Ref_ptr<T> >

  Item for list linked with cxx::Ref_ptr.
- template<typename T>
  using **Ref_ptr_list** = Bits::Smart_ptr_list<Ref_ptr_list_item<T> >

  Single-linked list where elements are connected via a cxx::Ref_ptr.

- template<typename T>
  using **Unique_ptr_list_item** = Bits::Smart_ptr_list_item<T, cxx::unique_ptr<T> >

  Item for list linked with cxx::unique_ptr.
- template<typename T>
  using **Unique_ptr_list** = Bits::Smart_ptr_list<Unique_ptr_list_item<T> >

  Single-linked list where elements are connected with a cxx::unique_ptr.

Functions

- template<typename A, typename ... ARGS>
  constexpr A const & min (A const &a1, A const &a2, ARGS const &...a)

  Get the minimum of `a1` and `a2` upt to `aN`.
- template<typename A, typename ... ARGS>
  constexpr A const & min (cxx::identity_t< A > const &a1, cxx::identity_t< A > const &a2, ARGS const &...a)

  Get the minimum of `a1` and `a2` upt to `aN`.
- template<typename A, typename ... ARGS>
  constexpr A const & max (A const &a1, A const &a2, ARGS const &...a)

  Get the maximum of `a1` and `a2` upt to `aN`.
- template<typename A, typename ... ARGS>
  constexpr A const & max (cxx::identity_t< A > const &a1, cxx::identity_t< A > const &a2, ARGS const &...a)

  Get the maximum of `a1` and `a2` upt to `aN`.
- template<typename T1>
  T1 clamp (T1 v, T1 lo, T1 hi)

  Limit v to the range given by lo and hi.
- template<typename T>
  constexpr T gcd (T a, T b)

  Compute the greatest common divisor of two unsigned values.
- template<typename T>
  constexpr T lcm (T a, T b)

  Compute the least common multiple of two unsigned values.
- template<typename T>
  T access_once (T const *a)

  Read the value at an address at most once.
- template<typename T, typename VAL>
  void write_now (T *a, VAL &&val)

  Write a value at an address exactly once.

14.1.1 Detailed Description

Our C++ library.
Small Low-Level C++ Library.
Strings.
Various kinds of C++ utilities.

14.1.2 Function Documentation

14.1.2.1 access_once()

```
template<typename T>
T cxx::access_once (
            T const * a)  [inline]
```

Read the value at an address at most once.
The read might be omitted if the result is not used by any code unless `typename` contains `volatile`. If the read operation has side effects and must not be omitted, use different means like L4drivers::Mmio_register_block or similar.
The compiler is disallowed to reuse a previous read at the same address, for example:

```
val1 = *a;
val2 = access_once(a);  // compiler may not replace this by val2 = val1;
```

The compiler is also disallowed to repeat the read, for example:

```
val1 = access_once(a);
val2 = val1;  // compiler may not replace this by val2 = *a;
```

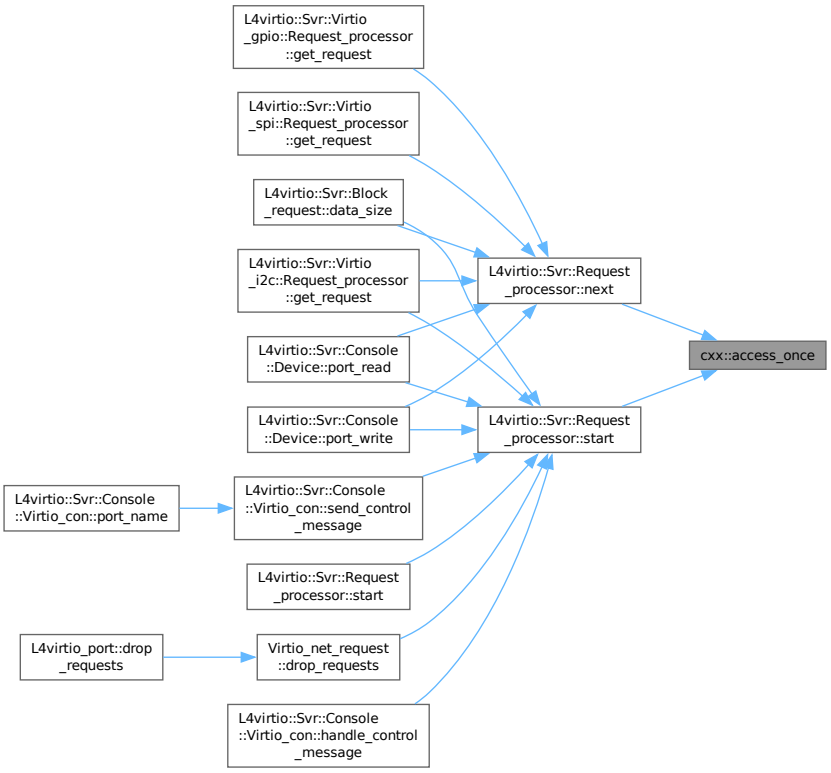
The above implies that the compiler is also disallowed to move the read out of or into loops.

Note

The read might still be moved relative to other code.

The value might be read from a hardware cache, not from RAM.

Definition at line 40 of file utils.
Referenced by L4virtio::Svr::Request_processor::next(), and L4virtio::Svr::Request_processor::start().
Here is the caller graph for this function:



14.1.2.2 gcd()

```
template<typename T>
T cxx::gcd (
            T a,
            T b)  [constexpr]
```

Compute the greatest common divisor of two unsigned values.
This uses the Euclidean modulo algorithm.

Note

Contrary to the C++17 specification, this implementation requires the same unsigned type of both arguments and returns the same type (not a common type). This should be fine for most practical use cases.

Contrary to the C++17 specification, this implementation does not accept signed arguments and negative literals.

Template Parameters

T	Unsigned integer type of the values.

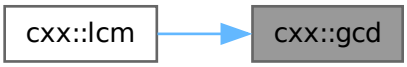
Parameters

a	First input.
b	Second input.

Returns

Greatest common divisor of the input values.

Definition at line 34 of file numeric.
Referenced by lcm().
Here is the caller graph for this function:



14.1.2.3 lcm()

```
template<typename T>
T cxx::lcm (
            T a,
            T b)  [constexpr]
```

Compute the least common multiple of two unsigned values.
This uses the greatest common divisor to compute the least common multiple.

Note

Contrary to the C++17 specification, this implementation requires the same unsigned type of both arguments and returns the same type (not a common type). This should be fine for most practical use cases.

Contrary to the C++17 specification, this implementation does not accept signed arguments and negative literals.

Template Parameters

T	Unsigned integer type of the values.

Parameters

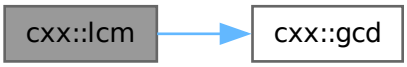
a	First input.

b	Second input.

Returns

Least common multiple of the input values.

Definition at line 68 of file numeric.
References gcd().
Here is the call graph for this function:



14.1.2.4 write_now()

```
template<typename T, typename VAL>
void cxx::write_now (
            T * a,
            VAL && val)  [inline]
```

Write a value at an address exactly once.
The compiler is disallowed to skip the write, for example:

```
*a = val;
write_now(a, val);  // compiler may not skip this line
```

The compiler is also disallowed to repeat the write.
The above implies that the compiler is also disallowed to move the write out of or into loops.

Note

The write might still be moved relative to other code.

The value might be written just to a hardware cache for the moment, not immediately to RAM.

Definition at line 71 of file utils.

14.2 cxx::Bits Namespace Reference

Internal helpers for the cxx package.

Data Structures

- struct Avl_map_get_key

  Key-getter for Avl_map.
- class Avl_set_iter

  Generic iterator for the AVL-tree based set.
- struct Avl_set_get_key

  Internal, key-getter for Avl_set nodes.
- class Base_avl_set

  AVL set with internally managed nodes.
- class Bst

Basic binary search tree (BST).

- struct Direction

  The direction to go in a binary search tree.
- class Bst_node

  Basic type of a node in a binary search tree (BST).
- class Basic_list

  Internal: Common functions for all head-based list implementations.
- class Smart_ptr_list_item

  List item for an arbitrary item in a Smart_ptr_list.
- class Smart_ptr_list

  List of smart-pointer-managed objects.

14.2.1 Detailed Description

Internal helpers for the cxx package.

14.3 Enum_bitops Namespace Reference

Mechanism to opt-in for enum bitwise operators.

Data Structures

- struct Has_marker

  Marker for the opt-in ADL function.
- struct Has_marker< T, Void< decltype(enum_bitops_enable(declval< T >()))> >

  Marker for the opt-in ADL function.
- struct Enable

  Check whether the given enum type opts in for the bitwise operators.

14.3.1 Detailed Description

Mechanism to opt-in for enum bitwise operators.
For an enumeration type T to opt-in for bitwise operators, there needs to be a declaration of a function
void enum_bitops_enable(T)
available for the argument-dependent lookup (the function is never actually called, thus no definition is required and no code is generated).

14.4 Enum_bitops_impl Namespace Reference

Bitwise operators on enumeration types.

Functions

- template<typename T, typename = L4::Types::Enable_if_t<L4::Types::Is_enum<T>::value>>
  constexpr L4::Types::Underlying_type_t< T > **to_underlying** (T const arg) noexcept

  Convert enum value to its underlying type value.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **operator~** (T const a) noexcept

  Negate enum value.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **operator&** (T l, T r) noexcept

  Intersect enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T & **operator&=** (T &a, T const b) noexcept

Intersect and assign enum values.

- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **operator|** (T l, T r) noexcept

  Union enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T & **operator|=** (T &a, T const b) noexcept

  Union and assign enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **operator-** (T l, T r) noexcept

  Difference (intersect with negation, clear bits) enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T & **operator-=** (T &a, T const b) noexcept

  Difference (intersect with negation, clear bits) and assign enum values.

14.4.1 Detailed Description

Bitwise operators on enumeration types.
These operators allow to use the enum type as a bitmask type with '∼', '&' and '|' operators that keep the enum type as result. The compound assignment operators '&=' and '|=' are also provided.
The set-difference '-' and '-=' operators (a shorthand for intersection with a negated second argument) can be used to clear specific bits from the enum value. There is also the to_underlying() helper function.

14.5 L4 Namespace Reference

L4 low-level kernel interface.

Namespaces

- namespace Typeid

  Definition of interface data-type helpers.
- namespace Ipc

  IPC related functionality.
- namespace Ipc_svr

  Helper classes for L4::Server instantiation.
- namespace Types

  L4 basic type helpers for C++.

Data Structures

- struct Type_info

  Dynamic Type Information for L4Re Interfaces.
- struct Kobject_typeid

  Meta object for handling access to type information of Kobjects.
- struct Kobject_typeid< void >

  Minimalistic ID for `void` interface.
- class Kobject_t

  Helper class to create an L4Re interface class that is derived from a single base class.
- class Kobject_2t

  Helper class to create an L4Re interface class that is derived from two base classes (see `L4::Kobject_t`).
- struct Kobject_3t

  Helper class to create an L4Re interface class that is derived from three base classes (see `L4::Kobject_t`).
- struct Kobject_demand

  Get the combined server-side resource requirements for all type T...

- struct Proto_t

  Data type for defining protocol numbers.
- struct Kobject_x

  Generic Kobject inheritance template.
- class Arm_smccc

  Wrapper for function calls that follow the ARM SMC/HVC calling convention.
- class Cap

  C++ interface for capabilities.
- class Cap_base

  Base class for all kinds of capabilities.
- class Reply_cap_idx

  Value class for optional reply capability index.
- class Reply_cap_alloc

  Interface to a reply capability allocator.
- class Reply_cap

  An explicit reply capability.
- struct Epiface

  Base class for interface implementations.
- struct Epiface_t0

  Epiface mixin for generic Kobject-based interfaces.
- struct Irqep_t

  Epiface implementation for interrupt handlers.
- class Registry_iface

  Abstract interface for object registries.
- struct Epiface_t

  Epiface implementation for Kobject-based interface implementations.
- class Basic_registry

  This registry returns the corresponding server object based on the label of an Ipc_gate.
- class Server

  Basic server loop for handling client requests.
- class Debugger

  C++ kernel debugger API.
- class Exception

  Exception interface.
- class Factory

  C++ Factory interface, see Factory for the C interface.
- class Iommu

  Interface for IO-MMUs used for DMA remapping.
- class Ipc_gate

  The C++ IPC gate interface, see IPC-Gate API for the C interface.
- class Irq_eoi

  Interface for sending an unmask message to an object.
- struct Triggerable

  Interface that allows an object to be triggered by some source.
- class Irq

  C++ Irq interface, see IRQs for the C interface.
- class Icu

  C++ Icu interface, see Interrupt controller for the C interface.
- class Kobject

  Base class for all kinds of kernel objects and remote objects, referenced by capabilities.
- class Meta

Meta interface that shall be implemented by each L4Re object and gives access to the dynamic type information for L4Re objects.

- class Io_pager

  Io_pager interface.
- class Pager

  Pager interface including the Io_pager interface.
- class Platform_control

  L4 C++ interface for controlling platform-wide properties, see Platform Control C API for the C interface.
- class Rcv_endpoint

  Interface for kernel objects that allow to receive IPC from them.
- class Scheduler

  C++ interface of the Scheduler kernel object, see Scheduler for the C interface.
- struct Semaphore

  C++ Kernel-provided semaphore interface, see Kernel-provided semaphore for the C interface.
- class Smart_cap

  Smart capability class.
- class Task

  C++ interface of the Task kernel object, see Task for the C interface.
- class Thread

  C++ L4 kernel thread interface, see Thread for the C interface.
- class Thread_group

  C++ L4 kernel thread group interface, see Thread groups for the C interface.
- class Vcon

  C++ L4 Vcon interface, see Virtual Console for the C interface.
- class Vm

  Virtual machine host address space.
- class Poll_timeout_kipclock

  A polling timeout based on the L4Re clock.
- class Alloc_list

  A simple list-based allocator.
- class IOModifier

  Modifier class for the IO stream.
- class Exception_tracer

  Back-trace support for exceptions.
- class Base_exception

  Base class for all exceptions, thrown by the L4Re framework.
- class Runtime_error

  Exception for an abstract runtime error.
- class Out_of_memory

  Exception signalling insufficient memory.
- class Element_already_exists

  Exception for duplicate element insertions.
- class Unknown_error

  Exception for an unknown condition.
- class Element_not_found

  Exception for a failed lookup (element not found).
- class Invalid_capability

  Indicates that an invalid object was invoked.
- class Com_error

  Error conditions during IPC.
- class Bounds_error

Access out of bounds.

- class Server_object

  Abstract server object to be used with L4::Server and L4::Basic_registry.
- struct Server_object_t

  Base class (template) for server implementing server objects.
- struct Server_object_x

  Helper class to implement p_dispatch based server objects.
- struct Irq_handler_object

  Server object base class for handling IRQ messages.
- class Lock_guard

  Basic lock guard implementation that prevents forgotten unlocks on exit paths from a method or a block of code.
- class String

  A null-terminated string container class.
- class Poll_timeout_counter

  Evaluate an expression for a maximum number of times.
- class Uart_apb

  Driver for the Advanced Peripheral Bus (APB) UART from the Cortex-M System Design Kit (CMSDK).
- class Uart

  Uart driver abstraction.

Typedefs

- typedef int **Opcode**

  Data type for RPC opcodes.

Enumerations

- enum : l4_proto_t { PROTO_ANY = 0 , PROTO_EMPTY = -19 }

Functions

- template<typename T>
  Type_info const * kobject_typeid () noexcept

  Get the L4::Type_info for the L4Re interface given in `T`.
- template<typename T, typename F>
  Cap< T > cap_dynamic_cast (Cap< F > const &c) noexcept

  `dynamic_cast` for capabilities.
- template<typename T, typename F>
  Cap< T > cap_cast (Cap< F > const &c) noexcept

  static_cast for capabilities.
- template<typename T, typename F>
  Cap< T > cap_reinterpret_cast (Cap< F > const &c) noexcept

  reinterpret_cast for capabilities.
- template<typename T>
  constexpr T trunc_order (T val, unsigned char order)

  Round a value down so the given number of lsb is zero.
- template<typename T>
  constexpr T round_order (T val, unsigned char order)

  Round a value up so the given number of lsb is zero.
- template<typename T, typename F, typename SMART>
  Smart_cap< T, SMART > cap_cast (Smart_cap< F, SMART > const &c) noexcept

  `static_cast` for (smart) capabilities.
- template<typename T, typename F, typename SMART>
  Smart_cap< T, SMART > cap_reinterpret_cast (Smart_cap< F, SMART > const &c) noexcept

reinterpret_cast for (smart) capabilities.

- void throw_ipc_exception (L4::Cap< void > const &o, l4_msgtag_t const &err, l4_utcb_t *utcb)

  Throw an L4 IPC error as exception.
- void throw_ipc_exception (void const *o, l4_msgtag_t const &err, l4_utcb_t *utcb)

  Throw an L4 IPC error as exception.

Variables

- IOModifier const **hex**

  Modifies the stream to print numbers as hexadecimal values.
- IOModifier const **dec**

  Modifies the stream to print numbers as decimal values.
- BasicOStream **cout**

  Standard output stream.
- BasicOStream **cerr**

  Standard error stream.

14.5.1 Detailed Description

L4 low-level kernel interface.

14.5.2 Enumeration Type Documentation

14.5.2.1 anonymous enum

```
anonymous enum :  l4_proto_t
```

Enumerator

PROTO_ANY	Default protocol used by Kobject_t and Kobject_x.
PROTO_EMPTY	Empty protocol for empty APIs.

Definition at line 44 of file __typeinfo.h.

14.5.3 Function Documentation

14.5.3.1 cap_cast() [1/2]

```
template<typename T, typename F>
Cap< T > L4::cap_cast (
            Cap< F > const & c)  [inline], [noexcept]
```

static_cast for capabilities.

Template Parameters

T	The target type of the capability
F	The source type (and is usually implicitly set)

Parameters

c	The source capability that shall be casted

Returns

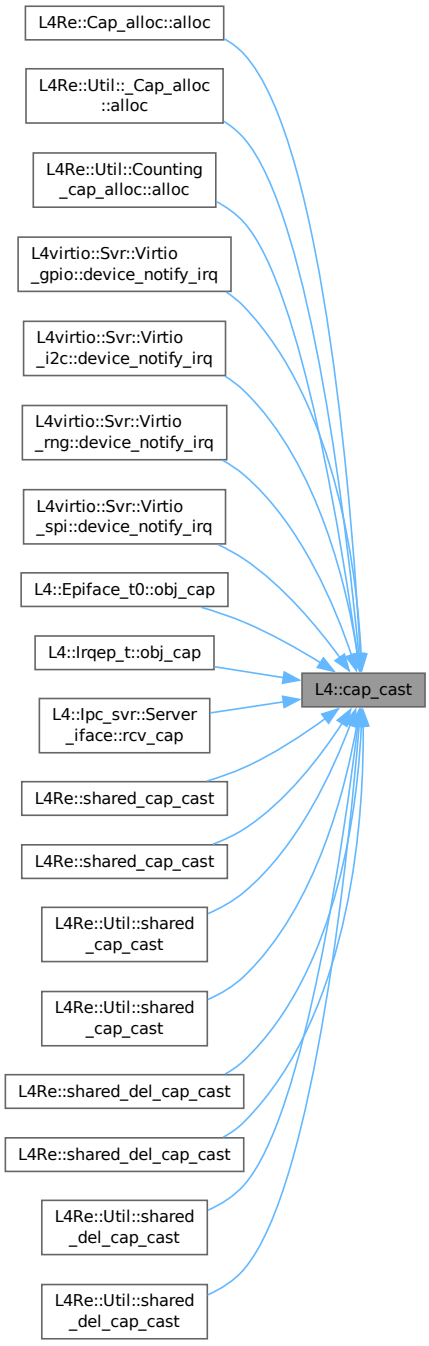
A capability typed to the interface `T`.

The use of this cast operator is similar to the `static_cast<>()` for C++ pointers. It does the same type checking and adjustments like C++ does on pointers.
Example code:

```
L4::Cap<L4::Kobject> obj = ... ;
L4::Cap<L4::Icu> icu = L4::cap_cast<L4::Icu>(obj);
```

Definition at line 437 of file capability.h.
Referenced by L4Re::Cap_alloc::alloc(), L4Re::Util::_Cap_alloc::alloc(), L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::a
L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::device_notify_irq(), L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::d
L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::device_notify_irq(), L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::device
L4::Epiface_t0< RPC_IFACE, BASE >::obj_cap(), L4::Irqep_t< Derived, BASE, bool >::obj_cap(), L4::Ipc_svr::Server_iface::rcv_ca
L4Re::shared_cap_cast(), L4Re::shared_cap_cast(), L4Re::Util::shared_cap_cast(), L4Re::Util::shared_cap_cast(),
L4Re::shared_del_cap_cast(), L4Re::shared_del_cap_cast(), L4Re::Util::shared_del_cap_cast(), and L4Re::Util::shared_del_cap_cas

Here is the caller graph for this function:



14.5.3.2 cap_cast() [2/2]

```
template<typename T, typename F, typename SMART>
Smart_cap< T, SMART > L4::cap_cast (
            Smart_cap< F, SMART > const & c)  [inline], [noexcept]
```

`static_cast` for (smart) capabilities.

Template Parameters

T	Type to cast the capability to.
F	(implicit) Type of the passed capability.
SMART	(implicit) Class implementing the Smart_cap interface.

Parameters

c	Capability to be casted.

Returns

A smart capability with new type `T`.

Definition at line 192 of file smart_capability.

14.5.3.3 cap_dynamic_cast()

```
template<typename T, typename F>
Cap< T > L4::cap_dynamic_cast (
            Cap< F > const & c)  [inline], [noexcept]
```

`dynamic_cast` for capabilities.

Template Parameters

T	The target type of the capability.
F	The source type (is usually implicitly set).

Parameters

c	The source capability that shall be casted.

Return values

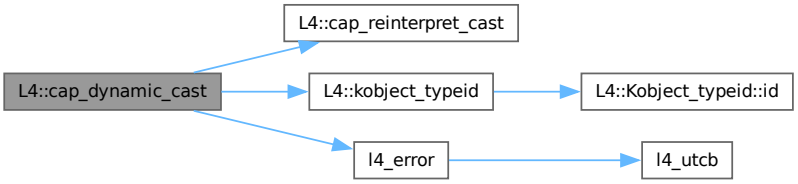
Cap<T>	Capability of target interface `T`.
L4_INVALID_CAP	`c` does not support the target interface `T` or the L4::Meta interface.

The use of this cast operator is similar to the `dynamic_cast<>()` for C++ pointers. It also induces overhead, because it uses the meta interface (L4::Meta) to do runtime type checking.
Example code:

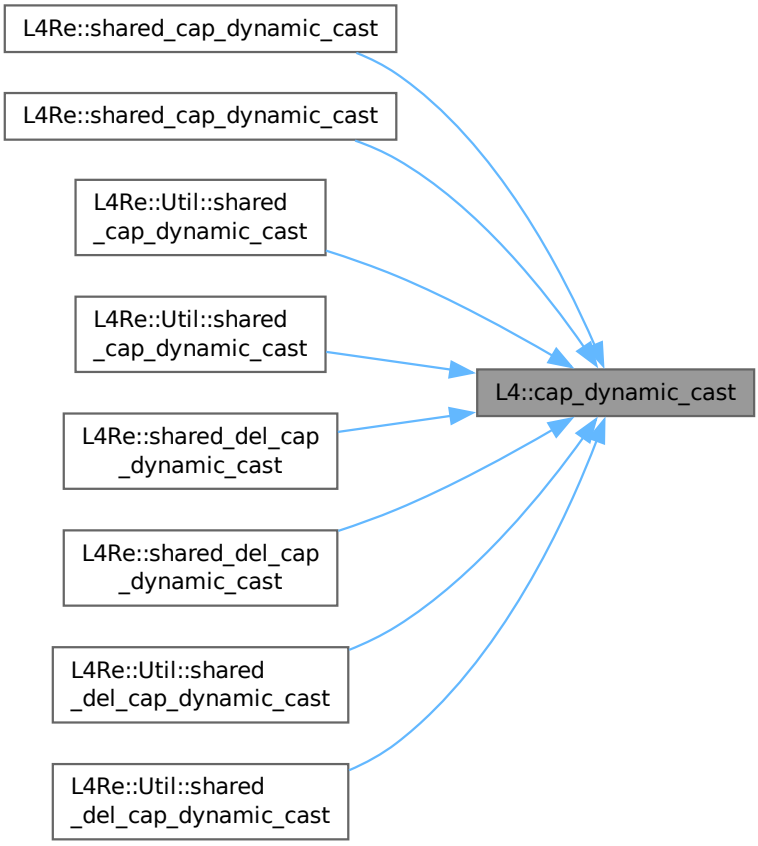
```
L4::Cap<L4::Kobject> obj = ... ;
L4::Cap<L4::Icu> icu = L4::cap_dynamic_cast<L4::Icu>(obj);
```

Definition at line 116 of file capability.
References cap_reinterpret_cast(), L4::Cap_base::Invalid, kobject_typeid(), and l4_error().
Referenced by L4Re::shared_cap_dynamic_cast(), L4Re::shared_cap_dynamic_cast(), L4Re::Util::shared_cap_dynamic_cast(), L4Re::Util::shared_cap_dynamic_cast(), L4Re::shared_del_cap_dynamic_cast(), L4Re::shared_del_cap_dynamic_cast(), L4Re::Util::shared_del_cap_dynamic_cast(), and L4Re::Util::shared_del_cap_dynamic_cast().

Here is the call graph for this function:



Here is the caller graph for this function:



14.5.3.4 cap_reinterpret_cast() [1/2]

```
template<typename T, typename F>
Cap< T > L4::cap_reinterpret_cast (
            Cap< F > const & c)  [inline], [noexcept]
```

reinterpret_cast for capabilities.

Template Parameters

T	The target type of the capability
F	The source type (and is usually implicitly set)

Parameters

c	The source capability that shall be casted

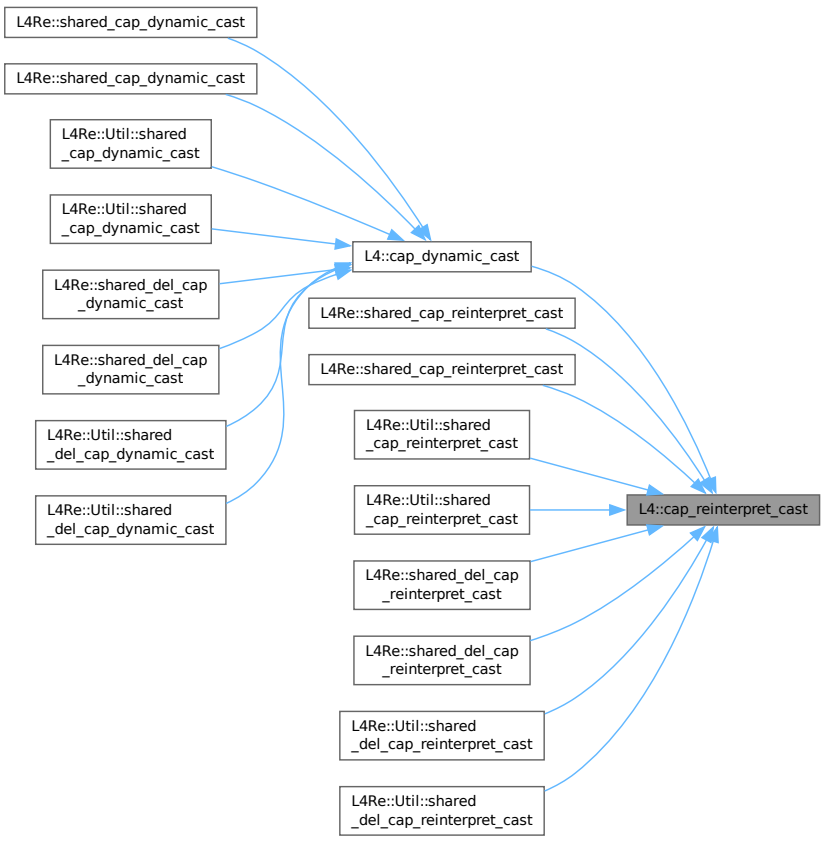
Returns

A capability typed to the interface `T`.

The use of this cast operator is similar to the `reinterpret_cast<>()` for C++ pointers. It does not do any type checking or type adjustment.
Example code:

```
L4::Cap<L4::Kobject> obj = ... ;
L4::Cap<L4::Icu> icu = L4::cap_reinterpret_cast<L4::Icu>(obj);
```

Definition at line 468 of file capability.h.
Referenced by cap_dynamic_cast(), L4Re::shared_cap_reinterpret_cast(), L4Re::shared_cap_reinterpret_cast(), L4Re::Util::shared_cap_reinterpret_cast(), L4Re::Util::shared_cap_reinterpret_cast(), L4Re::shared_del_cap_reinterpret_cast(), L4Re::shared_del_cap_reinterpret_cast(), L4Re::Util::shared_del_cap_reinterpret_cast(), and L4Re::Util::shared_del_cap_reinterpret
Here is the caller graph for this function:



14.5.3.5 cap_reinterpret_cast() [2/2]

```
template<typename T, typename F, typename SMART>
Smart_cap< T, SMART > L4::cap_reinterpret_cast (
            Smart_cap< F, SMART > const & c)  [inline], [noexcept]
```

`reinterpret_cast` for (smart) capabilities.

Template Parameters

T	Type to cast the capability to.
F	(implicit) Type of the passed capability.
SMART	(implicit) Class implementing the Smart_cap interface.

Parameters

c	Capability to be casted.

Returns

A smart capability with new type `T`.

Definition at line 211 of file smart_capability.

14.5.3.6 round_order()

```
template<typename T>
T L4::round_order (
            T val,
            unsigned char order)  [constexpr]
```

Round a value up so the given number of lsb is zero.

Template Parameters

T	The type of the value (shall be some integral type.

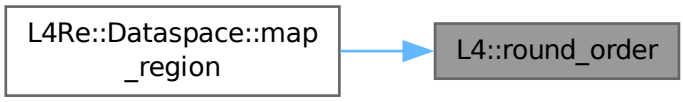
Parameters

val	The value to round up to the next multiple of 2^order.
order	order (2^order) to round up to.

Returns

val rounded up to the next 2^order.

Definition at line 32 of file consts.
Referenced by L4Re::Dataspace::map_region().
Here is the caller graph for this function:



14.5.3.7 trunc_order()

```
template<typename T>
T L4::trunc_order (
            T val,
            unsigned char order)  [constexpr]
```

Round a value down so the given number of lsb is zero.

Template Parameters

T	The type of the value (shall be some integral type.

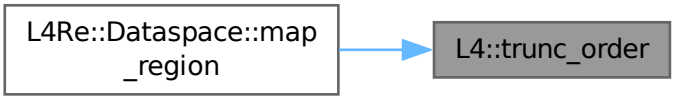
Parameters

val	The value where the given lsb shall be masked.
order	the number of least significant bits (lsb) to mask.

Returns

val with order lsb masked to zero.

Definition at line 18 of file consts.
Referenced by L4Re::Dataspace::map_region().
Here is the caller graph for this function:



14.6 L4::Ipc Namespace Reference

IPC related functionality.

Namespaces

- namespace Msg

  IPC Message related functionality.

Data Structures

- struct Array_ref

  Array reference data type for arrays located in the message.
- struct Array

  Array data type for dynamically sized arrays in RPCs.
- struct Array_in_buf

  Server-side copy in buffer for Array.
- struct Call

  RPC attribute for a standard RPC call.
- struct Call_zero_send_timeout

  RPC attribute for an RPC call, with zero send timeout.
- struct Call_t

  RPC attribute for an RPC call with required rights.
- struct Send_only

  RPC attribute for a send-only RPC.
- struct Out

  Mark an argument as a output value in an RPC signature.
- struct In_out

  Mark an argument as in-out argument.
- struct Opt

  Attribute for defining an optional RPC argument.
- class Small_buf

  A receive item for receiving a single object capability.
- class Gen_fpage

  Generic RPC base for typed message items.
- class Snd_fpage

  Send item or return item.
- class Rcv_fpage

  Non-small receive item.
- class Cap

  Capability type for RPC interfaces (see `L4::Cap<T>`).
- class Varg

  Variably sized RPC argument.
- class Varg_list

  Self-contained list of variable-sized RPC parameters.
- class Varg_list_ref

  List of variable-sized RPC parameters as received by the server.
- class Str_cp_in

  Abstraction for extracting a zero-terminated string from an Ipc::Istream.
- class Msg_ptr

  Pointer to an element of type T in an Ipc::Istream.
- class Istream

Input stream for IPC unmarshalling.

- class Ostream

  Output stream for IPC marshalling.

- class Iostream

  Input/Output stream for IPC [un]marshalling.

Typedefs

- using **Array_len_default** = unsigned short

  Default type for passing length of an array.

Functions

- template<typename T>
  Cap< T > make_cap (L4::Cap< T > cap, unsigned rights) noexcept

  Make an L4::Ipc::Cap<T> for the given capability and rights.

- template<typename T>
  Cap< T > make_cap_rw (L4::Cap< T > cap) noexcept

  Make an L4::Ipc::Cap<T> for the given capability with L4_CAP_FPAGE_RW rights.

- template<typename T>
  Cap< T > make_cap_rws (L4::Cap< T > cap) noexcept

  Make an L4::Ipc::Cap<T> for the given capability with L4_CAP_FPAGE_RWS rights.

- template<typename T>
  Cap< T > make_cap_full (L4::Cap< T > cap) noexcept

  Make an L4::IPC::Cap<T> for the given capability with full fpage and object-specific rights.

- template<typename T>
  Cap< T > make_cap_grant (L4::Cap< T > cap) noexcept

  Make an L4::IPC::Cap<T> for the given capability that shall be granted with full rights.

- template<typename T>
  Internal::Buf_cp_out< T > buf_cp_out (T const *v, unsigned long size)

  Insert an array into an Ipc::Ostream.

- template<typename T>
  Internal::Buf_cp_in< T > buf_cp_in (T *v, unsigned long &size)

  Extract an array from an Ipc::Istream.

- template<typename T>
  Str_cp_in< T > str_cp_in (T *v, unsigned long &size)

  Create a Str_cp_in for the given values.

- template<typename T>
  Msg_ptr< T > msg_ptr (T *&p)

  Create an Msg_ptr to adjust the given pointer.

- template<typename T>
  Internal::Buf_in< T > buf_in (T *&v, unsigned long &size)

  Return a pointer to stream array data.

- template<typename T>
  T read (Istream &s)

  Read a value out of a stream.

14.6.1 Detailed Description

IPC related functionality.

14.6.2 Function Documentation

14.6.2.1 buf_cp_in()

```
template<typename T>
Internal::Buf_cp_in< T > L4::Ipc::buf_cp_in (
            T * v,
            unsigned long & size)
```

Extract an array from an Ipc::Istream.

Parameters

	v	Pointer to the array that shall receive the values from the Ipc::Istream.
in,out	*size*	Input: the number of elements the array can take at most Output: the number of elements found in the stream.

buf_cp_in() can be used to extract an array from an Ipc::Istream. This is the counterpart buf_cp_out(). The data from the received message is thereby copied to the given buffer and size is set to the number of elements found in the stream. To avoid the copy operation buf_in() may be used instead.

See also

buf_in() and buf_cp_out().

Definition at line 159 of file ipc_stream.

14.6.2.2 buf_cp_out()

```
template<typename T>
Internal::Buf_cp_out< T > L4::Ipc::buf_cp_out (
            T const * v,
            unsigned long size)
```

Insert an array into an Ipc::Ostream.

Parameters

v	Pointer to the array that shall be inserted into an Ipc::Ostream.
size	Number of elements in the array.

This function inserts an array (e.g. a string) into an Ipc::Ostream. The data is copied to the stream. On insertion into the Ipc::Ostream exactly the given number of elements of type T are copied to the message buffer, this means the source buffer is no longer referenced after insertion into the stream.

See also

The counterpart is either buf_cp_in() or buf_in().

Definition at line 100 of file ipc_stream.

14.6.2.3 buf_in()

```
template<typename T>
Internal::Buf_in< T > L4::Ipc::buf_in (
            T *& v,
            unsigned long & size)
```

Return a pointer to stream array data.

Parameters

out	*v*	Pointer to the array within the Ipc::Istream.
out	*size*	The number of elements found in the stream.

This routine provides a possibility to extract an array from an Ipc::Istream, without extra copy overhead. In contrast to buf_cp_in() the data is not copied to a buffer, but a pointer to the array is returned. The user must make sure the UTCB is not used for other purposes while the returned pointer is still in use.
The mechanism is comparable to that of Msg_ptr, however it handles arrays inserted with buf_cp_out().

See also

buf_cp_in() and buf_cp_out().

Definition at line 310 of file ipc_stream.

14.6.2.4 make_cap()

```
template<typename T>
Cap< T > L4::Ipc::make_cap (
             L4::Cap< T > cap,
             unsigned rights)  [noexcept]
```

Make an L4::Ipc::Cap<T> for the given capability and rights.

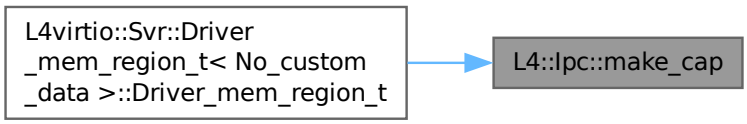
Template Parameters

T	(IMPLICIT) type of the referenced interface

Parameters

cap	source capability (L4::Cap<T>)
rights	rights mask that shall be applied on transfer.

Definition at line 845 of file ipc_types.
Referenced by L4virtio::Svr::Driver_mem_region_t< No_custom_data >::Driver_mem_region_t().
Here is the caller graph for this function:



14.6.2.5 make_cap_full()

```
template<typename T>
Cap< T > L4::Ipc::make_cap_full (
             L4::Cap< T > cap)  [noexcept]
```

Make an L4::IPC::Cap<T> for the given capability with full fpage and object-specific rights.

Template Parameters

T	(implicit) type of the referenced interface

Parameters

cap	source capability (L4::Cap<T>)

See also

L4_cap_fpage_rights

Attributes and additional permissions for object send items

Note

Full rights (including object-specific rights) are required when mapping an IPC gate where the receiver should become the server, i.e. where the receiver wants to call L4::Ipc_gate::bind_thread() or L4::Ipc_gate::bind_snd_destination().

Definition at line 884 of file ipc_types.
References L4_CAP_FPAGE_RWSD, and L4_FPAGE_C_OBJ_RIGHTS.

14.6.2.6 make_cap_grant()

```
template<typename T>
Cap< T > L4::Ipc::make_cap_grant (
            L4::Cap< T > cap)  [noexcept]
```

Make an L4::IPC::Cap<T> for the given capability that shall be granted with full rights.

Template Parameters

T	(implicit) type of the referenced interface

Parameters

cap	source capability (L4::Cap<T>)

See also

L4_MAP_ITEM_GRANT

Definition at line 897 of file ipc_types.
References L4::Ipc::Cap< T >::Grant, L4_CAP_FPAGE_RWSD, and L4_FPAGE_C_OBJ_RIGHTS.

14.6.2.7 make_cap_rw()

```
template<typename T>
Cap< T > L4::Ipc::make_cap_rw (
            L4::Cap< T > cap)  [noexcept]
```

Make an L4::Ipc::Cap<T> for the given capability with L4_CAP_FPAGE_RW rights.

Template Parameters

T	(IMPLICIT) type of the referenced interface

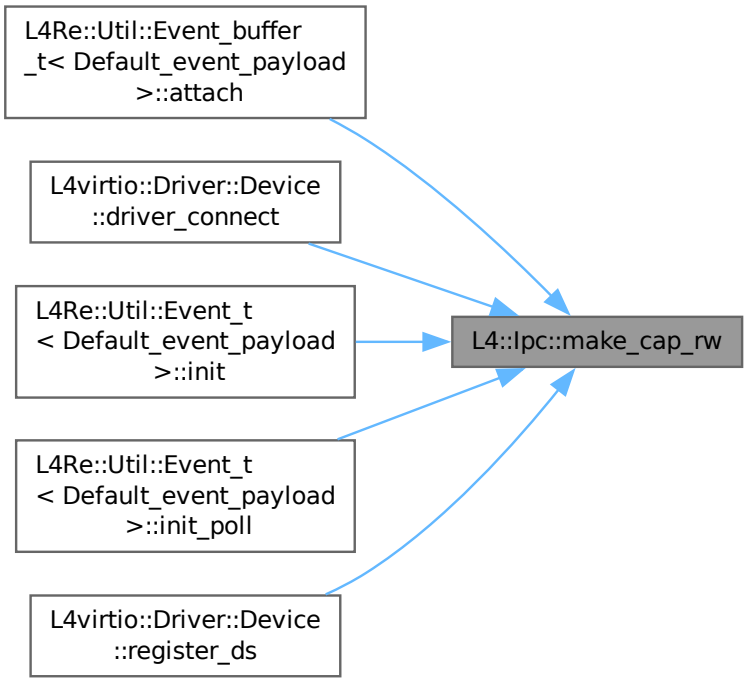
Parameters

cap	source capability (L4::Cap<T>)

Examples

examples/libs/l4re/c++/mem_alloc/ma+rm.cc, examples/libs/l4re/c++/shared_ds/ds_clnt.cc, and examples/libs/l4re/c++/shared_

Definition at line 855 of file ipc_types.
References L4_CAP_FPAGE_RW.
Referenced by L4Re::Util::Event_buffer_t< Default_event_payload >::attach(), L4virtio::Driver::Device::driver_connect(), L4Re::Util::Event_t< Default_event_payload >::init(), L4Re::Util::Event_t< Default_event_payload >::init_poll(), and L4virtio::Driver::Device::register_ds().
Here is the caller graph for this function:



14.6.2.8 make_cap_rws()

```
template<typename T>
Cap< T > L4::Ipc::make_cap_rws (
            L4::Cap< T > cap)  [noexcept]
```

Make an L4::Ipc::Cap<T> for the given capability with L4_CAP_FPAGE_RWS rights.

Template Parameters

T	(IMPLICIT) type of the referenced interface

Parameters

cap	source capability (L4::Cap<T>)

Definition at line 865 of file ipc_types.
References L4_CAP_FPAGE_RWS.

14.6.2.9 msg_ptr()

```
template<typename T>
Msg_ptr< T > L4::Ipc::msg_ptr (
            T *& p)
```

Create an Msg_ptr to adjust the given pointer.
This function makes it more convenient to extract pointers to data in the message buffer itself from an Ipc::Istream.
This may be used to avoid copy out of large data structures. (See Msg_ptr.)
Definition at line 252 of file ipc_stream.

14.6.2.10 read()

```
template<typename T>
T L4::Ipc::read (
            Istream & s)  [inline]
```

Read a value out of a stream.

Parameters

s	An Istream.

Returns

The value of type `T`.

The stream position is progressed accordingly.
Definition at line 1289 of file ipc_stream.

14.6.2.11 str_cp_in()

```
template<typename T>
Str_cp_in< T > L4::Ipc::str_cp_in (
            T * v,
            unsigned long & size)
```

Create a Str_cp_in for the given values.

Parameters

	v	Pointer to the array that shall receive the values from the Ipc::Istream.
`in,out`	*size*	Input: the number of elements the array can take at most Output: the number of elements found in the stream.

This function makes it more convenient to extract arrays from an Ipc::Istream (

See also

Str_cp_in.)

Definition at line 213 of file ipc_stream.

14.7 L4::Ipc::Msg Namespace Reference

IPC Message related functionality.

Data Structures

- struct Elem< Array< A, LEN > >

  Array as input arguments.
- struct Elem< Array< A, LEN > & >

  Array as output argument.
- struct Elem< Array_ref< A, LEN > & >

  Array_ref as output argument.
- struct Clnt_noops

  Empty client side marshalling code.
- struct Svr_noops

  Empty server side marshalling code.
- struct Clnt_val_ops

  Defines client-side handling of 'MTYPE' as RPC argument.
- struct Svr_val_ops

  Defines server-side handling of 'MTYPE' as RPC argument.
- struct Elem

  Helper struct to describe various aspects of an IPC argument.
- struct Is_valid_rpc_type

  Type trait defining a valid RPC parameter type.
- struct Svr_arg_pack

  Server-side RPC arguments data structure used to provide arguments to the server-side implementation of an RPC function.

Enumerations

- enum {
  Word_bytes = sizeof(l4_umword_t) , Item_words = 2 , Item_bytes = Word_bytes ∗ Item_words , Mr_words = L4_UTCB_GENERIC_DATA_SIZE ,
  Mr_bytes = Word_bytes ∗ Mr_words , Br_bytes = Word_bytes ∗ L4_UTCB_GENERIC_BUFFERS_SIZE }
- enum class Phase { }

  Phase during IPC argument mashalling.

Functions

- constexpr unsigned long align_to (unsigned long bytes, unsigned long align) noexcept

  Pad bytes to the given alignment align (in bytes).
- template<typename T>
  constexpr unsigned long align_to (unsigned long bytes) noexcept

  Pad bytes to the alignment of the type T.
- template<typename T>
  constexpr bool check_size (unsigned offset, unsigned limit) noexcept

  Check if there is enough space for T from offset to limit.
- template<typename T, typename CTYPE>
  bool check_size (unsigned offset, unsigned limit, CTYPE cnt) noexcept

Check if there is enough space for an array of T from offset to limit.

- template<typename T>
  int msg_add (char *msg, unsigned offs, unsigned limit, T v) noexcept

  Add some data to a message at offs.
- template<typename T>
  int msg_get (char *msg, unsigned offs, unsigned limit, T &v) noexcept

  Get some data from a message at offs.

14.7.1 Detailed Description

IPC Message related functionality.

14.7.2 Enumeration Type Documentation

14.7.2.1 anonymous enum

```
anonymous enum
```

Enumerator

Word_bytes	number of bytes for one message word
Item_words	number of message words for one message item
Item_bytes	number of bytes for one message item
Mr_words	number of message words available in the UTCB
Mr_bytes	number of bytes available in the UTCB message registers
Br_bytes	number of bytes available in the UTCB buffer registers

Definition at line 82 of file ipc_basics.

14.7.2.2 Phase

```
enum class L4::Ipc::Msg::Phase  [strong]
```

Phase during IPC argument mashalling.

Enumerator

Items	First phase: copy bytes to/from MRs.
Buffers	Second phase: place/read items into/from MRs.

Definition at line 142 of file ipc_basics.

14.7.3 Function Documentation

14.7.3.1 align_to() [1/2]

```
template<typename T>
unsigned long L4::Ipc::Msg::align_to (
            unsigned long bytes)  [constexpr], [noexcept]
```

Pad *bytes* to the alignment of the type *T*.

Template Parameters

T	The data type used for the alignment

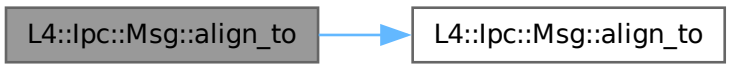
Parameters

bytes	The value to add the padding to

Returns

bytes padded to achieve the alignment of *T*.

Definition at line 37 of file ipc_basics.
References align_to().
Here is the call graph for this function:



14.7.3.2 align_to() [2/2]

```
unsigned long L4::Ipc::Msg::align_to (
            unsigned long bytes,
            unsigned long align)  [constexpr], [noexcept]
```

Pad bytes to the given alignment *align* (in bytes).

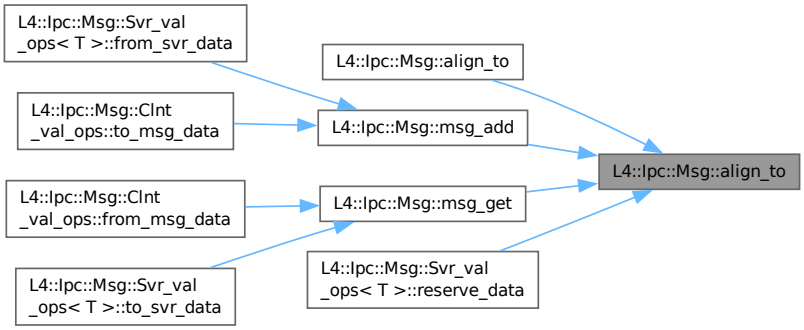
Parameters

bytes	The input value in bytes
align	The alignment value in bytes

Returns

the result after padding *bytes* to *align*.

Definition at line 27 of file ipc_basics.
Referenced by align_to(), msg_add(), msg_get(), and L4::Ipc::Msg::Svr_val_ops< T >::reserve_data().
Here is the caller graph for this function:



14.7.3.3 check_size() [1/2]

```
template<typename T>
bool L4::Ipc::Msg::check_size (
            unsigned offset,
            unsigned limit)  [constexpr], [noexcept]
```

Check if there is enough space for T from offset to limit.

Template Parameters

T	The data type that shall be fitted at *offset*

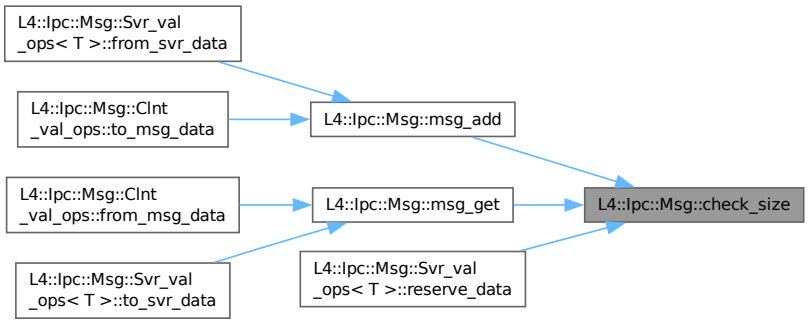
Parameters

offset	The current offset in bytes (must already be padded if desired).
limit	The limit in bytes that must not be exceeded after adding the size of *T*.

Returns

true if the limit will not be exceeded, false else.

Definition at line 50 of file ipc_basics.
Referenced by msg_add(), msg_get(), and L4::Ipc::Msg::Svr_val_ops< T >::reserve_data().
Here is the caller graph for this function:



14.7.3.4 check_size() [2/2]

```
template<typename T, typename CTYPE>
bool L4::Ipc::Msg::check_size (
            unsigned offset,
            unsigned limit,
            CTYPE cnt)  [inline], [noexcept]
```

Check if there is enough space for an array of T from offset to limit.

Template Parameters

T	The data type that shall be fitted at *offset*

CTYPE	Type of the *cnt* parameter

Parameters

offset	The current offset in bytes (must already be padded if desired).
limit	The limit in bytes that must not be exceeded after adding *cnt* times the size of *T*.
cnt	The number of elements of type *T* that shall be put at *offset*.

Returns

true if the limit will not be exceeded, false else.

Definition at line 68 of file ipc_basics.
References L4_UNLIKELY.

14.7.3.5 msg_add()

```
template<typename T>
int L4::Ipc::Msg::msg_add (
             char * msg,
             unsigned offs,
             unsigned limit,
             T v)  [inline], [noexcept]
```

Add some data to a message at offs.

Template Parameters

T	The type of the data to add

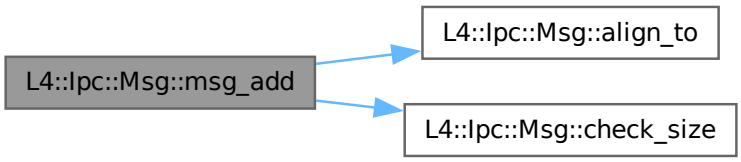
Parameters

msg	pointer to the start of the message
offs	The current offset within the message, this shall be padded to the alignment of *T* if *v* is added.
limit	The size limit in bytes that offset must not exceed.
v	The value to add to the message

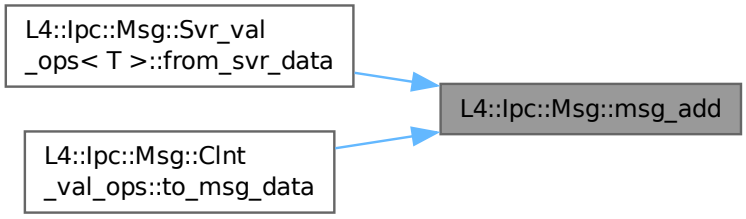
Returns

The new offset when successful, a negative value if the given limit will be exceeded.

Definition at line 111 of file ipc_basics.
References align_to(), check_size(), L4_EMSGTOOLONG, and L4_UNLIKELY.
Referenced by L4::Ipc::Msg::Svr_val_ops< T >::from_svr_data(), and L4::Ipc::Msg::Clnt_val_ops< MTYPE >::to_msg_data().
Here is the call graph for this function:



Here is the caller graph for this function:



14.7.3.6 msg_get()

```
template<typename T>
int L4::Ipc::Msg::msg_get (
             char * msg,
             unsigned offs,
             unsigned limit,
             T & v)  [inline], [noexcept]
```

Get some data from a message at offs.

Template Parameters

T	The type of the data to read

Parameters

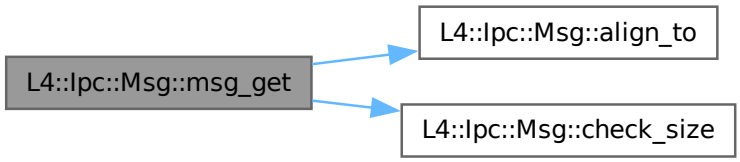
msg	Pointer to the start of the message

offs	The current offset within the message, this shall be padded to the alignment of *T* if a *v* can be read.
limit	The size limit in bytes that offset must not exceed.
v	A reference to receive the value from the message

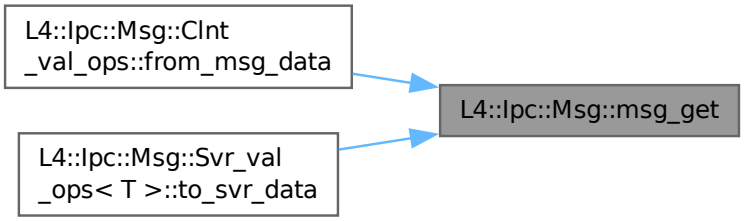
Returns

The new offset when successful, a negative value if the given limit will be exceeded.

Definition at line 132 of file ipc_basics.
References align_to(), check_size(), L4_EMSGTOOSHORT, and L4_UNLIKELY.
Referenced by L4::Ipc::Msg::Clnt_val_ops< MTYPE >::from_msg_data(), and L4::Ipc::Msg::Svr_val_ops< T >::to_svr_data().
Here is the call graph for this function:



Here is the caller graph for this function:



14.8 L4::Ipc_svr Namespace Reference

Helper classes for L4::Server instantiation.

Data Structures

- class Server_iface

  Interface for server-loop related functions.
- struct Ignore_errors

  Mix in for LOOP_HOOKS to ignore IPC errors.
- struct Default_timeout

  Mix in for LOOP_HOOKS to use a 0 send and an infinite receive timeout.
- struct Compound_reply

Mix in for LOOP_HOOKS to always use compound reply and wait.

- struct Default_setup_wait

  Mix in for LOOP_HOOKS for setup_wait no op.
- struct Direct_dispatch

  Direct dispatch helper, for forwarding dispatch calls to a registry R.
- struct Direct_dispatch< R * >

  Direct dispatch helper, for forwarding dispatch calls via a pointer to a registry R.
- struct Exc_dispatch

  Dispatch helper wrapping try {} catch {} around the dispatch call.
- struct Dbg_dispatch

  Dispatch helper that, in addition to what Exc_dispatch does, prints exception messages.
- class Br_manager_no_buffers

  Empty implementation of Server_iface.
- struct Default_loop_hooks

  Default LOOP_HOOKS.
- class Timeout

  Callback interface for Timeout_queue.
- class Timeout_queue

  Timeout queue to be used in l4re server loop.
- class Timeout_queue_hooks

  Loop hooks mixin for integrating a timeout queue into the server loop.

Enumerations

- enum Reply_mode { Reply_compound , Reply_separate }

  Reply mode for server loop.

14.8.1 Detailed Description

Helper classes for L4::Server instantiation.

14.9 L4::Typeid Namespace Reference

Definition of interface data-type helpers.

Data Structures

- struct P_dispatch

  Use for protocol based dispatch stage.
- struct Raw_ipc

  RPCs list for passing raw incoming IPC to the server object.
- struct Rpcs

  Standard list of RPCs of an interface.
- struct Rpcs_code

  List of RPCs of an interface using a special opcode type.
- struct Rpc_nocode

  List of RPCs of an interface using a single operation without an opcode.
- struct Rpcs_sys

  List of RPCs typically used for kernel interfaces.

14.9.1 Detailed Description

Definition of interface data-type helpers.

Note

These type helpers are intended for internal use, if you look for standard C++ type traits use the <type_traits> header for the standard C++ library or use <l4/cxx/type_traits>.

14.10 L4::Types Namespace Reference

L4 basic type helpers for C++.

Data Structures

- class Flags

  Template for defining typical Flags bitmaps.
- struct Int_for_size

  Metafunction to get an unsigned integral type for the given size.
- struct Int_for_type

  Metafunction to get an integral type of the same size as T.
- struct Flags_ops_t

  Mixin class to define a set of friend bitwise operators on DT.
- struct Flags_t

  Template type to define a flags type with bitwise operations.
- struct __Add_rvalue_reference_helper

  Helper template for Add_rvalue_reference.
- struct __Add_rvalue_reference_helper< T, Void< T && > >

  Helper template for Add_rvalue_reference.
- struct Add_rvalue_reference

  Create an rvalue reference of the given type.
- struct Bool

  Boolean meta type.
- struct False

  False meta value.
- struct True

  True meta value.
- struct Integral_constant

  Wrapper for a static constant of the given type.
- struct Is_enum

  Check whether the given type is an enumeration type.
- struct Is_trivially_copyable

  Check whether the given type is trivially copyable.
- struct __Underlying_type_helper

  Helper template for Underlying_type.
- struct __Underlying_type_helper< T, false >

  Helper template for Underlying_type.
- struct Underlying_type

  Get an underlying type of an enumeration type.
- struct Same

  Compare two data types for equality.
- struct Same_template

  Check if a type T is an instantiation of a given template.

Typedefs

- template<typename...>
  using **Void** = void

  Map a sequence of any types to the void type.
- template<typename T>
  using **Add_rvalue_reference_t** = typename Add_rvalue_reference<T>::type

  Helper type for the Add_rvalue_reference.
- template<typename T>
  using **Underlying_type_t** = typename Underlying_type<T>::type

  Helper type for Underlying_type.
- template<bool Condition, typename T = void>
  using **Enable_if_t** = typename Enable_if<Condition, T>::type

  Helper type for Enable_if.

Functions

- template<typename T>
  Add_rvalue_reference_t< T > declval () noexcept

  Template for writing typed expressions in unevaluated contexts.

14.10.1 Detailed Description

L4 basic type helpers for C++.

14.10.2 Function Documentation

14.10.2.1 declval()

```
template<typename T>
Add_rvalue_reference_t< T > L4::Types::declval ()  [noexcept]
```

Template for writing typed expressions in unevaluated contexts.
In unevaluated contexts, the template converts a type (possibly an incomplete type) to an expression of that type.

Template Parameters

T	Type to be converted to an expression of that type.

14.11 L4Re Namespace Reference

L4Re C++ Interfaces.

Namespaces

- namespace Vfs

  Virtual file system for interfaces in POSIX libc.
- namespace Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

Data Structures

- class Cap_alloc

  Capability allocator interface.
- class Smart_cap_auto

  Helper for Unique_cap and Unique_del_cap.
- class Smart_count_cap

Helper for Ref_cap and Ref_del_cap.

- class Console

  Console class.
- class Dataspace

  Interface for memory-like objects.
- class Debug_obj

  Debug interface.
- class Dma_space

  Managed DMA Address Space.
- class Dma_space_mgr

  A privileged interface to manage Dma_space associations for the clients.
- class Env

  C++ interface of the initial environment that is provided to an L4 task.
- class Event

  Event class.
- struct Default_event_payload

  Default event stream payload.
- class Event_buffer_t

  Event buffer class.
- class Inhibitor

  Set of inhibitor locks, which inhibit specific actions when held.
- class Itas

  Interface to the ITAS.
- class Log

  Log interface class.
- class Mem_alloc

  Memory allocation interface.
- struct Mmio_space

  Interface for memory-like address space accessible via IPC.
- class Namespace

  Name-space interface.
- class Parent

  Parent interface.
- struct Random

  Low-bandwidth interface for random number generators.
- class Rm

  Region map.

Typedefs

- template<typename T>
  using Shared_cap = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_ALL_SPACES>>

  Shared capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using Shared_del_cap = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_DELETE_OBJ>>

  Shared capability that implements automatic free and unmap+delete of the capability slot.
- template<typename T>
  using Unique_cap = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_ALL_SPACES>>

  Unique capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using Unique_del_cap = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_DELETE_OBJ>>

  Unique capability that implements automatic free and unmap+delete of the capability slot.

Functions

- void throw_error (long err, char const *extra="")

  Generate C++ exception.
- l4_ret_t chksys (l4_ret_t err, char const *extra="", l4_ret_t ret=0)

  Generate C++ exception on error.
- l4_ret_t chksys (l4_msgtag_t const &t, char const *extra="", l4_utcb_t *utcb=l4_utcb(), l4_ret_t ret=0)

  Generate C++ exception on error.
- l4_ret_t chksys (l4_msgtag_t const &t, l4_utcb_t *utcb, char const *extra="")

  Generate C++ exception on error.
- template<typename T>
  T chkcap (T &&cap, char const *extra="", l4_ret_t err=-L4_ENOMEM)

  Check for valid capability or raise C++ exception.
- l4_msgtag_t chkipc (l4_msgtag_t tag, char const *extra="", l4_utcb_t *utcb=l4_utcb())

  Test a message tag for IPC errors.
- template<typename T>
  Shared_cap< T > make_shared_cap (L4Re::Cap_alloc *ca)

  Allocate a capability slot and wrap it in a Shared_cap.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_reinterpret_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_reinterpret_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_dynamic_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a dynamic cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_dynamic_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by an dynamic cast from another shared capability with move semantics.
- template<typename T>
  Shared_del_cap< T > make_shared_del_cap (L4Re::Cap_alloc *ca)

  Allocate a capability slot and wrap it in a Shared_del_cap.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_reinterpret_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_reinterpret_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_dynamic_cast (Shared_del_cap< U > const &from) noexcept

Create a new shared capability by a dynamic cast from another shared capability.

- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_dynamic_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an dynamic cast from another shared capability with move semantics.
- template<typename T>
  Unique_cap< T > make_unique_cap (L4Re::Cap_alloc *ca)

  Allocate a capability slot and wrap it in an Unique_cap.
- template<typename T>
  Unique_del_cap< T > make_unique_del_cap (L4Re::Cap_alloc *ca)

  Allocate a capability slot and wrap it in an Unique_del_cap.

14.11.1 Detailed Description

L4Re C++ Interfaces.
L4 Runtime Environment.

14.11.2 Typedef Documentation

14.11.2.1 Shared_cap

```
template<typename T>
using L4Re::Shared_cap = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_ALL_SPACES>>
```

Shared capability that implements automatic free and unmap of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

This shared capability implements a counted reference to a capability slot. The capability shall be unmapped and freed when the reference count in the allocator goes to zero.

Note

This type is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::Shared_cap.

Definition at line 34 of file shared_cap.

14.11.2.2 Shared_del_cap

```
template<typename T>
using L4Re::Shared_del_cap = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_DELETE_OBJ>>
```

Shared capability that implements automatic free and unmap+delete of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

This shared capability implements a counted reference to a capability slot. The capability shall be unmapped and freed when the reference count in the allocator goes to zero. The main difference to Shared_cap is that the unmap is done with the deletion flag enabled and this leads to the deletion of the object if the current task holds appropriate deletion rights.

Note

This type is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::Shared_del_cap.

Definition at line 185 of file shared_cap.

14.11.2.3 Unique_cap

```
template<typename T>
using L4Re::Unique_cap = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_ALL_SPACES>>
```

Unique capability that implements automatic free and unmap of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

The ownership of the capability is managed in the same way as unique_ptr.

Note

This type is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::Unique_cap.

Definition at line 31 of file unique_cap.

14.11.2.4 Unique_del_cap

```
template<typename T>
using L4Re::Unique_del_cap = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_DELETE_OBJ>>
```

Unique capability that implements automatic free and unmap+delete of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

The main difference to Unique_cap is that the unmap is done with the deletion flag enabled and this leads to the deletion of the object if the current task holds appropriate deletion rights.

Note

This type is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::Unique_del_cap.

Definition at line 65 of file unique_cap.

14.11.3 Function Documentation

14.11.3.1 chkcap()

```
template<typename T>
T L4Re::chkcap (
            T && cap,
            char const * extra = "",
            l4_ret_t err = -L4_ENOMEM)  [inline]
```

Check for valid capability or raise C++ exception.

Template Parameters

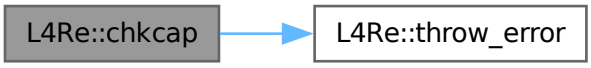
T	Type of object to check, must be capability-like (L4::Cap, L4Re::Util::Unique_cap etc.)

Parameters

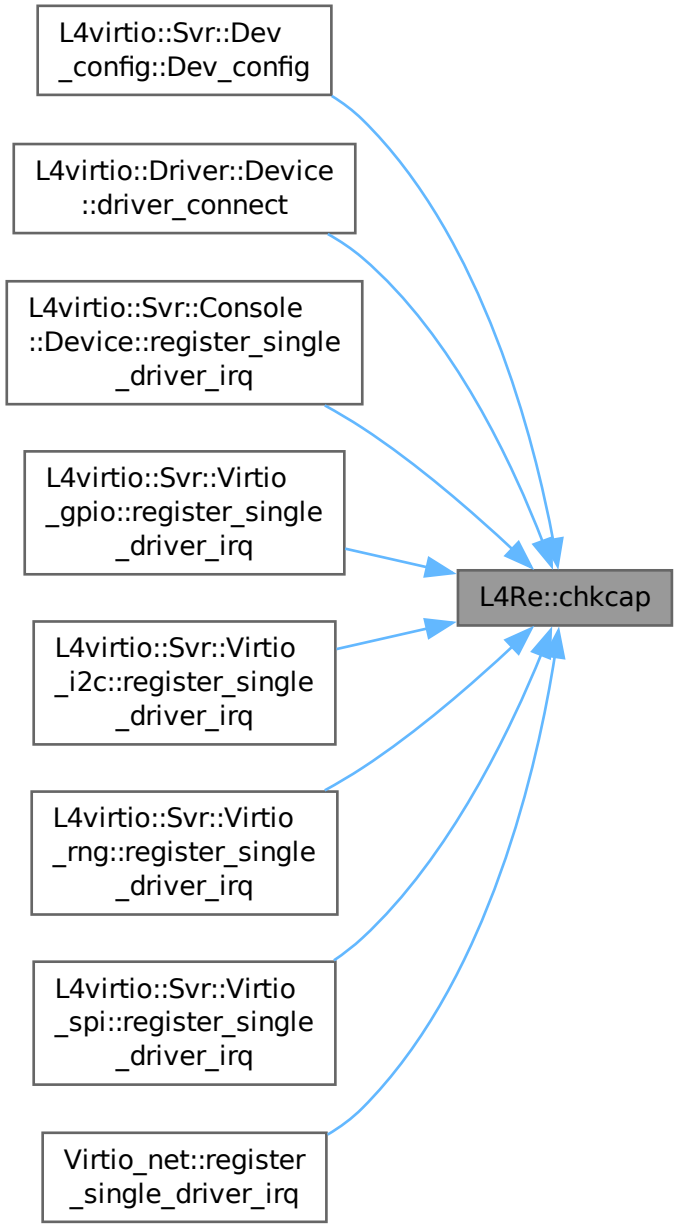
cap	Capability value to check.
extra	Optional text for exception.

err	Error value for exception or 0 if the error code stored in the invalid capability should be used.

This function checks whether the capability is valid. If the capability is invalid, a C++ exception is generated, using err if err is not zero, otherwise the capability value is used. A valid capability will just be returned.
Definition at line 149 of file error_helper.
References L4_ENOMEM, L4_UNLIKELY, and throw_error().
Referenced by L4virtio::Svr::Dev_config::Dev_config(), L4virtio::Driver::Device::driver_connect(), L4virtio::Svr::Console::Device::regist
L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::register_single_driver_irq(), L4virtio::Svr::Virtio_i2c< Request_handler, Epif
L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::register_single_driver_irq(), L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface
and Virtio_net::register_single_driver_irq().
Here is the call graph for this function:



Here is the caller graph for this function:



14.11.3.2 chkipc()

```
l4_msgtag_t L4Re::chkipc (
            l4_msgtag_t tag,
            char const * extra = "",
            l4_utcb_t * utcb = l4_utcb())  [inline]
```

Test a message tag for IPC errors.

Parameters

tag	Message tag returned by the IPC.
extra	Exception message in case of error.
utcb	The UTCB used in the IPC operation.

Returns

On IPC error an exception is thrown, otherwise `tag` is returned.

Exceptions

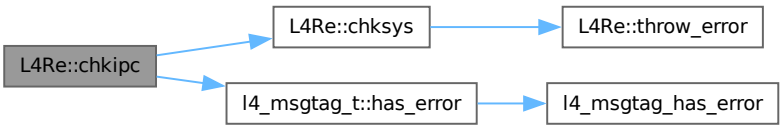
L4::Runtime_exception	with the translated IPC error code

This function does not check the message tag's label value.

Note

This must be called on a message tag before the UTCB is changed.

Definition at line 180 of file error_helper.
References chksys(), l4_msgtag_t::has_error(), and L4_UNLIKELY.
Here is the call graph for this function:



14.11.3.3 chksys() [1/3]

```
l4_ret_t L4Re::chksys (
             l4_msgtag_t const & t,
             char const * extra = "",
             l4_utcb_t * utcb = l4_utcb(),
             l4_ret_t ret = 0)  [inline]
```

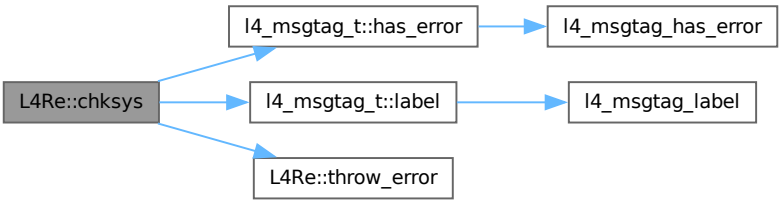
Generate C++ exception on error.

Parameters

t	Message tag.
extra	Optional text for exception (default "")
utcb	Option UTCB
ret	Optional value for exception, default is error value (err)

This function throws an exception if the message tag contains an error or the label in the message tag is negative.
Otherwise the label in the message tag is returned.
Definition at line 93 of file error_helper.

References l4_msgtag_t::has_error(), L4_UNLIKELY, l4_msgtag_t::label(), and throw_error().
Here is the call graph for this function:



14.11.3.4 chksys() [2/3]

```
l4_ret_t L4Re::chksys (
            l4_msgtag_t const & t,
            l4_utcb_t * utcb,
            char const * extra = "")  [inline]
```

Generate C++ exception on error.

Parameters

t	Message tag.
utcb	UTCB.
extra	Optional text for exception (default "")

This function throws an exception if the message tag contains an error or the label in the message tag is negative.
Otherwise the label in the message tag is returned.
Definition at line 116 of file error_helper.
References chksys().
Here is the call graph for this function:



14.11.3.5 chksys() [3/3]

```
l4_ret_t L4Re::chksys (
            l4_ret_t err,
            char const * extra = "",
            l4_ret_t ret = 0)  [inline]
```

Generate C++ exception on error.

Parameters

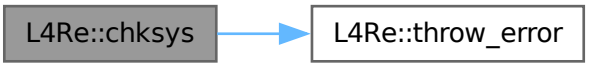
err	Error value, if negative exception will be thrown
extra	Optional text for exception (default "")
ret	Optional value for exception, default is error value (err)

This function throws an exception if the err is negative and otherwise returns err.

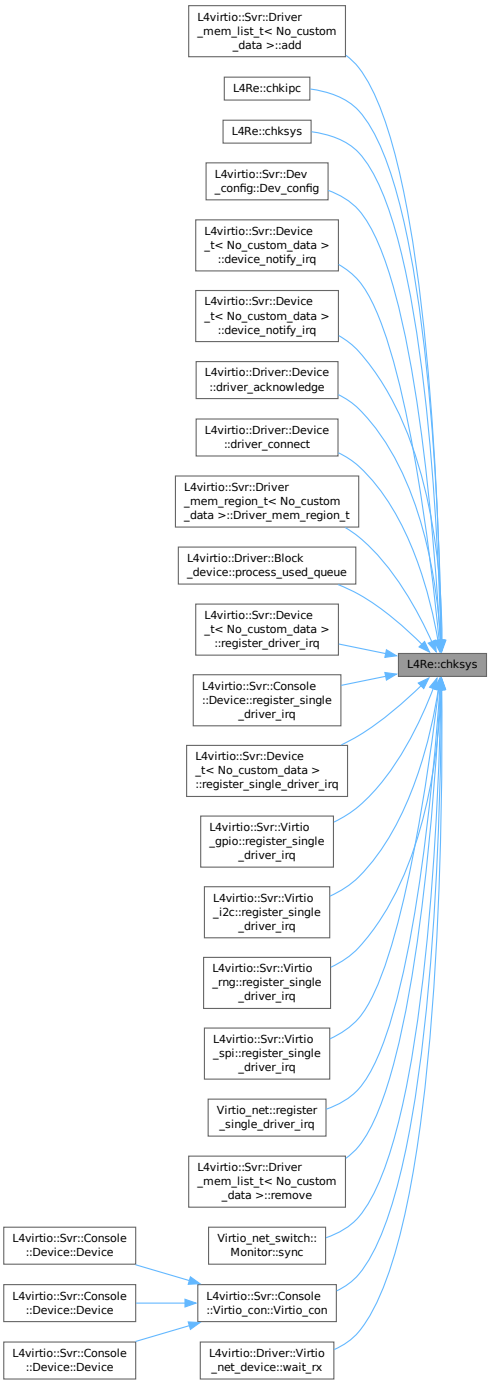
Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc.

Definition at line 72 of file error_helper.
References L4_UNLIKELY, and throw_error().
Referenced by L4virtio::Svr::Driver_mem_list_t< No_custom_data >::add(), chkipc(), chksys(), L4virtio::Svr::Dev_config::Dev_config(
L4virtio::Svr::Device_t< No_custom_data >::device_notify_irq(), L4virtio::Svr::Device_t< No_custom_data >::device_notify_irq(),
L4virtio::Driver::Device::driver_acknowledge(), L4virtio::Driver::Device::driver_connect(), L4virtio::Svr::Driver_mem_region_t< No_cu
L4virtio::Driver::Block_device::process_used_queue(), L4virtio::Svr::Device_t< No_custom_data >::register_driver_irq(),
L4virtio::Svr::Console::Device::register_single_driver_irq(), L4virtio::Svr::Device_t< No_custom_data >::register_single_driver_irq(),
L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::register_single_driver_irq(), L4virtio::Svr::Virtio_i2c< Request_handler, Epifa
L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::register_single_driver_irq(), L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >
Virtio_net::register_single_driver_irq(), L4virtio::Svr::Driver_mem_list_t< No_custom_data >::remove(), Virtio_net_switch::Monitor::s
L4virtio::Svr::Console::Virtio_con::Virtio_con(), and L4virtio::Driver::Virtio_net_device::wait_rx().
Here is the call graph for this function:



Here is the caller graph for this function:



14.11.3.6 make_shared_cap()

```
template<typename T>
Shared_cap< T > L4Re::make_shared_cap (
            L4Re::Cap_alloc * ca)
```

Allocate a capability slot and wrap it in a Shared_cap.

Template Parameters

T	Type of the object the capability refers to.

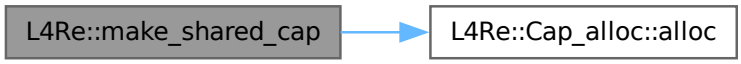
Parameters

ca	Capability allocator to use.

Note

This function is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::make_shared_cap<T>().

Definition at line 51 of file shared_cap.
References L4Re::Cap_alloc::alloc().
Here is the call graph for this function:



14.11.3.7 make_shared_del_cap()

```
template<typename T>
Shared_del_cap< T > L4Re::make_shared_del_cap (
            L4Re::Cap_alloc * ca)
```

Allocate a capability slot and wrap it in a Shared_del_cap.

Template Parameters

T	Type of the object the capability refers to.

Parameters

ca	Capability allocator to use.

Note

This function is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::make_shared_del_cap<T>().

Definition at line 202 of file shared_cap.
References L4Re::Cap_alloc::alloc().

Here is the call graph for this function:



14.11.3.8 make_unique_cap()

```
template<typename T>
Unique_cap< T > L4Re::make_unique_cap (
            L4Re::Cap_alloc * ca)
```

Allocate a capability slot and wrap it in an Unique_cap.

Template Parameters

T	Type of the object the capability refers to.

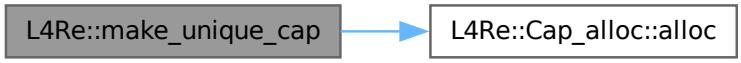
Parameters

ca	Capability allocator to use.

Note

This function is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::make_unique_cap<T>().

Definition at line 48 of file unique_cap.
References L4Re::Cap_alloc::alloc().
Here is the call graph for this function:



14.11.3.9 make_unique_del_cap()

```
template<typename T>
Unique_del_cap< T > L4Re::make_unique_del_cap (
            L4Re::Cap_alloc * ca)
```

Allocate a capability slot and wrap it in an Unique_del_cap.

Template Parameters

T	Type of the object the capability refers to.

Parameters

ca	Capability allocator to use.

Note

This function is intended for users who implement a custom capability allocator; otherwise use L4Re::Util::make_unique_del_cap<T>().

Definition at line 82 of file unique_cap.
References L4Re::Cap_alloc::alloc().
Here is the call graph for this function:



14.11.3.10 shared_cap_cast() [1/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::shared_cap_cast (
            Shared_cap< U > && from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability with move semantics.
Type `U` must be convertible to type `T`. After the call, `from` is empty.

See also

L4::cap_cast

Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 86 of file shared_cap.
References L4::cap_cast().

Here is the call graph for this function:



14.11.3.11 shared_cap_cast() [2/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::shared_cap_cast (
            Shared_cap< U > const & from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability.
Type `U` must be convertible to type `T`.

See also

L4::cap_cast

Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 67 of file shared_cap.
References L4::cap_cast().
Here is the call graph for this function:



14.11.3.12 shared_cap_dynamic_cast() [1/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::shared_cap_dynamic_cast (
            Shared_cap< U > && from)  [noexcept]
```

Create a new shared capability by an dynamic cast from another shared capability with move semantics.

See also

L4::cap_dynamic_cast

After the call, `from` is empty, unless the L4::cap_dynamic_cast fails.

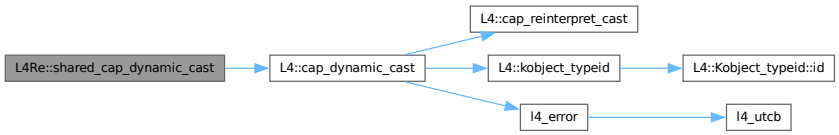
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 160 of file shared_cap.
References L4::cap_dynamic_cast().
Here is the call graph for this function:



14.11.3.13 shared_cap_dynamic_cast() [2/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::shared_cap_dynamic_cast (
            Shared_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a dynamic cast from another shared capability.

See also

L4::cap_dynamic_cast

Template Parameters

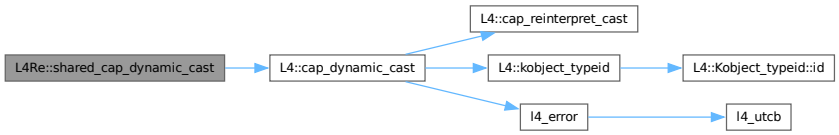
T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 139 of file shared_cap.
References L4::cap_dynamic_cast().

Here is the call graph for this function:



14.11.3.14 shared_cap_reinterpret_cast() [1/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::shared_cap_reinterpret_cast (
            Shared_cap< U > && from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability with move semantics. After the call, `from` is empty.

See also

L4::cap_reinterpret_cast

Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 122 of file shared_cap.
References L4::cap_reinterpret_cast().
Here is the call graph for this function:



14.11.3.15 shared_cap_reinterpret_cast() [2/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::shared_cap_reinterpret_cast (
            Shared_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability.

See also

L4::cap_reinterpret_cast

Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 103 of file shared_cap.
References L4::cap_reinterpret_cast().
Here is the call graph for this function:



14.11.3.16 shared_del_cap_cast() [1/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::shared_del_cap_cast (
            Shared_del_cap< U > && from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability with move semantics.
Type `U` must be convertible to type `T`. After the call, `from` is empty.

See also

L4::cap_cast

Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 237 of file shared_cap.
References L4::cap_cast().

Here is the call graph for this function:



14.11.3.17 shared_del_cap_cast() [2/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::shared_del_cap_cast (
            Shared_del_cap< U > const & from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability.
Type `U` must be convertible to type `T`.

See also

L4::cap_cast

Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 218 of file shared_cap.
References L4::cap_cast().
Here is the call graph for this function:



14.11.3.18 shared_del_cap_dynamic_cast() [1/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::shared_del_cap_dynamic_cast (
            Shared_del_cap< U > && from)  [noexcept]
```

Create a new shared capability by an dynamic cast from another shared capability with move semantics.

See also

L4::cap_dynamic_cast

After the call, `from` is empty, unless the L4::cap_dynamic_cast fails.

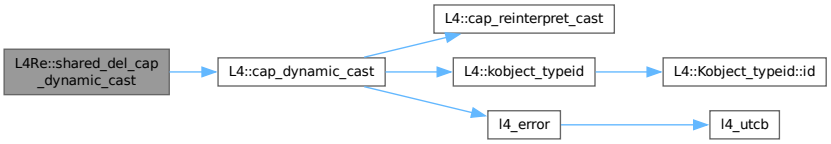
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 315 of file shared_cap.
References L4::cap_dynamic_cast().
Here is the call graph for this function:



14.11.3.19 shared_del_cap_dynamic_cast() [2/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::shared_del_cap_dynamic_cast (
            Shared_del_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a dynamic cast from another shared capability.

See also

L4::cap_dynamic_cast

Template Parameters

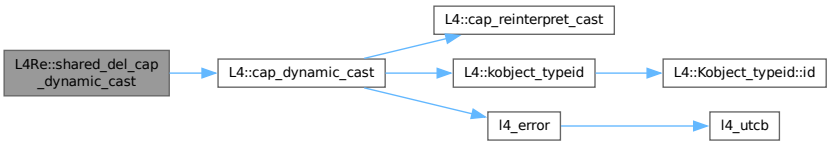
T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 293 of file shared_cap.
References L4::cap_dynamic_cast().

Here is the call graph for this function:



14.11.3.20 shared_del_cap_reinterpret_cast() [1/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::shared_del_cap_reinterpret_cast (
            Shared_del_cap< U > && from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
After the call, `from` is empty.

See also

L4::cap_reinterpret_cast

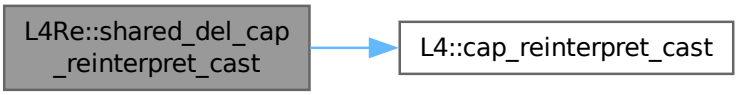
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 275 of file shared_cap.
References L4::cap_reinterpret_cast().
Here is the call graph for this function:



14.11.3.21 shared_del_cap_reinterpret_cast() [2/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::shared_del_cap_reinterpret_cast (
            Shared_del_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability.

See also

L4::cap_reinterpret_cast

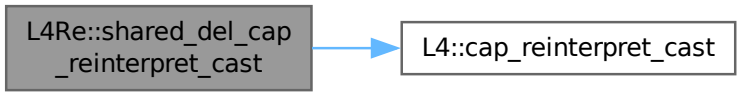
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 255 of file shared_cap.
References L4::cap_reinterpret_cast().
Here is the call graph for this function:



14.11.3.22 throw_error()

```
void L4Re::throw_error (
            long err,
            char const * extra = "")  [inline]
```

Generate C++ exception.

Parameters

err	Error value
extra	Optional text for exception (default "")

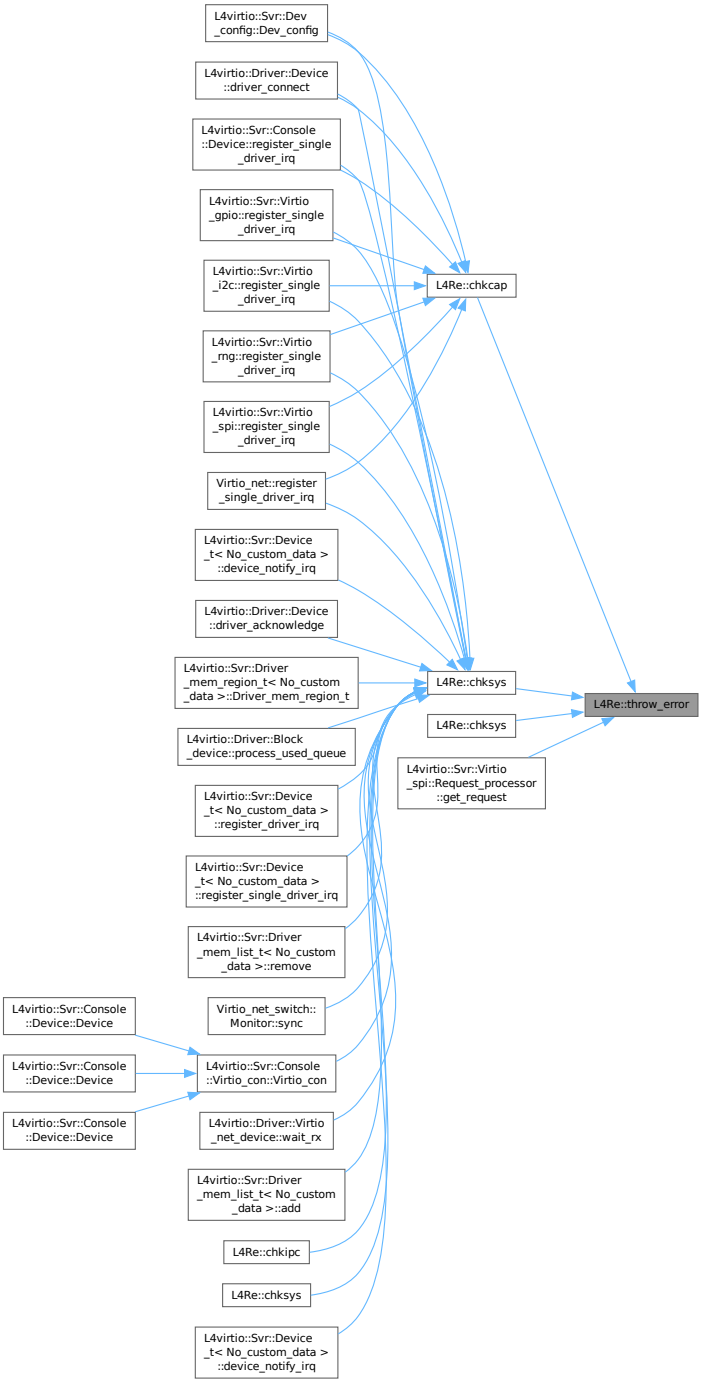
This function throws an L4 exception. The exact exception type depends on the error value (err). This function does never return.

Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc.

Definition at line 37 of file error_helper.
References L4_EEXIST, L4_ENOENT, L4_ENOMEM, and L4_ERANGE.
Referenced by chkcap(), chksys(), chksys(), and L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Request_processor::get_

Here is the caller graph for this function:



14.12 L4Re::Util Namespace Reference

Documentation of the L4 Runtime Environment utility functionality in C++.

Data Structures

- class Cap_alloc_base

  Capability allocator.

- class Br_manager

  Buffer-register (BR) manager for L4::Server.
- struct Br_manager_hooks

  Predefined server-loop hooks for a server loop using the Br_manager.
- struct Br_manager_timeout_hooks

  Predefined server-loop hooks for a server with using the Br_manager and a timeout queue.
- class Smart_cap_auto

  Helper for Unique_cap and Unique_del_cap.
- class Smart_count_cap

  Helper for Ref_cap and Ref_del_cap.
- struct Ref_cap

  Automatic capability that implements automatic free and unmap of the capability slot.
- struct Ref_del_cap

  Automatic capability that implements automatic free and unmap+delete of the capability slot.
- class _Cap_alloc

  Adapter to expose the cap allocator implementation as L4Re::Cap_alloc compatible class.
- struct Counter

  Counter for Counting_cap_alloc with variable data width.
- struct Counter_atomic

  Thread safe version of counter for Counting_cap_alloc.
- class Counting_cap_alloc

  Internal reference-counting cap allocator.
- class Dataspace_svr

  Dataspace server class.
- class Event_t

  Convenience wrapper for getting access to an event object.
- class Event_buffer_t

  Event_buffer utility class.
- class Event_buffer_consumer_t

  An event buffer consumer.
- class Event_svr

  Convenience wrapper for implementing an event server.
- class Item_alloc_base

  Item allocator.
- class Object_registry

  A registry that manages server objects and their attached IPC gates for a single server loop for a specific thread.
- class Registry_server

  A server loop object which has a Object_registry included.
- class Vcon_svr

  Console server template class.
- class Bitmap_base

  Basic bitmap abstraction.
- class Bitmap

  A static bitmap.

Typedefs

- template<typename T>
  using Shared_cap = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_ALL_SPACES>>

  Shared capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using Shared_del_cap = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_DELETE_OBJ>>

  Shared capability that implements automatic free and unmap+delete of the capability slot.
- template<typename T>
  using Unique_cap = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_ALL_SPACES>>

  Unique capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using Unique_del_cap = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_DELETE_OBJ>>

  Unique capability that implements automatic free and unmap+delete of the capability slot.

Functions

- template<typename T>
  Ref_cap< T >::Cap make_ref_cap ()

  Allocate a capability slot and wrap it in a Ref_cap.
- template<typename T>
  Ref_del_cap< T >::Cap make_ref_del_cap ()

  Allocate a capability slot and wrap it in a Ref_del_cap.
- int kumem_alloc (l4_addr_t *mem, unsigned pages_order, L4::Cap< L4::Task > task=L4Re::Env::env() ->task(), L4::Cap< L4Re::Rm > rm=L4Re::Env::env() ->rm()) noexcept

  Allocate state area.
- template<typename T>
  Shared_cap< T > make_shared_cap ()

  Allocate a capability slot and wrap it in a Shared_cap.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_reinterpret_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_reinterpret_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_dynamic_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a dynamic cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > shared_cap_dynamic_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by an dynamic cast from another shared capability with move semantics.
- template<typename T>
  Shared_del_cap< T > make_shared_del_cap ()

  Allocate a capability slot and wrap it in a Shared_del_cap.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.

- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_reinterpret_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_reinterpret_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_dynamic_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by a dynamic cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > shared_del_cap_dynamic_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an dynamic cast from another shared capability with move semantics.
- template<typename T>
  Unique_cap< T > make_unique_cap ()

  Allocate a capability slot and wrap it in an Unique_cap.
- template<typename T>
  Unique_del_cap< T > make_unique_del_cap ()

  Allocate a capability slot and wrap it in an Unique_del_cap.

Variables

- _Cap_alloc cap_alloc

  Capability allocator.
- Def_reply_cap_alloc reply_cap_alloc

  Reply capability allocator.

14.12.1 Detailed Description

Documentation of the L4 Runtime Environment utility functionality in C++.

14.12.2 Typedef Documentation

14.12.2.1 Shared_cap

```
template<typename T>
using L4Re::Util::Shared_cap = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_ALL_SPACES>>
```

Shared capability that implements automatic free and unmap of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

This shared capability implements a counted reference to a capability slot. The capability shall be unmapped and freed when the reference count in the allocator goes to zero.
Usage:

```
L4Re::Util::Shared_cap<L4Re::Dataspace> global_ds_cap;

{
  L4Re::Util::Shared_cap<L4Re::Dataspace>
    ds_cap = make_shared_cap<L4Re::Dataspace>();
  // reference count for the allocated capability slot is now 1

  // use the dataspace cap
```

```
  L4Re::chksys(mem_alloc->alloc(4096, ds_cap.get()));

  global_ds_cap = ds_cap;
  // reference count is now 2
  ...
}
// reference count dropped to 1 (ds_cap is no longer existing).
```

Definition at line 49 of file shared_cap.

14.12.2.2 Shared_del_cap

```
template<typename T>
using L4Re::Util::Shared_del_cap = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_DELETE_OB
```

Shared capability that implements automatic free and unmap+delete of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

This shared capability implements a counted reference to a capability slot. The capability shall be unmapped and freed when the reference count in the allocator goes to zero. The main difference to Shared_cap is that the unmap is done with the deletion flag enabled and this leads to the deletion of the object if the current task holds appropriate deletion rights.
Usage:

```
L4Re::Util::Shared_del_cap<L4Re::Dataspace> global_ds_cap;

{
  L4Re::Util::Shared_del_cap<L4Re::Dataspace>
    ds_cap = make_shared_del_cap<L4Re::Dataspace>();
  // reference count for the allocated capability slot is now 1

  // use the dataspace cap
  L4Re::chksys(mem_alloc->alloc(4096, ds_cap.get()));

  global_ds_cap = ds_cap;
  // reference count is now 2
  ...
}
// reference count dropped to 1 (ds_cap is no longer existing).
...
global_ds_cap = L4_INVALID_CAP;
// reference count dropped to 0 (data space shall be deleted).
```

Definition at line 214 of file shared_cap.

14.12.2.3 Unique_cap

```
template<typename T>
using L4Re::Util::Unique_cap = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_ALL_SPACES>>
```

Unique capability that implements automatic free and unmap of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

The ownership of the capability is managed in the same way as unique_ptr.
Usage:

```
{
  L4Re::Util::Unique_cap<L4Re::Dataspace>
    ds_cap = L4Re::Util::make_unique_cap<L4Re::Dataspace>();
```

```
  // use the dataspace cap
  L4Re::chksys(mem_alloc->alloc(L4_PAGESIZE, ds_cap.get()));

  ...

  // At the end of the scope ds_cap is unmapped and the capability
  // slot is freed.
}
```

Definition at line 43 of file unique_cap.

14.12.2.4 Unique_del_cap

```
template<typename T>
using L4Re::Util::Unique_del_cap = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_DELETE_OBJ
```

Unique capability that implements automatic free and unmap+delete of the capability slot.

Template Parameters

T	Type of the object the capability refers to.

The main difference to Unique_cap is that the unmap is done with the deletion flag enabled and this leads to the deletion of the object if the current task holds appropriate deletion rights.
Usage:

```
{
  L4Re::Util::Unique_del_cap<L4Re::Dataspace>
    ds_cap = make_unique_del_cap<L4Re::Dataspace>());

  // use the dataspace cap
  L4Re::chksys(mem_alloc->alloc(L4_PAGESIZE, ds_cap.get()));

  ...

  // At the end of the scope ds_cap is unmapped and the capability
  // slot is freed. Because the deletion flag is set the data space
  // shall also be deleted (even if there are other references to this
  // data space).
}
```

Definition at line 87 of file unique_cap.

14.12.3 Function Documentation

14.12.3.1 make_shared_cap()

```
template<typename T>
Shared_cap< T > L4Re::Util::make_shared_cap ()
```

Allocate a capability slot and wrap it in a Shared_cap.

Template Parameters

T	Type of the object the capability refers to.

Definition at line 62 of file shared_cap.
References cap_alloc.
Referenced by L4virtio::Svr::Dev_config::Dev_config().

Here is the caller graph for this function:



14.12.3.2 make_shared_del_cap()

```
template<typename T>
Shared_del_cap< T > L4Re::Util::make_shared_del_cap ()
```

Allocate a capability slot and wrap it in a Shared_del_cap.

Template Parameters

T	Type of the object the capability refers to.

Definition at line 227 of file shared_cap.
References cap_alloc.

14.12.3.3 make_unique_cap()

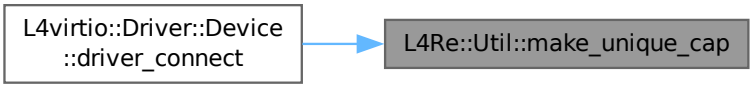
```
template<typename T>
Unique_cap< T > L4Re::Util::make_unique_cap ()
```

Allocate a capability slot and wrap it in an Unique_cap.

Template Parameters

T	Type of the object the capability refers to.

Definition at line 56 of file unique_cap.
References cap_alloc.
Referenced by L4virtio::Driver::Device::driver_connect().
Here is the caller graph for this function:



14.12.3.4 make_unique_del_cap()

```
template<typename T>
Unique_del_cap< T > L4Re::Util::make_unique_del_cap ()
```

Allocate a capability slot and wrap it in an Unique_del_cap.

Template Parameters

T	Type of the object the capability refers to.

Definition at line 100 of file unique_cap.
References cap_alloc.

14.12.3.5 shared_cap_cast() [1/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::Util::shared_cap_cast (
            Shared_cap< U > && from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability with move semantics.
Type `U` must be convertible to type `T`. After the call, `from` is empty.

See also

L4::cap_cast

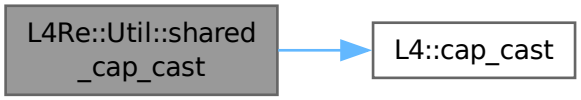
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 97 of file shared_cap.
References L4::cap_cast().
Here is the call graph for this function:



14.12.3.6 shared_cap_cast() [2/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::Util::shared_cap_cast (
            Shared_cap< U > const & from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability.
Type `U` must be convertible to type `T`.

See also

L4::cap_cast

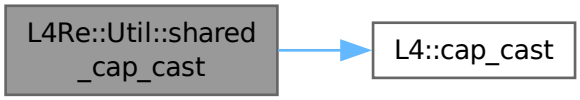
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 78 of file shared_cap.
References L4::cap_cast().
Here is the call graph for this function:



14.12.3.7 shared_cap_dynamic_cast() [1/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::Util::shared_cap_dynamic_cast (
            Shared_cap< U > && from)  [noexcept]
```

Create a new shared capability by an dynamic cast from another shared capability with move semantics.

See also

L4::cap_dynamic_cast

After the call, `from` is empty, unless the L4::cap_dynamic_cast fails.

Template Parameters

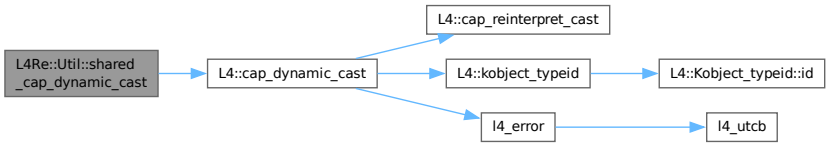
T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 171 of file shared_cap.
References L4::cap_dynamic_cast().

Here is the call graph for this function:



14.12.3.8 shared_cap_dynamic_cast() [2/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::Util::shared_cap_dynamic_cast (
            Shared_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a dynamic cast from another shared capability.

See also

L4::cap_dynamic_cast

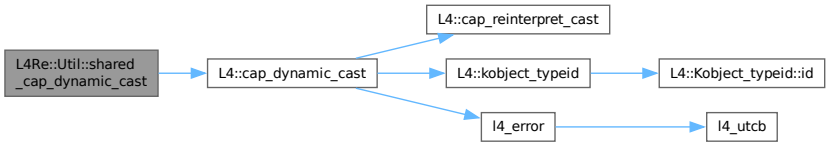
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 150 of file shared_cap.
References L4::cap_dynamic_cast().
Here is the call graph for this function:



14.12.3.9 shared_cap_reinterpret_cast() [1/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::Util::shared_cap_reinterpret_cast (
            Shared_cap< U > && from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
After the call, `from` is empty.

See also

L4::cap_reinterpret_cast

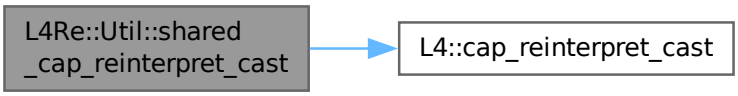
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 133 of file shared_cap.
References L4::cap_reinterpret_cast().
Here is the call graph for this function:



14.12.3.10 shared_cap_reinterpret_cast() [2/2]

```
template<typename T, typename U>
Shared_cap< T > L4Re::Util::shared_cap_reinterpret_cast (
            Shared_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability.

See also

L4::cap_reinterpret_cast

Template Parameters

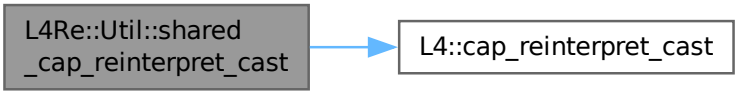
T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 114 of file shared_cap.
References L4::cap_reinterpret_cast().

Here is the call graph for this function:



14.12.3.11 shared_del_cap_cast() [1/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::Util::shared_del_cap_cast (
            Shared_del_cap< U > && from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability with move semantics. Type `U` must be convertible to type `T`. After the call, `from` is empty.

See also

L4::cap_cast

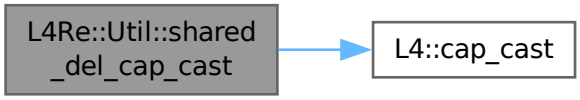
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 262 of file shared_cap.
References L4::cap_cast().
Here is the call graph for this function:



14.12.3.12 shared_del_cap_cast() [2/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::Util::shared_del_cap_cast (
            Shared_del_cap< U > const & from)  [noexcept]
```

Create a new shared capability by an explicit cast from another shared capability.
Type `U` must be convertible to type `T`.

See also

L4::cap_cast

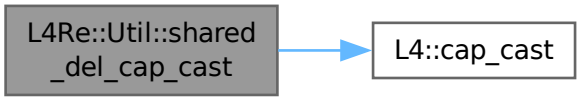
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 243 of file shared_cap.
References L4::cap_cast().
Here is the call graph for this function:



14.12.3.13 shared_del_cap_dynamic_cast() [1/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::Util::shared_del_cap_dynamic_cast (
            Shared_del_cap< U > && from)  [noexcept]
```

Create a new shared capability by an dynamic cast from another shared capability with move semantics.

See also

L4::cap_dynamic_cast

After the call, `from` is empty, unless the L4::cap_dynamic_cast fails.

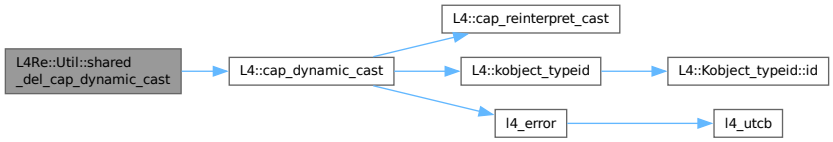
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 340 of file shared_cap.
References L4::cap_dynamic_cast().
Here is the call graph for this function:



14.12.3.14 shared_del_cap_dynamic_cast() [2/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::Util::shared_del_cap_dynamic_cast (
            Shared_del_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a dynamic cast from another shared capability.

See also

L4::cap_dynamic_cast

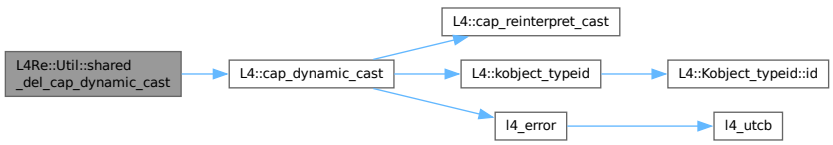
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 318 of file shared_cap.
References L4::cap_dynamic_cast().
Here is the call graph for this function:



14.12.3.15 shared_del_cap_reinterpret_cast() [1/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::Util::shared_del_cap_reinterpret_cast (
            Shared_del_cap< U > && from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
After the call, `from` is empty.

See also

L4::cap_reinterpret_cast

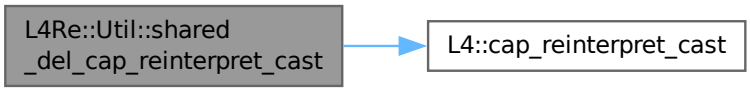
Template Parameters

T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 300 of file shared_cap.
References L4::cap_reinterpret_cast().
Here is the call graph for this function:



14.12.3.16 shared_del_cap_reinterpret_cast() [2/2]

```
template<typename T, typename U>
Shared_del_cap< T > L4Re::Util::shared_del_cap_reinterpret_cast (
            Shared_del_cap< U > const & from)  [noexcept]
```

Create a new shared capability by a reinterpret cast from another shared capability.

See also

L4::cap_reinterpret_cast

Template Parameters

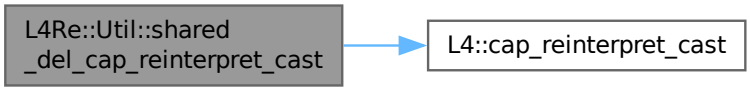
T	Type of the object the capability refers to.
U	Type of the source shared capability.

Parameters

from	Source shared capability.

Definition at line 280 of file shared_cap.

References L4::cap_reinterpret_cast().
Here is the call graph for this function:



14.13 L4Re::Vfs Namespace Reference

Virtual file system for interfaces in POSIX libc.

Data Structures

- class Be_file
  Boiler plate class for implementing an open file for L4Re::Vfs.
- class Be_file_system
  Boilerplate class for implementing a L4Re::Vfs::File_system.
- class Generic_file
  The common interface for an open POSIX file.
- class Directory
  Interface for a POSIX file that is a directory.
- class Regular_file
  Interface for a POSIX file that provides regular file semantics.
- class Special_file
  Interface for a POSIX file that provides special file semantics.
- class File
  The basic interface for an open POSIX file.
- class Mman
  Interface for POSIX memory management.
- class File_system
  Basic interface for an L4Re::Vfs file system.
- class Fs
  POSIX File-system related functionality.
- class Ops
  Interface for the POSIX backends of an application.

Functions

- L4Re::Vfs::Ops *vfs_ops **asm** ("l4re_env_posix_vfs_ops")
  Reference to the applications L4Re::Vfs::Ops singleton.

14.13.1 Detailed Description

Virtual file system for interfaces in POSIX libc.

14.14 L4vbus Namespace Reference

C++ interface of the Vbus API.

Data Structures

- class Pm

  Power-management API mixin.
- class Device

  Device on a L4vbus::Vbus.
- class Icu

  Vbus Interrupt controller API.
- class Vbus

  The virtual bus (Vbus) interface.
- class Gpio_pin

  A GPIO pin.
- class Gpio_module

  A Gpio_module groups multiple GPIO pins together.
- class Pci_host_bridge

  A Pci host bridge.
- class Pci_dev

  A PCI device.

14.14.1 Detailed Description

C++ interface of the Vbus API.
The virtual bus (Vbus) is a hierarchical (tree) structure of device nodes where each device has a set of resources attached to it. Each virtual bus provides an Icu (Interrupt controller) for interrupt handling.
The Vbus interface allows a client to find and query devices present on his virtual bus. After obtaining a device handle for a specific device the client can enumerate its resources.
Refer to L4 Vbus functions for the C API.

Include File

```
#include <l4/vbus/vbus>
```

Include File

```
#include <l4/vbus/vbus_gpio>
```

Include File

```
#include <l4/vbus/vbus_pci>
```

14.15 L4virtio Namespace Reference

L4-VIRTIO Transport C++ API.

Data Structures

- class Device

  IPC interface for virtio over L4 IPC.
- class Ptr

  Pointer used in virtio descriptors.
- class Virtqueue

  Low-level Virtqueue.

14.15.1 Detailed Description

L4-VIRTIO Transport C++ API.

Chapter 15

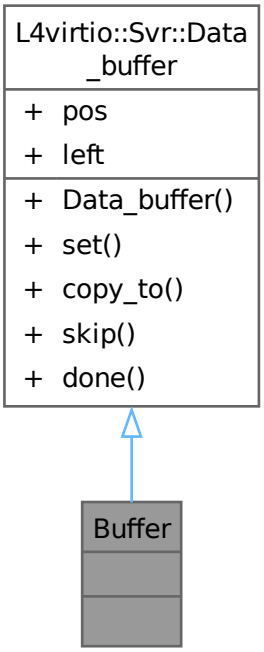
Data Structure Documentation

15.1 Buffer Struct Reference

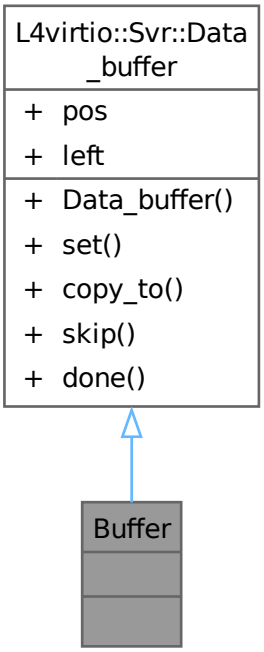
Data buffer used to transfer packets.

`#include <virtio_net_buffer.h>`

Inheritance diagram for Buffer:



Collaboration diagram for Buffer:



Additional Inherited Members

Public Member Functions inherited from L4virtio::Svr::Data_buffer

- template<typename T>
  Data_buffer (T *p)

  Create buffer for object p.
- template<typename T>
  void set (T *p)

  Set buffer for object p.
- l4_uint32_t copy_to (Data_buffer *dst, l4_uint32_t max=UINT_MAX)

  Copy contents from this buffer to the destination buffer.
- l4_uint32_t skip (l4_uint32_t bytes)

  Skip given number of bytes in this buffer.
- bool done () const

  Check if there are no more bytes left in the buffer.

Data Fields inherited from L4virtio::Svr::Data_buffer

- char * **pos**

  Current buffer position.
- l4_uint32_t **left**

  Bytes left in buffer.

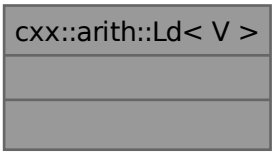
15.1.1 Detailed Description

Data buffer used to transfer packets.
Definition at line 19 of file virtio_net_buffer.h.
The documentation for this struct was generated from the following file:

- pkg/virtio-net-switch/server/switch/virtio_net_buffer.h

15.2 cxx::arith::Ld< V > Struct Template Reference

Computes the binary logarithm of the given number at compile time.
`#include <arith>`
Collaboration diagram for cxx::arith::Ld< V >:



15.2.1 Detailed Description

template<unsigned long V>
struct cxx::arith::Ld< V >

Computes the binary logarithm of the given number at compile time.

Parameters

val	Number whose logarithm to compute, must be greater than zero.

Returns

The binary logarithm of `val`.

Definition at line 48 of file arith.
The documentation for this struct was generated from the following file:

- l4/cxx/arith

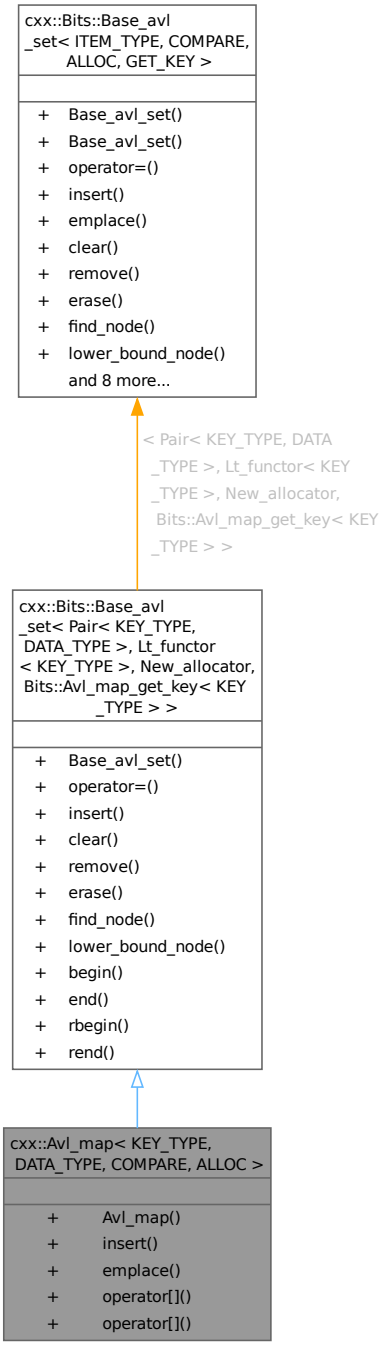
15.3 cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC > Class Template Reference

AVL tree based associative container.
`#include <avl_map>`

Inheritance diagram for cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >:



Collaboration diagram for cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >:



Public Types

- typedef COMPARE< KEY_TYPE > **Key_compare**

  Type of the comparison functor.
- typedef KEY_TYPE **Key_type**

  Type of the key values.
- typedef DATA_TYPE **Data_type**

  Type of the data values.

- typedef Base_type::Node **Node**

  Return type for find.
- typedef Base_type::Node_allocator **Node_allocator**

  Type of the allocator.

Public Types inherited from cxx::Bits::Base_avl_set< Pair< KEY_TYPE, DATA_TYPE >, Lt_functor< KEY_TYPE >, New_allocator,

- enum

  Return status constants.
- typedef Pair< KEY_TYPE, DATA_TYPE > **Item_type**

  Type for the items store in the set.
- typedef Bits::Avl_map_get_key< KEY_TYPE > **Get_key**

  Key-getter type to derive the sort key of an internal node.
- typedef Bits::Avl_map_get_key< KEY_TYPE >::Key_type **Key_type**

  Type of the sort key used for the items.
- typedef Type_traits< Item_type >::Const_type **Const_item_type**

  Type used for const items within the set.
- typedef Lt_functor< KEY_TYPE > **Item_compare**

  Type for the comparison functor.
- typedef New_allocator< _Node > **Node_allocator**

  Type for the node allocator.
- typedef Avl_set_iter< _Node, Item_type, Fwd > **Iterator**

  Forward iterator for the set.
- typedef Avl_set_iter< _Node, Const_item_type, Fwd > **Const_iterator**

  Constant forward iterator for the set.
- typedef Avl_set_iter< _Node, Item_type, Rev > **Rev_iterator**

  Backward iterator for the set.
- typedef Avl_set_iter< _Node, Const_item_type, Rev > **Const_rev_iterator**

  Constant backward iterator for the set.

Public Member Functions

- Avl_map (Node_allocator const &alloc=Node_allocator())

  Create an empty AVL-tree based map.
- cxx::Pair< Iterator, int > insert (Key_type const &key, Data_type const &data)

  Insert a <key, data> pair into the map.
- template<typename... Args>
  cxx::Pair< Iterator, int > emplace (Args &&...args)

  Emplace a pair into the map.
- Data_type const & operator[ ] (Key_type const &key) const &

  Get the data for the given key.
- Data_type & operator[ ] (Key_type const &key) &

  Get or insert data for the given key.

Public Member Functions inherited from cxx::Bits::Base_avl_set< Pair< KEY_TYPE, DATA_TYPE >, Lt_functor< KEY_TYPE >, New_allocator,

- Base_avl_set (Node_allocator const &alloc=Node_allocator())

  Create a AVL-tree based set.
- Base_avl_set & operator= (Base_avl_set const &o)

  Copy assignment operator of an AVL-tree based set.

- cxx::Pair< Iterator, int > insert (Item_type const &item)

  Insert an item into the set.
- void **clear** () noexcept

  Remove all items from the set.
- int remove (Key_type const &item)

  Remove an item from the set.
- int erase (Key_type const &item)

  Erase the item with the given key.
- Node find_node (Key_type const &item) const

  Lookup a node equal to `item`.
- Node lower_bound_node (Key_type const &key) const

  Find the first node greater or equal to `key`.
- Const_iterator begin () const

  Get the constant forward iterator for the first element in the set.
- Const_iterator end () const

  Get the end marker for the constant forward iterator.
- Const_rev_iterator rbegin () const

  Get the constant backward iterator for the last element in the set.
- Const_rev_iterator rend () const

  Get the end marker for the constant backward iterator.

15.3.1 Detailed Description

template<typename KEY_TYPE, typename DATA_TYPE, template< typename A > class COMPARE = Lt_↩ functor, template< typename B > class ALLOC = New_allocator>
class cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >

AVL tree based associative container.

Template Parameters

KEY_TYPE	Type of the key values.
DATA_TYPE	Type of the data values.
COMPARE	Type comparison functor for the key values.
ALLOC	Type of the allocator used for the nodes.

Definition at line 45 of file avl_map.

15.3.2 Constructor & Destructor Documentation

15.3.2.1 Avl_map()

```
template<typename KEY_TYPE, typename DATA_TYPE, template< typename A > class COMPARE = Lt_↩
functor, template< typename B > class ALLOC = New_allocator>
cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >::Avl_map (
            Node_allocator const & alloc = Node_allocator())  [inline]
```

Create an empty AVL-tree based map.

Parameters

alloc	The node allocator.

Definition at line 80 of file avl_map.

15.3.3 Member Function Documentation

15.3.3.1 emplace()

```
template<typename KEY_TYPE, typename DATA_TYPE, template< typename A > class COMPARE = Lt_↩
functor, template< typename B > class ALLOC = New_allocator>
template<typename...  Args>
cxx::Pair< Iterator, int > cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >::emplace (
            Args &&...  args)  [inline]
```

Emplace a pair into the map.

Parameters

args	The cxx::Pair constructor arguments for key & value.

Returns

A pair of iterator (`first`) and return value (`second`). `second` will be 0 if the element was inserted into the set and -#`E_exist` if the key was already in the set and the set was therefore not updated. In both cases, `first` contains an iterator that points to the element. `second` may also be -#`E_nomem` when memory for the new node could not be allocated. `first` is then invalid.

Definition at line 117 of file avl_map.

15.3.3.2 insert()

```
template<typename KEY_TYPE, typename DATA_TYPE, template< typename A > class COMPARE = Lt_↩
functor, template< typename B > class ALLOC = New_allocator>
cxx::Pair< Iterator, int > cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >::insert (
            Key_type const & key,
            Data_type const & data)  [inline]
```

Insert a <key, data> pair into the map.

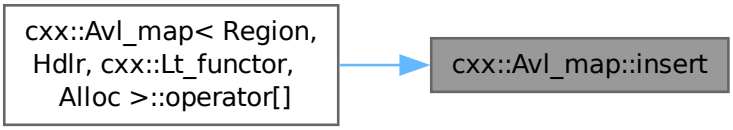
Parameters

key	The key value.
data	The data value to insert.

Returns

A pair of iterator (`first`) and return value (`second`). `second` will be 0 if the element was inserted into the set and `-#E_exist` if the key was already in the set and the set was therefore not updated. In both cases, `first` contains an iterator that points to the element. `second` may also be `-#E_nomem` when memory for the new node could not be allocated. `first` is then invalid.

Definition at line 99 of file avl_map.
Referenced by cxx::Avl_map< Region, Hdlr, cxx::Lt_functor, Alloc >::operator[]().
Here is the caller graph for this function:



15.3.3.3 operator[]() [1/2]

```
template<typename KEY_TYPE, typename DATA_TYPE, template< typename A > class COMPARE = Lt_↩
functor, template< typename B > class ALLOC = New_allocator>
Data_type & cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >::operator[] (
            Key_type const & key) &  [inline]
```

Get or insert data for the given key.

Parameters

key	The key value to use for lookup.

Returns

If the item already exists, a reference to the data item. Otherwise a new data item is default-constructed and inserted under the given key before a reference is returned.

Definition at line 139 of file avl_map.

15.3.3.4 operator[]() [2/2]

```
template<typename KEY_TYPE, typename DATA_TYPE, template< typename A > class COMPARE = Lt_↩
functor, template< typename B > class ALLOC = New_allocator>
Data_type const & cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >::operator[] (
            Key_type const & key) const &  [inline]
```

Get the data for the given key.

Parameters

key	The key value to use for lookup.

Precondition

A <key, data> pair for the given key value must exist.

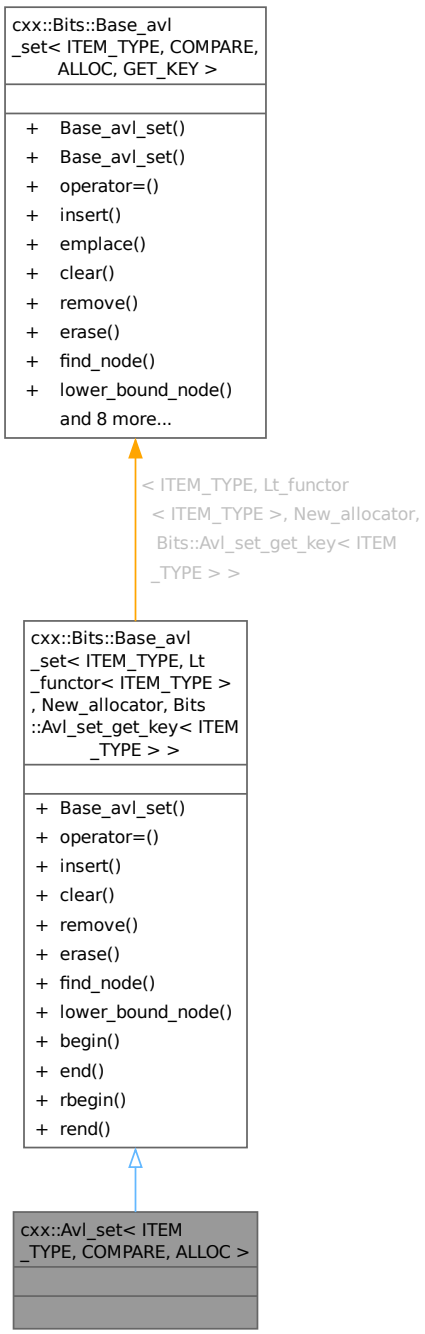
Definition at line 125 of file avl_map.
The documentation for this class was generated from the following file:

- l4/cxx/avl_map

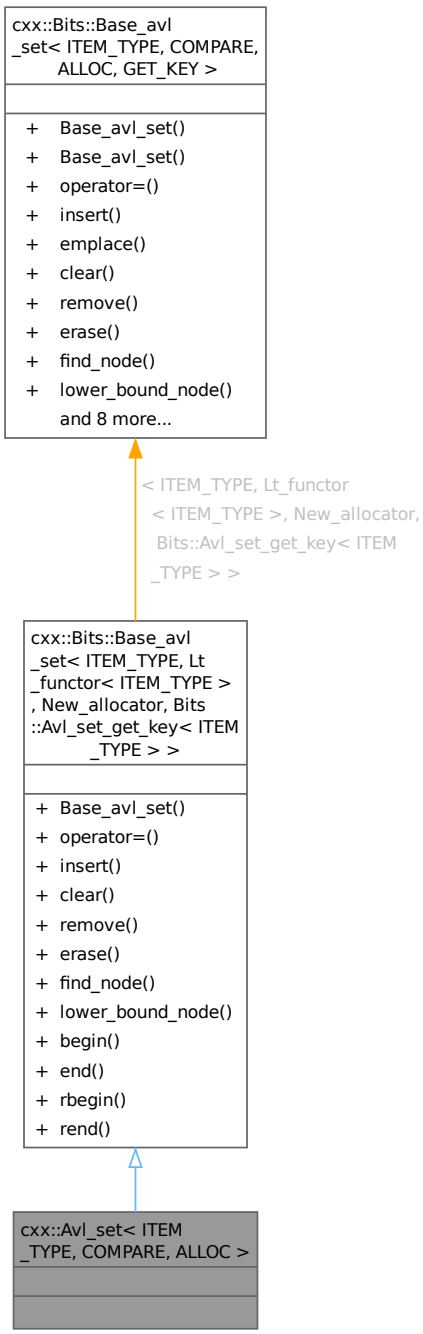
15.4 cxx::Avl_set< ITEM_TYPE, COMPARE, ALLOC > Class Template Reference

AVL set for simple comparable items.
`#include <avl_set>`

Inheritance diagram for cxx::Avl_set< ITEM_TYPE, COMPARE, ALLOC >:



Collaboration diagram for cxx::Avl_set< ITEM_TYPE, COMPARE, ALLOC >:



Additional Inherited Members

Public Types inherited from cxx::Bits::Base_avl_set< ITEM_TYPE, Lt_functor< ITEM_TYPE >, New_allocator, Bits::Avl_set_get_ke

- enum

  Return status constants.
- typedef ITEM_TYPE **Item_type**

Type for the items store in the set.

- typedef Bits::Avl_set_get_key< ITEM_TYPE > **Get_key**

  Key-getter type to derive the sort key of an internal node.
- typedef Bits::Avl_set_get_key< ITEM_TYPE >::Key_type **Key_type**

  Type of the sort key used for the items.
- typedef Type_traits< Item_type >::Const_type **Const_item_type**

  Type used for const items within the set.
- typedef Lt_functor< ITEM_TYPE > **Item_compare**

  Type for the comparison functor.
- typedef New_allocator< _Node > **Node_allocator**

  Type for the node allocator.
- typedef Avl_set_iter< _Node, Item_type, Fwd > **Iterator**

  Forward iterator for the set.
- typedef Avl_set_iter< _Node, Const_item_type, Fwd > **Const_iterator**

  Constant forward iterator for the set.
- typedef Avl_set_iter< _Node, Item_type, Rev > **Rev_iterator**

  Backward iterator for the set.
- typedef Avl_set_iter< _Node, Const_item_type, Rev > **Const_rev_iterator**

  Constant backward iterator for the set.

Public Member Functions inherited from cxx::Bits::Base_avl_set< ITEM_TYPE, Lt_functor< ITEM_TYPE >, New_allocator, Bits::Avl_set_get_ke

- Base_avl_set (Node_allocator const &alloc=Node_allocator())

  Create a AVL-tree based set.
- Base_avl_set & operator= (Base_avl_set const &o)

  Copy assignment operator of an AVL-tree based set.
- cxx::Pair< Iterator, int > insert (Item_type const &item)

  Insert an item into the set.
- void **clear** () noexcept

  Remove all items from the set.
- int remove (Key_type const &item)

  Remove an item from the set.
- int erase (Key_type const &item)

  Erase the item with the given key.
- Node find_node (Key_type const &item) const

  Lookup a node equal to `item`.
- Node lower_bound_node (Key_type const &key) const

  Find the first node greater or equal to `key`.
- Const_iterator begin () const

  Get the constant forward iterator for the first element in the set.
- Const_iterator end () const

  Get the end marker for the constant forward iterator.
- Const_rev_iterator rbegin () const

  Get the constant backward iterator for the last element in the set.
- Const_rev_iterator rend () const

  Get the end marker for the constant backward iterator.

15.4.1 Detailed Description

template<typename ITEM_TYPE, template< typename T > class COMPARE = Lt_functor, template< typename A > class ALLOC = New_allocator>
class cxx::Avl_set< ITEM_TYPE, COMPARE, ALLOC >

AVL set for simple comparable items.
The AVL set can store any kind of items where a partial order is defined. The default relation is defined by the '<' operator.

Template Parameters

ITEM_TYPE	The type of the items to be stored in the set.
COMPARE	The relation to define the partial order, default is to use operator '<'.
ALLOC	The allocator to use for the nodes of the AVL set.

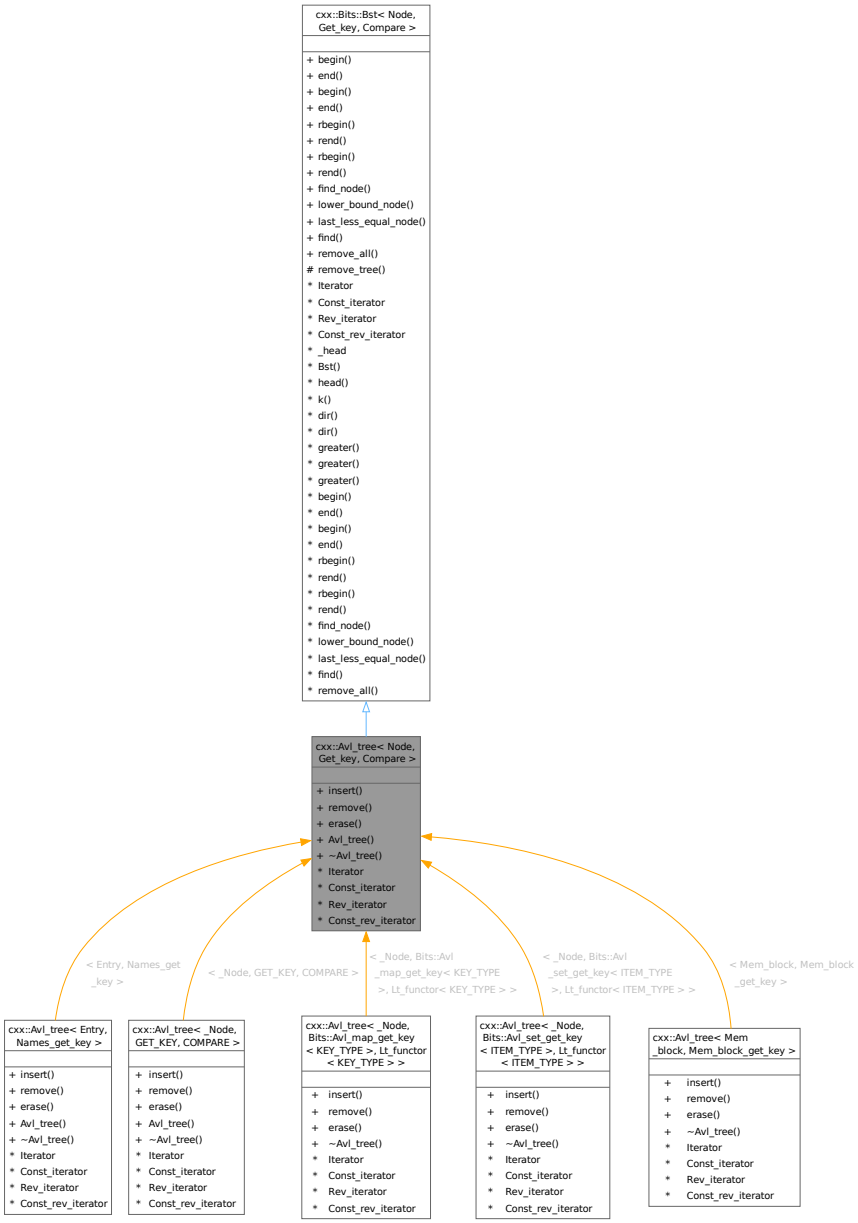
Definition at line 538 of file avl_set.
The documentation for this class was generated from the following file:

- l4/cxx/avl_set

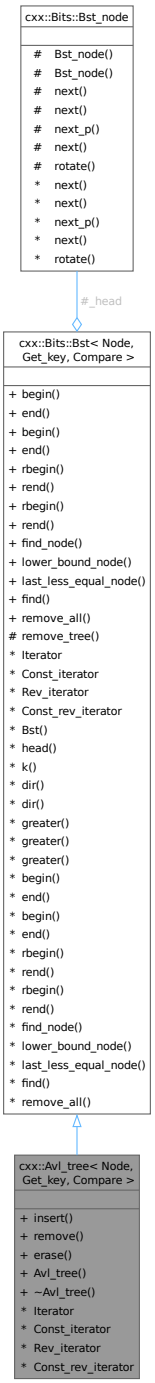
15.5 cxx::Avl_tree< Node, Get_key, Compare > Class Template Reference

A generic AVL tree.
`#include <avl_tree>`

Inheritance diagram for cxx::Avl_tree< Node, Get_key, Compare >:



Collaboration diagram for cxx::Avl_tree< Node, Get_key, Compare >:



Public Types

- typedef Bst::Iterator Iterator
- typedef Bst::Const_iterator **Const_iterator**

  Constant forward iterator for the tree.
- typedef Bst::Rev_iterator **Rev_iterator**

Backward iterator for the tree.

- typedef Bst::Const_rev_iterator **Const_rev_iterator**

  Constant backward iterator for the tree.

Public Types inherited from cxx::Bits::Bst< Node, Get_key, Compare >

- typedef Get_key::Key_type **Key_type**

  The type of key values used to generate the total order of the elements.
- typedef Type_traits< Key_type >::Param_type **Key_param_type**

  The type for key parameters.
- typedef Fwd **Fwd_iter_ops**

  Helper for building forward iterators for different wrapper classes.
- typedef Rev **Rev_iter_ops**

  Helper for building reverse iterators for different wrapper classes.
- typedef __Bst_iter< Node, Node, Fwd > **Iterator**

  Forward iterator.
- typedef __Bst_iter< Node, Node const, Fwd > **Const_iterator**

  Constant forward iterator.
- typedef __Bst_iter< Node, Node, Rev > **Rev_iterator**

  Backward iterator.
- typedef __Bst_iter< Node, Node const, Rev > **Const_rev_iterator**

  Constant backward.

Public Member Functions

- Pair< Node *, bool > insert (Node *new_node)

  Insert a new node into this AVL tree.
- Node * remove (Key_param_type key)

  Remove the node with key from the tree.
- Node * **erase** (Key_param_type key)

  An alias for remove().
- **Avl_tree** ()=default

  Create an empty AVL tree.
- ~**Avl_tree** () noexcept

  Destroy the tree.

Public Member Functions inherited from cxx::Bits::Bst< Node, Get_key, Compare >

- Const_iterator begin () const

  Get the constant forward iterator for the first element in the set.
- Const_iterator end () const

  Get the end marker for the constant forward iterator.
- Iterator begin ()

  Get the mutable forward iterator for the first element of the set.
- Iterator end ()

  Get the end marker for the mutable forward iterator.
- Const_rev_iterator rbegin () const

  Get the constant backward iterator for the last element in the set.
- Const_rev_iterator rend () const

  Get the end marker for the constant backward iterator.
- Rev_iterator rbegin ()

Get the mutable backward iterator for the last element of the set.

- Rev_iterator rend ()

  Get the end marker for the mutable backward iterator.

- Node * find_node (Key_param_type key) const

  find the node with the given key.

- Node * lower_bound_node (Key_param_type key) const

  Find the first node with a key not less than the given `key`.

- Node * last_less_equal_node (Key_param_type key) const

  Find the last node with a key less than or equal to the given `key`.

- Const_iterator find (Key_param_type key) const

  find the node with the given key.

- template<typename FUNC>
  void remove_all (FUNC &&callback)

  Clear the tree.

Additional Inherited Members

- **Bst** ()

  Create an empty tree.

- Node * **head** () const

  Access the head node as object of type Node.

Static Protected Member Functions inherited from cxx::Bits::Bst< Node, Get_key, Compare >

- template<typename FUNC>
  static void remove_tree (Bst_node *head, FUNC &&callback)

  Remove all elements in the subtree of head.

- static Key_type **k** (Bst_node const *n)

  Get the key value of n.

- static Dir dir (Key_param_type l, Key_param_type r)

  Get the direction to go from `l` to search for `r`.

- static Dir dir (Key_param_type l, Bst_node const *r)

  Get the direction to go from `l` to search for `r`.

- static bool **greater** (Key_param_type l, Key_param_type r)

  Is l greater than r.

- static bool **greater** (Key_param_type l, Bst_node const *r)

  Is l greater than r.

- static bool **greater** (Bst_node const *l, Bst_node const *r)

  Is l greater than r.

- Bst_node * **_head**

  The head pointer of the tree.

15.5.1 Detailed Description

template<typename Node, typename Get_key, typename Compare = Lt_functor<typename Get_key::Key_type>>
class cxx::Avl_tree< Node, Get_key, Compare >

A generic AVL tree.

Template Parameters

Node	The data type of the nodes (must inherit from Avl_tree_node).
Get_key	The meta function to get the key value from a node. The implementation uses `Get_key::key_of(ptr_to_node)`. The type of the key values must be defined in `Get_key::Key_type`.
Compare	Binary relation to establish a total order for the nodes of the tree. `Compare()(l, r)` must return true if the key *l* is smaller than the key *r*.

This implementation does not provide any memory management. It is the responsibility of the caller to allocate nodes before inserting them and to free them when they are removed or when the tree is destroyed. Conversely, the caller must also ensure that nodes are removed from the tree before they are destroyed.

Examples

tmpfs/lib/src/fs.cc.

Definition at line 100 of file avl_tree.

15.5.2 Member Typedef Documentation

15.5.2.1 Iterator

```
template<typename Node, typename Get_key, typename Compare = Lt_functor<typename Get_key::Key_type>>
typedef Bst::Iterator cxx::Avl_tree< Node, Get_key, Compare >::Iterator
```

Forward iterator for the tree.
Definition at line 130 of file avl_tree.

15.5.3 Member Function Documentation

15.5.3.1 insert()

```
template<typename Node, typename Get_key, class Compare>
Pair< Node *, bool > cxx::Avl_tree< Node, Get_key, Compare >::insert (
            Node * new_node)
```

Insert a new node into this AVL tree.

Parameters

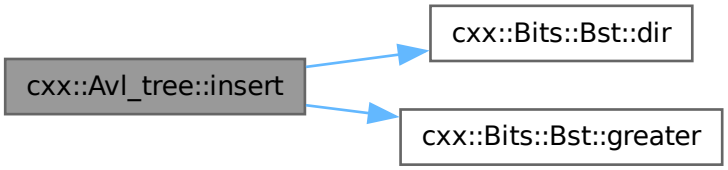
new_node	A pointer to the new node.

Returns

A pair, with *second* set to `true` and *first* pointing to *new_node*, on success. If there is already a node with the same key then *first* points to this node and *second* is 'false'.

Definition at line 220 of file avl_tree.
References cxx::Bits::Bst< Node, Get_key, Compare >::dir(), cxx::Bits::Bst< Node, Get_key, Compare >::greater(), and cxx::Bits::Direction::N.

Here is the call graph for this function:



15.5.3.2 remove()

```
template<typename Node, typename Get_key, class Compare>
Node * cxx::Avl_tree< Node, Get_key, Compare >::remove (
            Key_param_type key)  [inline]
```

Remove the node with *key* from the tree.

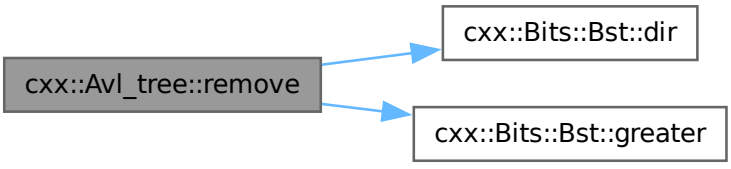
Parameters

key	The key to the node to remove.

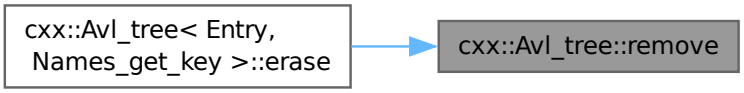
Returns

The pointer to the removed node on success, or 0 if no node with the *key* exists.

Definition at line 282 of file avl_tree.
References cxx::Bits::Bst< Node, Get_key, Compare >::dir(), cxx::Bits::Bst< Node, Get_key, Compare >::greater(), cxx::Bits::Direction::L, and cxx::Bits::Direction::N.
Referenced by cxx::Avl_tree< Entry, Names_get_key >::erase().
Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this class was generated from the following file:

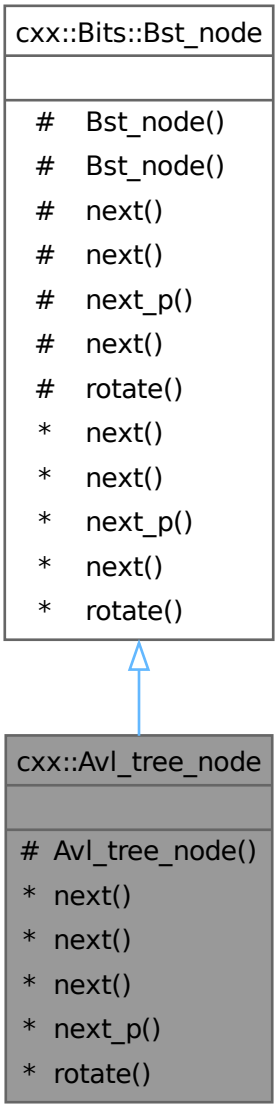
- l4/cxx/avl_tree

15.6 cxx::Avl_tree_node Class Reference

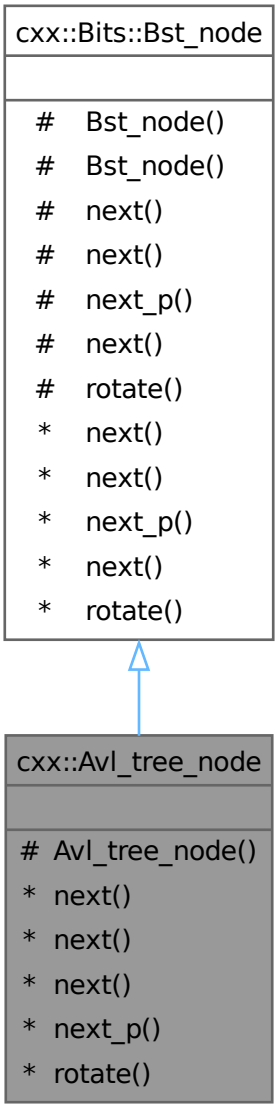
Node of an AVL tree.

`#include <avl_tree>`

Inheritance diagram for cxx::Avl_tree_node:



Collaboration diagram for cxx::Avl_tree_node:



Protected Member Functions

- **Avl_tree_node** ()=default

  Create an uninitialized node, this is what you should do.

Protected Member Functions inherited from cxx::Bits::Bst_node

- **Bst_node** ()

  Create uninitialized node.
- **Bst_node** (bool)

  Create initialized node.

Additional Inherited Members

Static Protected Member Functions inherited from cxx::Bits::Bst_node

- static Bst_node * **next** (Bst_node const *p, Direction d)

  Get next node in direction d.
- static void **next** (Bst_node *p, Direction d, Bst_node *n)

  Set next node of p in direction d to n.
- static Bst_node ** **next_p** (Bst_node *p, Direction d)

  Get pointer to link in direction d.
- template<typename Node>
  static Node * **next** (Bst_node const *p, Direction d)

  Get next node in direction d as type Node.
- static void **rotate** (Bst_node **t, Direction idir)

  Rotate subtree t in the opposite direction of idir.

15.6.1 Detailed Description

Node of an AVL tree.

Examples

tmpfs/lib/src/fs.cc.

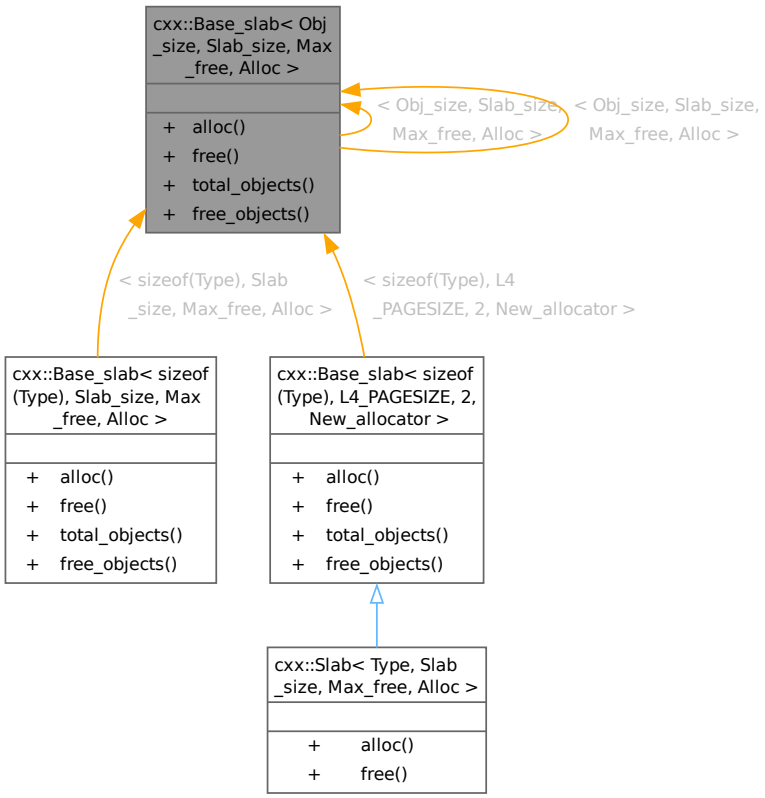
Definition at line 29 of file avl_tree.
The documentation for this class was generated from the following file:

- l4/cxx/avl_tree

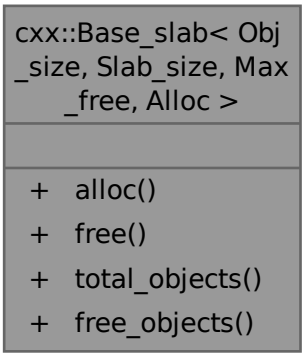
15.7 cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc > Class Template Reference

Basic slab allocator.
`#include <slab_alloc>`

Inheritance diagram for cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >:



Collaboration diagram for cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >:



Data Structures

- struct Slab_i

  Type of a slab.

Public Types

- enum { object_size = Obj_size , slab_size = Slab_size , objects_per_slab = (Slab_size - sizeof(Slab_head)) / object_size , max_free_slabs = Max_free }
- typedef Alloc< Slab_i > **Slab_alloc**

  Type of the backend allocator.

Public Member Functions

- void * alloc () noexcept

  Allocate a new object.
- void free (void *_o) noexcept

  Free the given object (_o).
- unsigned total_objects () const noexcept

  Get the total number of objects managed by the slab allocator.
- unsigned free_objects () const noexcept

  Get the number of objects which can be allocated before a new empty slab needs to be added to the slab allocator.

15.7.1 Detailed Description

template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A > class Alloc = New_allocator>
class cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >

Basic slab allocator.

Template Parameters

Obj_size	The size of the objects managed by the allocator (in bytes).
Slab_size	The size of a slab (in bytes).
Max_free	The maximum number of free slabs. When this limit is reached slabs are freed, provided that the backend allocator supports allocated memory to be freed.
Alloc	The backend allocator used to allocate slabs.

Definition at line 31 of file slab_alloc.

15.7.2 Member Enumeration Documentation

15.7.2.1 anonymous enum

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
anonymous enum
```

Enumerator

object_size	Size of an object.
slab_size	Size of a slab.
objects_per_slab	Objects per slab.
max_free_slabs	Maximum number of free slabs.

Definition at line 65 of file slab_alloc.

15.7.3 Member Function Documentation

15.7.3.1 alloc()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
void * cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >::alloc ()  [inline], [noexcept]
```

Allocate a new object.

Returns

A pointer to the new object if the allocation succeeds, or 0 on failure to acquire memory from the backend allocator when the slab cache memory is already exhausted.

Note

The user is responsible for initializing the object.

Definition at line 207 of file slab_alloc.

15.7.3.2 free()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
void cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >::free (
            void * _o)  [inline], [noexcept]
```

Free the given object (_o).

Precondition

The object must have been allocated with this allocator.

Definition at line 246 of file slab_alloc.

15.7.3.3 free_objects()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
unsigned cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >::free_objects () const  [inline],
[noexcept]
```

Get the number of objects which can be allocated before a new empty slab needs to be added to the slab allocator.

Returns

The number of free objects in the slab allocator.

Definition at line 308 of file slab_alloc.

15.7.3.4 total_objects()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
unsigned cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >::total_objects () const  [inline],
[noexcept]
```

Get the total number of objects managed by the slab allocator.

Returns

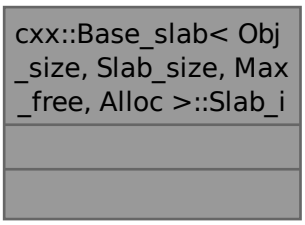
The number of objects managed by the allocator (including the free objects).

Definition at line 299 of file slab_alloc.
The documentation for this class was generated from the following file:

- l4/cxx/slab_alloc

15.8 cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >::Slab_i Struct Reference

Type of a slab.
`#include <slab_alloc>`
Collaboration diagram for cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >::Slab_i:



15.8.1 Detailed Description

template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A > class Alloc = New_allocator>
struct cxx::Base_slab< Obj_size, Slab_size, Max_free, Alloc >::Slab_i

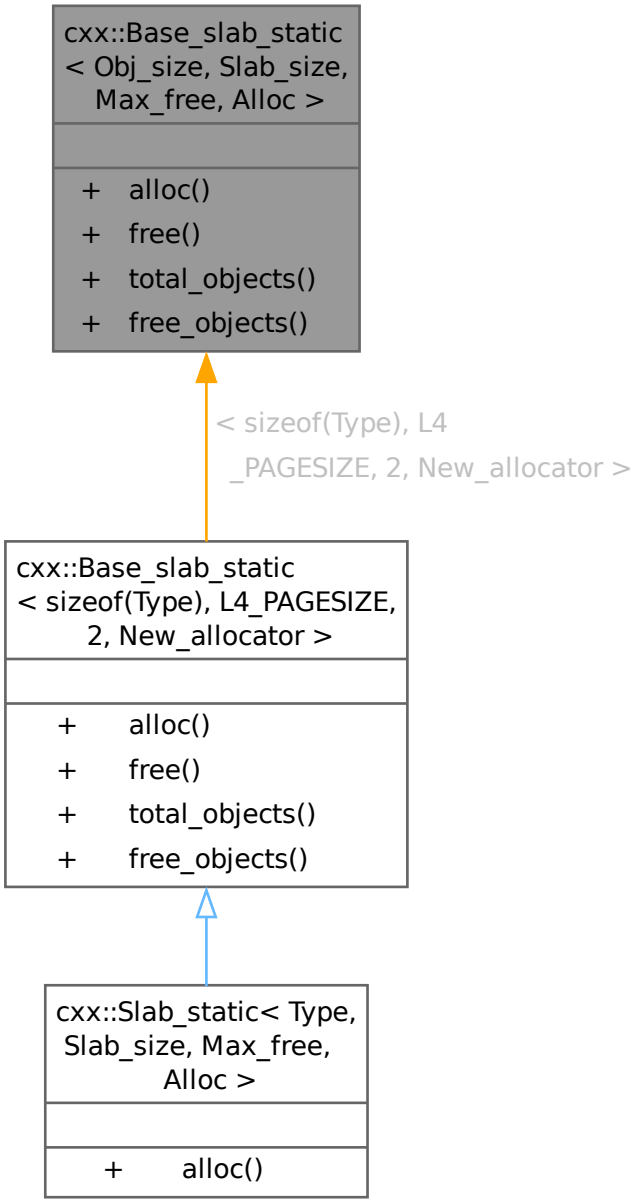
Type of a slab.
Definition at line 86 of file slab_alloc.
The documentation for this struct was generated from the following file:

- l4/cxx/slab_alloc

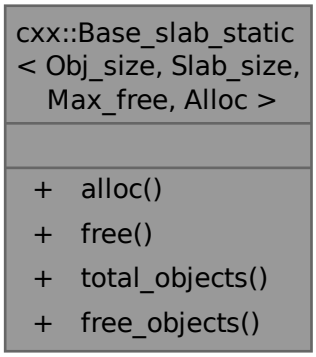
15.9 cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc > Class Template Reference

Merged slab allocator (allocators for objects of the same size are merged together).
`#include <slab_alloc>`

Inheritance diagram for cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >:



Collaboration diagram for cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >:



Public Types

- enum { object_size = Obj_size , slab_size = Slab_size , objects_per_slab = _A::objects_per_slab , max_free_slabs = Max_free }

Public Member Functions

- void * alloc () noexcept

  Allocate an object.
- void free (void *p) noexcept

  Free the given object (p).
- unsigned total_objects () const noexcept

  Get the total number of objects managed by the slab allocator.
- unsigned free_objects () const noexcept

  Get the number of free objects in the slab allocator.

15.9.1 Detailed Description

template< int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A > class Alloc = New_allocator >
class cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >

Merged slab allocator (allocators for objects of the same size are merged together).

Template Parameters

Obj_size	The size of an object managed by the slab allocator.
Slab_size	The size of a slab.
Max_free	The maximum number of free slabs.
Alloc	The allocator for the slabs.

This slab allocator class is useful for merging slab allocators with the same parameters (equal `Obj_size`, `Slab_size`, `Max_free`, and `Alloc` parameters) together and share the overhead for the slab caches among all equal-sized objects.
Definition at line 388 of file slab_alloc.

15.9.2 Member Enumeration Documentation

15.9.2.1 anonymous enum

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
anonymous enum
```

Enumerator

object_size	Size of an object.
slab_size	Size of a slab.
objects_per_slab	Number of objects per slab.
max_free_slabs	Maximum number of free slabs.

Definition at line 395 of file slab_alloc.

15.9.3 Member Function Documentation

15.9.3.1 alloc()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
void * cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >::alloc ()  [inline],
[noexcept]
```

Allocate an object.

Note

The user is responsible for initializing the object.

Definition at line 412 of file slab_alloc.

15.9.3.2 free()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
void cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >::free (
            void * p)  [inline], [noexcept]
```

Free the given object (p).

Parameters

p	The pointer to the object to free.

Precondition

p must be a pointer to an object allocated by this allocator.

Definition at line 420 of file slab_alloc.

15.9.3.3 free_objects()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
unsigned cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >::free_objects () const
[inline], [noexcept]
```

Get the number of free objects in the slab allocator.

Returns

The number of free objects in all free and partially used slabs managed by this allocator.

Note

The value is the merged value for all equal parameterized Base_slab_static instances.

Definition at line 440 of file slab_alloc.

15.9.3.4 total_objects()

```
template<int Obj_size, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
unsigned cxx::Base_slab_static< Obj_size, Slab_size, Max_free, Alloc >::total_objects () const
[inline], [noexcept]
```

Get the total number of objects managed by the slab allocator.

Returns

The number of objects managed by the allocator (including the free objects).

Note

The value is the merged value for all equal parameterized Base_slab_static instances.

Definition at line 430 of file slab_alloc.
The documentation for this class was generated from the following file:

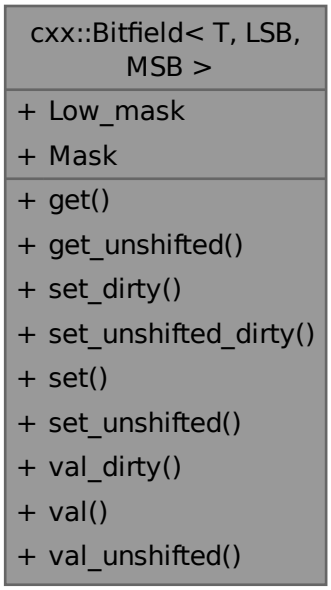
- l4/cxx/slab_alloc

15.10 cxx::Bitfield< T, LSB, MSB > Class Template Reference

Definition for a member (part) of a bit field.
`#include <bitfield>`
Inheritance diagram for cxx::Bitfield< T, LSB, MSB >:



Collaboration diagram for cxx::Bitfield< T, LSB, MSB >:



Data Structures

- class Value_base

  Internal helper type.
- class Value

  Internal helper type.
- class Value_unshifted

  Internal helper type.

Public Types

- enum { Bits = MSB + 1 - LSB , Lsb = LSB , Msb = MSB }
- typedef Best_type< Bits >::Type Bits_type

  Type to hold at least Bits bits.
- typedef Best_type< Bits+Lsb >::Type Shift_type

  Type to hold at least Bits + Lsb bits.
- typedef Value< Base_type & > **Ref**

  Reference type to access the bits inside a raw bit field.
- typedef Value< Base_type volatile & > **Ref_volatile**

  Volatile reference type to access the bits inside a raw bit field.
- typedef Value< Base_type const > **Val**

  Value type to access the bits inside a raw bit field.
- typedef Value_unshifted< Base_type & > **Ref_unshifted**

  Reference type to access the bits inside a raw bit field (in place).
- typedef Value_unshifted< Base_type volatile & > **Ref_unshifted_volatile**

  Volatile reference type to access the bits inside a raw bit field (in place).
- typedef Value_unshifted< Base_type const > **Val_unshifted**

  Value type to access the bits inside a raw bit field (in place).

Static Public Member Functions

- static constexpr Bits_type get (Shift_type val)

  Get the bits out of `val`.
- static constexpr Base_type get_unshifted (Shift_type val)

  Get the bits in place out of `val`.
- static constexpr Base_type set_dirty (Base_type dest, Shift_type val)

  Set the bits corresponding to `val`.
- static constexpr Base_type set_unshifted_dirty (Base_type dest, Shift_type val)

  Set the bits corresponding to `val`.
- static Base_type set (Base_type dest, Bits_type val)

  Set the bits corresponding to `val`.
- static Base_type set_unshifted (Base_type dest, Shift_type val)

  Set the bits corresponding to `val`.
- static constexpr Base_type val_dirty (Shift_type val)

  Get the shifted bits for `val`.
- static constexpr Base_type val (Bits_type val)

  Get the shifted bits for `val`.
- static constexpr Base_type val_unshifted (Shift_type val)

  Get the shifted bits for `val`.

Static Public Attributes

- static constexpr Base_type **Low_mask** = Base_type(~0ULL) >> (sizeof(Base_type) * 8 - Bits)

  Mask value to get Bits bits.
- static constexpr Base_type **Mask** = Low_mask << Lsb

  Mask value to the bits out of a `T`.

15.10.1 Detailed Description

template<typename T, unsigned LSB, unsigned MSB>
class cxx::Bitfield< T, LSB, MSB >

Definition for a member (part) of a bit field.

Parameters

T	The underlying type of the bit field.
LSB	The least significant bit of our bits.
MSB	The most significant bit of our bits.

Definition at line 24 of file bitfield.

15.10.2 Member Typedef Documentation

15.10.2.1 Bits_type

```
template<typename T, unsigned LSB, unsigned MSB>
typedef Best_type<Bits>::Type cxx::Bitfield< T, LSB, MSB >::Bits_type
```

Type to hold at least Bits bits.
This type can handle all values that can be stored in this part of the bit field.
Definition at line 71 of file bitfield.

15.10.2.2 Shift_type

```
template<typename T, unsigned LSB, unsigned MSB>
typedef Best_type<Bits+Lsb>::Type cxx::Bitfield< T, LSB, MSB >::Shift_type
```

Type to hold at least Bits + Lsb bits.
This type can handle all values that can be stored in this part of the bit field when they are at the target location (Lsb bits shifted to the left).
Definition at line 79 of file bitfield.

15.10.3 Member Enumeration Documentation

15.10.3.1 anonymous enum

```
template<typename T, unsigned LSB, unsigned MSB>
anonymous enum
```

Enumerator

Bits	Number of bits.
Lsb	index of the LSB
Msb	index of the MSB

Definition at line 52 of file bitfield.

15.10.4 Member Function Documentation

15.10.4.1 get()

```
template<typename T, unsigned LSB, unsigned MSB>
constexpr Bits_type cxx::Bitfield< T, LSB, MSB >::get (
             Shift_type val)  [inline], [static], [constexpr]
```

Get the bits out of `val`.

Parameters

val	The raw value of the whole bit field.

Returns

The bits form Lsb to Msb shifted to the right.

Definition at line 96 of file bitfield.

15.10.4.2 get_unshifted()

```
template<typename T, unsigned LSB, unsigned MSB>
constexpr Base_type cxx::Bitfield< T, LSB, MSB >::get_unshifted (
             Shift_type val)  [inline], [static], [constexpr]
```

Get the bits in place out of `val`.

Parameters

val	The raw value of the whole bit field.

Returns

The bits from Lsb to Msb (unshifted).

This means other bits are masked out, however the result is not shifted to the right.
Definition at line 109 of file bitfield.

15.10.4.3 set()

```
template<typename T, unsigned LSB, unsigned MSB>
Base_type cxx::Bitfield< T, LSB, MSB >::set (
             Base_type dest,
             Bits_type val)  [inline], [static]
```

Set the bits corresponding to `val`.

Parameters

dest	The current value of the whole bit field.
val	The value to set into the bits.

Returns

The new value of the whole bit field.

Definition at line 158 of file bitfield.

15.10.4.4 set_dirty()

```
template<typename T, unsigned LSB, unsigned MSB>
constexpr Base_type cxx::Bitfield< T, LSB, MSB >::set_dirty (
             Base_type dest,
             Shift_type val)  [inline], [static], [constexpr]
```

Set the bits corresponding to `val`.

Parameters

dest	The current value of the whole bit field.
val	The value to set into the bits.

Returns

The new value of the whole bit field.

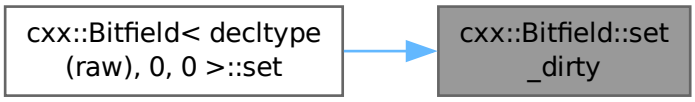
Precondition

`val` must not contain more than Bits bits.

Note

This function does not mask `val` to the right number of bits.

Definition at line 124 of file bitfield.
Referenced by cxx::Bitfield< decltype(raw), 0, 0 >::set().
Here is the caller graph for this function:



15.10.4.5 set_unshifted()

```
template<typename T, unsigned LSB, unsigned MSB>
Base_type cxx::Bitfield< T, LSB, MSB >::set_unshifted (
            Base_type dest,
            Shift_type val)  [inline], [static]
```

Set the bits corresponding to `val`.

Parameters

dest	The current value of the whole bit field.
val	The value shifted Lsb bits to the left that shall be set into the bit field.

Returns

the new value of the whole bit field.

Definition at line 170 of file bitfield.

15.10.4.6 set_unshifted_dirty()

```
template<typename T, unsigned LSB, unsigned MSB>
constexpr Base_type cxx::Bitfield< T, LSB, MSB >::set_unshifted_dirty (
            Base_type dest,
            Shift_type val)  [inline], [static], [constexpr]
```

Set the bits corresponding to `val`.

Parameters

dest	The current value of the whole bit field.
val	The value shifted Lsb bits to the left that shall be set into the bits.

Returns

The new value of the whole bit field.

Precondition

`val` must not contain more than Bits bits shifted Lsb bits to the left.

Note

This function does not mask `val` to the right number of bits.

Definition at line 144 of file bitfield.
Referenced by cxx::Bitfield< decltype(raw), 0, 0 >::set_unshifted().
Here is the caller graph for this function:



15.10.4.7 val()

```
template<typename T, unsigned LSB, unsigned MSB>
constexpr Base_type cxx::Bitfield< T, LSB, MSB >::val (
            Bits_type val)  [inline], [static], [constexpr]
```

Get the shifted bits for `val`.

Parameters

val	The value to set into the bits.

Returns

The raw bit field value.

Definition at line 193 of file bitfield.

15.10.4.8 val_dirty()

```
template<typename T, unsigned LSB, unsigned MSB>
constexpr Base_type cxx::Bitfield< T, LSB, MSB >::val_dirty (
            Shift_type val)  [inline], [static], [constexpr]
```

Get the shifted bits for `val`.

Parameters

val	The value to set into the bits.

Returns

The raw bit field value.

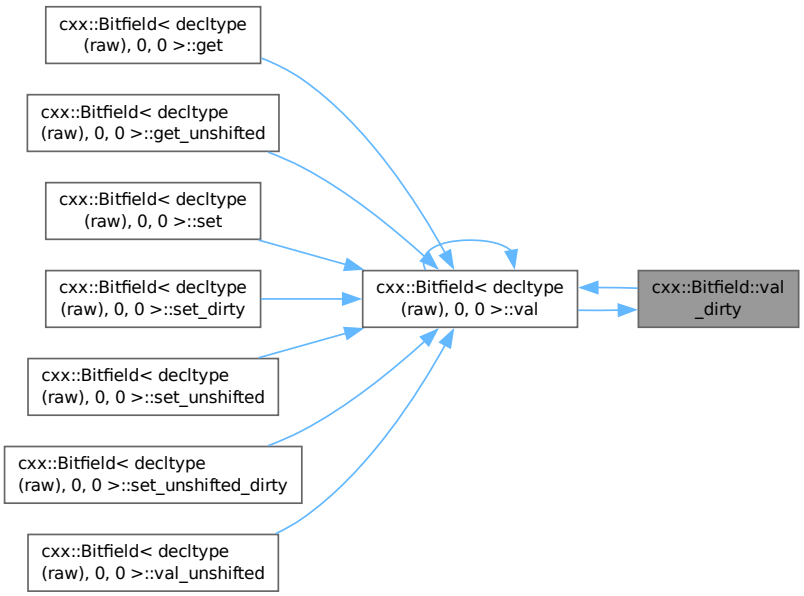
Precondition

`val` must not contain more than Bits bits.

Note

This function does not mask `val` to the right number of bits.

Definition at line 184 of file bitfield.
Referenced by cxx::Bitfield< decltype(raw), 0, 0 >::val().
Here is the caller graph for this function:



15.10.4.9 val_unshifted()

```
template<typename T, unsigned LSB, unsigned MSB>
constexpr Base_type cxx::Bitfield< T, LSB, MSB >::val_unshifted (
            Shift_type val)  [inline], [static], [constexpr]
```

Get the shifted bits for `val`.

Parameters

val	The value shifted Lsb bits to the left that shall be set into the bits.

Returns

The raw bit field value.

Definition at line 203 of file bitfield.
The documentation for this class was generated from the following file:

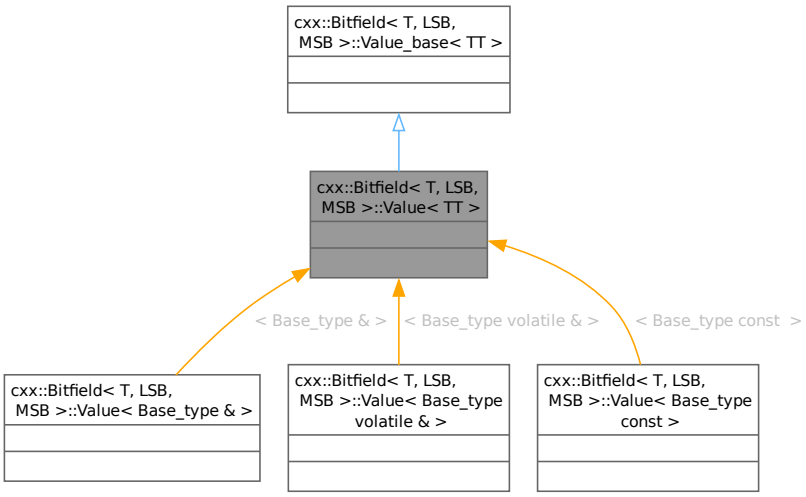
- l4/cxx/bitfield

15.11 cxx::Bitfield< T, LSB, MSB >::Value< TT > Class Template Reference

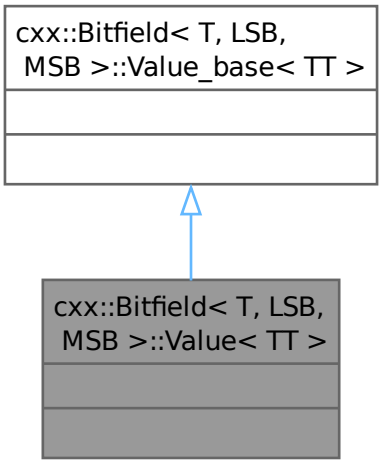
Internal helper type.

`#include <bitfield>`

Inheritance diagram for cxx::Bitfield< T, LSB, MSB >::Value< TT >:



Collaboration diagram for cxx::Bitfield< T, LSB, MSB >::Value< TT >:



15.11.1 Detailed Description

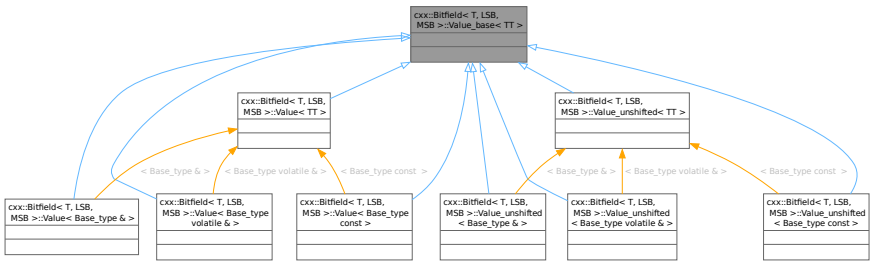
template<typename T, unsigned LSB, unsigned MSB>
template<typename TT>
class cxx::Bitfield< T, LSB, MSB >::Value< TT >

Internal helper type.
Definition at line 225 of file bitfield.
The documentation for this class was generated from the following file:

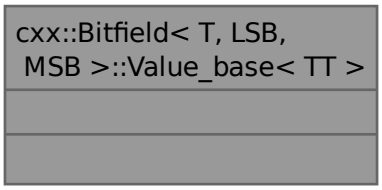
- l4/cxx/bitfield

15.12 cxx::Bitfield< T, LSB, MSB >::Value_base< TT > Class Template Reference

Internal helper type.
`#include <bitfield>`
Inheritance diagram for cxx::Bitfield< T, LSB, MSB >::Value_base< TT >:



Collaboration diagram for cxx::Bitfield< T, LSB, MSB >::Value_base< TT >:



15.12.1 Detailed Description

template<typename T, unsigned LSB, unsigned MSB>
template<typename TT>
class cxx::Bitfield< T, LSB, MSB >::Value_base< TT >

Internal helper type.
Definition at line 207 of file bitfield.
The documentation for this class was generated from the following file:

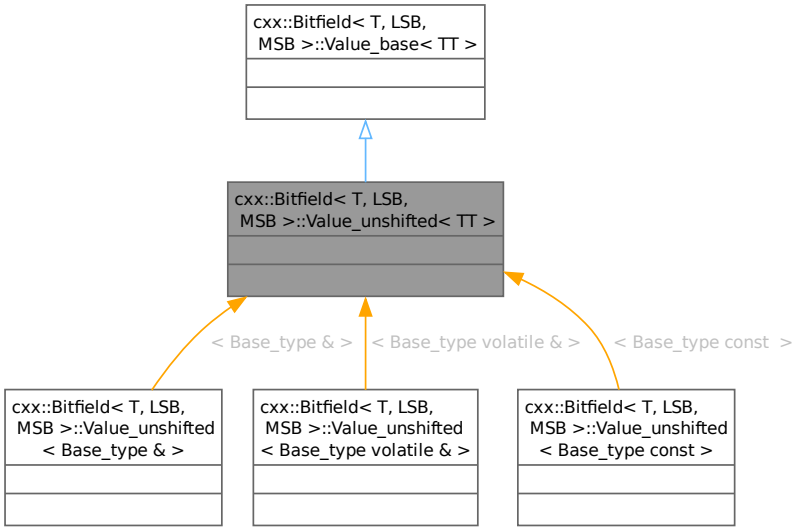
- l4/cxx/bitfield

15.13 cxx::Bitfield< T, LSB, MSB >::Value_unshifted< TT > Class Template Reference

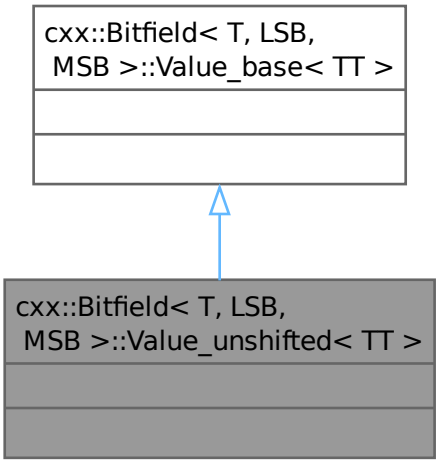
Internal helper type.

`#include <bitfield>`

Inheritance diagram for cxx::Bitfield< T, LSB, MSB >::Value_unshifted< TT >:



Collaboration diagram for cxx::Bitfield< T, LSB, MSB >::Value_unshifted< TT >:



15.13.1 Detailed Description

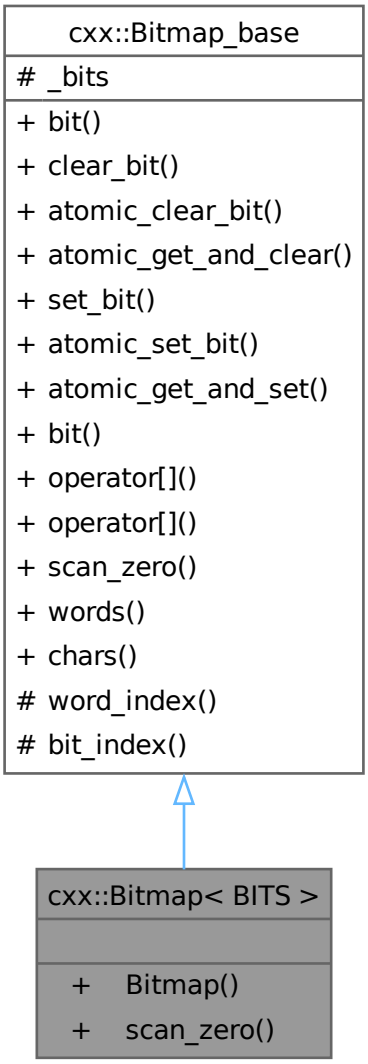
template<typename T, unsigned LSB, unsigned MSB>
template<typename TT>
class cxx::Bitfield< T, LSB, MSB >::Value_unshifted< TT >

Internal helper type.
Definition at line 238 of file bitfield.
The documentation for this class was generated from the following file:

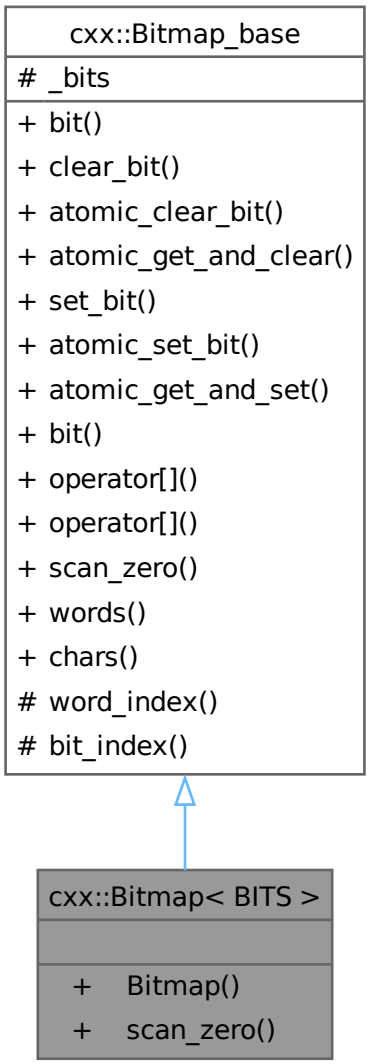
- l4/cxx/bitfield

15.14 cxx::Bitmap< BITS > Class Template Reference

A static bitmap.
`#include <bitmap>`
Inheritance diagram for cxx::Bitmap< BITS >:



Collaboration diagram for cxx::Bitmap< BITS >:



Public Member Functions

- **Bitmap** () noexcept

  Create a bitmap with `BITS` bits.
- long scan_zero (long start_bit=0) const noexcept

  Scan for the first zero bit.

Public Member Functions inherited from cxx::Bitmap_base

- void bit (long bit, bool on) noexcept

  Set the value of bit `bit` to `on`.
- void clear_bit (long bit) noexcept

  Clear bit `bit`.
- void atomic_clear_bit (long bit) noexcept

Clear bit `bit` atomically.

- word_type atomic_get_and_clear (long bit) noexcept

  Clear bit `bit` atomically and return old state.
- void set_bit (long bit) noexcept

  Set bit `bit`.
- void atomic_set_bit (long bit) noexcept

  Set bit `bit` atomically.
- word_type atomic_get_and_set (long bit) noexcept

  Set bit `bit` atomically and return old state.
- word_type bit (long bit) const noexcept

  Get the truth value of a bit.
- word_type operator[ ] (long bit) const noexcept

  Get the bit at index `bit`.
- Bit operator[ ] (long bit) noexcept

  Get the lvalue for the bit at index `bit`.
- long scan_zero (long max_bit, long start_bit=0) const noexcept

  Scan for the first zero bit.

Additional Inherited Members

Static Public Member Functions inherited from cxx::Bitmap_base

- static long **words** (long bits) noexcept

  Get the number of `Words` that are used for the bitmap.
- static long **chars** (long bits) noexcept

  Get the number of chars that are used for the bitmap.

Protected Types inherited from cxx::Bitmap_base

- enum { W_bits = sizeof(word_type) * 8 , C_bits = 8 }
- typedef unsigned long **word_type**

  Data type for each element of the bit buffer.

Static Protected Member Functions inherited from cxx::Bitmap_base

- static unsigned word_index (unsigned bit)

  Get the word index for the given bit.
- static unsigned bit_index (unsigned bit)

  Get the bit index within word_type for the given bit.

Protected Attributes inherited from cxx::Bitmap_base

- word_type * **_bits**

  Pointer to the buffer storing the bits.

15.14.1 Detailed Description

template<int BITS>
class cxx::Bitmap< BITS >

A static bitmap.

Template Parameters

BITS	The number of bits that shall be in the bitmap.

Definition at line 220 of file bitmap.

15.14.2 Member Function Documentation

15.14.2.1 scan_zero()

```
template<int BITS>
long cxx::Bitmap< BITS >::scan_zero (
            long start_bit = 0) const  [inline], [noexcept]
```

Scan for the first zero bit.

Parameters

start_bit	Hint at the number of the first bit to look at. Zero bits below `start_bit` may or may not be taken into account by the implementation.

Return values

>=	0 Number of first zero bit found.
-1	All bits at `start_bit` or higher are set.

Compared to Bitmap_base::scan_zero(), the upper bound is set to BITS.
Definition at line 365 of file bitmap.
References cxx::Bitmap_base::scan_zero().
Here is the call graph for this function:



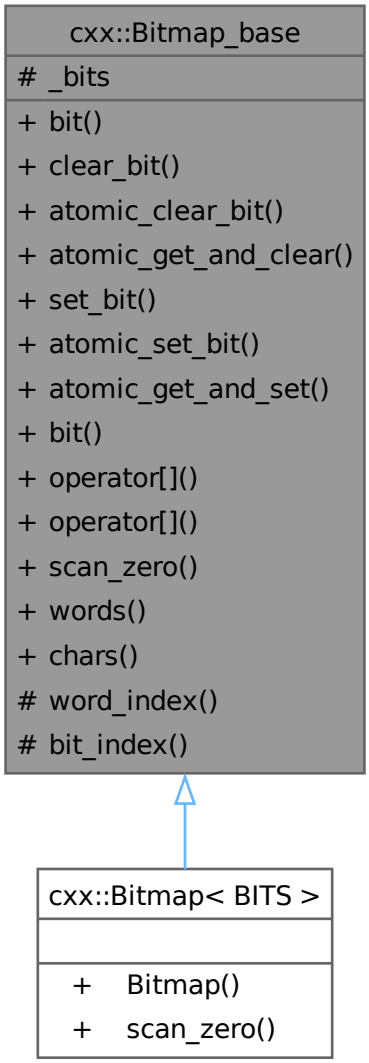
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

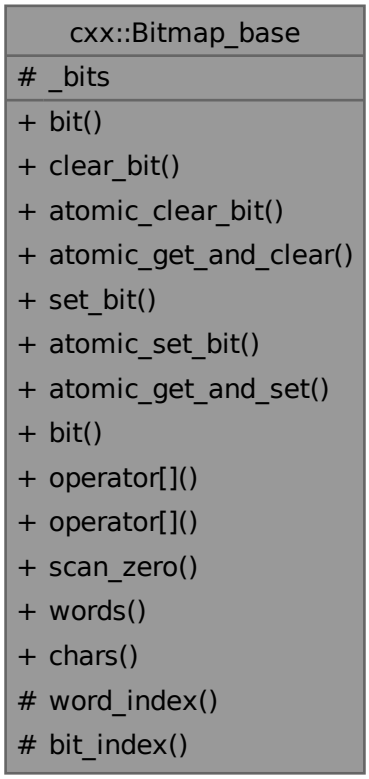
15.15 cxx::Bitmap_base Class Reference

Basic bitmap abstraction.
`#include <bitmap>`

Inheritance diagram for cxx::Bitmap_base:



Collaboration diagram for cxx::Bitmap_base:



Data Structures

- class Bit

  A writable bit in a bitmap.
- class Word

  Helper abstraction for a word contained in the bitmap.
- class Char

  Helper abstraction for a byte contained in the bitmap.

Public Member Functions

- void bit (long bit, bool on) noexcept

  Set the value of bit `bit` *to* `on`*.*
- void clear_bit (long bit) noexcept

  Clear bit `bit`*.*
- void atomic_clear_bit (long bit) noexcept

  Clear bit `bit` *atomically.*
- word_type atomic_get_and_clear (long bit) noexcept

  Clear bit `bit` *atomically and return old state.*
- void set_bit (long bit) noexcept

  Set bit `bit`*.*

- void atomic_set_bit (long bit) noexcept
  Set bit `bit` atomically.
- word_type atomic_get_and_set (long bit) noexcept
  Set bit `bit` atomically and return old state.
- word_type bit (long bit) const noexcept
  Get the truth value of a bit.
- word_type operator[ ] (long bit) const noexcept
  Get the bit at index `bit`.
- Bit operator[ ] (long bit) noexcept
  Get the lvalue for the bit at index `bit`.
- long scan_zero (long max_bit, long start_bit=0) const noexcept
  Scan for the first zero bit.

Static Public Member Functions

- static long **words** (long bits) noexcept
  Get the number of `Words` that are used for the bitmap.
- static long **chars** (long bits) noexcept
  Get the number of chars that are used for the bitmap.

Protected Types

- enum { W_bits = sizeof(word_type) * 8 , C_bits = 8 }
- typedef unsigned long **word_type**
  Data type for each element of the bit buffer.

Static Protected Member Functions

- static unsigned word_index (unsigned bit)
  Get the word index for the given bit.
- static unsigned bit_index (unsigned bit)
  Get the bit index within word_type for the given bit.

Protected Attributes

- word_type * **_bits**
  Pointer to the buffer storing the bits.

15.15.1 Detailed Description

Basic bitmap abstraction.
This abstraction keeps a pointer to a memory area that is used as bitmap.
Definition at line 18 of file bitmap.

15.15.2 Member Enumeration Documentation

15.15.2.1 anonymous enum

```
anonymous enum  [protected]
```

Enumerator

W_bits	number of bits in word_type
C_bits	number of bits in char

Definition at line 26 of file bitmap.

15.15.3 Member Function Documentation

15.15.3.1 atomic_clear_bit()

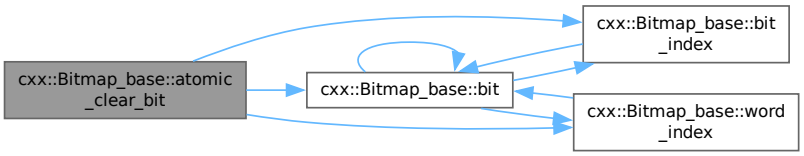
```
void cxx::Bitmap_base::atomic_clear_bit (
            long bit)  [inline], [noexcept]
```

Clear bit `bit` atomically.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to clear.

Definition at line 269 of file bitmap.
References _bits, bit(), bit_index(), and word_index().
Here is the call graph for this function:



15.15.3.2 atomic_get_and_clear()

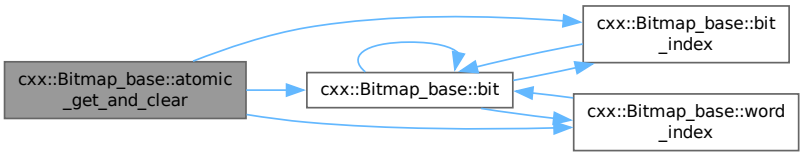
```
Bitmap_base::word_type cxx::Bitmap_base::atomic_get_and_clear (
            long bit)  [inline], [noexcept]
```

Clear bit `bit` atomically and return old state.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to clear.

Definition at line 279 of file bitmap.
References _bits, bit(), bit_index(), and word_index().
Here is the call graph for this function:



15.15.3.3 atomic_get_and_set()

```
Bitmap_base::word_type cxx::Bitmap_base::atomic_get_and_set (
```

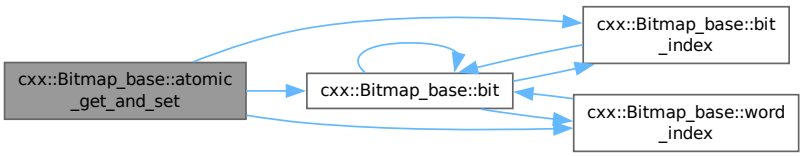
```
            long bit)  [inline], [noexcept]
```

Set bit `bit` atomically and return old state.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to set.

Definition at line 308 of file bitmap.
References _bits, bit(), bit_index(), and word_index().
Here is the call graph for this function:



15.15.3.4 atomic_set_bit()

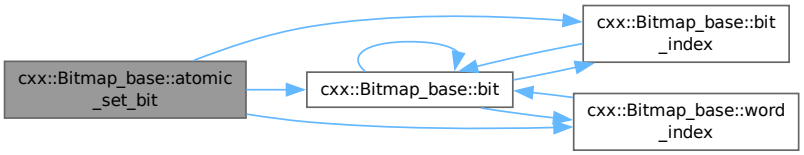
```
void cxx::Bitmap_base::atomic_set_bit (
            long bit)  [inline], [noexcept]
```

Set bit `bit` atomically.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to set.

Definition at line 298 of file bitmap.
References _bits, bit(), bit_index(), and word_index().
Here is the call graph for this function:



15.15.3.5 bit() [1/2]

```
Bitmap_base::word_type cxx::Bitmap_base::bit (
            long bit) const  [inline], [noexcept]
```

Get the truth value of a bit.

Parameters

bit	The number of the bit to read.

Return values

0	Bit is not set.
!=	0 Bit is set.

Definition at line 318 of file bitmap.
References _bits, bit(), bit_index(), and word_index().
Here is the call graph for this function:



15.15.3.6 bit() [2/2]

```
void cxx::Bitmap_base::bit (
            long bit,
            bool on)  [inline], [noexcept]
```

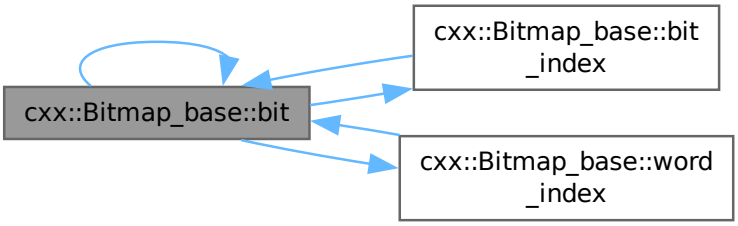
Set the value of bit `bit` to `on`.

Parameters

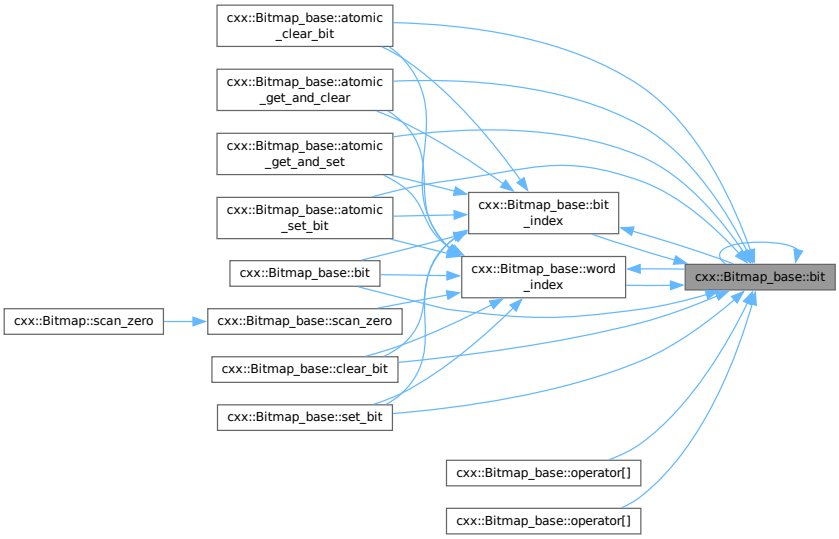
bit	The number of the bit.
on	The boolean value that shall be assigned to the bit.

Definition at line 251 of file bitmap.
References _bits, bit(), bit_index(), and word_index().
Referenced by atomic_clear_bit(), atomic_get_and_clear(), atomic_get_and_set(), atomic_set_bit(), bit(), bit(), bit_index(), clear_bit(), operator[ ](), operator[ ](), set_bit(), and word_index().

Here is the call graph for this function:



Here is the caller graph for this function:



15.15.3.7 bit_index()

```
unsigned cxx::Bitmap_base::bit_index (
            unsigned bit)  [inline], [static], [protected]
```

Get the bit index within word_type for the given bit.

Parameters

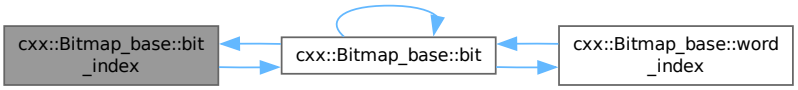
bit	The bit index in the bitmap.

Returns

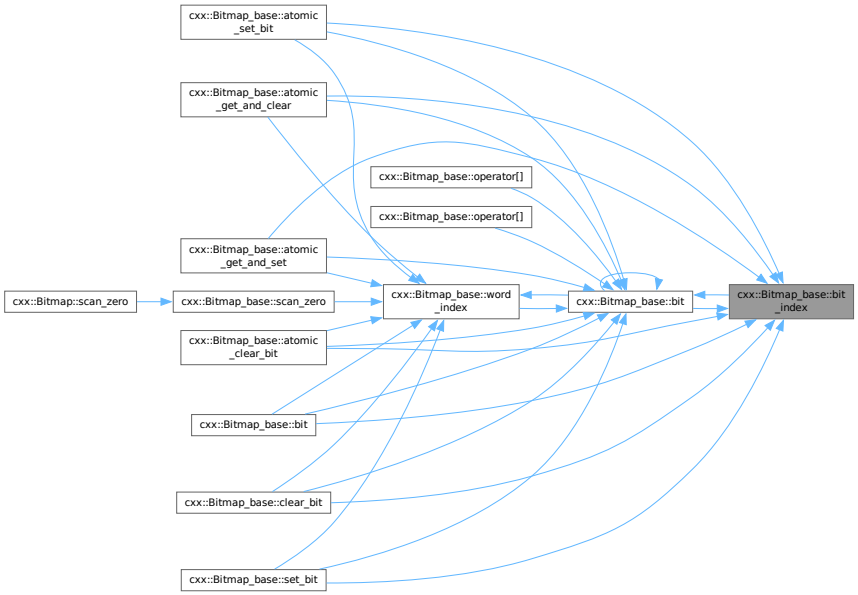
the bit index within word_type (bit % W_bits).

Definition at line 53 of file bitmap.
References bit(), and W_bits.

Referenced by atomic_clear_bit(), atomic_get_and_clear(), atomic_get_and_set(), atomic_set_bit(), bit(), bit(), clear_bit(), and set_bit().
Here is the call graph for this function:



Here is the caller graph for this function:



15.15.3.8 clear_bit()

```
void cxx::Bitmap_base::clear_bit (
            long bit)  [inline], [noexcept]
```

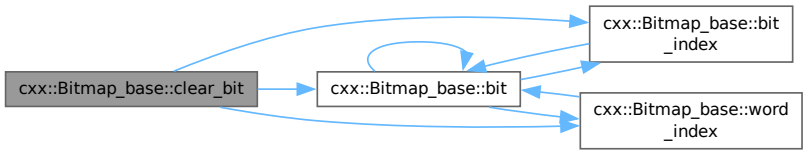
Clear bit `bit`.

Parameters

bit	The number of the bit to clear.

Definition at line 260 of file bitmap.
References _bits, bit(), bit_index(), and word_index().

Here is the call graph for this function:



15.15.3.9 operator[]() [1/2]

```
word_type cxx::Bitmap_base::operator[] (
            long bit) const  [inline], [noexcept]
```

Get the bit at index `bit`.

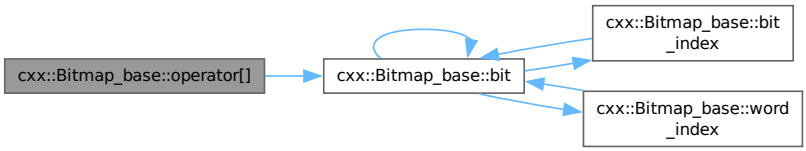
Parameters

bit	The number of the bit to read.

Return values

0	Bit is not set.
!=	0 Bit is set.

Definition at line 181 of file bitmap.
References bit().
Here is the call graph for this function:



15.15.3.10 operator[]() [2/2]

```
Bit cxx::Bitmap_base::operator[] (
            long bit)  [inline], [noexcept]
```

Get the lvalue for the bit at index `bit`.

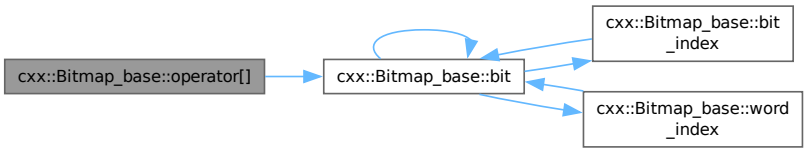
Parameters

bit	The number.

Returns

lvalue for `bit`

Definition at line 191 of file bitmap.
References bit().
Here is the call graph for this function:



15.15.3.11 scan_zero()

```
long cxx::Bitmap_base::scan_zero (
            long max_bit,
            long start_bit = 0) const  [inline], [noexcept]
```

Scan for the first zero bit.

Parameters

max_bit	Upper bound (exclusive) for the scanning operation.
start_bit	Hint at the number of the first bit to look at. Zero bits below `start_bit` may or may not be taken into account by the implementation.

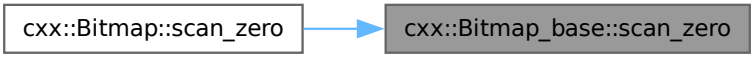
Return values

>=	0 Number of first zero bit found.
-1	All bits between `start_bit` and `max_bit` are set.

Definition at line 339 of file bitmap.
References _bits, W_bits, and word_index().
Referenced by cxx::Bitmap< BITS >::scan_zero().
Here is the call graph for this function:



Here is the caller graph for this function:



15.15.3.12 set_bit()

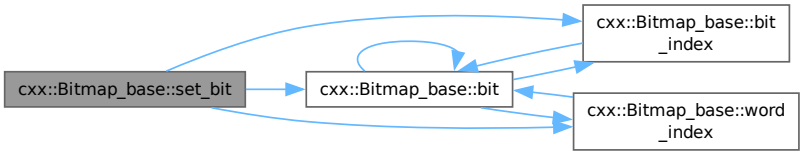
```
void cxx::Bitmap_base::set_bit (
            long bit)  [inline], [noexcept]
```

Set bit `bit`.

Parameters

bit	The number of the bit to set.

Definition at line 289 of file bitmap.
References _bits, bit(), bit_index(), and word_index().
Here is the call graph for this function:



15.15.3.13 word_index()

```
unsigned cxx::Bitmap_base::word_index (
            unsigned bit)  [inline], [static], [protected]
```

Get the word index for the given bit.

Parameters

bit	The index of the bit in question.

Returns

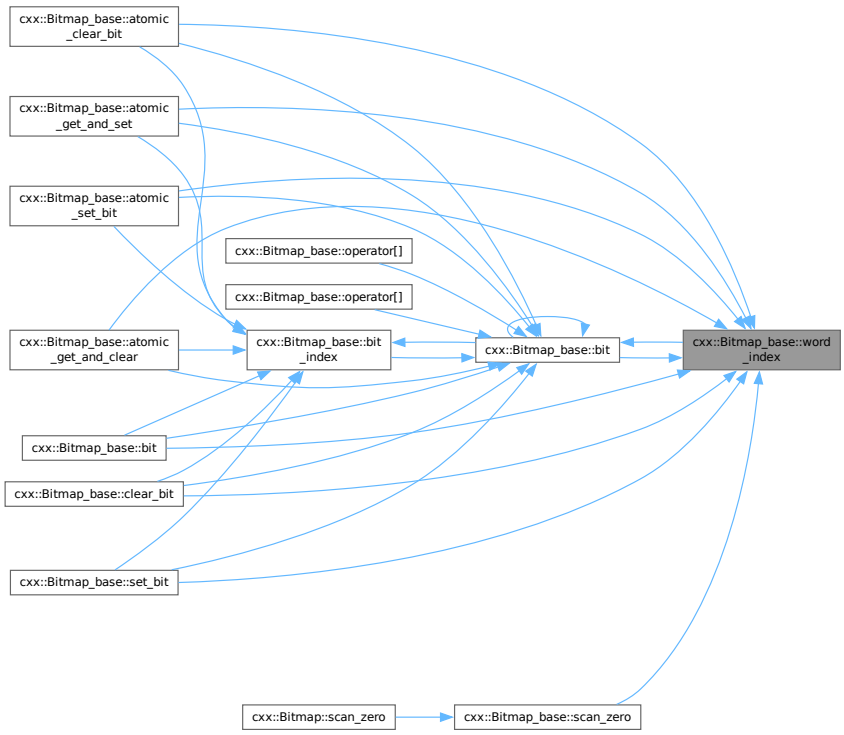
the index in Bitmap_base::_bits for the given bit (bit / W_bits).

Definition at line 44 of file bitmap.
References bit(), and W_bits.
Referenced by atomic_clear_bit(), atomic_get_and_clear(), atomic_get_and_set(), atomic_set_bit(), bit(), bit(), clear_bit(), scan_zero(), and set_bit().

Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this class was generated from the following file:

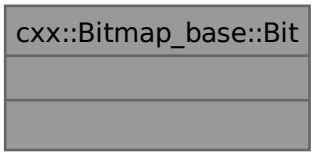
- l4/cxx/bitmap

15.16 cxx::Bitmap_base::Bit Class Reference

A writable bit in a bitmap.

`#include <bitmap>`

Collaboration diagram for cxx::Bitmap_base::Bit:



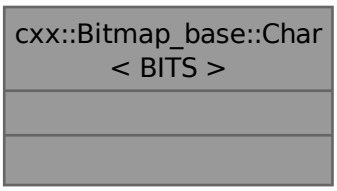
15.16.1 Detailed Description

A writable bit in a bitmap.
Definition at line 58 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

15.17 cxx::Bitmap_base::Char< BITS > Class Template Reference

Helper abstraction for a byte contained in the bitmap.
`#include <bitmap>`
Collaboration diagram for cxx::Bitmap_base::Char< BITS >:



15.17.1 Detailed Description

template<long BITS>
class cxx::Bitmap_base::Char< BITS >

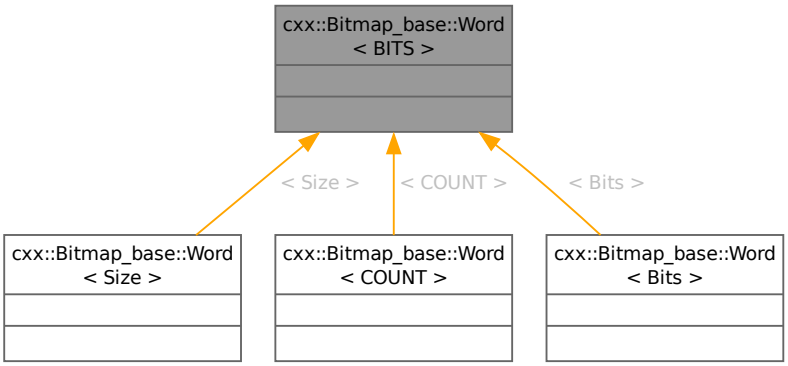
Helper abstraction for a byte contained in the bitmap.
Definition at line 95 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

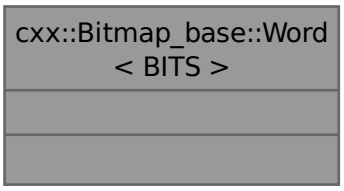
15.18 cxx::Bitmap_base::Word< BITS > Class Template Reference

Helper abstraction for a word contained in the bitmap.

#include <bitmap>
Inheritance diagram for cxx::Bitmap_base::Word< BITS >:



Collaboration diagram for cxx::Bitmap_base::Word< BITS >:



15.18.1 Detailed Description

template<**long BITS**>
class cxx::Bitmap_base::Word< **BITS** >

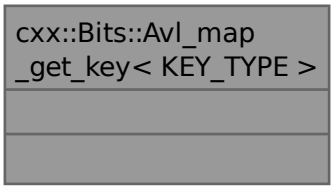
Helper abstraction for a word contained in the bitmap.
Definition at line 79 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

15.19 cxx::Bits::Avl_map_get_key< KEY_TYPE > Struct Template Reference

Key-getter for Avl_map.
#include <avl_map>

Collaboration diagram for cxx::Bits::Avl_map_get_key< KEY_TYPE >:



15.19.1 Detailed Description

template<typename KEY_TYPE>
struct cxx::Bits::Avl_map_get_key< KEY_TYPE >

Key-getter for Avl_map.
Definition at line 25 of file avl_map.
The documentation for this struct was generated from the following file:

- l4/cxx/avl_map

15.20 cxx::Bits::Avl_set_get_key< KEY_TYPE > Struct Template Reference

Internal, key-getter for Avl_set nodes.
`#include <avl_set>`
Collaboration diagram for cxx::Bits::Avl_set_get_key< KEY_TYPE >:



15.20.1 Detailed Description

template<typename KEY_TYPE>
struct cxx::Bits::Avl_set_get_key< KEY_TYPE >

Internal, key-getter for Avl_set nodes.
Definition at line 103 of file avl_set.
The documentation for this struct was generated from the following file:

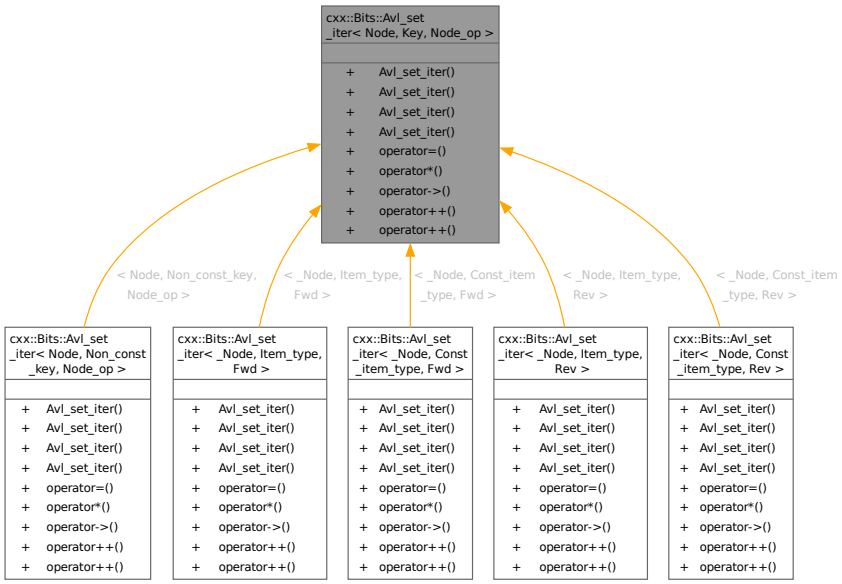
- l4/cxx/avl_set

15.21 cxx::Bits::Avl_set_iter< Node, Key, Node_op > Class Template Reference

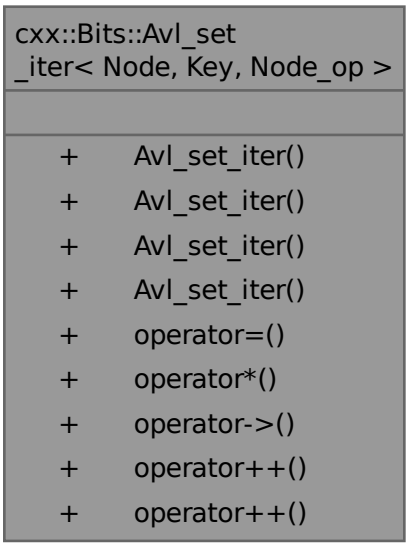
Generic iterator for the AVL-tree based set.

`#include <avl_set>`

Inheritance diagram for cxx::Bits::Avl_set_iter< Node, Key, Node_op >:



Collaboration diagram for cxx::Bits::Avl_set_iter< Node, Key, Node_op >:



Public Member Functions

- **Avl_set_iter** ()=default

  Create an invalid iterator (end marker).
- Avl_set_iter (Node const *t)

  Create an iterator for the given tree.
- Avl_set_iter (Base const &o)

  Create an iterator from a BST iterator.
- **Avl_set_iter** (Non_const_iter const &o)

  Allow copy of non-const iterator to const iterator versions.
- Avl_set_iter & **operator=** (Non_const_iter const &o)

  Allow assignment of non-const iterator to const iterator versions.
- Key & operator* () const

  Dereference the iterator and get the item out of the tree.
- Key * operator-> () const

  Member access to the item the iterator points to.
- Avl_set_iter & **operator++** ()

  Set the iterator to the next element (pre increment).
- Avl_set_iter **operator++** (int)

  Set the iterator to the next element (post increment).

15.21.1 Detailed Description

template<typename Node, typename Key, typename Node_op>
class cxx::Bits::Avl_set_iter< Node, Key, Node_op >

Generic iterator for the AVL-tree based set.
Definition at line 35 of file avl_set.

15.21.2 Constructor & Destructor Documentation

15.21.2.1 Avl_set_iter() [1/2]

```
template<typename Node, typename Key, typename Node_op>
cxx::Bits::Avl_set_iter< Node, Key, Node_op >::Avl_set_iter (
            Node const * t)  [inline]
```

Create an iterator for the given tree.

Parameters

t	the root node of the tree to iterate.

Definition at line 59 of file avl_set.

15.21.2.2 Avl_set_iter() [2/2]

```
template<typename Node, typename Key, typename Node_op>
cxx::Bits::Avl_set_iter< Node, Key, Node_op >::Avl_set_iter (
            Base const & o)  [inline]
```

Create an iterator from a BST iterator.

Parameters

o	The BST iterator that shall be copied.

Definition at line 65 of file avl_set.

15.21.3 Member Function Documentation

15.21.3.1 operator∗()

```
template<typename Node, typename Key, typename Node_op>
Key & cxx::Bits::Avl_set_iter< Node, Key, Node_op >::operator* () const  [inline]
```

Dereference the iterator and get the item out of the tree.

Returns

A reference to the data stored in the AVL tree.

Definition at line 80 of file avl_set.

15.21.3.2 operator->()

```
template<typename Node, typename Key, typename Node_op>
Key * cxx::Bits::Avl_set_iter< Node, Key, Node_op >::operator-> () const  [inline]
```

Member access to the item the iterator points to.

Returns

A pointer to the item in the node.

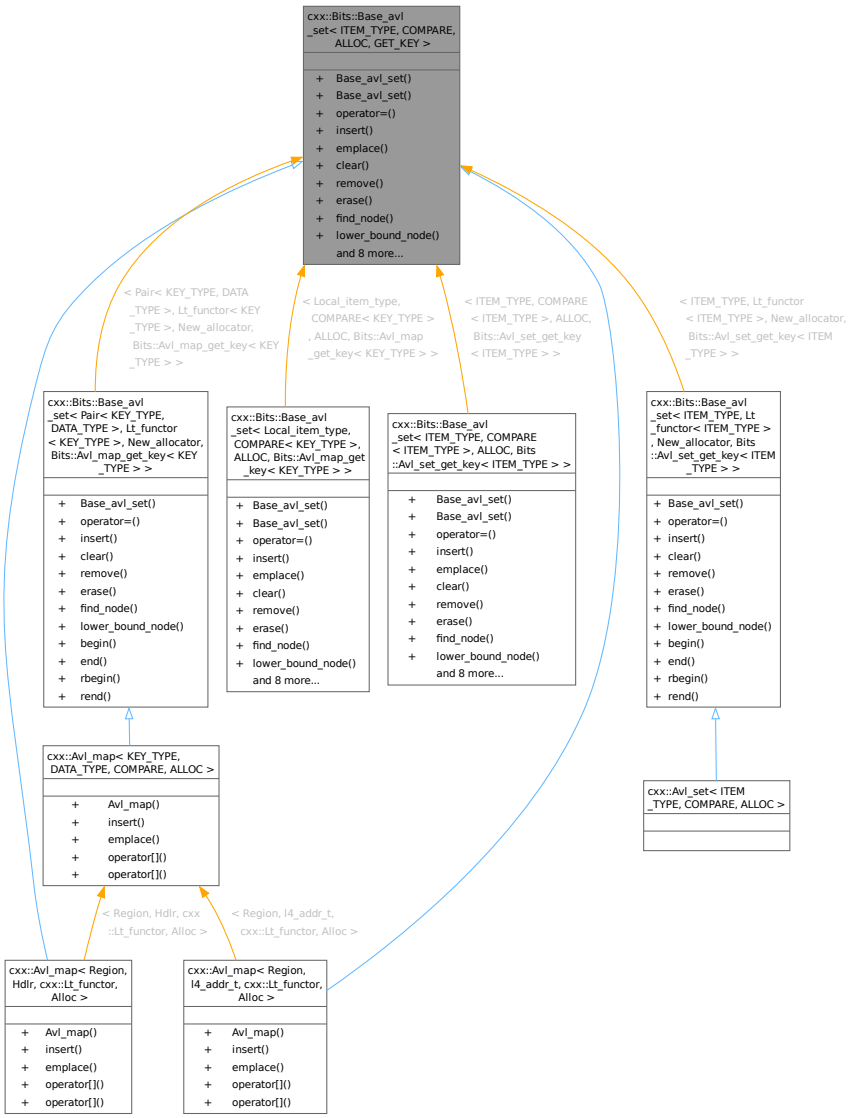
Definition at line 87 of file avl_set.
The documentation for this class was generated from the following file:

- l4/cxx/avl_set

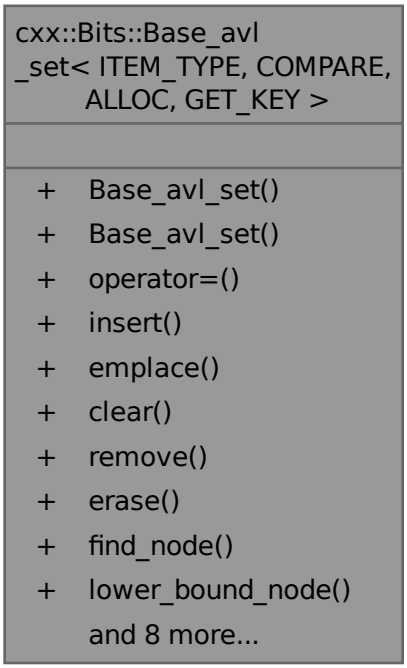
15.22 cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY > Class Template Reference

AVL set with internally managed nodes.
`#include <avl_set>`

Inheritance diagram for cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >:



Collaboration diagram for cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >:



Data Structures

- class Node

  A smart pointer to a tree item.

Public Types

- enum { E_noent = 2 , E_exist = 17 , E_nomem = 12 , E_inval = 22 }

  Return status constants.
- typedef ITEM_TYPE **Item_type**

  Type for the items store in the set.
- typedef GET_KEY **Get_key**

  Key-getter type to derive the sort key of an internal node.
- typedef GET_KEY::Key_type **Key_type**

  Type of the sort key used for the items.
- typedef Type_traits< Item_type >::Const_type **Const_item_type**

  Type used for const items within the set.
- typedef COMPARE **Item_compare**

  Type for the comparison functor.
- typedef ALLOC< _Node > **Node_allocator**

  Type for the node allocator.
- typedef Avl_set_iter< _Node, Item_type, Fwd > **Iterator**

  Forward iterator for the set.
- typedef Avl_set_iter< _Node, Const_item_type, Fwd > **Const_iterator**

Constant forward iterator for the set.

- typedef Avl_set_iter< _Node, Item_type, Rev > **Rev_iterator**

  Backward iterator for the set.
- typedef Avl_set_iter< _Node, Const_item_type, Rev > **Const_rev_iterator**

  Constant backward iterator for the set.

Public Member Functions

- Base_avl_set (Node_allocator const &alloc=Node_allocator())

  Create a AVL-tree based set.
- Base_avl_set (Base_avl_set const &o, Node_allocator const &alloc=Node_allocator())

  Create a copy of an AVL-tree based set.
- Base_avl_set & operator= (Base_avl_set const &o)

  Copy assignment operator of an AVL-tree based set.
- cxx::Pair< Iterator, int > insert (Item_type const &item)

  Insert an item into the set.
- template<typename... Args>
  cxx::Pair< Iterator, int > emplace (Args &&... args)

  Emplace an item into the set.
- void **clear** () noexcept

  Remove all items from the set.
- int remove (Key_type const &item)

  Remove an item from the set.
- int erase (Key_type const &item)

  Erase the item with the given key.
- Node find_node (Key_type const &item) const

  Lookup a node equal to `item`.
- Node lower_bound_node (Key_type const &key) const

  Find the first node greater or equal to `key`.
- Const_iterator begin () const

  Get the constant forward iterator for the first element in the set.
- Const_iterator end () const

  Get the end marker for the constant forward iterator.
- Iterator begin ()

  Get the mutable forward iterator for the first element of the set.
- Iterator end ()

  Get the end marker for the mutable forward iterator.
- Const_rev_iterator rbegin () const

  Get the constant backward iterator for the last element in the set.
- Const_rev_iterator rend () const

  Get the end marker for the constant backward iterator.
- Rev_iterator rbegin ()

  Get the mutable backward iterator for the last element of the set.
- Rev_iterator rend ()

  Get the end marker for the mutable backward iterator.

15.22.1 Detailed Description

template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename GET_KEY>
class cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >

AVL set with internally managed nodes.
Definition at line 127 of file avl_set.

15.22.2 Member Enumeration Documentation

15.22.2.1 anonymous enum

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
anonymous enum
```

Return status constants.
These constants are compatible with the L4 error codes, see l4_error_code_t.

Enumerator

E_noent	Item does not exist.
E_exist	Item exists already.
E_nomem	Memory allocation failed.
E_inval	Internal error.

Definition at line 138 of file avl_set.

15.22.3 Constructor & Destructor Documentation

15.22.3.1 Base_avl_set() [1/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Base_avl_set (
            Node_allocator const & alloc = Node_allocator())  [inline], [explicit]
```

Create a AVL-tree based set.

Parameters

alloc	Node allocator.

Create an empty set (AVL-tree based).
Definition at line 268 of file avl_set.

15.22.3.2 Base_avl_set() [2/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Base_avl_set (
            Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY > const & o,
            Node_allocator const & alloc = Node_allocator())  [inline]
```

Create a copy of an AVL-tree based set.

Parameters

o	The set to copy.
alloc	Node allocator.

Creates a deep copy of the set with all its items.
Definition at line 283 of file avl_set.

15.22.4 Member Function Documentation

15.22.4.1 begin() [1/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::begin ()  [inline]
```

Get the mutable forward iterator for the first element of the set.

Returns

The mutable forward iterator for the first element of the set.

Definition at line 431 of file avl_set.

15.22.4.2 begin() [2/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Const_iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::begin () const
[inline]
```

Get the constant forward iterator for the first element in the set.

Returns

Constant forward iterator for the first element in the set.

Definition at line 417 of file avl_set.

15.22.4.3 emplace()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
template<typename...  Args>
cxx::Pair< Iterator, int > cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >↩
::emplace (
            Args &&...  args)
```

Emplace an item into the set.

Parameters

args	Constructor arguments for the item constructor.

Returns

A pair of iterator (`first`) and return value (`second`). `second` will be 0 if the element was inserted into the set and `-#E_exist` if the element was already in the set and the set was therefore not updated. In both cases, `first` contains an iterator that points to the element. `second` may also be `-#E_nomem` when memory for the node could not be allocated. `first` is then invalid.

The element will always be constructed, even if there is already an existing element in the set. In case of such a collision the newly created element will then be immediately destructed.

15.22.4.4 end() [1/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::end ()  [inline]
```

Get the end marker for the mutable forward iterator.

Returns

The end marker for mutable forward iterator.

Definition at line 438 of file avl_set.

15.22.4.5 end() [2/2]

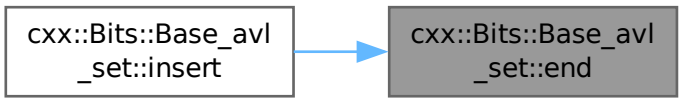
```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Const_iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::end () const
[inline]
```

Get the end marker for the constant forward iterator.

Returns

The end marker for the constant forward iterator.

Definition at line 424 of file avl_set.
Referenced by insert().
Here is the caller graph for this function:



15.22.4.6 erase()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
int cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::erase (
            Key_type const & item)  [inline]
```

Erase the item with the given key.

Parameters

item	The key of the item to remove.

Definition at line 384 of file avl_set.

15.22.4.7 find_node()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Node cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::find_node (
            Key_type const & item) const  [inline]
```

Lookup a node equal to `item`.

Parameters

item	The value to search for.

Returns

A smart pointer to the element found. If no element was found the smart pointer will be invalid.

Definition at line 395 of file avl_set.

15.22.4.8 insert()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Pair< typename Base_avl_set< Item, Compare, Alloc, KEY_TYPE >::Iterator, int > cxx::Bits::Base_avl_set<
Item, Compare, Alloc, KEY_TYPE >::insert (
            Item_type const & item)
```

Insert an item into the set.

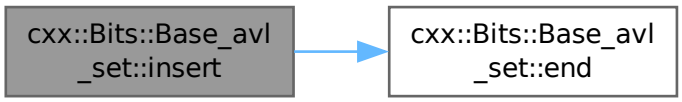
Parameters

item	The item to insert.

Returns

A pair of iterator (`first`) and return value (`second`). `second` will be 0 if the element was inserted into the set and -#E_exist if the element was already in the set and the set was therefore not updated. In both cases, `first` contains an iterator that points to the element. `second` may also be -#E_nomem when memory for the node could not be allocated. `first` is then invalid.

Insert a new item into the set, each item can only be once in the set.
Definition at line 485 of file avl_set.
References E_exist, E_nomem, end(), cxx::Pair< First, Second >::first, and cxx::Pair< First, Second >::second.
Here is the call graph for this function:



15.22.4.9 lower_bound_node()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Node cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::lower_bound_node (
            Key_type const & key) const  [inline]
```

Find the first node greater or equal to `key`.

Parameters

key	Minimum key to look for.

Returns

Smart pointer to the first node greater or equal to `key`. Will be invalid if no such element was found.

Definition at line 406 of file avl_set.

15.22.4.10 operator=()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Base_avl_set & cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::operator= (
            Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY > const & o)  [inline]
```

Copy assignment operator of an AVL-tree based set.

Parameters

o	The set to copy-assign.

Creates a deep copy of the set with all its items.
Definition at line 295 of file avl_set.

15.22.4.11 rbegin() [1/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Rev_iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::rbegin ()  [inline]
```

Get the mutable backward iterator for the last element of the set.

Returns

The mutable backward iterator for the last element of the set.

Definition at line 459 of file avl_set.

15.22.4.12 rbegin() [2/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Const_rev_iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::rbegin ()
const  [inline]
```

Get the constant backward iterator for the last element in the set.

Returns

The constant backward iterator for the last element in the set.

Definition at line 445 of file avl_set.

15.22.4.13 remove()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
int cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::remove (
            Key_type const & item)  [inline]
```

Remove an item from the set.

Parameters

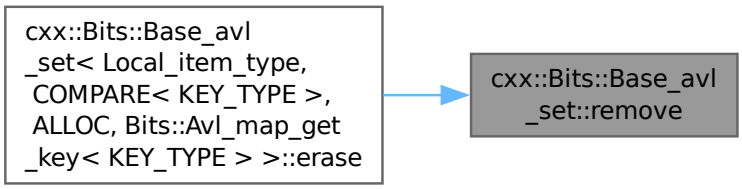
item	The item to remove.

Return values

0	Success

-E_noent	Item does not exist

Definition at line 366 of file avl_set.
Referenced by cxx::Bits::Base_avl_set< Local_item_type, COMPARE< KEY_TYPE >, ALLOC, Bits::Avl_map_get_key< KEY_TYPE
Here is the caller graph for this function:



15.22.4.14 rend() [1/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Rev_iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::rend ()  [inline]
```

Get the end marker for the mutable backward iterator.

Returns

The end marker for mutable backward iterator.

Definition at line 466 of file avl_set.

15.22.4.15 rend() [2/2]

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Const_rev_iterator cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::rend ()
const  [inline]
```

Get the end marker for the constant backward iterator.

Returns

The end marker for the constant backward iterator.

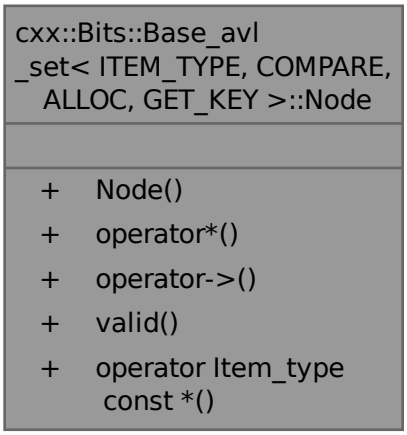
Definition at line 452 of file avl_set.
The documentation for this class was generated from the following file:

- l4/cxx/avl_set

15.23 cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Node Class Reference

A smart pointer to a tree item.
`#include <avl_set>`

Collaboration diagram for cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Node:



Public Member Functions

- **Node** ()

  Default construction for NIL pointer.
- Item_type const & operator∗ ()

  Dereference the pointer.
- Item_type const ∗ operator-> ()

  Dereferenced member access.
- bool valid () const

  Validity check.
- **operator Item_type const** ∗ ()

  Cast to a real item pointer.

15.23.1 Detailed Description

template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename GET_KEY>
class cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Node

A smart pointer to a tree item.
Definition at line 182 of file avl_set.

15.23.2 Member Function Documentation

15.23.2.1 operator∗()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Item_type const & cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Node::operator*
() [inline]
```

Dereference the pointer.

Precondition

Node is valid.

Definition at line 200 of file avl_set.

15.23.2.2 operator->()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
Item_type const * cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Node::operator->
() [inline]
```

Dereferenced member access.

Precondition

Node is valid.

Definition at line 207 of file avl_set.

15.23.2.3 valid()

```
template<typename ITEM_TYPE, class COMPARE, template< typename A > class ALLOC, typename
GET_KEY>
bool cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Node::valid () const
[inline]
```

Validity check.

Returns

false if the pointer is NIL, true if valid.

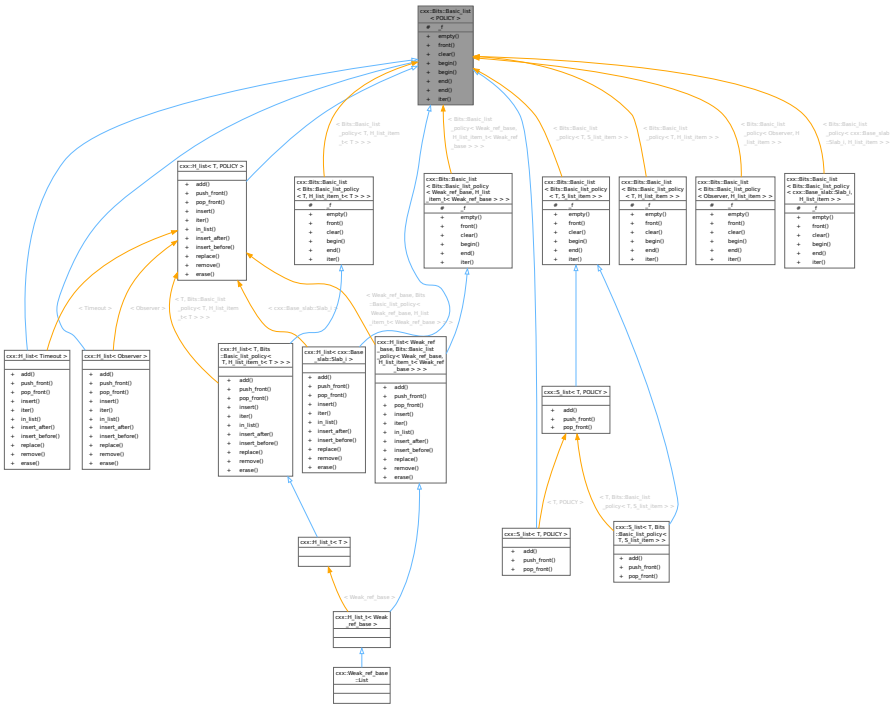
Definition at line 214 of file avl_set.
The documentation for this class was generated from the following file:

- l4/cxx/avl_set

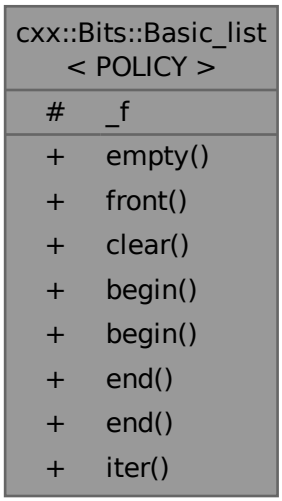
15.24 cxx::Bits::Basic_list< POLICY > Class Template Reference

Internal: Common functions for all head-based list implementations.
`#include <list_basics.h>`

Inheritance diagram for cxx::Bits::Basic_list< POLICY >:



Collaboration diagram for cxx::Bits::Basic_list< POLICY >:



Public Member Functions

- bool **empty** () const

  Check if the list is empty.
- Value_type **front** () const

Return the first element in the list.

- void clear ()

  Remove all elements from the list.

- Iterator **begin** ()

  Return an iterator to the beginning of the list.

- Const_iterator **begin** () const

  Return a const iterator to the beginning of the list.

- Const_iterator **end** () const

  Return a const iterator to the end of the list.

- Iterator **end** ()

  Return an iterator to the end of the list.

Static Public Member Functions

- static Const_iterator iter (Const_value_type c)

  Return a const iterator that begins at the given element.

Protected Attributes

- POLICY::Head_type **_f**

  Pointer to front of the list.

15.24.1 Detailed Description

template<typename POLICY>
class cxx::Bits::Basic_list< POLICY >

Internal: Common functions for all head-based list implementations.
Definition at line 39 of file list_basics.h.

15.24.2 Member Function Documentation

15.24.2.1 clear()

```
template<typename POLICY>
void cxx::Bits::Basic_list< POLICY >::clear ()  [inline]
```

Remove all elements from the list.
After the operation the state of the elements is undefined.
Definition at line 141 of file list_basics.h.
References _f.

15.24.2.2 iter()

```
template<typename POLICY>
Const_iterator cxx::Bits::Basic_list< POLICY >::iter (
            Const_value_type c)  [inline], [static]
```

Return a const iterator that begins at the given element.

Parameters

c	Element where the iterator should start.

Precondition

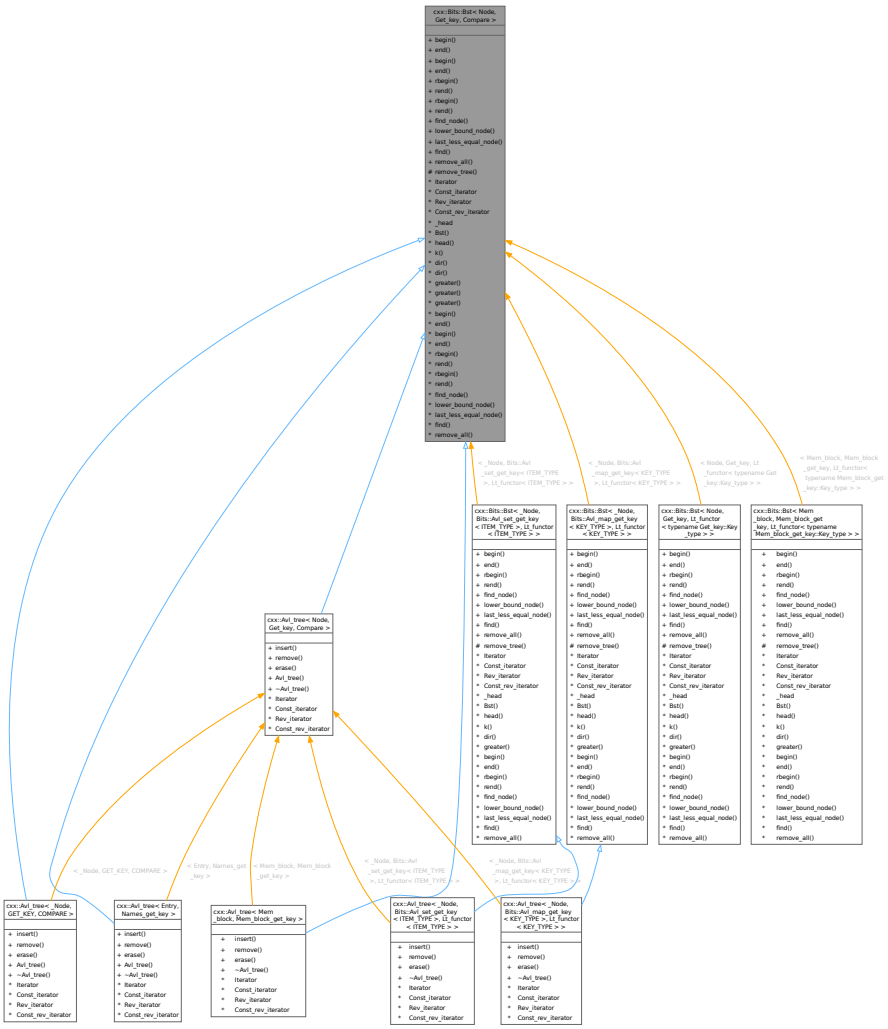
The element `c` must already be in a list.

Definition at line 154 of file list_basics.h.
The documentation for this class was generated from the following file:

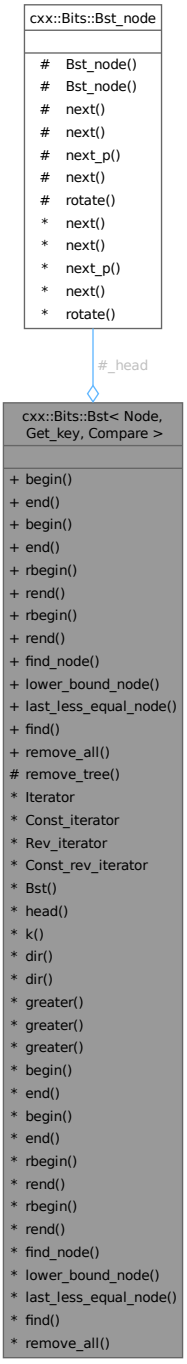
- l4/cxx/bits/list_basics.h

15.25 cxx::Bits::Bst< Node, Get_key, Compare > Class Template Reference

Basic binary search tree (BST).
`#include <bst.h>`
Inheritance diagram for cxx::Bits::Bst< Node, Get_key, Compare >:



Collaboration diagram for cxx::Bits::Bst< Node, Get_key, Compare >:



Public Types

- typedef Get_key::Key_type **Key_type**

  The type of key values used to generate the total order of the elements.
- typedef Type_traits< Key_type >::Param_type **Key_param_type**

  The type for key parameters.
- typedef Fwd **Fwd_iter_ops**

  Helper for building forward iterators for different wrapper classes.

- typedef Rev **Rev_iter_ops**

  Helper for building reverse iterators for different wrapper classes.

Iterators

- typedef __Bst_iter< Node, Node, Fwd > **Iterator**

  Forward iterator.
- typedef __Bst_iter< Node, Node const, Fwd > **Const_iterator**

  Constant forward iterator.
- typedef __Bst_iter< Node, Node, Rev > **Rev_iterator**

  Backward iterator.
- typedef __Bst_iter< Node, Node const, Rev > **Const_rev_iterator**

  Constant backward.

Public Member Functions

Get default iterators for the ordered tree.

- Const_iterator begin () const

  Get the constant forward iterator for the first element in the set.
- Const_iterator end () const

  Get the end marker for the constant forward iterator.
- Iterator begin ()

  Get the mutable forward iterator for the first element of the set.
- Iterator end ()

  Get the end marker for the mutable forward iterator.
- Const_rev_iterator rbegin () const

  Get the constant backward iterator for the last element in the set.
- Const_rev_iterator rend () const

  Get the end marker for the constant backward iterator.
- Rev_iterator rbegin ()

  Get the mutable backward iterator for the last element of the set.
- Rev_iterator rend ()

  Get the end marker for the mutable backward iterator.

Lookup functions.

- Node * find_node (Key_param_type key) const

  find the node with the given key.
- Node * lower_bound_node (Key_param_type key) const

  Find the first node with a key not less than the given `key`.
- Node * last_less_equal_node (Key_param_type key) const

  Find the last node with a key less than or equal to the given `key`.
- Const_iterator find (Key_param_type key) const

  find the node with the given key.
- template<typename FUNC>
  void remove_all (FUNC &&callback)

  Clear the tree.

Static Protected Member Functions

- template<typename FUNC>
  static void remove_tree (Bst_node *head, FUNC &&callback)

  Remove all elements in the subtree of head.

Interior access for descendants.

As this class is an intended base class we provide protected access to our interior, use 'using' to make this private in concrete implementations.

- Bst_node * **_head**

  The head pointer of the tree.
- **Bst** ()

  Create an empty tree.
- Node * **head** () const

  Access the head node as object of type Node.
- static Key_type **k** (Bst_node const *n)

  Get the key value of n.
- static Dir dir (Key_param_type l, Key_param_type r)

  Get the direction to go from `l` to search for `r`.
- static Dir dir (Key_param_type l, Bst_node const *r)

  Get the direction to go from `l` to search for `r`.
- static bool **greater** (Key_param_type l, Key_param_type r)

  Is l greater than r.
- static bool **greater** (Key_param_type l, Bst_node const *r)

  Is l greater than r.
- static bool **greater** (Bst_node const *l, Bst_node const *r)

  Is l greater than r.

15.25.1 Detailed Description

template<typename Node, typename Get_key, typename Compare>
class cxx::Bits::Bst< Node, Get_key, Compare >

Basic binary search tree (BST).
This class is intended as a base class for concrete binary search trees, such as an AVL tree. This class already provides the basic lookup methods and iterator definitions for a BST.
Definition at line 31 of file bst.h.

15.25.2 Member Function Documentation

15.25.2.1 begin() [1/2]

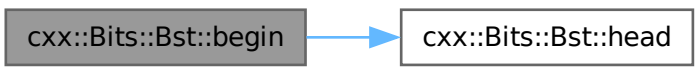
```
template<typename Node, typename Get_key, typename Compare>
Iterator cxx::Bits::Bst< Node, Get_key, Compare >::begin ()  [inline]
```

Get the mutable forward iterator for the first element of the set.

Returns

The mutable forward iterator for the first element of the set.

Definition at line 184 of file bst.h.
References head().
Here is the call graph for this function:



15.25.2.2 begin() [2/2]

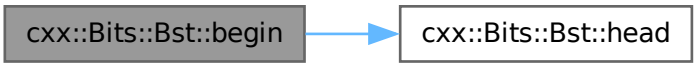
```
template<typename Node, typename Get_key, typename Compare>
Const_iterator cxx::Bits::Bst< Node, Get_key, Compare >::begin () const  [inline]
```

Get the constant forward iterator for the first element in the set.

Returns

Constant forward iterator for the first element in the set.

Definition at line 173 of file bst.h.
References head().
Here is the call graph for this function:



15.25.2.3 dir() [1/2]

```
template<typename Node, typename Get_key, typename Compare>
Dir cxx::Bits::Bst< Node, Get_key, Compare >::dir (
            Key_param_type l,
            Bst_node const * r)  [inline], [static], [protected]
```

Get the direction to go from `l` to search for `r`.

Parameters

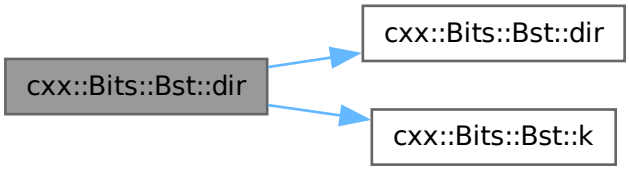
l	is the key to look for.
r	is the node at the current position.

Return values

Direction::L	For left.
Direction::R	For right.
Direction::N	If `l` is equal to `r`.

Definition at line 129 of file bst.h.
References dir(), and k().

Here is the call graph for this function:



15.25.2.4 dir() [2/2]

```
template<typename Node, typename Get_key, typename Compare>
Dir cxx::Bits::Bst< Node, Get_key, Compare >::dir (
            Key_param_type l,
            Key_param_type r)  [inline], [static], [protected]
```

Get the direction to go from `l` to search for `r`.

Parameters

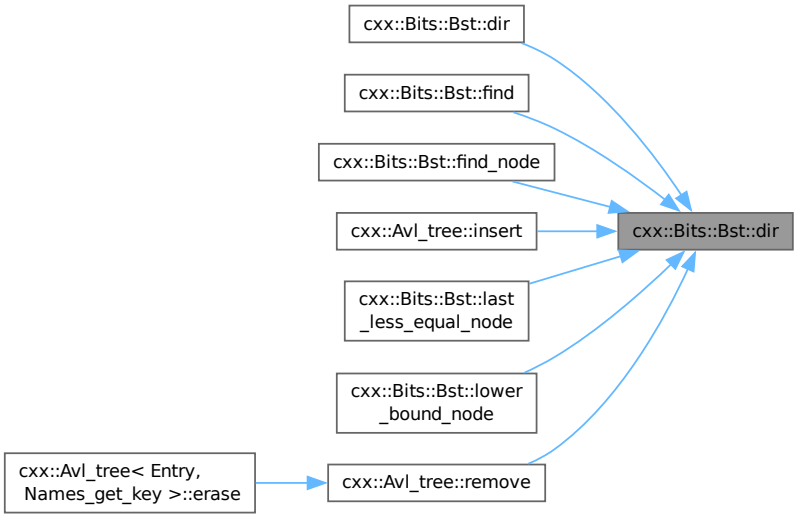
l	is the key to look for.
r	is the key at the current position.

Return values

Direction::L	for left
Direction::R	for right
Direction::N	if `l` is equal to `r`.

Definition at line 112 of file bst.h.
References cxx::Bits::Direction::L, and cxx::Bits::Direction::N.
Referenced by dir(), find(), find_node(), cxx::Avl_tree< Node, Get_key, Compare >::insert(), last_less_equal_node(), lower_bound_node(), and cxx::Avl_tree< Node, Get_key, Compare >::remove().

Here is the caller graph for this function:



15.25.2.5 end() [1/2]

```
template<typename Node, typename Get_key, typename Compare>
Iterator cxx::Bits::Bst< Node, Get_key, Compare >::end ()  [inline]
```

Get the end marker for the mutable forward iterator.

Returns

The end marker for mutable forward iterator.

Definition at line 189 of file bst.h.

15.25.2.6 end() [2/2]

```
template<typename Node, typename Get_key, typename Compare>
Const_iterator cxx::Bits::Bst< Node, Get_key, Compare >::end () const  [inline]
```

Get the end marker for the constant forward iterator.

Returns

The end marker for the constant forward iterator.

Definition at line 178 of file bst.h.

15.25.2.7 find()

```
template<typename Node, typename Get_key, class Compare>
Bst< Node, Get_key, Compare >::Const_iterator cxx::Bits::Bst< Node, Get_key, Compare >::find
(
            Key_param_type key) const  [inline]
```

find the node with the given *key*.

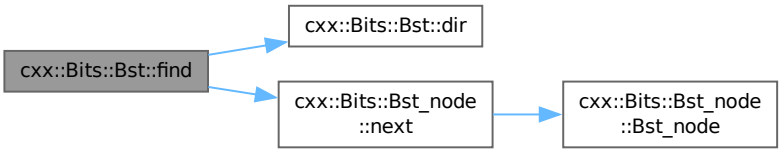
Parameters

key	The key value of the element to search.

Returns

A valid iterator for the node with the given *key*, or an invalid iterator if *key* was not found.

Definition at line 333 of file bst.h.
References _head, dir(), cxx::Bits::Direction::L, cxx::Bits::Direction::N, and cxx::Bits::Bst_node::next().
Here is the call graph for this function:



15.25.2.8 find_node()

```
template<typename Node, typename Get_key, class Compare>
Node * cxx::Bits::Bst< Node, Get_key, Compare >::find_node (
            Key_param_type key) const  [inline]
```

find the node with the given *key*.

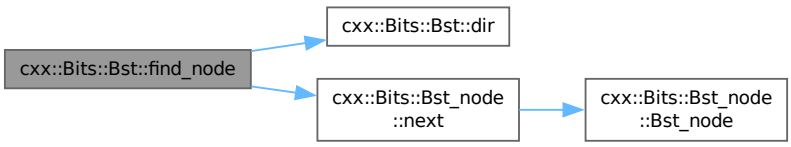
Parameters

key	The key value of the element to search.

Returns

A pointer to the node with the given *key*, or NULL if *key* was not found.

Definition at line 278 of file bst.h.
References _head, dir(), cxx::Bits::Direction::N, and cxx::Bits::Bst_node::next().
Here is the call graph for this function:



15.25.2.9 last_less_equal_node()

```
template<typename Node, typename Get_key, class Compare>
Node * cxx::Bits::Bst< Node, Get_key, Compare >::last_less_equal_node (
            Key_param_type key) const  [inline]
```

Find the last node with a key less than or equal to the given `key`.

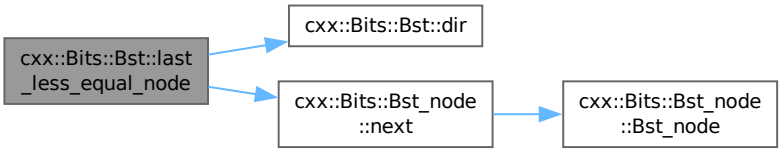
Parameters

key	The key used for the search.

Returns

A pointer to the found node, or `NULL` if no node was found.

Definition at line 313 of file bst.h.
References _head, dir(), cxx::Bits::Direction::N, cxx::Bits::Bst_node::next(), and cxx::Bits::Direction::R.
Here is the call graph for this function:



15.25.2.10 lower_bound_node()

```
template<typename Node, typename Get_key, class Compare>
Node * cxx::Bits::Bst< Node, Get_key, Compare >::lower_bound_node (
            Key_param_type key) const  [inline]
```

Find the first node with a key not less than the given `key`.

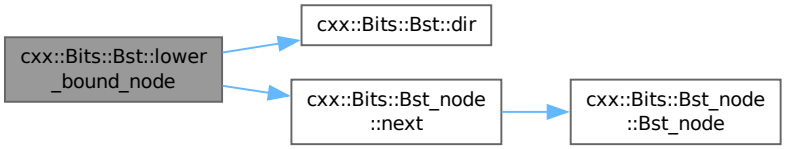
Parameters

key	The key used for the search.

Returns

A pointer to the found node, or `NULL` if no node was found.

Definition at line 294 of file bst.h.
References _head, dir(), cxx::Bits::Direction::L, cxx::Bits::Direction::N, and cxx::Bits::Bst_node::next().
Here is the call graph for this function:



15.25.2.11 rbegin() [1/2]

```
template<typename Node, typename Get_key, typename Compare>
Rev_iterator cxx::Bits::Bst< Node, Get_key, Compare >::rbegin ()  [inline]
```

Get the mutable backward iterator for the last element of the set.

Returns

The mutable backward iterator for the last element of the set.

Definition at line 206 of file bst.h.
References head().
Here is the call graph for this function:



15.25.2.12 rbegin() [2/2]

```
template<typename Node, typename Get_key, typename Compare>
Const_rev_iterator cxx::Bits::Bst< Node, Get_key, Compare >::rbegin () const  [inline]
```

Get the constant backward iterator for the last element in the set.

Returns

The constant backward iterator for the last element in the set.

Definition at line 195 of file bst.h.
References head().
Here is the call graph for this function:



15.25.2.13 remove_all()

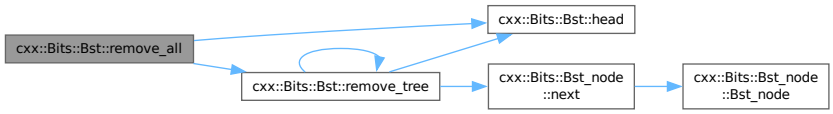
```
template<typename Node, typename Get_key, typename Compare>
template<typename FUNC>
void cxx::Bits::Bst< Node, Get_key, Compare >::remove_all (
            FUNC && callback)  [inline]
```

Clear the tree.

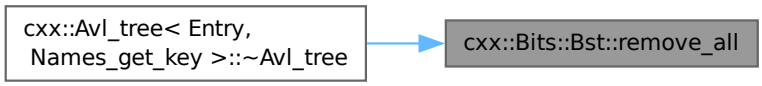
Parameters

callback	Optional function to be called on each removed element.

The callback may delete the elements. The function guarantees that the elements are no longer used after the callback has been called.
Definition at line 260 of file bst.h.
References _head, head(), and remove_tree().
Referenced by cxx::Avl_tree< Entry, Names_get_key >::~Avl_tree().
Here is the call graph for this function:



Here is the caller graph for this function:



15.25.2.14 remove_tree()

```
template<typename Node, typename Get_key, typename Compare>
template<typename FUNC>
void cxx::Bits::Bst< Node, Get_key, Compare >::remove_tree (
            Bst_node * head,
            FUNC && callback)  [inline], [static], [protected]
```

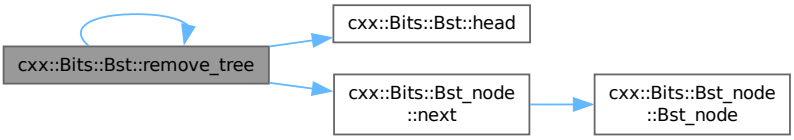
Remove all elements in the subtree of head.

Parameters

head	Head of the the subtree to remove
callback	Optional function called on each removed element.

Definition at line 152 of file bst.h.
References head(), cxx::Bits::Direction::L, cxx::Bits::Bst_node::next(), cxx::Bits::Direction::R, and remove_tree().
Referenced by remove_all(), and remove_tree().

Here is the call graph for this function:



Here is the caller graph for this function:



15.25.2.15 rend() [1/2]

```
template<typename Node, typename Get_key, typename Compare>
Rev_iterator cxx::Bits::Bst< Node, Get_key, Compare >::rend ()  [inline]
```

Get the end marker for the mutable backward iterator.

Returns

The end marker for mutable backward iterator.

Definition at line 211 of file bst.h.

15.25.2.16 rend() [2/2]

```
template<typename Node, typename Get_key, typename Compare>
Const_rev_iterator cxx::Bits::Bst< Node, Get_key, Compare >::rend () const  [inline]
```

Get the end marker for the constant backward iterator.

Returns

The end marker for the constant backward iterator.

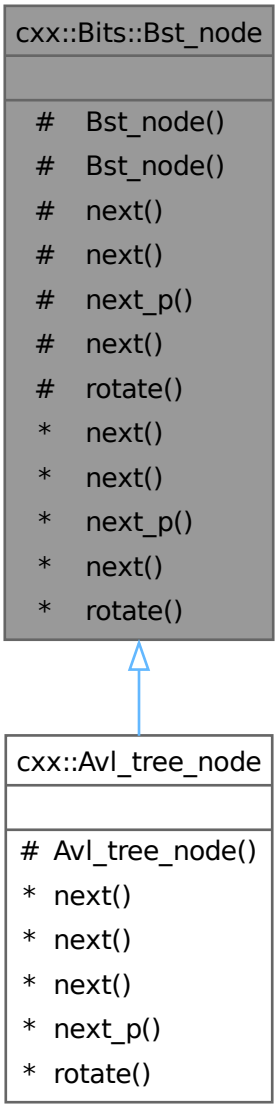
Definition at line 200 of file bst.h.
The documentation for this class was generated from the following file:

- l4/cxx/bits/bst.h

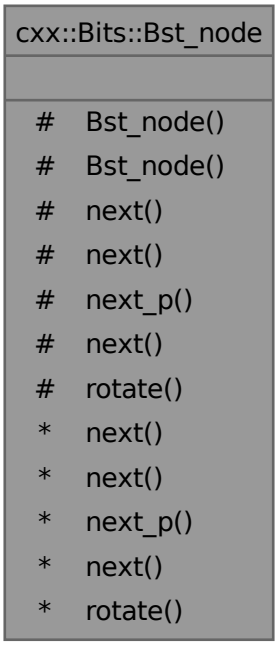
15.26 cxx::Bits::Bst_node Class Reference

Basic type of a node in a binary search tree (BST).
`#include <bst_base.h>`

Inheritance diagram for cxx::Bits::Bst_node:



Collaboration diagram for cxx::Bits::Bst_node:



Protected Member Functions

- **Bst_node** ()

  Create uninitialized node.
- **Bst_node** (bool)

  Create initialized node.

Static Protected Member Functions

Access to BST linkage.

Provide access to the tree linkage to inherited classes Inherited nodes, such as AVL nodes should make these methods private via 'using'

- static Bst_node * **next** (Bst_node const *p, Direction d)

  Get next node in direction d.
- static void **next** (Bst_node *p, Direction d, Bst_node *n)

  Set next node of p in direction d to n.
- static Bst_node ** **next_p** (Bst_node *p, Direction d)

  Get pointer to link in direction d.
- template<typename Node>
  static Node * **next** (Bst_node const *p, Direction d)

  Get next node in direction d as type Node.
- static void **rotate** (Bst_node **t, Direction idir)

  Rotate subtree t in the opposite direction of idir.

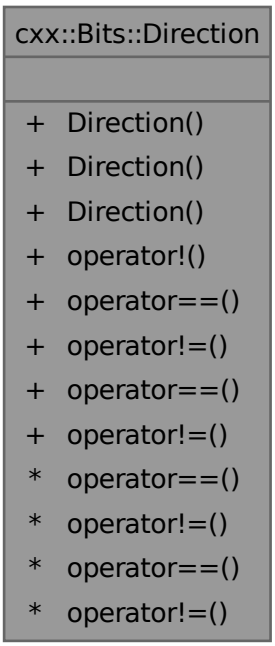
15.26.1 Detailed Description

Basic type of a node in a binary search tree (BST).
Definition at line 70 of file bst_base.h.
The documentation for this class was generated from the following file:

- l4/cxx/bits/bst_base.h

15.27 cxx::Bits::Direction Struct Reference

The direction to go in a binary search tree.
`#include <bst_base.h>`
Collaboration diagram for cxx::Bits::Direction:



Public Types

- enum Direction_e { L = 0 , R = 1 , N = 2 }

  The literal direction values.

Public Member Functions

- **Direction** ()=default

  Uninitialized direction.
- **Direction** (Direction_e d)

  Convert a literal direction (L, R, N) to an object.
- **Direction** (bool b)

  Convert a boolean to a direction (false == L, true == R).
- Direction operator! () const

  Negate the direction.

Comparison operators (equality and inequality)

- bool **operator==** (Direction_e o) const
  Compare for equality.
- bool **operator!=** (Direction_e o) const
  Compare for inequality.
- bool **operator==** (Direction o) const
  Compare for equality.
- bool **operator!=** (Direction o) const
  Compare for inequality.

15.27.1 Detailed Description

The direction to go in a binary search tree.
Definition at line 28 of file bst_base.h.

15.27.2 Member Enumeration Documentation

15.27.2.1 Direction_e

`enum cxx::Bits::Direction::Direction_e`
The literal direction values.

Enumerator

L	Go to the left child.
R	Go to the right child.
N	Stop.

Definition at line 31 of file bst_base.h.

15.27.3 Member Function Documentation

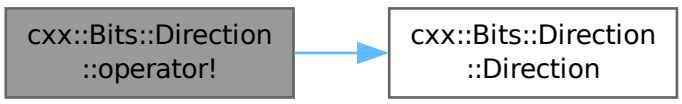
15.27.3.1 operator"!()

`Direction cxx::Bits::Direction::operator! () const [inline]`
Negate the direction.

Note

This is only defined for a current value of L or R

Definition at line 52 of file bst_base.h.
References Direction().
Here is the call graph for this function:



The documentation for this struct was generated from the following file:

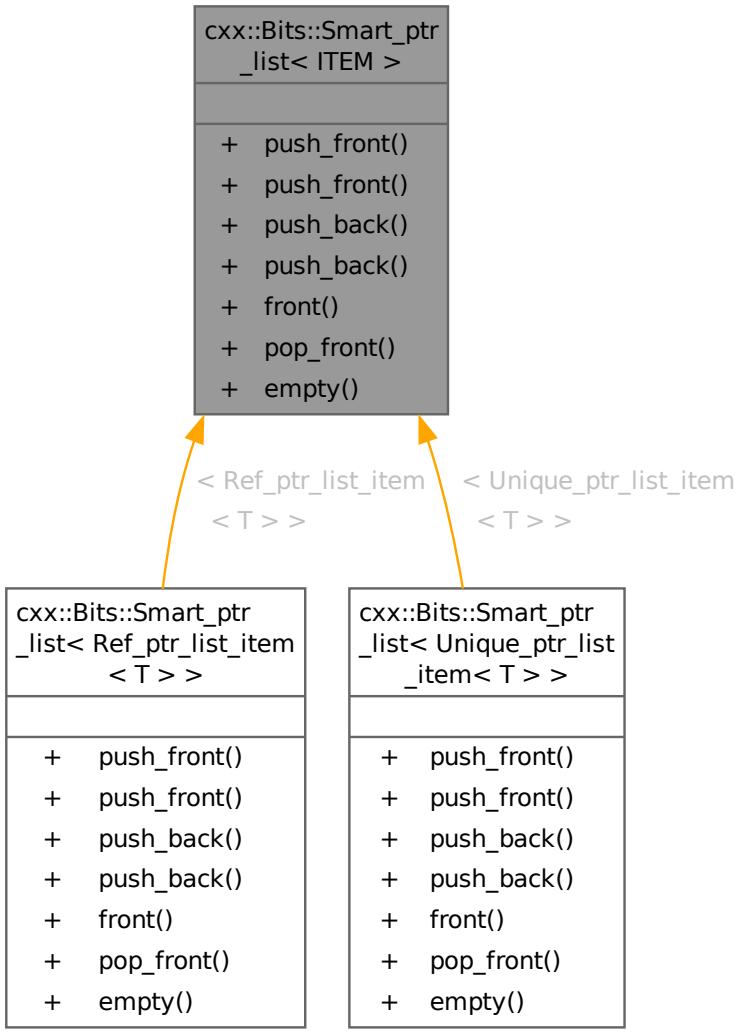
- l4/cxx/bits/bst_base.h

15.28 cxx::Bits::Smart_ptr_list< ITEM > Class Template Reference

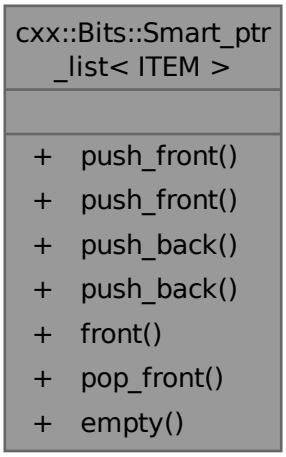
List of smart-pointer-managed objects.

`#include <smart_ptr_list.h>`

Inheritance diagram for cxx::Bits::Smart_ptr_list< ITEM >:



Collaboration diagram for cxx::Bits::Smart_ptr_list< ITEM >:



Public Member Functions

- void **push_front** (Next_type &&e)
  Add an element to the front of the list.
- void **push_front** (Next_type const &e)
  Add an element to the front of the list.
- void **push_back** (Next_type &&e)
  Add an element at the end of the list.
- void **push_back** (Next_type const &e)
  Add an element at the end of the list.
- Value_type * **front** () const
  Return a pointer to the first element in the list.
- Next_type pop_front ()
  Remove the element in front of the list and return it.
- bool **empty** () const
  Check if the list is empty.

15.28.1 Detailed Description

template<typename ITEM>
class cxx::Bits::Smart_ptr_list< ITEM >

List of smart-pointer-managed objects.

Template Parameters

ITEM	Type of the list items.

The list is implemented as a single-linked list connected via smart pointers, so that they are automatically cleaned up when they are removed from the list.
Definition at line 46 of file smart_ptr_list.h.

15.28.2 Member Function Documentation

15.28.2.1 pop_front()

```
template<typename ITEM>
Next_type cxx::Bits::Smart_ptr_list< ITEM >::pop_front ()  [inline]
```

Remove the element in front of the list and return it.

Returns

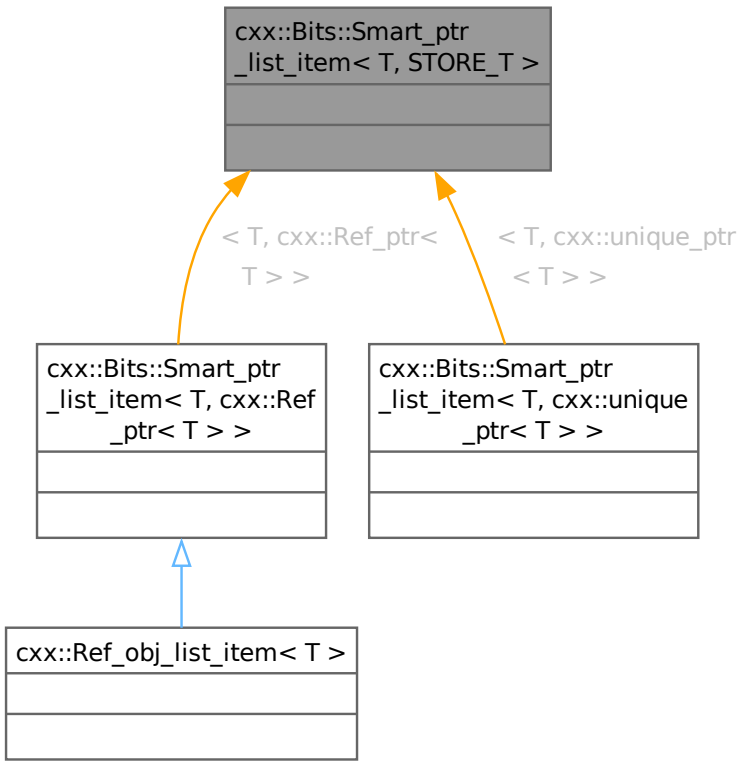
The element that was previously in front of the list as a managed pointer or a nullptr-equivalent when the list was already empty.

Definition at line 149 of file smart_ptr_list.h.
The documentation for this class was generated from the following file:

- l4/cxx/bits/smart_ptr_list.h

15.29 cxx::Bits::Smart_ptr_list_item< T, STORE_T > Class Template Reference

List item for an arbitrary item in a Smart_ptr_list.
`#include <smart_ptr_list.h>`
Inheritance diagram for cxx::Bits::Smart_ptr_list_item< T, STORE_T >:



Collaboration diagram for cxx::Bits::Smart_ptr_list_item< T, STORE_T >:



15.29.1 Detailed Description

template<typename T, typename STORE_T>
class cxx::Bits::Smart_ptr_list_item< T, STORE_T >

List item for an arbitrary item in a Smart_ptr_list.

Template Parameters

T	Type of object to be stored in the list.
STORE_T	Storage type for pointer to next item. The class must implement a get() function that returns a pointer to the stored object and destroy the stored object when the item goes out of scope.

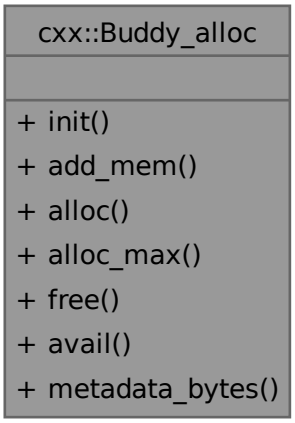
Definition at line 27 of file smart_ptr_list.h.
The documentation for this class was generated from the following file:

- l4/cxx/bits/smart_ptr_list.h

15.30 cxx::Buddy_alloc Class Reference

Buddy allocator backed by a perfect binary tree.
`#include <buddy_alloc>`

Collaboration diagram for cxx::Buddy_alloc:



Public Member Functions

- void init (l4_addr_t min_addr, l4_addr_t max_addr, unsigned char *metadata_addr, size_t metadata_size)

  Initialize the allocator.
- void add_mem (void *mem, size_t size)

  Add memory to the allocator.
- void * alloc (size_t size, size_t align, l4_addr_t lower=0, l4_addr_t upper=~0UL)

  Allocate a memory block.
- void * alloc_max (size_t min, size_t *max, size_t align, size_t granularity, l4_addr_t lower=0, l4_addr_t upper=~0UL)

  Allocate a memory block of `min` *<= size <=* `max`*.*
- void free (void *block, size_t size)

  Return a free memory block to the allocator.
- size_t avail () const

  Get the amount of available memory.

Static Public Member Functions

- static constexpr size_t metadata_bytes (l4_addr_t min_addr, l4_addr_t max_addr)

  Return metadata size in bytes required by the buddy allocator.

15.30.1 Detailed Description

Buddy allocator backed by a perfect binary tree.
The root node of the tree spans the entire memory area managed by the allocator and represents the largest block size supported by the allocator. Each subsequent level of the tree halves the block size until reaching the minimum block size.
Each node in the tree stores the largest order of block that can be allocated at or underneath it:

- A node with a value of 0 is allocated (used).
- A node with a value between 1 and level is split, i.e. has blocks allocated underneath it.
- A node with a value of level+1 is free.

An completely unallocated tree with four levels would look like:

```
        4
    3       3
 2    2   2   2
1 1 1 1 1 1 1 1
```

After allocating a block of `2 * Min_size`:

```
        3
    2       3
 0    2   2   2
1 1 1 1 1 1 1 1
```

Definition at line 56 of file buddy_alloc.

15.30.2 Member Function Documentation

15.30.2.1 add_mem()

```
void cxx::Buddy_alloc::add_mem (
             void * mem,
             size_t size)  [inline]
```

Add memory to the allocator.

Parameters

mem	Pointer to the memory.
size	Size of the memory.

Precondition

The memory must be within the memory range passed to init().

Definition at line 1307 of file buddy_alloc.
References L4_UNLIKELY.

15.30.2.2 alloc()

```
void * cxx::Buddy_alloc::alloc (
             size_t size,
             size_t align,
             l4_addr_t lower = 0,
             l4_addr_t upper = ~0UL)  [inline]
```

Allocate a memory block.

Parameters

size	Size of the memory block.
align	Alignment constraint (must be a power of two).
lower	Lower bound of the physical region the memory block should be allocated from.
upper	Upper bound of the physical region the memory block should be allocated from, value is inclusive.

Return values

nullptr	Allocation failed.

Returns

Pointer to memory block.

Precondition

0 < size

align <= size

Definition at line 1351 of file buddy_alloc.
References L4_LIKELY, and L4_UNLIKELY.

15.30.2.3 alloc_max()

```
void * cxx::Buddy_alloc::alloc_max (
            size_t min,
            size_t * max,
            size_t align,
            size_t granularity,
            l4_addr_t lower = 0,
            l4_addr_t upper = ~0UL)  [inline]
```

Allocate a memory block of min <= size <= max.

Parameters

	min	Minimal size to allocate (in bytes).
in,out	*max*	Maximum size to allocate (in bytes). The actual allocated size is returned here.
	align	Alignment constraint (must be a power of two).
	granularity	Granularity to use for the allocation (power of 2).
	lower	Lower bound of the physical region the memory block should be allocated from.
	upper	Upper bound of the physical region the memory block should be allocated from, value is inclusive.

Note

The allocated size is always a multiple of granularity, thus min is rounded up to a multiple of granularity internally.

Return values

nullptr	Allocation failed.

Returns

Pointer to memory block

Precondition

0 < min <= max

0 < max

align <= min

granularity <= align

Definition at line 1404 of file buddy_alloc.
References L4_LIKELY, and L4_UNLIKELY.

15.30.2.4 avail()

```
size_t cxx::Buddy_alloc::avail () const  [inline]
```

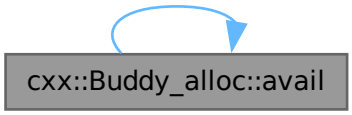
Get the amount of available memory.

Returns

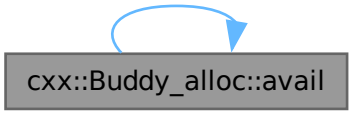
Available memory in bytes

Available memory in bytes.

Definition at line 1611 of file buddy_alloc.
References avail(), and L4_UNLIKELY.
Referenced by avail().
Here is the call graph for this function:



Here is the caller graph for this function:



15.30.2.5 free()

```
void cxx::Buddy_alloc::free (
            void * block,
            size_t size)  [inline]
```

Return a free memory block to the allocator.

Parameters

block	Pointer to memory block.
size	Size of memory block.

Precondition

`block` must not be NULL.

`block` must have been obtained through alloc() or alloc_max().

Definition at line 1500 of file buddy_alloc.
References L4_UNLIKELY.

15.30.2.6 init()

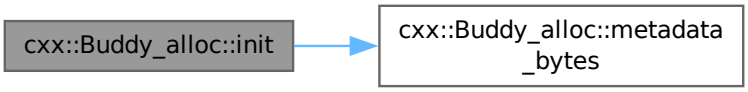
```
void cxx::Buddy_alloc::init (
            l4_addr_t min_addr,
            l4_addr_t max_addr,
            unsigned char * metadata_addr,
            size_t metadata_size)  [inline]
```

Initialize the allocator.

Parameters

min_addr	Minimum address covered by the allocator.
max_addr	Maximum address covered by the allocator (inclusive).
metadata_addr	Pointer to metadata memory chunk for the allocator.
metadata_size	Size of the metadata memory chunk.

Definition at line 139 of file buddy_alloc.
References metadata_bytes().
Here is the call graph for this function:



15.30.2.7 metadata_bytes()

```
constexpr size_t cxx::Buddy_alloc::metadata_bytes (
            l4_addr_t min_addr,
            l4_addr_t max_addr)  [inline], [static], [constexpr]
```

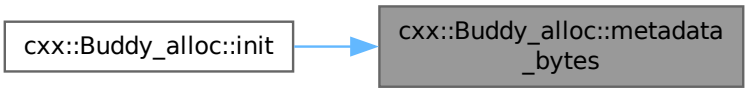
Return metadata size in bytes required by the buddy allocator.

Parameters

min_addr	Minimum address covered by the allocator.
max_addr	Maximum address covered by the allocator (inclusive).

Definition at line 124 of file buddy_alloc.
Referenced by init().

Here is the caller graph for this function:

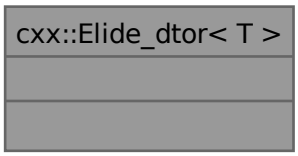


The documentation for this class was generated from the following file:

- l4/cxx/buddy_alloc

15.31 cxx::Elide_dtor< T > Class Template Reference

Wrapper class to remove destructor calls.
`#include <elide_dtor>`
Collaboration diagram for cxx::Elide_dtor< T >:



15.31.1 Detailed Description

template<typename T>
class cxx::Elide_dtor< T >

Wrapper class to remove destructor calls.
Use this class for global or static local objects that shall not be destructed. This can save some code size if the destructor of `T` is not trivial. It also prevents calls to atexit() at runtime.

Attention

Be careful if you use `Elide_dtor` in the global scope. Even if `T` is trivially constructible, the wrapper will force the compiler to emit a static initializer!

Definition at line 28 of file elide_dtor.
The documentation for this class was generated from the following file:

- l4/cxx/elide_dtor

15.32 cxx::Error Class Reference

Error value.
`#include <result>`

Collaboration diagram for cxx::Error:



15.32.1 Detailed Description

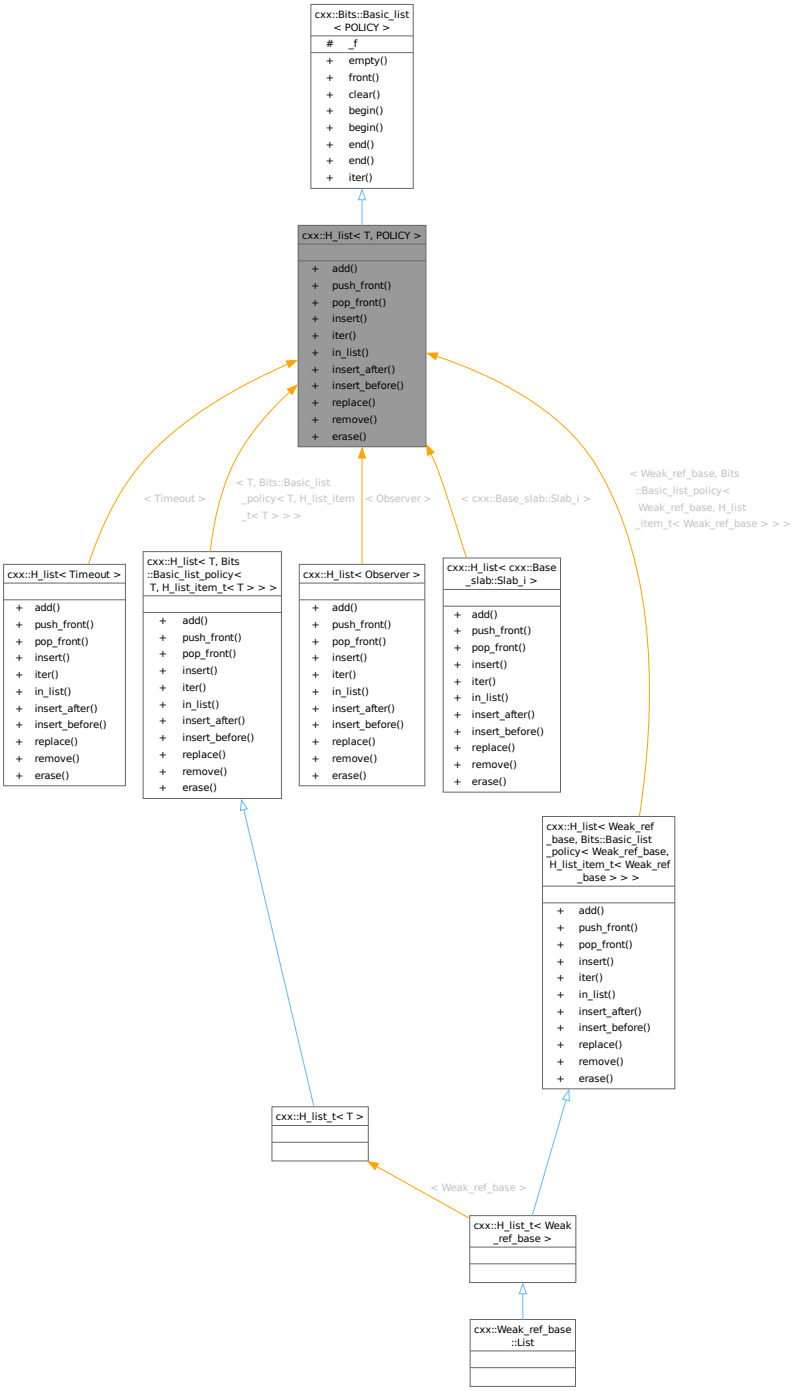
Error value.
Value class to make error value types explicit. Participates in the construction of Result objects.
Definition at line 19 of file result.
The documentation for this class was generated from the following file:

- l4/cxx/result

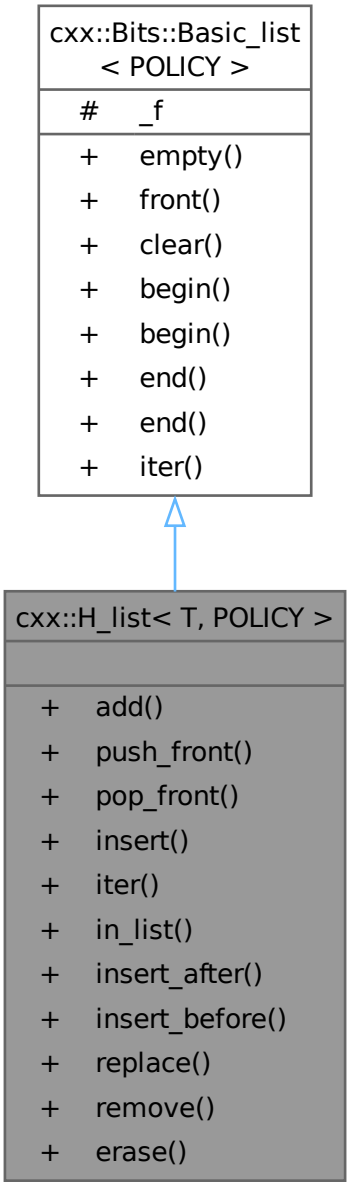
15.33 cxx::H_list< T, POLICY > Class Template Reference

General double-linked list of unspecified cxx::H_list_item elements.
`#include <hlist>`

Inheritance diagram for cxx::H_list< T, POLICY >:



Collaboration diagram for cxx::H_list< T, POLICY >:



Public Member Functions

- void **add** (T *e)

  Add element to the front of the list.
- void **push_front** (T *e)

  Add element to the front of the list.
- T * pop_front ()

  Remove and return the head element of the list.
- Iterator insert (T *e, Iterator const &pred)

  Insert an element at the iterator position.

Public Member Functions inherited from cxx::Bits::Basic_list< POLICY >

- bool **empty** () const

  Check if the list is empty.
- Value_type **front** () const

  Return the first element in the list.
- void clear ()

  Remove all elements from the list.
- Iterator **begin** ()

  Return an iterator to the beginning of the list.
- Const_iterator **begin** () const

  Return a const iterator to the beginning of the list.
- Const_iterator **end** () const

  Return a const iterator to the end of the list.
- Iterator **end** ()

  Return an iterator to the end of the list.

Static Public Member Functions

- static Iterator iter (T *c)

  Return an iterator for an arbitrary list element.
- static bool **in_list** (T const *e)

  Check if the given element is currently part of a list.
- static Iterator insert_after (T *e, Iterator const &pred)

  Insert an element after the iterator position.
- static void insert_before (T *e, Iterator const &succ)

  Insert an element before the iterator position.
- static void replace (T *p, T *e)

  Replace an element in a list with a new element.
- static void remove (T *e)

  Remove the given element from its list.
- static Iterator erase (Iterator const &e)

  Remove the element at the given iterator position.

Static Public Member Functions inherited from cxx::Bits::Basic_list< POLICY >

- static Const_iterator iter (Const_value_type c)

  Return a const iterator that begins at the given element.

Additional Inherited Members

Protected Attributes inherited from cxx::Bits::Basic_list< POLICY >

- POLICY::Head_type **_f**

  Pointer to front of the list.

15.33.1 Detailed Description

template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
class cxx::H_list< T, POLICY >

General double-linked list of unspecified cxx::H_list_item elements.
Most of the time, you want to use H_list_t.
Definition at line 69 of file hlist.

15.33.2 Member Function Documentation

15.33.2.1 erase()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
Iterator cxx::H_list< T, POLICY >::erase (
            Iterator const & e)  [inline], [static]
```

Remove the element at the given iterator position.

Parameters

e	Iterator pointing to the element to be removed. Must not point to end().

Returns

New iterator pointing to the element after the removed one.

Note

The hlist implementation guarantees that the original iterator is still valid after the element has been removed. In fact, the iterator returned is the same as the one supplied in the `e` parameter.

Definition at line 236 of file hlist.

15.33.2.2 insert()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
Iterator cxx::H_list< T, POLICY >::insert (
            T * e,
            Iterator const & pred)  [inline]
```

Insert an element at the iterator position.

Parameters

e	New Element to be inserted
pred	Iterator pointing to the element after which the element will be inserted. If end() is given, the element will be inserted at the beginning of the queue.

Returns

Iterator pointing to the newly inserted element.

Definition at line 133 of file hlist.

15.33.2.3 insert_after()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
Iterator cxx::H_list< T, POLICY >::insert_after (
            T * e,
            Iterator const & pred)  [inline], [static]
```

Insert an element after the iterator position.

Parameters

e	New element to be inserted.
pred	Iterator pointing to the element after which the element will be inserted. Must not be end().

Returns

Iterator pointing to the newly inserted element.

Precondition

The list must not be empty.

Definition at line 160 of file hlist.

15.33.2.4 insert_before()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
void cxx::H_list< T, POLICY >::insert_before (
            T * e,
            Iterator const & succ)  [inline], [static]
```

Insert an element before the iterator position.

Parameters

e	New element to be inserted.
succ	Iterator pointing to the element before which the element will be inserted. Must not be end().

Definition at line 180 of file hlist.

15.33.2.5 iter()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
Iterator cxx::H_list< T, POLICY >::iter (
            T * c)  [inline], [static]
```

Return an iterator for an arbitrary list element.

Parameters

c	List element to start the iteration.

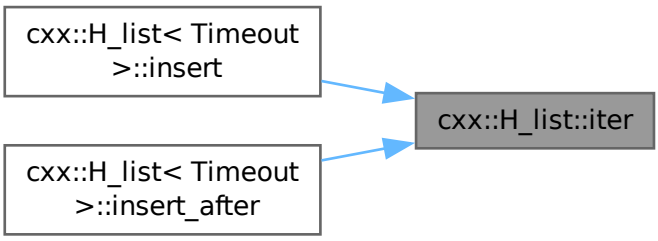
Returns

A mutable forward iterator.

Precondition

The element must be in a list.

Definition at line 93 of file hlist.
Referenced by cxx::H_list< Timeout >::insert(), and cxx::H_list< Timeout >::insert_after().
Here is the caller graph for this function:



15.33.2.6 pop_front()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
T * cxx::H_list< T, POLICY >::pop_front ()  [inline]
```

Remove and return the head element of the list.

Precondition

The list must not be empty or the behaviour will be undefined.

Definition at line 116 of file hlist.

15.33.2.7 remove()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
void cxx::H_list< T, POLICY >::remove (
            T * e)  [inline], [static]
```

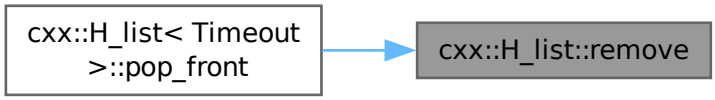
Remove the given element from its list.

Parameters

e	Element to be removed. Must be in a list.

Definition at line 220 of file hlist.
Referenced by cxx::H_list< Timeout >::pop_front().

Here is the caller graph for this function:



15.33.2.8 replace()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item>>
void cxx::H_list< T, POLICY >::replace (
            T * p,
            T * e)  [inline], [static]
```

Replace an element in a list with a new element.

Parameters

p	Element in list to be replaced.
e	Replacement element, must not yet be in a list.

Precondition

p and e must not be NULL.

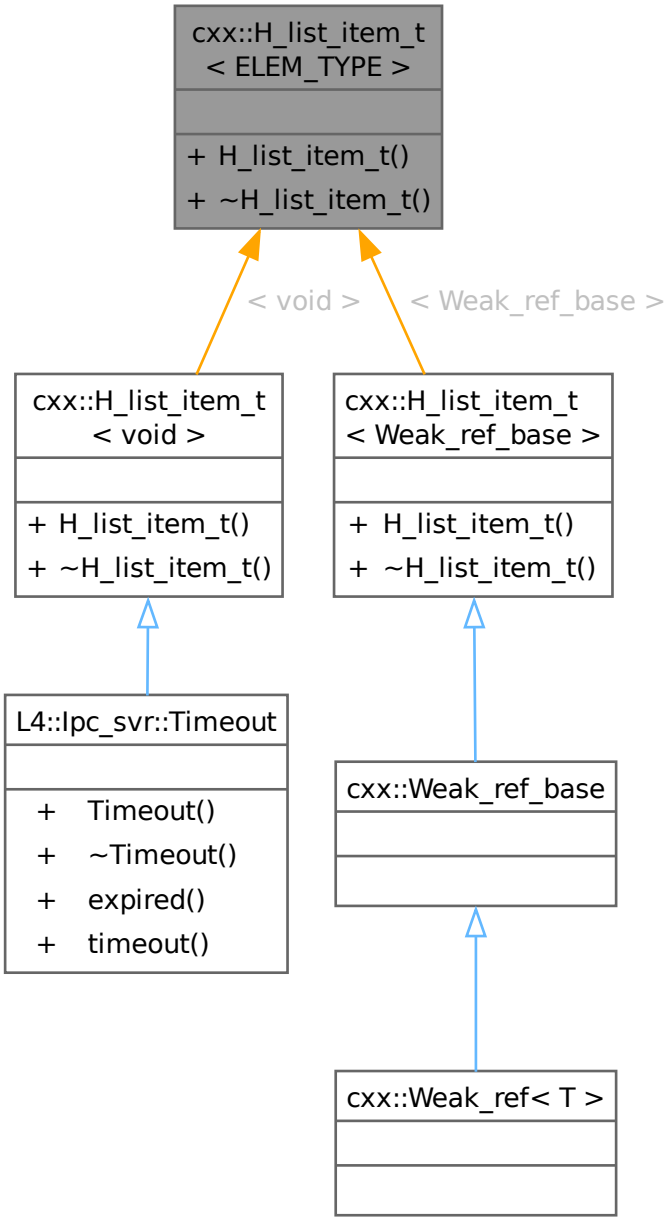
After the operation the p element is no longer in the list and may be reused.
Definition at line 204 of file hlist.
The documentation for this class was generated from the following file:

- l4/cxx/hlist

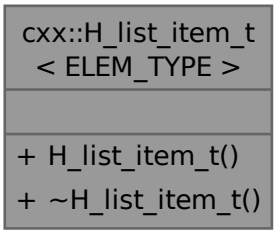
15.34 cxx::H_list_item_t< ELEM_TYPE > Class Template Reference

Basic element type for a double-linked H_list.
`#include <hlist>`

Inheritance diagram for cxx::H_list_item_t< ELEM_TYPE >:



Collaboration diagram for cxx::H_list_item_t< ELEM_TYPE >:



Public Member Functions

- constexpr H_list_item_t ()
  Constructor.
- ~H_list_item_t () noexcept
  Destructor.

15.34.1 Detailed Description

template<typename ELEM_TYPE>
class cxx::H_list_item_t< ELEM_TYPE >

Basic element type for a double-linked H_list.

Template Parameters

ELEM_TYPE	Base class of the list element.

Definition at line 22 of file hlist.

15.34.2 Constructor & Destructor Documentation

15.34.2.1 H_list_item_t()

```
template<typename ELEM_TYPE>
cxx::H_list_item_t< ELEM_TYPE >::H_list_item_t ()  [inline], [constexpr]
```

Constructor.
Creates an element that is not in any list.
Definition at line 30 of file hlist.

15.34.2.2 ~H_list_item_t()

```
template<typename ELEM_TYPE>
cxx::H_list_item_t< ELEM_TYPE >::~H_list_item_t ()  [inline], [noexcept]
```

Destructor.
Automatically removes the element from any list it still might be enchained in.
Definition at line 37 of file hlist.
The documentation for this class was generated from the following file:

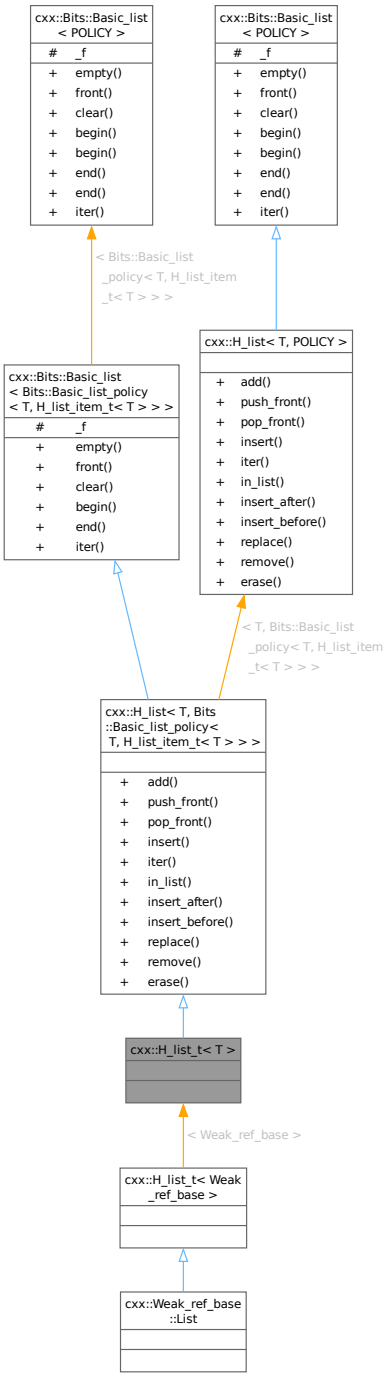
- l4/cxx/hlist

15.35 cxx::H_list_t< T > Struct Template Reference

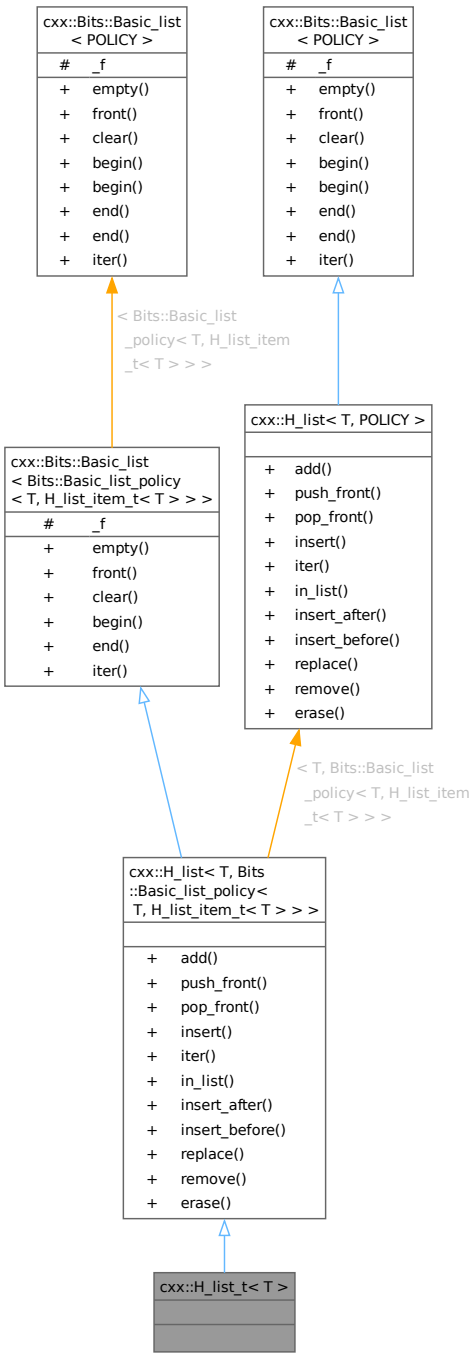
Double-linked list of typed H_list_item_t elements.

`#include <hlist>`

Inheritance diagram for cxx::H_list_t< T >:



Collaboration diagram for cxx::H_list_t< T >:



Additional Inherited Members

Public Member Functions inherited from cxx::H_list< T, Bits::Basic_list_policy< T, H_list_item_t< T > > >

- void **add** (T *e)

  Add element to the front of the list.

- void **push_front** (T *e)

Add element to the front of the list.

- T * pop_front ()

  Remove and return the head element of the list.

- Iterator insert (T *e, Iterator const &pred)

  Insert an element at the iterator position.

Public Member Functions inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< T, H_list_item_t< T > > >

- bool **empty** () const

  Check if the list is empty.

- Value_type **front** () const

  Return the first element in the list.

- void clear ()

  Remove all elements from the list.

- Iterator **begin** ()

  Return an iterator to the beginning of the list.

- Const_iterator **end** () const

  Return a const iterator to the end of the list.

Static Public Member Functions inherited from cxx::H_list< T, Bits::Basic_list_policy< T, H_list_item_t< T > > >

- static Iterator iter (T *c)

  Return an iterator for an arbitrary list element.

- static bool **in_list** (T const *e)

  Check if the given element is currently part of a list.

- static Iterator insert_after (T *e, Iterator const &pred)

  Insert an element after the iterator position.

- static void insert_before (T *e, Iterator const &succ)

  Insert an element before the iterator position.

- static void replace (T *p, T *e)

  Replace an element in a list with a new element.

- static void remove (T *e)

  Remove the given element from its list.

- static Iterator erase (Iterator const &e)

  Remove the element at the given iterator position.

Static Public Member Functions inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< T, H_list_item_t< T > > >

- static Const_iterator iter (Const_value_type c)

  Return a const iterator that begins at the given element.

Protected Attributes inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< T, H_list_item_t< T > > >

- Bits::Basic_list_policy< T, H_list_item_t< T > >::Head_type **_f**

  Pointer to front of the list.

15.35.1 Detailed Description

template<typename T>
struct cxx::H_list_t< T >

Double-linked list of typed H_list_item_t elements.

Note

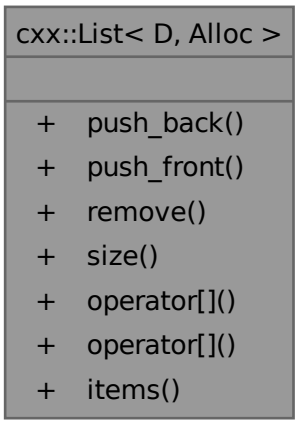
H_lists are not self-cleaning. Elements that are still chained during destruction are not removed and will therefore be in an undefined state after the destruction.

Definition at line 248 of file hlist.
The documentation for this struct was generated from the following file:

- l4/cxx/hlist

15.36 cxx::List< D, Alloc > Class Template Reference

Doubly linked list, with internal allocation.
`#include <list>`
Collaboration diagram for cxx::List< D, Alloc >:



Data Structures

- class Iter

  Iterator.

Public Member Functions

- void **push_back** (D const &d) noexcept

  Add element at the end of the list.
- void **push_front** (D const &d) noexcept

  Add element at the beginning of the list.
- void **remove** (Iter const &i) noexcept

  Remove element pointed to by the iterator.
- unsigned long **size** () const noexcept

Get the length of the list.

- D const & operator[ ] (unsigned long idx) const noexcept

  Random access.

- D & operator[ ] (unsigned long idx) noexcept

  Random access.

- Iter **items** () noexcept

  Get iterator for the list elements.

15.36.1 Detailed Description

template<typename D, template< typename A > class Alloc = New_allocator>
class cxx::List< D, Alloc >

Doubly linked list, with internal allocation.
Container for items of type D, implemented by a doubly linked list. Alloc defines the allocator policy.
Definition at line 326 of file list.

15.36.2 Member Function Documentation

15.36.2.1 operator[]() [1/2]

```
template<typename D, template< typename A > class Alloc = New_allocator>
D const & cxx::List< D, Alloc >::operator[] (
            unsigned long idx) const  [inline], [noexcept]
```

Random access.
Complexity is O(n).
Definition at line 396 of file list.

15.36.2.2 operator[]() [2/2]

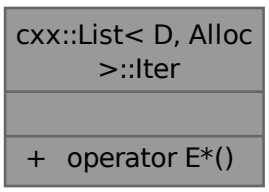
```
template<typename D, template< typename A > class Alloc = New_allocator>
D & cxx::List< D, Alloc >::operator[] (
            unsigned long idx)  [inline], [noexcept]
```

Random access.
Complexity is O(n).
Definition at line 400 of file list.
The documentation for this class was generated from the following file:

- l4/cxx/list

15.37 cxx::List< D, Alloc >::Iter Class Reference

Iterator.
`#include <list>`
Collaboration diagram for cxx::List< D, Alloc >::Iter:



Public Member Functions

- **operator E∗** () const noexcept

  operator for testing validity (syntactically equal to pointers)

15.37.1 Detailed Description

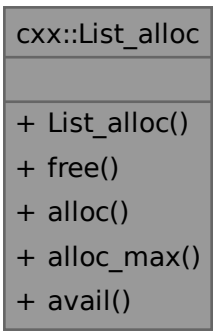
template<typename D, template< typename A > class Alloc = New_allocator>
class cxx::List< D, Alloc >::Iter

Iterator.
Forward and backward iteratable.
Definition at line 346 of file list.
The documentation for this class was generated from the following file:

- l4/cxx/list

15.38 cxx::List_alloc Class Reference

Standard list-based allocator.
`#include <list_alloc>`
Collaboration diagram for cxx::List_alloc:



Public Member Functions

- List_alloc ()

  Initializes an empty list allocator.
- void free (void ∗block, unsigned long size, bool initial_free=false)

  Return a free memory block to the allocator.
- void ∗ alloc (unsigned long size, unsigned long align, unsigned long lower=0, unsigned long upper=∼0UL)

  Allocate a memory block.
- void ∗ alloc_max (unsigned long min, unsigned long ∗max, unsigned long align, unsigned granularity, unsigned long lower=0, unsigned long upper=∼0UL)

  Allocate a memory block of `min` <= size <= `max`.
- unsigned long avail () const

  Get the amount of available memory.

15.38.1 Detailed Description

Standard list-based allocator.
Definition at line 26 of file list_alloc.

15.38.2 Constructor & Destructor Documentation

15.38.2.1 List_alloc()

```
cxx::List_alloc::List_alloc ()  [inline]
```

Initializes an empty list allocator.

Note

To initialize the allocator with available memory use the free() function.

Definition at line 52 of file list_alloc.

15.38.3 Member Function Documentation

15.38.3.1 alloc()

```
void * cxx::List_alloc::alloc (
            unsigned long size,
            unsigned long align,
            unsigned long lower = 0,
            unsigned long upper = ~0UL)  [inline]
```

Allocate a memory block.

Parameters

size	Size of the memory block.
align	Alignment constraint.
lower	Lower bound of the physical region the memory block should be allocated from.
upper	Upper bound of the physical region the memory block should be allocated from, value is inclusive.

Returns

Pointer to memory block

Precondition

0 < `size` <= `~0UL - 32`.

Definition at line 413 of file list_alloc.

15.38.3.2 alloc_max()

```
void * cxx::List_alloc::alloc_max (
            unsigned long min,
            unsigned long * max,
            unsigned long align,
            unsigned granularity,
            unsigned long lower = 0,
            unsigned long upper = ~0UL)  [inline]
```

Allocate a memory block of `min` <= size <= `max`.

Parameters

	min	Minimal size to allocate (in bytes).
in,out	*max*	Maximum size to allocate (in bytes). The actual allocated size is returned here.
	align	Alignment constraint.
	granularity	Granularity to use for the allocation (power of 2).
	lower	Lower bound of the physical region the memory block should be allocated from.
	upper	Upper bound of the physical region the memory block should be allocated from, value is inclusive.

Returns

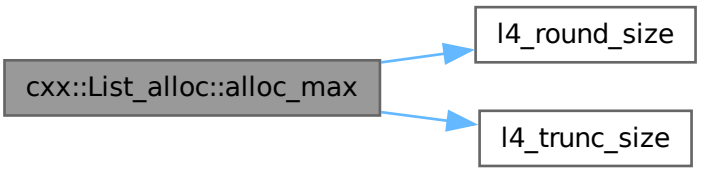
Pointer to memory block

Precondition

$0 < \texttt{min} <= \sim\texttt{0UL} - 32$.

$0 < \texttt{max}$.

Definition at line 293 of file list_alloc.
References l4_round_size(), and l4_trunc_size().
Here is the call graph for this function:



15.38.3.3 avail()

```
unsigned long cxx::List_alloc::avail () const  [inline]
```

Get the amount of available memory.

Returns

Available memory in bytes

Definition at line 501 of file list_alloc.

15.38.3.4 free()

```
void cxx::List_alloc::free (
            void * block,
            unsigned long size,
            bool initial_free = false)  [inline]
```

Return a free memory block to the allocator.

Parameters

block	Pointer to memory block.
size	Size of memory block.
initial_free	Set to true for putting fresh memory to the allocator. This will enforce alignment on that memory.

Precondition

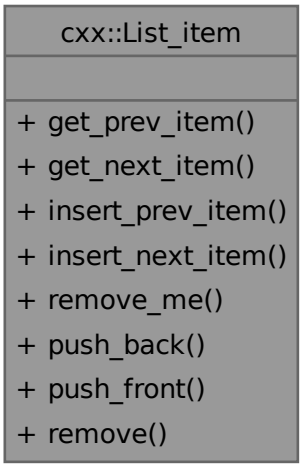
`block` must not be NULL.
`2 * sizeof(void *) <= size <= ~0UL - 32`.

Definition at line 248 of file list_alloc.
The documentation for this class was generated from the following file:

- l4/cxx/list_alloc

15.39 cxx::List_item Class Reference

Basic list item.
`#include <list>`
Collaboration diagram for cxx::List_item:



Data Structures

- class Iter

  Iterator for a list of ListItem-s.
- class T_iter

  Iterator for derived classes from ListItem.

Public Member Functions

- List_item * **get_prev_item** () const noexcept

  Get previous item.

- List_item * **get_next_item** () const noexcept

  Get next item.
- void **insert_prev_item** (List_item *p) noexcept

  Insert item p before this item.
- void **insert_next_item** (List_item *p) noexcept

  Insert item p after this item.
- void **remove_me** () noexcept

  Remove this item from the list.

Static Public Member Functions

- template<typename C, typename N>
  static C * push_back (C *head, N *p) noexcept

  Append item to a list.
- template<typename C, typename N>
  static C * push_front (C *head, N *p) noexcept

  Prepend item to a list.
- template<typename C, typename N>
  static C * remove (C *head, N *p) noexcept

  Remove item from a list.

15.39.1 Detailed Description

Basic list item.
Basic item that can be member of a doubly linked, cyclic list.
Definition at line 26 of file list.

15.39.2 Member Function Documentation

15.39.2.1 push_back()

```
template<typename C, typename N>
C * cxx::List_item::push_back (
            C * head,
            N * p)  [inline], [static], [noexcept]
```

Append item to a list.
Convenience function for empty-head corner case.

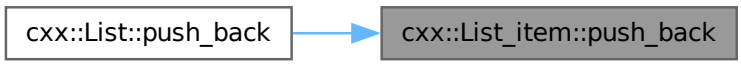
Parameters

head	Pointer to the current list head.
p	Pointer to new item.

Returns

the pointer to the new head.

Definition at line 240 of file list.
Referenced by cxx::List< D, Alloc >::push_back().
Here is the caller graph for this function:



15.39.2.2 push_front()

```
template<typename C, typename N>
C * cxx::List_item::push_front (
            C * head,
            N * p)  [inline], [static], [noexcept]
```

Prepend item to a list.
Convenience function for empty-head corner case.

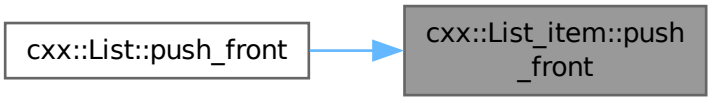
Parameters

head	pointer to the current list head.
p	pointer to new item.

Returns

the pointer to the new head.

Definition at line 251 of file list.
Referenced by cxx::List< D, Alloc >::push_front().
Here is the caller graph for this function:



15.39.2.3 remove()

```
template<typename C, typename N>
C * cxx::List_item::remove (
```

```
C * head,
N * p)  [inline], [static], [noexcept]
```

Remove item from a list.
Convenience function for remove-head corner case.

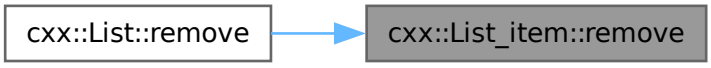
Parameters

head	pointer to the current list head.
p	pointer to the item to remove.

Returns

the pointer to the new head.

Definition at line 261 of file list.
Referenced by cxx::List< D, Alloc >::remove().
Here is the caller graph for this function:



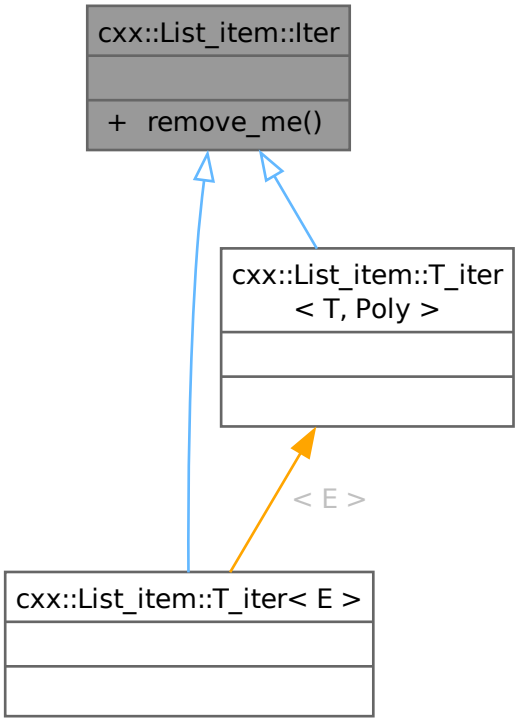
The documentation for this class was generated from the following file:

- l4/cxx/list

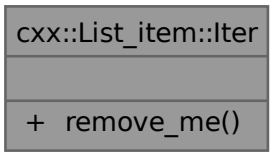
15.40 cxx::List_item::Iter Class Reference

Iterator for a list of ListItem-s.
`#include <list>`

Inheritance diagram for cxx::List_item::Iter:



Collaboration diagram for cxx::List_item::Iter:



Public Member Functions

- List_item ∗ **remove_me** () noexcept

  Remove item pointed to by iterator, and return pointer to element.

15.40.1 Detailed Description

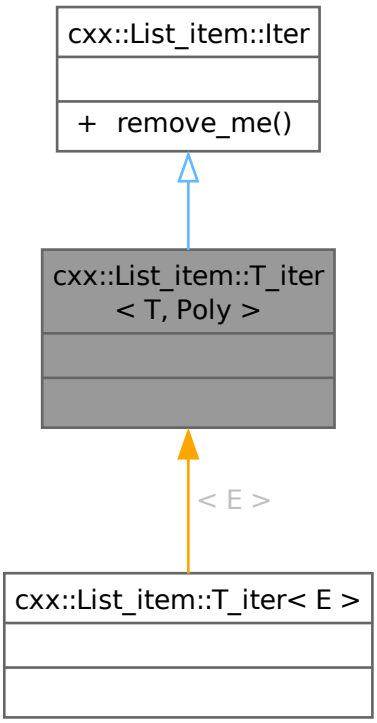
Iterator for a list of ListItem-s.
The Iterator iterates till it finds the first element again.
Definition at line 34 of file list.

The documentation for this class was generated from the following file:

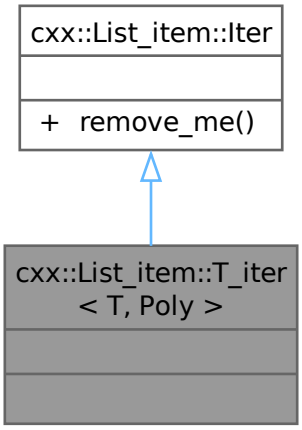
- l4/cxx/list

15.41 cxx::List_item::T_iter< T, Poly > Class Template Reference

Iterator for derived classes from ListItem.
`#include <list>`
Inheritance diagram for cxx::List_item::T_iter< T, Poly >:



Collaboration diagram for cxx::List_item::T_iter< T, Poly >:



Additional Inherited Members

Public Member Functions inherited from cxx::List_item::Iter

- List_item ∗ **remove_me** () noexcept

  Remove item pointed to by iterator, and return pointer to element.

15.41.1 Detailed Description

template<typename T, bool Poly = false>
class cxx::List_item::T_iter< T, Poly >

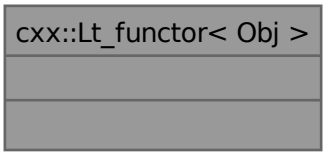
Iterator for derived classes from ListItem.
Allows direct access to derived classes by ∗ operator.
Example: class Foo : public ListItem { public: typedef T_iter<Foo> Iter; ... };
Definition at line 108 of file list.
The documentation for this class was generated from the following file:

- l4/cxx/list

15.42 cxx::Lt_functor< Obj > Struct Template Reference

Generic comparator class that defaults to the less-than operator.
`#include <std_ops>`

Collaboration diagram for cxx::Lt_functor< Obj >:



15.42.1 Detailed Description

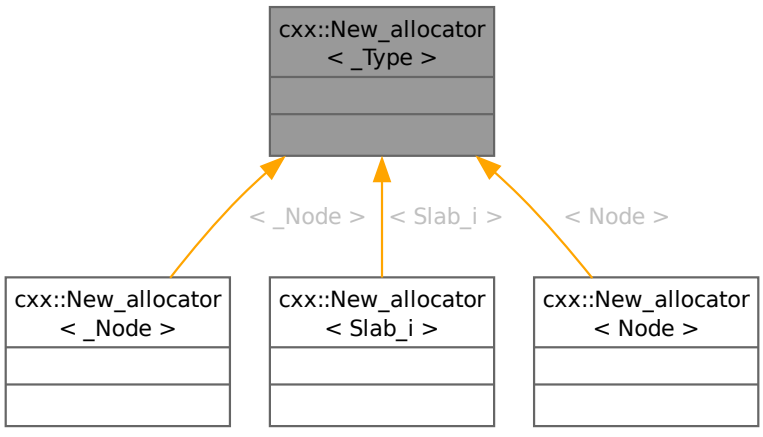
template<**typename Obj**>
struct cxx::Lt_functor< **Obj** >

Generic comparator class that defaults to the less-than operator.
Definition at line 18 of file std_ops.
The documentation for this struct was generated from the following file:

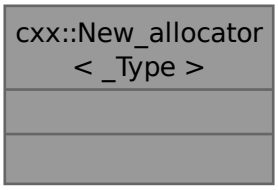
- l4/cxx/std_ops

15.43 cxx::New_allocator< _Type > Class Template Reference

Standard allocator based on `operator new ()` .
`#include <std_alloc>`
Inheritance diagram for cxx::New_allocator< _Type >:



Collaboration diagram for cxx::New_allocator< _Type >:



15.43.1 Detailed Description

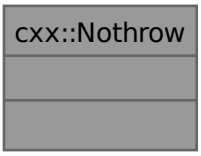
template<typename _Type>
class cxx::New_allocator< _Type >

Standard allocator based on `operator new ()` .
This allocator is the default allocator used for the *cxx Containers*, such as cxx::Avl_set and cxx::Avl_map, to allocate the internal data structures.
Definition at line 56 of file std_alloc.
The documentation for this class was generated from the following file:

- l4/cxx/std_alloc

15.44 cxx::Nothrow Class Reference

Helper type to distinguish the `operator new` version that does not throw exceptions.
`#include <std_alloc>`
Collaboration diagram for cxx::Nothrow:



15.44.1 Detailed Description

Helper type to distinguish the `operator new` version that does not throw exceptions.
Definition at line 19 of file std_alloc.
The documentation for this class was generated from the following file:

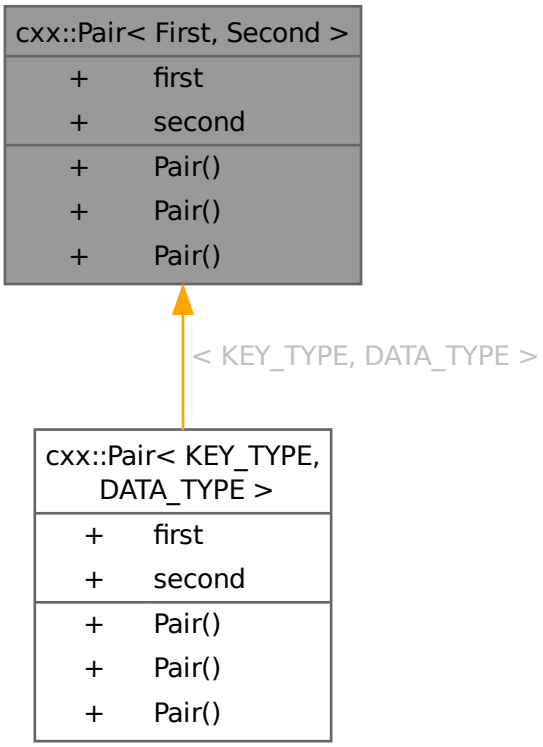
- l4/cxx/std_alloc

15.45 cxx::Pair< First, Second > Struct Template Reference

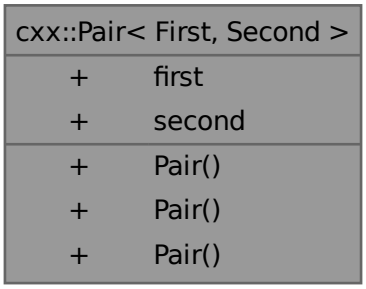
Pair of two values.

`#include <pair>`

Inheritance diagram for cxx::Pair< First, Second >:



Collaboration diagram for cxx::Pair< First, Second >:



Public Types

- typedef First **First_type**

  Type of first value.
- typedef Second **Second_type**

  Type of second value.

Public Member Functions

- template<typename A1, typename A2>
  Pair (A1 &&first, A2 &&second)

  Create a pair from the two values.
- template<typename A1>
  Pair (A1 &&first)

  Create a pair, default constructing the second value.
- **Pair** ()=default

  Default construction.

Data Fields

- First **first**

  First value.
- Second **second**

  Second value.

15.45.1 Detailed Description

template<typename First, typename Second>
struct cxx::Pair< First, Second >

Pair of two values.
Standard container for a pair of values.

Parameters

First	Type of the first value.
Second	Type of the second value.

Definition at line 27 of file pair.

15.45.2 Constructor & Destructor Documentation

15.45.2.1 Pair() [1/2]

```
template<typename First, typename Second>
template<typename A1, typename A2>
cxx::Pair< First, Second >::Pair (
            A1 && first,
            A2 && second)  [inline]
```

Create a pair from the two values.

Parameters

first	The first value.
second	The second value.

Definition at line 45 of file pair.

15.45.2.2 Pair() [2/2]

```
template<typename First, typename Second>
template<typename A1>
cxx::Pair< First, Second >::Pair (
             A1 && first)  [inline]
```

Create a pair, default constructing the second value.

Parameters

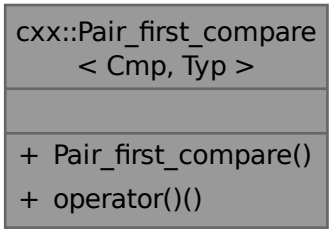
first	The first value.

Definition at line 53 of file pair.
The documentation for this struct was generated from the following file:

- l4/cxx/pair

15.46 cxx::Pair_first_compare< Cmp, Typ > Class Template Reference

Comparison functor for Pair.
`#include <pair>`
Collaboration diagram for cxx::Pair_first_compare< Cmp, Typ >:



Public Member Functions

- Pair_first_compare (Cmp const &cmp=Cmp())
  Construction.
- bool operator() (Typ const &l, Typ const &r) const
  Do the comparison based on the first value.

15.46.1 Detailed Description

template<typename Cmp, typename Typ>
class cxx::Pair_first_compare< Cmp, Typ >

Comparison functor for Pair.

Parameters

Cmp	Comparison functor for the first value of the pair.
Typ	The pair type.

This functor can be used to compare Pair values with respect to the first value.
Definition at line 74 of file pair.

15.46.2 Constructor & Destructor Documentation

15.46.2.1 Pair_first_compare()

```
template<typename Cmp, typename Typ>
cxx::Pair_first_compare< Cmp, Typ >::Pair_first_compare (
            Cmp const & cmp = Cmp())  [inline]
```

Construction.

Parameters

cmp	The comparison functor used for the first value.

Definition at line 84 of file pair.

15.46.3 Member Function Documentation

15.46.3.1 operator()()

```
template<typename Cmp, typename Typ>
bool cxx::Pair_first_compare< Cmp, Typ >::operator() (
            Typ const & l,
            Typ const & r) const  [inline]
```

Do the comparison based on the first value.

Parameters

l	The lefthand value.
r	The righthand value.

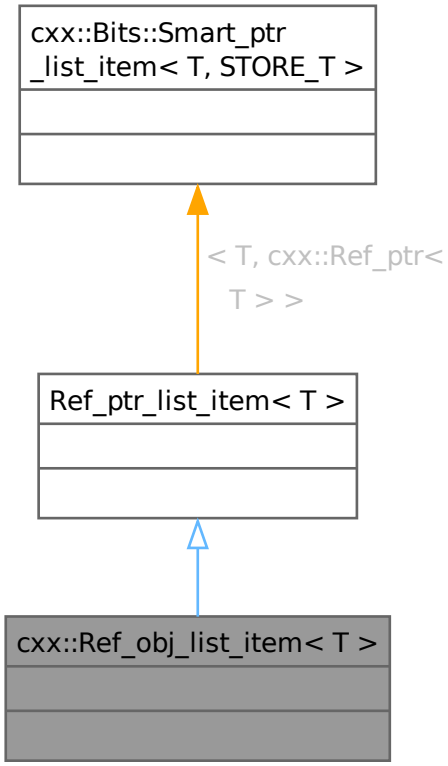
Definition at line 91 of file pair.
The documentation for this class was generated from the following file:

- l4/cxx/pair

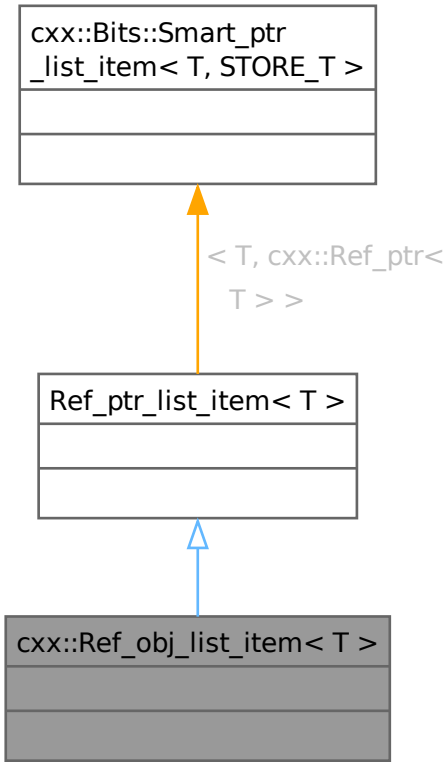
15.47 cxx::Ref_obj_list_item< T > Struct Template Reference

Item for list linked via cxx::Ref_ptr with default refence counting.
`#include <ref_ptr_list>`

Inheritance diagram for cxx::Ref_obj_list_item< T >:



Collaboration diagram for cxx::Ref_obj_list_item< T >:



15.47.1 Detailed Description

template<typename T>
struct cxx::Ref_obj_list_item< T >

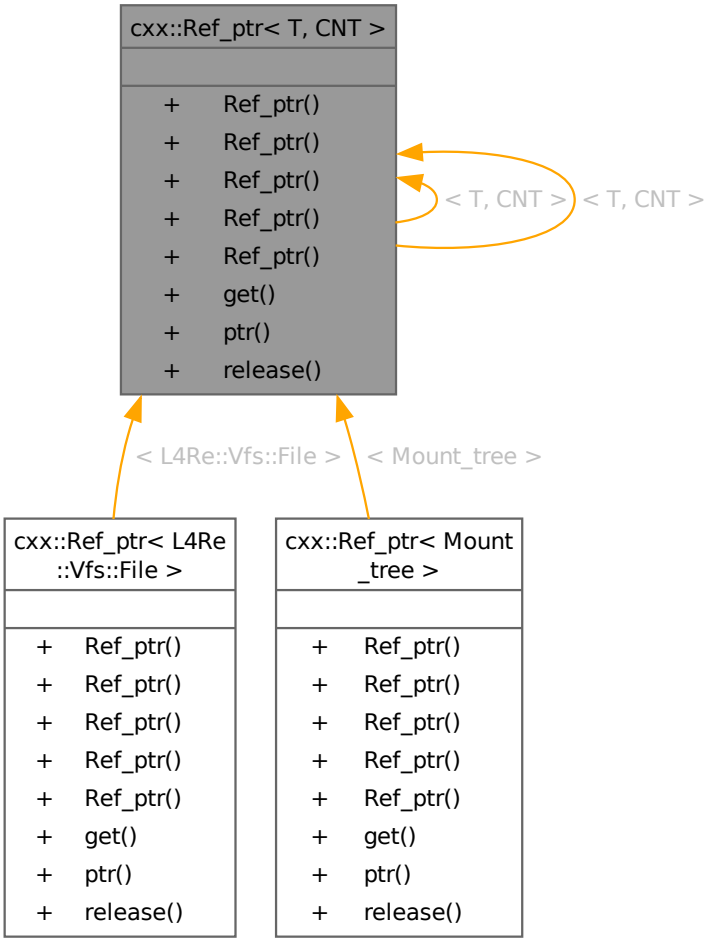
Item for list linked via cxx::Ref_ptr with default refence counting.
Definition at line 26 of file ref_ptr_list.
The documentation for this struct was generated from the following file:

- l4/cxx/ref_ptr_list

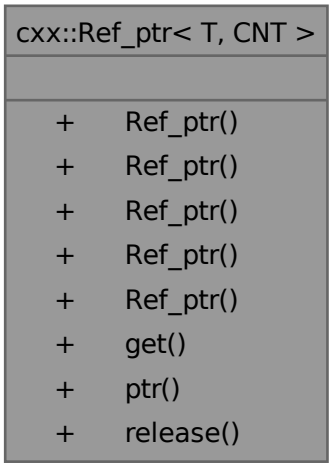
15.48 cxx::Ref_ptr< T, CNT > Class Template Reference

A reference-counting pointer with automatic cleanup.
`#include <ref_ptr>`

Inheritance diagram for cxx::Ref_ptr< T, CNT >:



Collaboration diagram for cxx::Ref_ptr< T, CNT >:



Public Member Functions

- **Ref_ptr** () noexcept

  Default constructor creates a pointer with no managed object.
- Ref_ptr (Wp const &o) noexcept

  Create a shared pointer from a weak pointer.
- **Ref_ptr** (decltype(nullptr) n) noexcept

  allow creation from `nullptr`
- template<typename X>
  Ref_ptr (X *o) noexcept

  Create a shared pointer from a raw pointer.
- Ref_ptr (T *o, bool d) noexcept

  Create a shared pointer from a raw pointer without creating a new reference.
- T * get () const noexcept

  Return a raw pointer to the object this shared pointer points to.
- T * ptr () const noexcept

  Return a raw pointer to the object this shared pointer points to.
- T * release () noexcept

  Release the shared pointer without removing the reference.

15.48.1 Detailed Description

template<typename T = void, template< typename X > class CNT = Default_ref_counter>
class cxx::Ref_ptr< T, CNT >

A reference-counting pointer with automatic cleanup.

Template Parameters

T	Type of object the pointer points to.

CNT	Type of management class that manages the life time of the object.

This pointer is similar to the standard C++-11 shared_ptr but it does the reference counting directly in the object being pointed to, so that no additional management structures need to be allocated from the heap.
Classes that use this pointer type must implement two functions:

```
int remove_ref()
```

is called when a reference is removed and must return 0 when there are no further references to the object.

```
void add_ref()
```

is called when another ref_ptr to the object is created.
Ref_obj provides a simple implementation of this interface from which classes may inherit.

Examples

tmpfs/lib/src/fs.cc.

Definition at line 70 of file ref_ptr.

15.48.2 Constructor & Destructor Documentation

15.48.2.1 Ref_ptr() [1/3]

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
cxx::Ref_ptr< T, CNT >::Ref_ptr (
            Wp const & o)  [inline], [noexcept]
```

Create a shared pointer from a weak pointer.
Increases references.
Definition at line 88 of file ref_ptr.

15.48.2.2 Ref_ptr() [2/3]

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
template<typename X>
cxx::Ref_ptr< T, CNT >::Ref_ptr (
            X * o)  [inline], [explicit], [noexcept]
```

Create a shared pointer from a raw pointer.
In contrast to C++11 shared_ptr it is safe to use this constructor multiple times and have the same reference counter.
Definition at line 101 of file ref_ptr.

15.48.2.3 Ref_ptr() [3/3]

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
cxx::Ref_ptr< T, CNT >::Ref_ptr (
            T * o,
            bool d)  [inline], [noexcept]
```

Create a shared pointer from a raw pointer without creating a new reference.

Parameters

o	Pointer to the object.
d	Dummy parameter to select this constructor at compile time. The value may be true or false.

This is the counterpart to release().
Definition at line 114 of file ref_ptr.

15.48.3 Member Function Documentation

15.48.3.1 get()

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
T * cxx::Ref_ptr< T, CNT >::get () const  [inline], [noexcept]
```

Return a raw pointer to the object this shared pointer points to.
This does not release the pointer or decrease the reference count.
Definition at line 121 of file ref_ptr.

15.48.3.2 ptr()

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
T * cxx::Ref_ptr< T, CNT >::ptr () const  [inline], [noexcept]
```

Return a raw pointer to the object this shared pointer points to.
This does not release the pointer or decrease the reference count.
Definition at line 127 of file ref_ptr.

15.48.3.3 release()

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
T * cxx::Ref_ptr< T, CNT >::release ()  [inline], [noexcept]
```

Release the shared pointer without removing the reference.

Returns

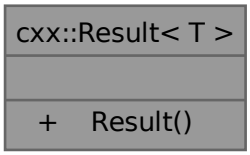
A raw pointer to the managed object.

Definition at line 138 of file ref_ptr.
The documentation for this class was generated from the following file:

- l4/cxx/ref_ptr

15.49 cxx::Result< T > Class Template Reference

A result of a function call.
`#include <result>`
Collaboration diagram for cxx::Result< T >:



Public Member Functions

- Result ()=delete

  Prevent default construction.

15.49.1 Detailed Description

template<typename T>
class cxx::Result< T >

A result of a function call.
Either has some resulting value or an error.
The error is always an integer and, if present, a negative value by convention. Any access to the value is fatal if the objects holds an error.
Definition at line 39 of file result.

15.49.2 Constructor & Destructor Documentation

15.49.2.1 Result()

```
template<typename T>
cxx::Result< T >::Result ()  [delete]
```

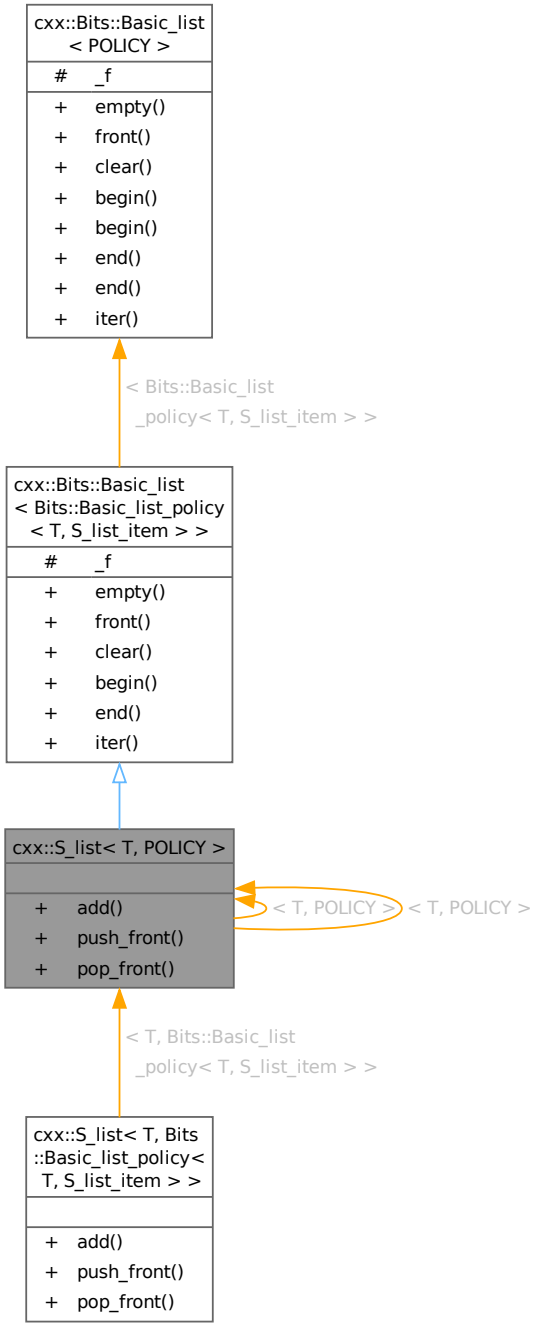
Prevent default construction.
A Result object either holds a value or an error. There is no third "empty" state.
The documentation for this class was generated from the following file:

- l4/cxx/result

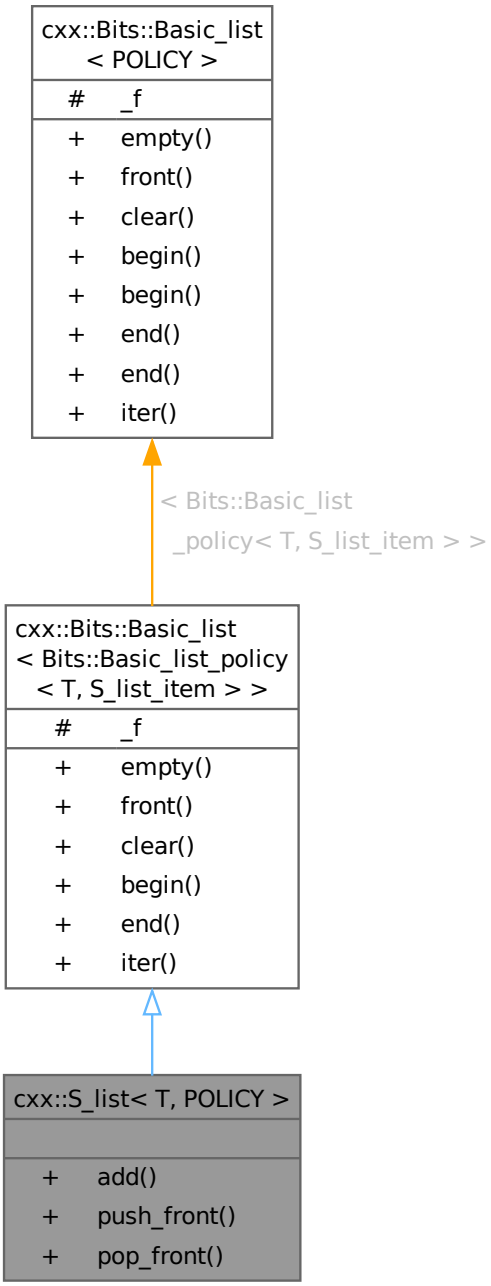
15.50 cxx::S_list< T, POLICY > Class Template Reference

Simple single-linked list.
`#include <slist>`

Inheritance diagram for cxx::S_list< T, POLICY >:



Collaboration diagram for cxx::S_list< T, POLICY >:



Public Member Functions

- void **add** (T ∗e)

  Add an element to the front of the list.
- void **push_front** (T ∗e)

  Add an element to the front of the list.
- T ∗ pop_front ()

  Remove and return the head element of the list.

Public Member Functions inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< T, S_list_item > >

- bool **empty** () const

  Check if the list is empty.
- Value_type **front** () const

  Return the first element in the list.
- void clear ()

  Remove all elements from the list.
- Iterator **begin** ()

  Return an iterator to the beginning of the list.
- Const_iterator **end** () const

  Return a const iterator to the end of the list.

Additional Inherited Members

Static Public Member Functions inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< T, S_list_item > >

- static Const_iterator iter (Const_value_type c)

  Return a const iterator that begins at the given element.

Protected Attributes inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< T, S_list_item > >

- Bits::Basic_list_policy< T, S_list_item >::Head_type **_f**

  Pointer to front of the list.

15.50.1 Detailed Description

template<typename T, typename POLICY = Bits::Basic_list_policy< T, S_list_item >>
class cxx::S_list< T, POLICY >

Simple single-linked list.

Template Parameters

T	Type of elements saved in the list. Must inherit from cxx::S_list_item

Definition at line 40 of file slist.

15.50.2 Member Function Documentation

15.50.2.1 pop_front()

```
template<typename T, typename POLICY = Bits::Basic_list_policy< T, S_list_item >>
T * cxx::S_list< T, POLICY >::pop_front ()  [inline]
```

Remove and return the head element of the list.

Precondition

The list must not be empty or the behaviour will be undefined.

Definition at line 91 of file slist.
The documentation for this class was generated from the following file:

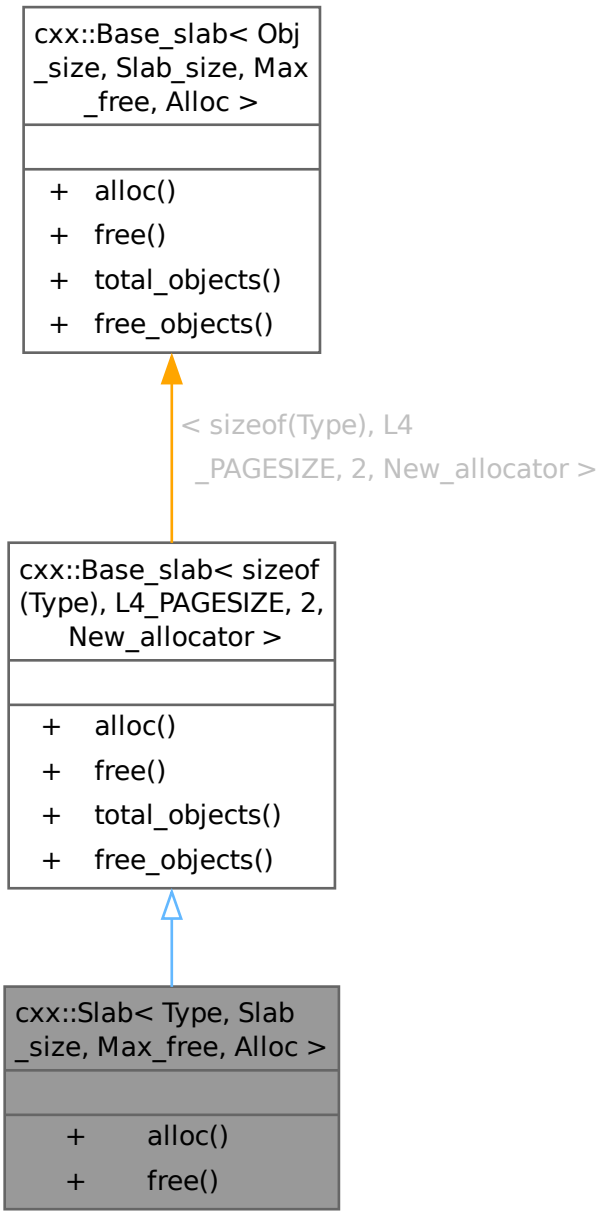
- l4/cxx/slist

15.51 cxx::Slab< Type, Slab_size, Max_free, Alloc > Class Template Reference

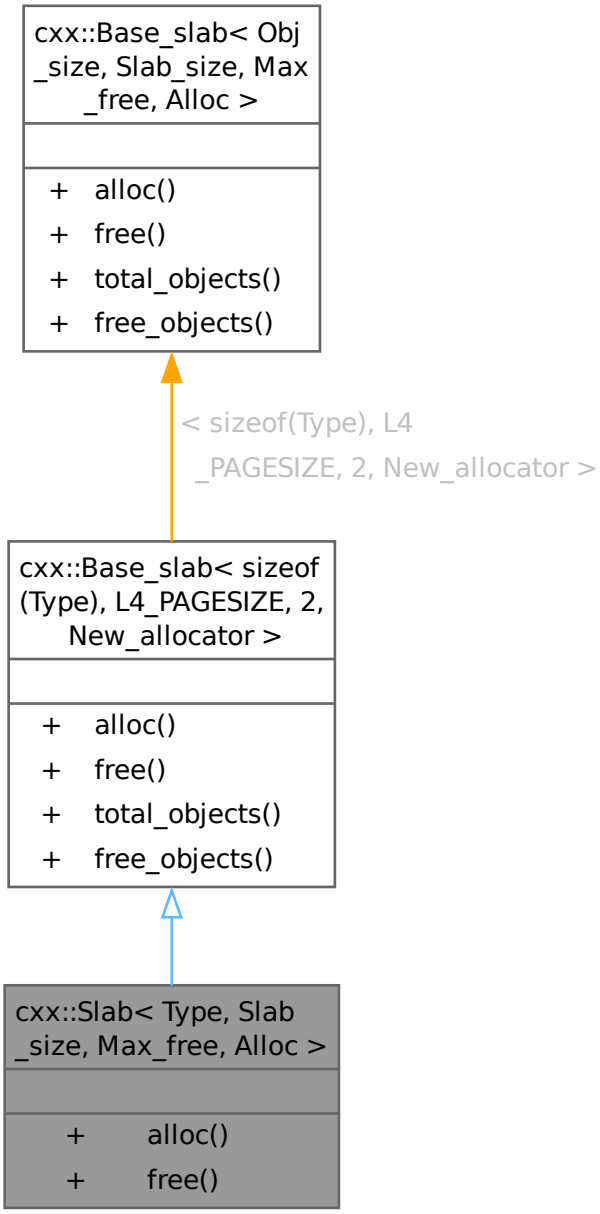
Slab allocator for object of type `Type`.

`#include <slab_alloc>`

Inheritance diagram for cxx::Slab< Type, Slab_size, Max_free, Alloc >:



Collaboration diagram for cxx::Slab< Type, Slab_size, Max_free, Alloc >:



Public Member Functions

- Type * alloc () noexcept

  Allocate an object of type `Type`.
- void free (Type *o) noexcept

  Free the object addressed by `o`.

Public Member Functions inherited from cxx::Base_slab< sizeof(Type), L4_PAGESIZE, 2, New_allocator >

- void * alloc () noexcept

  Allocate a new object.
- void free (void *_o) noexcept

  Free the given object (_o).
- unsigned total_objects () const noexcept

  Get the total number of objects managed by the slab allocator.
- unsigned free_objects () const noexcept

  Get the number of objects which can be allocated before a new empty slab needs to be added to the slab allocator.

Additional Inherited Members

Public Types inherited from cxx::Base_slab< sizeof(Type), L4_PAGESIZE, 2, New_allocator >

- typedef New_allocator< Slab_i > **Slab_alloc**

  Type of the backend allocator.

15.51.1 Detailed Description

template<typename Type, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A > class Alloc = New_allocator>
class cxx::Slab< Type, Slab_size, Max_free, Alloc >

Slab allocator for object of type `Type`.

Template Parameters

Type	The type of the objects to manage.
Slab_size	Size of a slab.
Max_free	The maximum number of free slabs.
Alloc	The allocator for the slabs.

Definition at line 335 of file slab_alloc.

15.51.2 Member Function Documentation

15.51.2.1 alloc()

```
template<typename Type, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
Type * cxx::Slab< Type, Slab_size, Max_free, Alloc >::alloc ()  [inline], [noexcept]
```

Allocate an object of type `Type`.

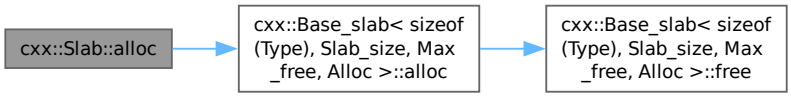
Returns

A pointer to the object just allocated, or 0 on failure.

Note

The user is responsible for initializing the object.

Definition at line 355 of file slab_alloc.
References cxx::Base_slab< sizeof(Type), Slab_size, Max_free, Alloc >::alloc().
Here is the call graph for this function:



15.51.2.2 free()

```
template<typename Type, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
void cxx::Slab< Type, Slab_size, Max_free, Alloc >::free (
            Type * o)  [inline], [noexcept]
```

Free the object addressed by o.

Parameters

o	The pointer to the object to free.

Precondition

The object must have been allocated with this allocator.

Definition at line 366 of file slab_alloc.
References free().
Referenced by free().
Here is the call graph for this function:



Here is the caller graph for this function:



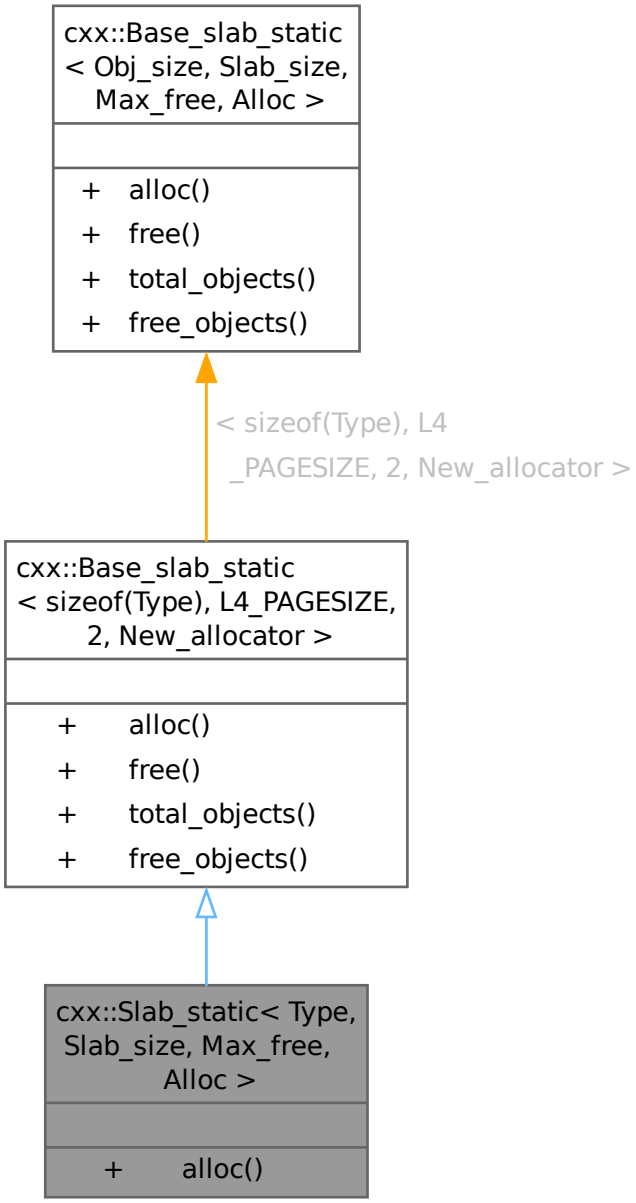
The documentation for this class was generated from the following file:

- l4/cxx/slab_alloc

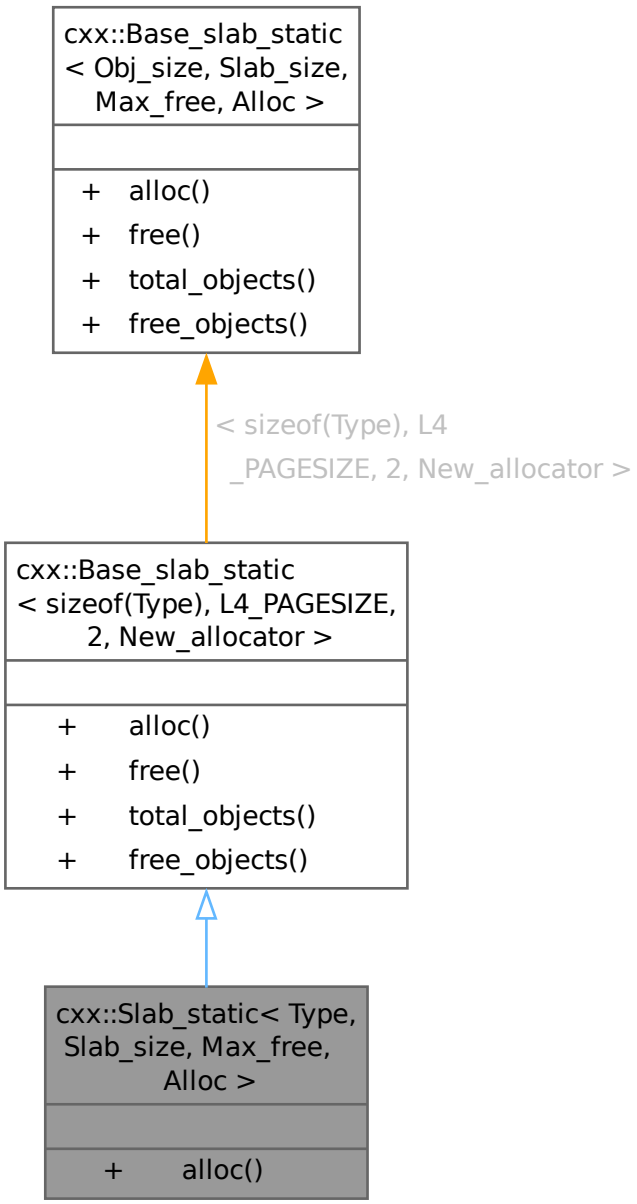
15.52 cxx::Slab_static< Type, Slab_size, Max_free, Alloc > Class Template Reference

Merged slab allocator (allocators for objects of the same size are merged together).
`#include <slab_alloc>`

Inheritance diagram for cxx::Slab_static< Type, Slab_size, Max_free, Alloc >:



Collaboration diagram for cxx::Slab_static< Type, Slab_size, Max_free, Alloc >:



Public Member Functions

- Type * alloc () noexcept

  Allocate an object of type `Type`.

Public Member Functions inherited from cxx::Base_slab_static< sizeof(Type), L4_PAGESIZE, 2, New_allocator >

- void * alloc () noexcept

  Allocate an object.

- void free (void *p) noexcept

  Free the given object (p).
- unsigned total_objects () const noexcept

  Get the total number of objects managed by the slab allocator.
- unsigned free_objects () const noexcept

  Get the number of free objects in the slab allocator.

Additional Inherited Members

Public Types inherited from cxx::Base_slab_static< sizeof(Type), L4_PAGESIZE, 2, New_allocator >

15.52.1 Detailed Description

template<typename Type, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A > class Alloc = New_allocator>
class cxx::Slab_static< Type, Slab_size, Max_free, Alloc >

Merged slab allocator (allocators for objects of the same size are merged together).

Template Parameters

Type	The type of the objects to manage.
Slab_size	The size of a slab.
Max_free	The maximum number of free slabs.
Alloc	The allocator for the slabs.

This slab allocator class is useful for merging slab allocators with the same parameters (equal `sizeof(Type)`, `Slab_size`, `Max_free`, and `Alloc` parameters) together and share the overhead for the slab caches among all equal-sized objects.
Definition at line 465 of file slab_alloc.

15.52.2 Member Function Documentation

15.52.2.1 alloc()

```
template<typename Type, int Slab_size = L4_PAGESIZE, int Max_free = 2, template< typename A >
class Alloc = New_allocator>
Type * cxx::Slab_static< Type, Slab_size, Max_free, Alloc >::alloc ()  [inline], [noexcept]
```

Allocate an object of type `Type`.

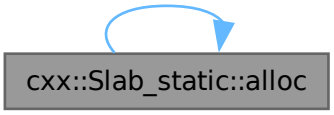
Returns

A pointer to the just allocated object, or 0 on failure.

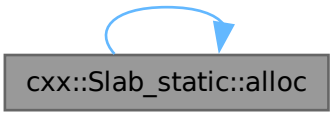
Note

The object is not zeroed out by the slab allocator.

Definition at line 478 of file slab_alloc.
References alloc().
Referenced by alloc().
Here is the call graph for this function:



Here is the caller graph for this function:

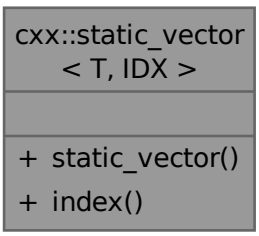


The documentation for this class was generated from the following file:

- l4/cxx/slab_alloc

15.53 cxx::static_vector< T, IDX > Class Template Reference

Simple encapsulation for a dynamically allocated array.
`#include <static_vector>`
Collaboration diagram for cxx::static_vector< T, IDX >:



Public Member Functions

- template<typename X, typename = enable_if_t<is_convertible_v<X, T>>>
  static_vector (static_vector< X, IDX > const &o)

  Conversion from compatible arrays.
- index_type **index** (value_type const *o) const

  Get the index of the given element of the array.

15.53.1 Detailed Description

template<typename T, typename IDX = unsigned>
class cxx::static_vector< T, IDX >

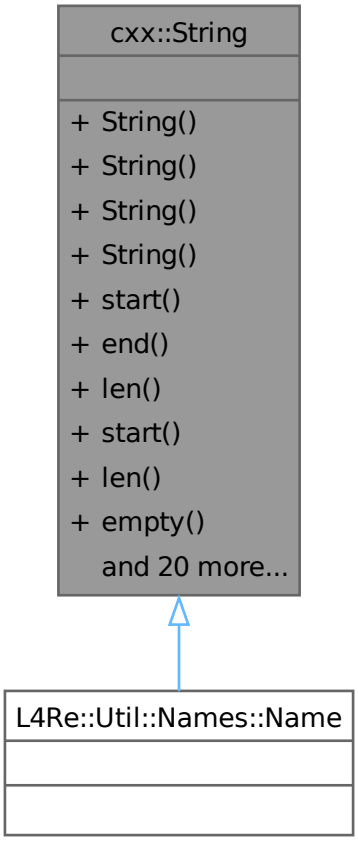
Simple encapsulation for a dynamically allocated array.
The main purpose of this class is to support C++11 range for for simple dynamically allocated array with static size.
Definition at line 16 of file static_vector.
The documentation for this class was generated from the following file:

- l4/cxx/static_vector

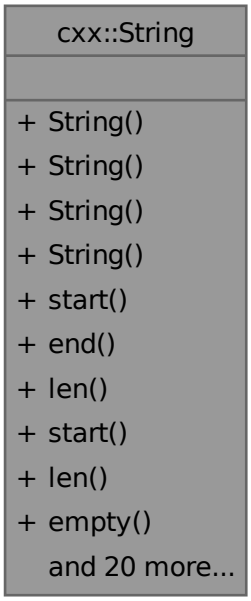
15.54 cxx::String Class Reference

Allocation free string class with explicit length field.
`#include <string>`

Inheritance diagram for cxx::String:



Collaboration diagram for cxx::String:



Public Types

- typedef char const ∗ **Index**

  Character index type.

Public Member Functions

- **String** (char const ∗s) noexcept

  Initialize from a zero-terminated string.
- **String** (char const ∗s, unsigned long len) noexcept

  Initialize from a pointer to first character and a length.
- String (char const ∗s, char const ∗e) noexcept

  Initialize with start and end pointer.
- **String** ()

  Zero-initialize. Create an invalid string.
- Index **start** () const

  Pointer to first character.
- Index **end** () const

  Pointer to first byte behind the string.
- int **len** () const

  Length.
- void **start** (char const ∗s)

  Set start.
- void **len** (unsigned long len)

  Set length.
- bool **empty** () const

Check if the string has length zero.

- String **head** (Index end) const

  Return prefix up to index.

- String **head** (unsigned long end) const

  Prefix of length `end`.

- String **substr** (unsigned long idx, unsigned long len=~0UL) const

  Substring of length `len` starting at `idx`.

- String **substr** (char const *start, unsigned long len=0) const

  Substring of length `len` starting at `start`.

- template<typename F>
  char const * **find_match** (F &&match) const

  Find matching character. `match` should be a function such as `isspace`.

- char const * **find** (char const *c) const

  Find character. Return end() if not found.

- char const * **find** (int c) const

  Find character. Return end() if not found.

- char const * **rfind** (char const *c) const

  Find right-most character. Return end() if not found.

- Index starts_with (cxx::String const &c) const

  Check if `c` is a prefix of string.

- char const * **find** (int c, char const *s) const

  Find character `c` starting at position `s`. Return end() if not found.

- char const * find (char const *c, char const *s) const

  Find character set at position.

- char const & **operator[ ]** (unsigned long idx) const

  Get character at `idx`.

- char const & **operator[ ]** (int idx) const

  Get character at `idx`.

- char const & **operator[ ]** (Index idx) const

  Get character at `idx`.

- bool **eof** (char const *s) const

  Check if pointer `s` points behind string.

- template<typename INT>
  int from_dec (INT *v) const

  Convert decimal string to integer.

- template<typename INT>
  int from_hex (INT *v) const

  Convert hex string to integer.

- template<typename INT>
  int from_number (INT *v, unsigned base=0) const

  Convert a number string to an integer.

- bool **operator==** (String const &o) const

  Equality.

- bool **operator!=** (String const &o) const

  Inequality.

15.54.1 Detailed Description

Allocation free string class with explicit length field.
This class is used to group characters of a string which belong to one syntactical token types number, identifier, string, whitespace or another single character.
Strings in this class can contain null bytes and may denote parts of other strings.

Examples

tmpfs/lib/src/fs.cc.

Definition at line 32 of file string.

15.54.2 Constructor & Destructor Documentation

15.54.2.1 String()

```
cxx::String::String (
             char const * s,
             char const * e)  [inline], [noexcept]
```

Initialize with start and end pointer.

Parameters

s	first character of the string
e	pointer to first byte behind the string

Definition at line 50 of file string.

15.54.3 Member Function Documentation

15.54.3.1 find()

```
char const * cxx::String::find (
             char const * c,
             char const * s) const  [inline]
```

Find character set at position.

Parameters

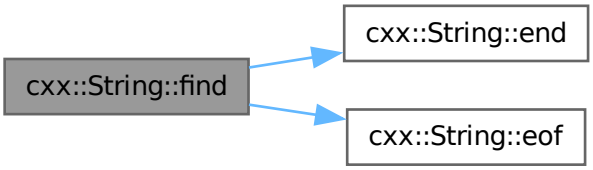
c	zero-terminated string of characters to search for
s	start position of search in string

Return values

end()	if no char in `c` is contained in string at or behind `s`.
position	in string of some character in `c`.

Definition at line 193 of file string.
References end(), and eof().

Here is the call graph for this function:



15.54.3.2 from_dec()

```
template<typename INT>
int cxx::String::from_dec (
            INT * v) const  [inline]
```

Convert decimal string to integer.

Template Parameters

INT	result integer type

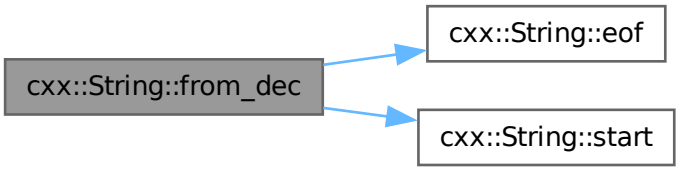
Parameters

out	*v*	conversion result

Returns

position of first character not converted.

Definition at line 230 of file string.
References eof(), and start().
Here is the call graph for this function:



15.54.3.3 from_hex()

```
template<typename INT>
int cxx::String::from_hex (
            INT * v) const  [inline]
```

Convert hex string to integer.

Template Parameters

INT	result integer type

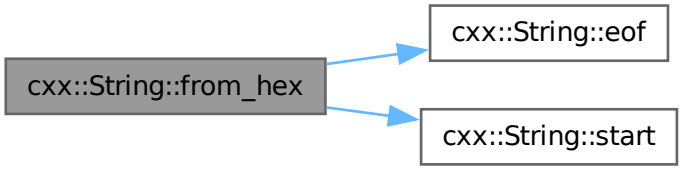
Parameters

out	*v*	conversion result

Return values

-1	if the maximal amount of digits fitting into INT have been read,
position	of first character not converted otherwise.

Definition at line 259 of file string.
References eof(), and start().
Here is the call graph for this function:



15.54.3.4 from_number()

```
template<typename INT>
int cxx::String::from_number (
            INT * v,
            unsigned base = 0) const  [inline]
```

Convert a number string to an integer.
Converts the initial part of the string to a number, according to the given base. The string may start with an arbitrary amount of white space followed by a single optional + or − sign. If base is zero or 16, the string may then include a "0x" or "0X" prefix, and the number will be read in base 16; otherwise, a zero base is taken as 10 (decimal) unless the next character is '0', in which case it is taken as 8 (octal).
Conversion stops at the first character that is not a valid digit for the chosen base. If the string does not contain any digit at all, zero is returned and v is left unmodified.

Template Parameters

INT	result integer type

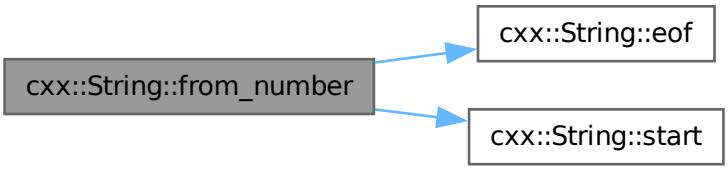
Parameters

out	*v*	conversion result
	base	Base of the number (0, 2..36)

Return values

>0	Success. Position of first character after the number.
0	The string does not contain a number.
-L4_EINVAL	Invalid base parameter
-L4_ERANGE	Parsed number too large to be stored in v

Definition at line 309 of file string.
References eof(), L4_EINVAL, L4_ERANGE, and start().
Here is the call graph for this function:



15.54.3.5 starts_with()

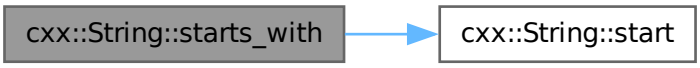
```
Index cxx::String::starts_with (
            cxx::String const & c) const  [inline]
```

Check if c is a prefix of string.

Returns

0 if c is not a prefix, if it is a prefix, return first position not in c (which might be end()).

Definition at line 157 of file string.
References start().
Here is the call graph for this function:

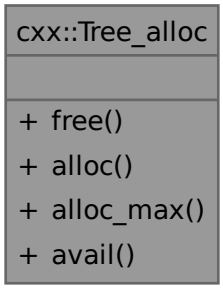


The documentation for this class was generated from the following file:

- l4/cxx/string

15.55 cxx::Tree_alloc Class Reference

Standard tree-based allocator.
`#include <tree_alloc>`
Collaboration diagram for cxx::Tree_alloc:



Public Member Functions

- void free (void *block, unsigned long size, bool initial_free=false)

  Return a free memory block to the allocator.
- void * alloc (unsigned long size, unsigned long align, unsigned long lower=0, unsigned long upper=~0UL)

  Allocate a memory block.
- void * alloc_max (unsigned long min, unsigned long *max, unsigned long align, unsigned granularity, unsigned long lower=0, unsigned long upper=~0UL)

  Allocate a memory block of `min` <= size <= `max`.
- unsigned long avail () const

  Get the amount of available memory.

15.55.1 Detailed Description

Standard tree-based allocator.
Definition at line 28 of file tree_alloc.

15.55.2 Member Function Documentation

15.55.2.1 alloc()

```
void * cxx::Tree_alloc::alloc (
            unsigned long size,
            unsigned long align,
            unsigned long lower = 0,
            unsigned long upper = ~0UL)  [inline]
```

Allocate a memory block.

Parameters

size	Size of the memory block.
align	Alignment constraint.
lower	Lower bound of the physical region the memory block should be allocated from.
upper	Upper bound of the physical region the memory block should be allocated from, value is inclusive.

Returns

Pointer to memory block

Precondition

0 < `size` <= `~0UL - 32`.

Definition at line 377 of file tree_alloc.

15.55.2.2 alloc_max()

```
void * cxx::Tree_alloc::alloc_max (
            unsigned long min,
            unsigned long * max,
            unsigned long align,
            unsigned granularity,
            unsigned long lower = 0,
            unsigned long upper = ~0UL)  [inline]
```

Allocate a memory block of `min` <= size <= `max`.

Parameters

	min	Minimal size to allocate (in bytes).
`in,out`	*max*	Maximum size to allocate (in bytes). The actual allocated size is returned here.
	align	Alignment constraint.
	granularity	Granularity to use for the allocation (power of 2).
	lower	Lower bound of the physical region the memory block should be allocated from.
	upper	Upper bound of the physical region the memory block should be allocated from, value is inclusive.

Returns

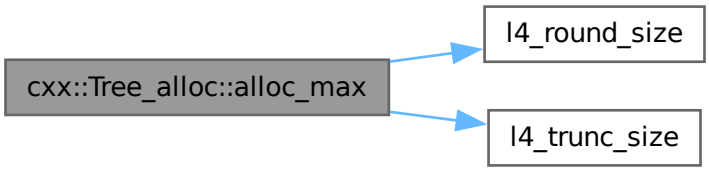
Pointer to memory block

Precondition

0 < `min` <= ~0UL - 32.

0 < `max`.

Definition at line 262 of file tree_alloc.
References l4_round_size(), and l4_trunc_size().
Here is the call graph for this function:



15.55.2.3 avail()

```
unsigned long cxx::Tree_alloc::avail () const  [inline]
```

Get the amount of available memory.

Returns

Available memory in bytes

Definition at line 458 of file tree_alloc.

15.55.2.4 free()

```
void cxx::Tree_alloc::free (
            void * block,
            unsigned long size,
            bool initial_free = false)  [inline]
```

Return a free memory block to the allocator.

Parameters

block	Pointer to memory block.
size	Size of memory block.
initial_free	Set to true for putting fresh memory to the allocator. This will enforce alignment on that memory.

Precondition

`block` must not be NULL.

`2 * sizeof(void *) <= size <= ~0UL - 32`.

Definition at line 217 of file tree_alloc.
The documentation for this class was generated from the following file:

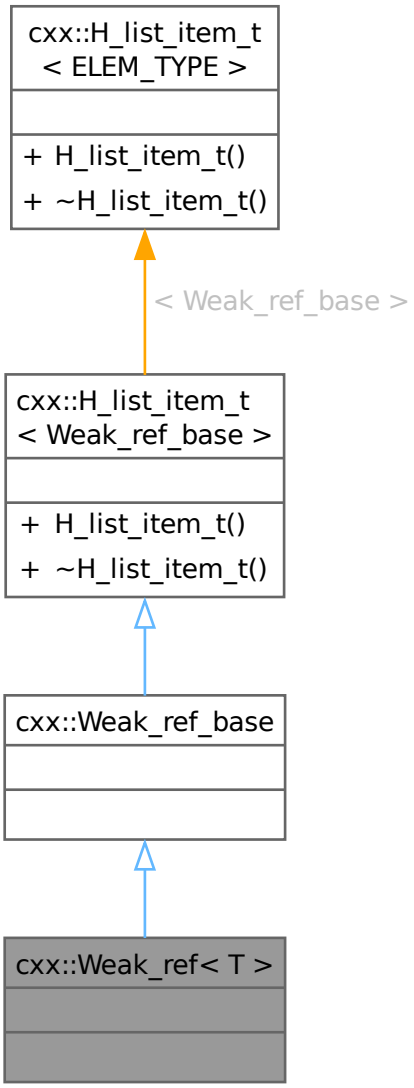
- l4/cxx/tree_alloc

15.56 cxx::Weak_ref< T > Class Template Reference

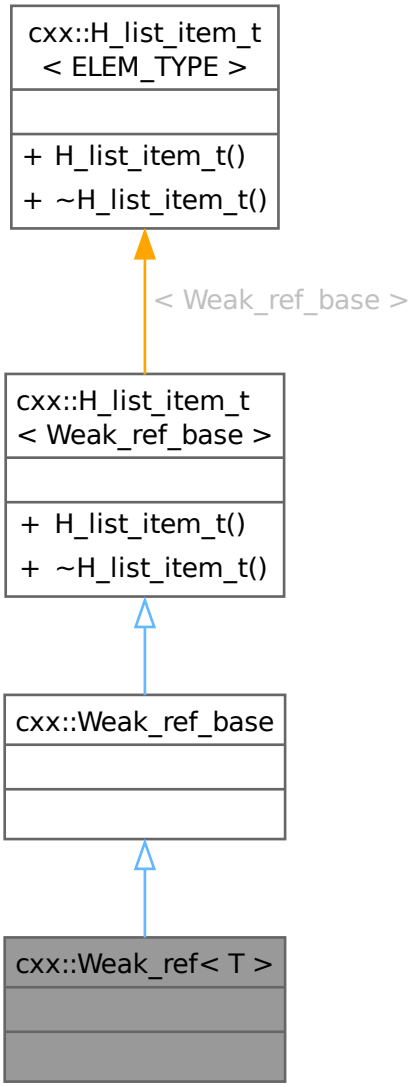
Typed weak reference to an object of type T.

`#include <weak_ref>`

Inheritance diagram for cxx::Weak_ref< T >:



Collaboration diagram for cxx::Weak_ref< T >:



Additional Inherited Members

Public Member Functions inherited from cxx::H_list_item_t< Weak_ref_base >

- constexpr H_list_item_t ()

  Constructor.
- ~H_list_item_t () noexcept

  Destructor.

15.56.1 Detailed Description

template<typename T>
class cxx::Weak_ref< T >

Typed weak reference to an object of type `T`.

Template Parameters

T	The type of the referenced object.

A weak reference is a reference that is invalidated when the referenced object is about to be deleted. All weak references to an object are kept in a linked list (see Weak_ref_base::List) and all the weak references are iterated and reset by the Weak_ref_base::List destructor or Weak_ref_base::List::reset().
The type `T` must provide two methods that handle the housekeeping of weak references: `remove_weak_ref(Weak_ref_base *)` and `add_weak_ref(Weak_ref_base *)`. These functions must handle the insertion and removal of the weak reference into the respective Weak_ref_base::List object. For convenience one can use the cxx::Weak_ref_obj as a base class that handles weak references for you.
For example:

```
class C : public cxx::Weak_ref_obj {};

int main()
{
  cxx::Weak_ref<C> r;  // r is nullptr
  {
    C c;
    r = &c;  // now r points to c
  }  // c is destructed, which implies resetting all weak references to c
  // now r is nullptr
  return 0;
}
```

Note

Weak references have no effect on the lifetime of the referenced object. Hence, a referenced object is *not* deleted when all weak references for it are gone. If automatic deletion is needed, see cxx::Ref_ptr.

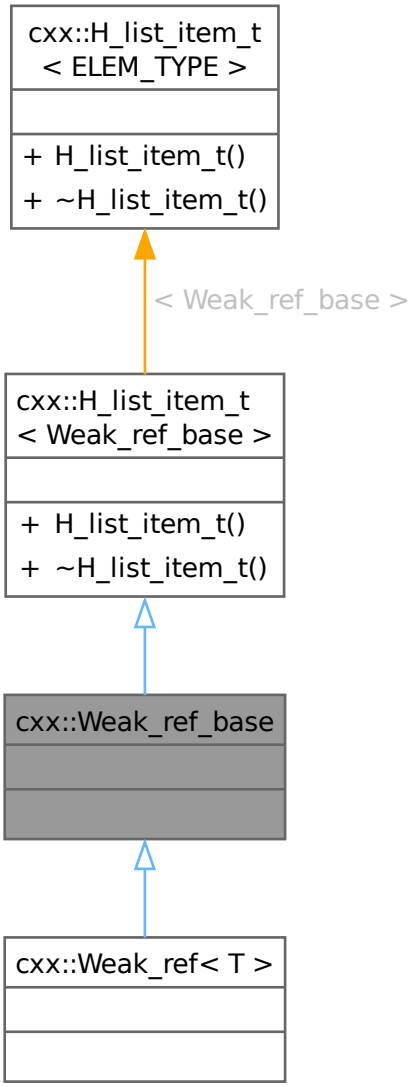
Definition at line 95 of file weak_ref.
The documentation for this class was generated from the following file:

- l4/cxx/weak_ref

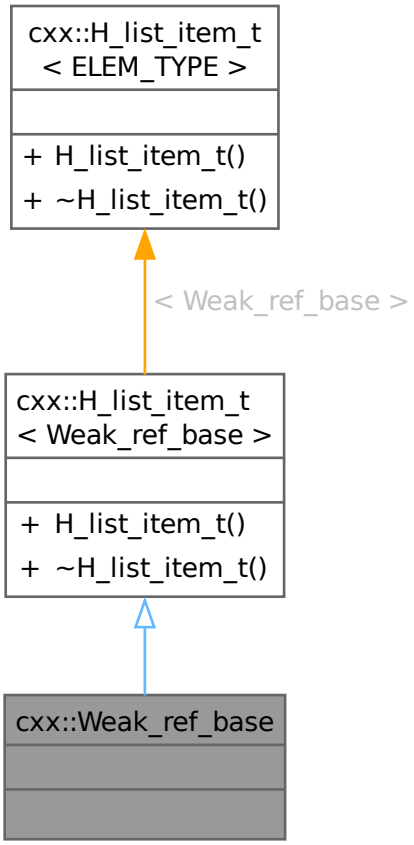
15.57 cxx::Weak_ref_base Class Reference

Generic (base) weak reference to some object.
`#include <weak_ref>`

Inheritance diagram for cxx::Weak_ref_base:



Collaboration diagram for cxx::Weak_ref_base:



Data Structures

- struct List

  The list type for keeping all weak references to an object.

Additional Inherited Members

Public Member Functions inherited from cxx::H_list_item_t< Weak_ref_base >

- constexpr H_list_item_t ()

  Constructor.
- ~H_list_item_t () noexcept

  Destructor.

15.57.1 Detailed Description

Generic (base) weak reference to some object.
A weak reference is a reference that gets reset to NULL when the object shall be deleted. All weak references to the same object are kept in a linked list of weak references.
For typed weak references see `cxx::Weak_ref`.
Definition at line 24 of file weak_ref.
The documentation for this class was generated from the following file:

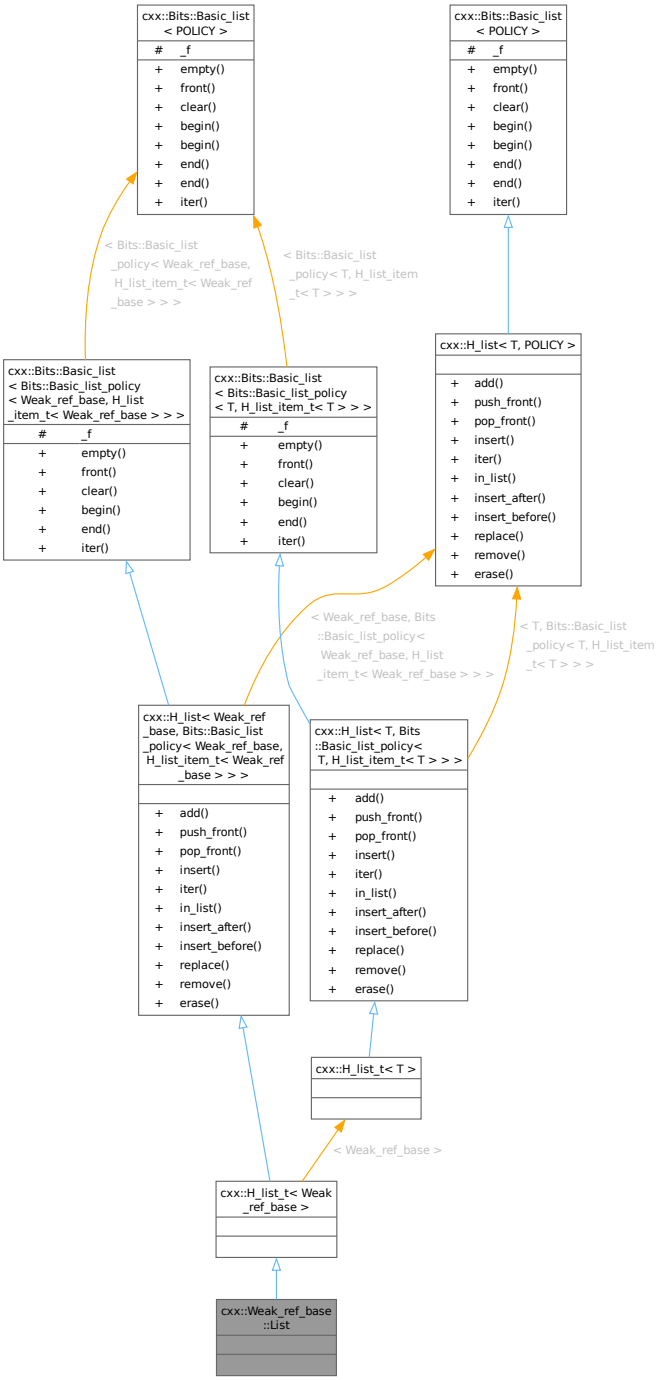
- l4/cxx/weak_ref

15.58 cxx::Weak_ref_base::List Struct Reference

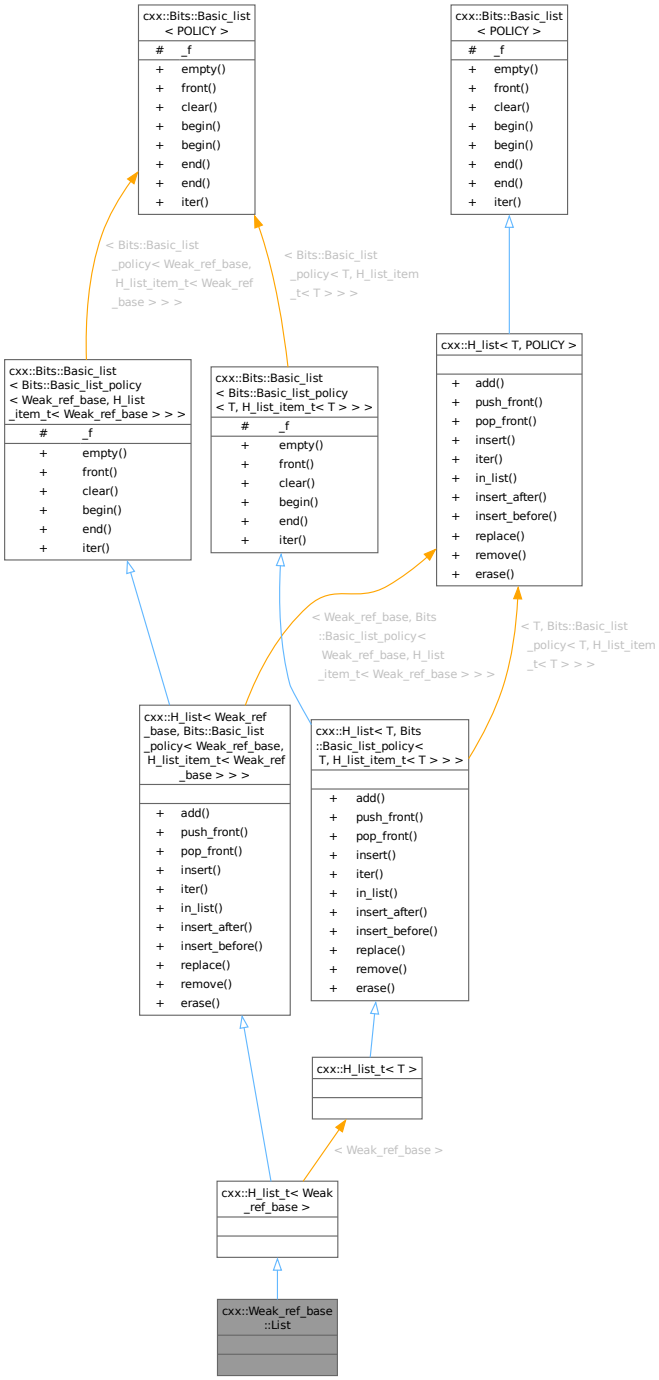
The list type for keeping all weak references to an object.

`#include <weak_ref>`

Inheritance diagram for cxx::Weak_ref_base::List:



Collaboration diagram for cxx::Weak_ref_base::List:



Additional Inherited Members

Public Member Functions inherited from cxx::H_list< Weak_ref_base, Bits::Basic_list_policy< Weak_ref_base, H_list_item_t< Weak_ref_base >

- void **add** (Weak_ref_base *e)

  Add element to the front of the list.
- void **push_front** (Weak_ref_base *e)

Add element to the front of the list.

- Weak_ref_base * pop_front ()

  Remove and return the head element of the list.

- Iterator insert (Weak_ref_base *e, Iterator const &pred)

  Insert an element at the iterator position.

Public Member Functions inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< Weak_ref_base, H_list_item_t< Weak_ref_base > > >

- bool **empty** () const

  Check if the list is empty.

- Value_type **front** () const

  Return the first element in the list.

- void clear ()

  Remove all elements from the list.

- Iterator **begin** ()

  Return an iterator to the beginning of the list.

- Const_iterator **end** () const

  Return a const iterator to the end of the list.

Static Public Member Functions inherited from cxx::H_list< Weak_ref_base, Bits::Basic_list_policy< Weak_ref_base, H_list_item_t< Weak_ref_base >

- static Iterator iter (Weak_ref_base *c)

  Return an iterator for an arbitrary list element.

- static bool **in_list** (Weak_ref_base const *e)

  Check if the given element is currently part of a list.

- static Iterator insert_after (Weak_ref_base *e, Iterator const &pred)

  Insert an element after the iterator position.

- static void insert_before (Weak_ref_base *e, Iterator const &succ)

  Insert an element before the iterator position.

- static void replace (Weak_ref_base *p, Weak_ref_base *e)

  Replace an element in a list with a new element.

- static void remove (Weak_ref_base *e)

  Remove the given element from its list.

- static Iterator erase (Iterator const &e)

  Remove the element at the given iterator position.

Static Public Member Functions inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< Weak_ref_base, H_list_item_t< Weak_ref_base > > >

- static Const_iterator iter (Const_value_type c)

  Return a const iterator that begins at the given element.

Protected Attributes inherited from cxx::Bits::Basic_list< Bits::Basic_list_policy< Weak_ref_base, H_list_item_t< Weak_ref_base > > >

- Bits::Basic_list_policy< Weak_ref_base, H_list_item_t< Weak_ref_base > >::Head_type **_f**

  Pointer to front of the list.

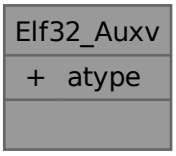
15.58.1 Detailed Description

The list type for keeping all weak references to an object.
On destruction of a list, all weak references to the respective object are set to `nullptr`.
Definition at line 38 of file weak_ref.
The documentation for this struct was generated from the following file:

- l4/cxx/weak_ref

15.59 Elf32_Auxv Struct Reference

Auxiliary vector (32-bit).
`#include <elf.h>`
Collaboration diagram for Elf32_Auxv:



Data Fields

- Elf32_Word atype

15.59.1 Detailed Description

Auxiliary vector (32-bit).
Definition at line 963 of file elf.h.

15.59.2 Field Documentation

15.59.2.1 atype

`Elf32_Word Elf32_Auxv::atype`

See also

Elf_ATs

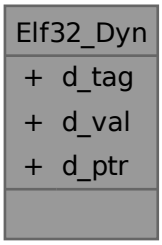
Definition at line 965 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.60 Elf32_Dyn Struct Reference

ELF32 dynamic entry.
`#include <elf.h>`

Collaboration diagram for Elf32_Dyn:



Data Fields

- Elf32_Sword d_tag

15.60.1 Detailed Description

ELF32 dynamic entry.
Definition at line 513 of file elf.h.

15.60.2 Field Documentation

15.60.2.1 d_tag

```
Elf32_Sword Elf32_Dyn::d_tag
```

See also

Elf_DTs

Definition at line 515 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.61 Elf32_Ehdr Struct Reference

ELF32 header.
`#include <elf.h>`

Collaboration diagram for Elf32_Ehdr:



Data Fields

- unsigned char **e_ident** [EI_NIDENT]

  see Elf_Els
- Elf32_Half e_type

  type of ELF file
- Elf32_Half e_machine

  required architecture
- Elf32_Word e_version

  file version
- Elf32_Addr **e_entry**

  initial program counter
- Elf32_Off **e_phoff**

  offset of program header table
- Elf32_Off **e_shoff**

  offset of file header table
- Elf32_Word e_flags

  processor-specific flags
- Elf32_Half **e_ehsize**

  size of ELF header
- Elf32_Half **e_phentsize**

  size of program header entry

- Elf32_Half **e_phnum**

  number of entries in program header table
- Elf32_Half **e_shentsize**

  size of section header entry
- Elf32_Half **e_shnum**

  number of entries in section header table
- Elf32_Half **e_shstrndx**

  section header table index of strtab

15.61.1 Detailed Description

ELF32 header.
Definition at line 125 of file elf.h.

15.61.2 Field Documentation

15.61.2.1 e_flags

`Elf32_Word Elf32_Ehdr::e_flags`
processor-specific flags

See also

Elf_EF_ARM_s

Definition at line 134 of file elf.h.

15.61.2.2 e_machine

`Elf32_Half Elf32_Ehdr::e_machine`
required architecture

See also

Elf_EMs

Definition at line 129 of file elf.h.

15.61.2.3 e_type

`Elf32_Half Elf32_Ehdr::e_type`
type of ELF file

See also

Elf_ETs

Definition at line 128 of file elf.h.

15.61.2.4 e_version

`Elf32_Word Elf32_Ehdr::e_version`
file version

See also

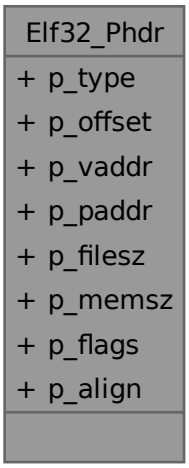
Elf_EVs

Definition at line 130 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.62 Elf32_Phdr Struct Reference

ELF32 program header.
`#include <elf.h>`
Collaboration diagram for Elf32_Phdr:



Data Fields

- Elf32_Word p_type
  type of program section
- Elf32_Off **p_offset**
  file offset of program section
- Elf32_Addr **p_vaddr**
  memory address of prog section
- Elf32_Addr **p_paddr**
  physical address (ignored)
- Elf32_Word **p_filesz**
  file size of program section
- Elf32_Word **p_memsz**
  memory size of program section
- Elf32_Word p_flags
  flags
- Elf32_Word **p_align**
  alignment of section

15.62.1 Detailed Description

ELF32 program header.
Definition at line 425 of file elf.h.

15.62.2 Field Documentation

15.62.2.1 p_flags

`Elf32_Word Elf32_Phdr::p_flags`
flags

See also

Elf_PFs

Definition at line 433 of file elf.h.

15.62.2.2 p_type

`Elf32_Word Elf32_Phdr::p_type`
type of program section

See also

Elf_PTs

Definition at line 427 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.63 Elf32_Rel Struct Reference

ELF32 relocation entry w/o addend.
`#include <elf.h>`
Collaboration diagram for Elf32_Rel:



15.63.1 Detailed Description

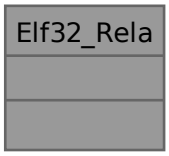
ELF32 relocation entry w/o addend.
Definition at line 631 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.64 Elf32_Rela Struct Reference

ELF32 relocation entry w/ addend.
`#include <elf.h>`

Collaboration diagram for Elf32_Rela:



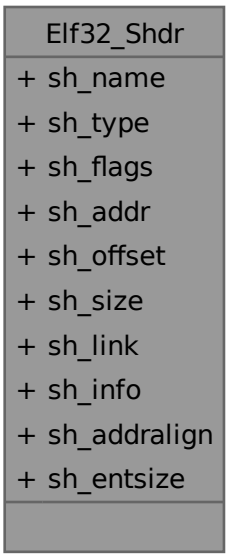
15.64.1 Detailed Description

ELF32 relocation entry w/ addend.
Definition at line 638 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.65 Elf32_Shdr Struct Reference

ELF32 section header.
`#include <elf.h>`
Collaboration diagram for Elf32_Shdr:



Data Fields

- Elf32_Word **sh_name**

name of sect (idx into strtab)

- Elf32_Word sh_type

  section's type

- Elf32_Word sh_flags

  section's flags

- Elf32_Addr **sh_addr**

  memory address of section

- Elf32_Off **sh_offset**

  file offset of section

- Elf32_Word **sh_size**

  file size of section

- Elf32_Word **sh_link**

  idx to associated header section

- Elf32_Word **sh_info**

  extra info of header section

- Elf32_Word **sh_addralign**

  address alignment constraints

- Elf32_Word **sh_entsize**

  size of entry if sect is table

15.65.1 Detailed Description

ELF32 section header.
Definition at line 347 of file elf.h.

15.65.2 Field Documentation

15.65.2.1 sh_flags

`Elf32_Word Elf32_Shdr::sh_flags`
section's flags

See also

Elf_SHFs

Definition at line 351 of file elf.h.

15.65.2.2 sh_type

`Elf32_Word Elf32_Shdr::sh_type`
section's type

See also

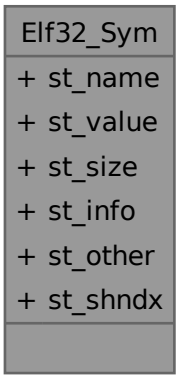
Elf_SHTs

Definition at line 350 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.66 Elf32_Sym Struct Reference

ELF32 symbol table entry.
`#include <elf.h>`
Collaboration diagram for Elf32_Sym:



Data Fields

- Elf32_Word **st_name**
  name of symbol (idx symstrtab)
- Elf32_Addr **st_value**
  value of associated symbol
- Elf32_Word **st_size**
  size of associated symbol
- unsigned char **st_info**
  type and binding info
- unsigned char **st_other**
  undefined
- Elf32_Half **st_shndx**
  associated section header

15.66.1 Detailed Description

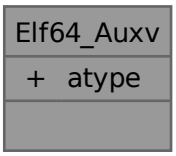
ELF32 symbol table entry.
Definition at line 871 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.67 Elf64_Auxv Struct Reference

Auxiliary vector (64-bit).
`#include <elf.h>`

Collaboration diagram for Elf64_Auxv:



Data Fields

- Elf64_Word atype

15.67.1 Detailed Description

Auxiliary vector (64-bit).
Definition at line 970 of file elf.h.

15.67.2 Field Documentation

15.67.2.1 atype

`Elf64_Word Elf64_Auxv::atype`

See also

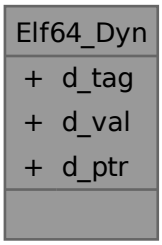
Elf_ATs

Definition at line 972 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.68 Elf64_Dyn Struct Reference

ELF64 dynamic entry.
`#include <elf.h>`
Collaboration diagram for Elf64_Dyn:



Data Fields

- Elf64_Sxword d_tag

15.68.1 Detailed Description

ELF64 dynamic entry.
Definition at line 524 of file elf.h.

15.68.2 Field Documentation

15.68.2.1 d_tag

```
Elf64_Sxword Elf64_Dyn::d_tag
```

See also

Elf_DTs

Definition at line 526 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.69 Elf64_Ehdr Struct Reference

ELF64 header.
`#include <elf.h>`
Collaboration diagram for Elf64_Ehdr:



Data Fields

- unsigned char **e_ident** [EI_NIDENT]

  see Elf_EIs
- Elf64_Half e_type

  type of ELF file
- Elf64_Half e_machine

  required architecture
- Elf64_Word e_version

  file version
- Elf64_Addr **e_entry**

  initial program counter
- Elf64_Off **e_phoff**

  offset of program header table
- Elf64_Off **e_shoff**

  offset of file header table
- Elf64_Word e_flags

  processor-specific flags
- Elf64_Half **e_ehsize**

  size of ELF header
- Elf64_Half **e_phentsize**

  size of program header entry
- Elf64_Half **e_phnum**

  number of entries in program header table
- Elf64_Half **e_shentsize**

  size of section header entry
- Elf64_Half **e_shnum**

  number of entries in section header table
- Elf64_Half **e_shstrndx**

  section header table index of strtab

15.69.1 Detailed Description

ELF64 header.
Definition at line 146 of file elf.h.

15.69.2 Field Documentation

15.69.2.1 e_flags

`Elf64_Word Elf64_Ehdr::e_flags`
processor-specific flags

See also

Elf_EF_ARM_s

Definition at line 155 of file elf.h.

15.69.2.2 e_machine

`Elf64_Half Elf64_Ehdr::e_machine`
required architecture

See also

Elf_EMs

Definition at line 150 of file elf.h.

15.69.2.3 e_type

`Elf64_Half Elf64_Ehdr::e_type`
type of ELF file

See also

Elf_ETs

Definition at line 149 of file elf.h.

15.69.2.4 e_version

`Elf64_Word Elf64_Ehdr::e_version`
file version

See also

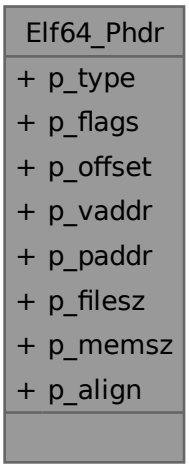
Elf_EVs

Definition at line 151 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.70 Elf64_Phdr Struct Reference

ELF64 program header.
`#include <elf.h>`
Collaboration diagram for Elf64_Phdr:



Data Fields

- Elf64_Word p_type
  type of program section
- Elf64_Word p_flags
  flags

- Elf64_Off **p_offset**

  file offset of program section
- Elf64_Addr **p_vaddr**

  memory address of prog section
- Elf64_Addr **p_paddr**

  physical address (ignored)
- Elf64_Xword **p_filesz**

  file size of program section
- Elf64_Xword **p_memsz**

  memory size of program section
- Elf64_Xword **p_align**

  alignment of section

15.70.1 Detailed Description

ELF64 program header.
Definition at line 438 of file elf.h.

15.70.2 Field Documentation

15.70.2.1 p_flags

`Elf64_Word Elf64_Phdr::p_flags`
flags

See also

Elf_PFs

Definition at line 441 of file elf.h.

15.70.2.2 p_type

`Elf64_Word Elf64_Phdr::p_type`
type of program section

See also

Elf_PTs

Definition at line 440 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.71 Elf64_Rel Struct Reference

ELF64 relocation entry w/o addend.
`#include <elf.h>`

Collaboration diagram for Elf64_Rel:



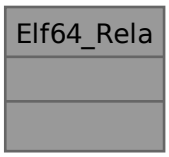
15.71.1 Detailed Description

ELF64 relocation entry w/o addend.
Definition at line 646 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.72 Elf64_Rela Struct Reference

ELF64 relocation entry w/ addend.
`#include <elf.h>`
Collaboration diagram for Elf64_Rela:



15.72.1 Detailed Description

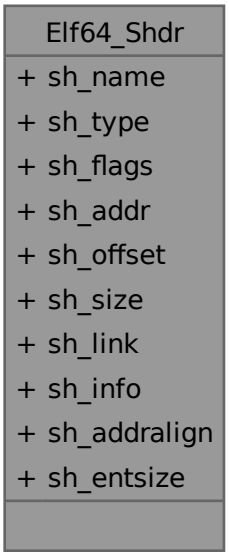
ELF64 relocation entry w/ addend.
Definition at line 653 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.73 Elf64_Shdr Struct Reference

ELF64 section header.
`#include <elf.h>`

Collaboration diagram for Elf64_Shdr:



Data Fields

- Elf64_Word **sh_name**
  name of sect (idx into strtab)
- Elf64_Word sh_type
  section's type
- Elf64_Xword sh_flags
  section's flags
- Elf64_Addr **sh_addr**
  memory address of section
- Elf64_Off **sh_offset**
  file offset of section
- Elf64_Xword **sh_size**
  file size of section
- Elf64_Word **sh_link**
  idx to associated header section
- Elf64_Word **sh_info**
  extra info of header section
- Elf64_Xword **sh_addralign**
  address alignment constraints
- Elf64_Xword **sh_entsize**
  size of entry if sect is table

15.73.1 Detailed Description

ELF64 section header.
Definition at line 362 of file elf.h.

15.73.2 Field Documentation

15.73.2.1 sh_flags

`Elf64_Xword Elf64_Shdr::sh_flags`
section's flags

See also

Elf_SHFs

Definition at line 366 of file elf.h.

15.73.2.2 sh_type

`Elf64_Word Elf64_Shdr::sh_type`
section's type

See also

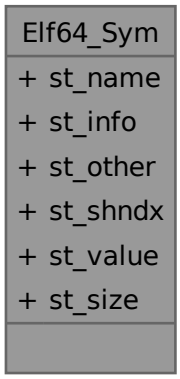
Elf_SHTs

Definition at line 365 of file elf.h.
The documentation for this struct was generated from the following file:

- l4/util/elf.h

15.74 Elf64_Sym Struct Reference

ELF64 symbol table entry.
`#include <elf.h>`
Collaboration diagram for Elf64_Sym:



Data Fields

- Elf64_Word **st_name**
  name of symbol (idx symstrtab)
- unsigned char **st_info**
  type and binding info
- unsigned char **st_other**

undefined

- Elf64_Half **st_shndx**

  associated section header

- Elf64_Addr **st_value**

  value of associated symbol

- Elf64_Xword **st_size**

  size of associated symbol

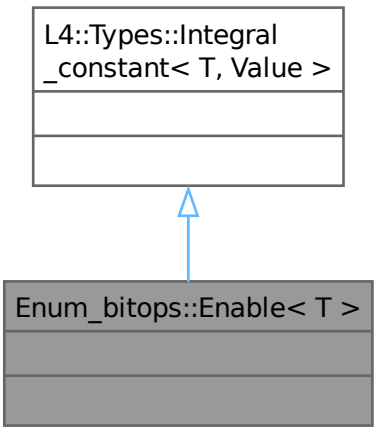
15.74.1 Detailed Description

ELF64 symbol table entry.
Definition at line 882 of file elf.h.
The documentation for this struct was generated from the following file:

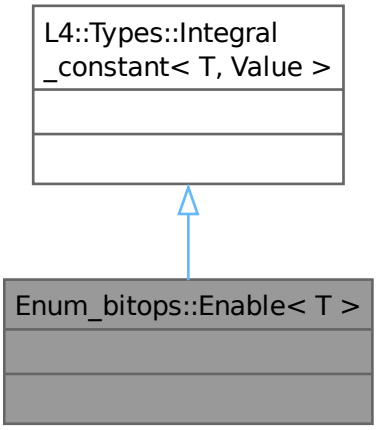
- l4/util/elf.h

15.75 Enum_bitops::Enable< T > Struct Template Reference

Check whether the given enum type opts in for the bitwise operators.
`#include <types>`
Inheritance diagram for Enum_bitops::Enable< T >:



Collaboration diagram for Enum_bitops::Enable< T >:



15.75.1 Detailed Description

template<typename T>
struct Enum_bitops::Enable< T >

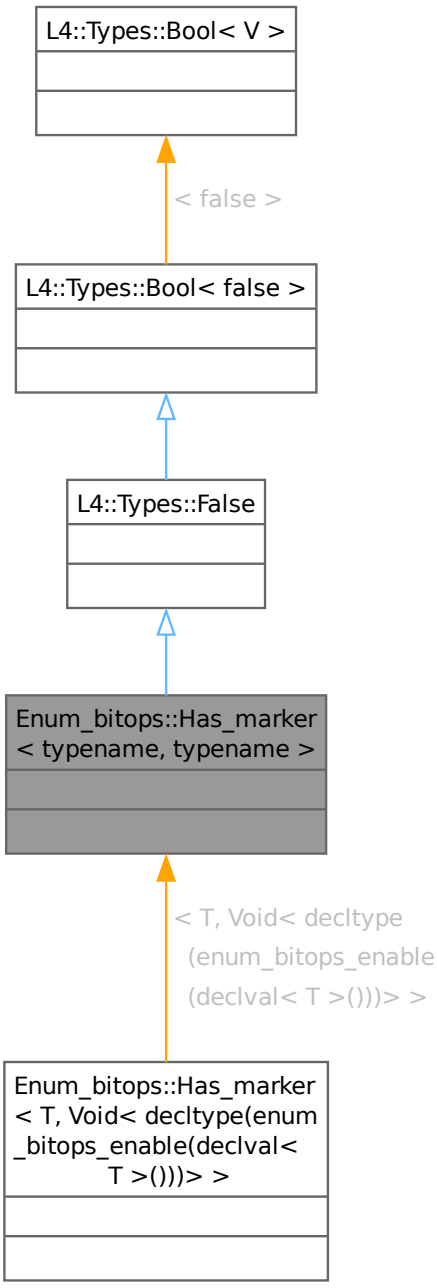
Check whether the given enum type opts in for the bitwise operators.
Definition at line 500 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

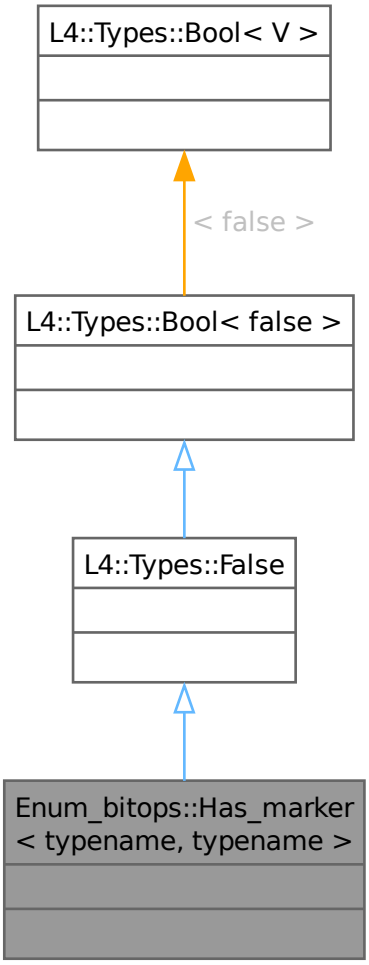
15.76 Enum_bitops::Has_marker< typename, typename > Struct Template Reference

Marker for the opt-in ADL function.
`#include <types>`

Inheritance diagram for Enum_bitops::Has_marker< typename, typename >:



Collaboration diagram for Enum_bitops::Has_marker< typename, typename >:



Additional Inherited Members

Public Types inherited from L4::Types::Bool< false >

- using **type**

  The meta type itself.

15.76.1 Detailed Description

template<typename, typename = void>
struct Enum_bitops::Has_marker< typename, typename >

Marker for the opt-in ADL function.
Definition at line 491 of file types.
The documentation for this struct was generated from the following file:

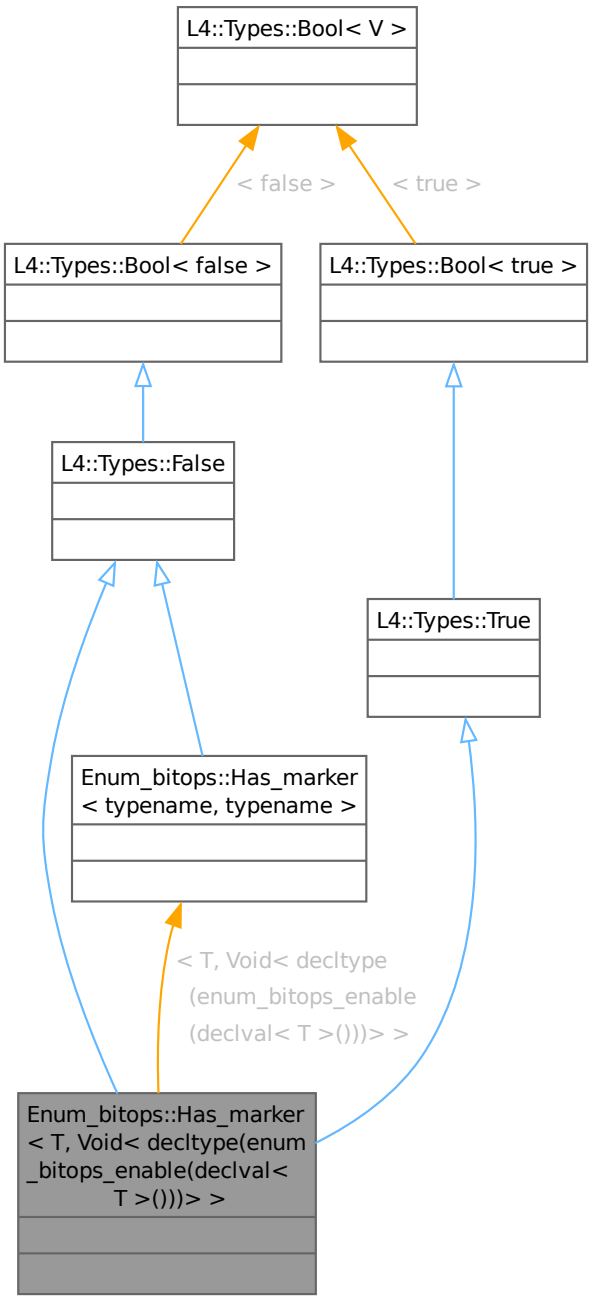
- l4/sys/cxx/types

15.77 Enum_bitops::Has_marker< T, Void< decltype(enum_bitops_enable(declval< T >()))> > Struct Template Reference

Marker for the opt-in ADL function.

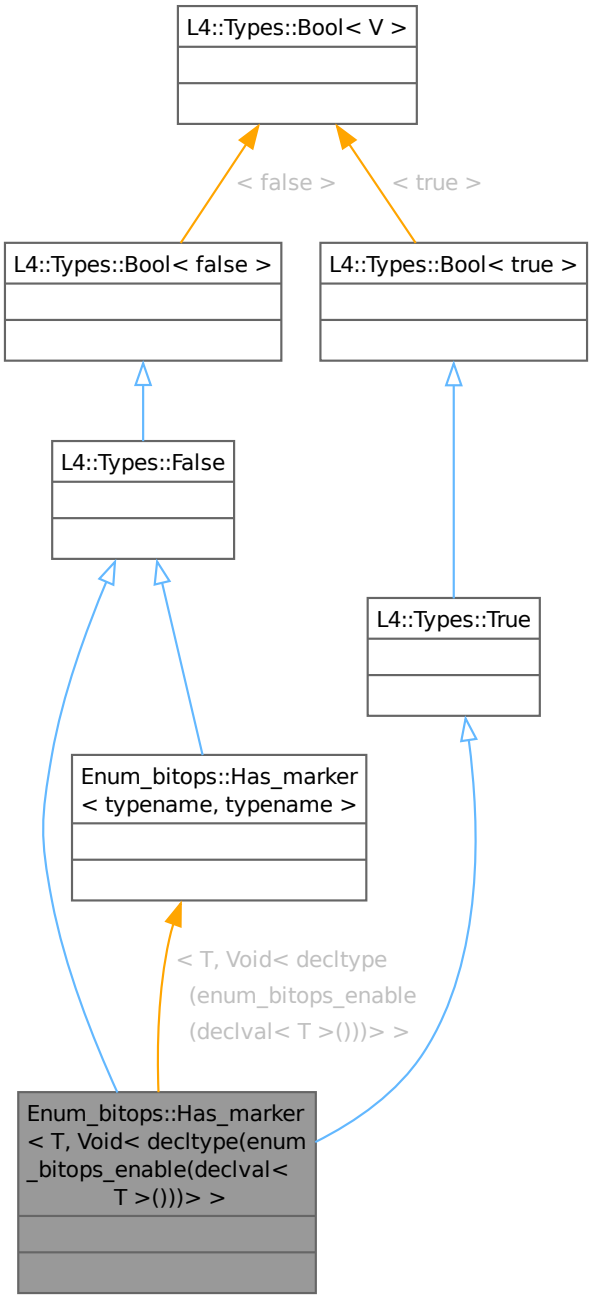
`#include <types>`

Inheritance diagram for Enum_bitops::Has_marker< T, Void< decltype(enum_bitops_enable(declval< T >()))> >:



Collaboration diagram for Enum_bitops::Has_marker< T, Void< decltype(enum_bitops_enable(declval< T >()))>

>:



Additional Inherited Members

Public Types inherited from L4::Types::Bool< false >

- using **type**

  The meta type itself.

Public Types inherited from L4::Types::Bool< true >

- using **type**

  The meta type itself.

15.77.1 Detailed Description

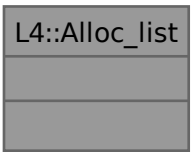
template<typename T>
struct Enum_bitops::Has_marker< T, Void< decltype(enum_bitops_enable(declval< T >()))> >

Marker for the opt-in ADL function.
Definition at line 495 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

15.78 L4::Alloc_list Class Reference

A simple list-based allocator.
`#include <alloc.h>`
Collaboration diagram for L4::Alloc_list:



15.78.1 Detailed Description

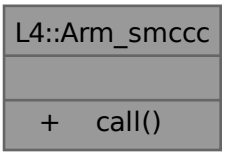
A simple list-based allocator.
Definition at line 20 of file alloc.h.
The documentation for this class was generated from the following file:

- l4/cxx/alloc.h

15.79 L4::Arm_smccc Class Reference

Wrapper for function calls that follow the ARM SMC/HVC calling convention.
`#include <arm_smccc>`

Collaboration diagram for L4::Arm_smccc:



Public Member Functions

- l4_msgtag_t call (l4_umword_t func, l4_umword_t in0, l4_umword_t in1, l4_umword_t in2, l4_umword_t in3, l4_umword_t in4, l4_umword_t in5, l4_umword_t *out0, l4_umword_t *out1, l4_umword_t *out2, l4_umword_t *out3, l4_umword_t client_id)

  ARM SMC/HVC function call.

15.79.1 Detailed Description

Wrapper for function calls that follow the ARM SMC/HVC calling convention.
See l4_arm_smccc_call() for the corresponding C interface.
Definition at line 23 of file arm_smccc.

15.79.2 Member Function Documentation

15.79.2.1 call()

```
l4_msgtag_t L4::Arm_smccc::call (
             l4_umword_t func,
             l4_umword_t in0,
             l4_umword_t in1,
             l4_umword_t in2,
             l4_umword_t in3,
             l4_umword_t in4,
             l4_umword_t in5,
             l4_umword_t * out0,
             l4_umword_t * out1,
             l4_umword_t * out2,
             l4_umword_t * out3,
             l4_umword_t client_id)
```

ARM SMC/HVC function call.
The input parameters consist of a function identifier, 6 arguments and a client id. Results are returned in 4 output parameters.

Parameters

	func	Function identifier. • Bit 31 has to be set: This marks the call as *Fast Call*. *Yielding Calls* (bit 31 unset) are rejected by the kernel. • Bit 30 defines the calling convention: • Bit 30 == 1: 64-bit calling convention. • Bit 30 == 0: 32-bit calling convention. • Bits 24..29 determine the service call ID. The permitted IDs are set in the kernel configuration. By default only service IDs >= 0x30000000 (*Trusted Application Calls* and *Trusted OS Calls*) are allowed.
in	*in0*	First input parameter.
in	*in1*	Second input parameter.
in	*in2*	Third input parameter.
in	*in3*	Fourth input parameter.
in	*in4*	Fifth input parameter.
in	*in5*	Sixth input parameter.
out	*out0*	First output parameter.
out	*out1*	Second output parameter.
out	*out2*	Third output parameter.
out	*out3*	Fourth output parameter.
in	*client_id*	Client ID. According to the specification, this value might be ignored by certain functions.

Return values

-L4_ENOSYS	Either bit 31 of the function call not set or service ID outside the range permitted by kernel configuration.
-L4_EINVAL	Invalid number of parameters.
<0	Other L4 error.
0	Success.

The documentation for this class was generated from the following file:

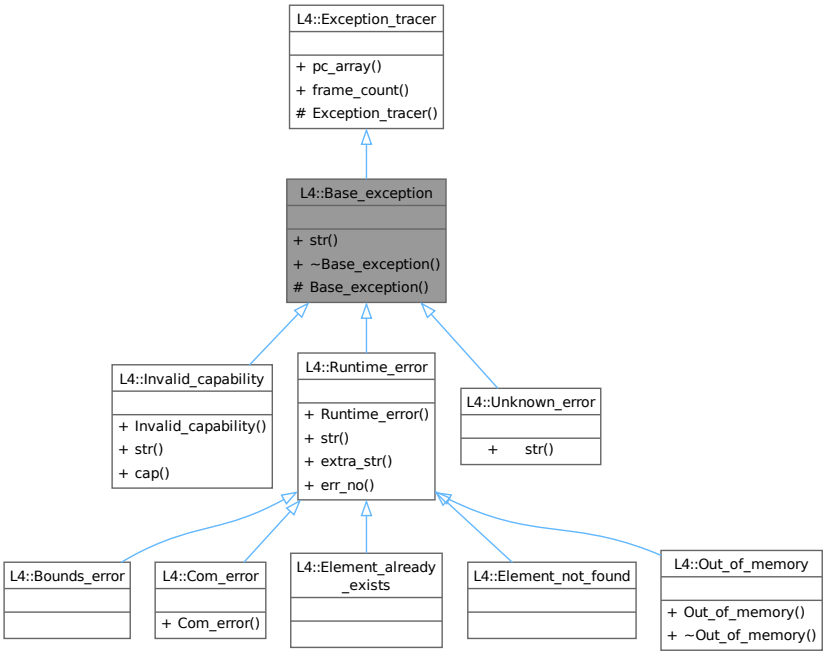
- l4/sys/arm_smccc

15.80 L4::Base_exception Class Reference

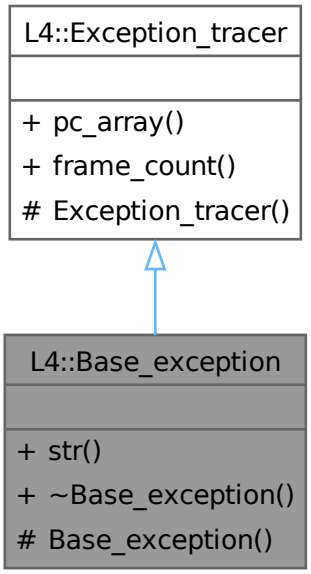
Base class for all exceptions, thrown by the L4Re framework.

`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Base_exception:



Collaboration diagram for L4::Base_exception:



Public Member Functions

- virtual char const ∗ **str** () const noexcept=0

Return a human readable string for the exception.

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.

- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Protected Member Functions

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

15.80.1 Detailed Description

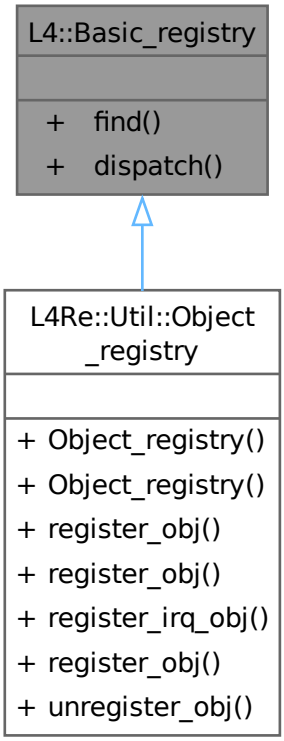
Base class for all exceptions, thrown by the L4Re framework.
This is the abstract base of all exceptions thrown within the L4Re framework. It is basically also a good idea to use it as base of all user defined exceptions.
Definition at line 105 of file exceptions.
The documentation for this class was generated from the following file:

- l4/cxx/exceptions

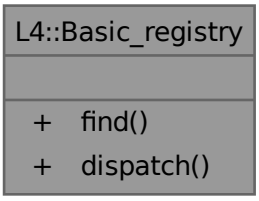
15.81 L4::Basic_registry Class Reference

This registry returns the corresponding server object based on the label of an Ipc_gate.
`#include <ipc_epiface>`

Inheritance diagram for L4::Basic_registry:



Collaboration diagram for L4::Basic_registry:



Static Public Member Functions

- static Value * find (l4_umword_t label)

  Get the server object for an lpc_gate label.
- static l4_msgtag_t dispatch (l4_msgtag_t tag, l4_umword_t label, l4_utcb_t *utcb)

  The dispatch function called by the server loop.

15.81.1 Detailed Description

This registry returns the corresponding server object based on the label of an lpc_gate.
Definition at line 690 of file ipc_epiface.

15.81.2 Member Function Documentation

15.81.2.1 dispatch()

```
l4_msgtag_t L4::Basic_registry::dispatch (
            l4_msgtag_t tag,
            l4_umword_t label,
            l4_utcb_t * utcb)  [inline], [static]
```

The dispatch function called by the server loop.
This function forwards the message to the server object identified by the given *label*.

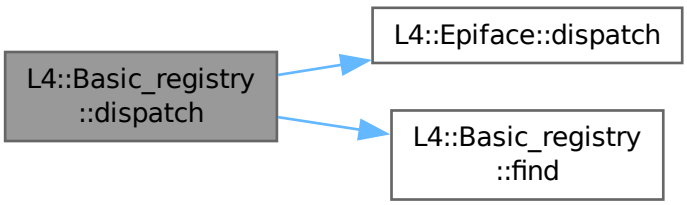
Parameters

tag	The message tag used for the invocation.
label	The label used to find the object including the rights bits of the invoked capability.
utcb	The UTCB used for the invocation.

Returns

The return code from the object's dispatch function or -L4_ENOENT if the object does not exist.

Definition at line 715 of file ipc_epiface.
References L4::Epiface::dispatch(), and find().
Here is the call graph for this function:



15.81.2.2 find()

```
Value * L4::Basic_registry::find (
            l4_umword_t label)  [inline], [static]
```

Get the server object for an lpc_gate label.

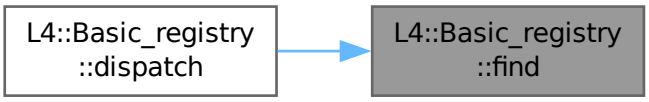
Parameters

label	The label usually stored in an lpc_gate.

Returns

A pointer to the Epiface identified by the given label.

Definition at line 699 of file ipc_epiface.
Referenced by dispatch().
Here is the caller graph for this function:



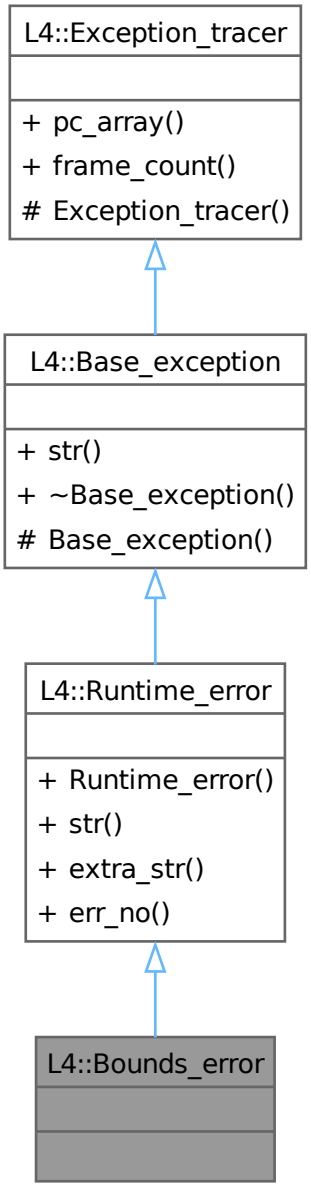
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_epiface

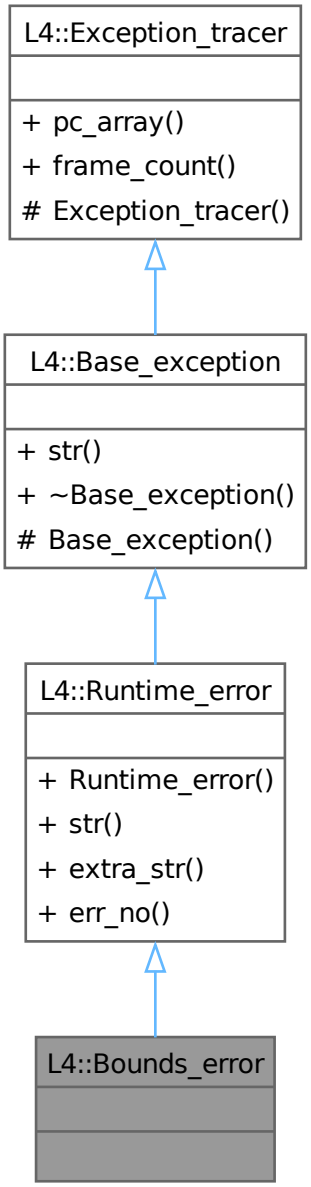
15.82 L4::Bounds_error Class Reference

Access out of bounds.
`#include <exceptions>`

Inheritance diagram for L4::Bounds_error:



Collaboration diagram for L4::Bounds_error:



Additional Inherited Members

Public Member Functions inherited from L4::Runtime_error

- Runtime_error (long err_no, char const *extra=0) noexcept

  Create a new Runtime_error.
- char const * **str** () const noexcept override

  Return a human readable string for the exception.
- char const * extra_str () const

  Get the description text for this runtime error.

- long err_no () const noexcept

  Get the error value for this runtime error.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.
- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

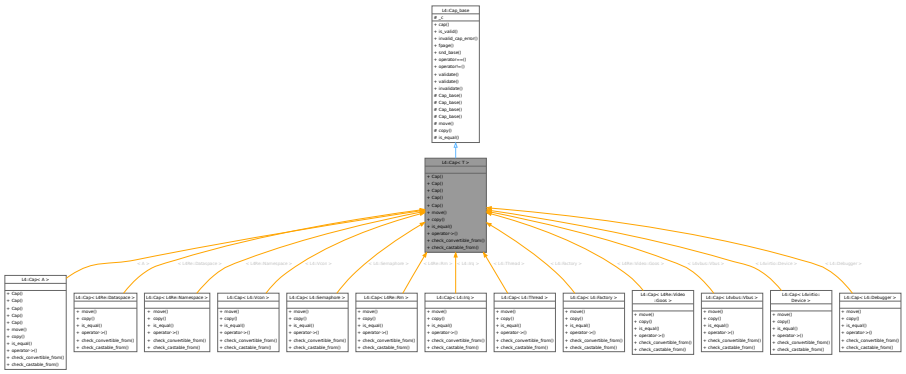
15.82.1 Detailed Description

Access out of bounds.
Definition at line 278 of file exceptions.
The documentation for this class was generated from the following file:

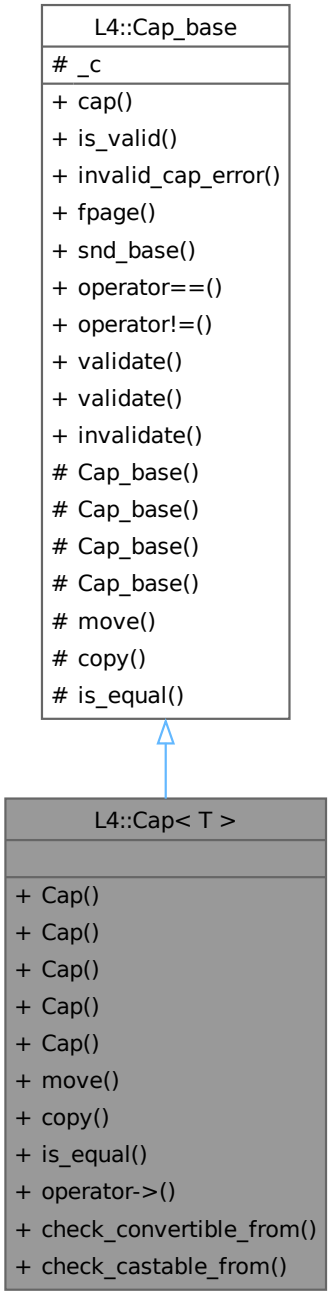
- l4/cxx/exceptions

15.83 L4::Cap< T > Class Template Reference

C++ interface for capabilities.
`#include <capability.h>`
Inheritance diagram for L4::Cap< T >:



Collaboration diagram for L4::Cap< T >:



Public Member Functions

- template<typename O>
  Cap (Cap< O > const &o) noexcept

  Create a copy from o, supporting implicit type casting.
- Cap (Cap_type cap) noexcept

  Constructor to create an invalid capability selector.
- Cap (l4_default_caps_t cap) noexcept

Initialize capability with one of the default capability selectors.

- Cap (l4_cap_idx_t idx=L4_INVALID_CAP) noexcept

  Initialize capability, defaults to the invalid capability selector.

- **Cap** (No_init_type) noexcept

  Create an uninitialized capability selector.

- bool move (Cap const &src) const noexcept

  Replace this capability with the contents of `src`.

- bool copy (Cap const &src) const noexcept

  Copy a capability.

- bool is_equal (Cap const &other) const noexcept

  Test whether this capability points to the same object with the same permissions as `other`.

- T * **operator->** () const noexcept

  Member access of a `T`.

Public Member Functions inherited from L4::Cap_base

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

- bool is_valid () const noexcept

  Test whether the capability is a valid capability index (i.e., L4_INVALID_CAP_BIT is not set).

- int **invalid_cap_error** () const noexcept

  Return the transported error code in an invalid capability selector.

- l4_fpage_t fpage (unsigned rights=L4_CAP_FPAGE_RWS) const noexcept

  Return flexpage for the capability.

- l4_umword_t snd_base (unsigned grant=L4_MAP_ITEM_MAP, l4_cap_idx_t base=L4_INVALID_CAP) const noexcept

  Return send base.

- bool **operator==** (Cap_base const &o) const noexcept

  Test if two capabilities are equal.

- bool **operator!=** (Cap_base const &o) const noexcept

  Test if two capabilities are not equal.

- l4_msgtag_t validate (l4_utcb_t *u=l4_utcb()) const noexcept

  Check whether a capability is present (refers to an object).

- l4_msgtag_t validate (Cap< Task > task, l4_utcb_t *u=l4_utcb()) const noexcept

  Check whether a capability is present (refers to an object).

- void **invalidate** () noexcept

  Set this capability to invalid (L4_INVALID_CAP).

Static Public Member Functions

- template<typename From>
  static void check_convertible_from () noexcept

  Perform the type conversion that needs to compile in order for a capability of type From to be convertible to one of type T.

- template<typename From>
  static void check_castable_from () noexcept

  Perform the type conversion that needs to compile in order for a capability of type From te be castable (via the correct cap_cast) to one of type T.

Friends

- class **L4::Kobject**

Additional Inherited Members

Public Types inherited from L4::Cap_base

- enum No_init_type { No_init }

  Special value for uninitialized capability objects.
- enum Cap_type { Invalid = L4_INVALID_CAP }

  Invalid capability type.

Protected Member Functions inherited from L4::Cap_base

- Cap_base (l4_cap_idx_t c) noexcept

  Generate a capability from its C representation.
- **Cap_base** (Cap_type cap) noexcept

  Constructor to create an invalid capability.
- Cap_base (l4_default_caps_t cap) noexcept

  Initialize capability with one of the default capabilities.
- **Cap_base** () noexcept

  Create an uninitialized instance.
- bool move (Cap_base const &src) const noexcept

  Replace this capability with the contents of `src`.
- bool copy (Cap_base const &src) const noexcept

  Copy a capability.
- bool is_equal (Cap_base const &other) const noexcept

  Test whether this capability points to the same object with the same permissions as `other`.

Protected Attributes inherited from L4::Cap_base

- l4_cap_idx_t **_c**

  The C representation of a capability selector.

15.83.1 Detailed Description

template<typename T>
class L4::Cap< T >

C++ interface for capabilities.

Template Parameters

T	Type of the object the capability points to.

The C++ version of a capability is comparable to a pointer, in fact it is a kind of smart pointer for our kernel objects and the objects derived from the kernel objects (L4::Kobject).
Add

```
#include <l4/sys/capability>
```

to your code to use the capability interface.

Examples

examples/clntsrv/src/client.cc, examples/libs/l4re/c++/mem_alloc/ma+rm.cc, examples/libs/l4re/c++/shared_ds/ds_clnt.cc, examples/libs/l4re/c++/shared_ds/ds_srv.cc, examples/libs/l4re/streammap/client.cc, and examples/sys/migrate/thread_migrate

Definition at line 248 of file capability.h.

15.83.2 Constructor & Destructor Documentation

15.83.2.1 Cap() [1/4]

```
template<typename T>
template<typename O>
L4::Cap< T >::Cap (
            Cap< O > const & o)  [inline], [noexcept]
```

Create a copy from o, supporting implicit type casting.

Parameters

o	The source selector that shall be copied (and casted).

Definition at line 300 of file capability.h.

15.83.2.2 Cap() [2/4]

```
template<typename T>
L4::Cap< T >::Cap (
            Cap_type cap)  [inline], [noexcept]
```

Constructor to create an invalid capability selector.

Parameters

cap	Capability selector.

Definition at line 307 of file capability.h.

15.83.2.3 Cap() [3/4]

```
template<typename T>
L4::Cap< T >::Cap (
            l4_default_caps_t cap)  [inline], [noexcept]
```

Initialize capability with one of the default capability selectors.

Parameters

cap	Capability selector.

Definition at line 313 of file capability.h.

15.83.2.4 Cap() [4/4]

```
template<typename T>
L4::Cap< T >::Cap (
            l4_cap_idx_t idx = L4_INVALID_CAP)  [inline], [explicit], [noexcept]
```

Initialize capability, defaults to the invalid capability selector.

Parameters

idx	Capability selector.

Definition at line 319 of file capability.h.

15.83.3 Member Function Documentation

15.83.3.1 check_castable_from()

```
template<typename T>
template<typename From>
void L4::Cap< T >::check_castable_from ()  [inline], [static], [noexcept]
```

Perform the type conversion that needs to compile in order for a capability of type From te be castable (via the correct cap_cast) to one of type T.

Template Parameters

From	Type to convert from

Definition at line 289 of file capability.h.

15.83.3.2 check_convertible_from()

```
template<typename T>
template<typename From>
void L4::Cap< T >::check_convertible_from ()  [inline], [static], [noexcept]
```

Perform the type conversion that needs to compile in order for a capability of type From to be convertible to one of type T.

Template Parameters

From	Type to convert from

Definition at line 276 of file capability.h.

15.83.3.3 copy()

```
template<typename T>
bool L4::Cap< T >::copy (
            Cap< T > const & src) const  [inline], [noexcept]
```

Copy a capability.

Parameters

src	the source capability.

After this operation this capability refers to the same object as `src`.
Definition at line 335 of file capability.h.

15.83.3.4 is_equal()

```
template<typename T>
bool L4::Cap< T >::is_equal (
            Cap< T > const & other) const  [inline], [noexcept]
```

Test whether this capability points to the same object with the same permissions as `other`.
As an extension, invalid capabilities are considered equal by this function. See l4_task_cap_equal() for further details.

Parameters

other	The capability to comapre to.

Definition at line 341 of file capability.h.

15.83.3.5 move()

```
template<typename T>
bool L4::Cap< T >::move (
            Cap< T > const & src) const  [inline], [noexcept]
```

Replace this capability with the contents of `src`.

Parameters

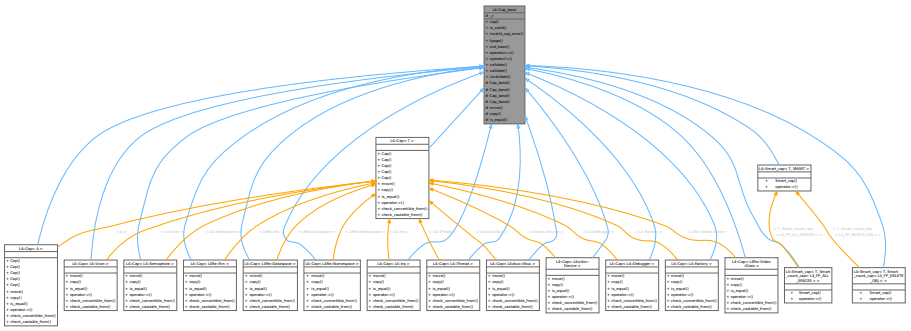
src	the source capability.

After the operation this capability refers to the object formerly referred to by the source capability `src`, and the source capability no longer refers to an object.
Definition at line 329 of file capability.h.
The documentation for this class was generated from the following file:

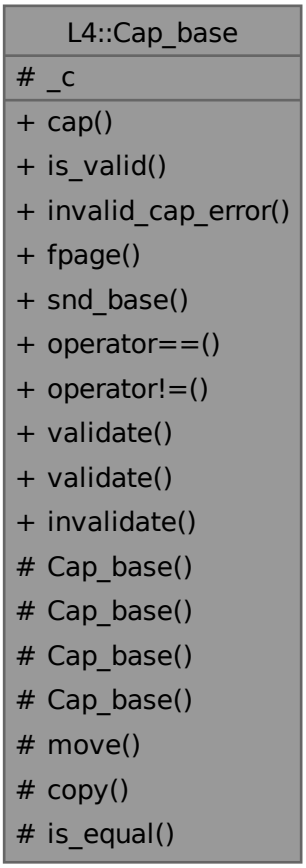
- l4/sys/cxx/capability.h

15.84 L4::Cap_base Class Reference

Base class for all kinds of capabilities.
`#include <l4/sys/capability>`
Inheritance diagram for L4::Cap_base:



Collaboration diagram for L4::Cap_base:



Public Types

- enum No_init_type { No_init }

  Special value for uninitialized capability objects.
- enum Cap_type { Invalid = L4_INVALID_CAP }

  Invalid capability type.

Public Member Functions

- l4_cap_idx_t cap () const noexcept

  Return capability selector.
- bool is_valid () const noexcept

  Test whether the capability is a valid capability index (i.e., L4_INVALID_CAP_BIT is not set).
- int **invalid_cap_error** () const noexcept

  Return the transported error code in an invalid capability selector.
- l4_fpage_t fpage (unsigned rights=L4_CAP_FPAGE_RWS) const noexcept

  Return flexpage for the capability.
- l4_umword_t snd_base (unsigned grant=L4_MAP_ITEM_MAP, l4_cap_idx_t base=L4_INVALID_CAP) const noexcept

Return send base.

- bool **operator==** (Cap_base const &o) const noexcept

  Test if two capabilities are equal.
- bool **operator!=** (Cap_base const &o) const noexcept

  Test if two capabilities are not equal.
- l4_msgtag_t validate (l4_utcb_t *u=l4_utcb()) const noexcept

  Check whether a capability is present (refers to an object).
- l4_msgtag_t validate (Cap< Task > task, l4_utcb_t *u=l4_utcb()) const noexcept

  Check whether a capability is present (refers to an object).
- void **invalidate** () noexcept

  Set this capability to invalid (L4_INVALID_CAP).

Protected Member Functions

- Cap_base (l4_cap_idx_t c) noexcept

  Generate a capability from its C representation.
- **Cap_base** (Cap_type cap) noexcept

  Constructor to create an invalid capability.
- Cap_base (l4_default_caps_t cap) noexcept

  Initialize capability with one of the default capabilities.
- **Cap_base** () noexcept

  Create an uninitialized instance.
- bool move (Cap_base const &src) const noexcept

  Replace this capability with the contents of `src`.
- bool copy (Cap_base const &src) const noexcept

  Copy a capability.
- bool is_equal (Cap_base const &other) const noexcept

  Test whether this capability points to the same object with the same permissions as `other`.

Protected Attributes

- l4_cap_idx_t **_c**

  The C representation of a capability selector.

15.84.1 Detailed Description

Base class for all kinds of capabilities.

Attention

This class is not for direct use, use L4::Cap instead.

This class contains all the things that are independent of the type of the object referred by the capability.

See also

L4::Cap for typed capabilities.

Definition at line 25 of file capability.h.

15.84.2 Member Enumeration Documentation

15.84.2.1 Cap_type

enum L4::Cap_base::Cap_type
Invalid capability type.

Enumerator

Invalid	Invalid capability selector.

Definition at line 40 of file capability.h.

15.84.2.2 No_init_type

enum L4::Cap_base::No_init_type
Special value for uninitialized capability objects.

Enumerator

No_init	Special value for constructing uninitialized Cap objects.

Definition at line 29 of file capability.h.

15.84.3 Constructor & Destructor Documentation

15.84.3.1 Cap_base() [1/2]

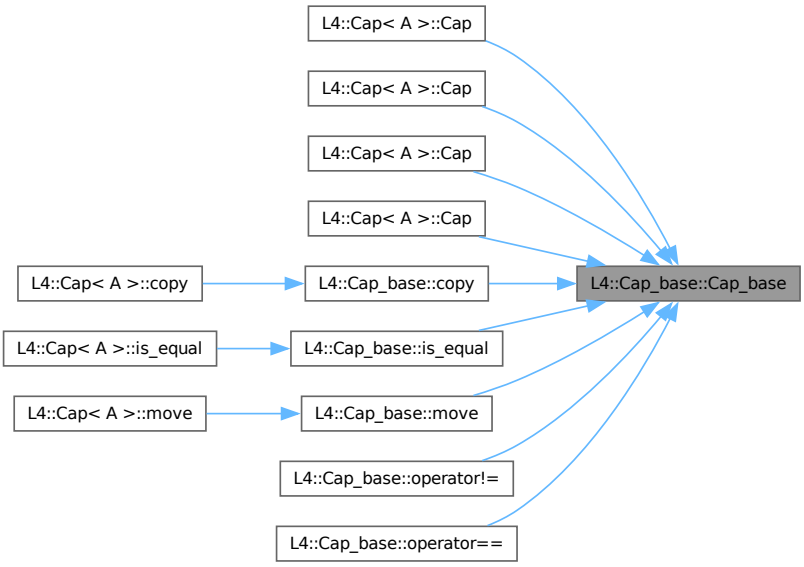
```
L4::Cap_base::Cap_base (
            l4_cap_idx_t c)  [inline], [explicit], [protected], [noexcept]
```
Generate a capability from its C representation.

Parameters

c	The C capability

Definition at line 149 of file capability.h.
References _c.
Referenced by L4::Cap< A >::Cap(), L4::Cap< A >::Cap(), L4::Cap< A >::Cap(), L4::Cap< A >::Cap(), copy(), is_equal(), move(), operator!=(), and operator==().

Here is the caller graph for this function:



15.84.3.2 Cap_base() [2/2]

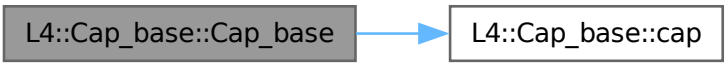
```
L4::Cap_base::Cap_base (
            l4_default_caps_t cap)  [inline], [explicit], [protected], [noexcept]
```

Initialize capability with one of the default capabilities.

Parameters

cap	Capability.

Definition at line 160 of file capability.h.
References _c, and cap().
Here is the call graph for this function:



15.84.4 Member Function Documentation

15.84.4.1 cap()

```
l4_cap_idx_t L4::Cap_base::cap () const  [inline], [noexcept]
```

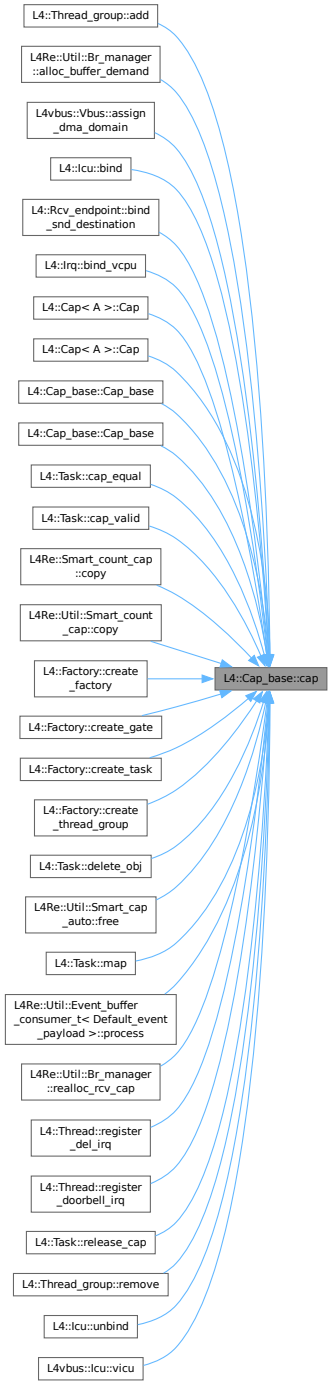
Return capability selector.

Returns

Capability selector.

Definition at line 49 of file capability.h.
References _c.
Referenced by L4::Thread_group::add(), L4Re::Util::Br_manager::alloc_buffer_demand(), L4vbus::Vbus::assign_dma_domain(), L4::Icu::bind(), L4::Rcv_endpoint::bind_snd_destination(), L4::Irq::bind_vcpu(), L4::Cap< A >::Cap(), L4::Cap< A >::Cap(), Cap_base(), Cap_base(), L4::Task::cap_equal(), L4::Task::cap_valid(), L4Re::Smart_count_cap< Unmap_flags >::copy(), L4Re::Util::Smart_count_cap< Unmap_flags >::copy(), L4::Factory::create_factory(), L4::Factory::create_gate(), L4::Factory::create_task(), L4::Factory::create_thread_group(), L4::Task::delete_obj(), L4Re::Util::Smart_cap_auto< Unmap_flags >
L4::Task::map(), L4Re::Util::Event_buffer_consumer_t< Default_event_payload >::process(), L4Re::Util::Br_manager::realloc_rcv_ca
L4::Thread::register_del_irq(), L4::Thread::register_doorbell_irq(), L4::Task::release_cap(), L4::Thread_group::remove(), L4::Icu::unbind(), and L4vbus::Icu::vicu().

Here is the caller graph for this function:



15.84.4.2 copy()

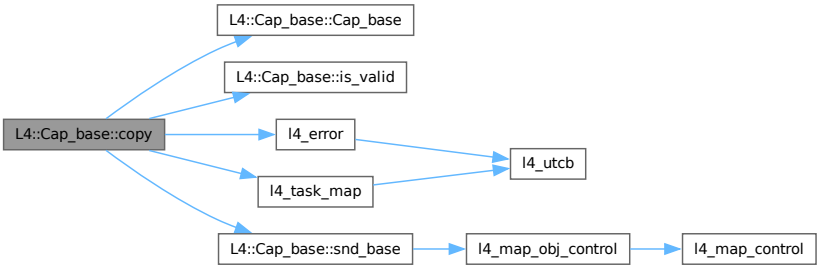
```
bool L4::Cap_base::copy (
            Cap_base const & src) const  [inline], [protected], [noexcept]
```

Copy a capability.

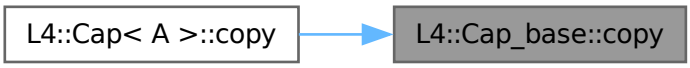
Parameters

src	the source capability.

After this operation this capability refers to the same object as `src`.
Definition at line 195 of file capability.h.
References Cap_base(), is_valid(), L4_BASE_TASK_CAP, L4_CAP_FPAGE_RWSD, l4_error(), L4_FPAGE_C_OBJ_RIGHTS, l4_task_map(), and snd_base().
Referenced by L4::Cap< A >::copy().
Here is the call graph for this function:



Here is the caller graph for this function:



15.84.4.3 fpage()

```
l4_fpage_t L4::Cap_base::fpage (
            unsigned rights = L4_CAP_FPAGE_RWS) const  [inline], [noexcept]
```

Return flexpage for the capability.

Parameters

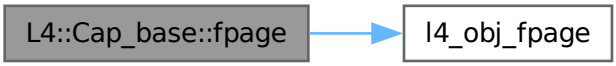
rights	Rights, defaults to 'rws'

Returns

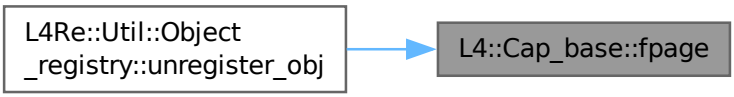
flexpage

Definition at line 74 of file capability.h.
References _c, L4_CAP_FPAGE_RWS, and l4_obj_fpage().
Referenced by L4Re::Util::Object_registry::unregister_obj().

Here is the call graph for this function:



Here is the caller graph for this function:



15.84.4.4 is_equal()

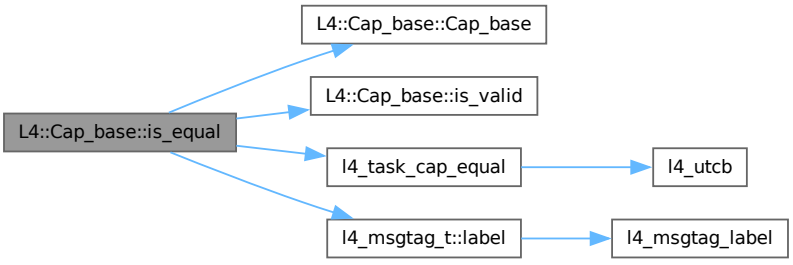
```
bool L4::Cap_base::is_equal (
            Cap_base const & other) const  [inline], [protected], [noexcept]
```

Test whether this capability points to the same object with the same permissions as `other`.
As an extension, invalid capabilities are considered equal by this function. See l4_task_cap_equal() for further details.

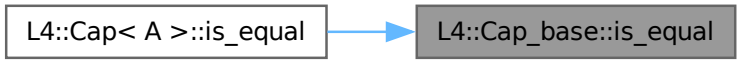
Parameters

other	The capability to comapre to.

Definition at line 215 of file capability.h.
References _c, Cap_base(), is_valid(), L4_BASE_TASK_CAP, l4_task_cap_equal(), and l4_msgtag_t::label().
Referenced by L4::Cap< A >::is_equal().
Here is the call graph for this function:



Here is the caller graph for this function:



15.84.4.5 is_valid()

`bool L4::Cap_base::is_valid () const [inline], [noexcept]`

Test whether the capability is a valid capability index (i.e., L4_INVALID_CAP_BIT is not set).

Returns

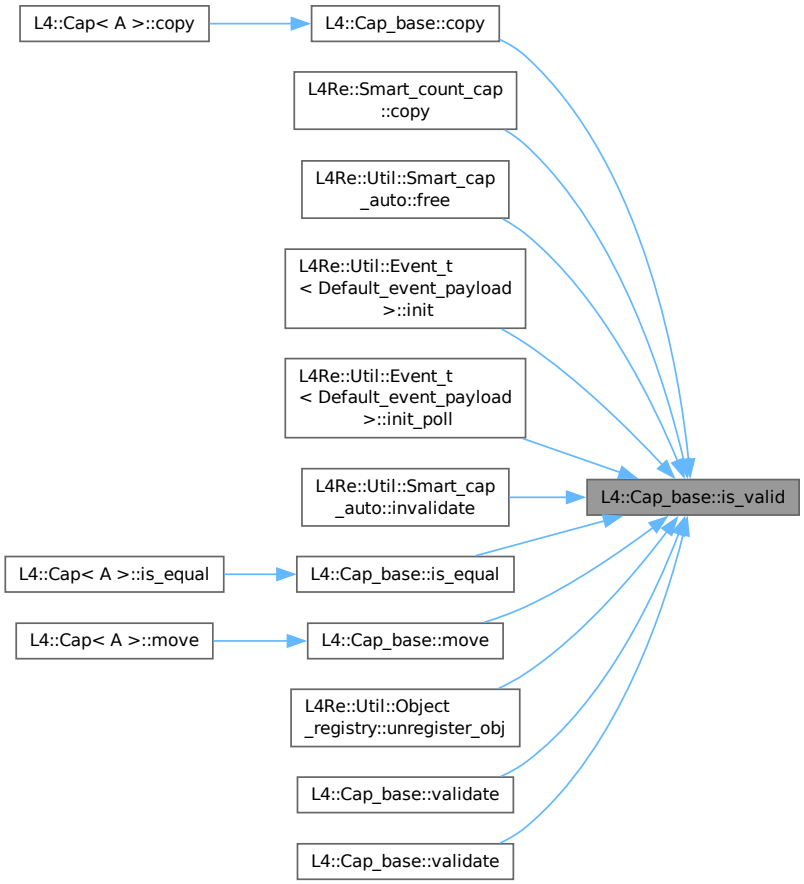
True if capability is not invalid, false if invalid

Examples

examples/libs/l4re/c++/mem_alloc/ma+rm.cc, and examples/libs/l4re/c++/shared_ds/ds_clnt.cc.

Definition at line 57 of file capability.h.
References _c, and L4_INVALID_CAP_BIT.
Referenced by copy(), L4Re::Smart_count_cap< Unmap_flags >::copy(), L4Re::Util::Smart_cap_auto< Unmap_flags >::free(), L4Re::Util::Event_t< Default_event_payload >::init(), L4Re::Util::Event_t< Default_event_payload >::init_poll(), L4Re::Util::Smart_cap_auto< Unmap_flags >::invalidate(), is_equal(), move(), L4Re::Util::Object_registry::unregister_obj(), validate(), and validate().

Here is the caller graph for this function:



15.84.4.6 move()

```
bool L4::Cap_base::move (
            Cap_base const & src) const  [inline], [protected], [noexcept]
```

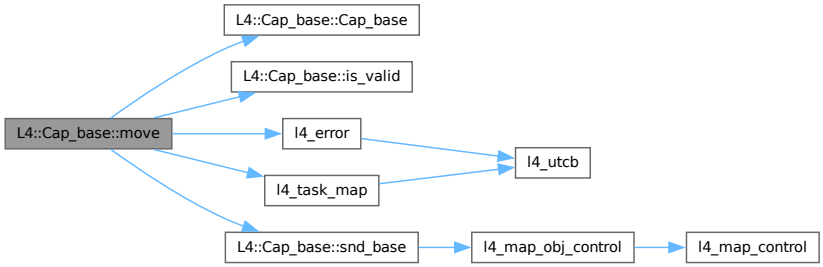
Replace this capability with the contents of `src`.

Parameters

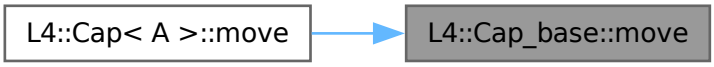
src	the source capability.

After the operation this capability refers to the object formerly referred to by the source capability `src`, and the source capability no longer refers to an object.
Definition at line 176 of file capability.h.
References Cap_base(), is_valid(), L4_BASE_TASK_CAP, L4_CAP_FPAGE_RWSD, l4_error(), L4_FPAGE_C_OBJ_RIGHTS, L4_MAP_ITEM_GRANT, l4_task_map(), and snd_base().
Referenced by L4::Cap< A >::move().

Here is the call graph for this function:



Here is the caller graph for this function:



15.84.4.7 snd_base()

```
l4_umword_t L4::Cap_base::snd_base (
            unsigned grant = L4_MAP_ITEM_MAP,
            l4_cap_idx_t base = L4_INVALID_CAP) const  [inline], [noexcept]
```

Return send base.

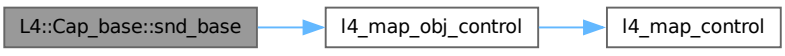
Parameters

grant	Indicates if object shall be granted. Allowed values: L4_MAP_ITEM_MAP, L4_MAP_ITEM_GRANT.
base	Base capability (first in a bundle of aligned capabilities)

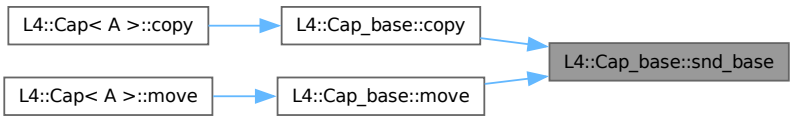
Returns

Map object.

Definition at line 86 of file capability.h.
References _c, L4_INVALID_CAP, L4_MAP_ITEM_MAP, and l4_map_obj_control().
Referenced by copy(), and move().
Here is the call graph for this function:



Here is the caller graph for this function:



15.84.4.8 validate() [1/2]

```
l4_msgtag_t L4::Cap_base::validate (
            Cap< Task > task,
            l4_utcb_t * u = l4_utcb()) const  [inline], [noexcept]
```

Check whether a capability is present (refers to an object).

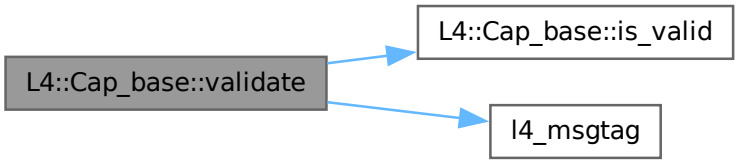
Parameters

task	Task to check the capability in.
u	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

l4_msgtag_t::label() > 0	Capability is present (refers to an object).
l4_msgtag_t::label() == 0	No capability present (void object or invalid capability selector).

A capability is considered present when it refers to an existing kernel object.
Definition at line 74 of file capability.
References _c, is_valid(), and l4_msgtag().
Here is the call graph for this function:



15.84.4.9 validate() [2/2]

```
l4_msgtag_t L4::Cap_base::validate (
            l4_utcb_t * u = l4_utcb()) const  [inline], [noexcept]
```

Check whether a capability is present (refers to an object).

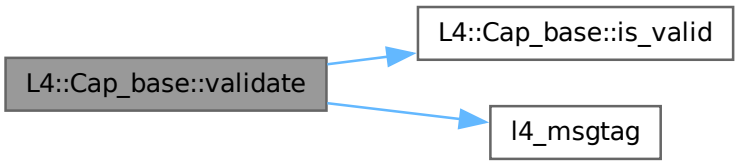
Parameters

u	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

l4_msgtag_t::label() > 0	Capability is present (refers to an object).
l4_msgtag_t::label() == 0	No capability present (void object or invalid capability selector).

A capability is considered present when it refers to an existing kernel object.
Definition at line 81 of file capability.
References _c, is_valid(), L4_BASE_TASK_CAP, and l4_msgtag().
Here is the call graph for this function:



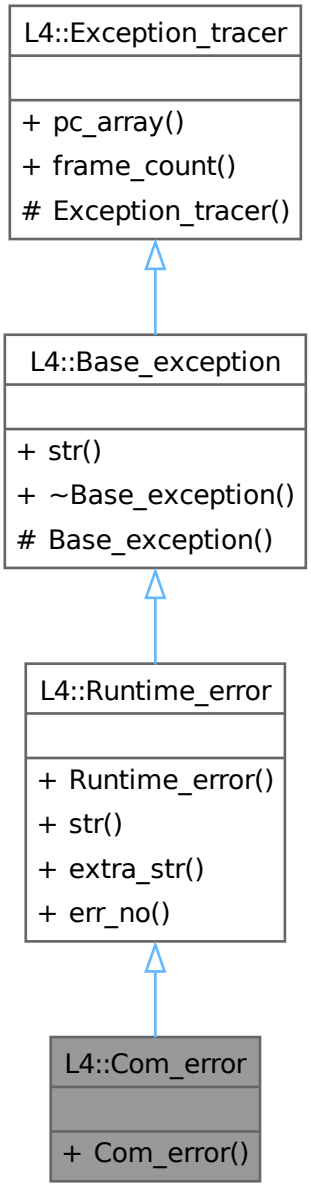
The documentation for this class was generated from the following files:

- l4/sys/cxx/capability.h
- l4/sys/capability

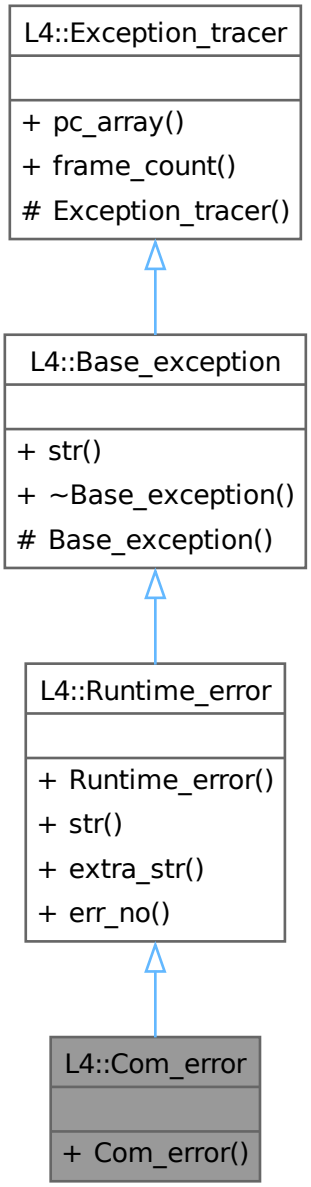
15.85 L4::Com_error Class Reference

Error conditions during IPC.
`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Com_error:



Collaboration diagram for L4::Com_error:



Public Member Functions

- Com_error (long err) noexcept

  Create a Com_error for the given L4 IPC error code.

Public Member Functions inherited from L4::Runtime_error

- Runtime_error (long err_no, char const ∗extra=0) noexcept

  Create a new Runtime_error.
- char const ∗ **str** () const noexcept override

Return a human readable string for the exception.

- char const * extra_str () const

  Get the description text for this runtime error.

- long err_no () const noexcept

  Get the error value for this runtime error.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.

- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Additional Inherited Members

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

15.85.1 Detailed Description

Error conditions during IPC.
This exception encapsulates all IPC error conditions of L4 IPC.
Definition at line 263 of file exceptions.

15.85.2 Constructor & Destructor Documentation

15.85.2.1 Com_error()

```
L4::Com_error::Com_error (
            long err)  [inline], [explicit], [noexcept]
```

Create a Com_error for the given L4 IPC error code.

Parameters

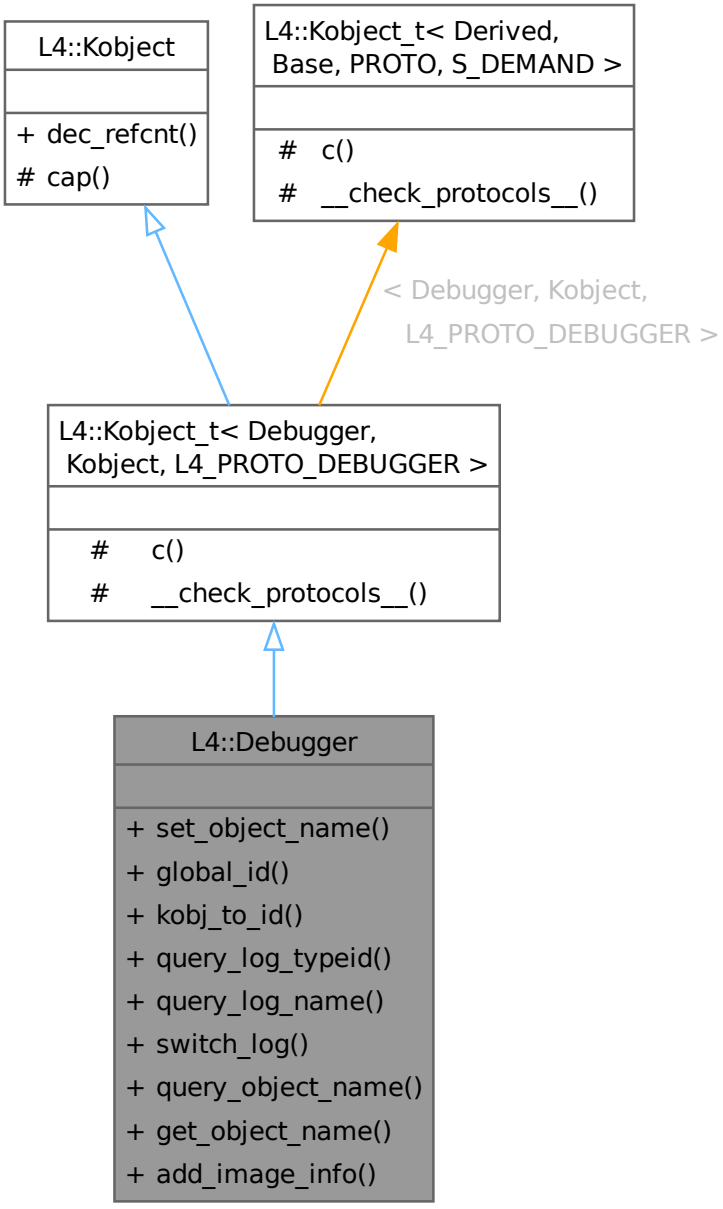
err	The L4 IPC error code (l4_ipc... return value).

Definition at line 270 of file exceptions.
The documentation for this class was generated from the following file:

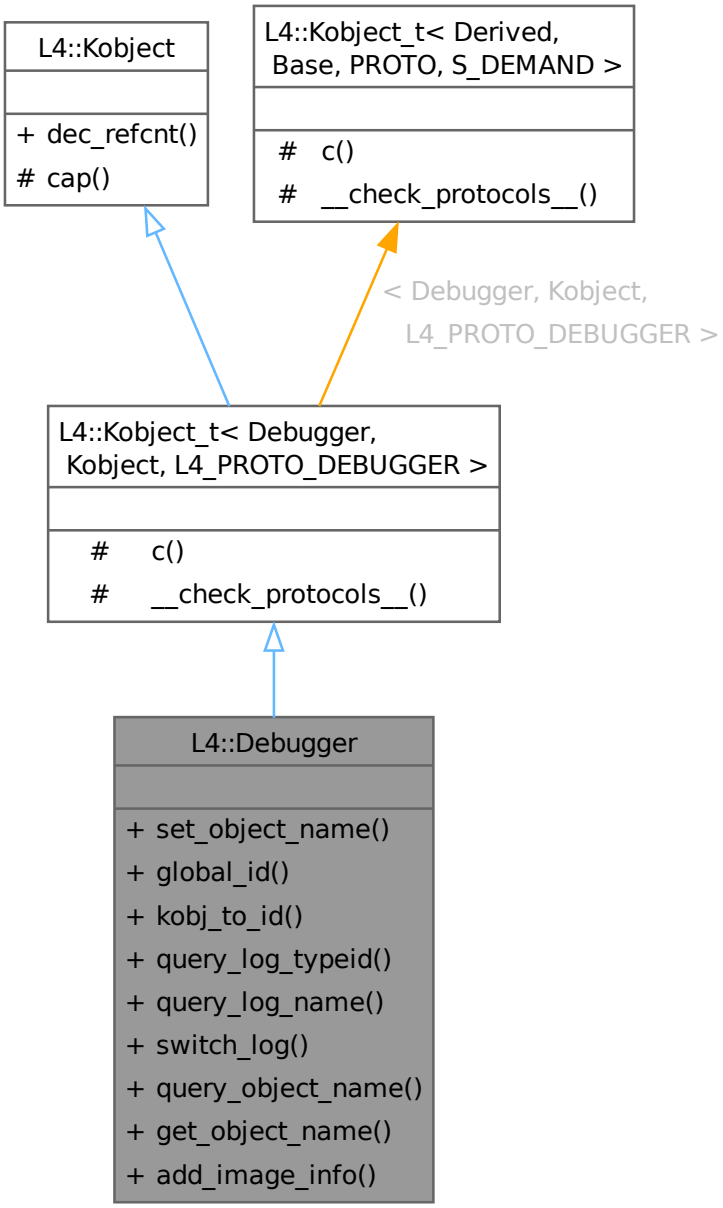
- l4/cxx/exceptions

15.86 L4::Debugger Class Reference

C++ kernel debugger API.
`#include <debugger>`
Inheritance diagram for L4::Debugger:



Collaboration diagram for L4::Debugger:



Public Member Functions

- l4_msgtag_t set_object_name (const char *name, l4_utcb_t *utcb=l4_utcb()) noexcept
  Set the name of a kernel object.
- unsigned long global_id (l4_utcb_t *utcb=l4_utcb()) noexcept
  Get the globally unique ID of the object behind a capability.
- unsigned long kobj_to_id (l4_addr_t kobjp, l4_utcb_t *utcb=l4_utcb()) noexcept
  Get the globally unique ID of the object behind the kobject pointer.
- l4_ret_t query_log_typeid (const char *name, unsigned idx, l4_utcb_t *utcb=l4_utcb()) noexcept
  Query the log-id for a log type.

- l4_ret_t query_log_name (unsigned idx, char *name, unsigned namelen, char *shortname, unsigned shortnamelen, l4_utcb_t *utcb=l4_utcb()) noexcept

  Query the name of a log type given the ID.
- l4_msgtag_t switch_log (const char *name, unsigned on_off, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set or unset log.
- l4_ret_t query_object_name (unsigned id, char *name, unsigned size, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get name of object with Id `id`.
- l4_ret_t get_object_name (char *name, unsigned size, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get name of object.
- l4_msgtag_t add_image_info (l4_addr_t base, const char *name, l4_utcb_t *utcb=l4_utcb()) noexcept

  Add loaded image information for a task.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Debugger, Kobject, L4_PROTO_DEBUGGER >

- typedef Debugger **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Debugger > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Debugger, Kobject, L4_PROTO_DEBUGGER >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Debugger, Kobject, L4_PROTO_DEBUGGER >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.86.1 Detailed Description

C++ kernel debugger API.

Attention

This API is subject to change! Do not rely on it in production code.

This API is to be used for debugging exclusively.
This is the API for accessing kernel-debugger functionality from user-level programs. Specifically, it provides functionality to enrich the kernel debugger with insights into the program. The purpose is to facilitate debugging with the kernel debugger. For instance, a developer might choose to name the threads of her program so that she can find them in the kernel debugger thread list.
This API interacts with a kernel object that interfaces with the kernel debugger, the jdb-kernel object. The jdb-kernel object is fix and only available when the kernel debugger is built into the microkernel. The developer needs to pass the capability through to her program.

Include File

```
#include <l4/sys/debugger>
```

Definition at line 42 of file debugger.

15.86.2 Member Function Documentation

15.86.2.1 add_image_info()

```
l4_msgtag_t L4::Debugger::add_image_info (
             l4_addr_t base,
             const char * name,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Add loaded image information for a task.

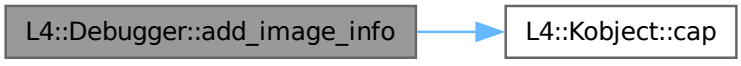
Parameters

base	Image load base address
name	Image name
utcb	The UTCB to use for the operation.

Returns

System call return tag.

Definition at line 177 of file debugger.
References L4::Kobject::cap().
Here is the call graph for this function:



15.86.2.2 get_object_name()

```
l4_ret_t L4::Debugger::get_object_name (
             char * name,
             unsigned size,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Get name of object.

Parameters

out	*name*	Buffer to copy the name into. The buffer must be allocated by the caller.
	size	Length of the name buffer.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

0	Success
<0	Error

Definition at line 164 of file debugger.
References L4::Kobject::cap().
Here is the call graph for this function:



15.86.2.3 global_id()

```
unsigned long L4::Debugger::global_id (
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Get the globally unique ID of the object behind a capability.

Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

~0UL	The capability is invalid.
>=0	The global debugger id.

Definition at line 71 of file debugger.
References L4::Kobject::cap().

Here is the call graph for this function:



15.86.2.4 kobj_to_id()

```
unsigned long L4::Debugger::kobj_to_id (
            l4_addr_t kobjp,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Get the globally unique ID of the object behind the kobject pointer.

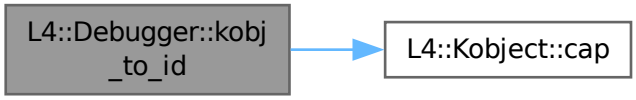
Parameters

kobjp	Kobject pointer
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

~0UL	The capability or the Kobject pointer are invalid.
>=0	The globally unique id.

Definition at line 83 of file debugger.
References L4::Kobject::cap().
Here is the call graph for this function:



15.86.2.5 query_log_name()

```
l4_ret_t L4::Debugger::query_log_name (
            unsigned idx,
            char * name,
            unsigned namelen,
            char * shortname,
```

```
            unsigned shortnamelen,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Query the name of a log type given the ID.

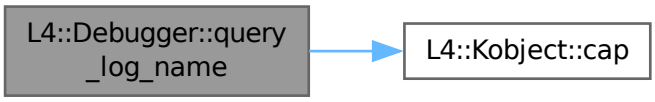
Parameters

	idx	ID to query.
out	*name*	Buffer to copy name to. The buffer must be allocated by the caller.
	namelen	Buffer length of name.
out	*shortname*	Buffer to copy `shortname` to. The buffer must be allocated by the caller.
	shortnamelen	Buffer length of `shortname`.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

0	Success
<0	Error

Definition at line 116 of file debugger.
References L4::Kobject::cap().
Here is the call graph for this function:



15.86.2.6 query_log_typeid()

```
l4_ret_t L4::Debugger::query_log_typeid (
            const char * name,
            unsigned idx,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Query the log-id for a log type.

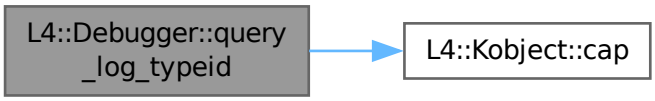
Parameters

name	Name to query for.
idx	Idx to start searching, start with 0
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

>=0	Id
<0	Error

Definition at line 97 of file debugger.
References L4::Kobject::cap().
Here is the call graph for this function:



15.86.2.7 query_object_name()

```
l4_ret_t L4::Debugger::query_object_name (
            unsigned id,
            char * name,
            unsigned size,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Get name of object with Id `id`.

Parameters

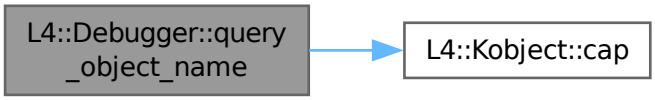
	id	Id of the object whose name is asked.
`out`	*name*	Buffer to copy the name into. The buffer must be allocated by the caller.
	size	Length of the `name` buffer.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

0	Success
<0	Error

Definition at line 149 of file debugger.
References L4::Kobject::cap().

Here is the call graph for this function:



15.86.2.8 set_object_name()

```
l4_msgtag_t L4::Debugger::set_object_name (
            const char * name,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Set the name of a kernel object.

Parameters

name	Name
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

System call return tag.

Definition at line 59 of file debugger.
References L4::Kobject::cap().
Here is the call graph for this function:



15.86.2.9 switch_log()

```
l4_msgtag_t L4::Debugger::switch_log (
            const char * name,
            unsigned on_off,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Set or unset log.

Parameters

name	Name of the log type.

on_off	1: turn log on, 0: turn log off
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

Definition at line 133 of file debugger.
References L4::Kobject::cap().
Here is the call graph for this function:



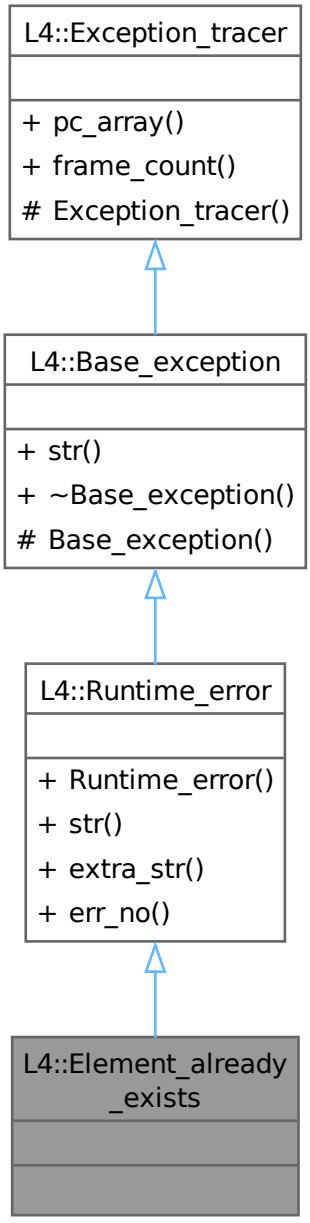
The documentation for this class was generated from the following file:

- l4/sys/debugger

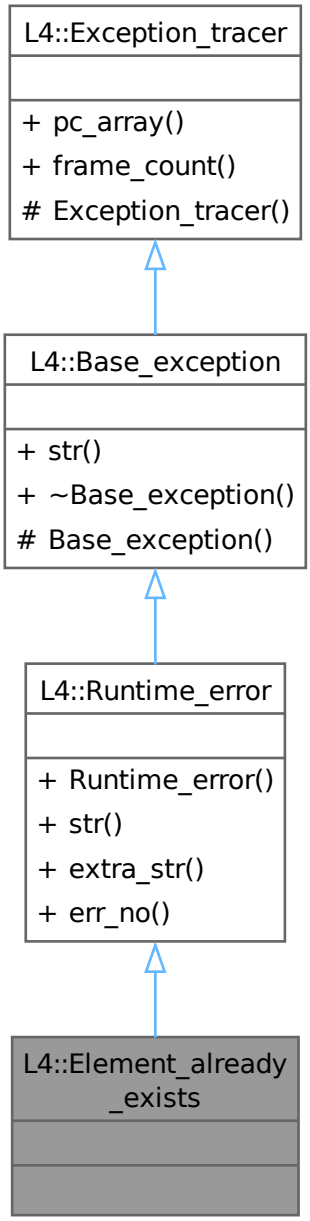
15.87 L4::Element_already_exists Class Reference

Exception for duplicate element insertions.
`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Element_already_exists:



Collaboration diagram for L4::Element_already_exists:



Additional Inherited Members

Public Member Functions inherited from L4::Runtime_error

- Runtime_error (long err_no, char const ∗extra=0) noexcept

  Create a new Runtime_error.
- char const ∗ **str** () const noexcept override

  Return a human readable string for the exception.
- char const ∗ extra_str () const

Get the description text for this runtime error.

- long err_no () const noexcept

  Get the error value for this runtime error.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.
- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

15.87.1 Detailed Description

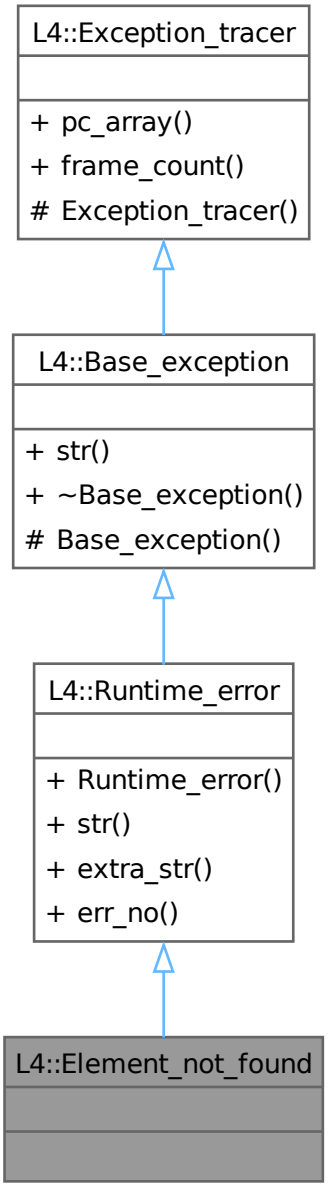
Exception for duplicate element insertions.
Definition at line 192 of file exceptions.
The documentation for this class was generated from the following file:

- l4/cxx/exceptions

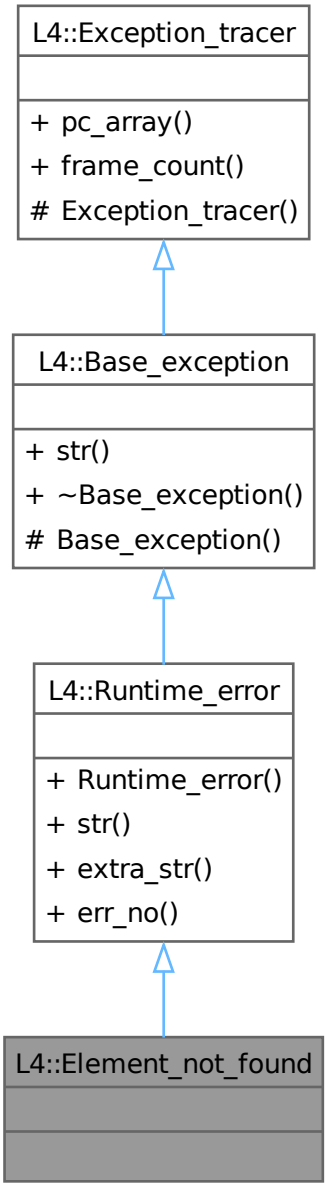
15.88 L4::Element_not_found Class Reference

Exception for a failed lookup (element not found).
`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Element_not_found:



Collaboration diagram for L4::Element_not_found:



Additional Inherited Members

Public Member Functions inherited from L4::Runtime_error

- Runtime_error (long err_no, char const *extra=0) noexcept

  Create a new Runtime_error.
- char const * **str** () const noexcept override

  Return a human readable string for the exception.
- char const * extra_str () const

  Get the description text for this runtime error.

- long err_no () const noexcept

  Get the error value for this runtime error.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.
- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

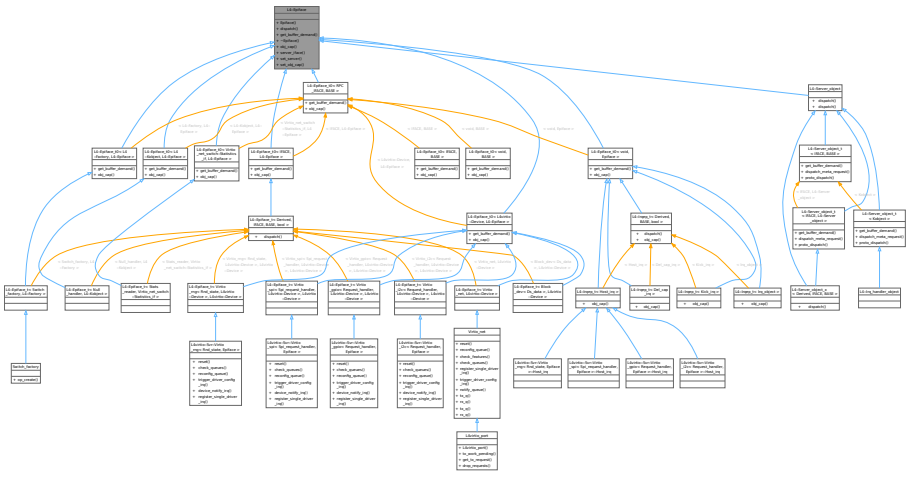
15.88.1 Detailed Description

Exception for a failed lookup (element not found).
Definition at line 220 of file exceptions.
The documentation for this class was generated from the following file:

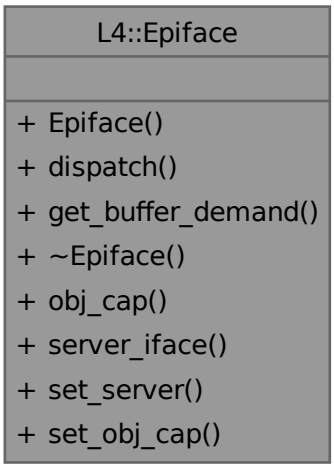
- l4/cxx/exceptions

15.89 L4::Epiface Struct Reference

Base class for interface implementations.
`#include <ipc_epiface>`
Inheritance diagram for L4::Epiface:



Collaboration diagram for L4::Epiface:



Public Types

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions

- **Epiface** ()

  Make a server object.
- virtual l4_msgtag_t dispatch (l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb)=0

  The abstract handler for client requests to the object.
- virtual Demand get_buffer_demand () const =0

  Get the server-side receive buffer demand for this object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

15.89.1 Detailed Description

Base class for interface implementations.
An Epiface is the base interface of objects registered in the server loop. Incoming IPC gets dispatched to the appropriate Epiface object where the call is then handled appropriately.

Note

Server loops are allowed to internally keep raw pointers to Epiface objects for dispatching calls. Instances must therefore never be copied or moved.

Definition at line 263 of file ipc_epiface.

15.89.2 Member Function Documentation

15.89.2.1 dispatch()

```
virtual l4_msgtag_t L4::Epiface::dispatch (
             l4_msgtag_t tag,
             unsigned rights,
             l4_utcb_t * utcb)  [pure virtual]
```

The abstract handler for client requests to the object.

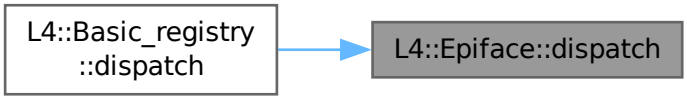
Parameters

tag	The message tag for this invocation.
rights	The rights bits in the invoked capability.
utcb	The UTCB used for the invocation.

Return values

-L4_ENOREPLY	No reply message is sent.
<0	Error, reply with error code.
>=0	Success, reply with return value.

This function must be implemented by application specific server objects.
Implemented in L4::Epiface_t< Derived, IFACE, BASE, bool >, L4::Epiface_t< Block_dev< Ds_data >, L4virtio::Device >, L4::Epiface_t< Null_handler, L4::Kobject >, L4::Epiface_t< Stats_reader, Virtio_net_switch::Statistics_if >, L4::Epiface_t< Switch_factory, L4::Factory >, L4::Epiface_t< Virtio_gpio< Request_handler, L4virtio::Device >, L4virtio::Device >, L4::Epiface_t< Virtio_i2c< Request_handler, L4virtio::Device >, L4virtio::Device >, L4::Epiface_t< Virtio_net, L4virtio::Device >, L4::Epiface_t< Virtio_rng< Rnd_state, L4virtio::Device >, L4virtio::Device >, L4::Epiface_t< Virtio_spi< Spi_request_handler, L4vi L4::Irqep_t< Derived, BASE, bool >, L4::Irqep_t< Del_cap_irq >, L4::Irqep_t< Host_irq >, L4::Irqep_t< Irq_object >, L4::Irqep_t< Kick_irq >, and L4::Server_object.
Referenced by L4::Basic_registry::dispatch().
Here is the caller graph for this function:



15.89.2.2 get_buffer_demand()

```
virtual Demand L4::Epiface::get_buffer_demand () const  [pure virtual]
```

Get the server-side receive buffer demand for this object.

Note

This function is usually not implemented directly, but by using Server_object_t template with an IPC interface definition.

Returns

The needed server-side receive buffers for this object

Implemented in L4::Epiface_t0< RPC_IFACE, BASE >, L4::Epiface_t0< IFACE, L4::Epiface >, L4::Epiface_t0< L4::Factory, L4::Epi
L4::Epiface_t0< L4::Kobject, L4::Epiface >, L4::Epiface_t0< L4virtio::Device, L4::Epiface >, L4::Epiface_t0< Virtio_net_switch::Stat
L4::Epiface_t0< void, Epiface >, L4::Server_object_t< IFACE, BASE >, L4::Server_object_t< IFACE, L4::Server_object >,
and L4::Server_object_t< Kobject >.

15.89.2.3 obj_cap()

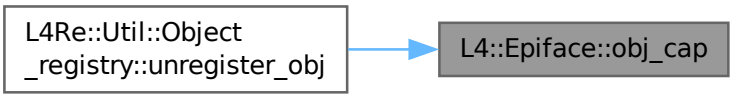
```
Stored_cap L4::Epiface::obj_cap () const  [inline]
```

Get the capability to the kernel object belonging to this object.

Returns

Capability for the kernel object behind the server.

This is usually either an Ipc_gate or an Irq.
Definition at line 324 of file ipc_epiface.
Referenced by L4Re::Util::Object_registry::unregister_obj().
Here is the caller graph for this function:



15.89.2.4 server_iface()

```
Server_iface * L4::Epiface::server_iface () const  [inline]
```

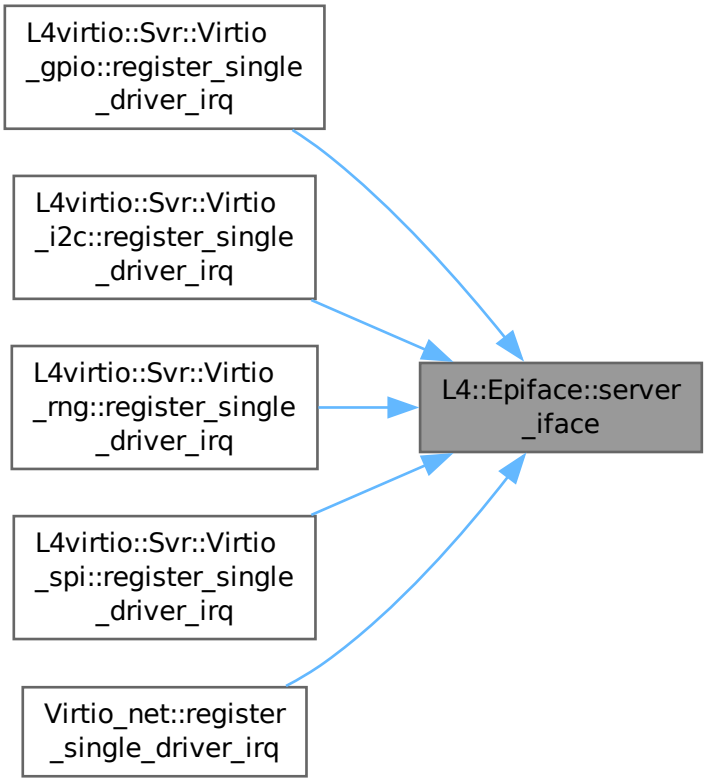
Get pointer to server interface at which the object is currently registered.

Returns

Pointer to the server at which the object is currently registered, NULL if the object is not registered at any server.

Definition at line 331 of file ipc_epiface.
Referenced by L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::register_single_driver_irq(), L4virtio::Svr::Virtio_i2c< Reques
L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::register_single_driver_irq(), L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface
and Virtio_net::register_single_driver_irq().

Here is the caller graph for this function:



15.89.2.5 set_server()

```
int L4::Epiface::set_server (
            Server_iface * srv,
            Cap< void > cap,
            bool managed = false)  [inline]
```

Set server registration info for the object.

Parameters

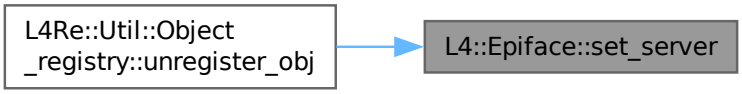
srv	The server to register at
cap	The capability that connects the object.
managed	Mark the capability as managed or unmanaged. Typical server implementations use this flag to remember whether the capability was internally allocated or not.

Returns

0 on success, -L4_EINVAL if the srv and cap are not consistent.

Definition at line 342 of file ipc_epiface.
References L4_EINVAL.

Referenced by L4Re::Util::Object_registry::unregister_obj().
Here is the caller graph for this function:

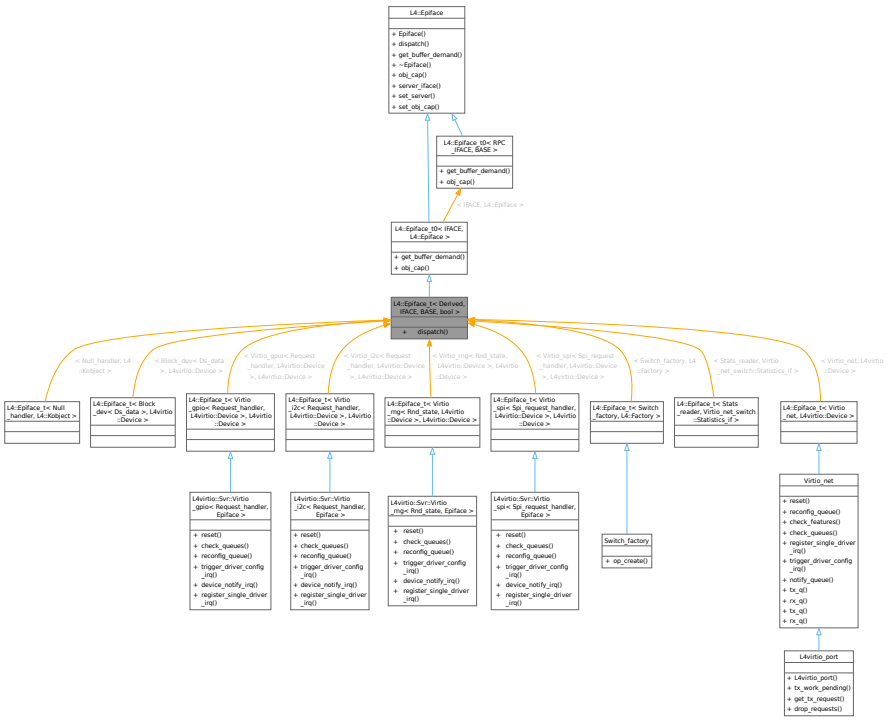


The documentation for this struct was generated from the following file:

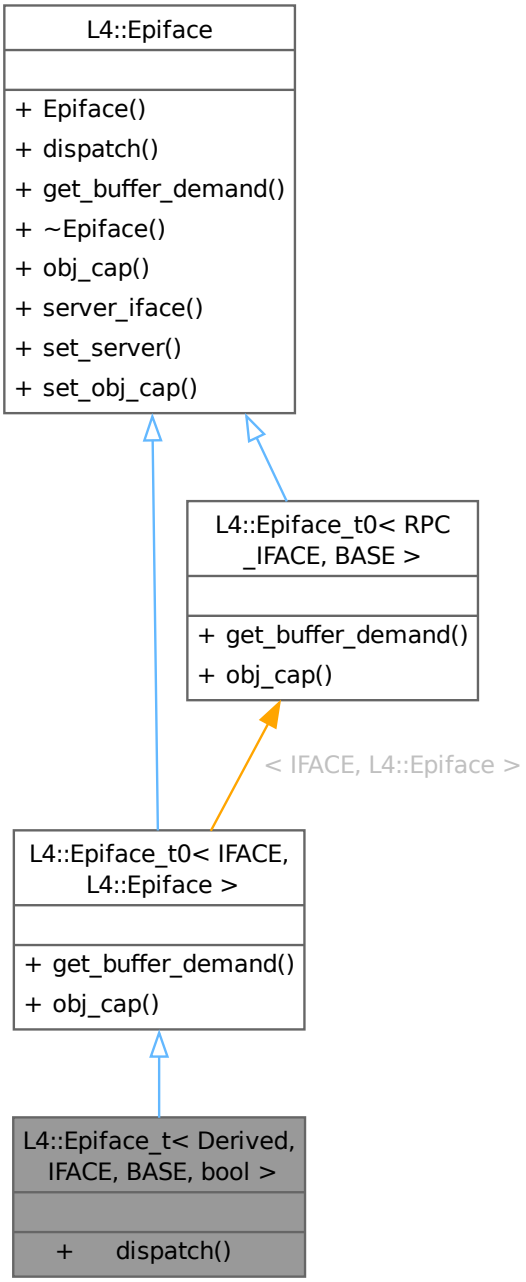
- l4/sys/cxx/ipc_epiface

15.90 L4::Epiface_t< Derived, IFACE, BASE, bool > Struct Template Reference

Epiface implementation for Kobject-based interface implementations.
`#include <ipc_epiface>`
Inheritance diagram for L4::Epiface_t< Derived, IFACE, BASE, bool >:



Collaboration diagram for L4::Epiface_t< Derived, IFACE, BASE, bool >:



Public Member Functions

- l4_msgtag_t dispatch (l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb) final

  The abstract handler for client requests to the object.

Public Member Functions inherited from L4::Epiface_t0< IFACE, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

Get the server-side buffer demand based in IFACE.

- Cap< IFACE > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< IFACE, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

15.90.1 Detailed Description

template<typename Derived, typename IFACE, typename BASE = L4::Epiface, bool = cxx::is_polymorphic<BASE>::value>
struct L4::Epiface_t< Derived, IFACE, BASE, bool >

Epiface implementation for Kobject-based interface implementations.

Template Parameters

Derived	Class providing the interface implementations.
BASE	Epiface base class.

Examples

examples/clntsrv/src/server.cc.

Definition at line 664 of file ipc_epiface.

15.90.2 Member Function Documentation

15.90.2.1 dispatch()

```
template<typename Derived, typename IFACE, typename BASE = L4::Epiface, bool = cxx::is_↩
polymorphic<BASE>::value>
l4_msgtag_t L4::Epiface_t< Derived, IFACE, BASE, bool >::dispatch (
            l4_msgtag_t tag,
            unsigned rights,
            l4_utcb_t * utcb)  [inline], [final], [virtual]
```

The abstract handler for client requests to the object.

Parameters

tag	The message tag for this invocation.
rights	The rights bits in the invoked capability.
utcb	The UTCB used for the invocation.

Return values

-L4_ENOREPLY	No reply message is sent.
<0	Error, reply with error code.
>=0	Success, reply with return value.

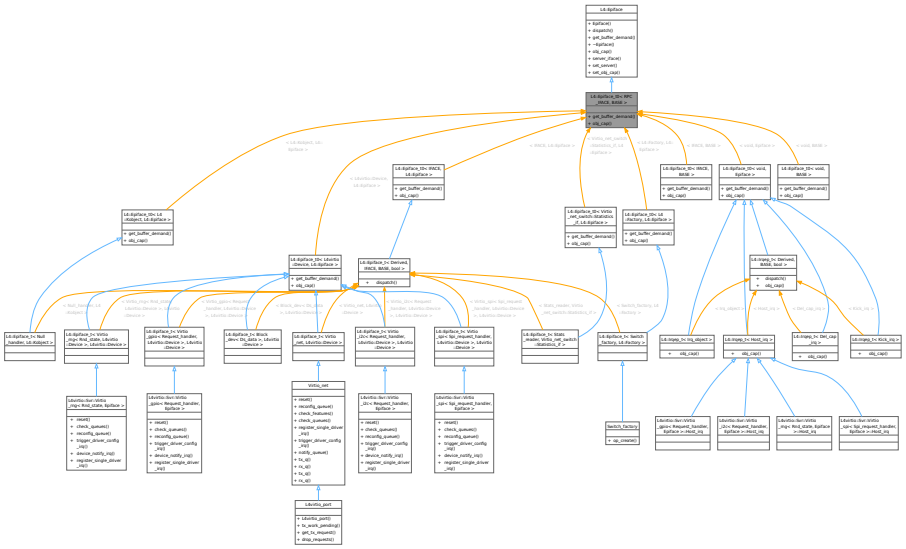
This function must be implemented by application specific server objects.
Implements L4::Epiface.
Definition at line 667 of file ipc_epiface.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_epiface

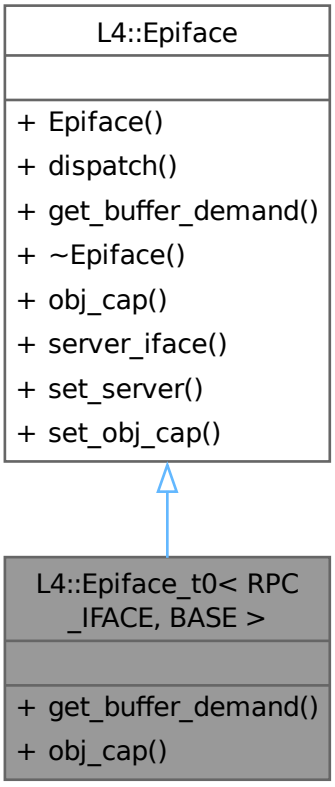
15.91 L4::Epiface_t0< RPC_IFACE, BASE > Struct Template Reference

Epiface mixin for generic Kobject-based interfaces.
`#include <ipc_epiface>`

Inheritance diagram for L4::Epiface_t0< RPC_IFACE, BASE >:



Collaboration diagram for L4::Epiface_t0< RPC_IFACE, BASE >:



Public Types

- using **Interface** = RPC_IFACE

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< RPC_IFACE > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual l4_msgtag_t dispatch (l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb)=0

  The abstract handler for client requests to the object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

15.91.1 Detailed Description

template<typename RPC_IFACE, typename BASE = Epiface>
struct L4::Epiface_t0< RPC_IFACE, BASE >

Epiface mixin for generic Kobject-based interfaces.

Template Parameters

RPC_IFACE	Data type of the IPC interface definition.
BASE	Base Epiface class.

Definition at line 374 of file ipc_epiface.

15.91.2 Member Function Documentation

15.91.2.1 obj_cap()

```
template<typename RPC_IFACE, typename BASE = Epiface>
Cap< RPC_IFACE > L4::Epiface_t0< RPC_IFACE, BASE >::obj_cap () const  [inline]
```

Get the (typed) capability to this object.

Returns

Capability for the kernel object behind the server.

Definition at line 387 of file ipc_epiface.
References L4::cap_cast().
Here is the call graph for this function:

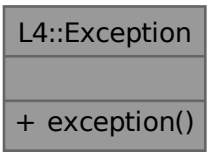


The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_epiface

15.92 L4::Exception Class Reference

Exception interface.
`#include <exception>`
Collaboration diagram for L4::Exception:



Public Member Functions

- l4_msgtag_t exception (L4::Ipc::In_out< l4_exc_regs_t * > regs, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  Exception call.

15.92.1 Detailed Description

Exception interface.

This class defines the interface for handling exception IPC. When an exception occurs during program execution, for example due to a division by zero, the kernel will synthesise an exception IPC and send it to the thread's exception handler, who can then handle it.
The exception handler is set with the L4::Thread::control interface.
Definition at line 31 of file exception.

15.92.2 Member Function Documentation

15.92.2.1 exception()

```
l4_msgtag_t L4::Exception::exception (
             L4::Ipc::In_out< l4_exc_regs_t * > regs,
             L4::Ipc::Rcv_fpage rwin,
             L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)
```

Exception call.

Parameters

	regs	Register state of the faulting thread.
	rwin	Receive window in the address space.
out	*fp*	Optional flexpage to resolve the exception.

Returns

Message tag containing error code.

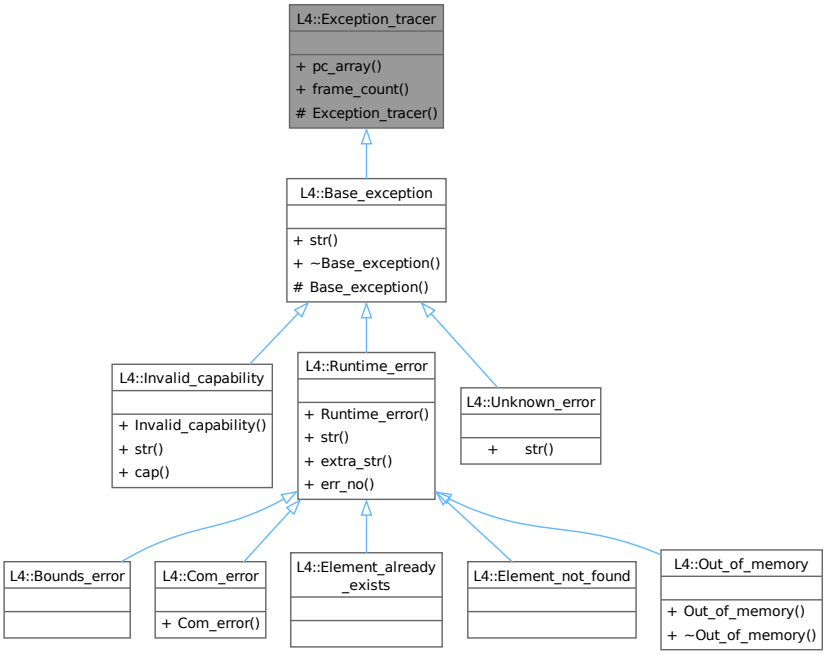
The documentation for this class was generated from the following file:

- l4/sys/exception

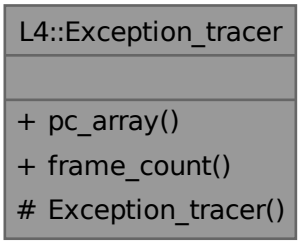
15.93 L4::Exception_tracer Class Reference

Back-trace support for exceptions.
`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Exception_tracer:



Collaboration diagram for L4::Exception_tracer:



Public Member Functions

- void const ∗const ∗ **pc_array** () const noexcept

  Get the array containing the call trace.
- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Protected Member Functions

- **Exception_tracer** () noexcept

  Create a back trace.

15.93.1 Detailed Description

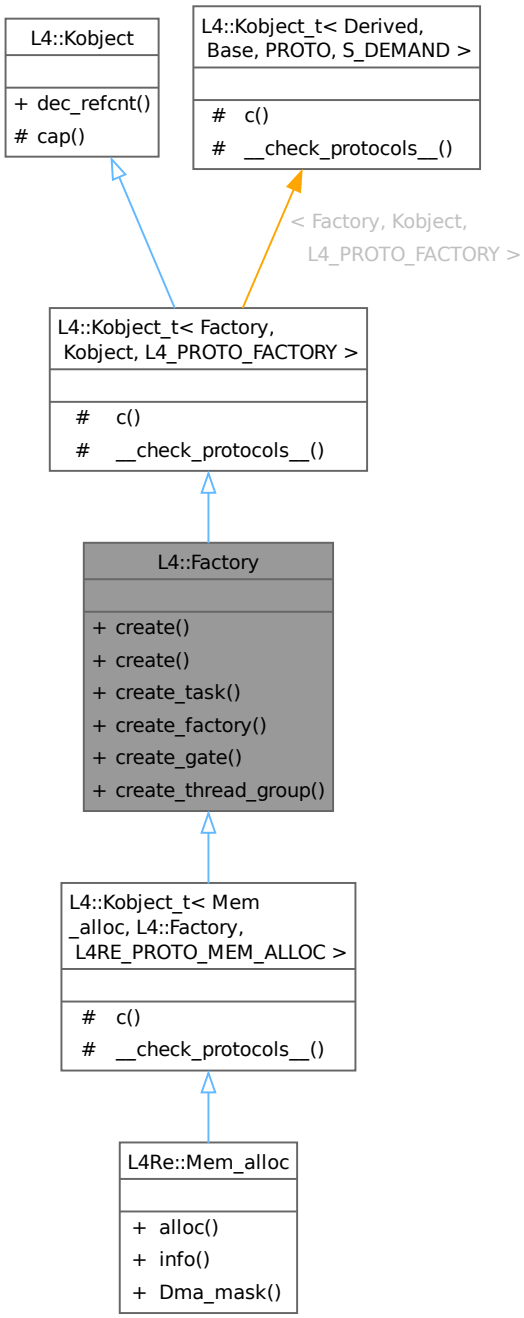
Back-trace support for exceptions.
This class holds an array of at most L4_CXX_EXCEPTION_BACKTRACE instruction pointers containing the call trace at the instant when an exception was thrown.
Definition at line 51 of file exceptions.
The documentation for this class was generated from the following file:

- l4/cxx/exceptions

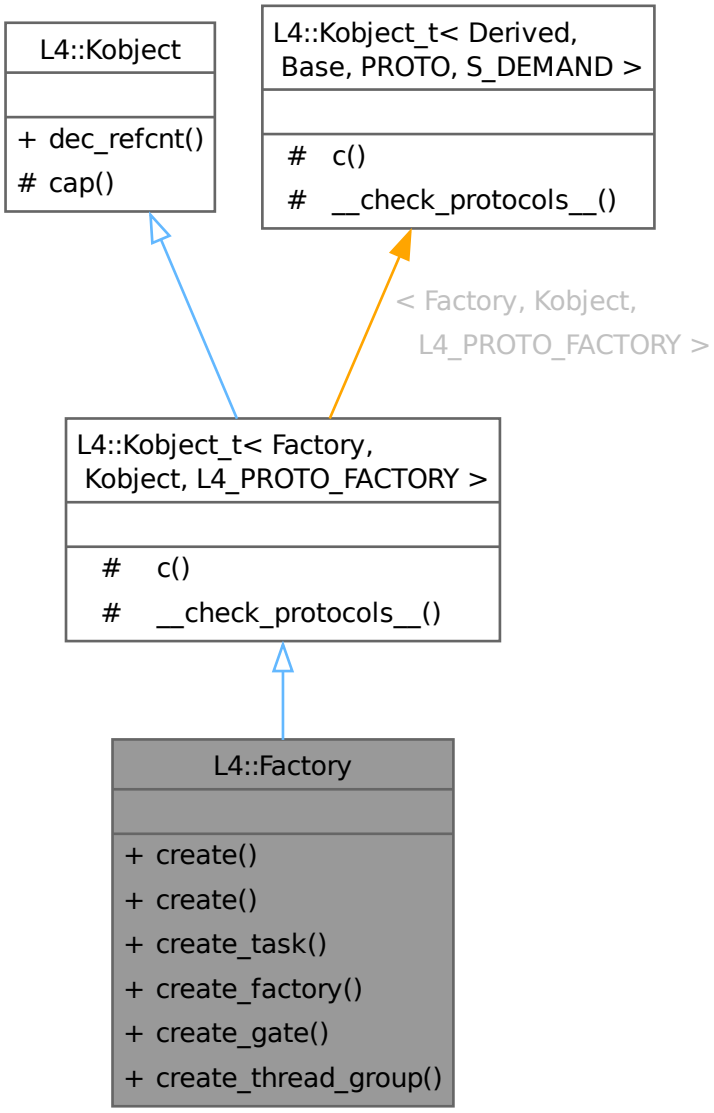
15.94 L4::Factory Class Reference

C++ Factory interface, see Factory for the C interface.
`#include <factory>`

Inheritance diagram for L4::Factory:



Collaboration diagram for L4::Factory:



Data Structures

- struct Nil

  Special type to add a void argument into the factory create stream.
- struct Lstr

  Special type to add a pascal string into the factory create stream.
- class S

  Stream class for the create() argument stream.

Public Member Functions

- S create (Cap< void > target, long obj, l4_utcb_t *utcb=l4_utcb()) noexcept

Generic create call to the factory.

- template<typename OBJ>
  S create (Cap< OBJ > target, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create call for typed capabilities.
- l4_msgtag_t create_task (Cap< Task > const &target_cap, l4_fpage_t *utcb_area, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new task.
- l4_msgtag_t create_factory (Cap< Factory > const &target_cap, unsigned long limit, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new factory.
- l4_msgtag_t create_gate (Cap< void > const &target_cap, Cap< Snd_destination > const &snd_dst_cap, l4_umword_t label, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new IPC gate, optionally bound to a send destination (a thread or thread group).
- l4_msgtag_t create_thread_group (Cap< Thread_group > const &target_cap, unsigned policy, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new thread group.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Factory, Kobject, L4_PROTO_FACTORY >

- typedef Factory **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Factory > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Factory, Kobject, L4_PROTO_FACTORY >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Factory, Kobject, L4_PROTO_FACTORY >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.94.1 Detailed Description

C++ Factory interface, see Factory for the C interface.
Factories provide an interface to create objects which are accessed via capabilities.
For additional information about which objects can be created via this interface, see server-specific information in Kernel Factory and L4Re Servers.

Include File

```
#include <l4/sys/factory>
```

For the C interface refer to Factory.
Definition at line 38 of file factory.

15.94.2 Member Function Documentation

15.94.2.1 create() [1/2]

```
template<typename OBJ>
S L4::Factory::create (
             Cap< OBJ > target,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Create call for typed capabilities.

Template Parameters

OBJ	Capability type of the object to be created.

Parameters

out	*target*	Capability of type OBJ.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

A create stream that allows additional arguments to be passed to the `create()` call via the left-shift (<<) operator (see S::operator <<).

This method does not directly invoke the factory. The factory is invoked when the create stream returned by this method is converted to an l4_msgtag_t (see S::operator l4_msgtag_t()), or otherwise when the stream goes out of scope (not recommended; see S::~S()).

Precondition

The invoked Factory capability must have the permission L4_CAP_FPAGE_S, otherwise the later factory IPC will fail with L4_EPERM (see S::operator l4_msgtag_t()).

Note

The create stream uses the UTCB to store parameters for the service call. During the lifetime of a create stream or, until it is converted to an l4_msgtag_t, other UTCB-using operations must not be used.

Usage:

```
L4::Cap<L4Re::Dataspace> ds = L4Re::Util::cap_alloc.alloc<L4Re::Dataspace>();
factory->create(ds) << l4_mword_t(size_in_bytes);
```

Definition at line 329 of file factory.
References L4::Kobject::cap().

Here is the call graph for this function:



15.94.2.2 create() [2/2]

```
S L4::Factory::create (
            Cap< void > target,
            long obj,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Generic create call to the factory.

Parameters

out	*target*	Capability slot for the new object. The caller must allocate the capability slot. The kernel stores the new object's capability into this slot.
	obj	The protocol ID that specifies which kind of object shall be created.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

A create stream that allows additional arguments to be passed to the `create()` call via the left-shift (<<) operator (see S::operator <<).

This method does not directly invoke the factory. The factory is invoked when the create stream returned by this method is converted to an l4_msgtag_t (see S::operator l4_msgtag_t()), or otherwise when the stream goes out of scope (not recommended; see S::~S()).

Precondition

The invoked Factory capability must have the permission L4_CAP_FPAGE_S, otherwise the later factory IPC will fail with L4_EPERM (see S::operator l4_msgtag_t()).

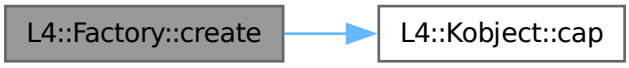
Note

The create stream uses the UTCB to store parameters for the service call. During the lifetime of a create stream or, until it is converted to an l4_msgtag_t, other UTCB-using operations must not be used.

See also

create(Cap<OBJ>, l4_utcb_t *)

Definition at line 292 of file factory.
References L4::Kobject::cap().
Here is the call graph for this function:



15.94.2.3 create_factory()

```
l4_msgtag_t L4::Factory::create_factory (
            Cap< Factory > const & target_cap,
            unsigned long limit,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Create a new factory.

Parameters

out	*target_cap*	The kernel stores the new factory's capability into this slot.
	limit	Limit for the new factory in bytes.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

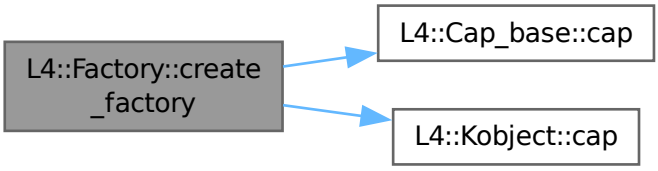
The invoked Factory capability must have the permission L4_CAP_FPAGE_S.

Note

In addition to memory needed for internal data structures, the `limit` (quota) of the new factory is counted towards the quota of the creating factory. The `limit` must be within `1 ≤ limit ≤ 2^(8 * sizeof(l4_umword_t) - 1) - 2` otherwise the behavior is undefined.

This method is only guaranteed to work with the Kernel Factory. For other services, use the generic create() method and consult the service documentation for information on the arguments that need to be passed to the create stream.

Definition at line 404 of file factory.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.94.2.4 create_gate()

```
l4_msgtag_t L4::Factory::create_gate (
            Cap< void > const & target_cap,
            Cap< Snd_destination > const & snd_dst_cap,
            l4_umword_t label,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Create a new IPC gate, optionally bound to a send destination (a thread or thread group).

Parameters

out	*target_cap*	The kernel stores the new IPC gate's capability into this slot.
	snd_dst_cap	Optional capability index of a thread or thread group to bind the gate to. Use L4_INVALID_CAP to create an unbound IPC gate.
	label	Optional label of the gate (precisely used if snd_dst_cap is valid). If snd_dst_cap is valid, label must be present.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag containing one of the following return codes.

Return values

L4_EOK	No error occurred.
-L4_ENOMEM	Out-of-memory during allocation of the Ipc_gate object.
-L4_EINVAL	snd_dst_cap is void or points to something that is not a thread or thread group.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

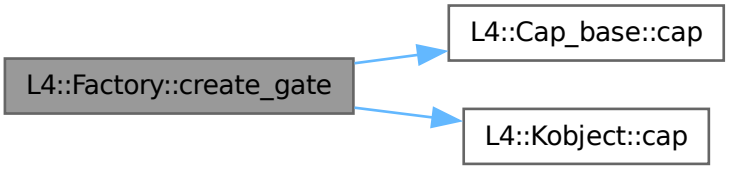
The invoked Factory capability must have the permission L4_CAP_FPAGE_S. Also snd_dst_cap (if valid) must have the permission L4_CAP_FPAGE_S.

An unbound IPC gate can be bound to a thread or thread group using L4::Ipc_gate::bind_thread() or bind_snd_↩ destination().

See also

L4::Ipc_gate

Definition at line 440 of file factory.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.94.2.5 create_task()

```
l4_msgtag_t L4::Factory::create_task (
            Cap< Task > const & target_cap,
            l4_fpage_t * utcb_area,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Create a new task.

Parameters

out	*target_cap*	The kernel stores the new task's capability into this slot.
in,out	*utcb_area*	Flexpage that describes an area in the address space of the new task, where the kernel should map the kernel-allocated kernel-user memory to. The kernel uses the kernel-user memory to store UTCBs and vCPU state-save-areas of the new task.

On systems without MMU, the flexpage is adjusted to reflect the actually allocated physical address.

Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.

<0	Error code.

Precondition

The invoked Factory capability must have the permission L4_CAP_FPAGE_S.

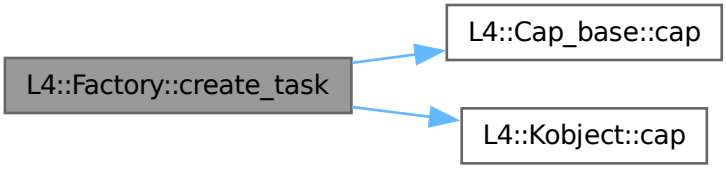
Note

The size of the UTCB area specifies indirectly the number of UTCBs available for this task. Refer to L4::Task::add_ku_mem for adding more of this type of memory.

See also

L4::Task

Definition at line 370 of file factory.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.94.2.6 create_thread_group()

```
l4_msgtag_t L4::Factory::create_thread_group (
            Cap< Thread_group > const & target_cap,
            unsigned policy,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Create a new thread group.
An IPC endpoint can be bound to a thread group. When a message arrives at the IPC endpoint, a specific thread of the thread group is selected to actually receive the message. A thread group is a send destination for an IPC endpoint.

Parameters

out	*target_cap*	The kernel stores the new thread group's capability into this slot.
	policy	Policy parameter for the thread group. See L4_thread_group_policy for a list of supported values.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

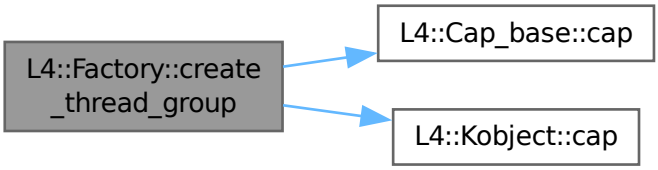
Returns

Syscall return tag containing one of the following return codes.

Return values

L4_EOK	No error occurred.
-L4_ENOMEM	Out-of-memory during allocation of the Thread_group object.
-L4_EINVAL	Invalid policy parameter.
-L4_EPERM	The factory instance requires L4_CAP_FPAGE_S rights on the invoked capability and L4_CAP_FPAGE_S is not present.

Definition at line 475 of file factory.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:

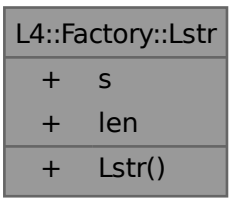


The documentation for this class was generated from the following file:

- l4/sys/factory

15.95 L4::Factory::Lstr Struct Reference

Special type to add a pascal string into the factory create stream.
`#include <factory>`
Collaboration diagram for L4::Factory::Lstr:



Public Member Functions

- Lstr (char const *s, unsigned len) noexcept

Data Fields

- char const * **s**

  The character buffer.
- unsigned **len**

  The number of characters in the buffer.

15.95.1 Detailed Description

Special type to add a pascal string into the factory create stream.
This encapsulates a string that has an explicit length.
Definition at line 54 of file factory.

15.95.2 Constructor & Destructor Documentation

15.95.2.1 Lstr()

```
L4::Factory::Lstr::Lstr (
            char const * s,
            unsigned len)  [inline], [noexcept]
```

Parameters

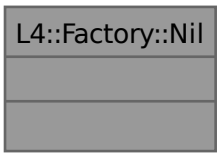
s	Pointer to the c-style string.
len	Length in number of characters of the string s.

Definition at line 70 of file factory.
References len, and s.
The documentation for this struct was generated from the following file:

- l4/sys/factory

15.96 L4::Factory::Nil Struct Reference

Special type to add a void argument into the factory create stream.
`#include <factory>`
Collaboration diagram for L4::Factory::Nil:



15.96.1 Detailed Description

Special type to add a void argument into the factory create stream.
Definition at line 47 of file factory.
The documentation for this struct was generated from the following file:

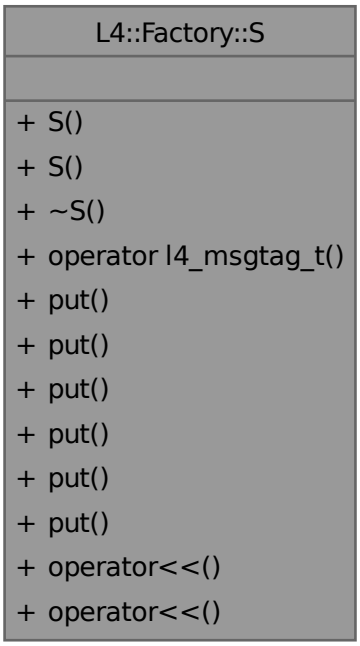
- l4/sys/factory

15.97 L4::Factory::S Class Reference

Stream class for the create() argument stream.

`#include <factory>`

Collaboration diagram for L4::Factory::S:



Public Member Functions

- S (S &&o) noexcept

  Move constructor.
- S (l4_cap_idx_t f, long obj, L4::Cap< void > target, l4_utcb_t *utcb) noexcept

  Create a stream for a specific create() call.
- ~S () noexcept

  Commit the create() operation if not already done explicitly via operator l4_msgtag_t().
- operator l4_msgtag_t () noexcept

  Explicitly commits the operation and returns the result.
- void put (l4_mword_t i) noexcept

  Put a single l4_mword_t as next argument.
- void put (l4_umword_t i) noexcept

  Put a single l4_umword_t as next argument.
- void put (char const *s) &noexcept

  Add a zero-terminated string as next argument.
- void put (Lstr const &s) &noexcept

  Add a pascal string as next argument.
- void **put** (Nil) &noexcept

  Add an empty argument.
- void put (l4_fpage_t d) &noexcept

Add a flexpage as next argument.

- template<typename T>
  S & operator<< (T const &d) &noexcept

  Add next argument.
- template<typename T>
  S && operator<< (T const &d) &&noexcept

  Add next argument.

15.97.1 Detailed Description

Stream class for the create() argument stream.
This stream allows a variable number of arguments to be added to a create() call.
Definition at line 79 of file factory.

15.97.2 Constructor & Destructor Documentation

15.97.2.1 S() [1/2]

```
L4::Factory::S::S (
            S && o)  [inline], [noexcept]
```

Move constructor.

Parameters

o	Instance of S to move.

Definition at line 98 of file factory.

15.97.2.2 S() [2/2]

```
L4::Factory::S::S (
            l4_cap_idx_t f,
            long obj,
            L4::Cap< void > target,
            l4_utcb_t * utcb)  [inline], [noexcept]
```

Create a stream for a specific create() call.

Parameters

	f	The capability for the factory object (L4::Factory).
	obj	The protocol ID to describe the type of the object that shall be created.
out	*target*	The capability slot for the new object. The caller must allocate the capability slot. The kernel stores the new object's capability into this slot.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Precondition

The capability `f` must have the permission L4_CAP_FPAGE_S, otherwise the later factory IPC will fail with L4_EPERM.

Definition at line 125 of file factory.

15.97.2.3 ~S()

```
L4::Factory::S::~S ()  [inline], [noexcept]
```

Commit the create() operation if not already done explicitly via operator l4_msgtag_t().

Warning

If the commit is deferred until destruction, potential errors are silently ignored. It is therefore recommended to commit explicitly via operator l4_msgtag_t() and check the return value.

Definition at line 139 of file factory.

15.97.3 Member Function Documentation

15.97.3.1 operator l4_msgtag_t()

```
L4::Factory::S::operator l4_msgtag_t () [inline], [noexcept]
```

Explicitly commits the operation and returns the result.

Returns

The result of the create() operation.

Return values

L4_EOK	No error occurred.
-L4_EPERM	Insufficient permissions; see precondition.
<0	Error code.

Precondition

The invoked Factory capability must have the permission L4_CAP_FPAGE_S.

Definition at line 157 of file factory.

15.97.3.2 operator<<() [1/2]

```
template<typename T>
S && L4::Factory::S::operator<< (
             T const & d) &&  [inline], [noexcept]
```

Add next argument.

Template Parameters

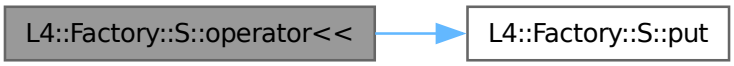
T	The argument type. Compilation succeeds only if it is a possible argument type for `S::put()`.

Parameters

d	The value to add as next argument.

Definition at line 252 of file factory.
References put().

Here is the call graph for this function:



15.97.3.3 operator<<() [2/2]

```
template<typename T>
S & L4::Factory::S::operator<< (
            T const & d) &  [inline], [noexcept]
```

Add next argument.

Template Parameters

T	The argument type. Compilation succeeds only if it is a possible argument type for `S::put()`.

Parameters

d	The value to add as next argument.

Definition at line 237 of file factory.
References put().
Here is the call graph for this function:



15.97.3.4 put() [1/5]

```
void L4::Factory::S::put (
            char const * s) &  [inline], [noexcept]
```

Add a zero-terminated string as next argument.

Parameters

s	The string to add as next argument.

The string will be added with the zero-terminator.
Definition at line 191 of file factory.

15.97.3.5 put() [2/5]

```
void L4::Factory::S::put (
            l4_fpage_t d) &  [inline], [noexcept]
```

Add a flexpage as next argument.

Parameters

d	The flexpage to add (there will be no map operation).

Definition at line 223 of file factory.

15.97.3.6 put() [3/5]

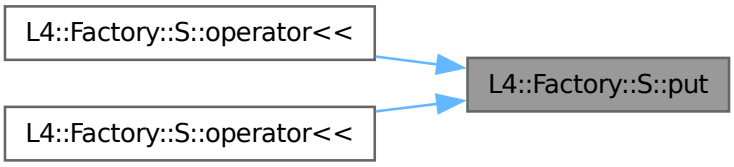
```
void L4::Factory::S::put (
            l4_mword_t i)  [inline], [noexcept]
```

Put a single l4_mword_t as next argument.

Parameters

i	The value to add as next argument.

Definition at line 169 of file factory.
Referenced by operator<<(), and operator<<().
Here is the caller graph for this function:



15.97.3.7 put() [4/5]

```
void L4::Factory::S::put (
            l4_umword_t i)  [inline], [noexcept]
```

Put a single l4_umword_t as next argument.

Parameters

i	The value to add as next argument.

Definition at line 179 of file factory.

15.97.3.8 put() [5/5]

```
void L4::Factory::S::put (
            Lstr const & s) &  [inline], [noexcept]
```

Add a pascal string as next argument.

Parameters

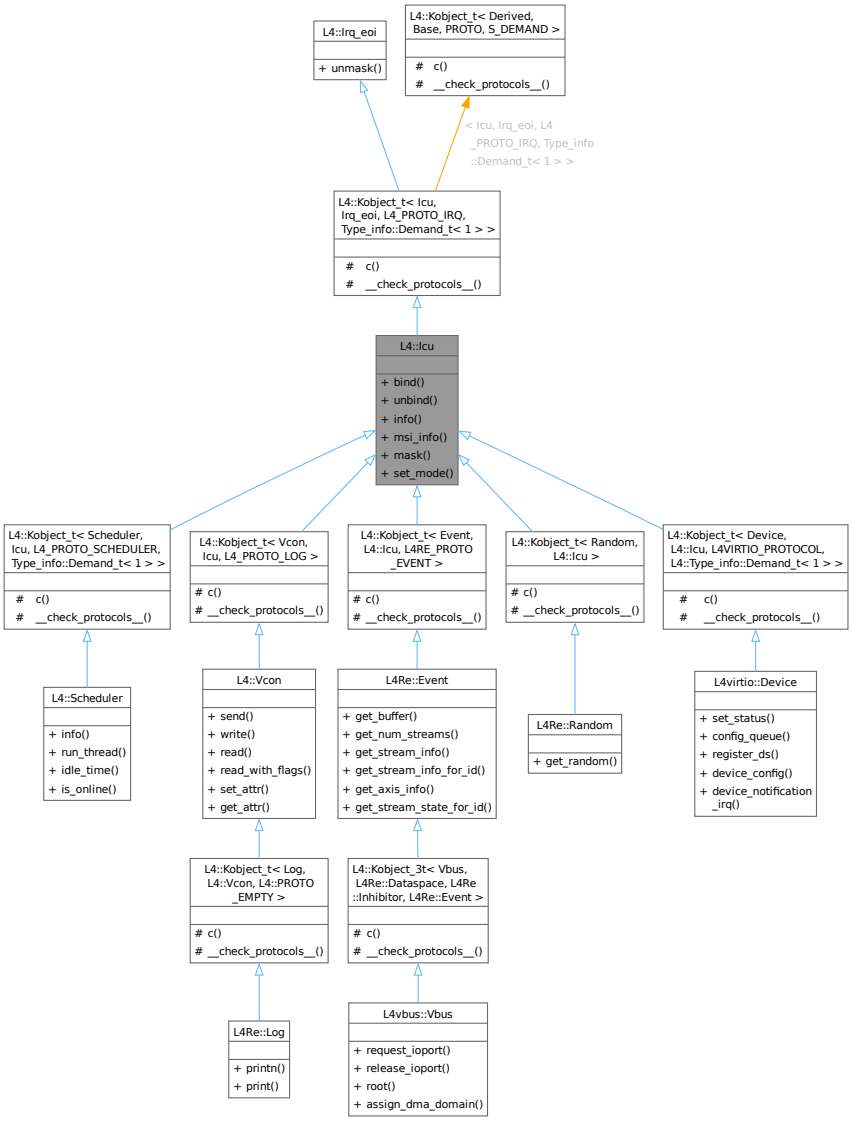
s	The string to add as next argument.

The string will be added with the exact length given. It is the responsibility of the caller to make sure that the string is zero- terminated when that is required by the server.
Definition at line 205 of file factory.
The documentation for this class was generated from the following file:

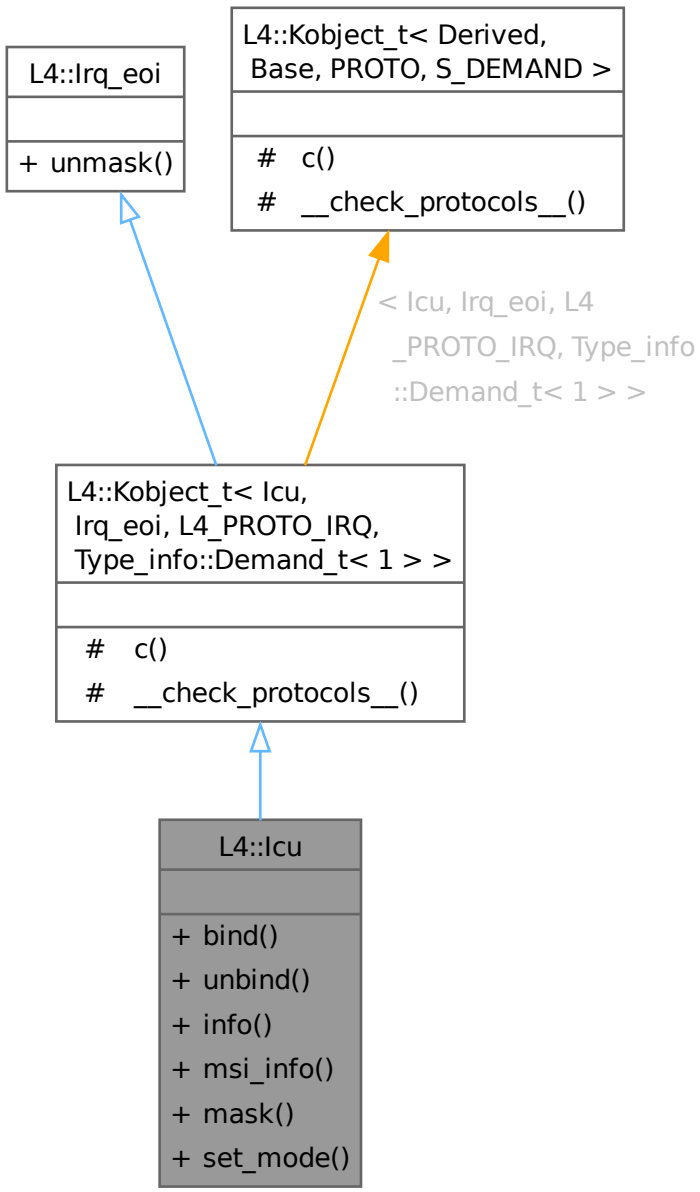
- l4/sys/factory

15.98 L4::Icu Class Reference

C++ Icu interface, see Interrupt controller for the C interface.
`#include <irq>`
Inheritance diagram for L4::Icu:



Collaboration diagram for L4::Icu:



Data Structures

- class Info

  This class encapsulates information about an ICU.

Public Member Functions

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

Remove binding of an interrupt line from the interrupt controller object.

- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)

  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.98.1 Detailed Description

C++ Icu interface, see Interrupt controller for the C interface.

Note

"ICU" is short for "interrupt control unit".

This class defines the interface for interrupt controllers. It defines functions for binding L4::Irq objects to interrupt lines and other interrupt sources, as well as functions for masking and unmasking of interrupts.
To setup an interrupt line the following steps are required:

1. set_mode() (optional if interrupt has a default mode)
2. L4::Rcv_endpoint::bind_thread() or L4::Rcv_endpoint::bind_snd_destination() to attach the L4::Irq object to a send destination.

3. bind()
4. unmask() to receive the first interrupt

For certain interrupt sources only some of these steps are necessary and supported, see L4::Scheduler and L4::Vcon.
At most one L4::Irq object can be bound to a certain interrupt source and a certain L4::Irq object can be bound to at most one interrupt source.

Include File

```
#include <l4/sys/icu>
```

Definition at line 250 of file irq.

15.98.2 Member Function Documentation

15.98.2.1 bind()

```
l4_msgtag_t L4::Icu::bind (
            unsigned irqnum,
            L4::Cap< Triggerable > irq,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Bind an interrupt line of an interrupt controller to an interrupt object.

Parameters

irqnum	IRQ line at the ICU.
irq	IRQ object for the given IRQ line to bind to this ICU.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag. The caller should check the return value using l4_error() to check for errors and to identify the correct method for unmasking the interrupt. Return values < 0 indicate an error. A return value of 0 means a direct unmask via the IRQ object using L4::Irq::unmask. A return value of 1 means that the interrupt has to be unmasked via the ICU using L4::Icu::unmask.

Return values

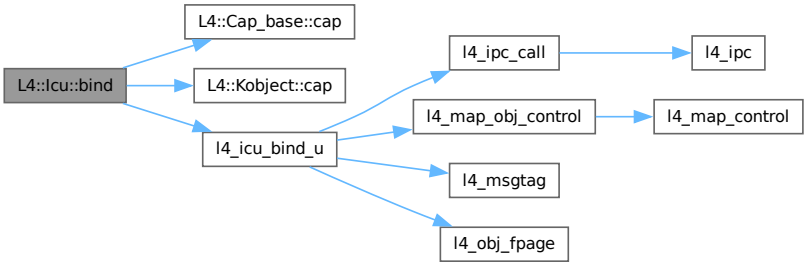
-L4_EINVAL	`irq` is bound to an interrupt source.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The capability `irq` must have the permission L4_CAP_FPAGE_W.

In case the `irq` is already bound to an interrupt source, it is unbound first. In case the `irq` is bound and the interrupt source is bound to a different L4::Irq object, only the unbinding happens. An L4::Irq object that is bound to an interrupt source will get unbound if the L4::Irq object is deleted.
Definition at line 310 of file irq.
References L4::Cap_base::cap(), L4::Kobject::cap(), and l4_icu_bind_u().

Here is the call graph for this function:



15.98.2.2 info()

```
l4_msgtag_t L4::Icu::info (
            l4_icu_info_t * info,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Get information about the ICU features.

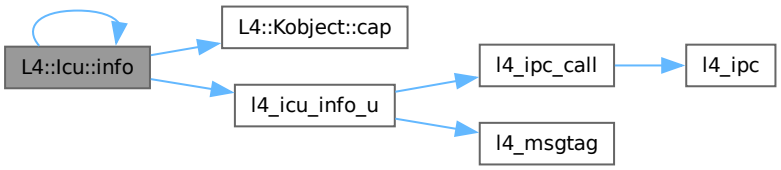
Parameters

out	*info*	Info structure to be filled with information.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

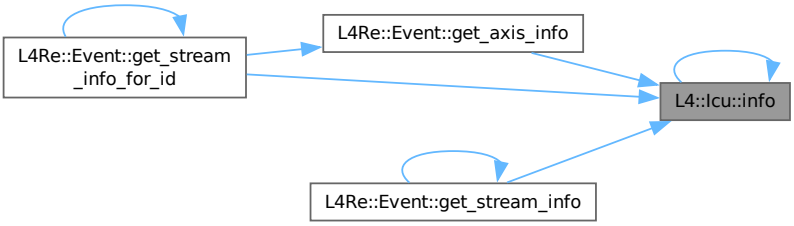
Returns

Syscall return tag

Definition at line 345 of file irq.
References L4::Kobject::cap(), info(), and l4_icu_info_u().
Referenced by L4Re::Event::get_axis_info(), L4Re::Event::get_stream_info(), L4Re::Event::get_stream_info_for_id(), and info().
Here is the call graph for this function:



Here is the caller graph for this function:



15.98.2.3 mask()

```
l4_msgtag_t L4::Icu::mask (
            unsigned irqnum,
            l4_umword_t * label = 0,
            l4_timeout_t to = L4_IPC_NEVER,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Mask an IRQ line.

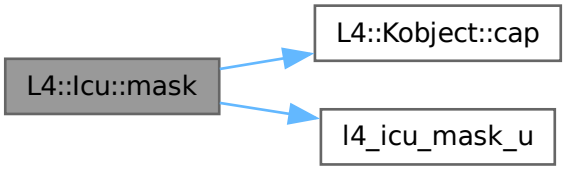
Parameters

irqnum	IRQ line at the ICU.
label	If NULL, this function is a send-only message to the ICU. If not NULL, this function will enter an open wait after sending the mask message and the received label is returned here.
to	The timeout-pair (send and receive) that shall be used for this operation. The receive timeout is used with a non-NULL `label` only.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag. If `label` is NULL, this function performs an IPC send-only operation and there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. In this case use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 393 of file irq.
References L4::Kobject::cap(), l4_icu_mask_u(), and L4_IPC_NEVER.
Here is the call graph for this function:



15.98.2.4 msi_info()

```
l4_msgtag_t L4::Icu::msi_info (
            l4_umword_t irqnum,
            l4_uint64_t source,
            l4_icu_msi_info_t * msi_info)
```

Get MSI info about IRQ.

Parameters

	irqnum	IRQ line at the ICU.
	source	Platform dependent requester ID for MSIs. On IA32 we use a 20bit source filter value as described in the Intel IRQ remapping specification.
out	*msi_info*	A l4_icu_msi_info_t structure receiving the address and the data value to trigger this MSI.

Returns

Syscall return tag

References msi_info().
Referenced by msi_info().
Here is the call graph for this function:



Here is the caller graph for this function:



15.98.2.5 set_mode()

```
l4_msgtag_t L4::Icu::set_mode (
            unsigned irqnum,
            l4_umword_t mode,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Set interrupt mode.

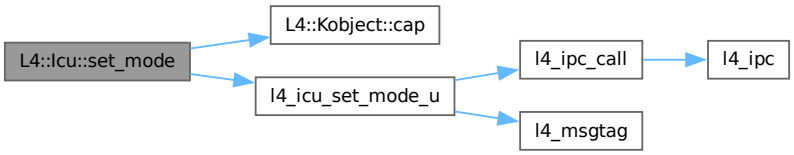
Parameters

irqnum	IRQ line at the ICU.
mode	Mode, see L4_irq_mode.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

Definition at line 421 of file irq.
References L4::Kobject::cap(), and l4_icu_set_mode_u().
Here is the call graph for this function:



15.98.2.6 unbind()

```
l4_msgtag_t L4::Icu::unbind (
            unsigned irqnum,
            L4::Cap< Triggerable > irq,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Remove binding of an interrupt line from the interrupt controller object.

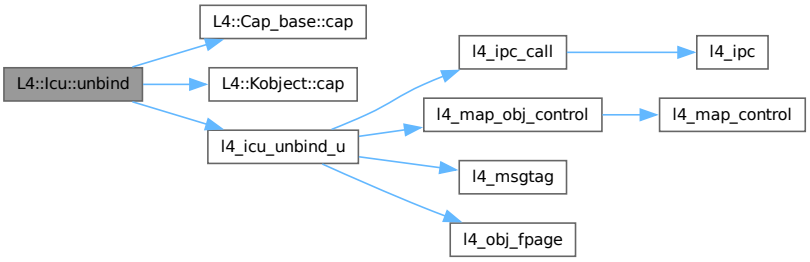
Parameters

irqnum	IRQ line at the ICU.
irq	IRQ object to remove from the ICU.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

Definition at line 328 of file irq.
References L4::Cap_base::cap(), L4::Kobject::cap(), and l4_icu_unbind_u().
Here is the call graph for this function:

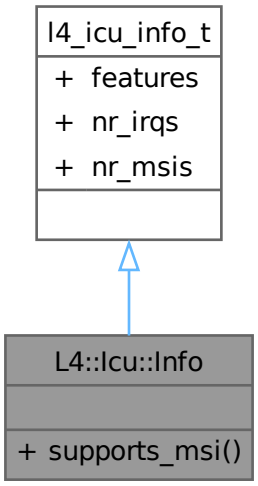


The documentation for this class was generated from the following file:

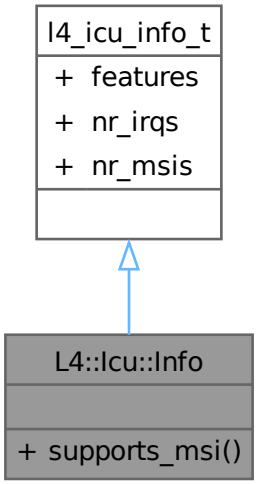
- l4/sys/irq

15.99 L4::Icu::Info Class Reference

This class encapsulates information about an ICU.
`#include <irq>`
Inheritance diagram for L4::Icu::Info:



Collaboration diagram for L4::Icu::Info:



Public Member Functions

- bool **supports_msi** () const noexcept

  True, if the ICU has support for MSIs.

Additional Inherited Members

Data Fields inherited from l4_icu_info_t

- unsigned features

  Feature flags.
- unsigned **nr_irqs**

  The number of IRQ lines supported by the ICU,.
- unsigned **nr_msis**

  The number of MSI vectors supported by the ICU,.

15.99.1 Detailed Description

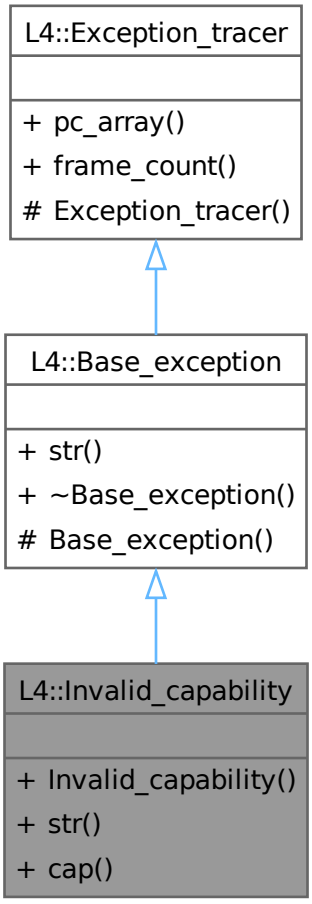
This class encapsulates information about an ICU.
Definition at line 277 of file irq.
The documentation for this class was generated from the following file:

- l4/sys/irq

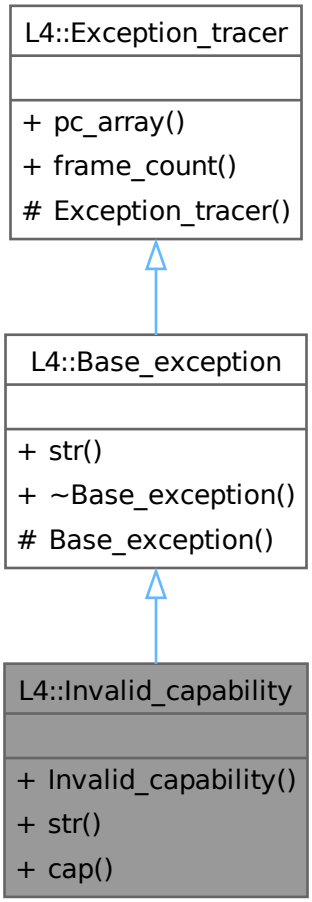
15.100 L4::Invalid_capability Class Reference

Indicates that an invalid object was invoked.
`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Invalid_capability:



Collaboration diagram for L4::Invalid_capability:



Public Member Functions

- Invalid_capability (Cap< void > const &o) noexcept

  Create an Invalid_object exception for the Object o.
- char const * **str** () const noexcept override

  Return a human readable string for the exception.
- Cap< void > const & cap () const noexcept

  Get the object that caused the error.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.

- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Additional Inherited Members

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

15.100.1 Detailed Description

Indicates that an invalid object was invoked.
An Object is invalid if it has L4_INVALID_ID as server L4 UID, or if the server does not know the object ID.
Definition at line 234 of file exceptions.

15.100.2 Constructor & Destructor Documentation

15.100.2.1 Invalid_capability()

```
L4::Invalid_capability::Invalid_capability (
            Cap< void > const & o)  [inline], [explicit], [noexcept]
```

Create an Invalid_object exception for the Object o.

Parameters

o	The object that caused the server side error.

Definition at line 244 of file exceptions.

15.100.3 Member Function Documentation

15.100.3.1 cap()

```
Cap< void > const & L4::Invalid_capability::cap () const  [inline], [noexcept]
```

Get the object that caused the error.

Returns

The object that caused the error on invocation.

Definition at line 253 of file exceptions.
The documentation for this class was generated from the following file:

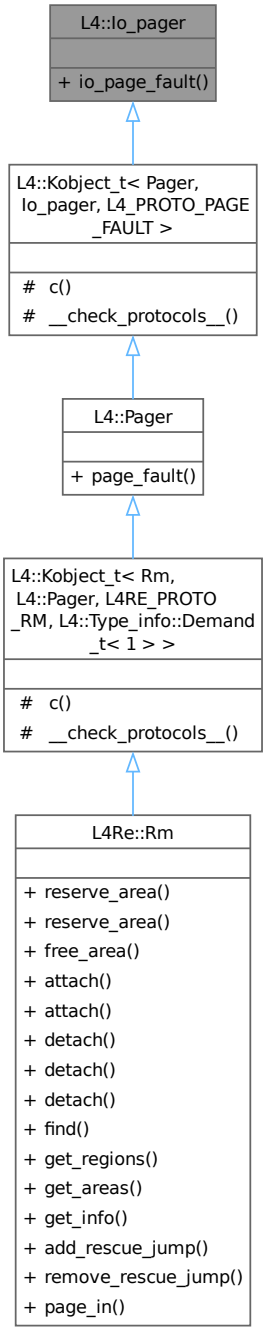
- l4/cxx/exceptions

15.101 L4::Io_pager Class Reference

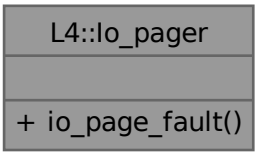
Io_pager interface.

```
#include <pager>
```

Inheritance diagram for L4::Io_pager:



Collaboration diagram for L4::Io_pager:



Public Member Functions

- l4_msgtag_t io_page_fault (l4_fpage_t io_pfa, l4_umword_t pc, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  IO page fault protocol message.

15.101.1 Detailed Description

Io_pager interface.

Note

This interface is x86 specific.

This class defines the interface for handling IO page faults. IO page faults happen when a thread tries to access an IO port that it does not currently have access to.
Depending on the microkernel's implementation, IO page faults can be handled in two ways.
If the microkernel does not support IO page faults, this IO pagefault interface is not used. Instead, the microkernel sends an exception IPC to the thread's exception handler (L4::Exception), indicating a GP (exception number 13). The exception handler must consult the faulting instruction to determine the cause of the exception. This is the default in the Fiasco microkernel.
In contrast, if the microkernel supports IO page faults, the microkernel will generate an IO page fault message and send it to the thread's page fault handler (pager). The page fault handler can implement this interface to handle the IO page faults.

Note

A program may use this mechanism to implement a lazy IO port access scheme.

The page fault and exception handlers are set with the L4::Thread::control interface.

Definition at line 51 of file pager.

15.101.2 Member Function Documentation

15.101.2.1 io_page_fault()

```
l4_msgtag_t L4::Io_pager::io_page_fault (
             l4_fpage_t io_pfa,
             l4_umword_t pc,
             L4::Ipc::Rcv_fpage rwin,
             L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)
```

IO page fault protocol message.

Parameters

	io_pfa	Flexpage describing the faulting IO-port.
	pc	Faulting program counter.
	rwin	The receive window for a flexpage mapping.
`out`	*fp*	Optional: flexpage descriptor to send to the task raising the page fault.

Returns

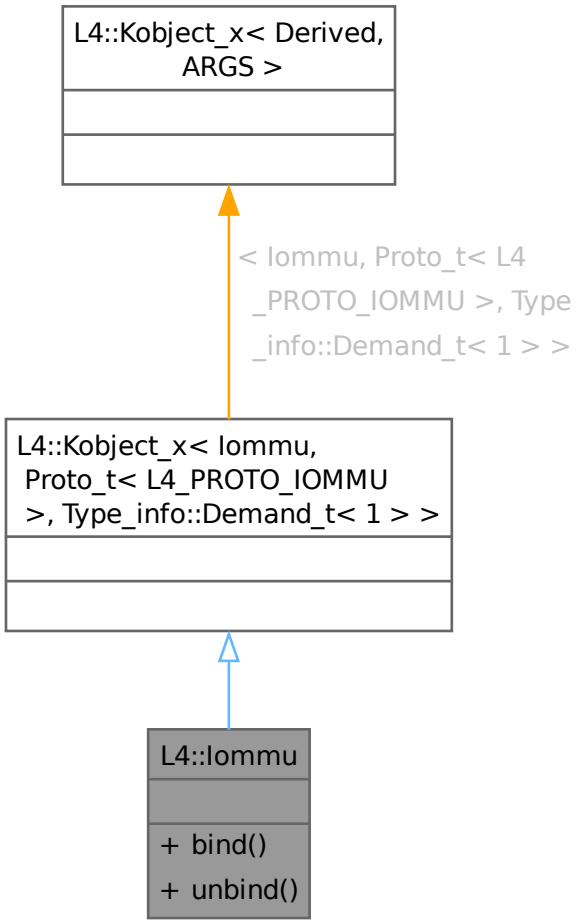
System call message tag; use l4_error() to check for errors.

IO-port fault messages are usually generated by the kernel and an IO-page-fault handler needs to be in place to handle such faults and generate a reply, potentially filling in `fp`.
The documentation for this class was generated from the following file:

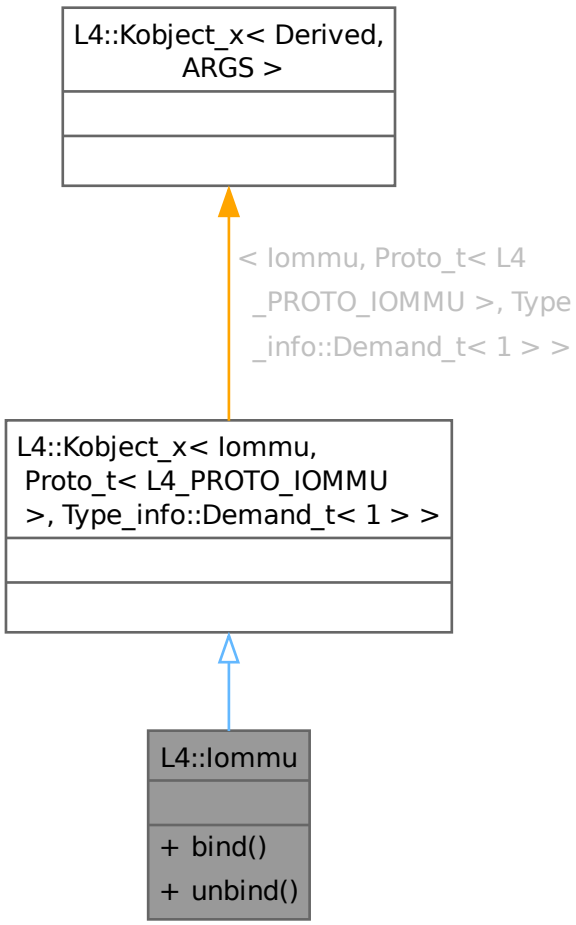
- l4/sys/pager

15.102 L4::Iommu Class Reference

Interface for IO-MMUs used for DMA remapping.
`#include <iommu>`
Inheritance diagram for L4::Iommu:



Collaboration diagram for L4::Iommu:



Public Member Functions

- l4_msgtag_t bind (l4_uint64_t src_id, Ipc::Cap< Task > dma_space, l4_uint64_t *min_addr, l4_uint64_t *max_addr)

  Associate `dma_space` with the set of device(s) specified by `src_id`.
- l4_msgtag_t unbind (l4_uint64_t src_id, Ipc::Cap< Task > dma_space)

  Remove the association of the given DMA address space from the device(s) specified by `src_id`.

15.102.1 Detailed Description

Interface for IO-MMUs used for DMA remapping.

Note

This interface is only present in the kernel if the kernel detected an IOMMU during boot.

This interface allows to associate a DMA address space with a platform dependent set of devices. The kernel automatically keeps the memory spaces of associated DMA spaces in sync with the respective page table structures in the IOMMU.
Definition at line 21 of file iommu.

15.102.2 Member Function Documentation

15.102.2.1 bind()

```
l4_msgtag_t L4::Iommu::bind (
             l4_uint64_t src_id,
             Ipc::Cap< Task > dma_space,
             l4_uint64_t * min_addr,
             l4_uint64_t * max_addr)
```

Associate `dma_space` with the set of device(s) specified by `src_id`.
Updates the respective page table structures in the IOMMU and keeps them in sync when memory is mapped to the `dma_space` or revoked from it.

Parameters

	src_id	Platform dependent source ID specifying the set of devices that shall use `dma_space` for DMA remapping.
	dma_space	The DMA space (L4::Task created with L4_PROTO_DMA_SPACE) providing the mappings that shall be used for the device(s).
`out`	*min_addr*	Minimum address supported by IOMMU for this device.
`out`	*max_addr*	Maximum address (inclusive) supported by IOMMU for this device.

Note

If an association for the source ID already exists, whether established through this interface or pre-configured by the kernel, it will be replaced.

15.102.2.2 unbind()

```
l4_msgtag_t L4::Iommu::unbind (
             l4_uint64_t src_id,
             Ipc::Cap< Task > dma_space)
```

Remove the association of the given DMA address space from the device(s) specified by `src_id`.
Clear the respective page table structures in the IOMMU.

Parameters

src_id	Platform dependent source ID specifying the set of devices that shall no longer use `dma_space` for DMA remapping.
dma_space	The DMA space formerly associated with bind().

References unbind().
Referenced by unbind().
Here is the call graph for this function:



Here is the caller graph for this function:

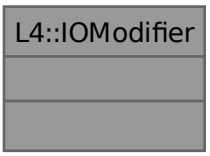


The documentation for this class was generated from the following file:

- l4/sys/iommu

15.103 L4::IOModifier Class Reference

Modifier class for the IO stream.
`#include <basic_ostream>`
Collaboration diagram for L4::IOModifier:



15.103.1 Detailed Description

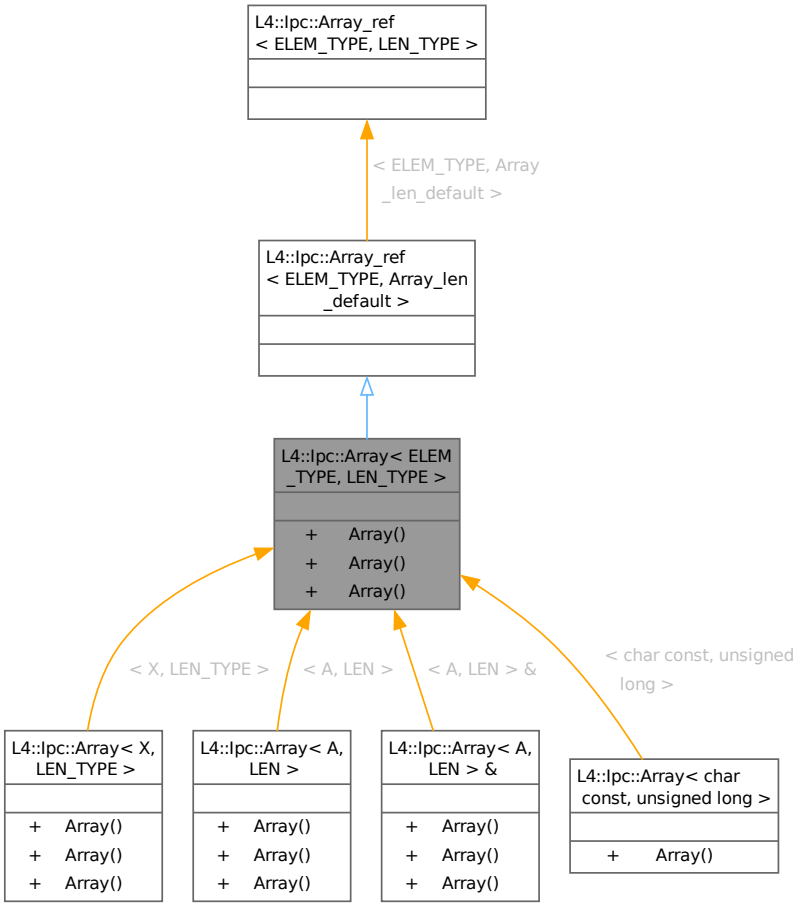
Modifier class for the IO stream.
An IO Modifier can be used to change properties of an IO stream for example the number format.
Definition at line 22 of file basic_ostream.
The documentation for this class was generated from the following file:

- l4/cxx/basic_ostream

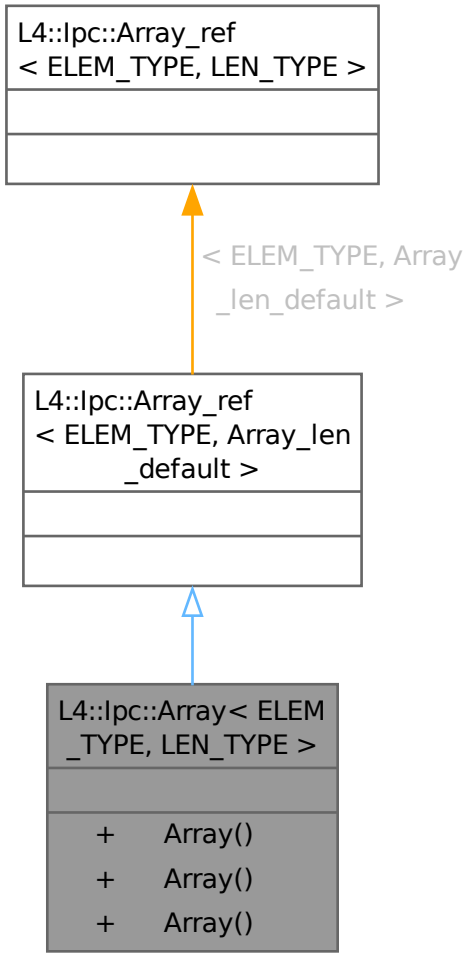
15.104 L4::Ipc::Array< ELEM_TYPE, LEN_TYPE > Struct Template Reference

Array data type for dynamically sized arrays in RPCs.
`#include <ipc_array>`

Inheritance diagram for L4::Ipc::Array< ELEM_TYPE, LEN_TYPE >:



Collaboration diagram for L4::Ipc::Array< ELEM_TYPE, LEN_TYPE >:



Public Member Functions

- **Array** ()

  Make array.
- **Array** (LEN_TYPE length, ELEM_TYPE *data)

  Make array from length and data pointer.
- **Array** (typename Non_const< ELEM_TYPE >::type const &other)

  Make a const array from a non-const array.

15.104.1 Detailed Description

template<typename ELEM_TYPE, typename LEN_TYPE = Array_len_default>
struct L4::Ipc::Array< ELEM_TYPE, LEN_TYPE >

Array data type for dynamically sized arrays in RPCs.

Template Parameters

ELEM_TYPE	The data type of an array element, should be 'const' when used as input.
LEN_TYPE	Data type used to store the number of elements in the array.

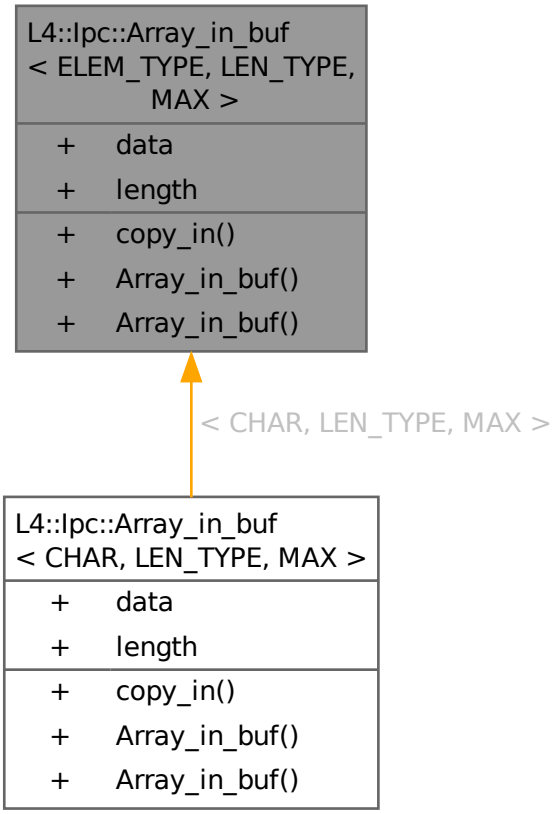
An Array generally encapsulates a data pointer and a length (number of elements). Array does *not* provide any storage for the data itself. The storage is either provided by a client-side caller or in the case of Array_ref is the message itself.
Arrays can be used as input or as output arguments, when used as input ELEM_TYPE should be qualified *const*, when used as output a reference to an array must be used and the ELEM_TYPE must *not* be qualified *const*. It is the caller's responsibility to provide an array buffer of sufficient length. If a message from the server is too large it will be silently truncated.
If backward compatibility with Ipc::Stream is required, then LEN_TYPE must be `unsigned long`.
Definition at line 81 of file ipc_array.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_array

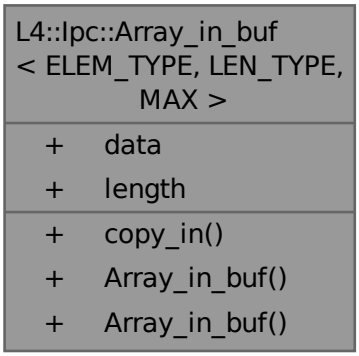
15.105 L4::Ipc::Array_in_buf< ELEM_TYPE, LEN_TYPE, MAX > Struct Template Reference

Server-side copy in buffer for Array.
`#include <ipc_array>`

Inheritance diagram for L4::Ipc::Array_in_buf< ELEM_TYPE, LEN_TYPE, MAX >:



Collaboration diagram for L4::Ipc::Array_in_buf< ELEM_TYPE, LEN_TYPE, MAX >:



Public Member Functions

- void **copy_in** (const_array a)

  copy in data from a source array
- **Array_in_buf** (const_array a)

  Make Array_in_buf from a const array.
- **Array_in_buf** (array a)

  Make Array_in_buf from a non-const array.

Data Fields

- ELEM_TYPE **data** [MAX]

  The data elements.
- LEN_TYPE **length**

  The length of the array.

15.105.1 Detailed Description

template<typename ELEM_TYPE, typename LEN_TYPE = Array_len_default, LEN_TYPE MAX = (L4_UTCB_GENERIC_DATA_SIZE * sizeof(l4_umword_t)) / sizeof(ELEM_TYPE)>
struct L4::Ipc::Array_in_buf< ELEM_TYPE, LEN_TYPE, MAX >

Server-side copy in buffer for Array.

Template Parameters

ELEM_TYPE	Data type of an array element.
LEN_TYPE	Data type for the number of elements in the array.
MAX	The maximum number of elements in the buffer. If the actual message is longer than the buffer, it will be silently truncated.

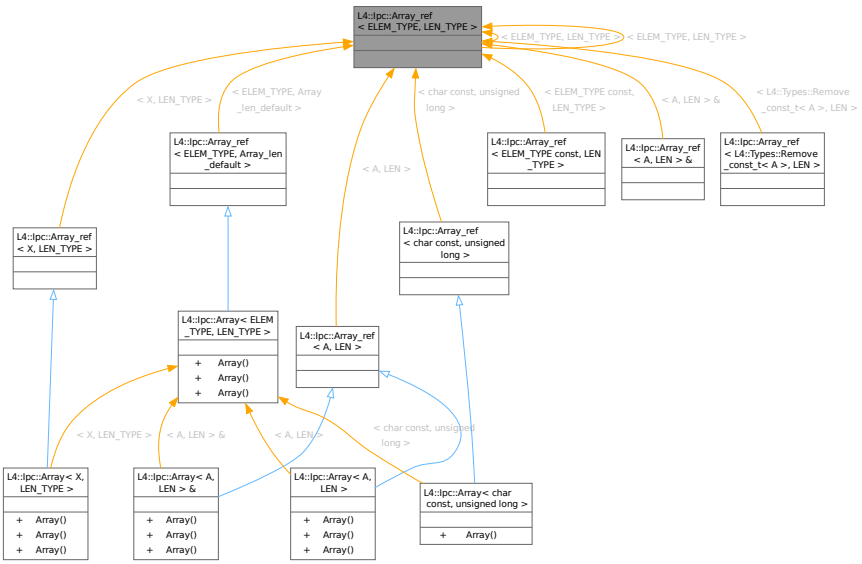
This type is assignment compatible to Array_ref<ELEM_TYPE, LEN_TYPE> and provides a transparent server-side copy-in mechanism for array parameters. The Array_in_buf provides the storage for the array data and receives a copy of the data passed to the server-function.
Definition at line 126 of file ipc_array.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_array

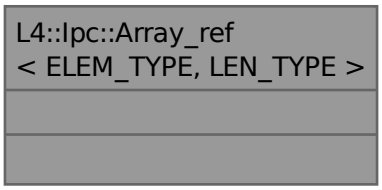
15.106 L4::Ipc::Array_ref< ELEM_TYPE, LEN_TYPE > Struct Template Reference

Array reference data type for arrays located in the message.
`#include <ipc_array>`

Inheritance diagram for L4::Ipc::Array_ref< ELEM_TYPE, LEN_TYPE >:



Collaboration diagram for L4::Ipc::Array_ref< ELEM_TYPE, LEN_TYPE >:



15.106.1 Detailed Description

template<typename ELEM_TYPE, typename LEN_TYPE = Array_len_default>
struct L4::Ipc::Array_ref< ELEM_TYPE, LEN_TYPE >

Array reference data type for arrays located in the message.

Note

Use Array for normal RPC interfaces, Array_ref is usually used as server-side argument, see Array.

Template Parameters

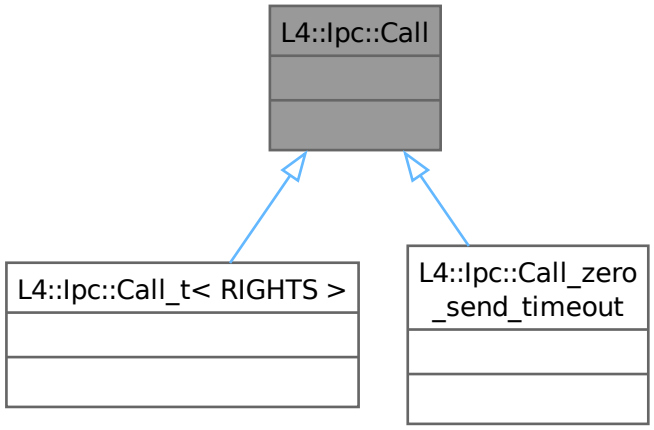
ELEM_TYPE	The data type of an array element, should be 'const' when used as input.
LEN_TYPE	Data type used to store the number of elements in the array.

Definition at line 28 of file ipc_array.
The documentation for this struct was generated from the following file:

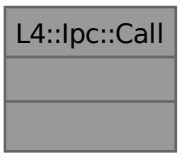
- l4/sys/cxx/ipc_array

15.107 L4::Ipc::Call Struct Reference

RPC attribute for a standard RPC call.
`#include <ipc_iface>`
Inheritance diagram for L4::Ipc::Call:



Collaboration diagram for L4::Ipc::Call:



15.107.1 Detailed Description

RPC attribute for a standard RPC call.
This is the default for the *FLAGS* parameter for L4::Ipc::Msg::Rpc_call L4::Ipc::Msg::Rpc_inline_call templates and declares the RPC to have default call semantics and timeouts.
Examples:

```
L4_RPC(l4_ret_t, send, (unsigned value), L4::Ipc::Call);
```

which is equivalent to:

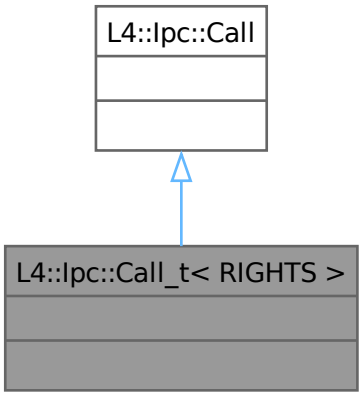
```
L4_RPC(l4_ret_t, send, (unsigned value));
```

Definition at line 239 of file ipc_iface.
The documentation for this struct was generated from the following file:

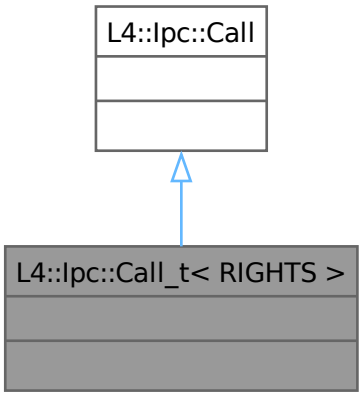
- l4/sys/cxx/ipc_iface

15.108 L4::Ipc::Call_t< RIGHTS > Struct Template Reference

RPC attribute for an RPC call with required rights.
`#include <ipc_iface>`
Inheritance diagram for L4::Ipc::Call_t< RIGHTS >:



Collaboration diagram for L4::Ipc::Call_t< RIGHTS >:



15.108.1 Detailed Description

template<unsigned RIGHTS>
struct L4::Ipc::Call_t< RIGHTS >

RPC attribute for an RPC call with required rights.

Template Parameters

RIGHTS	The capability rights required for this call. L4_CAP_FPAGE_W and L4_CAP_FPAGE_S are checked within the server (and -L4_EPERM shall be returned if the caller has insufficient rights). L4_CAP_FPAGE_R is always on but might be specified for documentation purposes. Other rights cannot be used in this context, because they cannot be checked at the server side.

Examples:

```
L4_RPC(l4_ret_t, func, (unsigned value), L4::Ipc::Call_t<L4_CAP_FPAGE_RW>);
```

Definition at line 270 of file ipc_iface.

The documentation for this struct was generated from the following file:

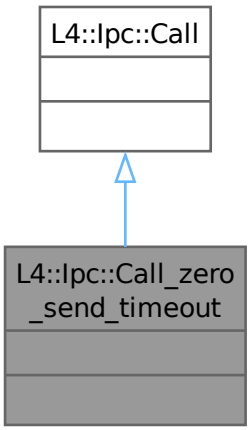
- l4/sys/cxx/ipc_iface

15.109 L4::Ipc::Call_zero_send_timeout Struct Reference

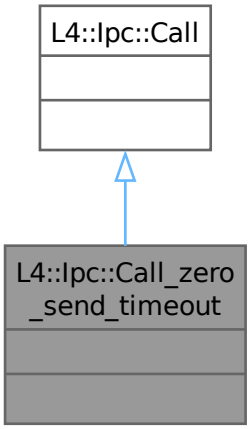
RPC attribute for an RPC call, with zero send timeout.

`#include <ipc_iface>`

Inheritance diagram for L4::Ipc::Call_zero_send_timeout:



Collaboration diagram for L4::Ipc::Call_zero_send_timeout:



15.109.1 Detailed Description

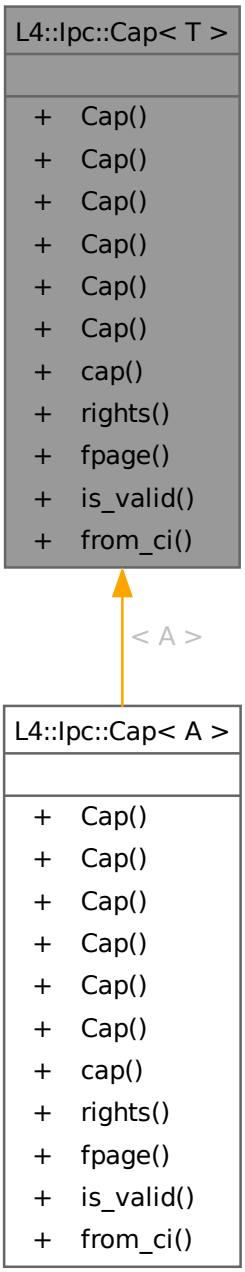
RPC attribute for an RPC call, with zero send timeout.
Definition at line 249 of file ipc_iface.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_iface

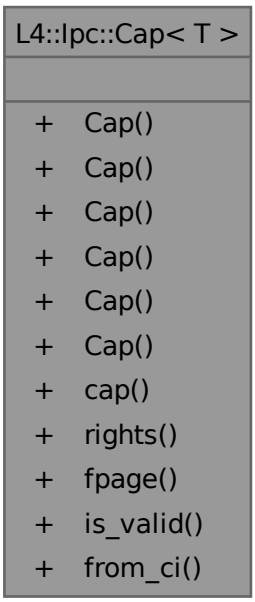
15.110 L4::Ipc::Cap< T > Class Template Reference

Capability type for RPC interfaces (see `L4::Cap<T>`).
`#include <ipc_types>`

Inheritance diagram for L4::Ipc::Cap< T >:



Collaboration diagram for L4::Ipc::Cap< T >:



Public Types

- enum { Rights_mask = 0xff , Map_type_mask = 0x100 , Cap_mask = L4_CAP_MASK }
- enum Map_type { Map = 0 , Grant = 0x100 }

  Kind of mapping.

Public Member Functions

- template<typename O>
  Cap (Cap< O > const &o) noexcept

  Make copy with conversion.
- **Cap** (L4::Cap< T > cap) noexcept

  Make a Cap from L4::Cap<T>, with minimal rights.
- template<typename O>
  Cap (L4::Cap< O > cap) noexcept

  Make IPC Cap from L4::Cap with conversion (and minimal rights).
- **Cap** () noexcept

  Make an invalid cap.
- Cap (L4::Cap< T > cap, unsigned char rights) noexcept

  Make a Cap from L4::Cap<T> with the given rights.
- Cap (L4::Cap< T > cap, unsigned char rights, Map_type map_type) noexcept

  Make a Cap from L4::Cap<T> with the given rights and map type.
- L4::Cap< T > **cap** () const noexcept

  Return the L4::Cap<T> of this Cap.
- unsigned **rights** () const noexcept

  Return the rights bits stored in this IPC cap.
- L4::Ipc::Snd_fpage **fpage** () const noexcept

Return the send flexpage for this Cap (see l4_fpage_t).

- bool **is_valid** () const noexcept

  Return true if this Cap is valid.

Static Public Member Functions

- static Cap from_ci (l4_cap_idx_t c) noexcept

  Create an IPC capability from a C capability index plus rights.

15.110.1 Detailed Description

template<typename T>
class L4::Ipc::Cap< T >

Capability type for RPC interfaces (see `L4::Cap<T>`).

Template Parameters

T	type of the interface referenced by the capability.

In contrast to `L4::Cap<T>` this type additionally stores a rights mask that shall be used when the capability is transferred to the receiver. This allows to apply restrictions to the transferred capability in the form of a subset of the rights possessed by the sender.

See also

L4::Ipc::make_cap()

Definition at line 724 of file ipc_types.

15.110.2 Member Enumeration Documentation

15.110.2.1 anonymous enum

```
template<typename T>
anonymous enum
```

Enumerator

Rights_mask	Mask for rights bits stored internally. (L4_FPAGE_RIGHTS_MASK | L4_FPAGE_C_NO_REF_CNT | L4_FPAGE_C_OBJ_RIGHTS).
Map_type_mask	Mask for map vs. grant operation.
Cap_mask	Mask for significant capability bits. (incl. the invalid bit to support invalid caps)

Definition at line 730 of file ipc_types.

15.110.2.2 Map_type

```
template<typename T>
enum L4::Ipc::Cap::Map_type
```

Kind of mapping.

Enumerator

Map	Map capability in RPC operation.

Grant	Grant capability in RPC operation. **See also** L4_MAP_ITEM_GRANT

Definition at line 752 of file ipc_types.

15.110.3 Constructor & Destructor Documentation

15.110.3.1 Cap() [1/2]

```
template<typename T>
L4::Ipc::Cap< T >::Cap (
            L4::Cap< T > cap,
            unsigned char rights)  [inline], [noexcept]
```

Make a Cap from L4::Cap<T> with the given rights.

Parameters

cap	Capability to be sent.
rights	Rights to be sent. Consists of L4_fpage_rights and Attributes and additional permissions for object send items.

Definition at line 790 of file ipc_types.

15.110.3.2 Cap() [2/2]

```
template<typename T>
L4::Ipc::Cap< T >::Cap (
            L4::Cap< T > cap,
            unsigned char rights,
            Map_type map_type)  [inline], [noexcept]
```

Make a Cap from L4::Cap<T> with the given rights and map type.

Parameters

cap	Capability to be sent.
rights	Rights to be sent. Consists of L4_fpage_rights and Attributes and additional permissions for object send items.
map_type	Indicate if capability is mapped or granted.

Definition at line 801 of file ipc_types.

15.110.4 Member Function Documentation

15.110.4.1 from_ci()

```
template<typename T>
Cap L4::Ipc::Cap< T >::from_ci (
            l4_cap_idx_t c)  [inline], [static], [noexcept]
```

Create an IPC capability from a C capability index plus rights.

Parameters

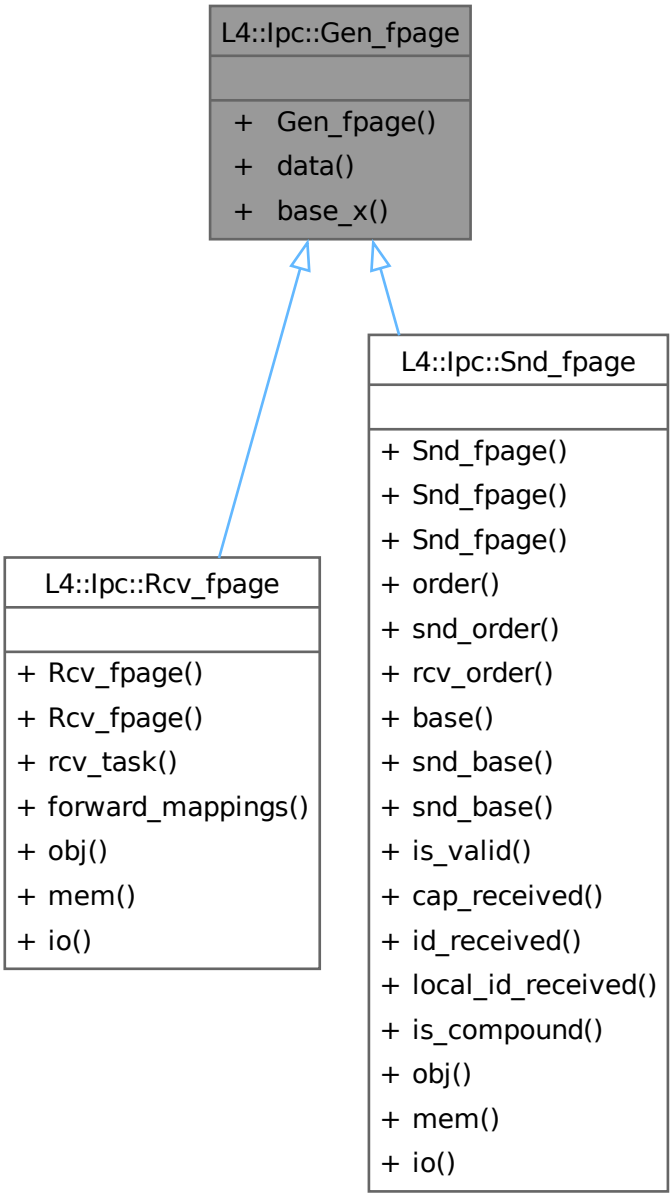
c	C capability index with the lowest 8 bits used as rights for the map operation (see L4_fpage_rights).

Definition at line 811 of file ipc_types.
The documentation for this class was generated from the following file:

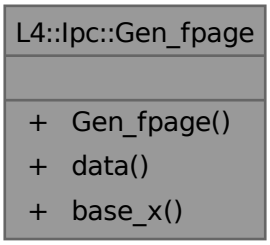
- l4/sys/cxx/ipc_types

15.111 L4::Ipc::Gen_fpage Class Reference

Generic RPC base for typed message items.
`#include <ipc_types>`
Inheritance diagram for L4::Ipc::Gen_fpage:



Collaboration diagram for L4::Ipc::Gen_fpage:



Public Types

- enum Type { Special = L4_FPAGE_SPECIAL << 4 , Memory = L4_FPAGE_MEMORY << 4 , Io = L4_↩ FPAGE_IO << 4 , Obj = L4_FPAGE_OBJ << 4 }

  Type of mapping object, see L4_fpage_type.

Public Member Functions

- **Gen_fpage** (l4_umword_t base, l4_umword_t data) noexcept

  Construct from raw values.
- l4_umword_t **data** () const noexcept

  Return the raw flexpage descriptor.
- l4_umword_t **base_x** () const noexcept

  Return the raw base descriptor.

15.111.1 Detailed Description

Generic RPC base for typed message items.
Definition at line 262 of file ipc_types.

15.111.2 Member Enumeration Documentation

15.111.2.1 Type

`enum L4::Ipc::Gen_fpage::Type`
Type of mapping object, see L4_fpage_type.

Enumerator

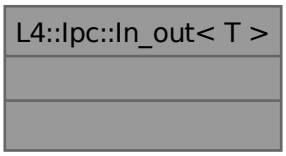
Special	Special flexpage, either l4_fpage_invalid() or l4_fpage_all(); only supported by selected interfaces.
Memory	Flexpage for memory spaces.
Io	Flexpage for I/O port spaces.
Obj	Flexpage for object spaces.

Definition at line 266 of file ipc_types.
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_types

15.112 L4::Ipc::In_out< T > Struct Template Reference

Mark an argument as in-out argument.
`#include <ipc_types>`
Collaboration diagram for L4::Ipc::In_out< T >:



15.112.1 Detailed Description

template<typename T>
struct L4::Ipc::In_out< T >

Mark an argument as in-out argument.

Template Parameters

T	The original argument type, usually a pointer or a reference.

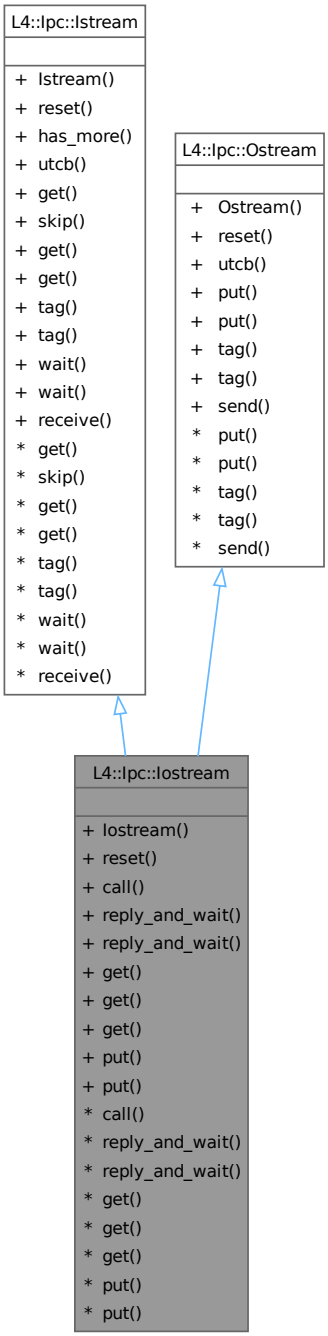
In_out<> is used when an otherwise output-only value shall also be used as input value.
Definition at line 41 of file ipc_types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_types

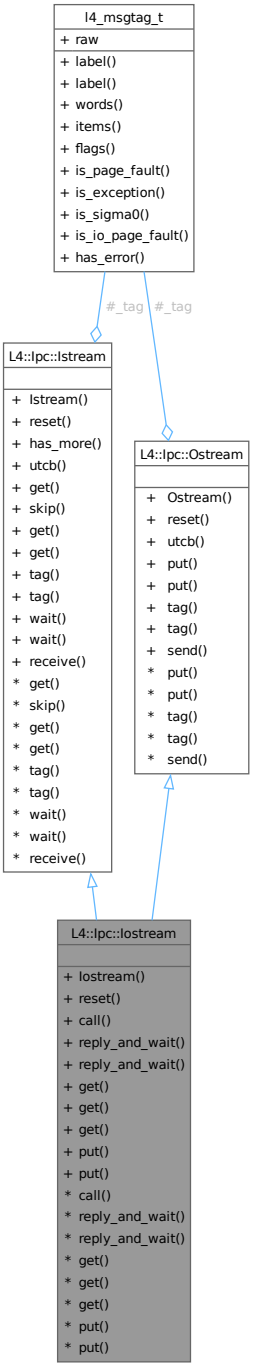
15.113 L4::Ipc::Iostream Class Reference

Input/Output stream for IPC [un]marshalling.
`#include <ipc_stream>`

Inheritance diagram for L4::Ipc::Iostream:



Collaboration diagram for L4::Ipc::Iostream:



Public Member Functions

- Iostream (l4_utcb_t *utcb)

  Create an IPC IO stream with a single message buffer.

- void reset ()

  Reset the stream to its initial state.

IPC operations.

- l4_msgtag_t call (l4_cap_idx_t dst, l4_timeout_t timeout, long proto=0)
  Do an IPC call using the message in the output stream and receive the reply in the input stream.
- l4_msgtag_t reply_and_wait (l4_umword_t *src_dst, long proto=0)
  Do an IPC reply and wait.
- l4_msgtag_t reply_and_wait (l4_umword_t *src_dst, l4_timeout_t timeout, long proto=0)
  Do an IPC reply and wait.

Get/Put functions.

These functions are basically used to implement the insertion operators (<<) and should not be called directly.

- template<typename T>
  unsigned long get (T *buf, unsigned long elems)
  Copy out an array of type `T` with `size` elements.
- template<typename T>
  unsigned long get (Msg_ptr< T > const &buf, unsigned long elems=1)
  Read one size elements of type T from the stream and return a pointer.
- template<typename T>
  bool get (T &v)
  Extract a single element of type T from the stream.
- template<typename T>
  bool put (T *buf, unsigned long size)
  Put an array with `size` elements of type `T` into the stream.
- template<typename T>
  bool put (T const &v)
  Insert an element of type `T` into the stream.

Public Member Functions inherited from L4::Ipc::Istream

- Istream (l4_utcb_t *utcb)
  Create an input stream for the given message buffer.
- void reset ()
  Reset the stream to empty, and ready for receive()/wait().
- template<typename T>
  bool **has_more** (unsigned long count=1)
  Check whether a value of type T can be obtained from the stream.
- l4_utcb_t * **utcb** () const
  Return utcb pointer.

- template<typename T>
  unsigned long get (T *buf, unsigned long elems)
  Copy out an array of type `T` with `size` elements.
- template<typename T>
  void skip (unsigned long elems)
  Skip size elements of type T in the stream.
- template<typename T>
  unsigned long get (Msg_ptr< T > const &buf, unsigned long elems=1)
  Read one size elements of type T from the stream and return a pointer.
- template<typename T>
  bool get (T &v)
  Extract a single element of type T from the stream.
- l4_msgtag_t tag () const
  Get the message tag of a received IPC.
- l4_msgtag_t & tag ()
  Get the message tag of a received IPC.

- l4_msgtag_t wait (l4_umword_t *src)

Wait for an incoming message from any sender.

- l4_msgtag_t wait (l4_umword_t *src, l4_timeout_t timeout)

  Wait for an incoming message from any sender.
- l4_msgtag_t receive (l4_cap_idx_t src)

  Wait for a message from the specified sender.

Public Member Functions inherited from L4::Ipc::Ostream

- **Ostream** (l4_utcb_t *utcb)

  Create an IPC output stream using the given message buffer `utcb`.
- void **reset** ()

  Reset the stream to empty, same state as a newly created stream.
- l4_utcb_t * **utcb** () const

  Return utcb pointer.

- template<typename T>
  bool put (T *buf, unsigned long size)

  Put an array with `size` elements of type `T` into the stream.
- template<typename T>
  bool put (T const &v)

  Insert an element of type `T` into the stream.
- l4_msgtag_t tag () const

  Extract the L4 message tag from the stream.
- l4_msgtag_t & tag ()

  Extract a reference to the L4 message tag from the stream.

- l4_msgtag_t send (l4_cap_idx_t dst, long proto=0, unsigned flags=0)

  Send the message via IPC to the given receiver.

15.113.1 Detailed Description

Input/Output stream for IPC [un]marshalling.
The Ipc::Iostream is part of the AW Env IPC framework as well as Ipc::Istream and Ipc::Ostream. In particular an Ipc::Iostream is a combination of an Ipc::Istream and an Ipc::Ostream. It can use either a single message buffer for receiving and sending messages or a pair of a receive and a send buffer. The stream also supports combined IPC operations such as call() and reply_and_wait(), which can be used to implement RPC functionality.

Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc, examples/libs/l4re/streammap/client.cc, and examples/libs/l4re/streammap/server.

Definition at line 789 of file ipc_stream.

15.113.2 Constructor & Destructor Documentation

15.113.2.1 Iostream()

```
L4::Ipc::Iostream::Iostream (
             l4_utcb_t * utcb)  [inline], [explicit]
```

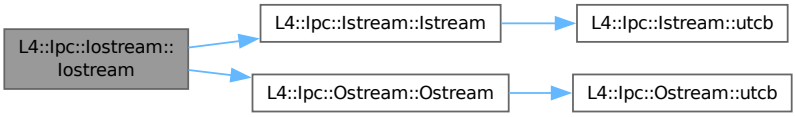
Create an IPC IO stream with a single message buffer.

Parameters

utcb	The message buffer used as backing store.

The created IO stream uses the same message buffer for sending and receiving IPC messages.
Definition at line 801 of file ipc_stream.

References L4::Ipc::Istream::Istream(), and L4::Ipc::Ostream::Ostream().
Here is the call graph for this function:



15.113.3 Member Function Documentation

15.113.3.1 call()

```
l4_msgtag_t L4::Ipc::Iostream::call (
            l4_cap_idx_t dst,
            l4_timeout_t timeout,
            long proto = 0)  [inline]
```

Do an IPC call using the message in the output stream and receive the reply in the input stream.

Parameters

dst	The destination to call.
timeout	The IPC timeout for the call.
proto	The protocol value to use in the message tag.

Returns

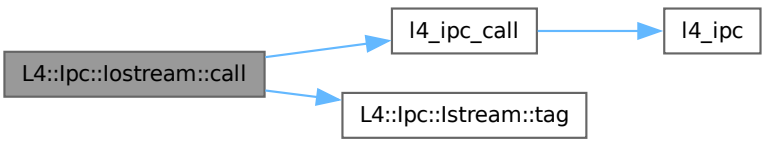
The result tag of the IPC operation.

This is a combined IPC operation consisting of a send and a receive to/from the given destination `dst`.
A call is usually used by clients for RPCs to a server.

Examples

examples/libs/l4re/streammap/client.cc.

Definition at line 966 of file ipc_stream.
References l4_ipc_call(), and L4::Ipc::Istream::tag().
Here is the call graph for this function:



15.113.3.2 get() [1/3]

```
template<typename T>
unsigned long L4::Ipc::Istream::get (
             Msg_ptr< T > const & buf,
             unsigned long elems = 1)  [inline]
```

Read one size elements of type T from the stream and return a pointer.

Parameters

buf	A Msg_ptr that is actually set to point to the element in the stream.
elems	Number of elements to extract (default is 1).

Returns

The number of elements extracted.

In contrast to a normal get, this version does actually not copy the data but returns a pointer to the data.
See operator>>()
Definition at line 439 of file ipc_stream.

15.113.3.3 get() [2/3]

```
template<typename T>
bool L4::Ipc::Istream::get (
             T & v)  [inline]
```

Extract a single element of type T from the stream.

Parameters

out	*v*	The element.

Return values

true	An element was successfully extracted.
false	An element could not be extracted.

See operator>>()
Definition at line 464 of file ipc_stream.

15.113.3.4 get() [3/3]

```
template<typename T>
unsigned long L4::Ipc::Istream::get (
             T * buf,
             unsigned long elems)  [inline]
```

Copy out an array of type T with size elements.

Parameters

buf	Pointer to a buffer for size elements of type T.
elems	Number of elements of type T to copy out.

Returns

The number of elements copied out.

See operator>>()
Definition at line 394 of file ipc_stream.

15.113.3.5 put() [1/2]

```
template<typename T>
bool L4::Ipc::Ostream::put (
             T * buf,
             unsigned long size)  [inline]
```

Put an array with `size` elements of type `T` into the stream.

Parameters

buf	A pointer to the array to insert into the buffer.
size	The number of elements in the array.

Definition at line 660 of file ipc_stream.

15.113.3.6 put() [2/2]

```
template<typename T>
bool L4::Ipc::Ostream::put (
             T const & v)  [inline]
```

Insert an element of type `T` into the stream.

Parameters

v	The element to insert.

Definition at line 678 of file ipc_stream.

15.113.3.7 reply_and_wait() [1/2]

```
l4_msgtag_t L4::Ipc::Iostream::reply_and_wait (
             l4_umword_t * src_dst,
             l4_timeout_t timeout,
             long proto = 0)  [inline]
```

Do an IPC reply and wait.

Parameters

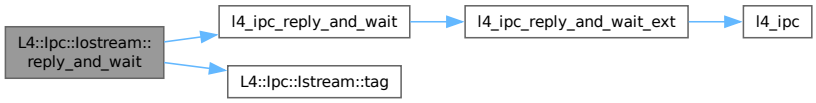
`in,out`	*src_dst*	Input: the destination for the send operation. Output: the source of the received message.
	timeout	Timeout used for IPC.
	proto	Protocol to use.

Returns

The result tag of the IPC operation.

This is a combined IPC operation consisting of a send operation and an open wait for any message.
A reply and wait is usually used by servers that reply to a client and wait for the next request by any other client.

Definition at line 981 of file ipc_stream.
References l4_ipc_reply_and_wait(), and L4::Ipc::Istream::tag().
Here is the call graph for this function:



15.113.3.8 reply_and_wait() [2/2]

```
l4_msgtag_t L4::Ipc::Iostream::reply_and_wait (
            l4_umword_t * src_dst,
            long proto = 0)  [inline]
```

Do an IPC reply and wait.

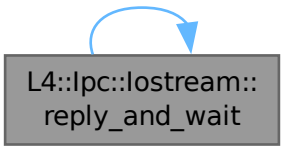
Parameters

in,out	*src_dst*	Input: the destination for the send operation. Output: the source of the received message.
	proto	Protocol to use.

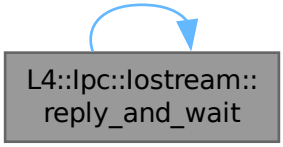
Returns

The result tag of the IPC operation.

This is a combined IPC operation consisting of a send operation and an open wait for any message.
A reply and wait is usually used by servers that reply to a client and wait for the next request by any other client.
Definition at line 874 of file ipc_stream.
References L4_IPC_SEND_TIMEOUT_0, and reply_and_wait().
Referenced by reply_and_wait().
Here is the call graph for this function:



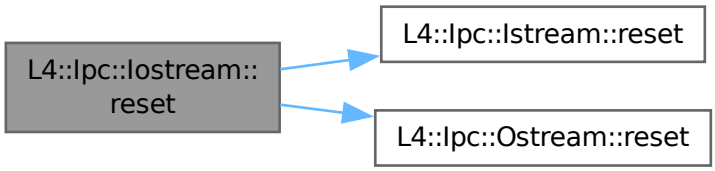
Here is the caller graph for this function:



15.113.3.9 reset()

```
void L4::Ipc::Iostream::reset () [inline]
```

Reset the stream to its initial state.
Input as well as the output stream are reset.
Definition at line 815 of file ipc_stream.
References L4::Ipc::Istream::reset(), and L4::Ipc::Ostream::reset().
Here is the call graph for this function:



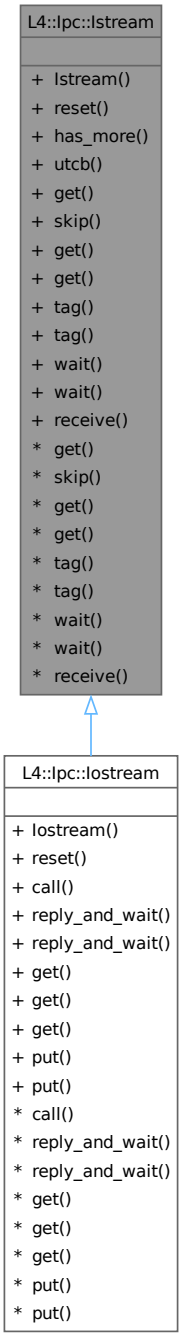
The documentation for this class was generated from the following file:

- l4/cxx/ipc_stream

15.114 L4::Ipc::Istream Class Reference

Input stream for IPC unmarshalling.
`#include <ipc_stream>`

Inheritance diagram for L4::Ipc::Istream:



Collaboration diagram for L4::Ipc::Istream:



Public Member Functions

- Istream (l4_utcb_t *utcb)

  Create an input stream for the given message buffer.
- void reset ()

  Reset the stream to empty, and ready for receive()/wait().
- template<typename T>
  bool **has_more** (unsigned long count=1)

Check whether a value of type T can be obtained from the stream.

- l4_utcb_t * **utcb** () const

  Return utcb pointer.

Get/Put Functions.

- template<typename T>
  unsigned long get (T *buf, unsigned long elems)

  Copy out an array of type `T` with `size` elements.
- template<typename T>
  void skip (unsigned long elems)

  Skip size elements of type T in the stream.
- template<typename T>
  unsigned long get (Msg_ptr< T > const &buf, unsigned long elems=1)

  Read one size elements of type T from the stream and return a pointer.
- template<typename T>
  bool get (T &v)

  Extract a single element of type T from the stream.
- l4_msgtag_t tag () const

  Get the message tag of a received IPC.
- l4_msgtag_t & tag ()

  Get the message tag of a received IPC.

IPC operations.

- l4_msgtag_t wait (l4_umword_t *src)

  Wait for an incoming message from any sender.
- l4_msgtag_t wait (l4_umword_t *src, l4_timeout_t timeout)

  Wait for an incoming message from any sender.
- l4_msgtag_t receive (l4_cap_idx_t src)

  Wait for a message from the specified sender.

15.114.1 Detailed Description

Input stream for IPC unmarshalling.
Ipc::Istream is part of the dynamic IPC marshalling infrastructure, as well as Ipc::Ostream and Ipc::Iostream.
Ipc::Istream is an input stream supporting extraction of values from an IPC message buffer. A received IPC message can be unmarshalled using the usual extraction operator (>>).
There exist some special wrapper classes to extract arrays (see Ipc_buf_cp_in and Ipc_buf_in) and indirect strings (see Msg_in_buffer and Msg_io_buffer).
Definition at line 334 of file ipc_stream.

15.114.2 Constructor & Destructor Documentation

15.114.2.1 Istream()

```
L4::Ipc::Istream::Istream (
            l4_utcb_t * utcb)  [inline]
```

Create an input stream for the given message buffer.
The given message buffer is used for IPC operations wait()/receive() and received data can be extracted using the >> operator afterwards. In the case of indirect message parts a buffer of type Msg_in_buffer must be inserted into the stream before the IPC operation and contains received data afterwards.

Parameters

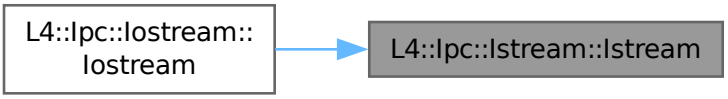
utcb	The message buffer to receive IPC messages.

Definition at line 348 of file ipc_stream.

References utcb().
Referenced by L4::Ipc::Iostream::Iostream().
Here is the call graph for this function:



Here is the caller graph for this function:



15.114.3 Member Function Documentation

15.114.3.1 get() [1/3]

```
template<typename T>
unsigned long L4::Ipc::Istream::get (
            Msg_ptr< T > const & buf,
            unsigned long elems = 1)  [inline]
```

Read one size elements of type T from the stream and return a pointer.

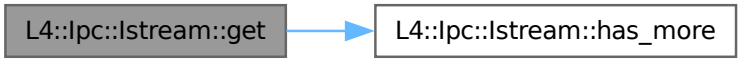
Parameters

buf	A Msg_ptr that is actually set to point to the element in the stream.
elems	Number of elements to extract (default is 1).

Returns

The number of elements extracted.

In contrast to a normal get, this version does actually not copy the data but returns a pointer to the data.
See operator>>()
Definition at line 439 of file ipc_stream.
References has_more(), and L4_UNLIKELY.
Here is the call graph for this function:



15.114.3.2 get() [2/3]

```
template<typename T>
bool L4::Ipc::Istream::get (
            T & v)  [inline]
```

Extract a single element of type T from the stream.

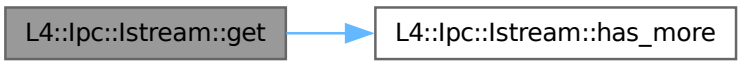
Parameters

out	*v*	The element.

Return values

true	An element was successfully extracted.
false	An element could not be extracted.

See operator>>()
Definition at line 464 of file ipc_stream.
References has_more(), and L4_UNLIKELY.
Here is the call graph for this function:



15.114.3.3 get() [3/3]

```
template<typename T>
unsigned long L4::Ipc::Istream::get (
```

```
T * buf,
unsigned long elems)  [inline]
```

Copy out an array of type `T` with `size` elements.

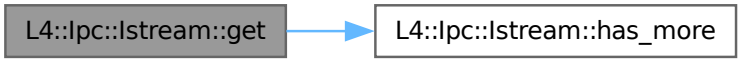
Parameters

buf	Pointer to a buffer for size elements of type T.
elems	Number of elements of type T to copy out.

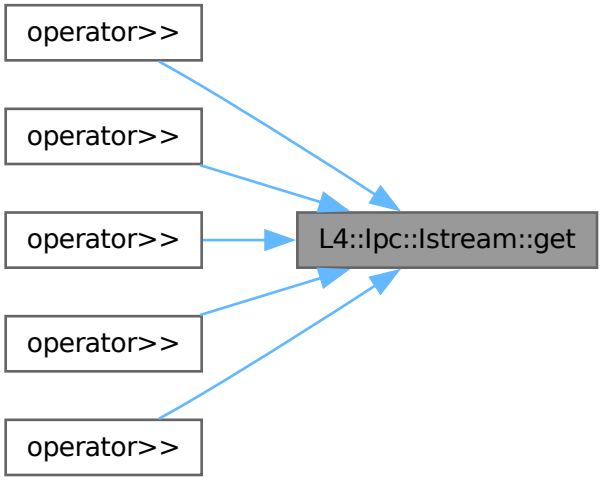
Returns

The number of elements copied out.

See operator>>()
Definition at line 394 of file ipc_stream.
References has_more(), and L4_UNLIKELY.
Referenced by operator>>(), operator>>(), operator>>(), operator>>(), and operator>>().
Here is the call graph for this function:



Here is the caller graph for this function:



15.114.3.4 receive()

```
l4_msgtag_t L4::Ipc::Istream::receive (
```

l4_cap_idx_t *src*) [inline]

Wait for a message from the specified sender.

Parameters

src	The sender id to receive from.

Returns

The IPC result tag (l4_msgtag_t).

This is commonly known as 'closed wait'.
Definition at line 572 of file ipc_stream.
References L4_IPC_NEVER, and receive().
Referenced by receive().
Here is the call graph for this function:



Here is the caller graph for this function:

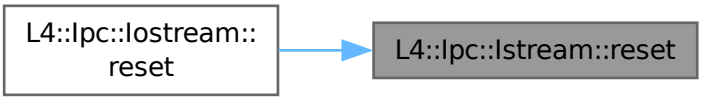


15.114.3.5 reset()

void L4::Ipc::Istream::reset () [inline]

Reset the stream to empty, and ready for receive()/wait().
The stream is reset to the same state as on its creation.
Definition at line 358 of file ipc_stream.
Referenced by L4::Ipc::Iostream::reset().

Here is the caller graph for this function:



15.114.3.6 skip()

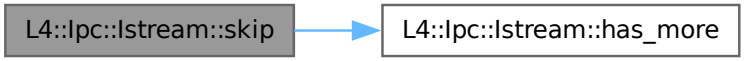
```
template<typename T>
void L4::Ipc::Istream::skip (
             unsigned long elems)  [inline]
```

Skip size elements of type T in the stream.

Parameters

elems	Number of elements to skip.

Definition at line 414 of file ipc_stream.
References has_more(), and L4_UNLIKELY.
Here is the call graph for this function:



15.114.3.7 tag() [1/2]

```
l4_msgtag_t & L4::Ipc::Istream::tag ()  [inline]
```

Get the message tag of a received IPC.

Returns

A reference to the L4 message tag for the received IPC.

This is in particular useful for handling page faults or exceptions.
See operator>>()
Definition at line 517 of file ipc_stream.

15.114.3.8 tag() [2/2]

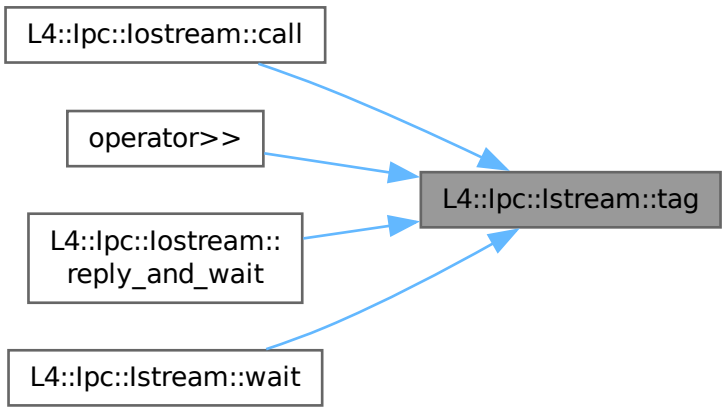
```
l4_msgtag_t L4::Ipc::Istream::tag () const  [inline]
```

Get the message tag of a received IPC.

Returns

The L4 message tag for the received IPC.

This is in particular useful for handling page faults or exceptions.
See operator>>()
Definition at line 505 of file ipc_stream.
Referenced by L4::Ipc::Iostream::call(), operator>>(), L4::Ipc::Iostream::reply_and_wait(), and wait().
Here is the caller graph for this function:



15.114.3.9 wait() [1/2]

```
l4_msgtag_t L4::Ipc::Istream::wait (
            l4_umword_t * src)  [inline]
```

Wait for an incoming message from any sender.

Parameters

out	*src*	Contains the sender after a successful IPC operation.

Returns

Syscall return tag.

This wait is actually known as 'open wait'.
Definition at line 548 of file ipc_stream.
References L4_IPC_NEVER, and wait().
Referenced by wait().
Here is the call graph for this function:



Here is the caller graph for this function:



15.114.3.10 wait() [2/2]

```
l4_msgtag_t L4::Ipc::Istream::wait (
              l4_umword_t * src,
              l4_timeout_t timeout)  [inline]
```

Wait for an incoming message from any sender.

Parameters

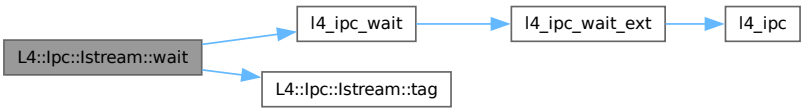
out	*src*	Contains the sender after a successful IPC operation.
	timeout	Timeout used for IPC.

Returns

The IPC result tag (l4_msgtag_t).

This wait is actually known as 'open wait'.
Definition at line 1013 of file ipc_stream.
References l4_ipc_wait(), and tag().

Here is the call graph for this function:



The documentation for this class was generated from the following file:

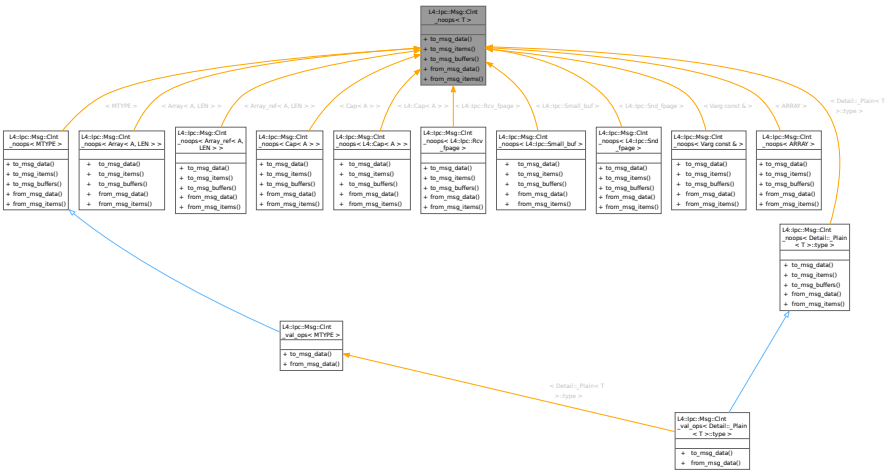
- l4/cxx/ipc_stream

15.115 L4::Ipc::Msg::Clnt_noops< T > Struct Template Reference

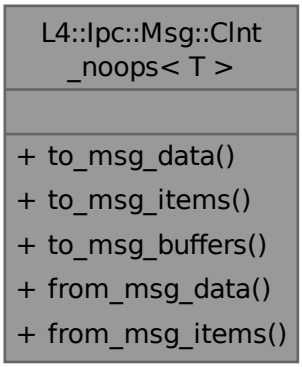
Empty client side marshalling code.

`#include <ipc_basics>`

Inheritance diagram for L4::Ipc::Msg::Clnt_noops< T >:



Collaboration diagram for L4::Ipc::Msg::Clnt_noops< T >:



Static Public Member Functions

- static constexpr int to_msg_data (char *msg, unsigned offset, unsigned limit, T const &arg) noexcept
  Write IPC data of `arg` into UTCB.
- static constexpr int to_msg_items (char *msg, unsigned offset, unsigned limit, T const &arg) noexcept
  Write IPC send items of `arg` into UTCB.
- static constexpr int to_msg_buffers (char *brs, unsigned offset, unsigned limit, T const &arg) noexcept
  Setup receive buffers for object capabilities in UTCB.
- static constexpr int from_msg_data (char *msg, unsigned offset, unsigned limit, T &arg) noexcept
  Read IPC data for `arg` from UTCB.
- static constexpr int from_msg_items (char *msg, unsigned offset, unsigned limit, T &arg) noexcept
  Read IPC return items for `arg` from UTCB.

15.115.1 Detailed Description

template<typename T>
struct L4::Ipc::Msg::Clnt_noops< T >

Empty client side marshalling code.
Used as basis for concrete marshalling code.
Definition at line 193 of file ipc_basics.

15.115.2 Member Function Documentation

15.115.2.1 from_msg_data()

```
template<typename T>
constexpr int L4::Ipc::Msg::Clnt_noops< T >::from_msg_data (
            char * msg,
            unsigned offset,
            unsigned limit,
            T & arg)  [inline], [static], [constexpr], [noexcept]
```

Read IPC data for `arg` from UTCB.
Called only for output arguments.

Parameters

	msg	Pointer to first filled UTCB MR
	offset	Byte offset into UTCB MRs
	limit	Number of bytes available in `msg` array
`out`	*arg*	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

Definition at line 263 of file ipc_basics.

15.115.2.2 from_msg_items()

```
template<typename T>
constexpr int L4::Ipc::Msg::Clnt_noops< T >::from_msg_items (
             char * msg,
             unsigned offset,
             unsigned limit,
             T & arg)  [inline], [static], [constexpr], [noexcept]
```

Read IPC return items for `arg` from UTCB.
Called only for output arguments.

Parameters

	msg	Pointer to first filled UTCB MR
	offset	Byte offset into UTCB MRs
	limit	Number of bytes available in `msg` array
`out`	*arg*	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

Definition at line 282 of file ipc_basics.

15.115.2.3 to_msg_buffers()

```
template<typename T>
constexpr int L4::Ipc::Msg::Clnt_noops< T >::to_msg_buffers (
             char * brs,
             unsigned offset,
             unsigned limit,
             T const & arg)  [inline], [static], [constexpr], [noexcept]
```

Setup receive buffers for object capabilities in UTCB.
Called only for output arguments.

Parameters

brs	Pointer to first usable UTCB BR
offset	Byte offset into UTCB BRs
limit	Maximum number of bytes available in `brs` array
arg	The IPC argument

Return values

<0	Error code
>=0	Offset into `brs` for next IPC argument

Definition at line 244 of file ipc_basics.

15.115.2.4 to_msg_data()

```
template<typename T>
constexpr int L4::Ipc::Msg::Clnt_noops< T >::to_msg_data (
            char * msg,
            unsigned offset,
            unsigned limit,
            T const & arg)  [inline], [static], [constexpr], [noexcept]
```

Write IPC data of `arg` into UTCB.
Called only for input arguments.

Parameters

msg	Pointer to first usable UTCB MR
offset	Byte offset into UTCB MRs
limit	Maximum number of bytes available in `msg` array
arg	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

Definition at line 208 of file ipc_basics.

15.115.2.5 to_msg_items()

```
template<typename T>
constexpr int L4::Ipc::Msg::Clnt_noops< T >::to_msg_items (
            char * msg,
            unsigned offset,
            unsigned limit,
            T const & arg)  [inline], [static], [constexpr], [noexcept]
```

Write IPC send items of `arg` into UTCB.
Called only for input arguments.

Parameters

msg	Pointer to first usable UTCB MR
offset	Byte offset into UTCB MRs
limit	Maximum number of bytes available in `msg` array
arg	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

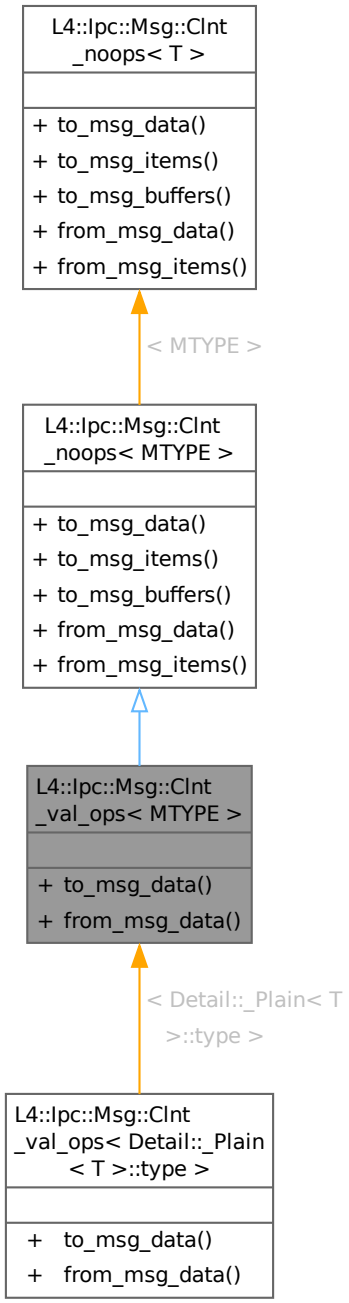
Definition at line 226 of file ipc_basics.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_basics

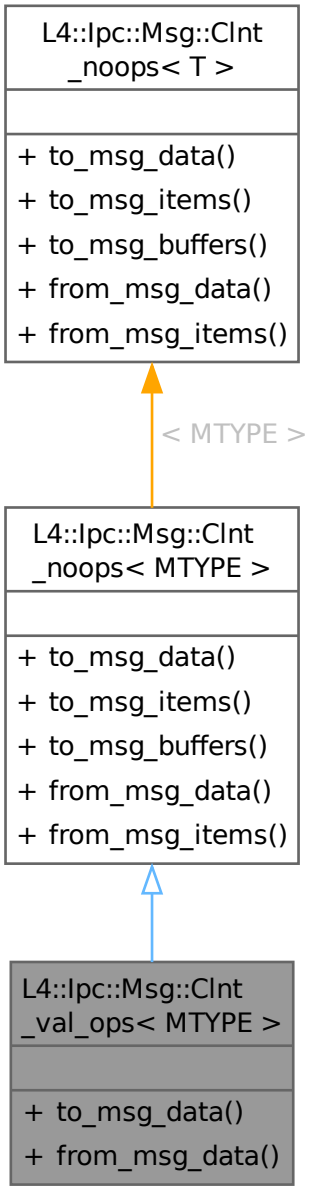
15.116 L4::Ipc::Msg::Clnt_val_ops< MTYPE > Struct Template Reference

Defines client-side handling of 'MTYPE' as RPC argument.
`#include <ipc_basics>`

Inheritance diagram for L4::Ipc::Msg::Clnt_val_ops< MTYPE >:



Collaboration diagram for L4::Ipc::Msg::Clnt_val_ops< MTYPE >:



Static Public Member Functions

- static int **to_msg_data** (char *msg, unsigned offset, unsigned limit, MTYPE const &arg) noexcept

  Copy a T into the message (arg must be either MTYPE or MTYPE const &).
- static int **from_msg_data** (char *msg, unsigned offset, unsigned limit, MTYPE &arg) noexcept

  Copy data from the message to a T client reference (arg must be MTYPE &).

Static Public Member Functions inherited from L4::Ipc::Msg::Clnt_noops< MTYPE >

- static constexpr int to_msg_data (char *msg, unsigned offset, unsigned limit, MTYPE const &arg) noexcept

Write IPC data of `arg` into UTCB.

- static constexpr int to_msg_items (char *msg, unsigned offset, unsigned limit, MTYPE const &arg) noexcept

  Write IPC send items of `arg` into UTCB.
- static constexpr int to_msg_buffers (char *brs, unsigned offset, unsigned limit, MTYPE const &arg) noexcept

  Setup receive buffers for object capabilities in UTCB.
- static constexpr int from_msg_data (char *msg, unsigned offset, unsigned limit, MTYPE &arg) noexcept

  Read IPC data for `arg` from UTCB.
- static constexpr int from_msg_items (char *msg, unsigned offset, unsigned limit, MTYPE &arg) noexcept

  Read IPC return items for `arg` from UTCB.

15.116.1 Detailed Description

template<typename MTYPE>
struct L4::Ipc::Msg::Clnt_val_ops< MTYPE >

Defines client-side handling of 'MTYPE' as RPC argument.
This provides the default implementation for trivially copyable data types. Other types override the marshalling operations by partially specializing Clnt_val_ops.
The template is always instantiated with the `Detail::_Plain<typename Elem<ARG>::arg_type>::type` of the IPC method signature.

Template Parameters

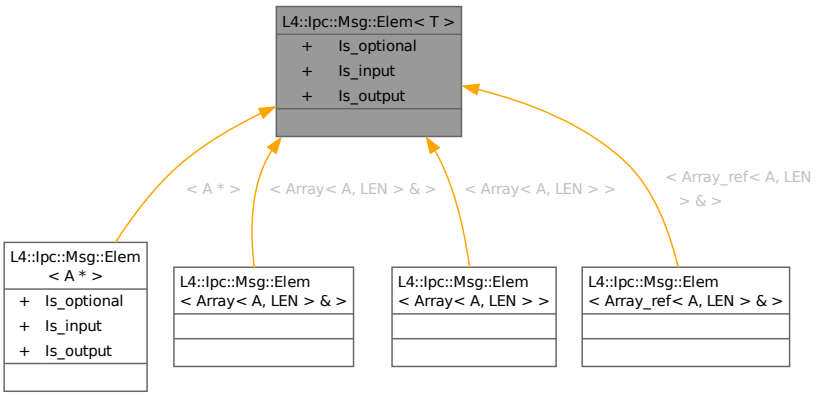
MTYPE	Elem<T>::arg_type (where T is the type used in the RPC definition)

Definition at line 408 of file ipc_basics.
The documentation for this struct was generated from the following file:

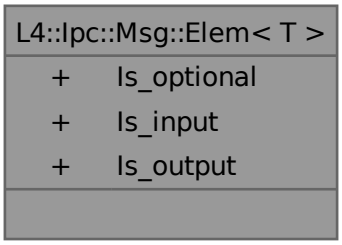
- l4/sys/cxx/ipc_basics

15.117 L4::Ipc::Msg::Elem< T > Struct Template Reference

Helper struct to describe various aspects of an IPC argument.
`#include <ipc_basics>`
Inheritance diagram for L4::Ipc::Msg::Elem< T >:



Collaboration diagram for L4::Ipc::Msg::Elem< T >:



Public Types

- using **arg_type** = T

  The type used in client argument list.
- using **svr_type** = T

  The data type used to store the T on the server-side.
- using **svr_arg_type** = T

  The argument type for the server-side function.

Static Public Attributes

- static constexpr bool **Is_optional** = false

  Is it an optional argument?
- static constexpr bool **Is_input** = true

  Is the argument transferred from client to server?
- static constexpr bool **Is_output** = false

  Is the argument transferred from server to client?

15.117.1 Detailed Description

template<typename T>
struct L4::Ipc::Msg::Elem< T >

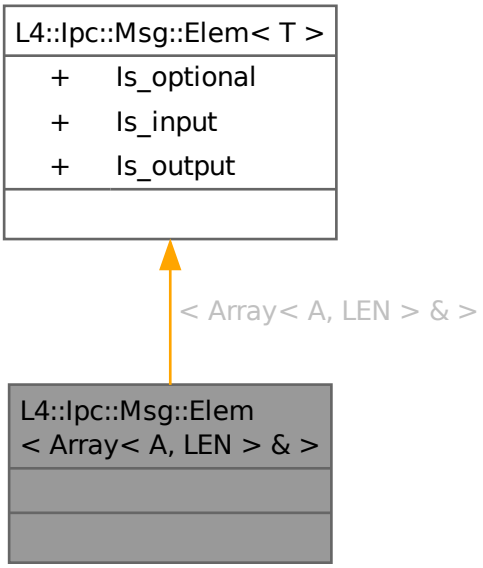
Helper struct to describe various aspects of an IPC argument.
There are standard specializations to handle input and output arguments of trivial data types. More complex types need to add further specializations as needed.
Definition at line 471 of file ipc_basics.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_basics

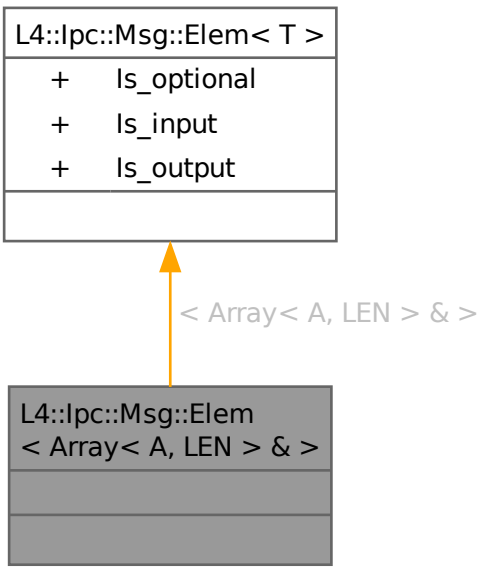
15.118 L4::Ipc::Msg::Elem< Array< A, LEN > & > Struct Template Reference

Array as output argument.
`#include <ipc_array>`

Inheritance diagram for L4::Ipc::Msg::Elem< Array< A, LEN > & >:



Collaboration diagram for L4::Ipc::Msg::Elem< Array< A, LEN > & >:



Public Types

- using **arg_type** = Array<A, LEN> &

  Array<> & at the interface.
- using **svr_type** = Array_ref<A, LEN>

  Array_ref<> as server storage type.
- using **svr_arg_type** = svr_type &

  Array_ref<> & at the server side.

15.118.1 Detailed Description

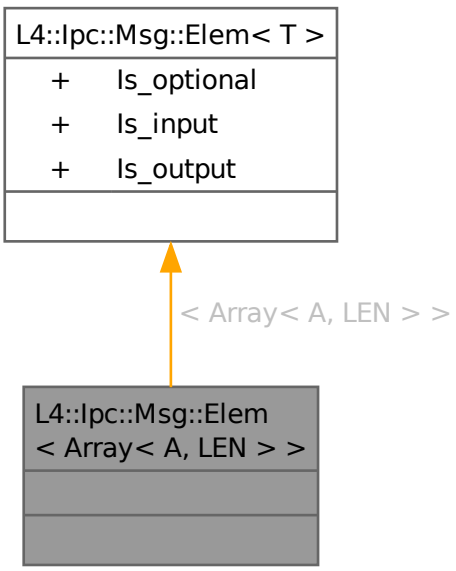
template<typename A, typename LEN>
struct L4::Ipc::Msg::Elem< Array< A, LEN > & >

Array as output argument.
Definition at line 172 of file ipc_array.
The documentation for this struct was generated from the following file:

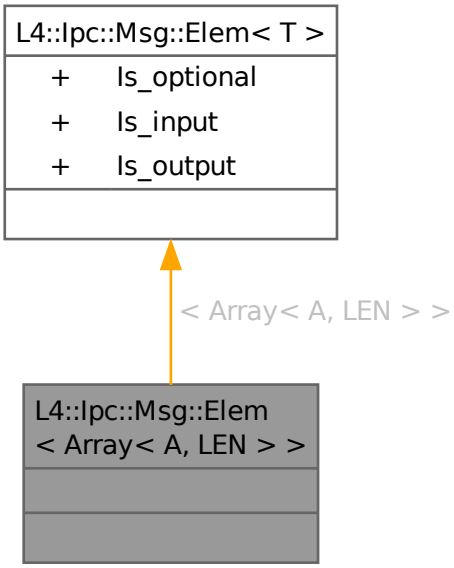
- l4/sys/cxx/ipc_array

15.119 L4::Ipc::Msg::Elem< Array< A, LEN > > Struct Template Reference

Array as input arguments.
`#include <ipc_array>`
Inheritance diagram for L4::Ipc::Msg::Elem< Array< A, LEN > >:



Collaboration diagram for L4::Ipc::Msg::Elem< Array< A, LEN > >:



Public Types

- using **arg_type** = Array<A, LEN>
  Array<> as argument at the interface.
- using **svr_type** = Array_ref<A, LEN>
  Array_ref<> at the server side.

15.119.1 Detailed Description

template<typename A, typename LEN>
struct L4::Ipc::Msg::Elem< Array< A, LEN > >

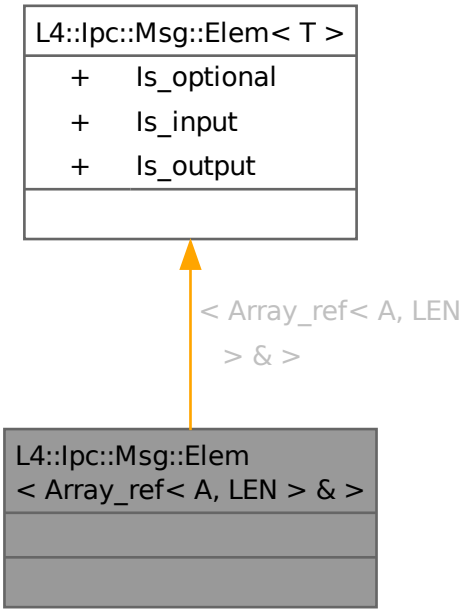
Array as input arguments.
Definition at line 158 of file ipc_array.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_array

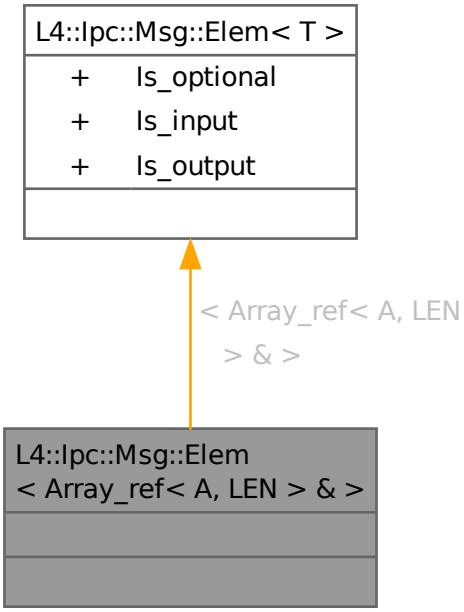
15.120 L4::Ipc::Msg::Elem< Array_ref< A, LEN > & > Struct Template Reference

Array_ref as output argument.
`#include <ipc_array>`

Inheritance diagram for L4::Ipc::Msg::Elem< Array_ref< A, LEN > & >:



Collaboration diagram for L4::Ipc::Msg::Elem< Array_ref< A, LEN > & >:



Public Types

- using **arg_type** = Array_ref<A, LEN> &

  Array_ref<> at the interface.
- using **svr_type** = Array_ref<L4::Types::Remove_const_t<A>, LEN>

  Array_ref<> as server storage.
- using **svr_arg_type** = svr_type &

  Array_ref<> & as server argument.

15.120.1 Detailed Description

template<typename A, typename LEN>
struct L4::Ipc::Msg::Elem< Array_ref< A, LEN > & >

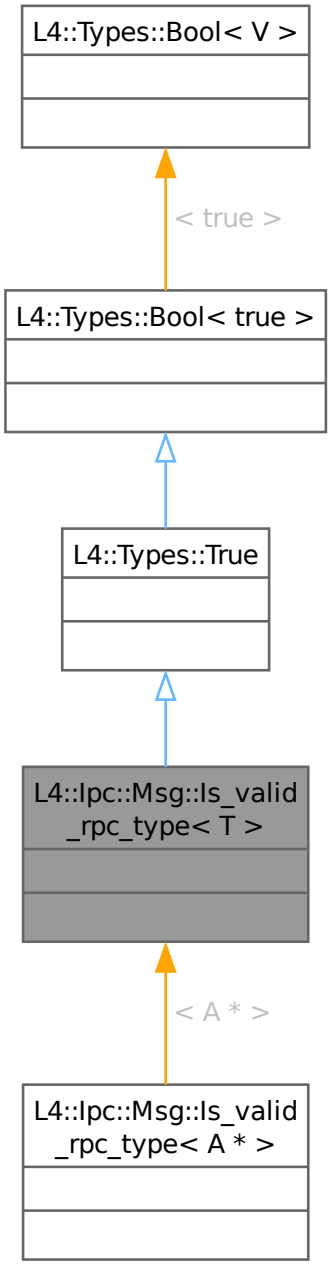
Array_ref as output argument.
Definition at line 187 of file ipc_array.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_array

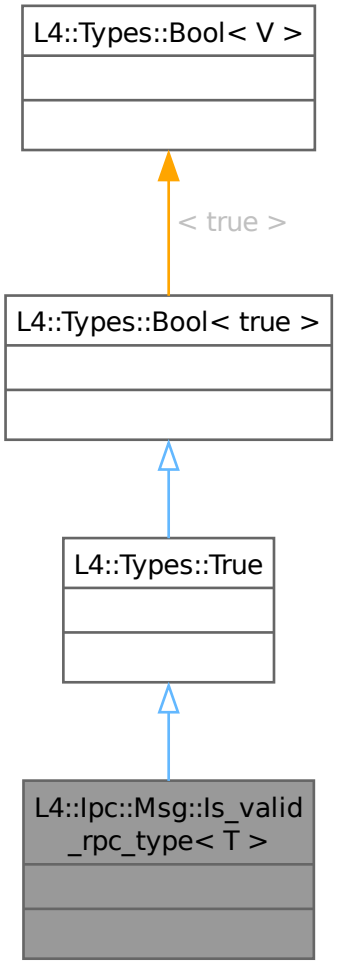
15.121 L4::Ipc::Msg::Is_valid_rpc_type< T > Struct Template Reference

Type trait defining a valid RPC parameter type.
`#include <ipc_basics>`

Inheritance diagram for L4::Ipc::Msg::Is_valid_rpc_type< T >:



Collaboration diagram for L4::Ipc::Msg::Is_valid_rpc_type< T >:



Additional Inherited Members

Public Types inherited from L4::Types::Bool< true >

- using **type**

  The meta type itself.

15.121.1 Detailed Description

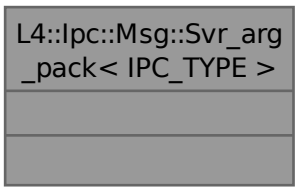
template<typename T>
struct L4::Ipc::Msg::Is_valid_rpc_type< T >

Type trait defining a valid RPC parameter type.
Definition at line 521 of file ipc_basics.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_basics

15.122 L4::Ipc::Msg::Svr_arg_pack< IPC_TYPE > Struct Template Reference

Server-side RPC arguments data structure used to provide arguments to the server-side implementation of an RPC function.
Collaboration diagram for L4::Ipc::Msg::Svr_arg_pack< IPC_TYPE >:



15.122.1 Detailed Description

template<typename IPC_TYPE>
struct L4::Ipc::Msg::Svr_arg_pack< IPC_TYPE >

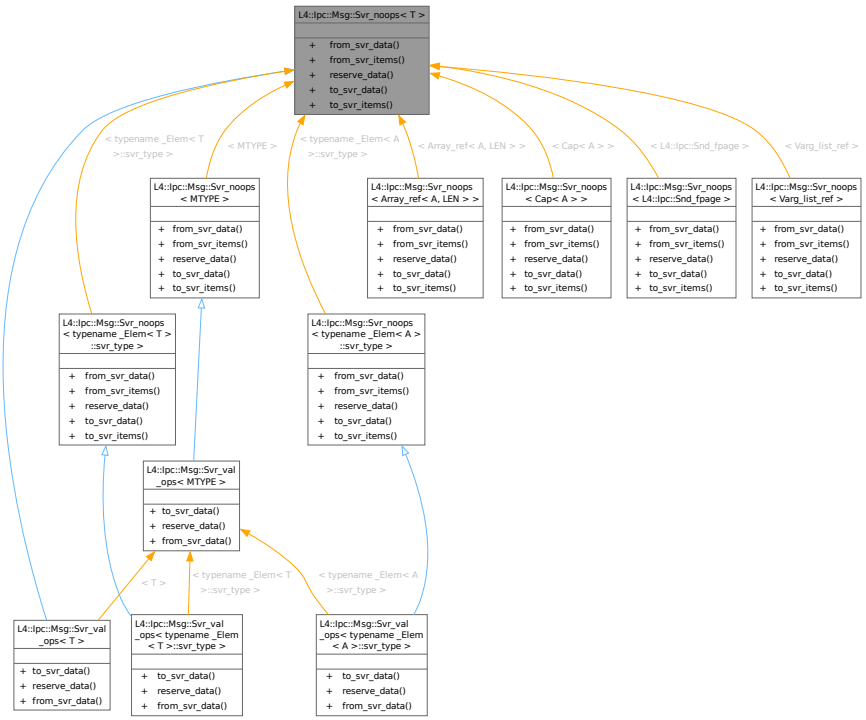
Server-side RPC arguments data structure used to provide arguments to the server-side implementation of an RPC function.
Definition at line 222 of file ipc_server.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_server

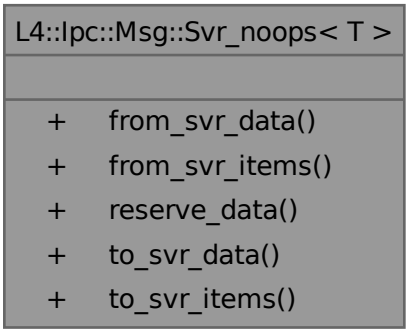
15.123 L4::Ipc::Msg::Svr_noops< T > Struct Template Reference

Empty server side marshalling code.
`#include <ipc_basics>`

Inheritance diagram for L4::Ipc::Msg::Svr_noops< T >:



Collaboration diagram for L4::Ipc::Msg::Svr_noops< T >:



Static Public Member Functions

- static constexpr int from_svr_data (char *msg, unsigned offset, unsigned limit, T const &arg) noexcept

  Write IPC data of `arg` into UTCB.
- static constexpr int from_svr_items (char *msg, unsigned offset, unsigned limit, T const &arg) noexcept

  Write IPC send items of `arg` into UTCB.
- static constexpr int reserve_data (char *msg, unsigned offset, unsigned limit, T &arg) noexcept

  Reserve IPC data bytes in UTCB.

- static constexpr int to_svr_data (char *msg, unsigned offset, unsigned limit, T &arg) noexcept
  Read IPC data for `arg` from UTCB.
- static constexpr int to_svr_items (char *msg, unsigned offset, unsigned limit, T &arg) noexcept
  Read IPC return items for `arg` from UTCB.

15.123.1 Detailed Description

template<typename T>
struct L4::Ipc::Msg::Svr_noops< T >

Empty server side marshalling code.
Used as basis for concrete marshalling code.
Definition at line 294 of file ipc_basics.

15.123.2 Member Function Documentation

15.123.2.1 from_svr_data()

```
template<typename T>
constexpr int L4::Ipc::Msg::Svr_noops< T >::from_svr_data (
            char * msg,
            unsigned offset,
            unsigned limit,
            T const & arg)  [inline], [static], [constexpr], [noexcept]
```

Write IPC data of `arg` into UTCB.
Called only for output arguments.

Parameters

msg	Pointer to first usable UTCB MR
offset	Byte offset into UTCB MRs
limit	Maximum number of bytes available in `msg` array
arg	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

Definition at line 309 of file ipc_basics.

15.123.2.2 from_svr_items()

```
template<typename T>
constexpr int L4::Ipc::Msg::Svr_noops< T >::from_svr_items (
            char * msg,
            unsigned offset,
            unsigned limit,
            T const & arg)  [inline], [static], [constexpr], [noexcept]
```

Write IPC send items of `arg` into UTCB.
Called only for output arguments.

Parameters

msg	Pointer to first usable UTCB MR
offset	Byte offset into UTCB MRs
limit	Maximum number of bytes available in `msg` array
arg	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

Definition at line 328 of file ipc_basics.

15.123.2.3 reserve_data()

```
template<typename T>
constexpr int L4::Ipc::Msg::Svr_noops< T >::reserve_data (
             char * msg,
             unsigned offset,
             unsigned limit,
             T & arg)  [inline], [static], [constexpr], [noexcept]
```

Reserve IPC data bytes in UTCB.
Called only for output arguments. The argument type may remember the `msg` pointer if the data is put directly into the UTCB.

Parameters

msg	Pointer to first usable UTCB MR
offset	Byte offset into UTCB MRs
limit	Maximum number of bytes available in `msg` array
arg	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

Definition at line 348 of file ipc_basics.

15.123.2.4 to_svr_data()

```
template<typename T>
constexpr int L4::Ipc::Msg::Svr_noops< T >::to_svr_data (
             char * msg,
             unsigned offset,
             unsigned limit,
             T & arg)  [inline], [static], [constexpr], [noexcept]
```

Read IPC data for `arg` from UTCB.
Called only for input arguments.

Parameters

	msg	Pointer to first filled UTCB MR
	offset	Byte offset into UTCB MRs
	limit	Number of bytes available in `msg` array
`out`	*arg*	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

Definition at line 367 of file ipc_basics.

15.123.2.5 to_svr_items()

```
template<typename T>
constexpr int L4::Ipc::Msg::Svr_noops< T >::to_svr_items (
             char * msg,
             unsigned offset,
             unsigned limit,
             T & arg)  [inline], [static], [constexpr], [noexcept]
```

Read IPC return items for `arg` from UTCB.
Called only for input arguments.

Parameters

	msg	Pointer to first filled UTCB MR
	offset	Byte offset into UTCB MRs
	limit	Number of bytes available in `msg` array
`out`	*arg*	The IPC argument

Return values

<0	Error code
>=0	Offset into `msg` for next IPC argument

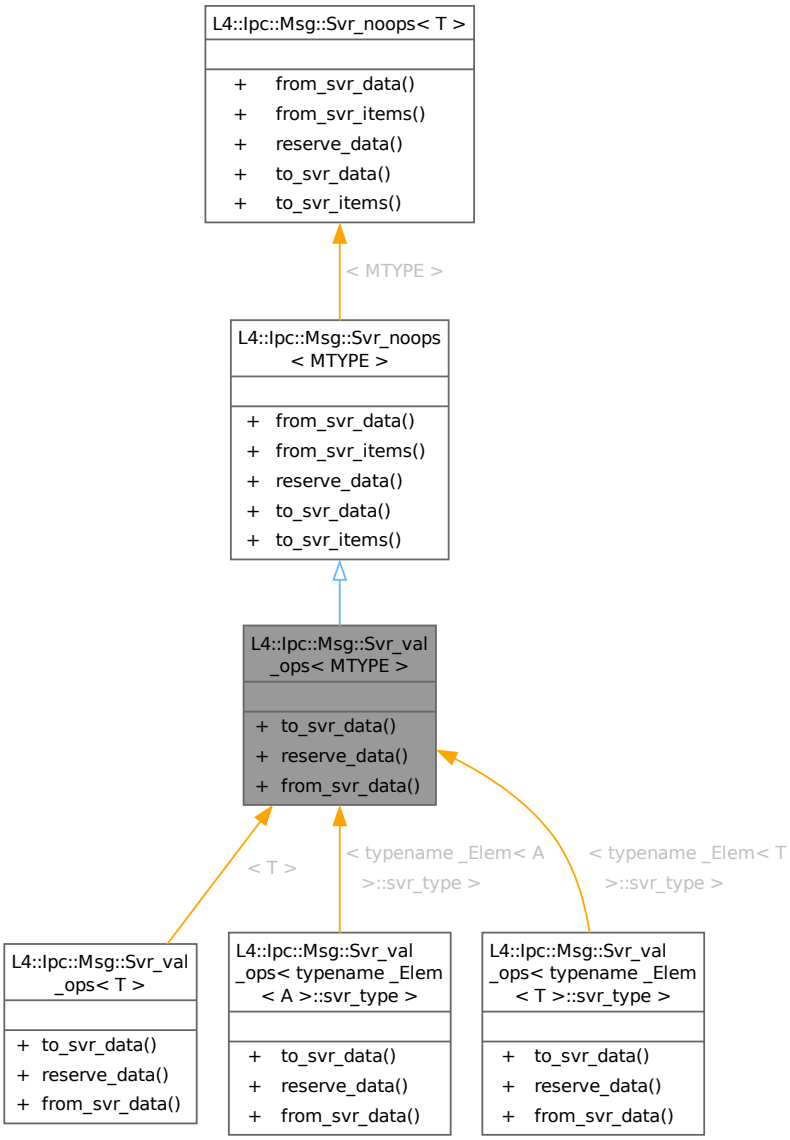
Definition at line 386 of file ipc_basics.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_basics

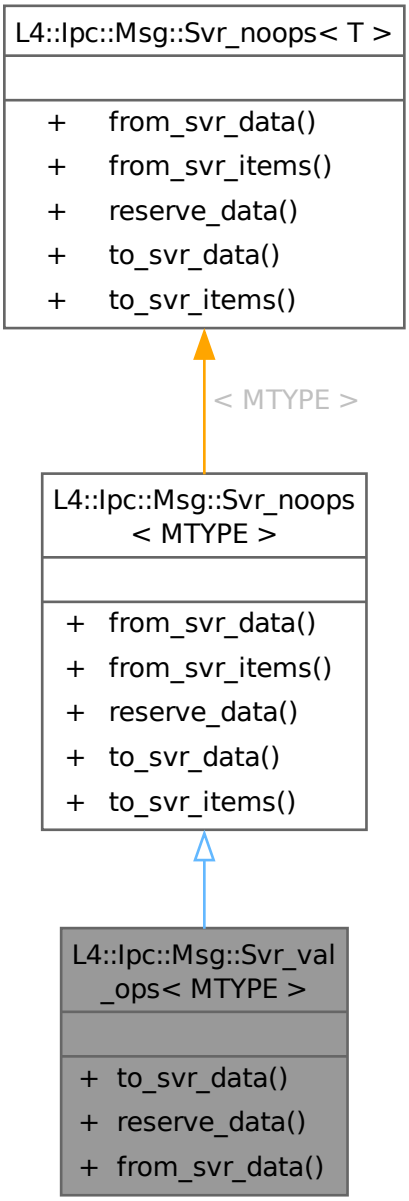
15.124 L4::Ipc::Msg::Svr_val_ops< MTYPE > Struct Template Reference

Defines server-side handling of 'MTYPE' as RPC argument.
`#include <ipc_basics>`

Inheritance diagram for L4::Ipc::Msg::Svr_val_ops< MTYPE >:



Collaboration diagram for L4::Ipc::Msg::Svr_val_ops< MTYPE >:



Static Public Member Functions

- static int **to_svr_data** (char ∗msg, unsigned offset, unsigned limit, MTYPE &arg) noexcept

  Copy data from the message to a T server reference (arg must be MTYPE &).
- static int **reserve_data** (char ∗, unsigned offs, unsigned limit, MTYPE &) noexcept

  Prepare a T output operand (arg must be MTYPE &).
- static int **from_svr_data** (char ∗msg, unsigned offset, unsigned limit, MTYPE const &arg) noexcept

  Copy a T into the message (arg must be either MTYPE or MTYPE const &).

Static Public Member Functions inherited from L4::Ipc::Msg::Svr_noops< MTYPE >

- static constexpr int from_svr_data (char *msg, unsigned offset, unsigned limit, MTYPE const &arg) noexcept
  Write IPC data of `arg` into UTCB.
- static constexpr int from_svr_items (char *msg, unsigned offset, unsigned limit, MTYPE const &arg) noexcept
  Write IPC send items of `arg` into UTCB.
- static constexpr int reserve_data (char *msg, unsigned offset, unsigned limit, MTYPE &arg) noexcept
  Reserve IPC data bytes in UTCB.
- static constexpr int to_svr_data (char *msg, unsigned offset, unsigned limit, MTYPE &arg) noexcept
  Read IPC data for `arg` from UTCB.
- static constexpr int to_svr_items (char *msg, unsigned offset, unsigned limit, MTYPE &arg) noexcept
  Read IPC return items for `arg` from UTCB.

15.124.1 Detailed Description

template<typename MTYPE>
struct L4::Ipc::Msg::Svr_val_ops< MTYPE >

Defines server-side handling of 'MTYPE' as RPC argument.
This provides the default implementation for trivially copyable data types. Other types override the marshalling operations by partially specializing Svr_val_ops.
The template is always instantiated with the `Elem<ARG>::svr_type` of the IPC method signature.

Template Parameters

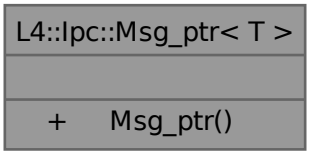
MTYPE	Elem<T>::arg_type (where T is the type used in the RPC definition)

Definition at line 438 of file ipc_basics.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_basics

15.125 L4::Ipc::Msg_ptr< T > Class Template Reference

Pointer to an element of type T in an Ipc::Istream.
`#include <ipc_stream>`
Collaboration diagram for L4::Ipc::Msg_ptr< T >:



Public Member Functions

- Msg_ptr (T *&p)
  Create a Msg_ptr object that set pointer p to point into the message buffer.

15.125.1 Detailed Description

template<typename T>
class L4::Ipc::Msg_ptr< T >

Pointer to an element of type T in an Ipc::Istream.
This wrapper can be used to extract an element of type T from an Ipc::Istream, whereas the data is not copied out, but a pointer into the message buffer itself is returned. With is mechanism it is possible to avoid an extra copy of large data structures from a received IPC message, instead the returned pointer gives direct access to the data in the message.
See msg_ptr().
Definition at line 229 of file ipc_stream.

15.125.2 Constructor & Destructor Documentation

15.125.2.1 Msg_ptr()

```
template<typename T>
L4::Ipc::Msg_ptr< T >::Msg_ptr (
            T *& p)  [inline], [explicit]
```

Create a Msg_ptr object that set pointer p to point into the message buffer.

Parameters

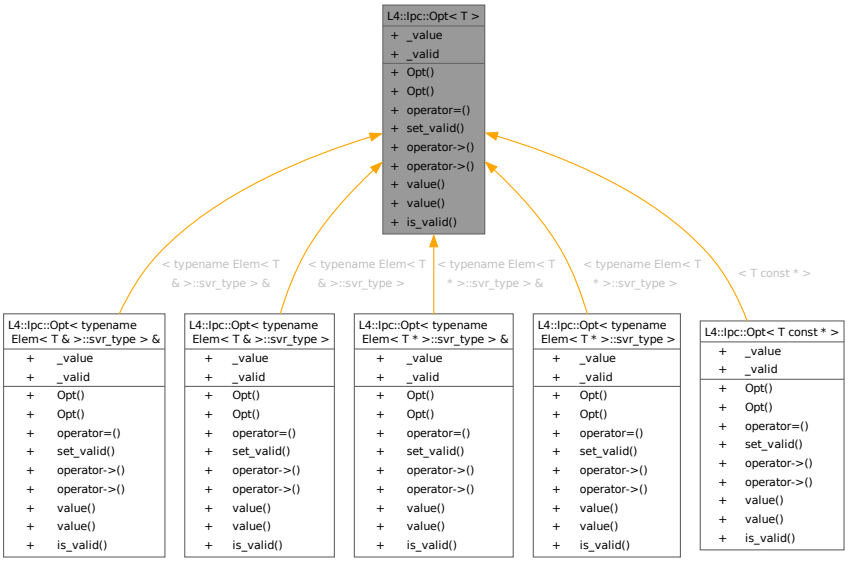
p	The pointer that is adjusted to point into the message buffer.

Definition at line 240 of file ipc_stream.
The documentation for this class was generated from the following file:

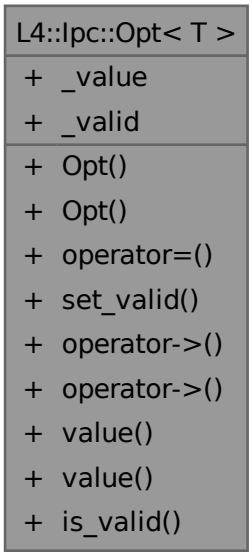
- l4/cxx/ipc_stream

15.126 L4::Ipc::Opt< T > Struct Template Reference

Attribute for defining an optional RPC argument.
`#include <ipc_types>`
Inheritance diagram for L4::Ipc::Opt< T >:



Collaboration diagram for L4::Ipc::Opt< T >:



Public Member Functions

- **Opt** () noexcept=default

  Make an absent optional argument.
- **Opt** (T value) noexcept

  Make a present optional argument with the given value.
- Opt & **operator=** (T value) noexcept

  Assign a value to the optional argument (makes the argument present).
- void **set_valid** (bool valid=true) noexcept

  Set the argument to present or absent.
- T * **operator->** () noexcept

  Get the pointer to the value.
- T const * **operator->** () const noexcept

  Get the const pointer to the value.
- T const & **value** () const noexcept

  Get the value.
- T & **value** () noexcept

  Get the value.
- bool **is_valid** () const noexcept

  Get true if present, false if not.

Data Fields

- T **_value** {}

  The value.
- bool **_valid** = false

  True if the optional argument is present, false else.

15.126.1 Detailed Description

template<typename T>
struct L4::Ipc::Opt< T >

Attribute for defining an optional RPC argument.

Attention

Do not use in new code. It is solely used for the implementation of some legacy message formats and should generally not be needed for the definition of ordinary interfaces.

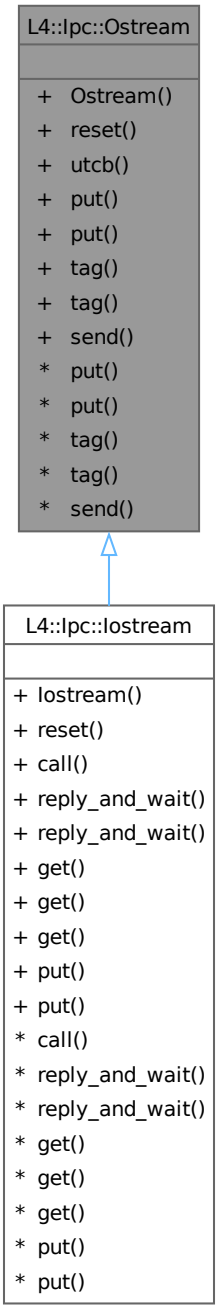
Definition at line 80 of file ipc_types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_types

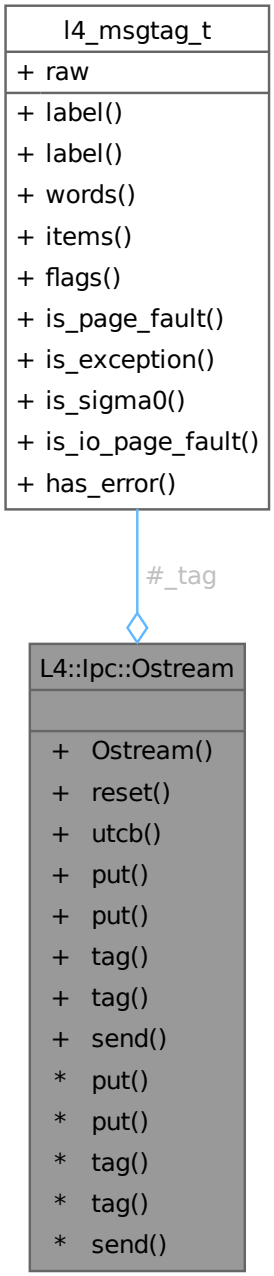
15.127 L4::Ipc::Ostream Class Reference

Output stream for IPC marshalling.
`#include <ipc_stream>`

Inheritance diagram for L4::Ipc::Ostream:



Collaboration diagram for L4::Ipc::Ostream:



Public Member Functions

- **Ostream** (l4_utcb_t *utcb)

  Create an IPC output stream using the given message buffer `utcb`.
- void **reset** ()

  Reset the stream to empty, same state as a newly created stream.
- l4_utcb_t * **utcb** () const

  Return utcb pointer.

Get/Put functions.

These functions are basically used to implement the insertion operators (<<) and should not be called directly.

- template<typename T>
  bool put (T *buf, unsigned long size)
  Put an array with `size` elements of type `T` into the stream.
- template<typename T>
  bool put (T const &v)
  Insert an element of type `T` into the stream.
- l4_msgtag_t tag () const
  Extract the L4 message tag from the stream.
- l4_msgtag_t & tag ()
  Extract a reference to the L4 message tag from the stream.

IPC operations.

- l4_msgtag_t send (l4_cap_idx_t dst, long proto=0, unsigned flags=0)
  Send the message via IPC to the given receiver.

15.127.1 Detailed Description

Output stream for IPC marshalling.
Ipc::Ostream is part of the dynamic IPC marshalling infrastructure, as well as Ipc::Istream and Ipc::Iostream.
Ipc::Ostream is an output stream supporting insertion of values into an IPC message buffer. A IPC message can be marshalled using the usual insertion operator <<, see IPC stream operators .
There exist some special wrapper classes to insert arrays (see Ipc::Buf_cp_out) and indirect strings (see Msg_↩ out_buffer and Msg_io_buffer).
Definition at line 623 of file ipc_stream.

15.127.2 Member Function Documentation

15.127.2.1 put() [1/2]

```
template<typename T>
bool L4::Ipc::Ostream::put (
            T * buf,
            unsigned long size)  [inline]
```

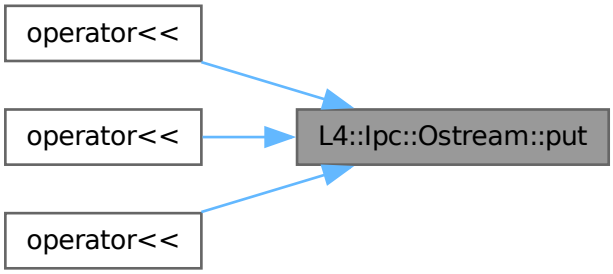
Put an array with `size` elements of type `T` into the stream.

Parameters

buf	A pointer to the array to insert into the buffer.
size	The number of elements in the array.

Definition at line 660 of file ipc_stream.
Referenced by operator<<(), operator<<(), and operator<<().

Here is the caller graph for this function:



15.127.2.2 put() [2/2]

```
template<typename T>
bool L4::Ipc::Ostream::put (
             T const & v)  [inline]
```

Insert an element of type `T` into the stream.

Parameters

v	The element to insert.

Definition at line 678 of file ipc_stream.

15.127.2.3 send()

```
l4_msgtag_t L4::Ipc::Ostream::send (
             l4_cap_idx_t dst,
             long proto = 0,
             unsigned flags = 0)  [inline]
```

Send the message via IPC to the given receiver.

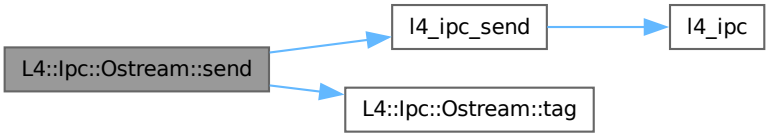
Parameters

dst	The destination for the message.
proto	Protocol to use.
flags	Flags to use.

Returns

The syscall return tag.

Definition at line 959 of file ipc_stream.
References L4_IPC_NEVER, l4_ipc_send(), L4_MSGTAG_FLAGS, and tag().
Here is the call graph for this function:



15.127.2.4 tag() [1/2]

```
l4_msgtag_t & L4::Ipc::Ostream::tag ()  [inline]
```

Extract a reference to the L4 message tag from the stream.

Returns

A reference to the L4 message tag.

Definition at line 713 of file ipc_stream.

15.127.2.5 tag() [2/2]

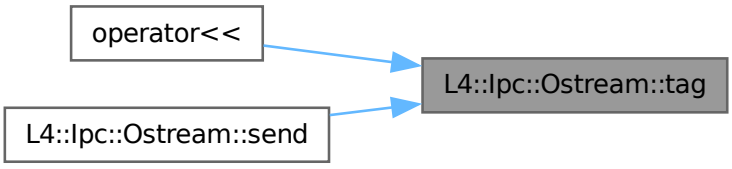
```
l4_msgtag_t L4::Ipc::Ostream::tag () const  [inline]
```

Extract the L4 message tag from the stream.

Returns

The extracted L4 message tag.

Definition at line 706 of file ipc_stream.
Referenced by operator<<(), and send().
Here is the caller graph for this function:

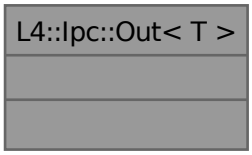


The documentation for this class was generated from the following file:

- l4/cxx/ipc_stream

15.128 L4::Ipc::Out< T > Struct Template Reference

Mark an argument as a output value in an RPC signature.
Collaboration diagram for L4::Ipc::Out< T >:



15.128.1 Detailed Description

template<typename T>
struct L4::Ipc::Out< T >

Mark an argument as a output value in an RPC signature.

Template Parameters

T	The original type of the argument.

Note

The use of Out<> is usually not needed, because typical output data types in C++ (pointers to non-const objects or non-const references are interpreted as output values anyway. However, there are some data types, such as returned capabilities that can be marked as such by using Out<>.

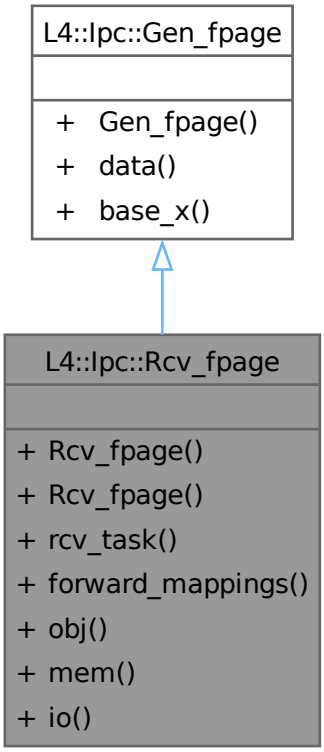
Definition at line 31 of file ipc_types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_types

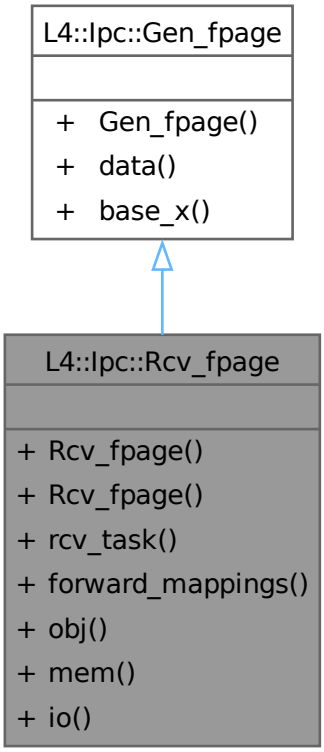
15.129 L4::Ipc::Rcv_fpage Class Reference

Non-small receive item.
`#include <ipc_types>`

Inheritance diagram for L4::Ipc::Rcv_fpage:



Collaboration diagram for L4::Ipc::Rcv_fpage:



Public Member Functions

- **Rcv_fpage** () noexcept

  Construct a void receive item.
- Rcv_fpage (l4_fpage_t const &fp, l4_addr_t snd_base=0, l4_cap_idx_t rcv_task=L4_INVALID_CAP) noexcept

  Construct a non-small receive item.
- l4_cap_idx_t rcv_task () const

  Get the capability index of the destination task for received capabilities.
- bool **forward_mappings** () const noexcept

  Check if rcv_task() shall be used as destination for received capabilities.

Public Member Functions inherited from L4::Ipc::Gen_fpage

- **Gen_fpage** (l4_umword_t base, l4_umword_t data) noexcept

  Construct from raw values.
- l4_umword_t **data** () const noexcept

  Return the raw flexpage descriptor.
- l4_umword_t **base_x** () const noexcept

  Return the raw base descriptor.

Static Public Member Functions

- static Rcv_fpage obj (l4_cap_idx_t base, int order, l4_addr_t snd_base=0, L4::Cap< void > rcv_task=L4::Cap< void >::Invalid) noexcept

  Construct a non-small receive item for the object space.
- static Rcv_fpage mem (l4_addr_t base, int order, l4_addr_t snd_base=0, L4::Cap< void > rcv_task=L4::Cap< void >::Invalid) noexcept

  Construct a receive item for the memory space.
- static Rcv_fpage io (unsigned long base, int order, l4_addr_t snd_base=0, L4::Cap< void > rcv_task=L4::Cap< void >::Invalid) noexcept

  Construct a receive item for the I/O port space.

Additional Inherited Members

Public Types inherited from L4::Ipc::Gen_fpage

- enum Type { Special = L4_FPAGE_SPECIAL << 4 , Memory = L4_FPAGE_MEMORY << 4 , Io = L4_↩ FPAGE_IO << 4 , Obj = L4_FPAGE_OBJ << 4 }

  Type of mapping object, see L4_fpage_type.

15.129.1 Detailed Description

Non-small receive item.
This class represents a non-small receive item. A receive item is a message item in the buffer registers of the UTCB of the receiver (see l4_utcb_br()).
In an RPC interface, a Rcv_fpage must be combined with a Snd_fpage output argument. The Rcv_fpage argument is removed from the server function signature. Instead, the adjacent Snd_fpage output argument is used by the server function to send the capability. On the client side, the caller can check the Snd_fpage output argument what has been received. See the following example:

```
L4_RPC(l4_ret_t, test, (L4::Ipc::Rcv_fpage fp, L4::Ipc::Snd_fpage &snd_fp));
```

Definition at line 531 of file ipc_types.

15.129.2 Constructor & Destructor Documentation

15.129.2.1 Rcv_fpage()

```
L4::Ipc::Rcv_fpage::Rcv_fpage (
             l4_fpage_t const & fp,
             l4_addr_t snd_base = 0,
             l4_cap_idx_t rcv_task = L4_INVALID_CAP)  [inline], [noexcept]
```

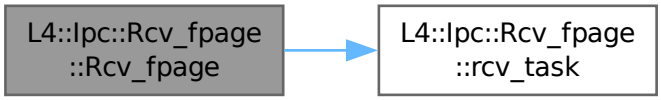
Construct a non-small receive item.

Parameters

fp	Flexpage defining where and which kind of capabilities may be received.
snd_base	Reserved; should be zero.
rcv_task	Optional destination task for received capabilities. If invalid, capabilities are received in the invoking task.

Definition at line 548 of file ipc_types.
References L4_INVALID_CAP, L4_ITEM_MAP, L4_RCV_ITEM_FORWARD_MAPPINGS, and rcv_task().

Here is the call graph for this function:



15.129.3 Member Function Documentation

15.129.3.1 io()

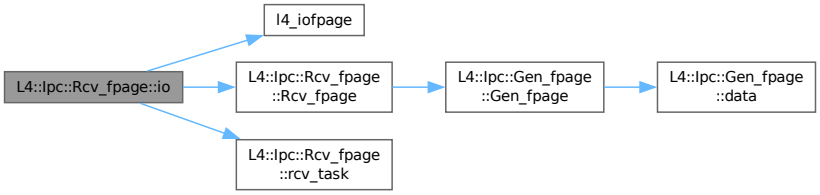
```
Rcv_fpage L4::Ipc::Rcv_fpage::io (
            unsigned long base,
            int order,
            l4_addr_t snd_base = 0,
            L4::Cap< void > rcv_task = L4::Cap<void>::Invalid)  [inline], [static], [noexcept]
```

Construct a receive item for the I/O port space.

Parameters

base	Start of flexpage (see l4_iofpage()).
order	Log_2 size of flexpage (see l4_iofpage()).
snd_base	Reserved; should be zero.
rcv_task	Optional destination task for received capabilities. If invalid, capabilities are received in the invoking task.

Definition at line 596 of file ipc_types.
References L4::Cap_base::Invalid, l4_iofpage(), Rcv_fpage(), and rcv_task().
Here is the call graph for this function:



15.129.3.2 mem()

```
Rcv_fpage L4::Ipc::Rcv_fpage::mem (
            l4_addr_t base,
            int order,
            l4_addr_t snd_base = 0,
            L4::Cap< void > rcv_task = L4::Cap<void>::Invalid)  [inline], [static], [noexcept]
```

Construct a receive item for the memory space.

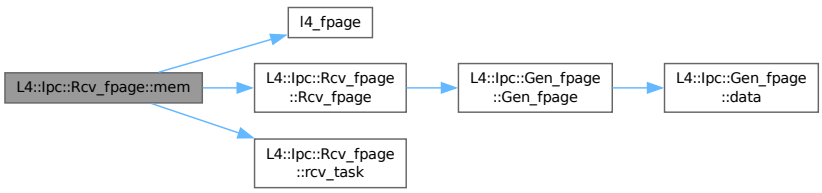
Parameters

base	Start of flexpage (see l4_fpage()).
order	Log_2 size of flexpage (see l4_fpage()).
snd_base	Reserved; should be zero.
rcv_task	Optional destination task for received capabilities. If invalid, capabilities are received in the invoking task.

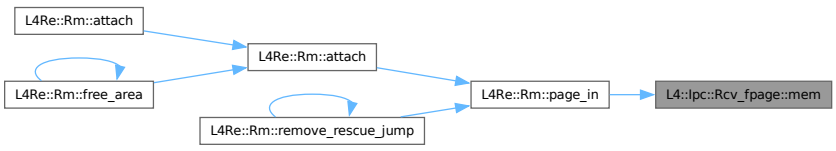
Examples

examples/libs/l4re/streammap/client.cc.

Definition at line 581 of file ipc_types.
References L4::Cap_base::Invalid, l4_fpage(), Rcv_fpage(), and rcv_task().
Referenced by L4Re::Rm::page_in().
Here is the call graph for this function:



Here is the caller graph for this function:



15.129.3.3 obj()

```
Rcv_fpage L4::Ipc::Rcv_fpage::obj (
            l4_cap_idx_t base,
            int order,
            l4_addr_t snd_base = 0,
            L4::Cap< void > rcv_task = L4::Cap<void>::Invalid)  [inline], [static], [noexcept]
```

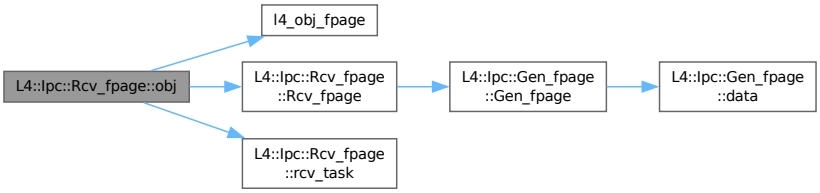
Construct a non-small receive item for the object space.

Parameters

base	Start of flexpage (see l4_obj_fpage()).
order	Log_2 size of flexpage (see l4_obj_fpage()).

snd_base	Reserved; should be zero.
rcv_task	Optional destination task for received capabilities. If invalid, capabilities are received in the invoking task.

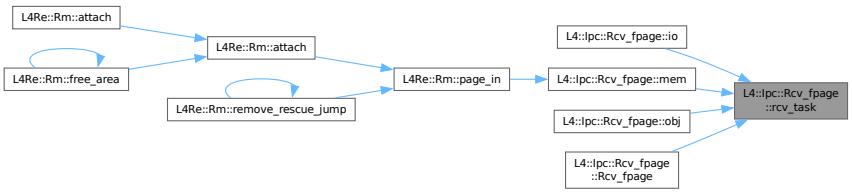
Definition at line 565 of file ipc_types.
References L4::Cap_base::Invalid, l4_obj_fpage(), Rcv_fpage(), and rcv_task().
Here is the call graph for this function:



15.129.3.4 rcv_task()

```
l4_cap_idx_t L4::Ipc::Rcv_fpage::rcv_task () const  [inline]
```

Get the capability index of the destination task for received capabilities.
Only relevant if forward_mappings() is true.
Definition at line 607 of file ipc_types.
Referenced by io(), mem(), obj(), and Rcv_fpage().
Here is the caller graph for this function:



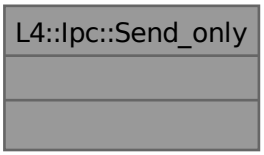
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_types

15.130 L4::Ipc::Send_only Struct Reference

RPC attribute for a send-only RPC.
`#include <ipc_iface>`

Collaboration diagram for L4::Ipc::Send_only:



15.130.1 Detailed Description

RPC attribute for a send-only RPC.
This class can be used as FLAGS parameter to L4::Ipc::Msg::Rpc_call and L4::Ipc::Msg::Rpc_inline_call templates and declares the RPC to use send-only semantics and timeouts.
Examples:

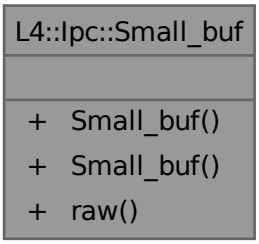
```
L4_RPC(l4_ret_t, send, (unsigned value), L4::Ipc::Send_only);
```

Definition at line 287 of file ipc_iface.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_iface

15.131 L4::Ipc::Small_buf Class Reference

A receive item for receiving a single object capability.
`#include <ipc_types>`
Collaboration diagram for L4::Ipc::Small_buf:



Public Member Functions

- Small_buf (L4::Cap< void > cap, unsigned long flags=0) noexcept

  Create a receive item from a C++ cap.
- Small_buf (l4_cap_idx_t cap, unsigned long flags=0) noexcept

  Create a receive item from a C cap.
- l4_umword_t **raw** () const noexcept

  Return the raw data.

15.131.1 Detailed Description

A receive item for receiving a single object capability.
This class is the main abstraction for receiving object capabilities via Ipc::Istream. To receive an object capability, an instance of Small_buf that refers to an empty capability slot must be inserted into the Ipc::Istream before the receive operation.
In an RPC interface, a Small_buf must be combined with a Snd_fpage output argument. The Small_buf argument is removed from the server function signature. Instead, the adjacent Snd_fpage output argument is used by the server function to send the capability. On the client side, the caller can check the Snd_fpage output argument what has been received. See the following example:

```
L4_RPC(l4_ret_t, test, (L4::Ipc::Small_buf cap, L4::Ipc::Snd_fpage &snd_cap));
```

Definition at line 233 of file ipc_types.

15.131.2 Constructor & Destructor Documentation

15.131.2.1 Small_buf() [1/2]

```
L4::Ipc::Small_buf::Small_buf (
            L4::Cap< void > cap,
            unsigned long flags = 0)  [inline], [explicit], [noexcept]
```

Create a receive item from a C++ cap.

Parameters

cap	Capability slot where to save the capability.
flags	Receive buffer flags, see l4_msg_item_consts_t. L4_RCV_ITEM_SINGLE_CAP will always be set.

Definition at line 243 of file ipc_types.
References L4_RCV_ITEM_SINGLE_CAP.

15.131.2.2 Small_buf() [2/2]

```
L4::Ipc::Small_buf::Small_buf (
            l4_cap_idx_t cap,
            unsigned long flags = 0)  [inline], [explicit], [noexcept]
```

Create a receive item from a C cap.

Parameters

cap	Capability slot where to save the capability.
flags	Receive buffer flags, see l4_msg_item_consts_t. L4_RCV_ITEM_SINGLE_CAP will always be set.

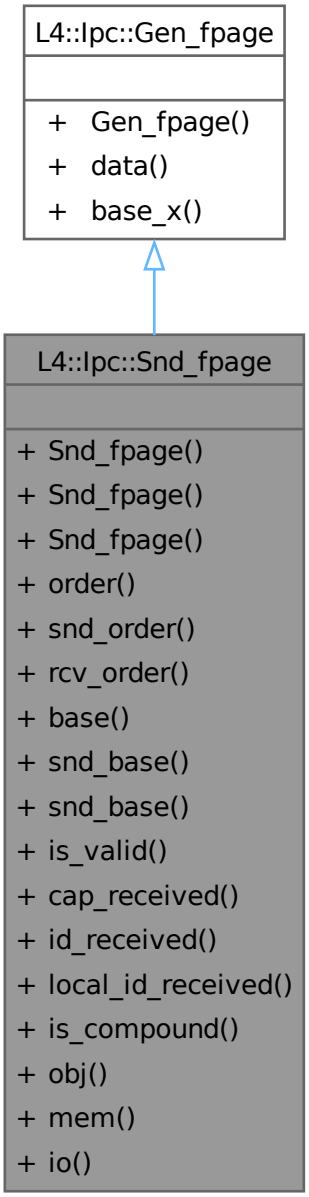
Definition at line 250 of file ipc_types.
References L4_RCV_ITEM_SINGLE_CAP.
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_types

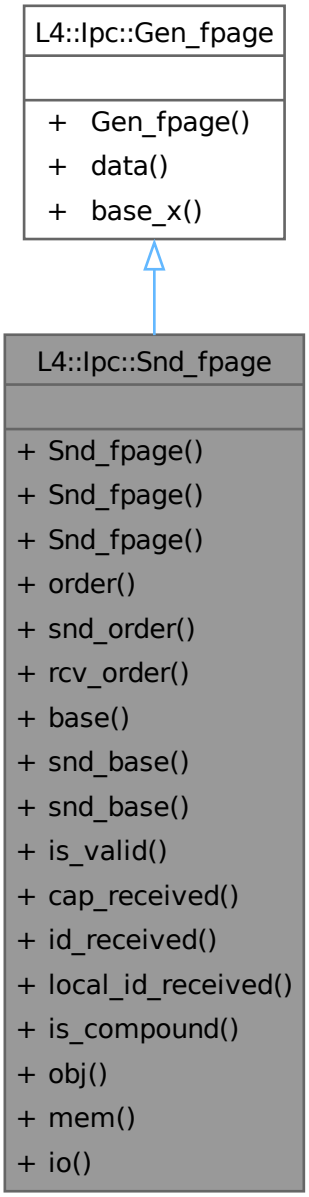
15.132 L4::Ipc::Snd_fpage Class Reference

Send item or return item.
`#include <ipc_types>`

Inheritance diagram for L4::Ipc::Snd_fpage:



Collaboration diagram for L4::Ipc::Snd_fpage:



Public Types

- enum Map_type { Map = L4_MAP_ITEM_MAP , Grant = L4_MAP_ITEM_GRANT }

  (Defined for send items only.) Kind of mapping.
- enum Cacheopt { None = 0 , Cached = L4_FPAGE_CACHEABLE << 4 , Buffered = L4_FPAGE_↩ BUFFERABLE << 4 , Uncached = L4_FPAGE_UNCACHEABLE << 4 }

  (Defined for memory send items only.) Caching options, see l4_fpage_cacheability_opt_t.
- enum Continue { Single = 0 , Last = 0 , More = L4_ITEM_CONT , Compound = L4_ITEM_CONT }

  Specify if the following item is associated with the same receive item as this one, see L4_ITEM_CONT.

Public Types inherited from L4::Ipc::Gen_fpage

- enum Type { Special = L4_FPAGE_SPECIAL << 4 , Memory = L4_FPAGE_MEMORY << 4 , Io = L4_↩ FPAGE_IO << 4 , Obj = L4_FPAGE_OBJ << 4 }

  Type of mapping object, see L4_fpage_type.

Public Member Functions

- **Snd_fpage** (l4_umword_t base=0, l4_umword_t data=0) noexcept

  Construct from raw values.
- Snd_fpage (l4_fpage_t const &fp, l4_addr_t snd_base=0, Map_type map_type=Map, Cacheopt cache=None, Continue cont=Last) noexcept

  Construct a send item for the memory space.
- Snd_fpage (L4::Cap< void > cap, unsigned rights, Map_type map_type=Map) noexcept

  Construct a send item for the object space.
- unsigned **order** () const noexcept

  (Defined only if send item or if local_id_received() is true.) Get $\log_2$ size.
- unsigned **snd_order** () const noexcept

  (Defined only if send item or if local_id_received() is true.) Get $\log_2$ size.
- unsigned **rcv_order** () const noexcept

  (Defined for return items only.) Get $\log_2$ size.
- l4_addr_t **base** () const noexcept

  (Defined only if send item or if local_id_received() is true.) Get the start of the item (i.e., the start of its flexpage).
- l4_addr_t **snd_base** () const noexcept

  Get the position in receive window for the case that this item has a different size than the corresponding receive item.
- void **snd_base** (l4_addr_t b) noexcept

  Set the position in receive window for the case that this item has a different size than the corresponding receive item.
- bool **is_valid** () const noexcept

  Check if the capability is valid.
- bool cap_received () const noexcept

  (Defined for return items only.) Check if at least one object capability has been mapped for this item.
- bool id_received () const noexcept

  (Defined for return items only.) Check if an IPC gate label has been received instead of a mapping.
- bool local_id_received () const noexcept

  (Defined for return items only.) Check if a raw object flexpage has been received instead of a mapping.
- bool is_compound () const noexcept

  Check if the item has the compound bit set, see Continue.

Public Member Functions inherited from L4::Ipc::Gen_fpage

- **Gen_fpage** (l4_umword_t base, l4_umword_t data) noexcept

  Construct from raw values.
- l4_umword_t **data** () const noexcept

  Return the raw flexpage descriptor.
- l4_umword_t **base_x** () const noexcept

  Return the raw base descriptor.

Static Public Member Functions

- static Snd_fpage obj (l4_cap_idx_t base, int order, unsigned char rights, l4_addr_t snd_base=0, Map_type map_type=Map, Continue cont=Last) noexcept

  Construct a send item for the object space.
- static Snd_fpage mem (l4_addr_t base, int order, unsigned char rights, l4_addr_t snd_base=0, Map_type map_type=Map, Cacheopt cache=None, Continue cont=Last) noexcept

  Construct a send item for the memory space.
- static Snd_fpage io (unsigned long base, int order, unsigned char rights, l4_addr_t snd_base=0, Map_type map_type=Map, Continue cont=Last) noexcept

  Construct a send item for the I/O port space.

15.132.1 Detailed Description

Send item or return item.
This class represents a typed message item in the message registers of the UTCB. If it is provided by the sender, then it is a *send item*. If it is provided by the kernel during IPC, it is a *return item*.
Note that some members are dedicated for send items only or return items only.
Definition at line 299 of file ipc_types.

15.132.2 Member Enumeration Documentation

15.132.2.1 Cacheopt

`enum L4::Ipc::Snd_fpage::Cacheopt`
(Defined for memory send items only.) Caching options, see l4_fpage_cacheability_opt_t.

Enumerator

None	Copy options from sender.
Cached	Cacheability option to enable caches for the mapping.
Buffered	Cacheability option to enable buffered writes for the mapping.
Uncached	Cacheability option to disable caching for the mapping.

Definition at line 312 of file ipc_types.

15.132.2.2 Continue

`enum L4::Ipc::Snd_fpage::Continue`
Specify if the following item is associated with the same receive item as this one, see L4_ITEM_CONT.

Enumerator

Single	Inverse of Compound.
Last	Inverse of More.
More	Alias for Compound.
Compound	Denote that the following item shall be put into the same receive item as this one.

Definition at line 322 of file ipc_types.

15.132.2.3 Map_type

`enum L4::Ipc::Snd_fpage::Map_type`
(Defined for send items only.) Kind of mapping.

Enumerator

Map	Flag as usual *map* operation.
Grant	Flag as *grant* instead of *map* operation. This means, the sender delegates access to the receiver and the kernel removes the rights from the sender (basically a move operation). The mapping in the receiver gets the new parent of any child mappings of the mapping of the sender. Rights revocation via send item/flexpage is *not* guaranteed to be applied to descendant mappings in case of grant. See Spaces and Mappings for more details on map/grant. **Note** The grant operation is not performed if the resulting rights of the receiver mapping would not contain the L4_CAP_FPAGE_R bit (for object capabilities) or none of the L4_FPAGE_RWX bits (memory and IO ports). In that case, the mapping is not created in the receiver space and not removed from the sender space. If the removal of the whole mapping from the sender is not possible because the size of the mapped frame at the sender exceeds the size defined by the send or receive flexpage, the grant operation is turned into a regular map operation and the mapping is *not* removed from the sender. This would happen if, for example, a smaller part of an L4 superpage mapping shall be granted.

Definition at line 304 of file ipc_types.

15.132.3 Constructor & Destructor Documentation

15.132.3.1 Snd_fpage() [1/2]

```
L4::Ipc::Snd_fpage::Snd_fpage (
             l4_fpage_t const & fp,
             l4_addr_t snd_base = 0,
             Map_type map_type = Map,
             Cacheopt cache = None,
             Continue cont = Last)  [inline], [noexcept]
```

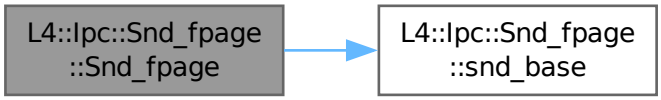
Construct a send item for the memory space.

Parameters

fp	Memory flexpage defining which range and kind of capabilities shall be sent (see l4_fpage()).
snd_base	Position in receive window in case it has a different size than `fp`.
map_type	See Map_type.
cache	See Cacheopt.
cont	See Continue.

Definition at line 346 of file ipc_types.
References L4_ITEM_MAP, Last, Map, None, and snd_base().

Here is the call graph for this function:



15.132.3.2 Snd_fpage() [2/2]

```
L4::Ipc::Snd_fpage::Snd_fpage (
            L4::Cap< void > cap,
            unsigned rights,
            Map_type map_type = Map)  [inline], [noexcept]
```

Construct a send item for the object space.

Parameters

cap	Capability to be sent.
rights	Permissions to be transferred. See L4_cap_fpage_rights and Attributes and additional permissions for object send items.
map_type	See Map_type.

Definition at line 362 of file ipc_types.
References L4_ITEM_MAP, and Map.

15.132.4 Member Function Documentation

15.132.4.1 cap_received()

```
bool L4::Ipc::Snd_fpage::cap_received () const  [inline], [noexcept]
```

(Defined for return items only.) Check if at least one object capability has been mapped for this item.
The capabilities themselves can then be retrieved from the cap slots that have been provided in the receive operation.

Note

If this function returns `true` and the receive window covers more than one capability slot, then it is not possible to determine which slots actually got capabilities mapped from the sender.

If the received capabilities do not have type object (see L4_FPAGE_OBJ), then this function returns `false`.

Definition at line 472 of file ipc_types.

15.132.4.2 id_received()

```
bool L4::Ipc::Snd_fpage::id_received () const  [inline], [noexcept]
```

(Defined for return items only.) Check if an IPC gate label has been received instead of a mapping.
If the L4_RCV_ITEM_LOCAL_ID flag has been set by the receiver, the conditions for local_id_received() do not apply, the sender sent an IPC gate capability, and the receiving thread is in the same task as the thread that is attached to the IPC gate, then no mapping is done for this item and only the bitwise OR (|) of the label of the IPC gate and the special and write permission (L4_CAP_FPAGE_S and L4_CAP_FPAGE_W) that would have been mapped is received.

The bitwise OR of the label and the permissions can be retrieved with Gen_fpage::data().
Definition at line 488 of file ipc_types.

15.132.4.3 io()

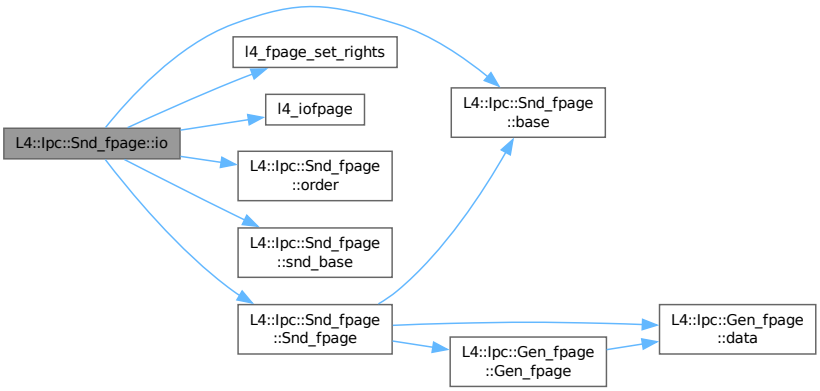
```
Snd_fpage L4::Ipc::Snd_fpage::io (
            unsigned long base,
            int order,
            unsigned char rights,
            l4_addr_t snd_base = 0,
            Map_type map_type = Map,
            Continue cont = Last)  [inline], [static], [noexcept]
```

Construct a send item for the I/O port space.

Parameters

base	Start of flexpage (see l4_iofpage()).
order	Log_2 size of flexpage (see l4_iofpage()).
rights	Permissions of flexpage (see L4_fpage_rights).
snd_base	Position in receive window in case it has a different size than `1 << order`.
map_type	See Map_type.
cont	See Continue.

Definition at line 421 of file ipc_types.
References base(), l4_fpage_set_rights(), l4_iofpage(), Last, Map, None, order(), snd_base(), and Snd_fpage().
Here is the call graph for this function:



15.132.4.4 is_compound()

```
bool L4::Ipc::Snd_fpage::is_compound () const  [inline], [noexcept]
```

Check if the item has the compound bit set, see Continue.
A set compound bit means the next message item of the same type will be mapped to the same receive buffer as this message item.
Definition at line 511 of file ipc_types.

15.132.4.5 local_id_received()

```
bool L4::Ipc::Snd_fpage::local_id_received () const  [inline], [noexcept]
```

(Defined for return items only.) Check if a raw object flexpage has been received instead of a mapping.
If the L4_RCV_ITEM_LOCAL_ID flag has been set by the receiver, and sender and receiver are in the same task, then no mapping is done for this item and only the raw flexpage (l4_fpage_t) is received.
This function checks if this is the case and if it is an object flexpage.
The flexpage can be retrieved with Gen_fpage::data().

Note

If a raw flexpage was received, but it does not have type object (see L4_FPAGE_OBJ), then this function returns `false`.

Definition at line 504 of file ipc_types.

15.132.4.6 mem()

```
Snd_fpage L4::Ipc::Snd_fpage::mem (
             l4_addr_t base,
             int order,
             unsigned char rights,
             l4_addr_t snd_base = 0,
             Map_type map_type = Map,
             Cacheopt cache = None,
             Continue cont = Last)  [inline], [static], [noexcept]
```

Construct a send item for the memory space.

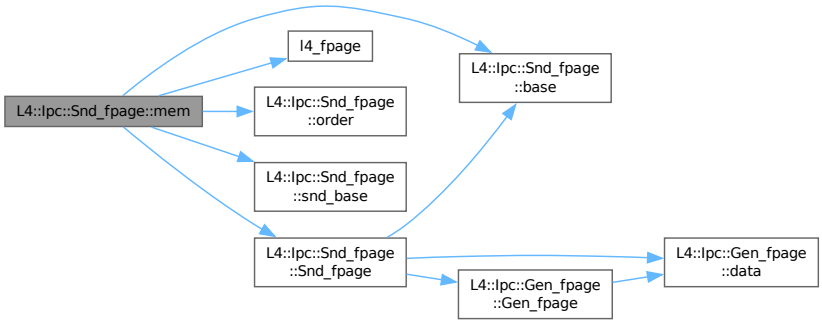
Parameters

base	Start of flexpage (see l4_fpage()).
order	Log_2 size of flexpage (see l4_fpage()).
rights	Permissions of flexpage (see l4_fpage()).
snd_base	Position in receive window in case it has a different size than `1 << order`.
map_type	See Map_type.
cache	See Cacheopt.
cont	See Continue.

Examples

examples/libs/l4re/streammap/server.cc.

Definition at line 400 of file ipc_types.
References base(), l4_fpage(), Last, Map, None, order(), snd_base(), and Snd_fpage().
Here is the call graph for this function:



15.132.4.7 obj()

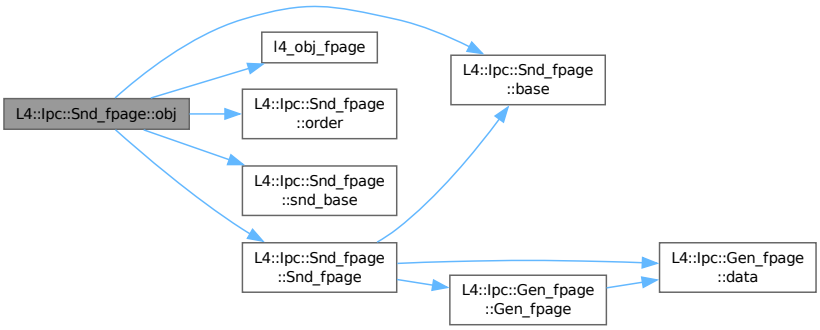
```
Snd_fpage L4::Ipc::Snd_fpage::obj (
            l4_cap_idx_t base,
            int order,
            unsigned char rights,
            l4_addr_t snd_base = 0,
            Map_type map_type = Map,
            Continue cont = Last)  [inline], [static], [noexcept]
```

Construct a send item for the object space.

Parameters

base	Start of flexpage (see l4_obj_fpage()).
order	Log_2 size of flexpage (see l4_obj_fpage()).
rights	Permissions of flexpage (see l4_obj_fpage()).
snd_base	Position in receive window in case it has a different size than `1 << order`.
map_type	See Map_type.
cont	See Continue.

Definition at line 378 of file ipc_types.
References base(), l4_obj_fpage(), Last, Map, None, order(), snd_base(), and Snd_fpage().
Here is the call graph for this function:



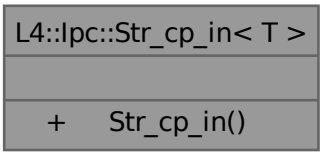
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_types

15.133 L4::Ipc::Str_cp_in< T > Class Template Reference

Abstraction for extracting a zero-terminated string from an Ipc::Istream.
`#include <ipc_stream>`

Collaboration diagram for L4::Ipc::Str_cp_in< T >:



Public Member Functions

- Str_cp_in (T *v, unsigned long &size)

  Create a buffer for extracting an array from an Ipc::Istream.

15.133.1 Detailed Description

template<typename T>
class L4::Ipc::Str_cp_in< T >

Abstraction for extracting a zero-terminated string from an Ipc::Istream.
An instance of Str_cp_in can be used to extract a zero-terminated string an Ipc::Istream. The data from the received message is thereby copied to the given buffer and size is set to the number of characters found in the stream. The string is zero terminated in any circumstances. When the given buffer is smaller than the received string the last byte in the buffer will be the zero terminator. In the case the received string is shorter than the given buffer the zero termination will be placed behind the received data. This provides a zero-terminated result even in cases where the sender did not provide proper termination or in cases of too small receiver buffers.

See also

str_cp_in().

Definition at line 178 of file ipc_stream.

15.133.2 Constructor & Destructor Documentation

15.133.2.1 Str_cp_in()

```
template<typename T>
L4::Ipc::Str_cp_in< T >::Str_cp_in (
            T * v,
            unsigned long & size)  [inline]
```

Create a buffer for extracting an array from an Ipc::Istream.

Parameters

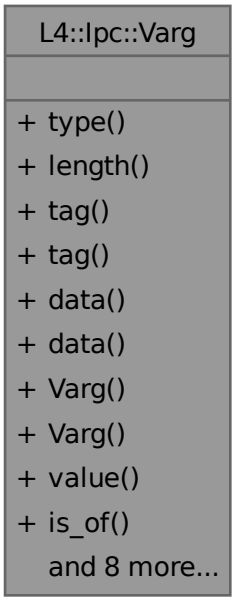
	v	The buffer for string.
in,out	*size*	Input: The number of bytes available in v Output: The number of bytes received (including the terminator).

Definition at line 189 of file ipc_stream.
The documentation for this class was generated from the following file:

- l4/cxx/ipc_stream

15.134 L4::Ipc::Varg Class Reference

Variably sized RPC argument.
`#include <ipc_varg>`
Collaboration diagram for L4::Ipc::Varg:



Public Types

- using **Tag** = l4_umword_t

  The data type for the tag.

Public Member Functions

- L4_varg_type type () const
- unsigned length () const

  Get the size of the RPC argument.
- Tag tag () const
- void **tag** (Tag tag)

  Set Varg tag (usually from message).
- void **data** (char const *d)

  Set Varg to indirect data value (usually in UTCB).
- char const * data () const
- **Varg** ()=default

  Make uninitialized Varg.
- **Varg** (L4_varg_type t, void const *v, int len)

  Make an indirect varg.
- template<typename V>
  Va_type< V >::Ret_value value () const
- template<typename T>
  bool is_of () const

- bool is_nil () const
- bool is_of_int () const
- template<typename T>
  bool get_value (typename Va_type< T >::Value *v) const

  Get the value of the Varg as type T.
- template<typename T>
  void **set_value** (void const *d)

  Set to indirect value of type T.
- template<typename T>
  void **set_direct_value** (T val, L4::Types::Enable_if_t< sizeof(T)<=sizeof(char const *), bool >=true)

  Set to directly stored value of type T.
- template<typename T>
  Varg (T const *data)

  Make Varg from indirect value (pointer).
- **Varg** (char const *data)

  Make Varg from null-terminated string.
- template<typename T>
  Varg (T data, L4::Types::Enable_if_t< sizeof(T)<=sizeof(char const *), bool >=true)

  Make Varg from direct value.

15.134.1 Detailed Description

Variably sized RPC argument.
Definition at line 96 of file ipc_varg.

15.134.2 Member Function Documentation

15.134.2.1 data()

```
char const * L4::Ipc::Varg::data () const  [inline]
```

Returns

pointer to the data, also safe for direct data

Definition at line 129 of file ipc_varg.

15.134.2.2 get_value()

```
template<typename T>
bool L4::Ipc::Varg::get_value (
            typename Va_type< T >::Value * v) const  [inline]
```

Get the value of the Varg as type T.

Template Parameters

T	The expected type of the Varg.

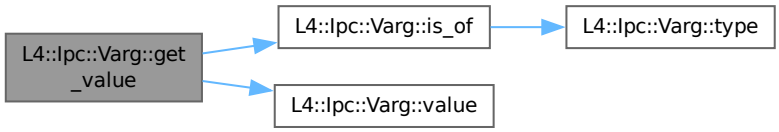
Parameters

v	Pointer to store the value

Returns

true when the Varg is of type T, false if not

Definition at line 191 of file ipc_varg.
References is_of(), and value().
Here is the call graph for this function:



15.134.2.3 is_nil()

```
bool L4::Ipc::Varg::is_nil () const  [inline]
```

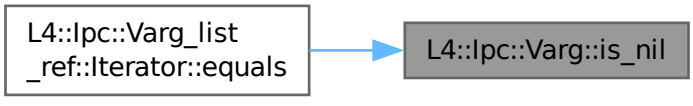
Returns

true if the Varg is of nil type.

Definition at line 178 of file ipc_varg.
References is_of().
Referenced by L4::Ipc::Varg_list_ref::Iterator::equals().
Here is the call graph for this function:



Here is the caller graph for this function:



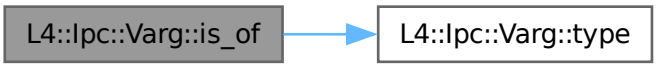
15.134.2.4 is_of()

```
template<typename T>
bool L4::Ipc::Varg::is_of () const  [inline]
```

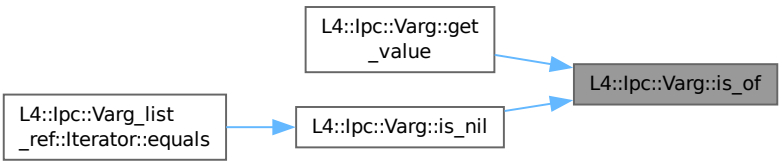
Returns

true if the Varg is of type T

Definition at line 175 of file ipc_varg.
References type().
Referenced by get_value(), and is_nil().
Here is the call graph for this function:



Here is the caller graph for this function:



15.134.2.5 is_of_int()

```
bool L4::Ipc::Varg::is_of_int () const  [inline]
```

Returns

true if the Varg is an integer type (signed or unsigned).

Definition at line 181 of file ipc_varg.
References type().
Here is the call graph for this function:



15.134.2.6 length()

```
unsigned L4::Ipc::Varg::length () const  [inline]
```

Get the size of the RPC argument.

Returns

The size of the RPC argument

Definition at line 114 of file ipc_varg.

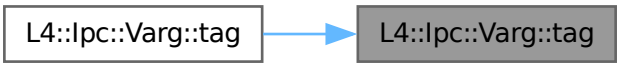
15.134.2.7 tag()

```
Tag L4::Ipc::Varg::tag () const  [inline]
```

Returns

the tag value (the Direct_data bit masked)

Definition at line 116 of file ipc_varg.
Referenced by tag().
Here is the caller graph for this function:



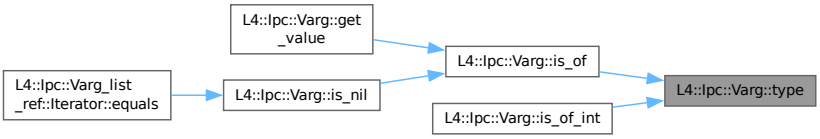
15.134.2.8 type()

```
L4_varg_type L4::Ipc::Varg::type () const  [inline]
```

Returns

the type field of the tag

Definition at line 109 of file ipc_varg.
Referenced by is_of(), and is_of_int().
Here is the caller graph for this function:



15.134.2.9 value()

```
template<typename V>
Va_type< V >::Ret_value L4::Ipc::Varg::value () const  [inline]
```

Template Parameters

V	The data type of the value to retrieve.

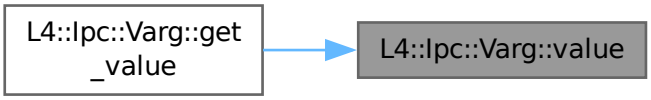
Precondition

The Varg must be of type *V* (otherwise the result is unpredictable).

Returns

The value of the Varg as type V.

Definition at line 161 of file ipc_varg.
Referenced by get_value().
Here is the caller graph for this function:

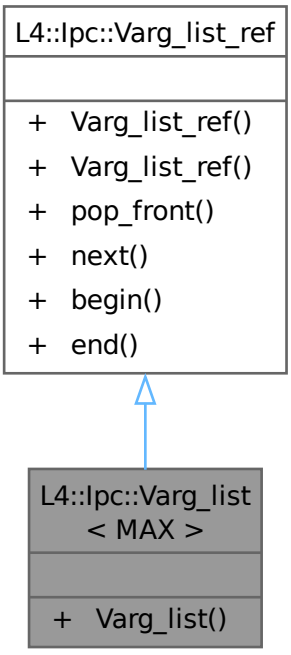


The documentation for this class was generated from the following file:

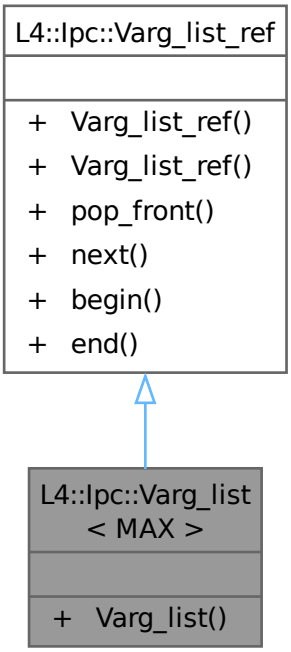
- l4/sys/cxx/ipc_varg

15.135 L4::Ipc::Varg_list< MAX > Class Template Reference

Self-contained list of variable-sized RPC parameters.
`#include <ipc_varg>`
Inheritance diagram for L4::Ipc::Varg_list< MAX >:



Collaboration diagram for L4::Ipc::Varg_list< MAX >:



Public Member Functions

- **Varg_list** (Varg_list_ref const &r)

  Create a parameter list as a copy from a referencing list.

Public Member Functions inherited from L4::Ipc::Varg_list_ref

- **Varg_list_ref** ()=default

  Create an empty parameter list.
- Varg_list_ref (void const *start, void const *end)

  Create a parameter list over a given memory region.
- Varg **pop_front** ()

  Get the next parameter in the list.
- Varg **next** ()

  Get the next parameter in the list.
- Iterator **begin** () const

  Returns an iterator to the first Varg.
- Iterator **end** () const

  Returns the end of the list.

15.135.1 Detailed Description

template<unsigned MAX>
class L4::Ipc::Varg_list< MAX >

Self-contained list of variable-sized RPC parameters.

Works like Varg_list_ref but contains a full copy of the data. Use this as a parameter in server functions, if the handler function needs to use the UTCB (e.g. while sending further IPC).

Template Parameters

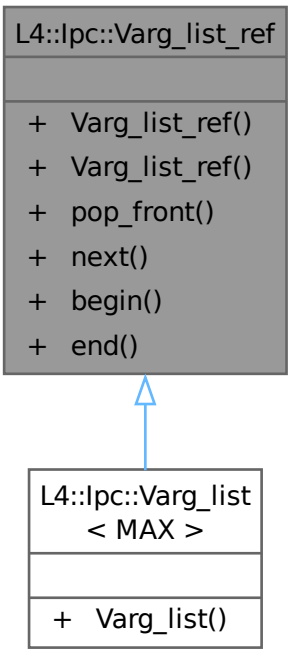
MAX	Size of the copy, in machine words. A list that does not fit is truncated; the default is large enough for any list that can arrive in the message registers.

Definition at line 421 of file ipc_varg.
The documentation for this class was generated from the following file:

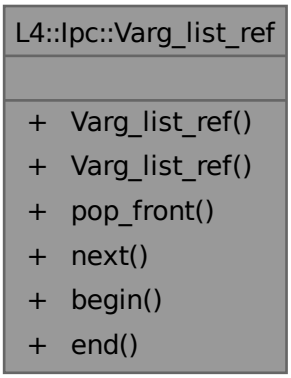
- l4/sys/cxx/ipc_varg

15.136 L4::Ipc::Varg_list_ref Class Reference

List of variable-sized RPC parameters as received by the server.
`#include <ipc_varg>`
Inheritance diagram for L4::Ipc::Varg_list_ref:



Collaboration diagram for L4::Ipc::Varg_list_ref:



Data Structures

- class Iterator

  Iterator for Valists.

Public Member Functions

- **Varg_list_ref** ()=default

  Create an empty parameter list.
- Varg_list_ref (void const ∗start, void const ∗end)

  Create a parameter list over a given memory region.
- Varg **pop_front** ()

  Get the next parameter in the list.
- Varg **next** ()

  Get the next parameter in the list.
- Iterator **begin** () const

  Returns an iterator to the first Varg.
- Iterator **end** () const

  Returns the end of the list.

15.136.1 Detailed Description

List of variable-sized RPC parameters as received by the server.
The list can be traversed exactly once using *next()*.
This is a reference list, where the returned Varg point to data in the underlying storage, conventionally the UTCB. This type should only be used in server functions when the implementation can ensure that all content is read before the UTCB is reused (e.g. for IPC), otherwise use Varg_list.
Definition at line 259 of file ipc_varg.

15.136.2 Constructor & Destructor Documentation

15.136.2.1 Varg_list_ref()

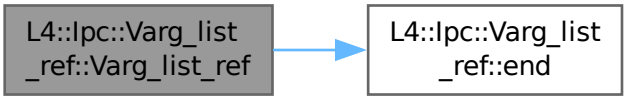
```
L4::Ipc::Varg_list_ref::Varg_list_ref (
            void const * start,
            void const * end)  [inline]
```

Create a parameter list over a given memory region.

Parameters

start	Pointer to start of the parameter list.
end	Pointer to end of the list (inclusive).

Definition at line 338 of file ipc_varg.
References end().
Here is the call graph for this function:

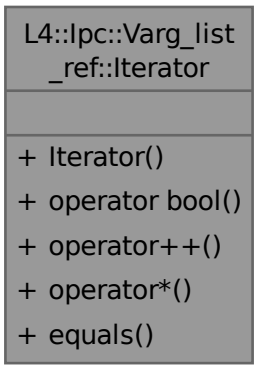


The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_varg

15.137 L4::Ipc::Varg_list_ref::Iterator Class Reference

Iterator for Valists.
`#include <ipc_varg>`
Collaboration diagram for L4::Ipc::Varg_list_ref::Iterator:



Public Member Functions

- **Iterator** (Iter_state const &s)

  Create a new iterator.

- **operator bool** () const

  validity check for the iterator
- Iterator & **operator++** ()

  increment iterator to the next arg
- Varg **operator*** () const

  dereference the iterator, get Varg
- bool **equals** (Iterator const &o) const

  check for equality

15.137.1 Detailed Description

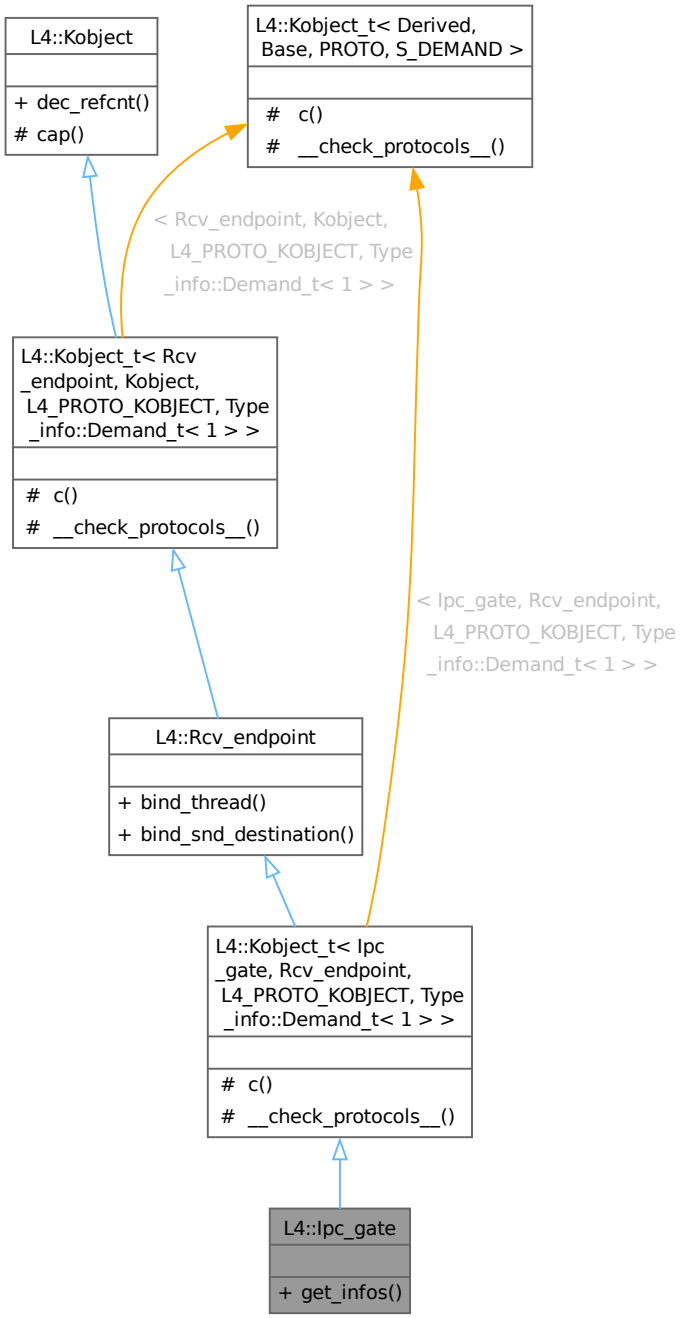
Iterator for Valists.
Definition at line 344 of file ipc_varg.
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_varg

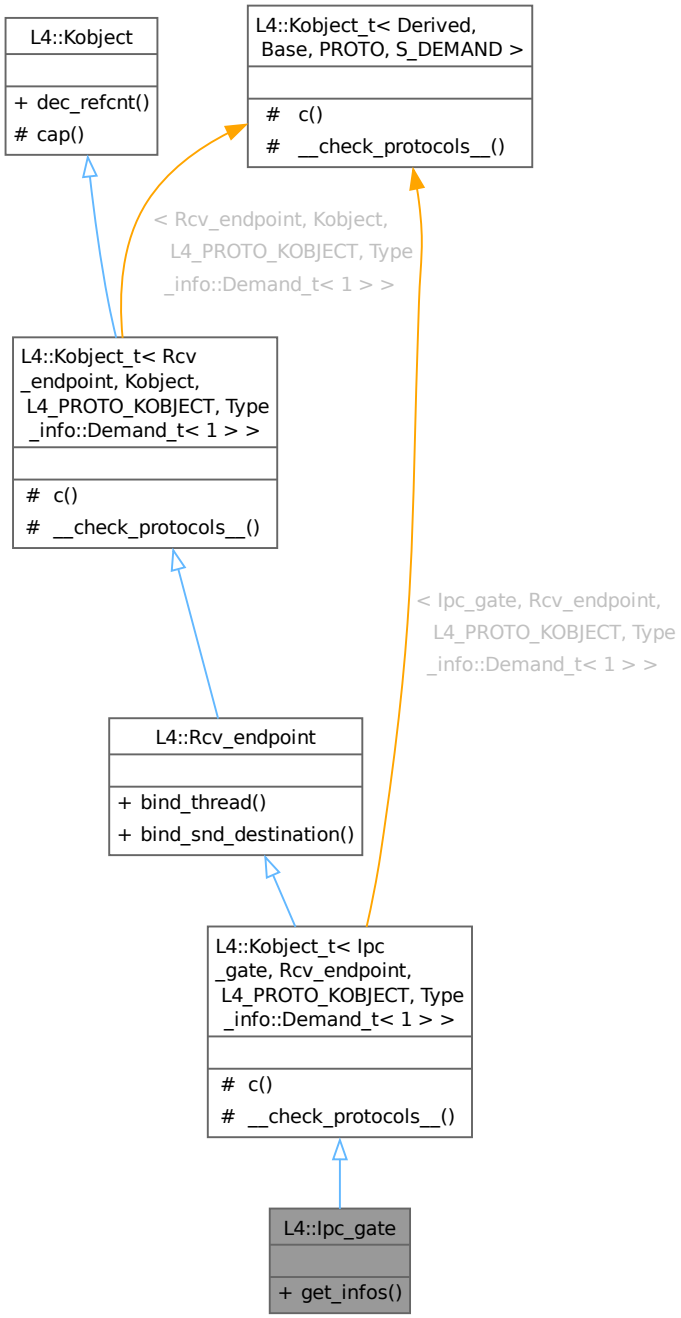
15.138 L4::Ipc_gate Class Reference

The C++ IPC gate interface, see IPC-Gate API for the C interface.
`#include <ipc_gate>`

Inheritance diagram for L4::Ipc_gate:



Collaboration diagram for L4::Ipc_gate:



Public Member Functions

- l4_msgtag_t get_infos (l4_umword_t *label)

  Get information about the IPC-gate.

Public Member Functions inherited from L4::Rcv_endpoint

- l4_msgtag_t bind_thread (Ipc::Cap< Thread > t, l4_umword_t label)

Bind the IPC receive endpoint to a thread.

- l4_msgtag_t bind_snd_destination (Cap< Snd_destination > snd_dst, l4_umword_t label)

  Bind a send destination (a thread or thread group) to an IPC receive endpoint.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Ipc_gate, Rcv_endpoint, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- typedef Ipc_gate **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Ipc_gate > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Rcv_endpoint::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- typedef Rcv_endpoint **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Rcv_endpoint > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Ipc_gate, Rcv_endpoint, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Ipc_gate, Rcv_endpoint, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.138.1 Detailed Description

The C++ IPC gate interface, see IPC-Gate API for the C interface.
IPC gates are used to create secure communication channels between protection domains. An IPC gate can be created using the L4::Factory interface.
Depending on the permissions of the capability used, an IPC gate forwards IPC to the L4::Thread or L4::Thread_group the IPC gate is *bound* to (cf. bind_thread() and bind_snd_destination()). If the capability has the L4_FPAGE_C_IPCGATE_SVR permission, only IPC using a protocol different from the L4_PROTO_KOBJECT protocol is forwarded. Without the L4_FPAGE_C_IPCGATE_SVR permission, all IPC is forwarded. The latter is the usual case for a client in a client/server scenario. When not bound to a thread or thread group yet, the forwarded IPC blocks until the IPC gate is bound to a thread or thread group, or the IPC times out.
Forwarded IPC is always forwarded to the userland of the thread the IPC gate is bound to, either directly or indirectly using a thread group. That means, the L4::Thread interface of that thread is not accessible via an IPC gate. The L4::Ipc_gate interface of an IPC gate is only accessible if the capability used has the L4_FPAGE_C_IPCGATE_SVR permission (cf. previous paragraph). Conversely that means, if the capability used lacks the L4_FPAGE_C_IPCGATE_SVR permission, L4::Ipc_gate interface calls are forwarded to the thread or thread group the IPC gate is bound to instead of being processed by the IPC gate itself. In a client/server scenario, a client should only get IPC gate capabilities without L4_FPAGE_C_IPCGATE_SVR permission so the client cannot tamper with the IPC gate.
When binding an IPC gate to a thread or thread group, a user-defined, kernel protected, machine-word sized payload called the IPC gate's *label* is assigned to the IPC gate (note that the two least significant bits of the label must be zero; cf. bind_thread() and bind_snd_destination()). When a send-only IPC or call IPC is forwarded via an IPC gate, the label provided by the sender is ignored and replaced by the IPC gate's label where the two least significant bits are set to the L4_CAP_FPAGE_S and L4_CAP_FPAGE_W permissions of the capability used. The replaced label is only visible to the thread the IPC gate is bound to (or to the selected thread of the thread group the IPC gate is bound to) upon receive. However, the configured label of an IPC gate can also be queried via get_infos() if the capability used has the L4_FPAGE_C_IPCGATE_SVR permission.
When deleting an IPC gate or when unbinding it from a thread or thread group, the label of IPC already in flight won't be changed. To ensure that no IPC from this IPC gate is received by a thread with an unexpected label, L4::Thread::modify_senders() shall be used to change the labels of every pending IPC to that gate. This is also required if the label of an already bound IPC gate is changed. It is not necessary after binding the IPC gate to a thread or thread group for the first time.
When binding a currently bound IPC gate to a new thread or thread group, the same label should be used that was used with the old thread. Otherwise the old and the new thread need to synchronize to avoid IPC messages with unexpected labels.

Include File

```
#include <l4/sys/ipc_gate>
```

For the C interface refer to the C IPC-Gate API.

See also

Object Invocation

Definition at line 85 of file ipc_gate.

15.138.2 Member Function Documentation

15.138.2.1 get_infos()

```
l4_msgtag_t L4::Ipc_gate::get_infos (
              l4_umword_t * label)
```

Get information about the IPC-gate.

Parameters

out	*label*	The label of the IPC gate is returned here.

Returns

System call return tag.

Precondition

If the IPC gate capability used to invoke this operation does not possess the L4_FPAGE_C_IPCGATE_SVR right, the kernel will not perform the operation. Instead, the underlying IPC message will be forwarded to the thread or thread group the IPC gate is bound to, blocking the caller if the IPC gate is not bound yet.

References get_infos().
Referenced by get_infos().
Here is the call graph for this function:



Here is the caller graph for this function:



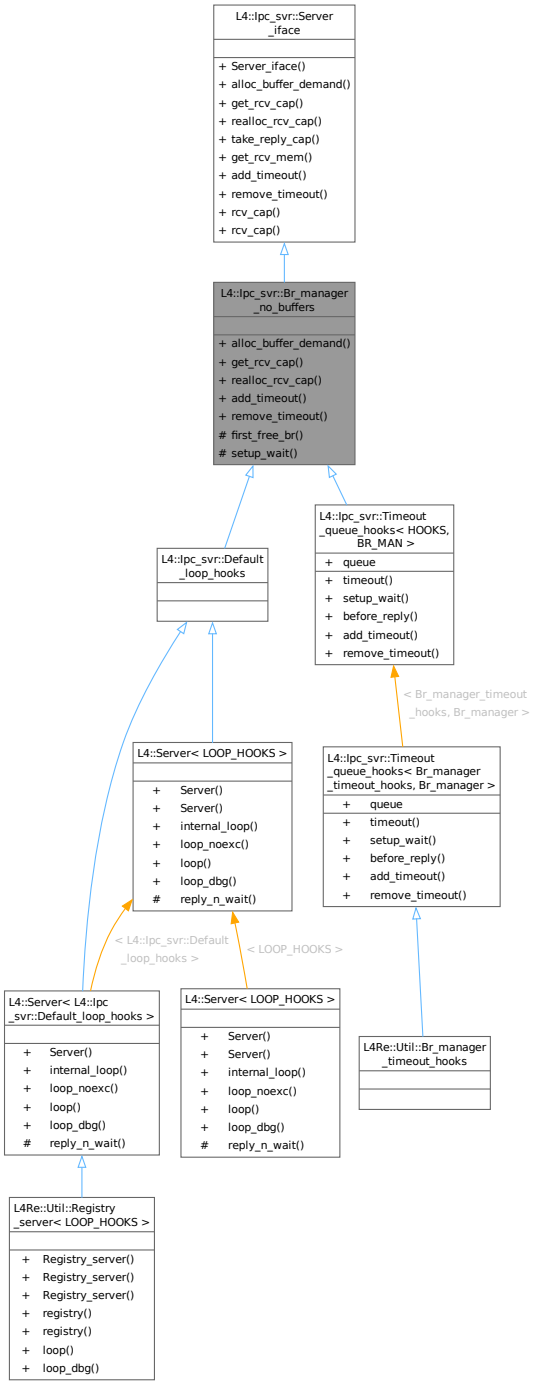
The documentation for this class was generated from the following file:

- l4/sys/ipc_gate

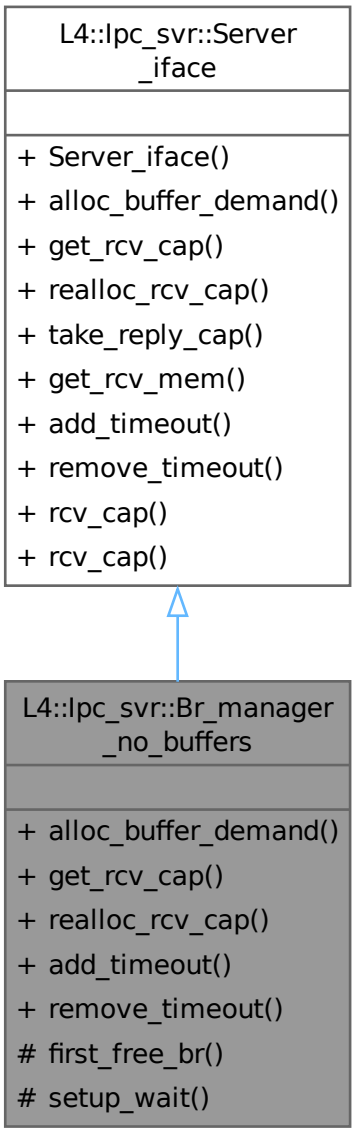
15.139 L4::Ipc_svr::Br_manager_no_buffers Class Reference

Empty implementation of Server_iface.
`#include <ipc_server_loop>`

Inheritance diagram for L4::Ipc_svr::Br_manager_no_buffers:



Collaboration diagram for L4::Ipc_svr::Br_manager_no_buffers:



Public Member Functions

- int alloc_buffer_demand (Demand const &demand) override

  Tells the server to allocate buffers for the given demand.
- L4::Cap< void > **get_rcv_cap** (int) const override

  Returns L4::Cap<void>::Invalid, we have no buffer management.
- int **realloc_rcv_cap** (int) override

  Returns -L4_ENOMEM, we have no buffer management.
- int **add_timeout** (Timeout *, l4_kernel_clock_t) override

  Returns -L4_ENOSYS, we have no timeout queue.
- int **remove_timeout** (Timeout *) override

  Returns -L4_ENOSYS, we have no timeout queue.

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- virtual cxx::Result< Mem_window > get_rcv_mem () noexcept

  Take the current memory receive window.
- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Protected Member Functions

- unsigned **first_free_br** () const

  Returns 1 as first free buffer.
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)

  Setup wait function for the server loop (Server<>).

Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

15.139.1 Detailed Description

Empty implementation of Server_iface.
This implementation of Server_iface provides no buffer or timeout management at all it just returns errors for all calls that express other than empty demands. However, this may be useful for very simple servers that serve simple server objects only.
Definition at line 233 of file ipc_server_loop.

15.139.2 Member Function Documentation

15.139.2.1 alloc_buffer_demand()

```
int L4::Ipc_svr::Br_manager_no_buffers::alloc_buffer_demand (
            Demand const & demand)  [inline], [override], [virtual]
```

Tells the server to allocate buffers for the given demand.

Parameters

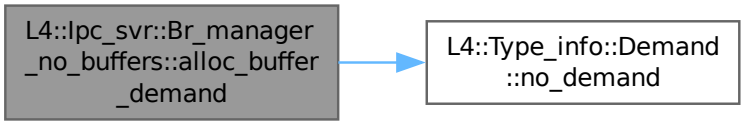
demand	The total server-side demand of receive buffers needed for a given interface, see Demand.

This function is not called by user applications directly. Usually the server implementation or the registry implementation calls this function whenever a new object is registered at the server.

Returns

success (0) if demand is empty, -L4_ENOMEM else.

Implements L4::Ipc_svr::Server_iface.
Definition at line 240 of file ipc_server_loop.
References L4_ENOMEM, L4_EOK, and L4::Type_info::Demand::no_demand().
Here is the call graph for this function:



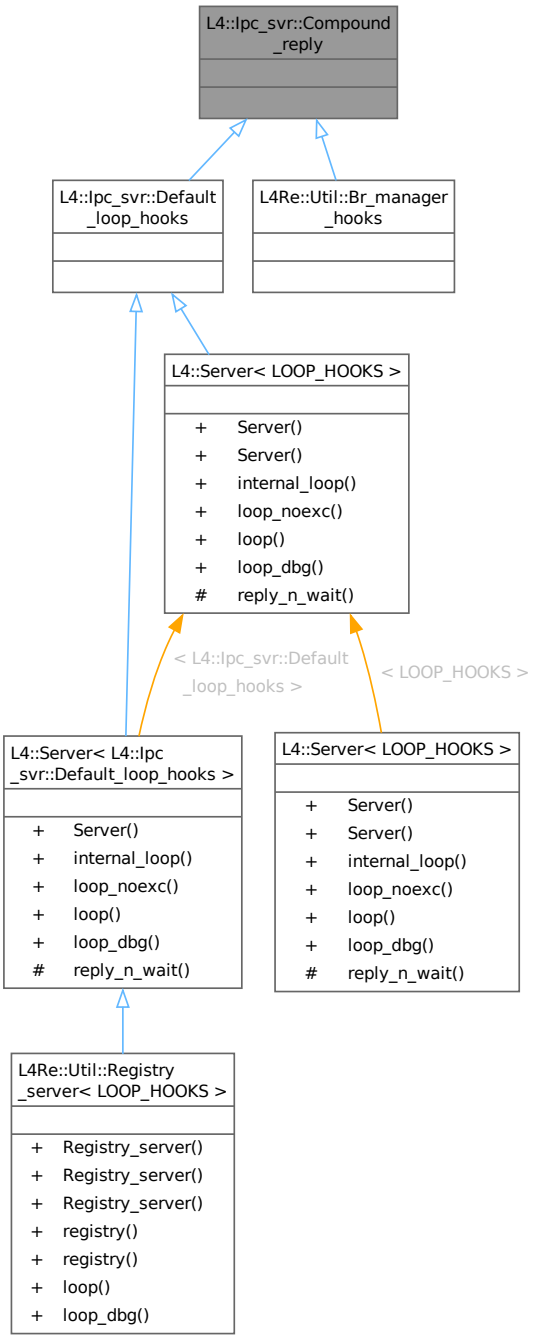
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_server_loop

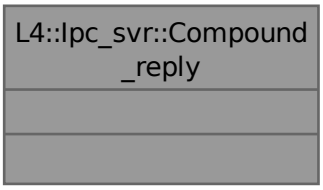
15.140 L4::Ipc_svr::Compound_reply Struct Reference

Mix in for LOOP_HOOKS to always use compound reply and wait.
`#include <ipc_server_loop>`

Inheritance diagram for L4::Ipc_svr::Compound_reply:



Collaboration diagram for L4::Ipc_svr::Compound_reply:



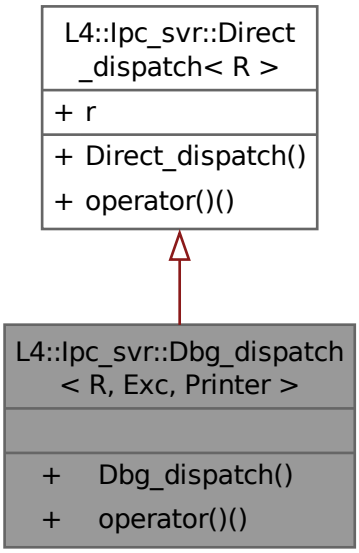
15.140.1 Detailed Description

Mix in for LOOP_HOOKS to always use compound reply and wait.
Definition at line 73 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

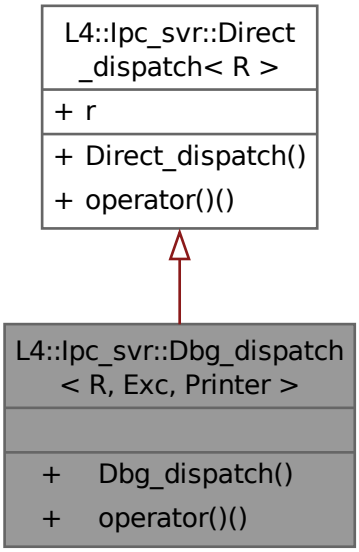
- l4/sys/cxx/ipc_server_loop

15.141 L4::Ipc_svr::Dbg_dispatch< R, Exc, Printer > Struct Template Reference

Dispatch helper that, in addition to what Exc_dispatch does, prints exception messages.
`#include <ipc_server_loop>`
Inheritance diagram for L4::Ipc_svr::Dbg_dispatch< R, Exc, Printer >:



Collaboration diagram for L4::Ipc_svr::Dbg_dispatch< R, Exc, Printer >:



Public Member Functions

- **Dbg_dispatch** (R r, Printer p)

  Make an exception handling dispatcher.
- l4_msgtag_t **operator()** (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)

  Dispatch the call via Direct_dispatch<R>(), handle exceptions, and print the exception message.

15.141.1 Detailed Description

template<typename R, typename Exc, typename Printer>
struct L4::Ipc_svr::Dbg_dispatch< R, Exc, Printer >

Dispatch helper that, in addition to what Exc_dispatch does, prints exception messages.

Template Parameters

R	Data type of the registry used for dispatching to objects.
Exc	Data type of the exceptions that shall be caught. This data type must provide a member err_no() that returns the negative integer (int) error code for the exception. In addition, methods str() and extra_str() are required that return a c-string describing the error.
Printer	A type that provides a printf() member that is used (with the usual format string syntax) to print error messages.

This dispatcher wraps Direct_dispatch<R> with a try-catch (Exc).
Definition at line 184 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

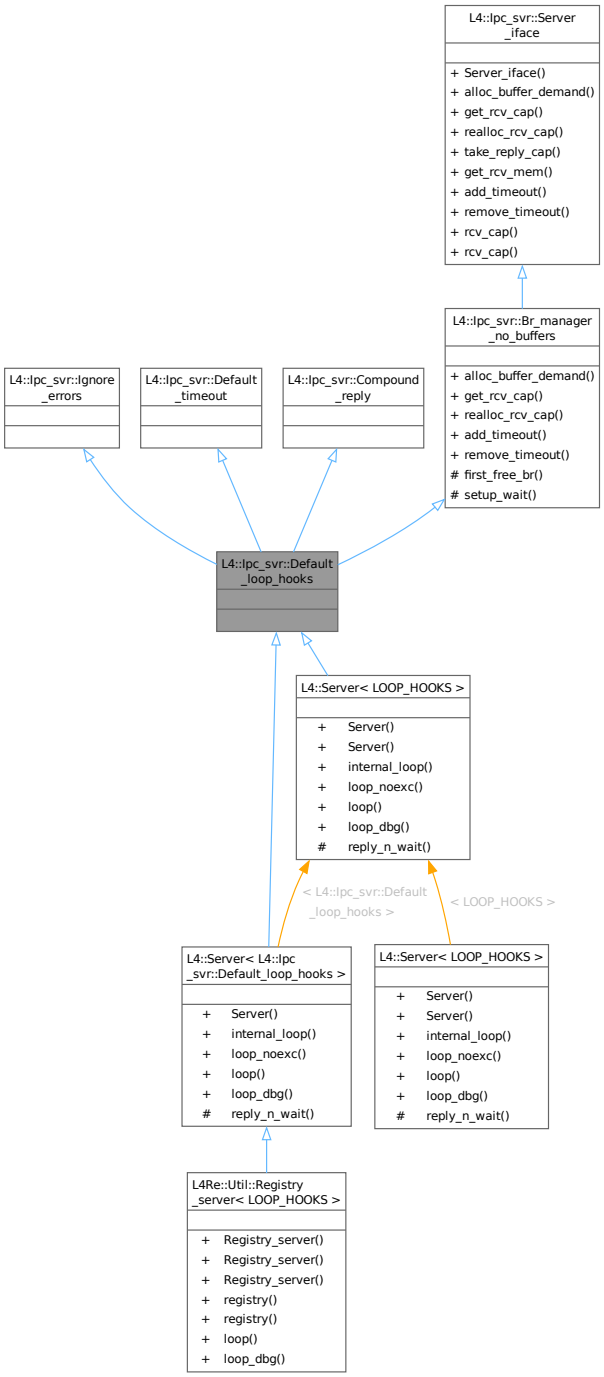
- l4/sys/cxx/ipc_server_loop

15.142 L4::Ipc_svr::Default_loop_hooks Struct Reference

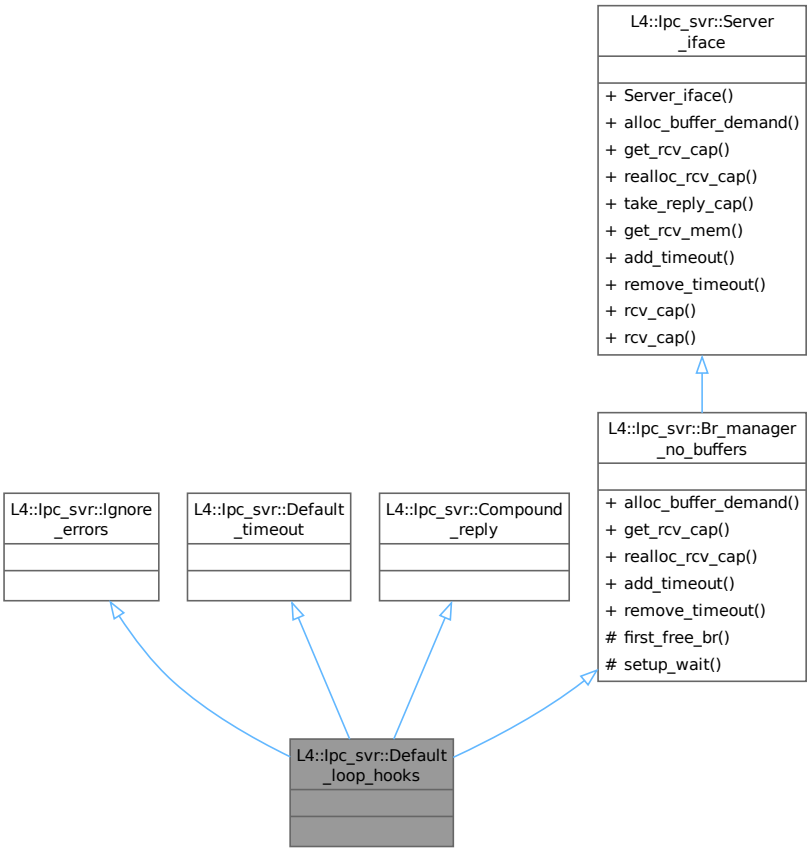
Default LOOP_HOOKS.

`#include <ipc_server_loop>`

Inheritance diagram for L4::Ipc_svr::Default_loop_hooks:



Collaboration diagram for L4::Ipc_svr::Default_loop_hooks:



Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

Public Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- int alloc_buffer_demand (Demand const &demand) override

  Tells the server to allocate buffers for the given demand.
- L4::Cap< void > **get_rcv_cap** (int) const override

  Returns L4::Cap<void>::Invalid, we have no buffer management.
- int **realloc_rcv_cap** (int) override

  Returns -L4_ENOMEM, we have no buffer management.
- int **add_timeout** (Timeout *, l4_kernel_clock_t) override

  Returns -L4_ENOSYS, we have no timeout queue.
- int **remove_timeout** (Timeout *) override

  Returns -L4_ENOSYS, we have no timeout queue.

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- virtual cxx::Result< Mem_window > get_rcv_mem () noexcept

  Take the current memory receive window.
- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Protected Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- unsigned **first_free_br** () const

  Returns 1 as first free buffer.
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)

  Setup wait function for the server loop (Server<>).

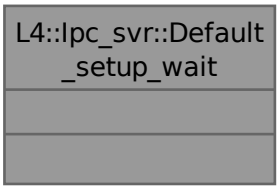
15.142.1 Detailed Description

Default LOOP_HOOKS.
Combination of Ignore_errors, Default_timeout, Compound_reply, and Br_manager_no_buffers.
Definition at line 285 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_server_loop

15.143 L4::Ipc_svr::Default_setup_wait Struct Reference

Mix in for LOOP_HOOKS for setup_wait no op.
`#include <ipc_server_loop>`
Collaboration diagram for L4::Ipc_svr::Default_setup_wait:



15.143.1 Detailed Description

Mix in for LOOP_HOOKS for setup_wait no op.
Definition at line 84 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

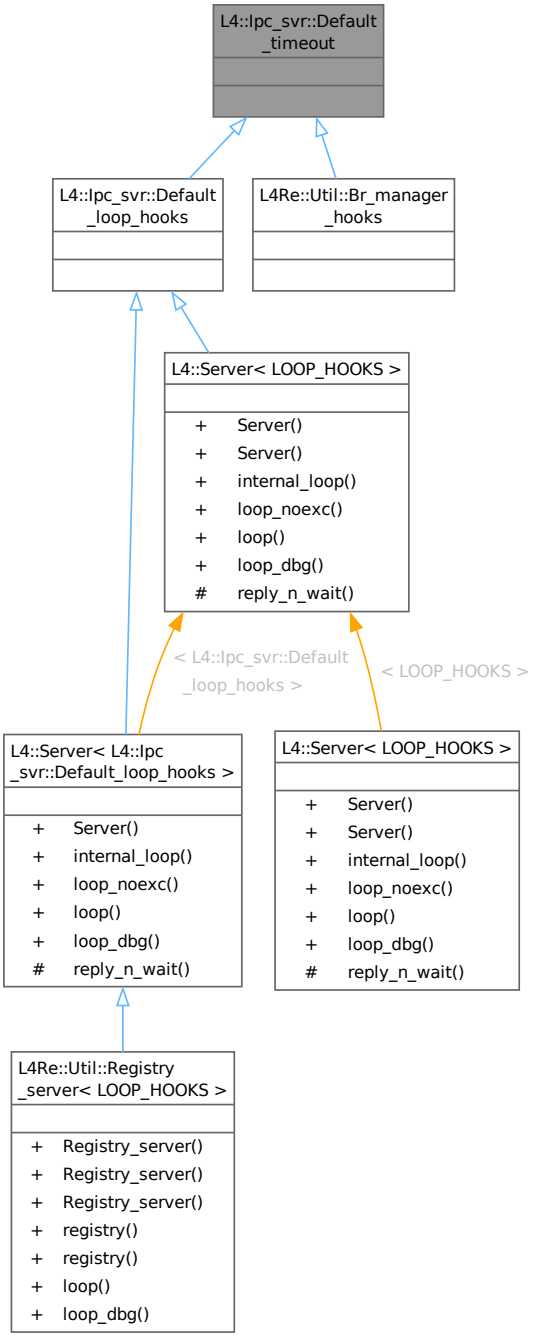
- l4/sys/cxx/ipc_server_loop

15.144 L4::Ipc_svr::Default_timeout Struct Reference

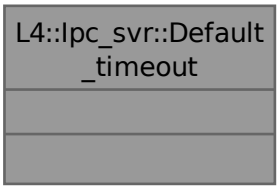
Mix in for LOOP_HOOKS to use a 0 send and an infinite receive timeout.

`#include <ipc_server_loop>`

Inheritance diagram for L4::Ipc_svr::Default_timeout:



Collaboration diagram for L4::Ipc_svr::Default_timeout:



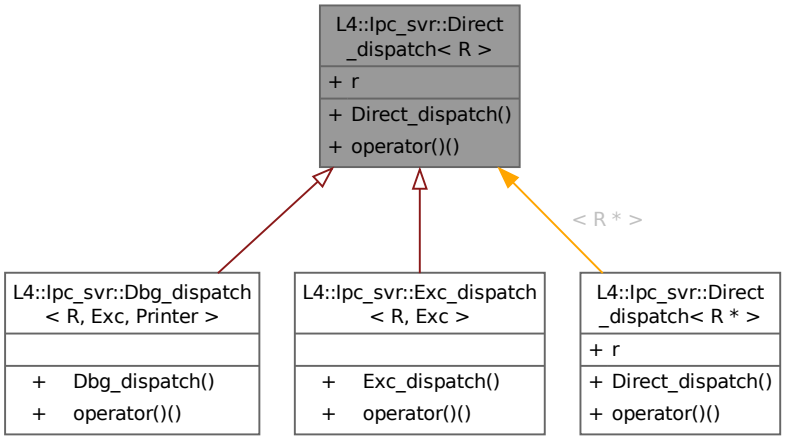
15.144.1 Detailed Description

Mix in for LOOP_HOOKS to use a 0 send and an infinite receive timeout.
Definition at line 65 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

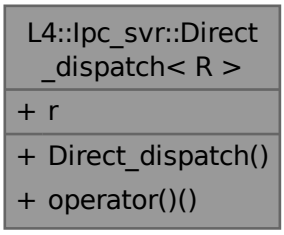
- l4/sys/cxx/ipc_server_loop

15.145 L4::Ipc_svr::Direct_dispatch< R > Struct Template Reference

Direct dispatch helper, for forwarding dispatch calls to a registry *R*.
`#include <ipc_server_loop>`
Inheritance diagram for L4::Ipc_svr::Direct_dispatch< R >:



Collaboration diagram for L4::Ipc_svr::Direct_dispatch< R >:



Public Member Functions

- **Direct_dispatch** (R &r)

  Make a direct dispatcher.
- l4_msgtag_t **operator()** (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)

  call operator forwarding to r.dispatch()

Data Fields

- R & **r**

  stores a reference to the registry object

15.145.1 Detailed Description

template<typename R>
struct L4::Ipc_svr::Direct_dispatch< R >

Direct dispatch helper, for forwarding dispatch calls to a registry *R*.

Template Parameters

R	Data type of the registry that is used for dispatching to different server objects, usually based on the protected IPC label.

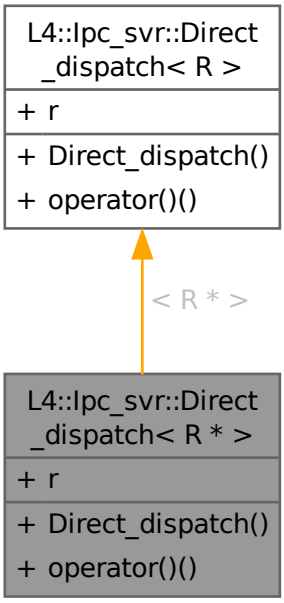
Definition at line 95 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_server_loop

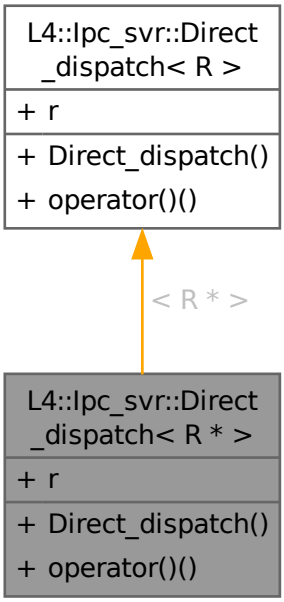
15.146 L4::Ipc_svr::Direct_dispatch< R * > Struct Template Reference

Direct dispatch helper, for forwarding dispatch calls via a pointer to a registry *R*.
`#include <ipc_server_loop>`

Inheritance diagram for L4::Ipc_svr::Direct_dispatch< R * >:



Collaboration diagram for L4::Ipc_svr::Direct_dispatch< R * >:



Public Member Functions

- **Direct_dispatch** (R *r)

  Make a direct dispatcher.
- l4_msgtag_t **operator()** (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)

  call operator forwarding to r->dispatch()

Data Fields

- R * **r**

  stores a pointer to the registry object

15.146.1 Detailed Description

template<typename R>
struct L4::Ipc_svr::Direct_dispatch< R * >

Direct dispatch helper, for forwarding dispatch calls via a pointer to a registry *R*.

Template Parameters

R	Data type of the registry that is used for dispatching to different server objects, usually based on the protected IPC label.

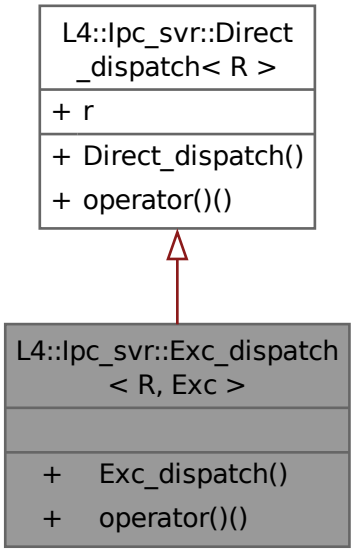
Definition at line 116 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_server_loop

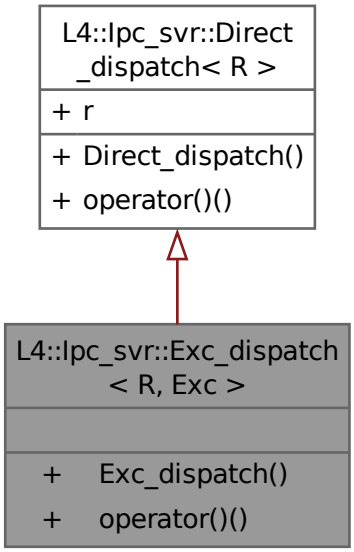
15.147 L4::Ipc_svr::Exc_dispatch< R, Exc > Struct Template Reference

Dispatch helper wrapping try {} catch {} around the dispatch call.
`#include <ipc_server_loop>`

Inheritance diagram for L4::Ipc_svr::Exc_dispatch< R, Exc >:



Collaboration diagram for L4::Ipc_svr::Exc_dispatch< R, Exc >:



Public Member Functions

- **Exc_dispatch** (R r)

Make an exception handling dispatcher.

- l4_msgtag_t **operator()** (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)

  Dispatch the call via Direct_dispatch<R>() and handle exceptions.

15.147.1 Detailed Description

template<typename R, typename Exc>
struct L4::Ipc_svr::Exc_dispatch< R, Exc >

Dispatch helper wrapping try {} catch {} around the dispatch call.

Template Parameters

R	Data type of the registry used for dispatching to objects.
Exc	Data type of the exceptions that shall be caught. This data type must provide a member err_no() that returns the negative integer (int) error code for the exception.

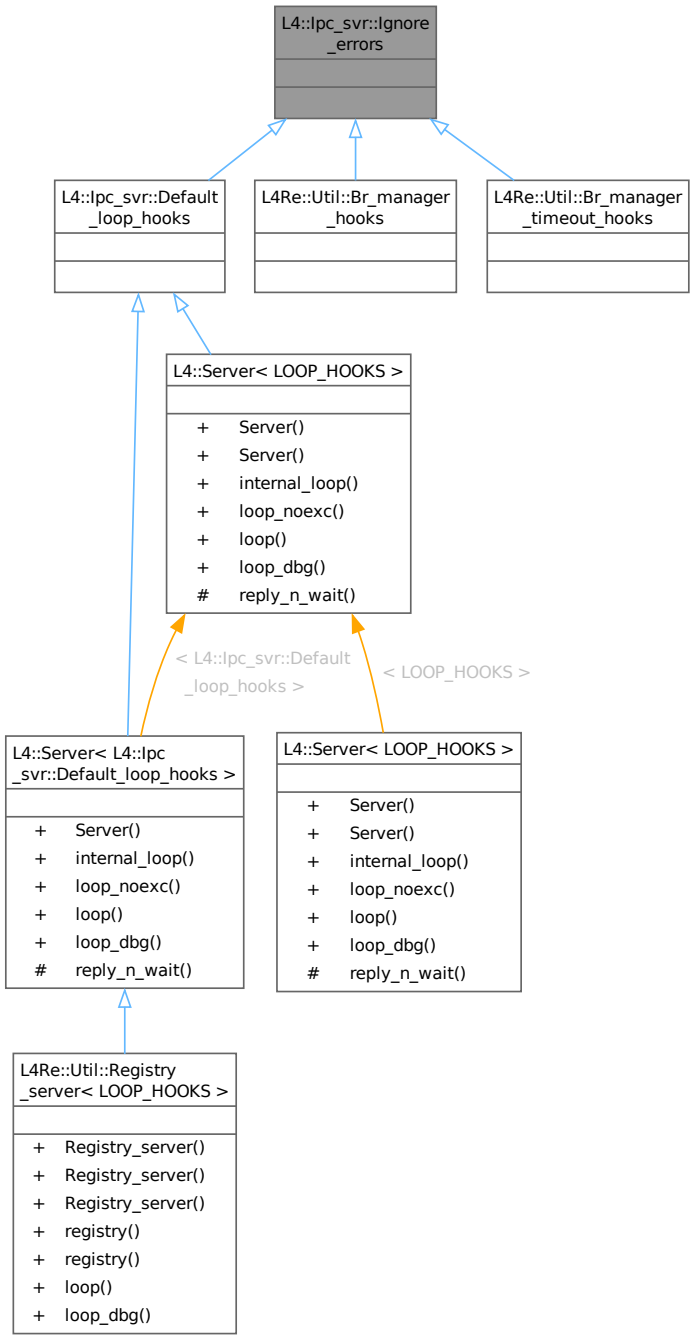
This dispatcher wraps Direct_dispatch<R> with a try-catch (Exc).
Definition at line 140 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_server_loop

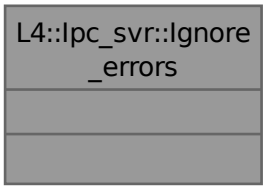
15.148 L4::Ipc_svr::Ignore_errors Struct Reference

Mix in for LOOP_HOOKS to ignore IPC errors.
`#include <ipc_server_loop>`

Inheritance diagram for L4::Ipc_svr::Ignore_errors:



Collaboration diagram for L4::Ipc_svr::Ignore_errors:



15.148.1 Detailed Description

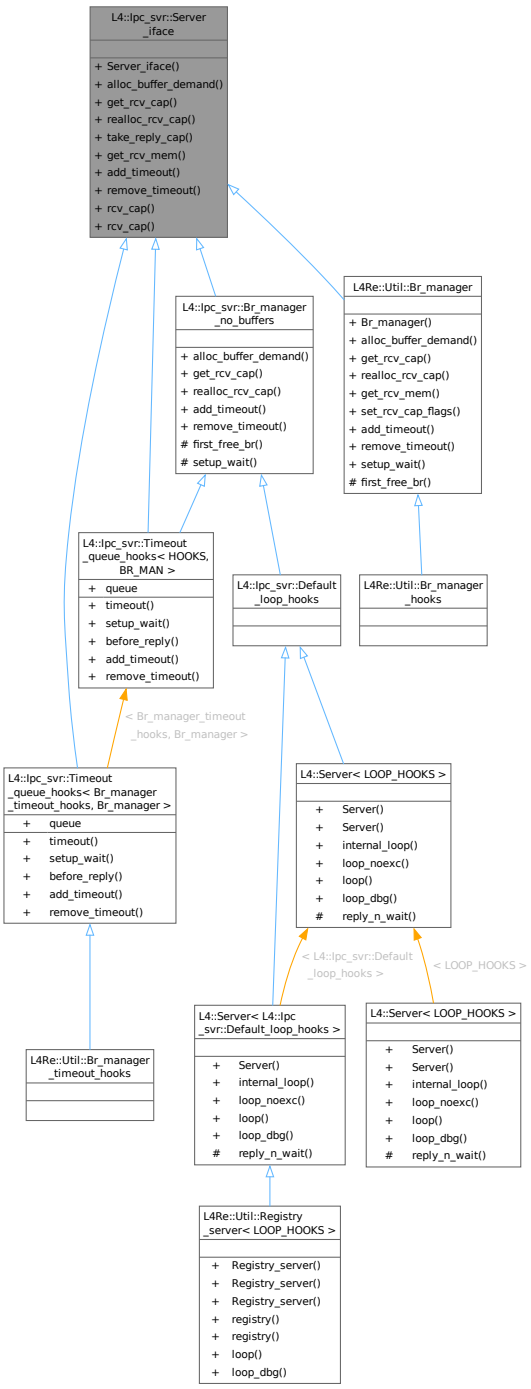
Mix in for LOOP_HOOKS to ignore IPC errors.
Definition at line 57 of file ipc_server_loop.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_server_loop

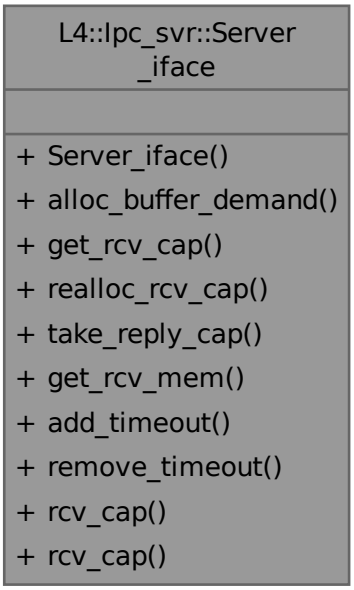
15.149 L4::Ipc_svr::Server_iface Class Reference

Interface for server-loop related functions.
`#include <ipc_epiface>`

Inheritance diagram for L4::Ipc_svr::Server_iface:



Collaboration diagram for L4::Ipc_svr::Server_iface:



Data Structures

- class Mem_window

  Memory receive window.

Public Types

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

Public Member Functions

- **Server_iface** ()

  Make a server interface.
- virtual int alloc_buffer_demand (Demand const &demand)=0

  Tells the server to allocate buffers for the given demand.
- virtual L4::Cap< void > get_rcv_cap (int index) const =0

  Get capability slot allocated to the given receive buffer.
- virtual int realloc_rcv_cap (int index)=0

  Allocate a new capability for the given receive buffer.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- virtual cxx::Result< Mem_window > get_rcv_mem () noexcept

  Take the current memory receive window.
- virtual int add_timeout (Timeout *timeout, l4_kernel_clock_t time)=0

  Add a timeout to the server internal timeout queue.
- virtual int remove_timeout (Timeout *timeout)=0

Remove the given timeout from the timer queue.

- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

15.149.1 Detailed Description

Interface for server-loop related functions.
This interface provides access to high-level server-loop related functions, such as management of receive buffers and timeouts.
Definition at line 37 of file ipc_epiface.

15.149.2 Member Function Documentation

15.149.2.1 add_timeout()

```
virtual int L4::Ipc_svr::Server_iface::add_timeout (
             Timeout * timeout,
             l4_kernel_clock_t time)  [pure virtual]
```

Add a timeout to the server internal timeout queue.

Parameters

timeout	The timeout object to register.
time	The time (absolute) at which the timeout shall expire.

Precondition

timeout must not be in any queue.

Returns

0 on success, 1 if timeout is already expired, < 0 on error.

Implemented in L4::Ipc_svr::Br_manager_no_buffers, L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >, L4::Ipc_svr::Timeout_queue_hooks< Br_manager_timeout_hooks, Br_manager >, and L4Re::Util::Br_manager.

15.149.2.2 alloc_buffer_demand()

```
virtual int L4::Ipc_svr::Server_iface::alloc_buffer_demand (
             Demand const & demand)  [pure virtual]
```

Tells the server to allocate buffers for the given demand.

Parameters

demand	The total server-side demand of receive buffers needed for a given interface, see Demand.

This function is not called by user applications directly. Usually the server implementation or the registry implementation calls this function whenever a new object is registered at the server.
Implemented in L4::Ipc_svr::Br_manager_no_buffers, and L4Re::Util::Br_manager.

15.149.2.3 get_rcv_cap()

```
virtual L4::Cap< void > L4::Ipc_svr::Server_iface::get_rcv_cap (
            int index) const  [pure virtual]
```

Get capability slot allocated to the given receive buffer.

Parameters

index	The receive buffer index of the expected capability argument (0 <= `index` < `caps` registered with alloc_buffer_demand()).

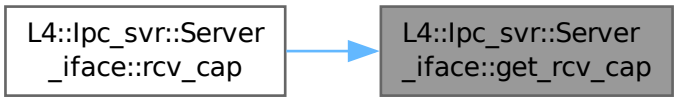
Precondition

0 <= `index` < `caps` registered with alloc_buffer_demand()

Returns

Capability slot currently allocated to the given receive buffer.

Implemented in L4::Ipc_svr::Br_manager_no_buffers, and L4Re::Util::Br_manager.
Referenced by rcv_cap().
Here is the caller graph for this function:



15.149.2.4 get_rcv_mem()

```
virtual cxx::Result< Mem_window > L4::Ipc_svr::Server_iface::get_rcv_mem ()  [inline], [virtual],
[noexcept]
```

Take the current memory receive window.
The caller takes the ownership of the memory receive window. A new receive window will be allocated for the next call.

Attention

The caller has to ensure that the received IPC call actually mapped some memory flexpage. Still, the IPC client can revoke the pages at any time. Thus, any access into the memory window could create unresolved page faults.

Reimplemented in L4Re::Util::Br_manager.
Definition at line 201 of file ipc_epiface.
References L4_ENOSYS.

15.149.2.5 rcv_cap() [1/2]

```
L4::Cap< void > L4::Ipc_svr::Server_iface::rcv_cap (
            int index) const  [inline]
```

Get receive cap with the given index as generic (void) type.

Parameters

index	The index of the cap receive buffer of the expected capability. (0 <= `index` < `caps` registered with alloc_buffer_demand().)

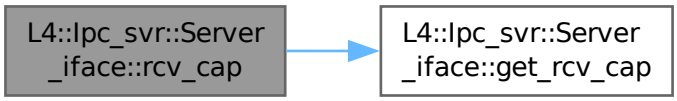
Returns

Capability slot currently allocated to the given capability buffer.

Note

This is a convenience wrapper for get_rcv_cap().

Definition at line 244 of file ipc_epiface.
References get_rcv_cap().
Here is the call graph for this function:



15.149.2.6 rcv_cap() [2/2]

```
template<typename T>
L4::Cap< T > L4::Ipc_svr::Server_iface::rcv_cap (
            int index) const  [inline]
```

Get given receive buffer as typed capability.

See also

get_rcv_cap()

Parameters

index	The receive buffer index of the expected capability argument. (0 <= `index` < `caps` registered with alloc_buffer_demand().)

Precondition

0 <= `index` < `caps` registered with alloc_buffer_demand()

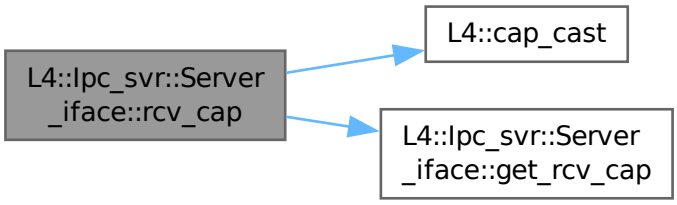
Returns

Capability slot currently allocated to the given receive buffer.

Note

This is a convenience wrapper for get_rcv_cap() to avoid L4::cap_cast<>().

Definition at line 232 of file ipc_epiface.
References L4::cap_cast(), and get_rcv_cap().
Here is the call graph for this function:



15.149.2.7 realloc_rcv_cap()

```
virtual int L4::Ipc_svr::Server_iface::realloc_rcv_cap (
            int index)  [pure virtual]
```

Allocate a new capability for the given receive buffer.

Parameters

index	The receive buffer index of the expected capability argument (0 <= `index` < `caps` registered with alloc_buffer_demand()).

Precondition

0 <= `index` < `caps` registered with alloc_buffer_demand()

Returns

0 on success, < 0 on error.

On success, the caller implicitly takes ownership of the former rcv_cap(`index`) prior to the call. On error, rcv_cap(`index`) remains unchanged and will be reused for the next IPC receive of the server.
Implemented in L4::Ipc_svr::Br_manager_no_buffers, and L4Re::Util::Br_manager.

15.149.2.8 remove_timeout()

```
virtual int L4::Ipc_svr::Server_iface::remove_timeout (
            Timeout * timeout)  [pure virtual]
```

Remove the given timeout from the timer queue.

Parameters

timeout	The timout object to remove.

Returns

0 on success, < 0 on error.

Implemented in L4::Ipc_svr::Br_manager_no_buffers, L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >, L4::Ipc_svr::Timeout_queue_hooks< Br_manager_timeout_hooks, Br_manager >, and L4Re::Util::Br_manager.

15.149.2.9 take_reply_cap()

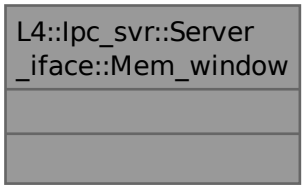
```
virtual cxx::Result< L4::Reply_cap > L4::Ipc_svr::Server_iface::take_reply_cap () [inline],
[virtual], [noexcept]
```

Take the currently used reply capability.
The caller takes ownership of the reply capability. A new reply capability is allocated for the next call.
Definition at line 187 of file ipc_epiface.
References L4_ENOSYS.
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_epiface

15.150 L4::Ipc_svr::Server_iface::Mem_window Class Reference

Memory receive window.
`#include <ipc_epiface>`
Collaboration diagram for L4::Ipc_svr::Server_iface::Mem_window:



15.150.1 Detailed Description

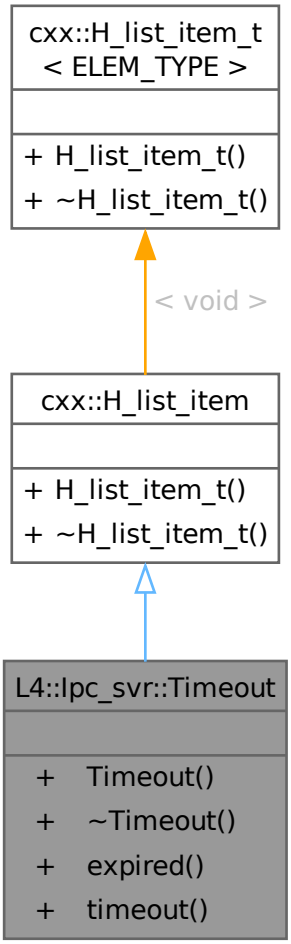
Memory receive window.
Represents a region in the virtual address space in which an IPC call *potentially* mapped pages.
Definition at line 50 of file ipc_epiface.
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_epiface

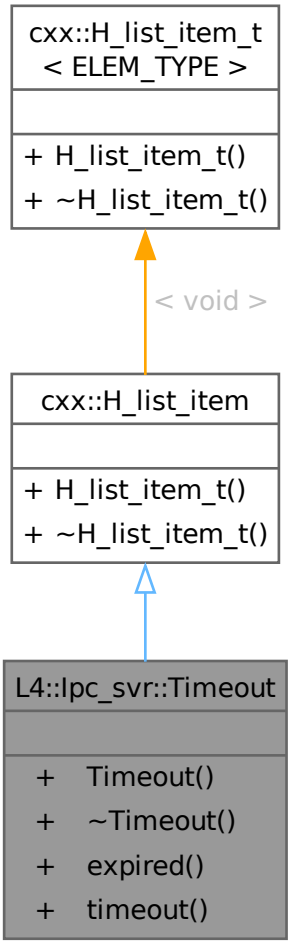
15.151 L4::Ipc_svr::Timeout Class Reference

Callback interface for Timeout_queue.
`#include <ipc_timeout_queue>`

Inheritance diagram for L4::Ipc_svr::Timeout:



Collaboration diagram for L4::Ipc_svr::Timeout:



Public Member Functions

- **Timeout** ()

  Make a timeout.
- virtual ~**Timeout** ()=0

  Destroy a timeout.
- virtual void expired ()=0

  callback function to be called when timeout happened
- l4_kernel_clock_t timeout () const

  return absolute timeout of this callback.

Public Member Functions inherited from cxx::H_list_item_t< void >

- constexpr H_list_item_t ()

  Constructor.
- ~H_list_item_t () noexcept

  Destructor.

15.151.1 Detailed Description

Callback interface for Timeout_queue.
Definition at line 18 of file ipc_timeout_queue.

15.151.2 Member Function Documentation

15.151.2.1 expired()

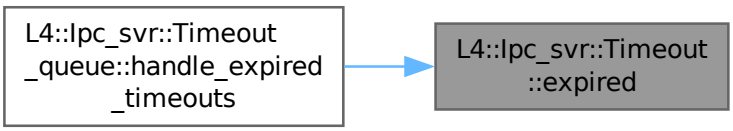
```
virtual void L4::Ipc_svr::Timeout::expired ()  [pure virtual]
```

callback function to be called when timeout happened

Note

The timeout object is already dequeued when this function is called, this means the timeout may be safely queued again within the expired() function.

Referenced by L4::Ipc_svr::Timeout_queue::handle_expired_timeouts().
Here is the caller graph for this function:



15.151.2.2 timeout()

```
l4_kernel_clock_t L4::Ipc_svr::Timeout::timeout () const  [inline]
```

return absolute timeout of this callback.

Returns

absolute timeout for this instance of the timeout.

Precondition

The timeout object must have been in a queue before, otherwise the timeout is not set.

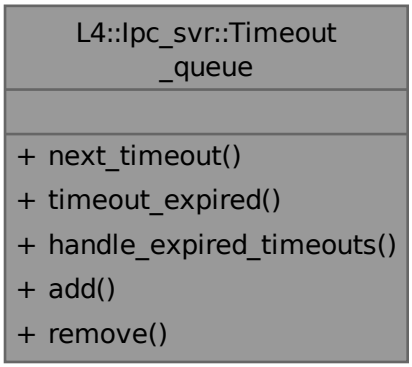
Definition at line 42 of file ipc_timeout_queue.
The documentation for this class was generated from the following file:

- l4/cxx/ipc_timeout_queue

15.152 L4::Ipc_svr::Timeout_queue Class Reference

Timeout queue to be used in l4re server loop.
`#include <ipc_timeout_queue>`

Collaboration diagram for L4::Ipc_svr::Timeout_queue:



Public Types

- typedef L4::Ipc_svr::Timeout **Timeout**

  Provide a local definition of Timeout for backward compatibility.

Public Member Functions

- l4_kernel_clock_t next_timeout () const

  Get the time for the next timeout.
- bool timeout_expired (l4_kernel_clock_t now) const

  Determine if a timeout has happened.
- void handle_expired_timeouts (l4_kernel_clock_t now)

  run the callbacks of expired timeouts
- void add (Timeout *timeout, l4_kernel_clock_t time)

  Add a timeout to the queue.
- void remove (Timeout *timeout)

  Remove timeout from the queue.

15.152.1 Detailed Description

Timeout queue to be used in l4re server loop.
Definition at line 55 of file ipc_timeout_queue.

15.152.2 Member Function Documentation

15.152.2.1 add()

```
void L4::Ipc_svr::Timeout_queue::add (
            Timeout * timeout,
            l4_kernel_clock_t time)  [inline]
```

Add a timeout to the queue.

Parameters

timeout	timeout object to add
time	the time when the timeout expires

Precondition

timeout must not be in any queue already

Definition at line 111 of file ipc_timeout_queue.

15.152.2.2 handle_expired_timeouts()

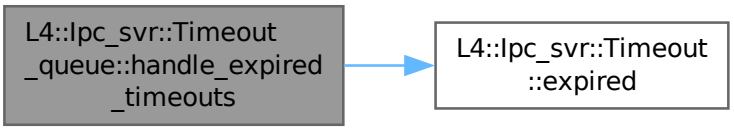
```
void L4::Ipc_svr::Timeout_queue::handle_expired_timeouts (
            l4_kernel_clock_t now)  [inline]
```

run the callbacks of expired timeouts

Parameters

now	the current time.

Definition at line 91 of file ipc_timeout_queue.
References L4::Ipc_svr::Timeout::expired().
Here is the call graph for this function:



15.152.2.3 next_timeout()

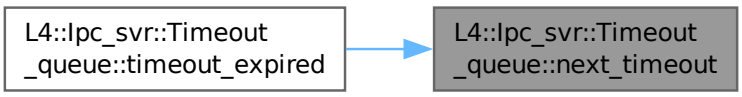
```
l4_kernel_clock_t L4::Ipc_svr::Timeout_queue::next_timeout () const  [inline]
```

Get the time for the next timeout.

Returns

the time for the next timeout or 0 if there is none

Definition at line 65 of file ipc_timeout_queue.
Referenced by timeout_expired().
Here is the caller graph for this function:



15.152.2.4 remove()

```
void L4::Ipc_svr::Timeout_queue::remove (
            Timeout * timeout)  [inline]
```

Remove *timeout* from the queue.

Parameters

timeout	timeout to remove from timeout queue

Precondition

timeout must be in this queue

Definition at line 126 of file ipc_timeout_queue.

15.152.2.5 timeout_expired()

```
bool L4::Ipc_svr::Timeout_queue::timeout_expired (
            l4_kernel_clock_t now) const  [inline]
```

Determine if a timeout has happened.

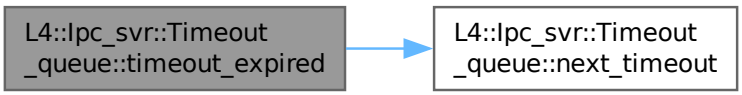
Parameters

now	The current time.

Return values

true	There is at least one expired timeout in the queue. false No expired timeout in the queue.

Definition at line 81 of file ipc_timeout_queue.
References next_timeout().
Here is the call graph for this function:



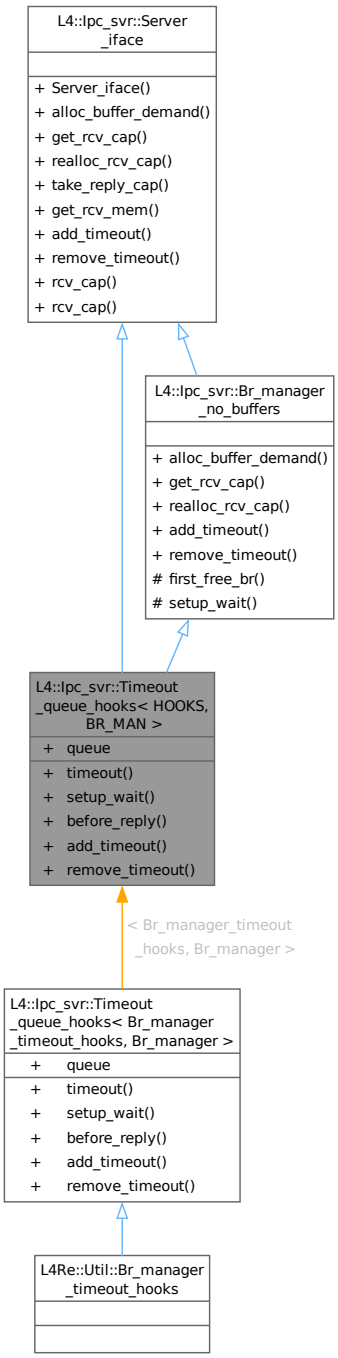
The documentation for this class was generated from the following file:

- l4/cxx/ipc_timeout_queue

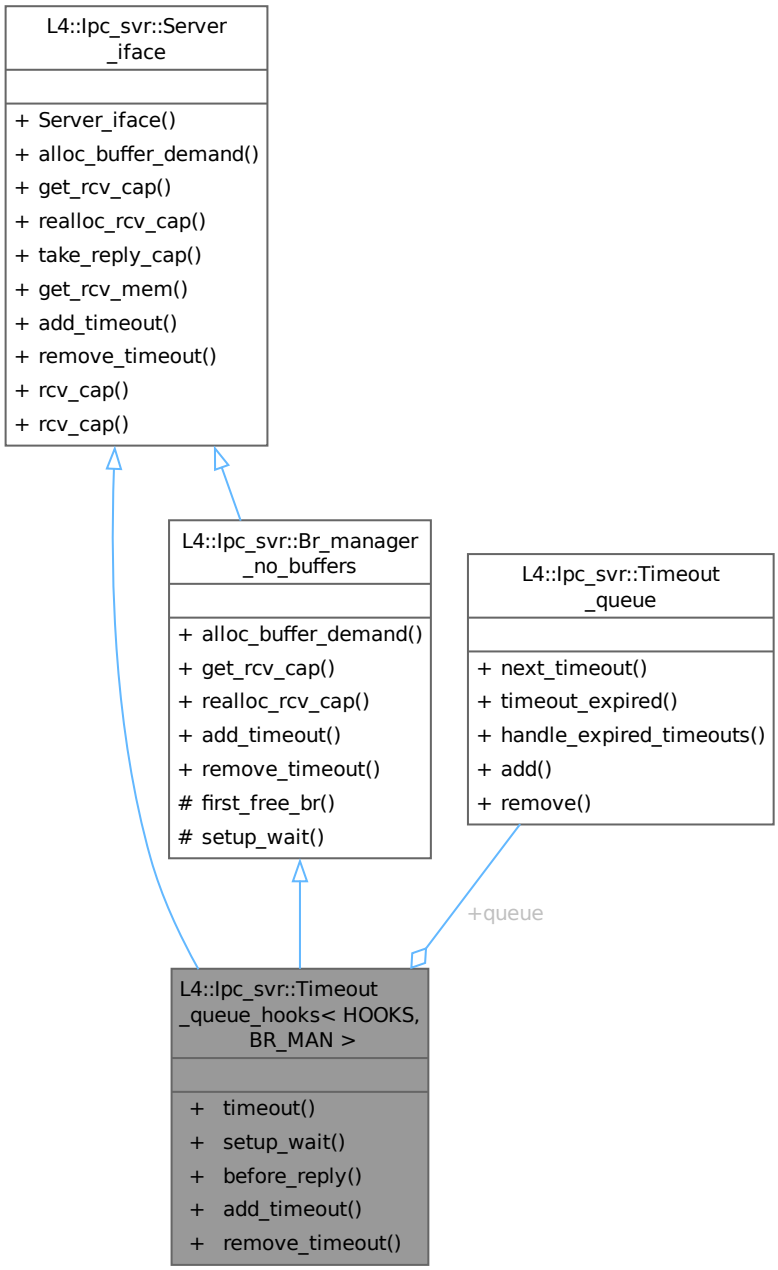
15.153 L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN > Class Template Reference

Loop hooks mixin for integrating a timeout queue into the server loop.
`#include <ipc_timeout_queue>`

Inheritance diagram for L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >:



Collaboration diagram for L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >:



Public Member Functions

- l4_timeout_t **timeout** ()

  get the time for the next timeout
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode mode)

  setup_wait() for the server loop
- L4::Ipc_svr::Reply_mode **before_reply** (l4_msgtag_t, l4_utcb_t *)

  server loop hook
- int add_timeout (Timeout *timeout, l4_kernel_clock_t time) override

Add a timeout to the queue for time time.

- int remove_timeout (Timeout *timeout) override

  Remove timeout from the queue.

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- virtual cxx::Result< Mem_window > get_rcv_mem () noexcept

  Take the current memory receive window.
- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Public Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- int alloc_buffer_demand (Demand const &demand) override

  Tells the server to allocate buffers for the given demand.
- L4::Cap< void > **get_rcv_cap** (int) const override

  Returns L4::Cap< void >::Invalid, we have no buffer management.
- int **realloc_rcv_cap** (int) override

  Returns -L4_ENOMEM, we have no buffer management.

Data Fields

- Timeout_queue **queue**

  Use this timeout queue.

Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

Protected Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- unsigned **first_free_br** () const

  Returns 1 as first free buffer.
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)

  Setup wait function for the server loop (Server<>).

15.153.1 Detailed Description

template<typename HOOKS, typename BR_MAN = Br_manager_no_buffers>
class L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >

Loop hooks mixin for integrating a timeout queue into the server loop.

Template Parameters

HOOKS	has to inherit from Timeout_queue_hooks<> and provide the functions now() that has to return the current time.
BR_MAN	This used as a base class for and provides the API for selecting the buffer register (BR) that is used to store the timeout value. This is usually L4Re::Util::Br_manager or L4::Ipc_svr::Br_manager_no_buffers.

Definition at line 150 of file ipc_timeout_queue.

15.153.2 Member Function Documentation

15.153.2.1 add_timeout()

```
template<typename HOOKS, typename BR_MAN = Br_manager_no_buffers>
int L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >::add_timeout (
            Timeout * timeout,
            l4_kernel_clock_t time)  [inline], [override], [virtual]
```

Add a timeout to the queue for time *time*.

Parameters

timeout	The timeout object to add into the queue (must not be in any queue currently).
time	The time when the timeout shall expire.

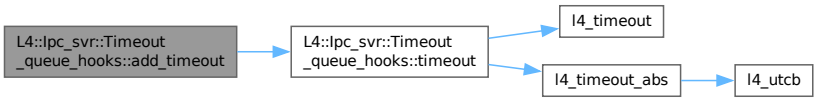
Precondition

timeout must not be in any queue.

Note

The timeout is automatically dequeued before the Timeout::expired() function is called

Implements L4::Ipc_svr::Server_iface.
Definition at line 202 of file ipc_timeout_queue.
References queue, and timeout().
Here is the call graph for this function:



15.153.2.2 remove_timeout()

```
template<typename HOOKS, typename BR_MAN = Br_manager_no_buffers>
int L4::Ipc_svr::Timeout_queue_hooks< HOOKS, BR_MAN >::remove_timeout (
            Timeout * timeout)  [inline], [override], [virtual]
```

Remove timeout from the queue.

Parameters

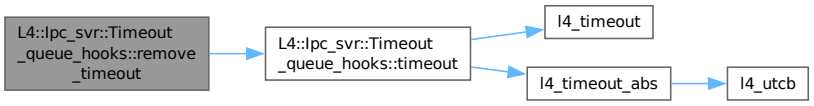
timeout	The timeout object to be removed from the queue.

Note

This function may be safely called even if the timeout is not currently enqueued.

in Timeout::expired() the timeout is already dequeued!

Implements L4::Ipc_svr::Server_iface.
Definition at line 215 of file ipc_timeout_queue.
References queue, and timeout().
Here is the call graph for this function:



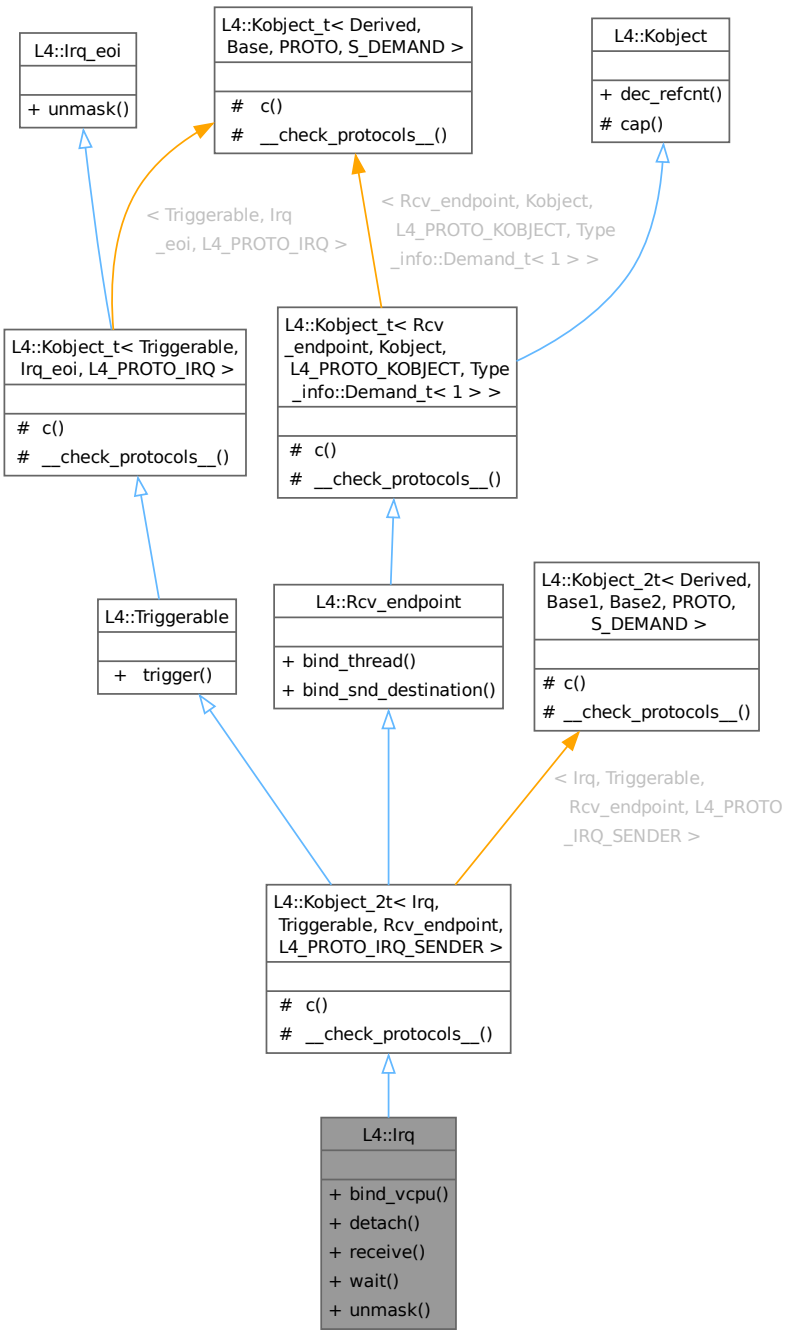
The documentation for this class was generated from the following file:

- l4/cxx/ipc_timeout_queue

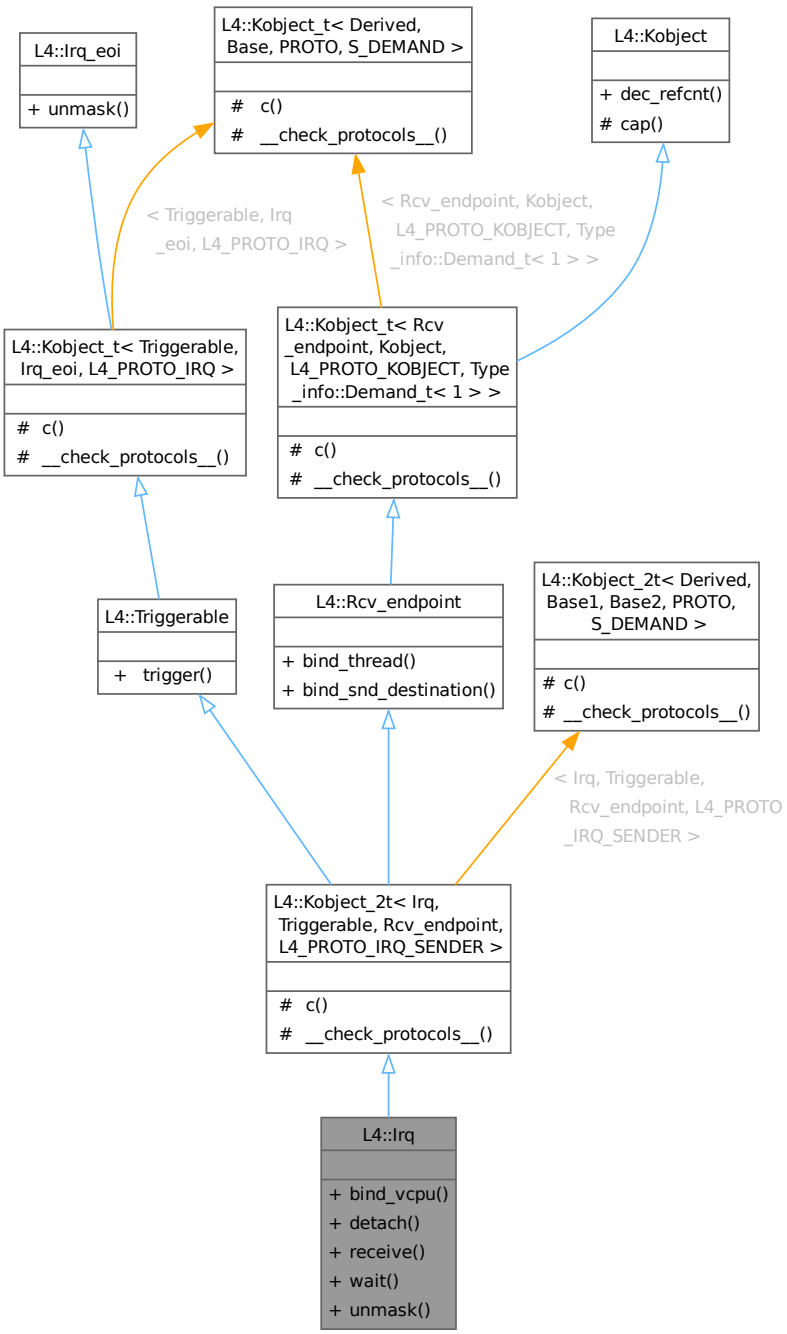
15.154 L4::Irq Class Reference

C++ Irq interface, see IRQs for the C interface.
`#include <irq>`

Inheritance diagram for L4::Irq:



Collaboration diagram for L4::Irq:



Public Member Functions

- l4_msgtag_t bind_vcpu (L4::Cap< Thread > const &thread, l4_umword_t cfg, l4_utcb_t *utcb=l4_utcb()) noexcept

  Bind a thread to this Irq for vCPU interrupt forwarding.
- l4_msgtag_t detach (l4_utcb_t *utcb=l4_utcb()) noexcept

  Detach from this interrupt.
- l4_msgtag_t receive (l4_timeout_t timeout=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

Unmask and wait for this IRQ.

- l4_msgtag_t wait (l4_umword_t *label, l4_timeout_t timeout=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask IRQ and (open) wait for any message.

- l4_msgtag_t unmask (l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask this IRQ.

Public Member Functions inherited from L4::Triggerable

- l4_msgtag_t trigger (l4_utcb_t *utcb=l4_utcb()) noexcept

  Trigger the object.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Public Member Functions inherited from L4::Rcv_endpoint

- l4_msgtag_t bind_thread (Ipc::Cap< Thread > t, l4_umword_t label)

  Bind the IPC receive endpoint to a thread.

- l4_msgtag_t bind_snd_destination (Cap< Snd_destination > snd_dst, l4_umword_t label)

  Bind a send destination (a thread or thread group) to an IPC receive endpoint.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_2t< Irq, Triggerable, Rcv_endpoint, L4_PROTO_IRQ_SENDER >

- typedef Irq Class

  The target interface type (inheriting from Kobject_t).

- typedef Typeid::Iface< PROTO, Irq > __Iface

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, Typeid::Merge_list< typename Triggerable::__Iface_list, typename Rcv_endpoint::__Iface_list > > __Iface_list

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- typedef Triggerable **Class**

  The target interface type (inheriting from Kobject_t).

- typedef Typeid::Iface< PROTO, Triggerable > **__Iface**

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- typedef Rcv_endpoint **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Rcv_endpoint > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_2t< Irq, Triggerable, Rcv_endpoint, L4_PROTO_IRQ_SENDER >

- L4::Cap< Class > c () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_2t< Irq, Triggerable, Rcv_endpoint, L4_PROTO_IRQ_SENDER >

- static void __check_protocols__ () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.154.1 Detailed Description

C++ Irq interface, see IRQs for the C interface.

Note

"IRQ" is short for "interrupt request". This is often used interchangeably for "interrupt"

The Irq class provides access to abstract interrupts provided by the microkernel. Interrupts may be

- hardware interrupts provided by the platform interrupt controller,
- virtual device interrupts provided by the microkernel's virtual devices (virtual serial or trace buffer) or
- virtual interrupts that can be triggered by user programs (IRQs) via the inherited method L4::Triggerable::trigger().

For hardware and virtual device interrupts the Irq object must be bound to an interrupt source, see L4::Icu. To receive interrupts, the Irq object must be bound to a thread, see L4::Rcv_endpoint.
Irq objects can be created using a factory, see the L4::Factory API (L4::Factory::create()).

Include File

```
#include <l4/sys/irq>
```

For the C interface refer to the IRQs API for an overview.

Examples

examples/libs/l4re/c++/shared_ds/ds_clnt.cc.

Definition at line 120 of file irq.

15.154.2 Member Function Documentation

15.154.2.1 bind_vcpu()

```
l4_msgtag_t L4::Irq::bind_vcpu (
             L4::Cap< Thread > const & thread,
             l4_umword_t cfg,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Bind a thread to this Irq for vCPU interrupt forwarding.
If the interrupt is triggered, the kernel will directly inject the interrupt into the guest. This requires that the thread is currently in extended vCPU user mode. Otherwise the interrupt will stay pending and gets injected on the next vCPU user mode transition. Optionally a doorbell Irq can be registered on the thread (see Thread::register_doorbell_irq()) that is triggered in this case.
If a guest has acknowledged the interrupt but has not yet issued an EOI (i.e. the interrupt is in "active" state), it is not possible to bind the Irq to a new thread object. Either wait for the guest to issue the EOI or detach() from the current thread. In this case the interrupt will stay active in the guest and it is the responsibility of the VMM to handle the eventual EOI of the guest.

Parameters

thread	Thread object this Irq shall be bound to.
cfg	Architecture specific interrupt configuration.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

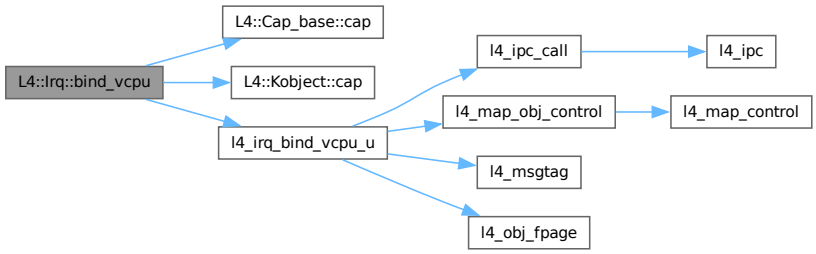
Return values

-L4_EPERM	Insufficient permissions; see precondition.
-L4_EBUSY	Cannot bind to the new thread because interrupt is active on previous thread and guest has to issue end-of-interrupt first.
-L4_ENOSYS	The kernel does not support direct interrupt forwarding.

Precondition

The invoked Irq capability and the capability `thread` both must have the permission L4_CAP_FPAGE_S.

Definition at line 158 of file irq.
References L4::Cap_base::cap(), L4::Kobject::cap(), and l4_irq_bind_vcpu_u().
Here is the call graph for this function:



15.154.2.2 detach()

```
l4_msgtag_t L4::Irq::detach (
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Detach from this interrupt.

Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

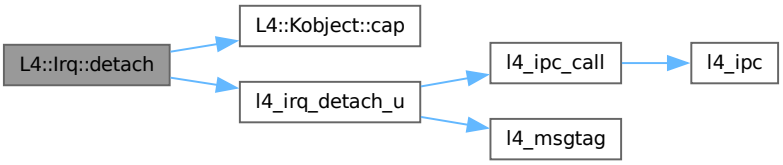
Return values

0	Successfully detached, there was no interrupt pending.
1	Successfully detached, there was an interrupt pending.
2	Successfully detached, an active vIRQ was abandoned.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The invoked Irq capability must have the permission L4_CAP_FPAGE_S.

Definition at line 176 of file irq.
References L4::Kobject::cap(), and l4_irq_detach_u().
Here is the call graph for this function:



15.154.2.3 receive()

```
l4_msgtag_t L4::Irq::receive (
            l4_timeout_t timeout = L4_IPC_NEVER,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Unmask and wait for this IRQ.

Parameters

timeout	Timeout.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

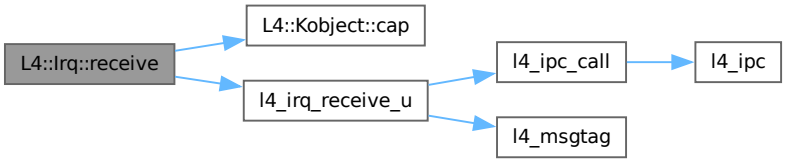
Returns

Syscall return tag

Note

If this is the function normally used for your IRQs consider using L4::Semaphore instead of L4::Irq.

Definition at line 191 of file irq.
References L4::Kobject::cap(), L4_IPC_NEVER, and l4_irq_receive_u().
Here is the call graph for this function:



15.154.2.4 unmask()

```
l4_msgtag_t L4::Irq::unmask (
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Unmask this IRQ.

Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

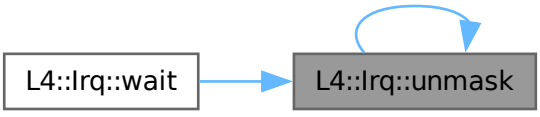
Returns

Syscall return tag for a send-only operation, this means there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. Use l4_ipc_error() to check for errors and **do not** use l4_error().

Irq::wait() and Irq::receive() operations already include an unmask(), do not use an extra unmask() in these cases.
Definition at line 221 of file irq.
References L4_IPC_NEVER, and unmask().
Referenced by unmask(), and wait().
Here is the call graph for this function:



Here is the caller graph for this function:



15.154.2.5 wait()

```
l4_msgtag_t L4::Irq::wait (
            l4_umword_t * label,
            l4_timeout_t timeout = L4_IPC_NEVER,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Unmask IRQ and (open) wait for any message.

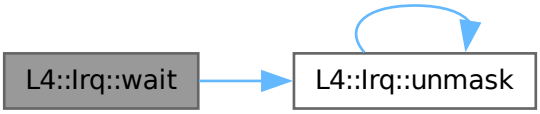
Parameters

label	The *protected label* shall be received here.
timeout	Timeout.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

Definition at line 204 of file irq.
References L4_IPC_NEVER, and unmask().
Here is the call graph for this function:



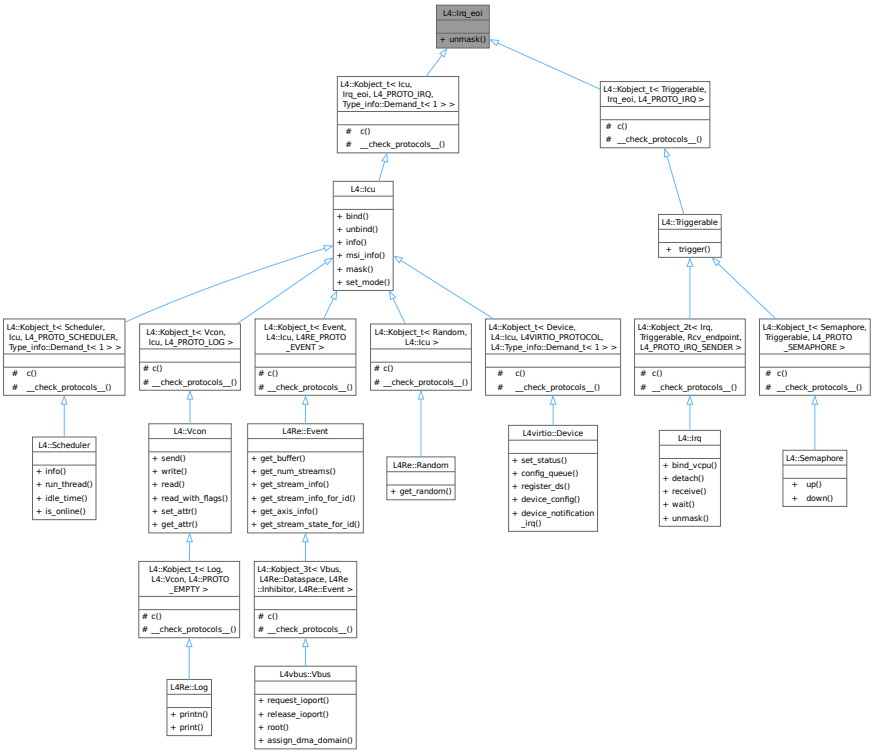
The documentation for this class was generated from the following file:

- l4/sys/irq

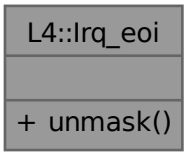
15.155 L4::Irq_eoi Class Reference

Interface for sending an unmask message to an object.
`#include <irq>`

Inheritance diagram for L4::Irq_eoi:



Collaboration diagram for L4::Irq_eoi:



Public Member Functions

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

15.155.1 Detailed Description

Interface for sending an unmask message to an object.
The object is usually an ICU or an IRQ.
When the kernel receives an IRQ, it masks the interrupt line at the interrupt controller and immediately acknowledges the interrupt. This interface is used to let the kernel know that userspace has dealt with the IRQ. The kernel will unmask the interrupt line and further IRQs can then be delivered.

See also

L4::Icu, L4::Irq

Definition at line 37 of file irq.

15.155.2 Member Function Documentation

15.155.2.1 unmask()

```
l4_msgtag_t L4::Irq_eoi::unmask (
             unsigned irqnum,
             l4_umword_t * label = 0,
             l4_timeout_t to = L4_IPC_NEVER,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Unmask the given interrupt line.
When the object is an IRQ, the given interrupt line is ignored and instead the line which the IRQ is bound to (if any) is unmasked.
Its counterpart for explicitly masking an interrupt line is L4::Icu::mask().

Parameters

	irqnum	The interrupt line that shall be unmasked. Ignored if the object is an IRQ.
out	*label*	If NULL, this is a send-only unmask. If not NULL, this operation enters an open wait and the *protected label* shall be received here.
	to	The timeout-pair (send and receive) that shall be used for this operation. The receive timeout is used with a non-NULL `label` only.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag. If `label` is NULL, this function performs an IPC send-only operation and there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. In this case use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 64 of file irq.
References L4::Kobject::cap(), and L4_IPC_NEVER.
Here is the call graph for this function:



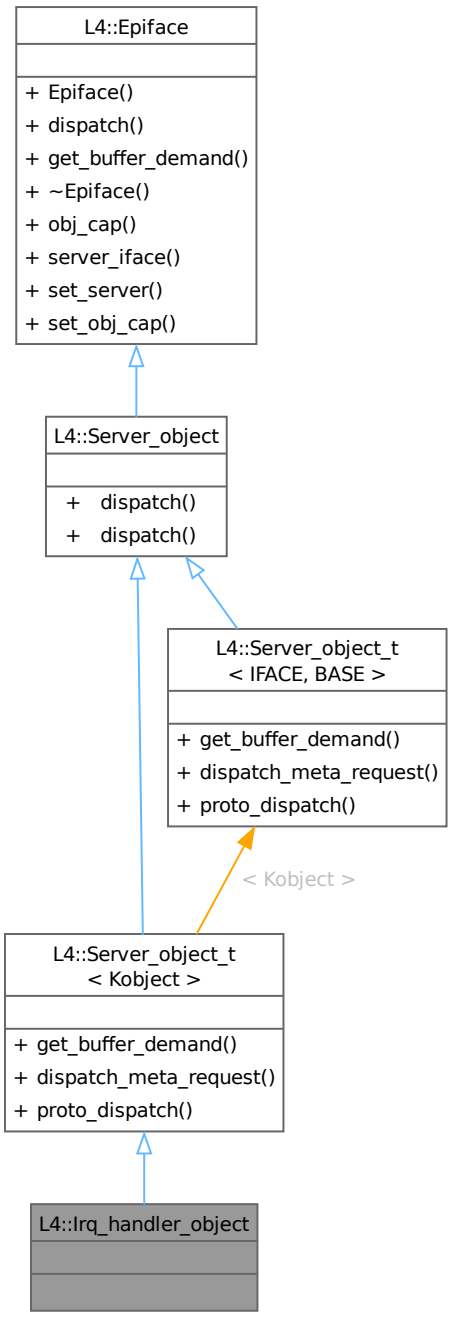
The documentation for this class was generated from the following file:

- l4/sys/irq

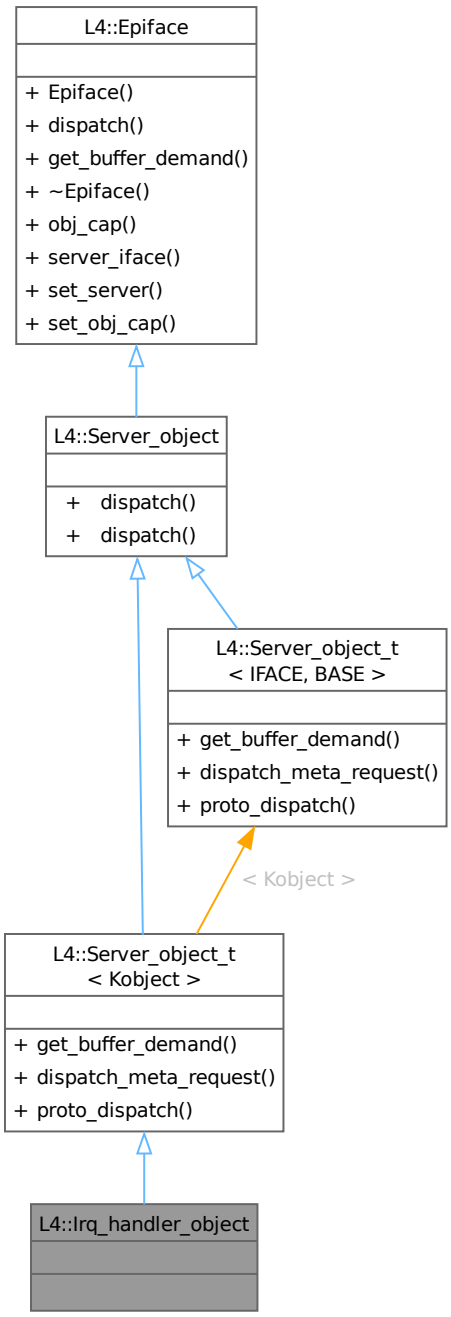
15.156 L4::Irq_handler_object Struct Reference

Server object base class for handling IRQ messages.
`#include <ipc_server>`

Inheritance diagram for L4::Irq_handler_object:



Collaboration diagram for L4::Irq_handler_object:



Additional Inherited Members

Public Types inherited from L4::Server_object_t< Kobject >

- typedef Kobject **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions inherited from L4::Server_object_t< Kobject >

- L4::Server_object::Demand get_buffer_demand () const override
- int dispatch_meta_request (L4::Ipc::Iostream &ios)

  Implementation of the meta protocol based on IFACE.

Public Member Functions inherited from L4::Server_object

- virtual int dispatch (unsigned long rights, Ipc::Iostream &ios)=0

  The abstract handler for client requests to the object.
- l4_msgtag_t dispatch (l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb) override

  The abstract handler for client requests to the object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Static Public Member Functions inherited from L4::Server_object_t< Kobject >

- static int proto_dispatch (THIS *self, l4_umword_t rights, L4::Ipc::Iostream &ios)

  Implementation of protocol-based dispatch for this server object.

15.156.1 Detailed Description

Server object base class for handling IRQ messages.
This server object base class implements the empty interface (L4::Kobject). The implementation of Server_object::dispatch() must return -L4_ENOREPLY, because IRQ messages do not handle replies.

Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc.

Definition at line 161 of file ipc_server.
The documentation for this struct was generated from the following file:

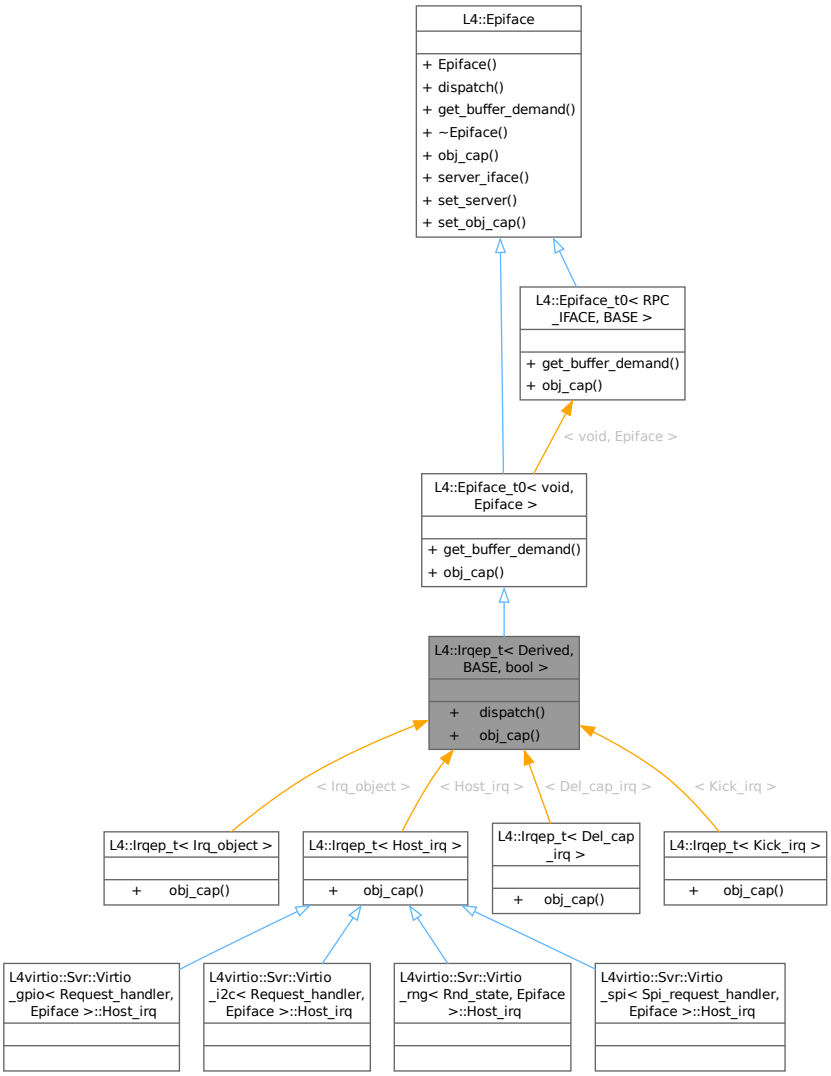
- l4/cxx/ipc_server

15.157 L4::Irqep_t< Derived, BASE, bool > Struct Template Reference

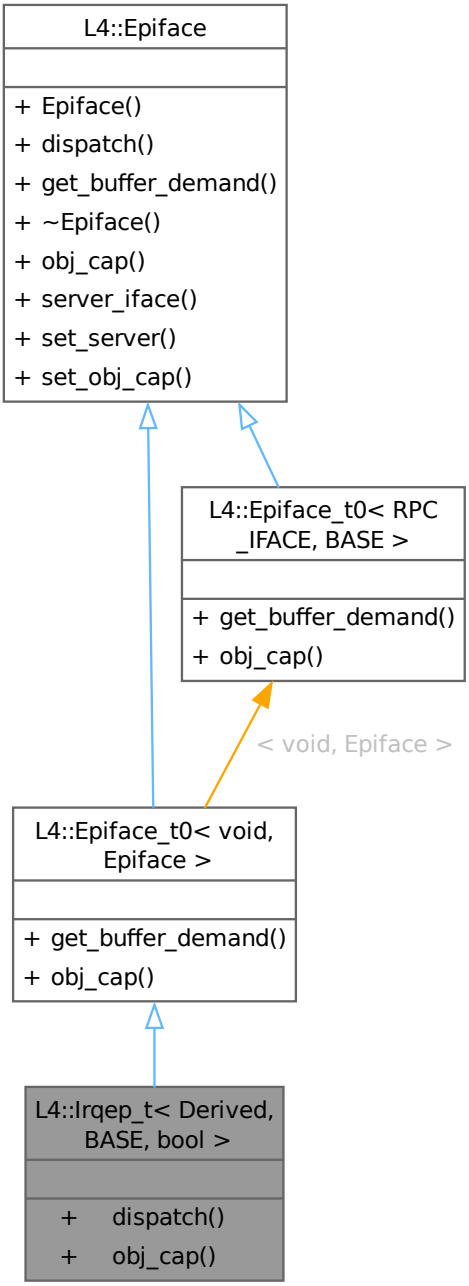
Epiface implementation for interrupt handlers.

`#include <ipc_epiface>`

Inheritance diagram for L4::Irqep_t< Derived, BASE, bool >:



Collaboration diagram for L4::Irqep_t< Derived, BASE, bool >:



Public Member Functions

- l4_msgtag_t dispatch (l4_msgtag_t, unsigned, l4_utcb_t *) final

  The abstract handler for client requests to the object.
- Cap< L4::Irq > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface_t0< void, Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< void > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< void, Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

15.157.1 Detailed Description

template<typename Derived, typename BASE = Epiface, bool = cxx::is_polymorphic<BASE>::value>
struct L4::Irqep_t< Derived, BASE, bool >

Epiface implementation for interrupt handlers.

Template Parameters

Derived	Irq handler implementation class. The class must provide a single function handle_irq().
BASE	Base Epiface class.

Definition at line 400 of file ipc_epiface.

15.157.2 Member Function Documentation

15.157.2.1 dispatch()

```
template<typename Derived, typename BASE = Epiface, bool = cxx::is_polymorphic<BASE>::value>
l4_msgtag_t L4::Irqep_t< Derived, BASE, bool >::dispatch (
            l4_msgtag_t tag,
            unsigned rights,
            l4_utcb_t * utcb)  [inline], [final], [virtual]
```

The abstract handler for client requests to the object.

Parameters

tag	The message tag for this invocation.
rights	The rights bits in the invoked capability.
utcb	The UTCB used for the invocation.

Return values

-L4_ENOREPLY	No reply message is sent.
<0	Error, reply with error code.
>=0	Success, reply with return value.

This function must be implemented by application specific server objects.
Implements L4::Epiface.
Definition at line 402 of file ipc_epiface.
References L4_ENOREPLY, and l4_msgtag().
Here is the call graph for this function:



15.157.2.2 obj_cap()

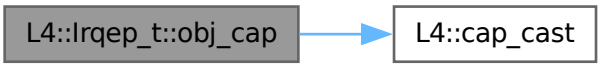
```
template<typename Derived, typename BASE = Epiface, bool = cxx::is_polymorphic<BASE>::value>
Cap< L4::Irq > L4::Irqep_t< Derived, BASE, bool >::obj_cap () const  [inline]
```

Get the (typed) capability to this object.

Returns

Irq capability for the kernel object behind the server.

Definition at line 412 of file ipc_epiface.
References L4::cap_cast().
Here is the call graph for this function:

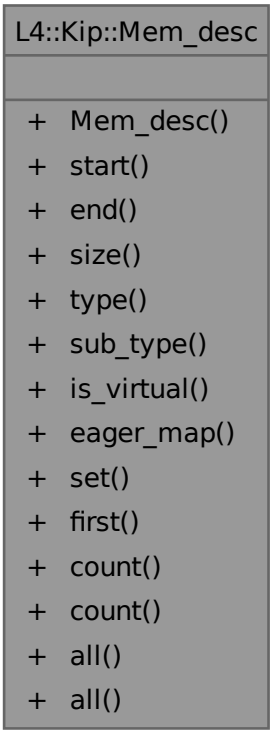


The documentation for this struct was generated from the following file:

- l4/sys/cxx/ipc_epiface

15.158 L4::Kip::Mem_desc Class Reference

Memory descriptors stored in the kernel interface page.
`#include <kip>`
Collaboration diagram for L4::Kip::Mem_desc:



Public Types

- enum Mem_type {
  Undefined = 0x0 , Conventional = 0x1 , Reserved = 0x2 , Dedicated = 0x3 ,
  Shared = 0x4 , Kmem = 0x5 , Info = 0xd , Bootloader = 0xe ,
  Arch = 0xf }

  Memory types.
- enum Info_sub_type { Info_acpi_rsdp = 0 , Reserved_kernel = 0 , Reserved_heap = 1 , Reserved_mmio = 2 }

  Memory sub types for the Mem_type::Info type.
- enum Arch_sub_type_common { Arch_acpi_tables = 3 , Arch_acpi_nvs = 4 , Arch_cpu_fw = 5 }

  Common sub types across all architectures for the Mem_type::Arch type.

Public Member Functions

- Mem_desc (unsigned long start, unsigned long end, Mem_type t, unsigned char st=0, bool virt=false, bool eager=false) noexcept

  Initialize memory descriptor.
- unsigned long start () const noexcept

  Return start address of memory descriptor.
- unsigned long end () const noexcept

  Return end address of memory descriptor.
- unsigned long size () const noexcept

  Return size of region described by the memory descriptor.
- Mem_type type () const noexcept

  Return type of the memory descriptor.
- unsigned char sub_type () const noexcept

  Return sub-type of the memory descriptor.
- unsigned is_virtual () const noexcept

  Return whether the memory descriptor describes a virtual or physical region.
- unsigned **eager_map** () const noexcept

  Return whether the region shall be eligible for eager mapping in sigma0 or the root task.
- void set (unsigned long start, unsigned long end, Mem_type t, unsigned char st=0, bool virt=false, bool eager=false) noexcept

  Set values of a memory descriptor.

Static Public Member Functions

- static Mem_desc * first (l4_kernel_info_t *kip) noexcept

  Get first memory descriptor.
- static unsigned long count (l4_kernel_info_t const *kip) noexcept

  Return number of memory descriptors stored in the kernel info page.
- static void count (l4_kernel_info_t *kip, unsigned count) noexcept

  Set number of memory descriptors.
- static cxx::static_vector< Mem_desc const > all (l4_kernel_info_t const *kip)

  Return enumerable list of memory descriptors.
- static cxx::static_vector< Mem_desc > all (l4_kernel_info_t *kip)

  Return enumerable list of memory descriptors.

15.158.1 Detailed Description

Memory descriptors stored in the kernel interface page.

Include File

```
#include <l4/sys/kip>
```

Definition at line 42 of file kip.

15.158.2 Member Enumeration Documentation

15.158.2.1 Arch_sub_type_common

`enum L4::Kip::Mem_desc::Arch_sub_type_common`
Common sub types across all architectures for the Mem_type::Arch type.

Enumerator

Arch_acpi_tables	Firmware ACPI tables.
Arch_acpi_nvs	Firmware reserved address space.
Arch_cpu_fw	CPU firmware.

Definition at line 79 of file kip.

15.158.2.2 Info_sub_type

`enum L4::Kip::Mem_desc::Info_sub_type`
Memory sub types for the Mem_type::Info type.

Enumerator

Info_acpi_rsdp	Physical address of the ACPI root pointer.
Reserved_kernel	Kernel image.
Reserved_heap	Kernel heap.
Reserved_mmio	MMIO range reserved by kernel.

Definition at line 67 of file kip.

15.158.2.3 Mem_type

`enum L4::Kip::Mem_desc::Mem_type`
Memory types.

Enumerator

Undefined	Undefined memory.
Conventional	Conventional memory.
Reserved	Reserved region, do not use this memory.
Dedicated	Dedicated.
Shared	Shared.
Kmem	Kernel memory.
Info	Info by boot loader.
Bootloader	Memory belongs to the boot loader.
Arch	Architecture specific memory.

Definition at line 48 of file kip.

15.158.3 Constructor & Destructor Documentation

15.158.3.1 Mem_desc()

`L4::Kip::Mem_desc::Mem_desc (`

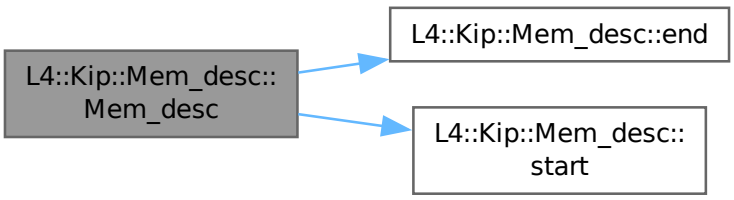
```
            unsigned long start,
            unsigned long end,
            Mem_type t,
            unsigned char st = 0,
            bool virt = false,
            bool eager = false)  [inline], [noexcept]
```

Initialize memory descriptor.

Parameters

start	Start address
end	End address
t	Memory type
st	Memory subtype, defaults to 0
virt	True for virtual memory, false for physical memory, defaults to physical
eager	The region shall be eligible for eager mapping in sigma0 or the root task. This is just an optimization to prevent on-demand paging.

Definition at line 166 of file kip.
References end(), and start().
Referenced by first().
Here is the call graph for this function:



Here is the caller graph for this function:



15.158.4 Member Function Documentation

15.158.4.1 all() [1/2]

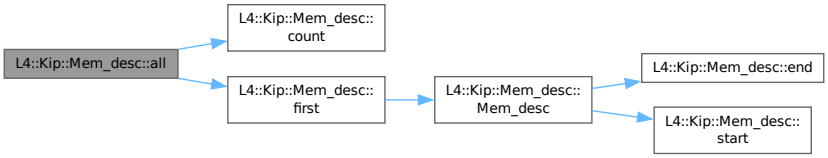
```
cxx::static_vector< Mem_desc > L4::Kip::Mem_desc::all (
            l4_kernel_info_t * kip)  [inline], [static]
```

Return enumerable list of memory descriptors.

Parameters

kip	Pointer to the kernel info page.

Definition at line 147 of file kip.
References count(), and first().
Here is the call graph for this function:



15.158.4.2 all() [2/2]

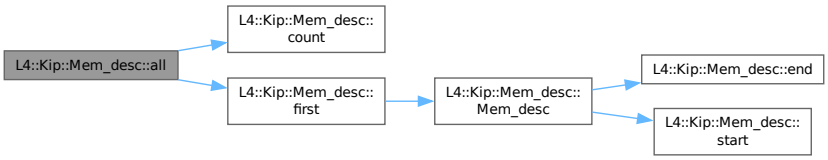
```
cxx::static_vector< Mem_desc const > L4::Kip::Mem_desc::all (
            l4_kernel_info_t const * kip)  [inline], [static]
```

Return enumerable list of memory descriptors.

Parameters

kip	Pointer to the kernel info page.

Definition at line 136 of file kip.
References count(), and first().
Here is the call graph for this function:



15.158.4.3 count() [1/2]

```
void L4::Kip::Mem_desc::count (
            l4_kernel_info_t * kip,
            unsigned count)  [inline], [static], [noexcept]
```

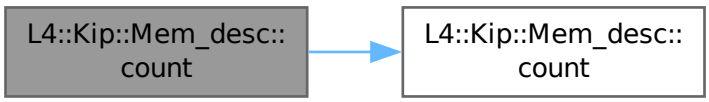
Set number of memory descriptors.

Parameters

kip	Pointer to the kernel info page

count	Number of memory descriptors

Definition at line 126 of file kip.
References count().
Here is the call graph for this function:



15.158.4.4 count() [2/2]

```
unsigned long L4::Kip::Mem_desc::count (
            l4_kernel_info_t const * kip)  [inline], [static], [noexcept]
```

Return number of memory descriptors stored in the kernel info page.

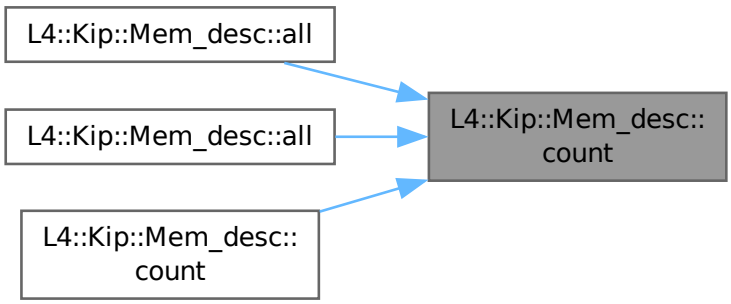
Parameters

kip	Pointer to the kernel info page

Returns

Number of memory descriptors in the kernel info page.

Definition at line 115 of file kip.
Referenced by all(), all(), and count().
Here is the caller graph for this function:



15.158.4.5 end()

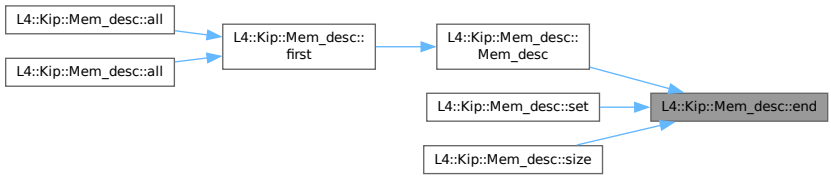
```
unsigned long L4::Kip::Mem_desc::end () const  [inline], [noexcept]
```

Return end address of memory descriptor.

Returns

End address of memory descriptor

Definition at line 185 of file kip.
Referenced by Mem_desc(), set(), and size().
Here is the caller graph for this function:



15.158.4.6 first()

```
Mem_desc * L4::Kip::Mem_desc::first (
            l4_kernel_info_t * kip)  [inline], [static], [noexcept]
```

Get first memory descriptor.

Parameters

kip	Pointer to the kernel info page

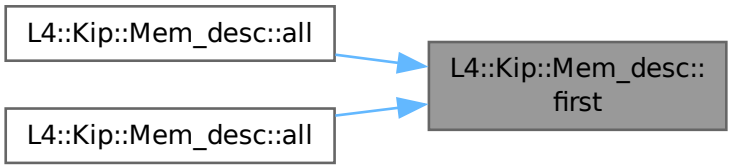
Returns

First memory descriptor stored in the kernel info page

Definition at line 97 of file kip.
References Mem_desc().
Referenced by all(), and all().
Here is the call graph for this function:



Here is the caller graph for this function:



15.158.4.7 is_virtual()

```
unsigned L4::Kip::Mem_desc::is_virtual () const  [inline], [noexcept]
```

Return whether the memory descriptor describes a virtual or physical region.

Returns

True for virtual region, false for physical region.

Definition at line 217 of file kip.

15.158.4.8 set()

```
void L4::Kip::Mem_desc::set (
             unsigned long start,
             unsigned long end,
             Mem_type t,
             unsigned char st = 0,
             bool virt = false,
             bool eager = false)  [inline], [noexcept]
```

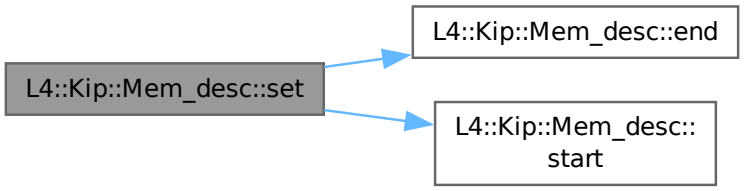
Set values of a memory descriptor.

Parameters

start	Start address
end	End address
t	Memory type
st	Sub-type, defaults to 0
virt	Virtual or physical memory region, defaults to physical
eager	The region shall be eligible for eager mapping in sigma0 or the root task. This is just an optimization to prevent on-demand paging.

Definition at line 237 of file kip.
References end(), and start().

Here is the call graph for this function:



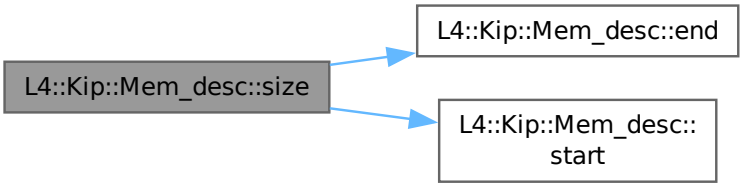
15.158.4.9 size()

`unsigned long L4::Kip::Mem_desc::size () const [inline], [noexcept]`
Return size of region described by the memory descriptor.

Returns

Size of the region described by the memory descriptor

Definition at line 192 of file kip.
References end(), and start().
Here is the call graph for this function:



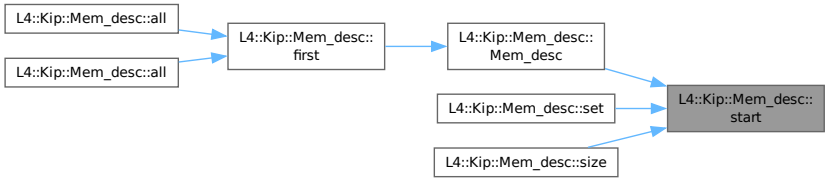
15.158.4.10 start()

`unsigned long L4::Kip::Mem_desc::start () const [inline], [noexcept]`
Return start address of memory descriptor.

Returns

Start address of memory descriptor

Definition at line 178 of file kip.
Referenced by Mem_desc(), set(), and size().
Here is the caller graph for this function:



15.158.4.11 sub_type()

`unsigned char L4::Kip::Mem_desc::sub_type () const [inline], [noexcept]`
Return sub-type of the memory descriptor.

Returns

Sub-type of the memory descriptor

Definition at line 209 of file kip.

15.158.4.12 type()

`Mem_type L4::Kip::Mem_desc::type () const [inline], [noexcept]`
Return type of the memory descriptor.

Returns

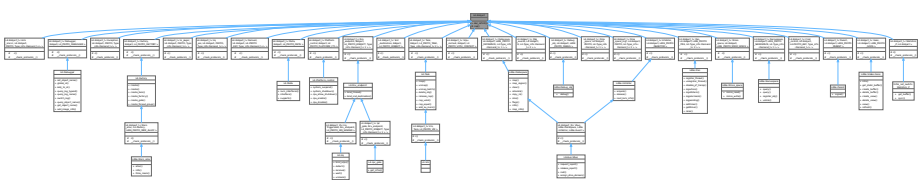
Type of the memory descriptor

Definition at line 199 of file kip.
The documentation for this class was generated from the following file:

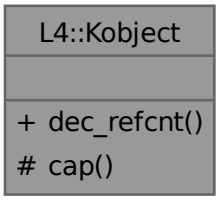
- l4/sys/kip

15.159 L4::Kobject Class Reference

Base class for all kinds of kernel objects and remote objects, referenced by capabilities.
`#include <kobject>`
Inheritance diagram for L4::Kobject:



Collaboration diagram for L4::Kobject:



Public Member Functions

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Protected Member Functions

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

15.159.1 Detailed Description

Base class for all kinds of kernel objects and remote objects, referenced by capabilities.

Include File

```
#include <l4/sys/capability>
```

This is the base class for all remote objects accessible using RPC. However, subclasses do not directly inherit from L4::Kobject but *must* use L4::Kobject_t (L4::Kobject_0t, L4::Kobject_2t, L4::Kobject_3t, or L4::Kobject_x) for inheritance, otherwise these classes cannot be used as RPC interfaces.

Attention

Objects derived from Kobject *must* never add any data to those objects. Kobjects can act only as proxy object for encapsulating object invocations.

Definition at line 36 of file kobject.

15.159.2 Member Function Documentation

15.159.2.1 cap()

```
l4_cap_idx_t L4::Kobject::cap () const  [inline], [protected], [noexcept]
```

Return capability selector.

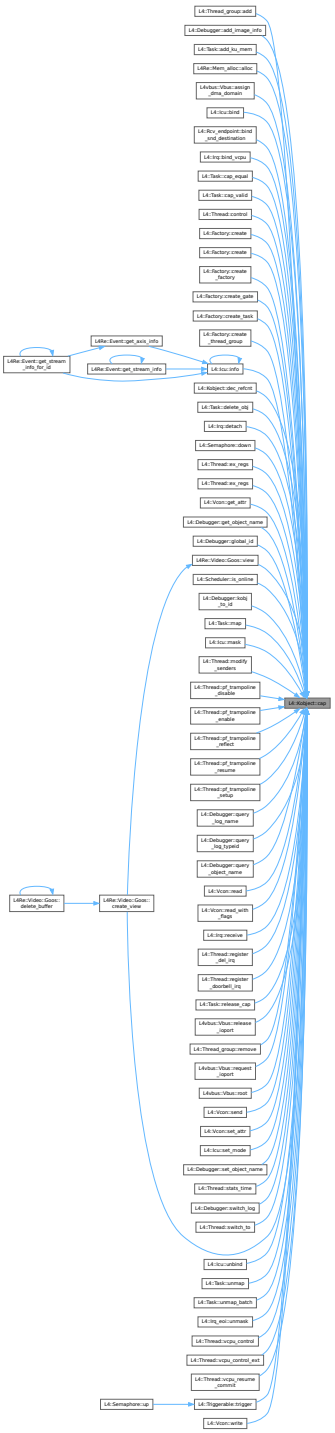
Returns

Capability selector.

This method is for derived classes to gain access to the actual capability selector.
Definition at line 69 of file kobject.
Referenced by L4::Thread_group::add(), L4::Debugger::add_image_info(), L4::Task::add_ku_mem(), L4Re::Mem_alloc::alloc(), L4vbus::Vbus::assign_dma_domain(), L4::Icu::bind(), L4::Rcv_endpoint::bind_snd_destination(), L4::Irq::bind_vcpu(), L4::Task::cap_equal(), L4::Task::cap_valid(), L4::Thread::control(), L4::Factory::create(), L4::Factory::create(),

L4::Factory::create_factory(), L4::Factory::create_gate(), L4::Factory::create_task(), L4::Factory::create_thread_group(), L4Re::Video::Goos::create_view(), dec_refcnt(), L4::Task::delete_obj(), L4::Irq::detach(), L4::Semaphore::down(), L4::Thread::ex_regs(), L4::Thread::ex_regs(), L4::Vcon::get_attr(), L4::Debugger::get_object_name(), L4::Debugger::global_id(), L4::Icu::info(), L4::Scheduler::is_online(), L4::Debugger::kobj_to_id(), L4::Task::map(), L4::Icu::mask(), L4::Thread::modify_senders(), L4::Thread::pf_trampoline_disable(), L4::Thread::pf_trampoline_enable(), L4::Thread::pf_trampoline_reflect(), L4::Thread::pf_trampoline_resume(), L4::Thread::pf_trampoline_setup(), L4::Debugger::query_log_name(), L4::Debugger::query_log_typeid(), L4::Debugger::query_object_name(), L4::Vcon::read(), L4::Vcon::read_with_flags(), L4::Irq::receive(), L4::Thread::register_del_irq(), L4::Thread::register_doorbell_irq(), L4::Task::release_cap(), L4vbus::Vbus::release_ioport(), L4::Thread_group::remove(), L4vbus::Vbus::request_ioport(), L4vbus::Vbus::root(), L4::Vcon::send(), L4::Vcon::set_attr(), L4::Icu::set_mode(), L4::Debugger::set_object_name(), L4::Thread::stats_time(), L4::Debugger::switch_log(), L4::Thread::switch_to(), L4::Triggerable::trigger(), L4::Icu::unbind(), L4::Task::unmap(), L4::Task::unmap_batch(), L4::Irq_eoi::unmask(), L4::Thread::vcpu_control(), L4::Thread::vcpu_control_ext(), L4::Thread::vcpu_resume_commit(), L4Re::Video::Goos::view(), and L4::Vcon::write().

Here is the caller graph for this function:



15.159.2.2 dec_refcnt()

```
l4_msgtag_t L4::Kobject::dec_refcnt (
            l4_mword_t diff,
            l4_utcb_t * utcb = l4_utcb())  [inline]
```

Decrement the in kernel reference counter for the object.

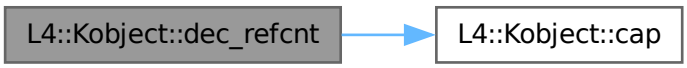
Parameters

diff	The delta that shall be subtracted from the reference count.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag

This function is intended for servers to be able to remove the servers own capability from the counted references. This leads to the semantics that the kernel will delete the object even if the capability of the server is valid. The server can detect the deletion by polling its capabilities or by using the IPC-gate deletion IRQs. And to cleanup if the clients dropped the last reference (capability) to the object.
This function only succeeds on a kernel object of type L4::Ipc_gate which has the server right (L4_FPAGE_C_IPCGATE_SVR). For other kernel objects, -L4_ENOSYS is returned.
Definition at line 100 of file kobject.
References cap().
Here is the call graph for this function:



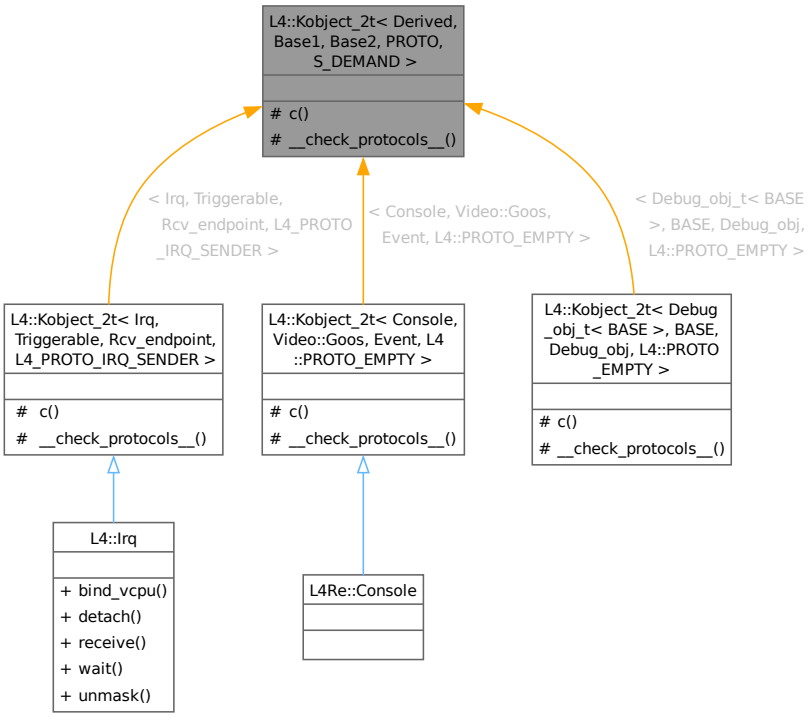
The documentation for this class was generated from the following file:

- l4/sys/kobject

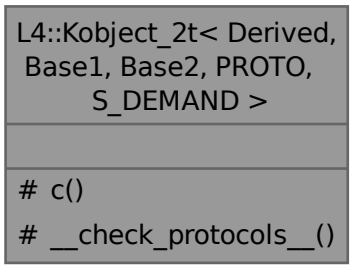
15.160 L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND > Class Template Reference

Helper class to create an L4Re interface class that is derived from two base classes (see `L4::Kobject_t`).
`#include <l4/sys/capability>`

Inheritance diagram for L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >:



Collaboration diagram for L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >:



Protected Types

- typedef Derived Class

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Derived > __Iface

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, Typeid::Merge_list< typename Base1::__Iface↩ _list, typename Base2::__Iface_list > > __Iface_list

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions

- L4::Cap< Class > c () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions

- static void __check_protocols__ () noexcept

  Helper to check for protocol conflicts.

15.160.1 Detailed Description

template<typename Derived, typename Base1, typename Base2, l4_proto_t PROTO = PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
class L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >

Helper class to create an L4Re interface class that is derived from two base classes (see `L4::Kobject_t`).

Template Parameters

Derived	is the name of the new interface.
Base1	is the name of the interface's first base class.
Base2	is the name of the interface's second base class.
PROTO	may be set to the statically assigned protocol number used to communicate with this interface.
S_DEMAND	type defining the demand of server-side resources for this interface, usually a L4::Type_info::Demand_t. This value must describe the server-side resources needed by the interface itself, the resource demand of the base interfaces (Base1 and Base2) are automatically included.

The typical usage pattern is shown in the following code snippet. The semantics of this example is an interface My_iface that is derived from L4::Icu and L4Re::Dataspace.

```
class My_iface : public L4::Kobject_2t<My_iface, L4::Icu, L4Re::Dataspace>
{
  ...
};
```

Definition at line 827 of file __typeinfo.h.

15.160.2 Member Typedef Documentation

15.160.2.1 __Iface

```
template<typename Derived, typename Base1, typename Base2, l4_proto_t PROTO = PROTO_ANY, typename
S_DEMAND = Type_info::Demand_t<>>
typedef Typeid::Iface<PROTO, Derived> L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND
>::__Iface  [protected]
```

The interface description for the derived class.
Definition at line 833 of file __typeinfo.h.

15.160.2.2 __Iface_list

```
template<typename Derived, typename Base1, typename Base2, l4_proto_t PROTO = PROTO_ANY, typename
S_DEMAND = Type_info::Demand_t<>>
typedef Typeid::Merge_list< Typeid::Iface_list<__Iface>, Typeid::Merge_list< typename Base1↩
::__Iface_list, typename Base2::__Iface_list > > L4::Kobject_2t< Derived, Base1, Base2, PROTO,
S_DEMAND >::__Iface_list  [protected]
```

The list of all RPC interfaces provided directly or through inheritance.
Definition at line 841 of file __typeinfo.h.

15.160.2.3 Class

```
template<typename Derived, typename Base1, typename Base2, l4_proto_t PROTO = PROTO_ANY, typename
S_DEMAND = Type_info::Demand_t<>>
typedef Derived L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >::Class  [protected]
```

The target interface type (inheriting from Kobject_t).
Definition at line 831 of file __typeinfo.h.

15.160.3 Member Function Documentation

15.160.3.1 __check_protocols__()

```
template<typename Derived, typename Base1, typename Base2, l4_proto_t PROTO = PROTO_ANY, typename
S_DEMAND = Type_info::Demand_t<>>
void L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >::__check_protocols__ ()  [inline],
[static], [protected], [noexcept]
```

Helper to check for protocol conflicts.
Definition at line 844 of file __typeinfo.h.

15.160.3.2 c()

```
template<typename Derived, typename Base1, typename Base2, l4_proto_t PROTO = PROTO_ANY, typename
S_DEMAND = Type_info::Demand_t<>>
L4::Cap< Class > L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >::c () const  [inline],
[protected], [noexcept]
```

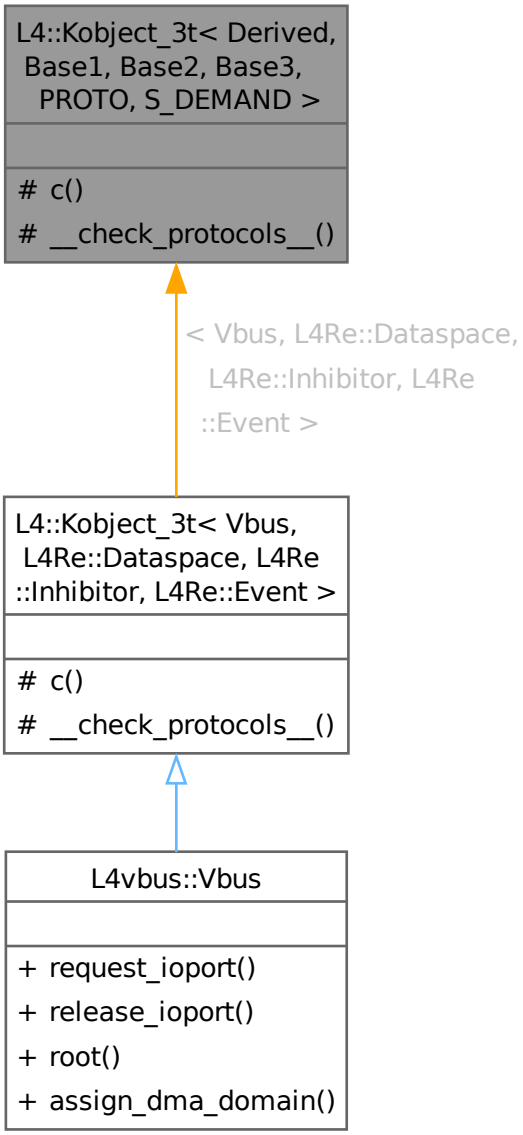
Get the capability to ourselves.
Definition at line 863 of file __typeinfo.h.
The documentation for this class was generated from the following file:

- l4/sys/__typeinfo.h

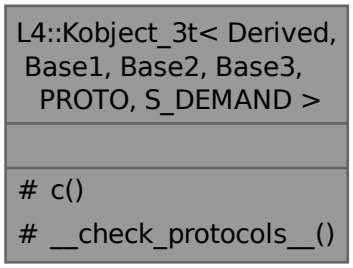
15.161 L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND > Struct Template Reference

Helper class to create an L4Re interface class that is derived from three base classes (see `L4::Kobject_t`).
`#include <l4/sys/capability>`

Inheritance diagram for L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >:



Collaboration diagram for L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >:



Protected Types

- typedef Derived Class

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Derived > __Iface

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, Typeid::Merge_list< typename Base1::__Iface_list, Typeid::Merge_list< typename Base2::__Iface_list, typename Base3::__Iface_list > > > __Iface_list

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions

- L4::Cap< Class > c () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions

- static void __check_protocols__ () noexcept

  Helper to check for protocol conflicts.

15.161.1 Detailed Description

template<typename Derived, typename Base1, typename Base2, typename Base3, l4_proto_t PROTO = PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
struct L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >

Helper class to create an L4Re interface class that is derived from three base classes (see `L4::Kobject_t`).

Template Parameters

Derived	is the name of the new interface.
Base1	is the name of the interface's first base class.
Base2	is the name of the interface's second base class.
Base3	is the name of the interfaces third base class.
PROTO	may be set to the statically assigned protocol number used to communicate with this interface.

S_DEMAND	type defining the demand on server-side resources for this interface, usually a L4::Type_info::Demand_t. This value must describe the server-side resources needed by the interface itself, the resource demand of the base interfaces (Base1 and Base2) are automatically included.

See also

L4::Kobject_t, L4::Kobject_2t, L4::Kobject_0t, L4::Kobject_x

Definition at line 930 of file __typeinfo.h.

15.161.2 Member Typedef Documentation

15.161.2.1 __Iface

```
template<typename Derived, typename Base1, typename Base2, typename Base3, l4_proto_t PROTO =
PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
typedef Typeid::Iface<PROTO, Derived> L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO,
S_DEMAND >::__Iface  [protected]
```

The interface description for the derived class.
Definition at line 936 of file __typeinfo.h.

15.161.2.2 __Iface_list

```
template<typename Derived, typename Base1, typename Base2, typename Base3, l4_proto_t PROTO =
PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
typedef Typeid::Merge_list< Typeid::Iface_list<__Iface>, Typeid::Merge_list< typename Base1↩
::__Iface_list, Typeid::Merge_list< typename Base2::__Iface_list, typename Base3::__Iface↩
_list > > > L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >::__Iface_list
[protected]
```

The list of all RPC interfaces provided directly or through inheritance.
Definition at line 947 of file __typeinfo.h.

15.161.2.3 Class

```
template<typename Derived, typename Base1, typename Base2, typename Base3, l4_proto_t PROTO =
PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
typedef Derived L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >::Class  [protected]
```

The target interface type (inheriting from Kobject_t).
Definition at line 934 of file __typeinfo.h.

15.161.3 Member Function Documentation

15.161.3.1 __check_protocols__()

```
template<typename Derived, typename Base1, typename Base2, typename Base3, l4_proto_t PROTO =
PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
void L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >::__check_protocols__ ()
[inline], [static], [protected], [noexcept]
```

Helper to check for protocol conflicts.
Definition at line 950 of file __typeinfo.h.

15.161.3.2 c()

```
template<typename Derived, typename Base1, typename Base2, typename Base3, l4_proto_t PROTO =
PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
L4::Cap< Class > L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >::c () const
[inline], [protected], [noexcept]
```

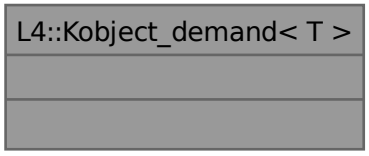
Get the capability to ourselves.

Definition at line 978 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

15.162 L4::Kobject_demand< T > Struct Template Reference

Get the combined server-side resource requirements for all type T...
Collaboration diagram for L4::Kobject_demand< T >:



15.162.1 Detailed Description

template<typename ... T>
struct L4::Kobject_demand< T >

Get the combined server-side resource requirements for all type T...

Template Parameters

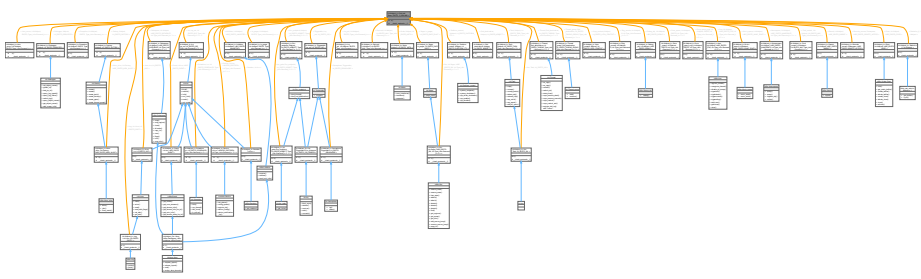
T	List of IPC interface types for which the combined server-side resource requirements shall be calculated.

Definition at line 1031 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

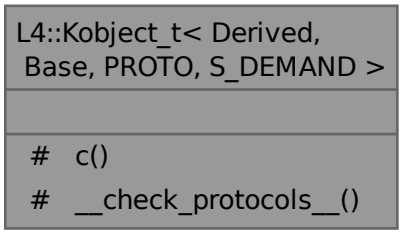
- l4/sys/__typeinfo.h

15.163 L4::Kobject_t< Derived, Base, PROTO, S_DEMAND > Class Template Reference

Helper class to create an L4Re interface class that is derived from a single base class.
`#include <l4/sys/capability>`
Inheritance diagram for L4::Kobject_t< Derived, Base, PROTO, S_DEMAND >:



Collaboration diagram for L4::Kobject_t< Derived, Base, PROTO, S_DEMAND >:



Protected Types

- typedef Derived **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Derived > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Base::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.163.1 Detailed Description

template<typename Derived, typename Base, l4_proto_t PROTO = PROTO_ANY, typename S_DEMAND = Type_info::Demand_t<>>
class L4::Kobject_t< Derived, Base, PROTO, S_DEMAND >

Helper class to create an L4Re interface class that is derived from a single base class.

Template Parameters

Derived	is the name of the new interface.
Base	is the name of the interfaces single base class.
PROTO	may be set to the statically assigned protocol number used to communicate with this interface.
S_DEMAND	type defining the demand on server-side resources for this interface, usually a L4::Type_info::Demand_t. This value must describe the server-side resources needed by the interface itself, the resource demand of the base interface `Base` is automatically included.

The typical usage pattern is shown in the following code snippet. The semantics of this example is an interface My_iface that is derived from L4::Kobject.

```
class My_iface : public L4::Kobject_t<My_iface, L4::Kobject>
{
  ...
};
```

Examples

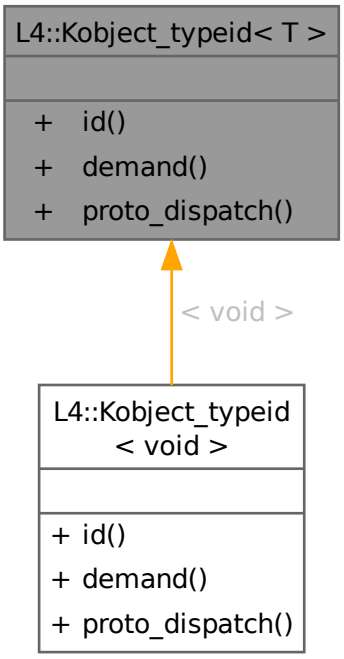
examples/clntsrv/src/shared.h.

Definition at line 749 of file __typeinfo.h.
The documentation for this class was generated from the following file:

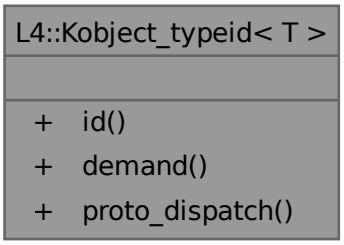
- l4/sys/__typeinfo.h

15.164 L4::Kobject_typeid< T > Struct Template Reference

Meta object for handling access to type information of Kobjects.
`#include <__typeinfo.h>`
Inheritance diagram for L4::Kobject_typeid< T >:



Collaboration diagram for L4::Kobject_typeid< T >:



Public Types

- typedef T::__Kobject_typeid::Demand Demand

  Data type expressing the static demand of receive buffers in a server.

Static Public Member Functions

- static Type_info const * id () noexcept

  Get a pointer to the Kobject type information of T.
- static Type_info::Demand demand () noexcept

  Get the receive-buffer demand for the server providing the interface T.
- template<typename THIS, typename A1, typename A2>
  static int proto_dispatch (THIS *self, l4_proto_t proto, A1 a1, A2 &a2)

  Protocol based server-side dispatch function.

15.164.1 Detailed Description

template<typename T>
struct L4::Kobject_typeid< T >

Meta object for handling access to type information of Kobjects.

Template Parameters

T	The data type derived from Kobject, usually using Kobject_t.

Definition at line 610 of file __typeinfo.h.

15.164.2 Member Typedef Documentation

15.164.2.1 Demand

```
template<typename T>
typedef T::__Kobject_typeid::Demand L4::Kobject_typeid< T >::Demand
```

Data type expressing the static demand of receive buffers in a server.
This information is the combined demand of all base interfaces for T and the buffer demand of T itself. The buffer demand of T is usually specified as the S_DEMAND argument of the Kobject_t or Kobject_2t inheritance helpers. S_DEMAND is usually of type L4::Type_info::Demand_t, or L4::Type_info::Demand_union_t.
Definition at line 622 of file __typeinfo.h.

15.164.3 Member Function Documentation

15.164.3.1 demand()

```
template<typename T>
Type_info::Demand L4::Kobject_typeid< T >::demand ()  [inline], [static], [noexcept]
```

Get the receive-buffer demand for the server providing the interface T.

Returns

A demand value describing the minimum receive buffers needed for handling server side requests for interface T.

Definition at line 639 of file __typeinfo.h.

15.164.3.2 id()

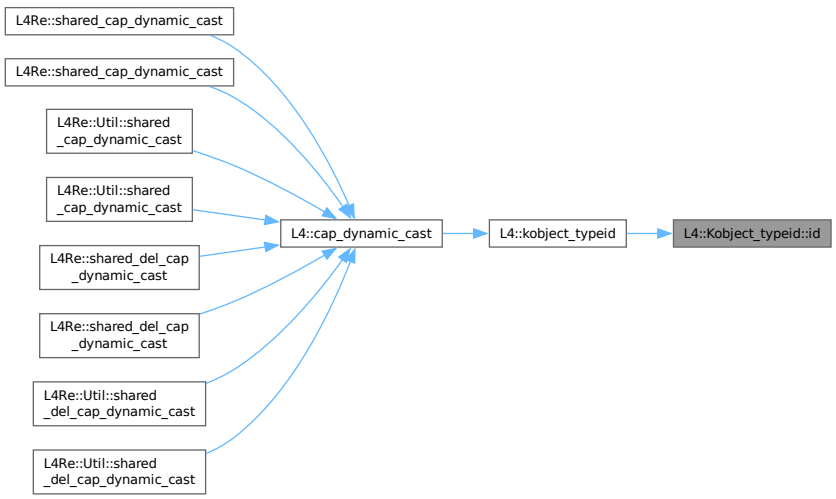
```
template<typename T>
Type_info const * L4::Kobject_typeid< T >::id ()  [inline], [static], [noexcept]
```

Get a pointer to the Kobject type information of T.

Returns

a pointer to the Kobject typeinfo of T.

Definition at line 630 of file __typeinfo.h.
Referenced by L4::kobject_typeid().
Here is the caller graph for this function:



15.164.3.3 proto_dispatch()

```
template<typename T>
template<typename THIS, typename A1, typename A2>
int L4::Kobject_typeid< T >::proto_dispatch (
            THIS * self,
            l4_proto_t proto,
            A1 a1,
            A2 & a2)  [inline], [static]
```

Protocol based server-side dispatch function.

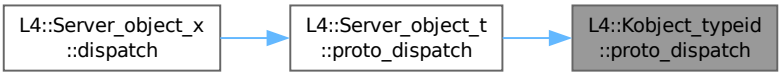
Template Parameters

THIS	Data type of the server-side object implementing the interface T.
A1	Data type of second argument for p_dispatch()
A2	Data type of third argument for p_dispatch()

Parameters

self	The pointer to the server object
proto	The protocol number used by the caller
a1	The second argument passed to self->p_dispatch()
a2	The third argument passed to self->p_dispatch()

This function forwards the call to the overloaded p_dispatch() function of self. The data type of the first argument for p_dispatch is determined by the given protocol number.
Definition at line 660 of file __typeinfo.h.
Referenced by L4::Server_object_t< IFACE, BASE >::proto_dispatch().
Here is the caller graph for this function:



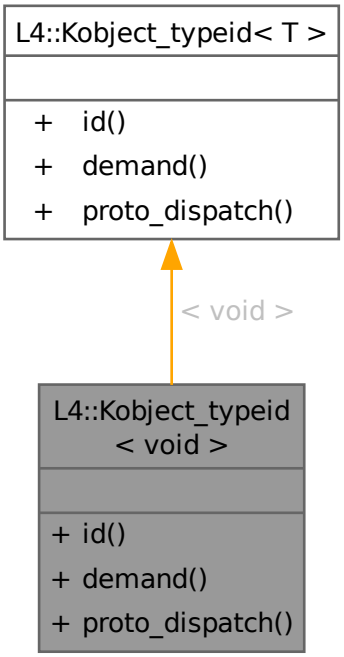
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

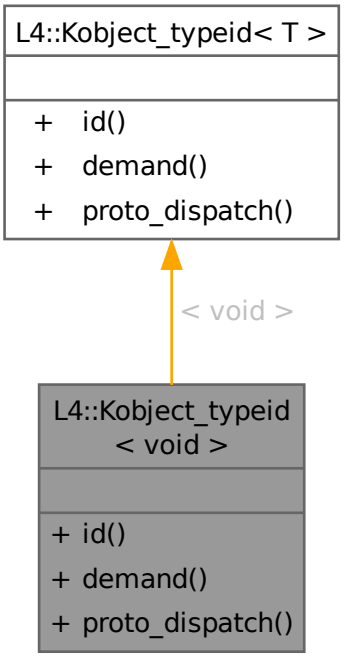
15.165 L4::Kobject_typeid< void > Struct Reference

Minimalistic ID for `void` interface.
`#include <__typeinfo.h>`

Inheritance diagram for L4::Kobject_typeid< void >:



Collaboration diagram for L4::Kobject_typeid< void >:



Static Public Member Functions

- static Type_info const * id () noexcept

  Get a pointer to the Kobject type information of T.
- static Type_info::Demand demand () noexcept

  Get the receive-buffer demand for the server providing the interface T.
- static int proto_dispatch (THIS *self, l4_proto_t proto, A1 a1, A2 &a2)

  Protocol based server-side dispatch function.

15.165.1 Detailed Description

Minimalistic ID for `void` interface.
Definition at line 667 of file __typeinfo.h.

15.165.2 Member Function Documentation

15.165.2.1 demand()

`Type_info::Demand L4::Kobject_typeid< void >::demand () [inline], [static], [noexcept]`
Get the receive-buffer demand for the server providing the interface T.

Returns

A demand value describing the minimum receive buffers needed for handling server side requests for interface T.

Definition at line 639 of file __typeinfo.h.

15.165.2.2 id()

```
Type_info const * L4::Kobject_typeid< void >::id ()  [inline], [static], [noexcept]
```

Get a pointer to the Kobject type information of T.

Returns

a pointer to the Kobject typeinfo of T.

Definition at line 630 of file __typeinfo.h.

15.165.2.3 proto_dispatch()

```
int L4::Kobject_typeid< void >::proto_dispatch (
            THIS * self,
            l4_proto_t proto,
            A1 a1,
            A2 & a2)  [inline], [static]
```

Protocol based server-side dispatch function.

Template Parameters

THIS	Data type of the server-side object implementing the interface T.
A1	Data type of second argument for p_dispatch()
A2	Data type of third argument for p_dispatch()

Parameters

self	The pointer to the server object
proto	The protocol number used by the caller
a1	The second argument passed to self->p_dispatch()
a2	The third argument passed to self->p_dispatch()

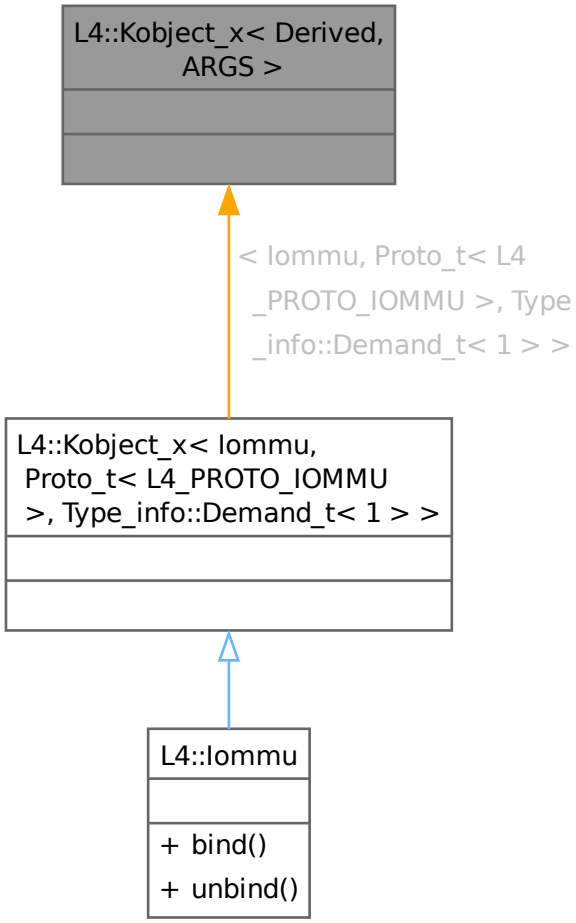
This function forwards the call to the overloaded p_dispatch() function of self. The data type of the first argument for p_dispatch is determined by the given protocol number.
Definition at line 660 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

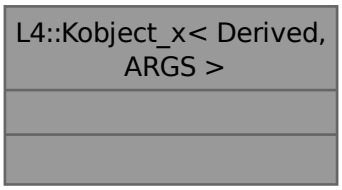
15.166 L4::Kobject_x< Derived, ARGS > Struct Template Reference

Generic Kobject inheritance template.

Inheritance diagram for L4::Kobject_x< Derived, ARGS >:



Collaboration diagram for L4::Kobject_x< Derived, ARGS >:



15.166.1 Detailed Description

template<typename Derived, typename ... ARGS>
struct L4::Kobject_x< Derived, ARGS >

Generic Kobject inheritance template.

Template Parameters

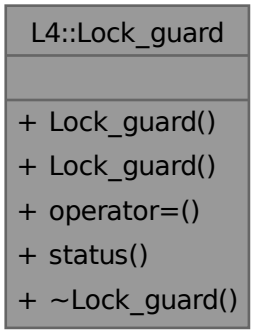
Derived	The class name that derives from Kobject_x.
ARGS	An optional protocol number via L4::Proto_t, followed by an optional server-side requirement passed as L4::Type_info::Demand_t, followed by the list of base classes.

Definition at line 1197 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

15.167 L4::Lock_guard Class Reference

Basic lock guard implementation that prevents forgotten unlocks on exit paths from a method or a block of code.
`#include <lock_guard.h>`
Collaboration diagram for L4::Lock_guard:



Public Member Functions

- Lock_guard (pthread_mutex_t &lock)

  Construct the lock guard and lock the associated mutex.
- Lock_guard (Lock_guard &&guard)

  Move constructor from other lock guard.
- Lock_guard & operator= (Lock_guard &&guard)

  Move assignment from other lock guard.
- int status () const

  Return last lock/unlock operation error status.
- ~Lock_guard ()

  Lock guard destructor.

15.167.1 Detailed Description

Basic lock guard implementation that prevents forgotten unlocks on exit paths from a method or a block of code.
Targeting `pthread_mutex_t`.
An instance of lock guard cannot be copied, but it can be moved.
The typical usage pattern of the lock guard is:

```
pthread_mutex_t mtx = PTHREAD_MUTEX_INITIALIZER;

{
  auto guard = L4Re::Lock_guard(mtx);

  // Correctness check.
  assert(guard.status() == 0);

  // Critical section protected by mtx.

  // The mtx is automatically unlocked when guard goes out of scope.
}
```

Definition at line 44 of file lock_guard.h.

15.167.2 Constructor & Destructor Documentation

15.167.2.1 Lock_guard() [1/2]

```
L4::Lock_guard::Lock_guard (
            pthread_mutex_t & lock)  [inline], [explicit]
```

Construct the lock guard and lock the associated mutex.
The error condition of the locking operation can be checked by the status() method.

Parameters

lock	Associated mutex to be locked.

Definition at line 59 of file lock_guard.h.

15.167.2.2 Lock_guard() [2/2]

```
L4::Lock_guard::Lock_guard (
            Lock_guard && guard)  [inline]
```

Move constructor from other lock guard.
The mutex associated with the other lock guard is kept locked.

Parameters

guard	Lock guard to be moved.

Definition at line 71 of file lock_guard.h.

15.167.2.3 ~Lock_guard()

```
L4::Lock_guard::~Lock_guard ()  [inline]
```

Lock guard destructor.
The associated mutex (if any) is unlocked.
There is no mechanism for indicating any error conditions. However, if the mutex has been previously locked successfully by this class and if the implementation of the mutex behaves according to the POSIX specification, the construction of this class guarantees that the unlock operation does not fail.
Definition at line 126 of file lock_guard.h.

15.167.3 Member Function Documentation

15.167.3.1 operator=()

```
Lock_guard & L4::Lock_guard::operator= (
            Lock_guard && guard)  [inline]
```

Move assignment from other lock guard.
The mutex currently associated with this lock guard is unlocked. The mutex associated with the other lock guard is kept locked.
There is no mechanism for indicating any error conditions of the unlocking operation. However, if the mutex has been previously locked successfully by this class and if the implementation of the mutex behaves according to the POSIX specification, the construction of this class guarantees that the unlock operation does not fail.

Parameters

guard	Lock guard to be moved.

Definition at line 90 of file lock_guard.h.

15.167.3.2 status()

```
int L4::Lock_guard::status () const  [inline]
```

Return last lock/unlock operation error status.

Returns

Zero indicating no errors, any other value indicating an error.

Definition at line 110 of file lock_guard.h.
The documentation for this class was generated from the following file:

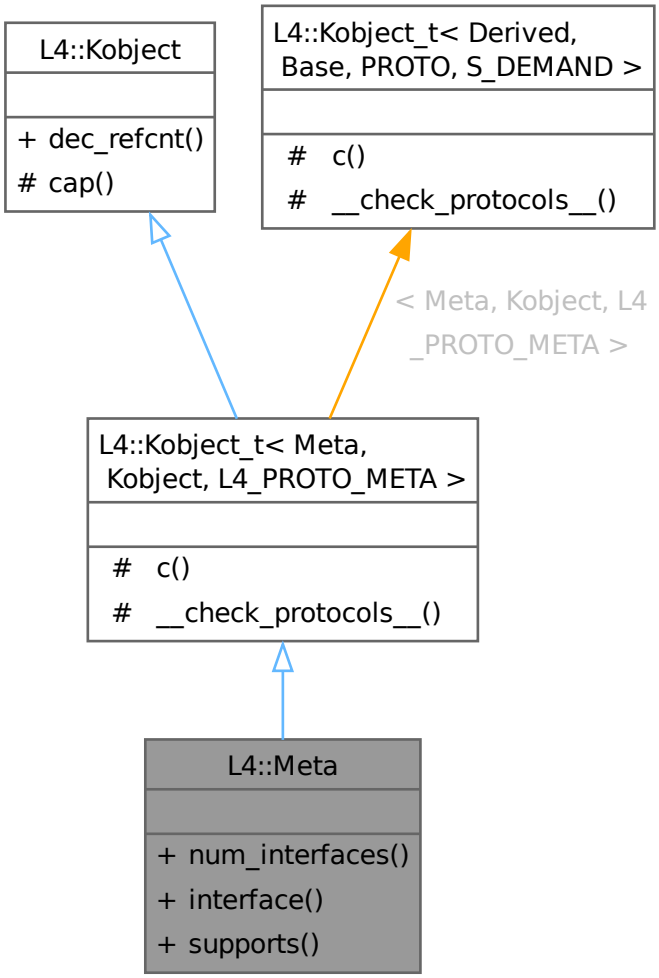
- l4/cxx/lock_guard.h

15.168 L4::Meta Class Reference

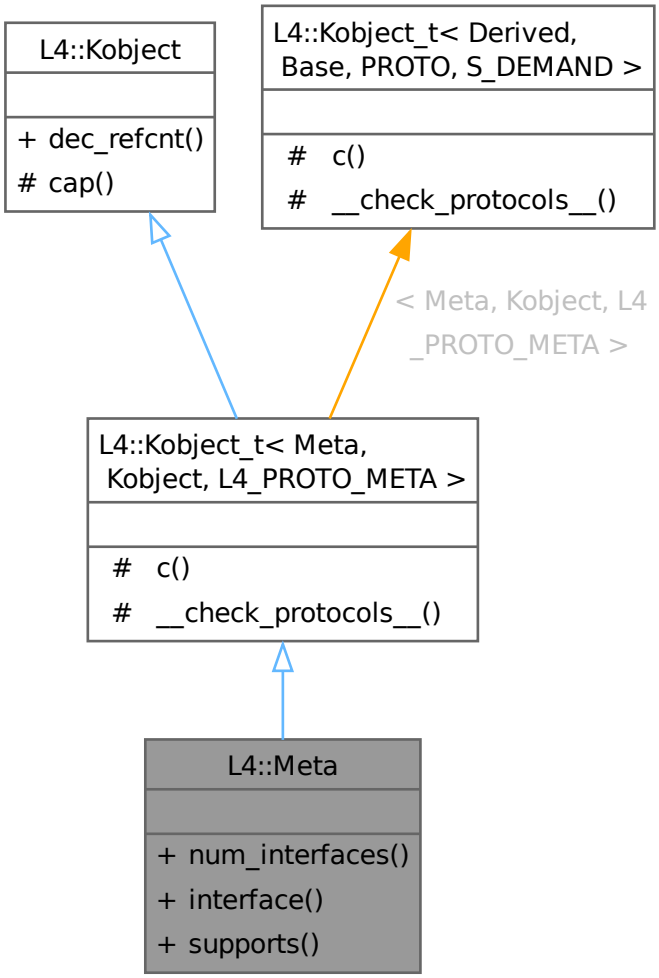
Meta interface that shall be implemented by each L4Re object and gives access to the dynamic type information for L4Re objects.

```
#include <meta>
```

Inheritance diagram for L4::Meta:



Collaboration diagram for L4::Meta:



Public Member Functions

- l4_msgtag_t num_interfaces ()

  Get the number of interfaces implemented by this object.
- l4_msgtag_t interface (l4_umword_t idx, long *proto, L4::Ipc::String< char > *name)

  Get the protocol number that must be used for the interface with the number `idx`.
- l4_msgtag_t supports (l4_mword_t protocol)

  Figure out if the object supports the given protocol (number).

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Meta, Kobject, L4_PROTO_META >

- typedef Meta **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Meta > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Meta, Kobject, L4_PROTO_META >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Meta, Kobject, L4_PROTO_META >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.168.1 Detailed Description

Meta interface that shall be implemented by each L4Re object and gives access to the dynamic type information for L4Re objects.
Definition at line 26 of file meta.

15.168.2 Member Function Documentation

15.168.2.1 interface()

```
l4_msgtag_t L4::Meta::interface (
             l4_umword_t idx,
             long * proto,
             L4::Ipc::String< char > * name)
```

Get the protocol number that must be used for the interface with the number `idx`.

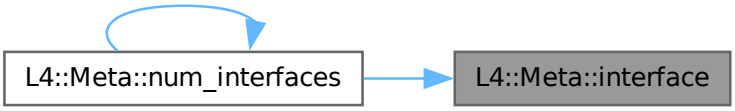
Parameters

	idx	The index of the interface to get the protocol number for. `idx` must be >= 0 and < the return value of num_interfaces().
`out`	*proto*	The protocol number for interface `idx`.
`out`	*name*	The protocol name for interface `idx`.

Return values

l4_msgtag_t::label() == 0	Successful; see `proto` and `name`.
l4_msgtag_t::label() < 0	Error code.

Referenced by num_interfaces().
Here is the caller graph for this function:



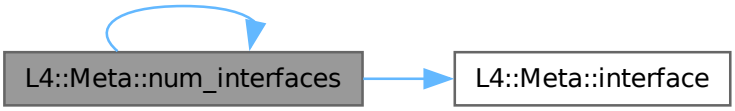
15.168.2.2 num_interfaces()

`l4_msgtag_t L4::Meta::num_interfaces ()`
Get the number of interfaces implemented by this object.

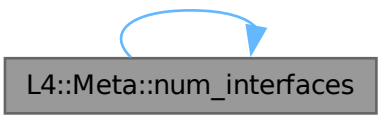
Return values

l4_msgtag_t::label() >= 0	The number of supported interfaces.
l4_msgtag_t::label() < 0	Error code of the occurred error.

References interface(), and num_interfaces().
Referenced by num_interfaces().
Here is the call graph for this function:



Here is the caller graph for this function:



15.168.2.3 supports()

```
l4_msgtag_t L4::Meta::supports (
            l4_mword_t protocol)
```

Figure out if the object supports the given protocol (number).

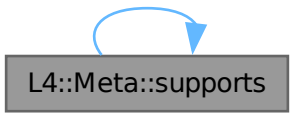
Parameters

protocol	The protocol number to check for.

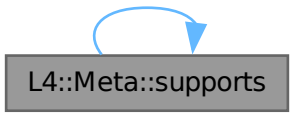
Return values

l4_msgtag_t::label() == 1	protocol is supported.
l4_msgtag_t::label() == 0	protocol is not supported.

This method is intended to be used for statically assigned protocol numbers.
References supports().
Referenced by supports().
Here is the call graph for this function:



Here is the caller graph for this function:



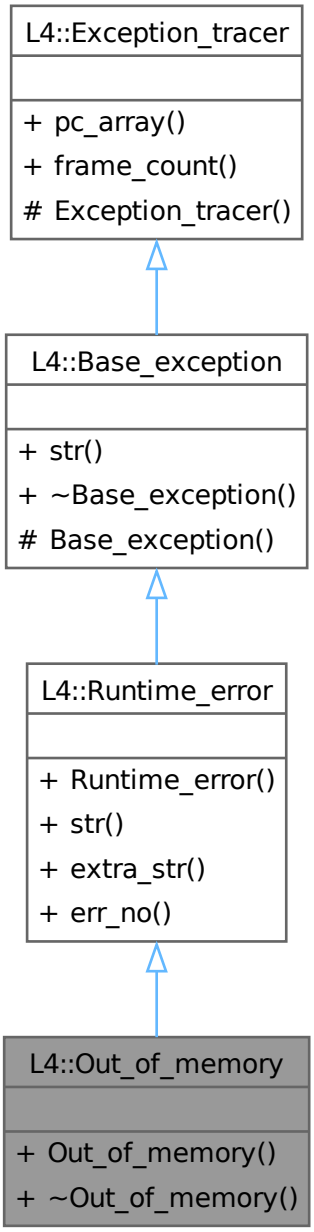
The documentation for this class was generated from the following file:

- l4/sys/meta

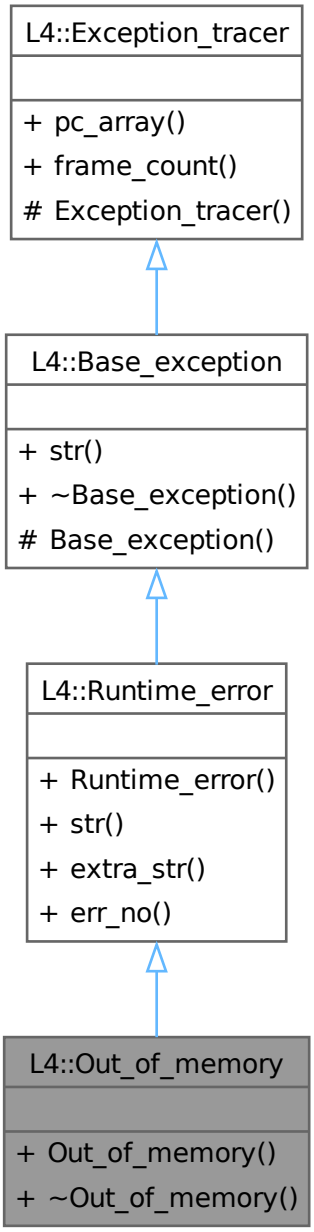
15.169 L4::Out_of_memory Class Reference

Exception signalling insufficient memory.
`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Out_of_memory:



Collaboration diagram for L4::Out_of_memory:



Public Member Functions

- **Out_of_memory** (char const *extra="") noexcept

  Create an out-of-memory exception.
- ~**Out_of_memory** () noexcept

  Destruction.

Public Member Functions inherited from L4::Runtime_error

- Runtime_error (long err_no, char const *extra=0) noexcept

  Create a new Runtime_error.
- char const * **str** () const noexcept override

  Return a human readable string for the exception.
- char const * extra_str () const

  Get the description text for this runtime error.
- long err_no () const noexcept

  Get the error value for this runtime error.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.
- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Additional Inherited Members

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

15.169.1 Detailed Description

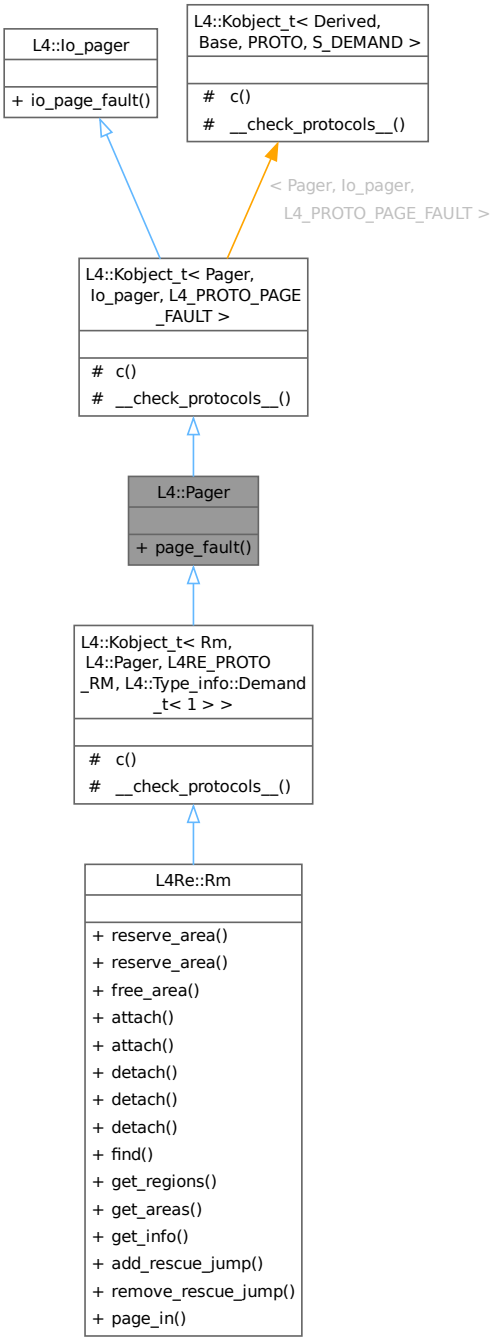
Exception signalling insufficient memory.
Definition at line 177 of file exceptions.
The documentation for this class was generated from the following file:

- l4/cxx/exceptions

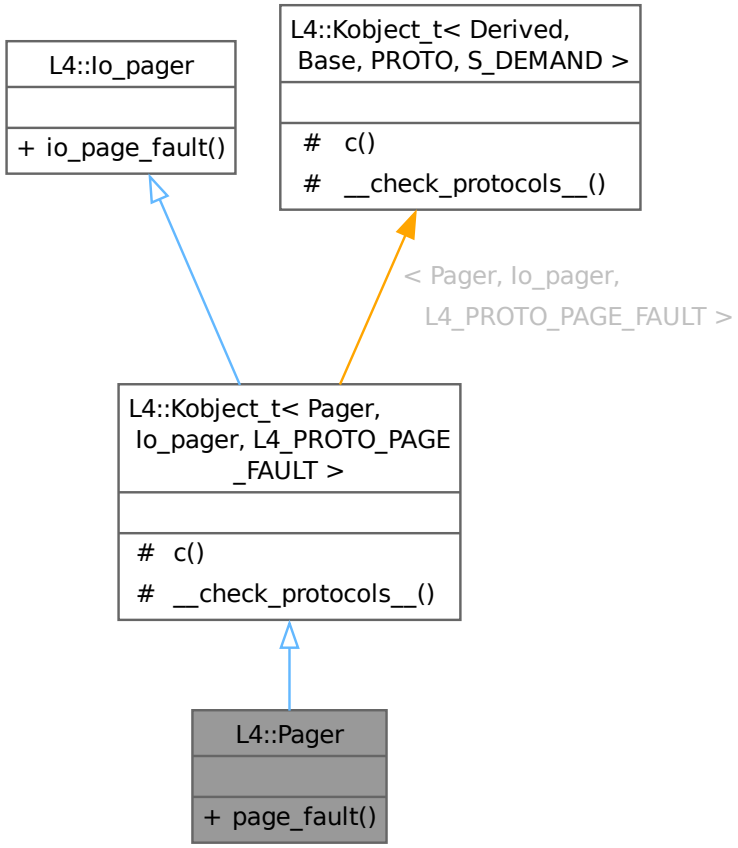
15.170 L4::Pager Class Reference

Pager interface including the Io_pager interface.
`#include <pager>`

Inheritance diagram for L4::Pager:



Collaboration diagram for L4::Pager:



Public Member Functions

- l4_msgtag_t page_fault (l4_umword_t pfa, l4_umword_t pc, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  Page-fault protocol message.

Public Member Functions inherited from L4::Io_pager

- l4_msgtag_t io_page_fault (l4_fpage_t io_pfa, l4_umword_t pc, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  IO page fault protocol message.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- typedef Pager **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Pager > **__Iface**

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Io_pager::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.170.1 Detailed Description

Pager interface including the Io_pager interface.
This class defines the interface for handling page fault IPC. If a thread causes a page fault, the microkernel synthesises a page fault IPC message and sends it to the thread's page fault handler (pager). The pager can then handle the message, for example by establishing a suitable page mapping.
The page fault handler is set with the L4::Thread::control interface.
Definition at line 88 of file pager.

15.170.2 Member Function Documentation

15.170.2.1 page_fault()

```
l4_msgtag_t L4::Pager::page_fault (
             l4_umword_t pfa,
             l4_umword_t pc,
             L4::Ipc::Rcv_fpage rwin,
             L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)
```

Page-fault protocol message.

Parameters

	pfa	Faulting address including failure reason: bits [0:2].
	pc	Faulting program counter.
	rwin	Receive window for a flexpage mapping resolving the page fault.
out	*fp*	Optional: flexpage descriptor to send to the task raising the page fault.

Returns

System call message tag; use l4_error() to check for errors.

Page-fault messages are usually generated by the kernel and need to be handled by an appropriate handler function, potentially filling in `fp` for the reply.
`pfa` encoding is as shown:

[63/31 .. 3]	2	1	0
PFA	X	W	r

- **PFA** Bits 63/31..3 of `pfa` are the page fault address bits 63/31 to 3, bits 2..0 are masked.

- **X** Bit 2 of `pfa` if set, indicates a page fault during instruction fetch. Note, this bit is implementation-defined and might always be clear. Therefore, if this bit is clear it does not imply that the page fault is not due to an instruction fetch.
- **W** Bit 1 of `pfa` is set to 1 for a page fault due to a write operation.
- **r** Bit0: reserved, undefined.

The documentation for this class was generated from the following file:

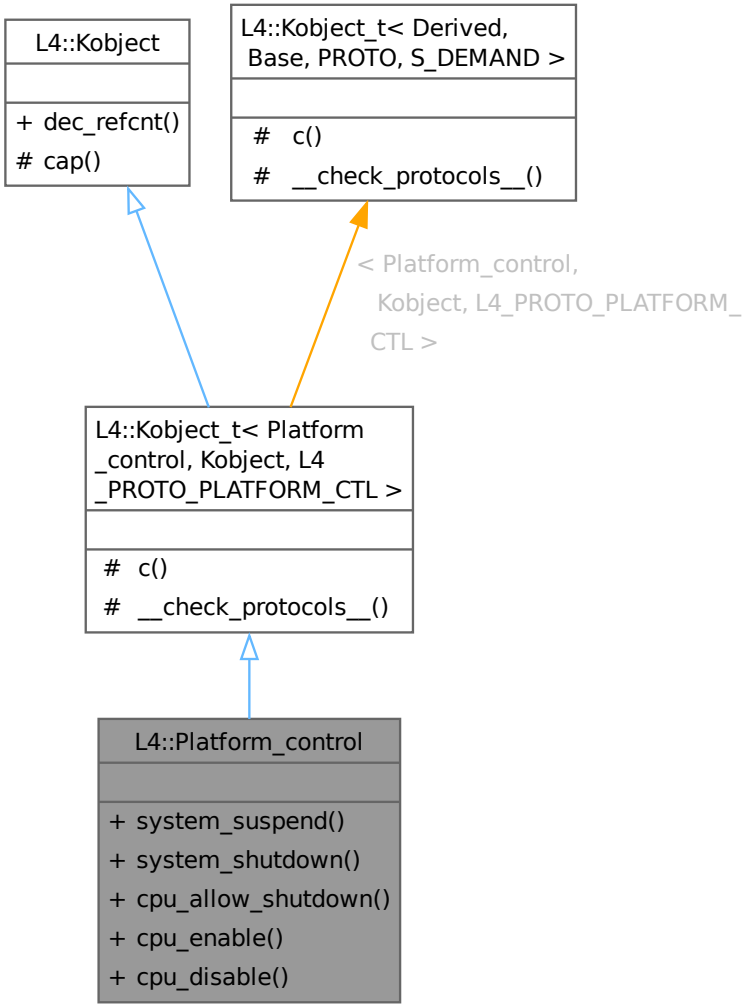
- l4/sys/pager

15.171 L4::Platform_control Class Reference

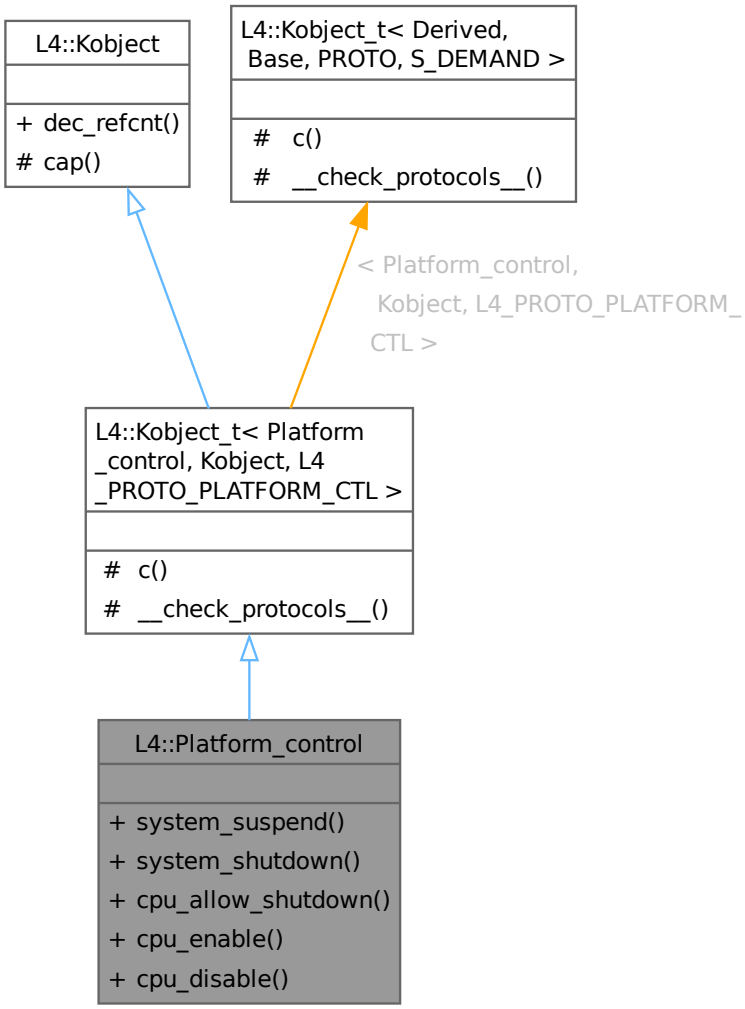
L4 C++ interface for controlling platform-wide properties, see Platform Control C API for the C interface.

`#include <platform_control>`

Inheritance diagram for L4::Platform_control:



Collaboration diagram for L4::Platform_control:



Public Member Functions

- l4_msgtag_t system_suspend (l4_umword_t extras)

  Enter suspend to RAM.
- l4_msgtag_t system_shutdown (l4_umword_t reboot)

  Shutdown/Reboot the system.
- l4_msgtag_t cpu_allow_shutdown (l4_umword_t phys_id, l4_umword_t enable)

  Allow CPU shutdown.
- l4_msgtag_t cpu_enable (l4_umword_t phys_id)

  Enable an offline CPU.
- l4_msgtag_t cpu_disable (l4_umword_t phys_id)

  Disable an online CPU.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Platform_control, Kobject, L4_PROTO_PLATFORM_CTL >

- typedef Platform_control **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Platform_control > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Platform_control, Kobject, L4_PROTO_PLATFORM_CTL >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Platform_control, Kobject, L4_PROTO_PLATFORM_CTL >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.171.1 Detailed Description

L4 C++ interface for controlling platform-wide properties, see Platform Control C API for the C interface.
Add

```
#include <l4/sys/platform_control>
```

to your code to use the platform control functions. The API allows a client to suspend, reboot or shutdown the system.
For the C interface refer to the Platform Control C API.
Definition at line 36 of file platform_control.

15.171.2 Member Function Documentation

15.171.2.1 cpu_allow_shutdown()

```
l4_msgtag_t L4::Platform_control::cpu_allow_shutdown (
             l4_umword_t phys_id,
             l4_umword_t enable)
```

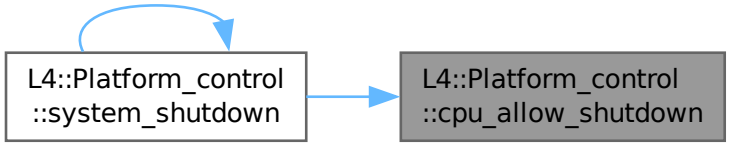
Allow CPU shutdown.

Parameters

phys_id	Physical CPU id of CPU (e.g. local APIC id) to disable.

enable	Allow shutdown when 1, disallow when 0.

Sets or unsets a hint that a CPU that is not currently used may be powered down.
References L4_PLATFORM_CTL_CPU_ENABLE_OP.
Referenced by system_shutdown().
Here is the caller graph for this function:



15.171.2.2 cpu_disable()

```
l4_msgtag_t L4::Platform_control::cpu_disable (
             l4_umword_t phys_id)
```

Disable an online CPU.

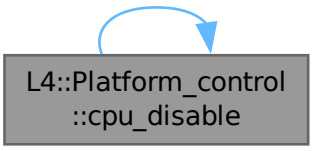
Parameters

phys↩ _id	Physical CPU id of CPU (e.g. local APIC id) to disable.

Returns

System call message tag

This function is currently only supported on the ARM EXYNOS platform.
References cpu_disable().
Referenced by cpu_disable().
Here is the call graph for this function:



Here is the caller graph for this function:



15.171.2.3 cpu_enable()

```
l4_msgtag_t L4::Platform_control::cpu_enable (
            l4_umword_t phys_id)
```

Enable an offline CPU.

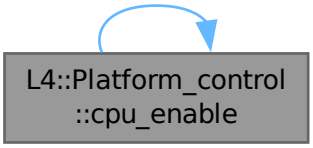
Parameters

phys↩ _id	Physical CPU id of CPU (e.g. local APIC id) to enable.

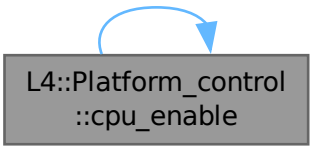
Returns

System call message tag

This function is currently only supported on the ARM EXYNOS platform.
References cpu_enable(), and L4_PLATFORM_CTL_CPU_DISABLE_OP.
Referenced by cpu_enable().
Here is the call graph for this function:



Here is the caller graph for this function:



15.171.2.4 system_shutdown()

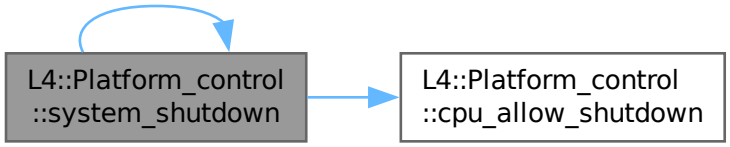
```
l4_msgtag_t L4::Platform_control::system_shutdown (
            l4_umword_t reboot)
```

Shutdown/Reboot the system.

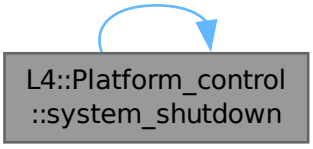
Parameters

reboot	1 for reboot, 0 for power off

References cpu_allow_shutdown(), L4_PLATFORM_CTL_CPU_ALLOW_SHUTDOWN_OP, and system_shutdown().
Referenced by system_shutdown().
Here is the call graph for this function:



Here is the caller graph for this function:



15.171.2.5 system_suspend()

```
l4_msgtag_t L4::Platform_control::system_suspend (
            l4_umword_t extras)
```

Enter suspend to RAM.

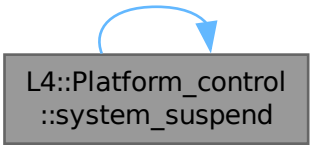
Precondition

Must only be invoked on the boot CPU. Furthermore it must be ensured that the invoking thread is not migrated to a different CPU during the suspend.

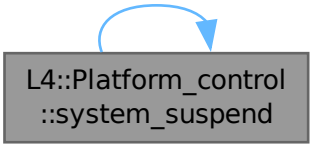
Parameters

extras	Some extra platform-specific information needed to enter suspend to RAM. On x86 platforms and when using the Platform_control object provided by Fiasco, the value defines the sleep state. The sleep states are defined in the ACPI table. Other platforms as well as Io's Platform_control object don't make use of this value at the moment.

References L4_PLATFORM_CTL_SYS_SHUTDOWN_OP, and system_suspend().
Referenced by system_suspend().
Here is the call graph for this function:



Here is the caller graph for this function:



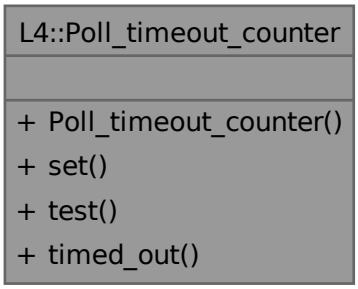
The documentation for this class was generated from the following file:

- l4/sys/platform_control

15.172 L4::Poll_timeout_counter Class Reference

Evaluate an expression for a maximum number of times.
`#include <poll_timeout_counter.h>`

Collaboration diagram for L4::Poll_timeout_counter:



Public Member Functions

- Poll_timeout_counter (unsigned counter_val)

  Constructor.
- void set (unsigned counter_val)

  Set the counter to a certain value.
- bool **test** (bool expression=true)

  Evaluate the expression for a maximum number of times.
- bool timed_out () const

  Indicator if the maximum number of tests was required.

15.172.1 Detailed Description

Evaluate an expression for a maximum number of times.
A typical use case is testing for a bit change in a hardware register for a maximum number of times (polling). For example:

```
Mmio_register_block regs;
Poll_timeout_counter i(3000000);
while (i.test(!(regs.read<l4_uint32_t>(0x04) & 1)))
  ;
```

The following usage is **wrong:**

```
...
Poll_timeout_counter i(3000000);
while (!i.test((regs.read<l4_uint32_t>(0x04) & 1)))
  ;
```

This loop would never terminate if the hardware register doesn't change!
Definition at line 34 of file poll_timeout_counter.h.

15.172.2 Constructor & Destructor Documentation

15.172.2.1 Poll_timeout_counter()

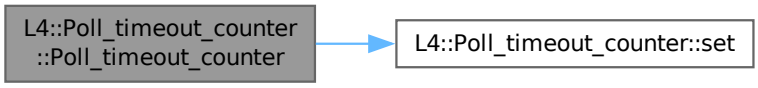
```
L4::Poll_timeout_counter::Poll_timeout_counter (
            unsigned counter_val)  [inline]
```

Constructor.

Parameters

counter_val	Maximum number of times to repeat the test.

Definition at line 42 of file poll_timeout_counter.h.
References set().
Here is the call graph for this function:



15.172.3 Member Function Documentation

15.172.3.1 set()

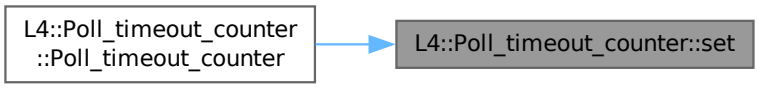
```
void L4::Poll_timeout_counter::set (
            unsigned counter_val)  [inline]
```

Set the counter to a certain value.

Parameters

counter_val	New counter value for maximum number of times to repeat the test.

Definition at line 53 of file poll_timeout_counter.h.
Referenced by Poll_timeout_counter().
Here is the caller graph for this function:



15.172.3.2 timed_out()

```
bool L4::Poll_timeout_counter::timed_out () const  [inline]
```

Indicator if the maximum number of tests was required.

Return values

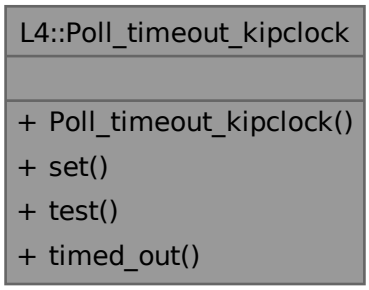
true,if	the maximum number of tests was required or if the counter was initialized to zero.

Definition at line 81 of file poll_timeout_counter.h.
The documentation for this class was generated from the following file:

- pkg/drivers-frst/include/poll_timeout_counter.h

15.173 L4::Poll_timeout_kipclock Class Reference

A polling timeout based on the L4Re clock.
`#include <poll_timeout_kipclock>`
Collaboration diagram for L4::Poll_timeout_kipclock:



Public Member Functions

- Poll_timeout_kipclock (unsigned poll_time_us)

  Initialise relative timeout in microseconds.
- void set (unsigned poll_time_us)

  (Re-)Set relative timeout in microseconds
- bool test (bool expression=true)

  Test whether timeout has expired.
- bool timed_out () const

  Query whether timeout has expired.

15.173.1 Detailed Description

A polling timeout based on the L4Re clock.
This class allows to conveniently add a timeout to a polling loop.
The original

```
while (device.read(State) & Busy)
  ;
```

is converted to

```
Poll_timeout_kipclock timeout(10000);
while (timeout.test(device.read(State) & Busy))
  ;
if (timeout.timed_out())
  printf("ERROR: Device does not respond.\n");
```

Definition at line 35 of file poll_timeout_kipclock.

15.173.2 Constructor & Destructor Documentation

15.173.2.1 Poll_timeout_kipclock()

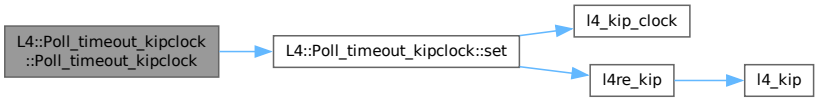
```
L4::Poll_timeout_kipclock::Poll_timeout_kipclock (
            unsigned poll_time_us)  [inline]
```

Initialise relative timeout in microseconds.

Parameters

poll_time_us	Polling timeout in microseconds.

Definition at line 42 of file poll_timeout_kipclock.
References set().
Here is the call graph for this function:



15.173.3 Member Function Documentation

15.173.3.1 set()

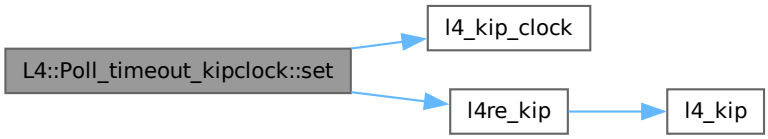
```
void L4::Poll_timeout_kipclock::set (
            unsigned poll_time_us)  [inline]
```

(Re-)Set relative timeout in microseconds

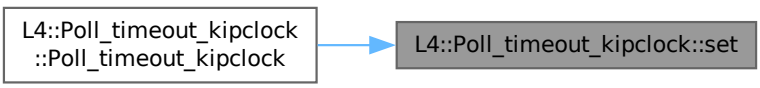
Parameters

poll_time_us	Polling timeout in microseconds.

Definition at line 51 of file poll_timeout_kipclock.
References l4_kip_clock(), and l4re_kip().
Referenced by Poll_timeout_kipclock().
Here is the call graph for this function:



Here is the caller graph for this function:



15.173.3.2 test()

```
bool L4::Poll_timeout_kipclock::test (
            bool expression = true)  [inline]
```

Test whether timeout has expired.

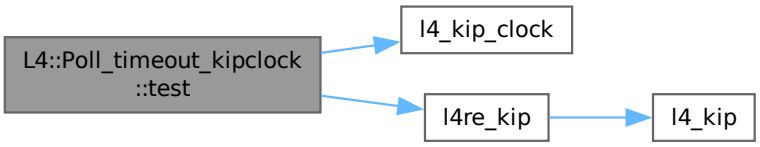
Parameters

expression	Optional expression.

Return values

false	The timeout has expired or the given expression returned false.
true	The timeout has not expired and the optionally given expression returns true.

Definition at line 65 of file poll_timeout_kipclock.
References l4_kip_clock(), and l4re_kip().
Here is the call graph for this function:



15.173.3.3 timed_out()

```
bool L4::Poll_timeout_kipclock::timed_out () const  [inline]
```

Query whether timeout has expired.

Returns

Expiry state of timeout

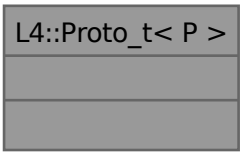
Definition at line 77 of file poll_timeout_kipclock.
The documentation for this class was generated from the following file:

- l4/re/util/poll_timeout_kipclock

15.174 L4::Proto_t< P > Struct Template Reference

Data type for defining protocol numbers.
`#include <__typeinfo.h>`

Collaboration diagram for L4::Proto_t< P >:



15.174.1 Detailed Description

template<l4_proto_t P = PROTO_EMPTY>
struct L4::Proto_t< P >

Data type for defining protocol numbers.

Template Parameters

P	The protocol number itself

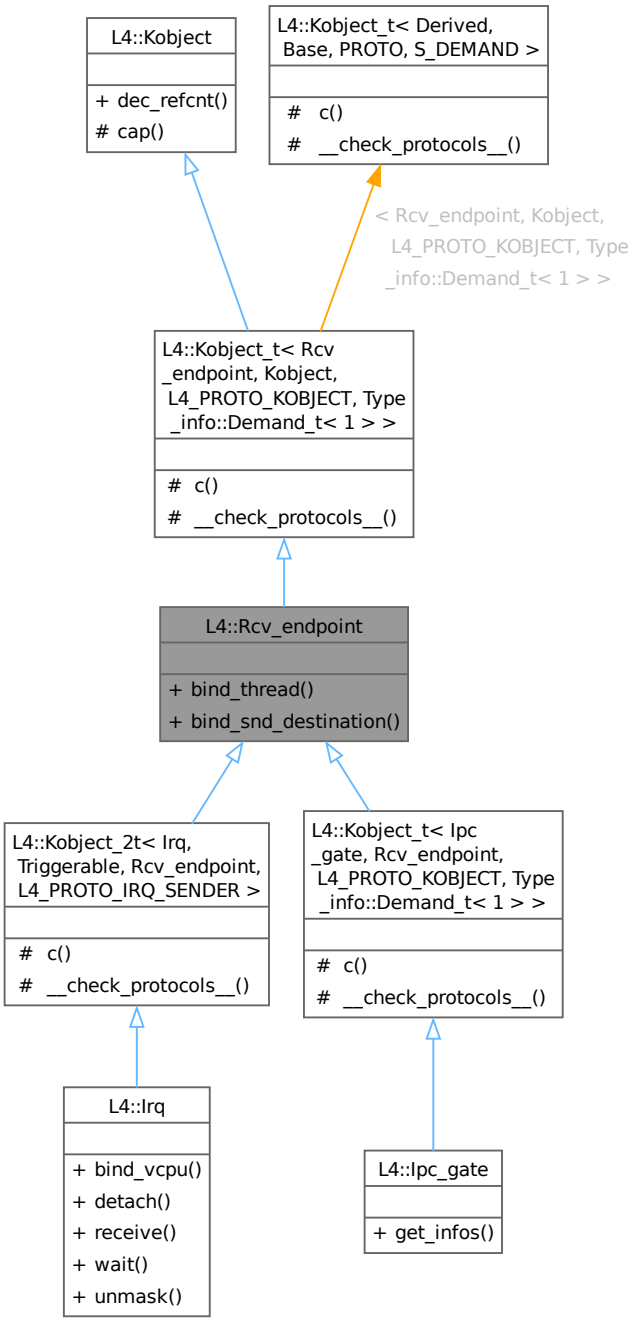
This type must be used when specifying a protocol number with Kobject_x.
Definition at line 1181 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

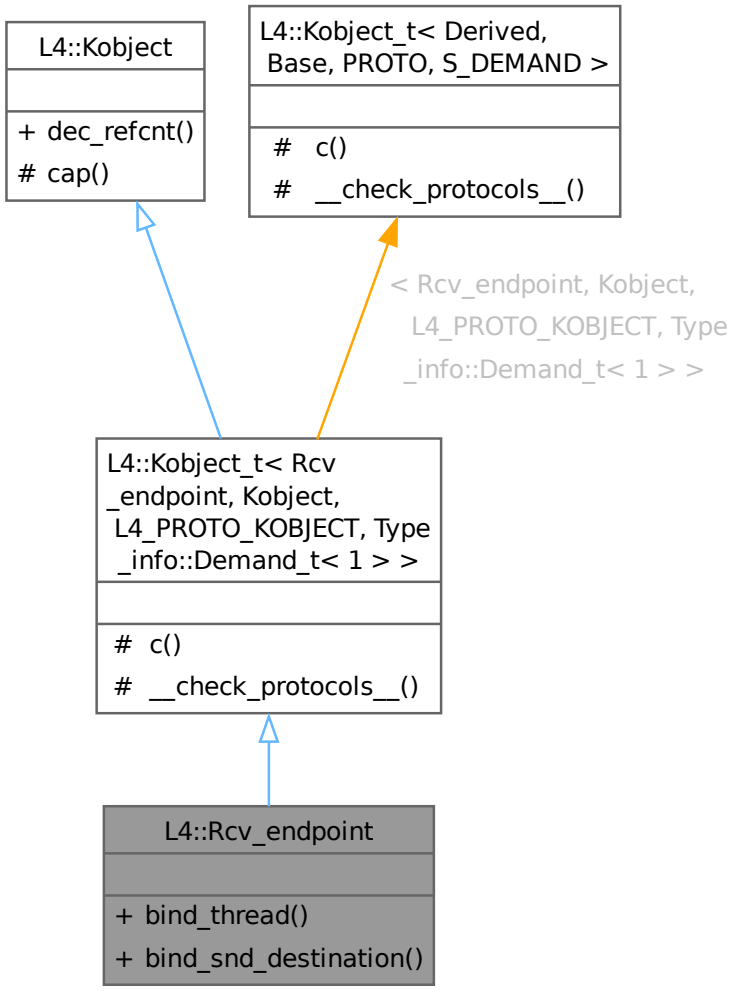
15.175 L4::Rcv_endpoint Class Reference

Interface for kernel objects that allow to receive IPC from them.
`#include <rcv_endpoint>`

Inheritance diagram for L4::Rcv_endpoint:



Collaboration diagram for L4::Rcv_endpoint:



Public Member Functions

- l4_msgtag_t bind_thread (Ipc::Cap< Thread > t, l4_umword_t label)

  Bind the IPC receive endpoint to a thread.
- l4_msgtag_t bind_snd_destination (Cap< Snd_destination > snd_dst, l4_umword_t label)

  Bind a send destination (a thread or thread group) to an IPC receive endpoint.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- typedef Rcv_endpoint **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Rcv_endpoint > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Rcv_endpoint, Kobject, L4_PROTO_KOBJECT, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.175.1 Detailed Description

Interface for kernel objects that allow to receive IPC from them.
Such an object is for example an Ipc_gate (with server rights) or an Irq. Those objects can be bound to a thread that shall receive IPC from these objects via bind_thread() or bind_snd_destination().
Definition at line 30 of file rcv_endpoint.

15.175.2 Member Function Documentation

15.175.2.1 bind_snd_destination()

```
l4_msgtag_t L4::Rcv_endpoint::bind_snd_destination (
            Cap< Snd_destination > snd_dst,
            l4_umword_t label)  [inline]
```

Bind a send destination (a thread or thread group) to an IPC receive endpoint.

Parameters

snd_dst	Snd_destination object (a thread or thread group) that shall be bound to this receive endpoint. See bind_thread() and bind_snd_destination() for binding a thread or thread group object.
label	Label to assign to `this` receive endpoint. For IPC gates, the two least significant bits must be set to zero.

Returns

Syscall return tag containing one of the following return codes.

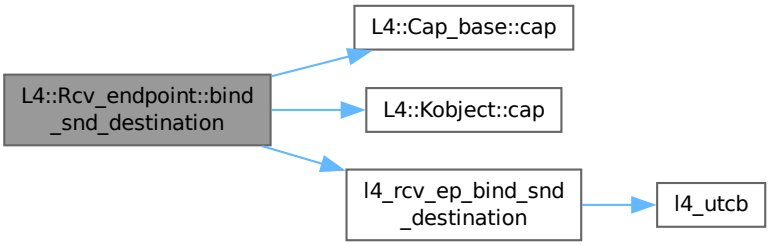
Return values

L4_EOK	Operation successful.
-L4_EINVAL	`snd_dst` is not a thread or thread group object or other arguments were malformed.
-L4_EPERM	No L4_CAP_FPAGE_S right on `snd_dst` or the capability used to invoke this operation.

Precondition

If this operation is invoked using an IPC gate capability without the L4_FPAGE_C_IPCGATE_SVR right, the kernel will not perform the operation. Instead, the underlying IPC message will be forwarded to the thread bound to the IPC gate, blocking the caller if no thread or thread group is bound yet.

The specified `label` is passed to the receiver of the incoming IPC. It is possible to re-bind a receive endpoint to the same or a different thread or thread group. In this case, IPC already in flight will be delivered with the old label to the previously bound thread or thread group unless L4::Thread::modify_senders() is used to change these labels.
Definition at line 101 of file rcv_endpoint.
References L4::Cap_base::cap(), L4::Kobject::cap(), and l4_rcv_ep_bind_snd_destination().
Here is the call graph for this function:



15.175.2.2 bind_thread()

```
l4_msgtag_t L4::Rcv_endpoint::bind_thread (
             Ipc::Cap< Thread > t,
             l4_umword_t label)
```

Bind the IPC receive endpoint to a thread.

Parameters

t	Thread object this receive endpoint shall be bound to.
label	Label to assign to `this` receive endpoint. For IPC gates, the two least significant bits must be set to zero.

Returns

Syscall return tag containing one of the following return codes.

Return values

L4_EOK	Operation successful.
-L4_EINVAL	`t` is not a thread object or other arguments were malformed.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

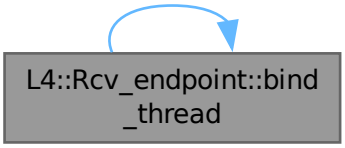
The invoked capability and the capability `t` both must have the permission L4_CAP_FPAGE_S.

Deprecated Use bind_snd_destination() instead.

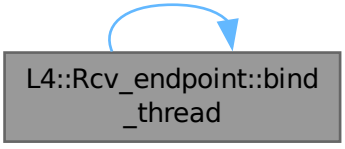
Precondition

If this operation is invoked using an IPC gate capability without the L4_FPAGE_C_IPCGATE_SVR right, the kernel will not perform the operation. Instead, the underlying IPC message will be forwarded to the thread the IPC gate is bound to, blocking the caller if the IPC gate was not bound yet.

The specified `label` is passed to the receiver of the incoming IPC. It is possible to re-bind a receive endpoint to the same or a different thread. In this case, IPC already in flight will be delivered with the old label to the previously bound thread unless L4::Thread::modify_senders() is used to change these labels.
References bind_thread().
Referenced by bind_thread().
Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this class was generated from the following file:

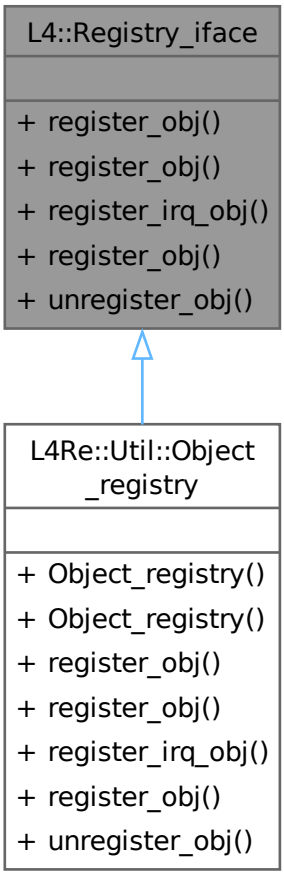
- l4/sys/rcv_endpoint

15.176 L4::Registry_iface Class Reference

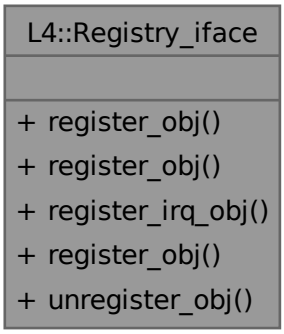
Abstract interface for object registries.

`#include <ipc_epiface>`

Inheritance diagram for L4::Registry_iface:



Collaboration diagram for L4::Registry_iface:



Public Member Functions

- virtual L4::Cap< void > register_obj (L4::Epiface *o, char const *service)=0

  Register an L4::Epiface for an IPC gate available in the applications environment under the name `service`.
- virtual L4::Cap< void > register_obj (L4::Epiface *o)=0

  Register o as server-side object for synchronous RPC.
- virtual L4::Cap< L4::Irq > register_irq_obj (L4::Epiface *o)=0

  Register o as server-side object for asynchronous IRQs.
- virtual L4::Cap< L4::Rcv_endpoint > register_obj (L4::Epiface *o, L4::Cap< L4::Rcv_endpoint > ep)=0

  Register o as server-side object for a pre-allocated capability.
- virtual void unregister_obj (L4::Epiface *o, bool unmap=true)=0

  Unregister the given object o from the server.

15.176.1 Detailed Description

Abstract interface for object registries.
An object registry allows to register L4::Epiface objects at a server loop either for synchronous RPC messages or for asynchronous IRQ messages.
Definition at line 440 of file ipc_epiface.

15.176.2 Member Function Documentation

15.176.2.1 register_irq_obj()

```
virtual L4::Cap< L4::Irq > L4::Registry_iface::register_irq_obj (
            L4::Epiface * o)  [pure virtual]
```

Register o as server-side object for asynchronous IRQs.

Parameters

o	Pointer to an Epiface object that shall be registered as server-side object for IRQs.

Return values

L4::Cap<L4::Irq>	Capability to a new IRQ object on success.
L4::Cap<L4::Irq>::Invalid	The allocation of the IRQ has failed.

After successful registration `o->obj_cap()` will be the capability of the allocated IRQ object.
The function may allocate a capability slot for the object. In that case unregister_obj() is responsible for freeing the slot as well.
Implemented in L4Re::Util::Object_registry.

15.176.2.2 register_obj() [1/3]

```
virtual L4::Cap< void > L4::Registry_iface::register_obj (
            L4::Epiface * o)  [pure virtual]
```

Register `o` as server-side object for synchronous RPC.

Parameters

o	Pointer to an Epiface object that shall be registered as server-side object for RPC.

Return values

L4::Cap<void>	A valid capability to a new IPC gate.
L4::Cap<void>::Invalid	The allocation of the IPC gate has failed.

After successful registration `o->obj_cap()` will be the capability of the allocated IPC gate.
The function may allocate a capability slot for the object. In that case unregister_obj() is responsible for freeing the slot as well.
Implemented in L4Re::Util::Object_registry.

15.176.2.3 register_obj() [2/3]

```
virtual L4::Cap< void > L4::Registry_iface::register_obj (
            L4::Epiface * o,
            char const * service)  [pure virtual]
```

Register an L4::Epiface for an IPC gate available in the applications environment under the name `service`.

Parameters

o	Pointer to an Epiface object that shall be registered.
service	Name of the capability that shall be used to connect `o` to as a server-side object.

Return values

L4::Cap<void>	The capability known as `service` on success.
L4::Cap<void>::Invalid	No capability with the given name found.

After a successful call to this function `o->obj_cap()` is equal to the capability in the environment with the name given by `service`.
Implemented in L4Re::Util::Object_registry.

15.176.2.4 register_obj() [3/3]

```
virtual L4::Cap< L4::Rcv_endpoint > L4::Registry_iface::register_obj (
            L4::Epiface * o,
            L4::Cap< L4::Rcv_endpoint > ep)  [pure virtual]
```

Register o as server-side object for a pre-allocated capability.

Parameters

o	Pointer to an Epiface object that shall be registered as server-side object.
ep	Capability to an already allocated capability where o shall be attached as server-side handler. The capability may point to an IPC gate or an IRQ.

Return values

L4::Cap<L4::Rcv_endpoint>	Capability ep on success.
L4::Cap<L4::Rcv_endpoint>::Invalid	The IRQ attach operation has failed.

After successful registration o->obj_cap() will be equal to ep.
Implemented in L4Re::Util::Object_registry.

15.176.2.5 unregister_obj()

```
virtual void L4::Registry_iface::unregister_obj (
            L4::Epiface * o,
            bool unmap = true)  [pure virtual]
```

Unregister the given object o from the server.

Parameters

o	Pointer to the Epiface object that shall be unregistered. The object must have been registered with any of the register methods if Registry_iface.
unmap	If true the capability o->obj_cap() shall be unmapped from the local object space.

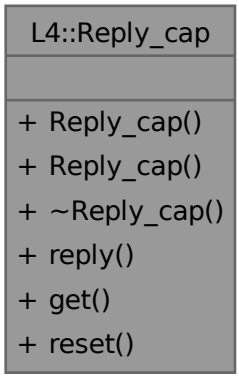
The function always unmaps and frees the capability if it was allocated by either Registry_iface::register_irq_obj(L4::Epiface *), or by Registry_iface::register_obj(L4::Epiface *).
Implemented in L4Re::Util::Object_registry.
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_epiface

15.177 L4::Reply_cap Class Reference

An explicit reply capability.
#include <capability.h>

Collaboration diagram for L4::Reply_cap:



Public Member Functions

- constexpr **Reply_cap** () noexcept=default

  Construct an invalid reply capability.
- constexpr Reply_cap (Reply_cap_idx cap, Reply_cap_alloc *alloc) noexcept

  Construct a valid explicit reply capability.
- ~Reply_cap ()

  Destroy reply capability.
- l4_ret_t reply (l4_msgtag_t tag, l4_utcb_t *utcb=l4_utcb()) noexcept

  Reply with this reply capability.
- constexpr Reply_cap_idx get () const noexcept

  Get reply capability index.
- void reset (Reply_cap_idx cap=Reply_cap_idx(), Reply_cap_alloc *alloc=nullptr) noexcept

  Replace reply capability.

15.177.1 Detailed Description

An explicit reply capability.
Represents a use-once, explicit reply capability. If valid, the class will ensure that the caller will always get a reply. Once used, the reply capability slot will be immediately released to the associated reply capability allocator.
Definition at line 549 of file capability.h.

15.177.2 Constructor & Destructor Documentation

15.177.2.1 Reply_cap()

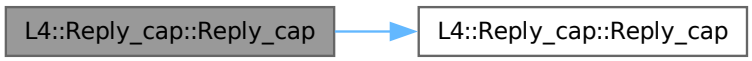
```
L4::Reply_cap::Reply_cap (
            Reply_cap_idx cap,
            Reply_cap_alloc * alloc)  [inline], [constexpr], [noexcept]
```

Construct a valid explicit reply capability.
The object will take ownership of the reply capability slot. It is returned to the allocator after being used.

Parameters

cap	The reply capability index
alloc	The associated reply capability allocator.

Definition at line 564 of file capability.h.
References Reply_cap().
Here is the call graph for this function:



15.177.2.2 ~Reply_cap()

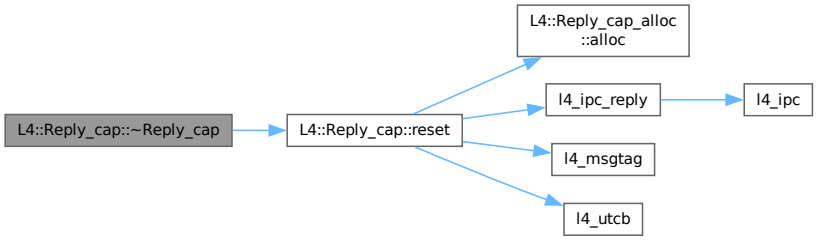
```
L4::Reply_cap::~Reply_cap ()  [inline]
```

Destroy reply capability.

Attention

If the reply capability is still valid, an L4_EDROPREPLY error reply is sent. See Reply_cap::reset().

Definition at line 574 of file capability.h.
References reset().
Here is the call graph for this function:



15.177.3 Member Function Documentation

15.177.3.1 get()

```
Reply_cap_idx L4::Reply_cap::get () const  [inline], [constexpr], [noexcept]
```

Get reply capability index.
This method must not be used to send a reply. Use Reply_cap::reply() instead that does the proper reply capability lifetime management.
Definition at line 632 of file capability.h.

15.177.3.2 reply()

```
l4_ret_t L4::Reply_cap::reply (
            l4_msgtag_t tag,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Reply with this reply capability.
Disposes the reply capability after the reply was sent. Can be used only once. If the reply object is not valid, no message is sent.

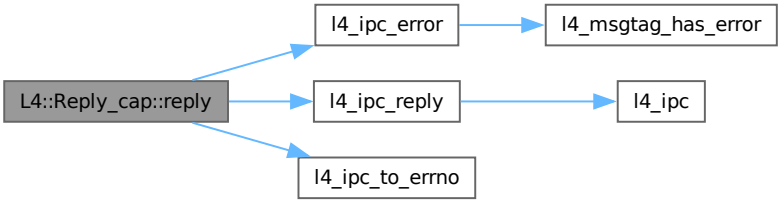
Parameters

tag	Message tag for reply. The UTCB must have been prepared.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

0	Success
-(L4_EIPC_LO	+ L4_IPC_ENOT_EXISTENT) Reply capability not valid
<0	Other IPC error

Definition at line 609 of file capability.h.
References L4_IPC_BOTH_TIMEOUT_0, L4_IPC_ENOT_EXISTENT, l4_ipc_error(), l4_ipc_reply(), and l4_ipc_to_errno().
Here is the call graph for this function:



15.177.3.3 reset()

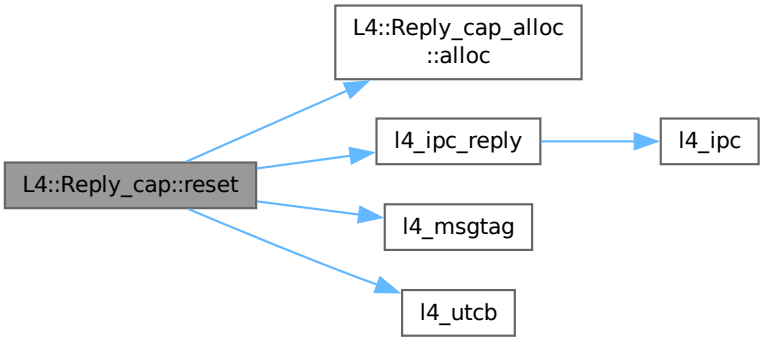
```
void L4::Reply_cap::reset (
             Reply_cap_idx cap = Reply_cap_idx(),
             Reply_cap_alloc * alloc = nullptr)  [inline], [noexcept]
```

Replace reply capability.

Attention

If the current reply capability is valid, an L4_EDROPREPLY error reply is sent to the caller!

Definition at line 659 of file capability.h.
References L4::Reply_cap_alloc::alloc(), L4_EDROPREPLY, L4_IPC_BOTH_TIMEOUT_0, l4_ipc_reply(), l4_msgtag(), and l4_utcb().
Referenced by ~Reply_cap().
Here is the call graph for this function:



Here is the caller graph for this function:



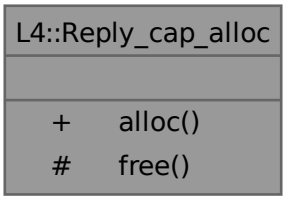
The documentation for this class was generated from the following file:

- l4/sys/cxx/capability.h

15.178 L4::Reply_cap_alloc Class Reference

Interface to a reply capability allocator.
`#include <capability.h>`

Collaboration diagram for L4::Reply_cap_alloc:



Public Member Functions

- virtual Reply_cap alloc () noexcept=0

  Allocate new reply capability slot.

Protected Member Functions

- virtual void free (Reply_cap_idx cap) noexcept=0

  Free reply capability slot.

15.178.1 Detailed Description

Interface to a reply capability allocator.
Definition at line 508 of file capability.h.

15.178.2 Member Function Documentation

15.178.2.1 alloc()

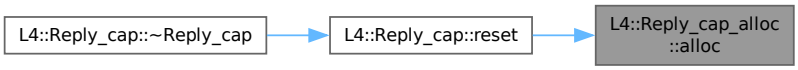
```
virtual Reply_cap L4::Reply_cap_alloc::alloc ()  [pure virtual], [noexcept]
```

Allocate new reply capability slot.

Returns

Reply capability index or invalid index if exhausted.

Referenced by L4::Reply_cap::reset().
Here is the caller graph for this function:



15.178.2.2 free()

```
virtual void L4::Reply_cap_alloc::free (
            Reply_cap_idx cap)  [protected], [pure virtual], [noexcept]
```

Free reply capability slot.

The slot must have been allocated by the same allocator.

Parameters

cap	The reply capability slot to free.

References free().
Referenced by free().
Here is the call graph for this function:



Here is the caller graph for this function:



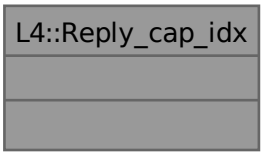
The documentation for this class was generated from the following file:

- l4/sys/cxx/capability.h

15.179 L4::Reply_cap_idx Class Reference

Value class for optional reply capability index.
`#include <capability.h>`

Collaboration diagram for L4::Reply_cap_idx:



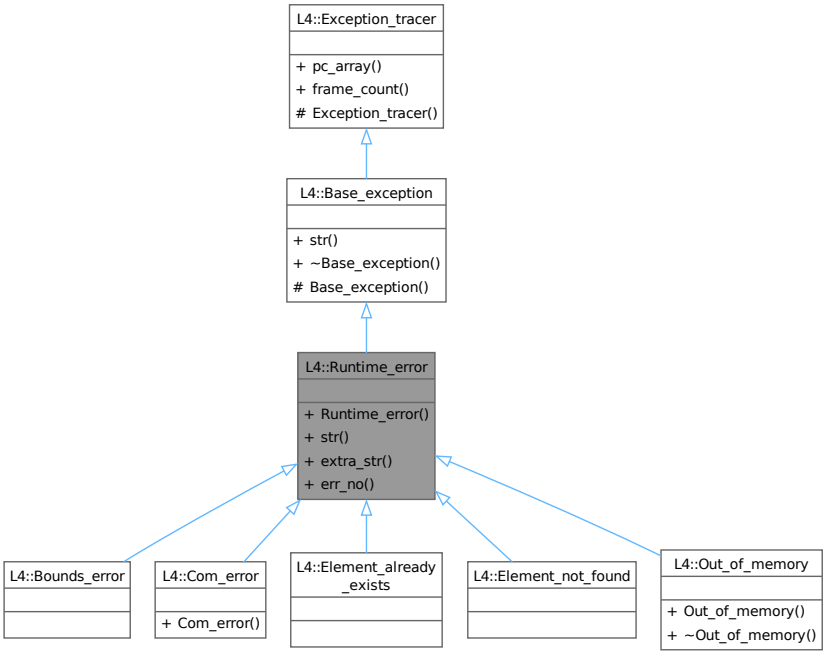
15.179.1 Detailed Description

Value class for optional reply capability index.
Optional means that the value can be invalid (see L4_INVALID_CAP_BIT).
Definition at line 478 of file capability.h.
The documentation for this class was generated from the following file:

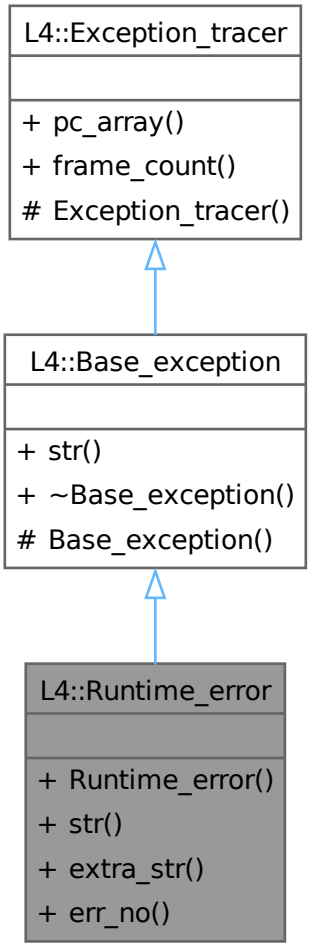
- l4/sys/cxx/capability.h

15.180 L4::Runtime_error Class Reference

Exception for an abstract runtime error.
`#include <l4/cxx/exceptions>`
Inheritance diagram for L4::Runtime_error:



Collaboration diagram for L4::Runtime_error:



Public Member Functions

- Runtime_error (long err_no, char const *extra=0) noexcept

  Create a new Runtime_error.
- char const * **str** () const noexcept override

  Return a human readable string for the exception.
- char const * extra_str () const

  Get the description text for this runtime error.
- long err_no () const noexcept

  Get the error value for this runtime error.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const ∗const ∗ **pc_array** () const noexcept

  Get the array containing the call trace.
- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Additional Inherited Members

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

  Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

15.180.1 Detailed Description

Exception for an abstract runtime error.
This is the base class for a set of exceptions that cover all errors that have a C error value (see l4_error_code_t).
Definition at line 128 of file exceptions.

15.180.2 Constructor & Destructor Documentation

15.180.2.1 Runtime_error()

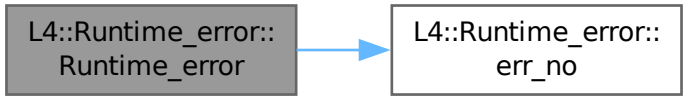
```
L4::Runtime_error::Runtime_error (
            long err_no,
            char const * extra = 0)  [inline], [explicit], [noexcept]
```

Create a new Runtime_error.

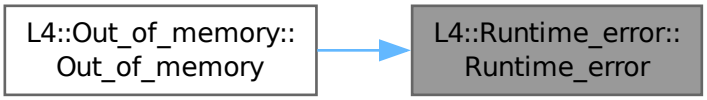
Parameters

err_no	Error value for this runtime error.
extra	Description of what happened when the error occurred.

Definition at line 141 of file exceptions.
References err_no().
Referenced by L4::Out_of_memory::Out_of_memory().
Here is the call graph for this function:



Here is the caller graph for this function:



15.180.3 Member Function Documentation

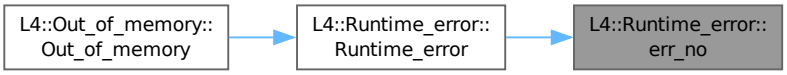
15.180.3.1 err_no()

`long L4::Runtime_error::err_no () const [inline], [noexcept]`
Get the error value for this runtime error.

Returns

Error value.

Definition at line 170 of file exceptions.
Referenced by Runtime_error().
Here is the caller graph for this function:



15.180.3.2 extra_str()

`char const * L4::Runtime_error::extra_str () const [inline]`
Get the description text for this runtime error.

Returns

Pointer to the description string.

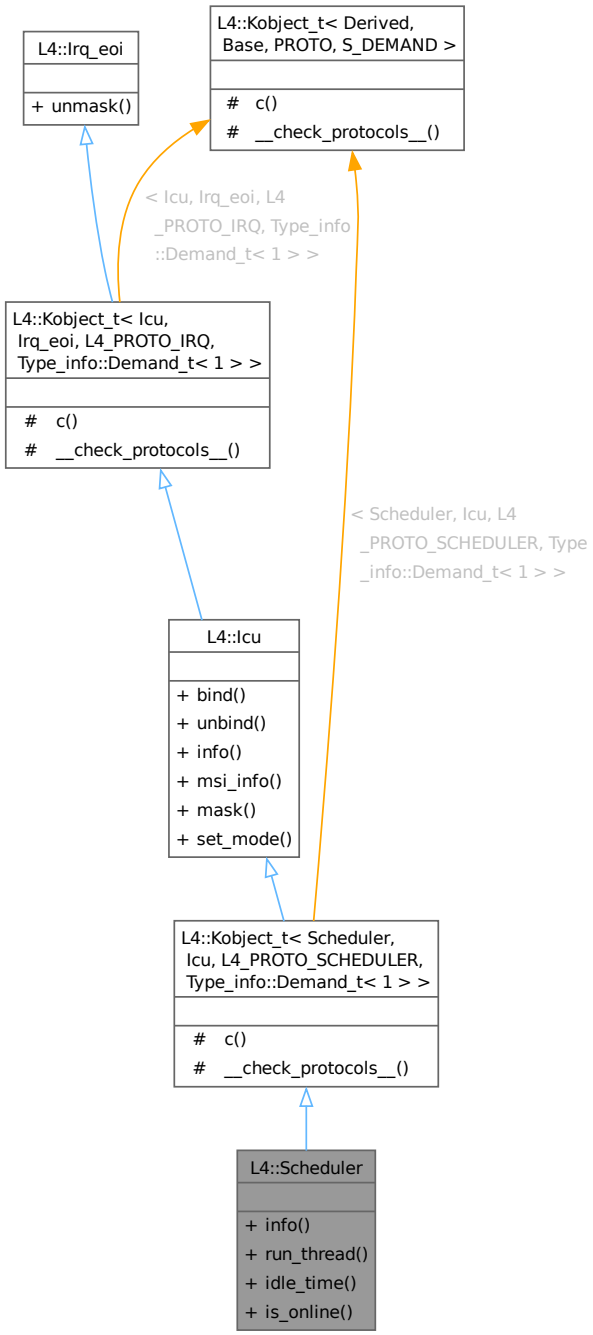
Definition at line 162 of file exceptions.
The documentation for this class was generated from the following file:

- l4/cxx/exceptions

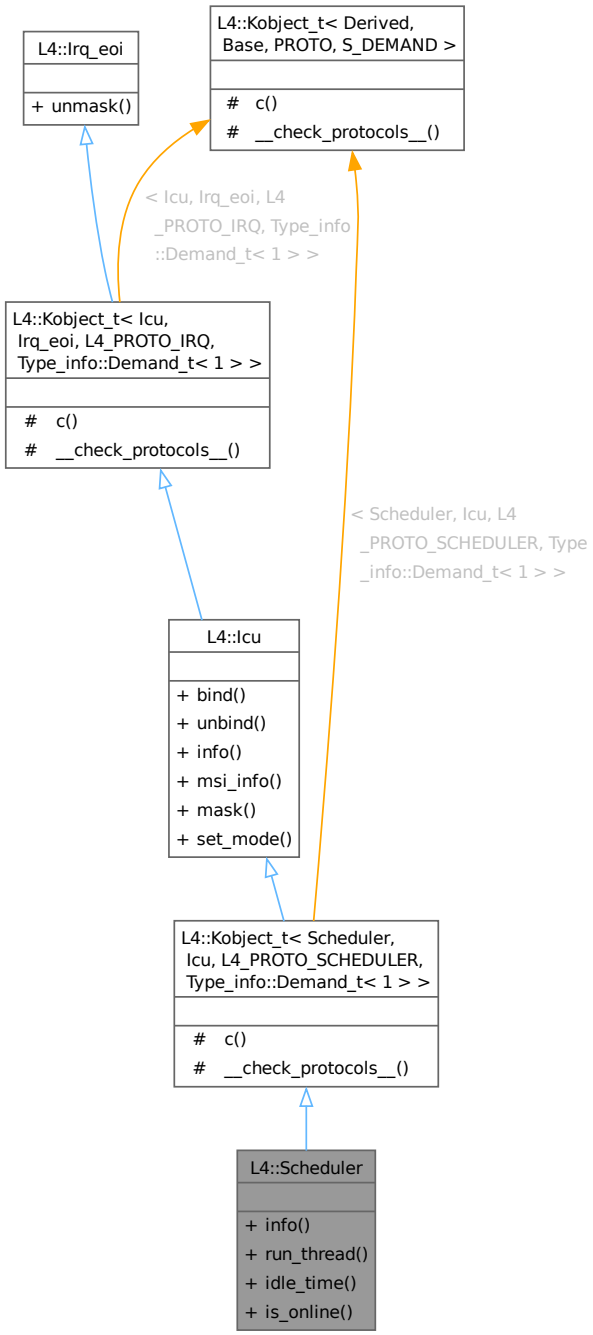
15.181 L4::Scheduler Class Reference

C++ interface of the Scheduler kernel object, see Scheduler for the C interface.
`#include <scheduler>`

Inheritance diagram for L4::Scheduler:



Collaboration diagram for L4::Scheduler:



Public Member Functions

- l4_msgtag_t info (l4_umword_t *cpu_max, l4_sched_cpu_set_t *cpus, l4_umword_t *sched_classes=nullptr, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Get scheduler information.
- l4_msgtag_t run_thread (Ipc::Cap< Thread > thread, l4_sched_param_t const &sp)

  Run a thread on a Scheduler.
- l4_msgtag_t idle_time (l4_sched_cpu_set_t const &cpus, l4_kernel_clock_t *us)

Query the idle time (in µs) of a CPU.

- bool is_online (l4_umword_t cpu, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Query if a CPU is online.

Public Member Functions inherited from L4::Icu

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)

  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Scheduler, Icu, L4_PROTO_SCHEDULER, Type_info::Demand_t< 1 > >

- typedef Scheduler **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Scheduler > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Icu::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Scheduler, Icu, L4_PROTO_SCHEDULER, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Scheduler, Icu, L4_PROTO_SCHEDULER, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.181.1 Detailed Description

C++ interface of the Scheduler kernel object, see Scheduler for the C interface.
The Scheduler interface allows a client to manage CPU resources. The API provides functions to query scheduler information, check the online state of CPUs, query CPU idle time and to start threads on defined CPU sets.
The scheduler offers IRQ number 0, which triggers when the number of online cores changes, e.g. due to hotplug events.
The Scheduler interface inherits from L4::Icu and L4::Irq_eoi for managing the scheduler virtual device IRQ which, in contrast to hardware IRQs, implements a limited functionality:

- Only IRQ line 0 is supported, no MSI vectors.
- The IRQ is edge-triggered and the IRQ mode cannot be changed.
- As the IRQ is edge-triggered, it does not have to be explicitly unmasked.

It depends on the platform, which hotplug events actually trigger the IRQ. Many platforms only support triggering the IRQ when a CPU core different from the boot CPU goes online.

Include File

```
#include <l4/sys/scheduler>
```

Definition at line 46 of file scheduler.

15.181.2 Member Function Documentation

15.181.2.1 idle_time()

```
l4_msgtag_t L4::Scheduler::idle_time (
            l4_sched_cpu_set_t const & cpus,
            l4_kernel_clock_t * us)
```

Query the idle time (in µs) of a CPU.

Parameters

	cpus	Set of CPUs to query. Only the idle time of the first selected CPU in `cpus.map` is queried.
`out`	*us*	Idle time of queried CPU in µs.

Return values

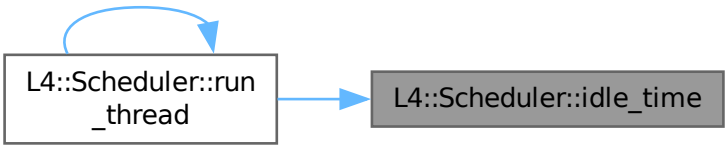
0	Success.
-L4_EINVAL	Invalid CPU requested in cpu set.

This function retrieves the idle time in µs of the first selected CPU in `cpus.map`. The idle time is the accumulated time a CPU has spent in the idle thread since its last reset. To calculate a load estimate `l` one has to retrieve the idle time at the beginning (`i1`) and the end (`i2`) of a known time interval `t`. The load is then calculated as l = 1 - (i2 - i1)/t.
The idle time is only defined for online CPUs. Reading the idle time from offline CPUs is undefined and may result in either getting -L4_EINVAL or calculating an estimated (incorrect) load of 1.

Note

The idle time statistics of remote CPUs is updated on context switch events only, hence may not be up-to-date when requested cross-CPU. To get up-to-date idle time you should use a thread running on the same CPU of which the idle time is requested.

Referenced by run_thread().
Here is the caller graph for this function:



15.181.2.2 info()

```
l4_msgtag_t L4::Scheduler::info (
             l4_umword_t * cpu_max,
             l4_sched_cpu_set_t * cpus,
             l4_umword_t * sched_classes = nullptr,
             l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Get scheduler information.

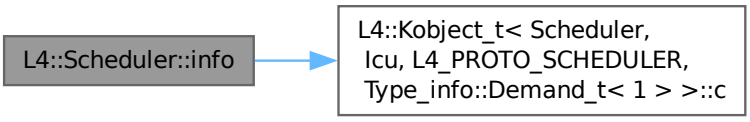
Parameters

`out`	*cpu_max*	Maximum number of CPUs ever available. Optional, can be nullptr.
`in,out`	*cpus*	*cpus.offset* is first CPU of interest. *cpus.granularity* (see l4_sched_cpu_set_t). *cpus.map* Bitmap of online CPUs. Must not be nullptr.
`out`	*sched_classes*	A bitmap of available scheduling classes (see L4_scheduler_classes). Pass nullptr to omit this information.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

0	Success.
-L4_ERANGE	The given CPU offset is larger than the maximum number of CPUs.

Definition at line 74 of file scheduler.
References L4::Kobject_t< Scheduler, Icu, L4_PROTO_SCHEDULER, Type_info::Demand_t< 1 > >::c(), l4_sched_cpu_set_t::gran_offset, and l4_sched_cpu_set_t::map.
Here is the call graph for this function:



15.181.2.3 is_online()

```
bool L4::Scheduler::is_online (
            l4_umword_t cpu,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Query if a CPU is online.

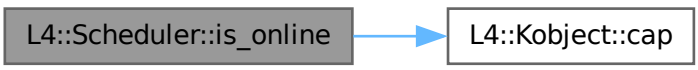
Parameters

cpu	CPU number whose online status should be queried.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

true	The CPU is online.
false	The CPU is offline

Definition at line 154 of file scheduler.
References L4::Kobject::cap().
Here is the call graph for this function:



15.181.2.4 run_thread()

```
l4_msgtag_t L4::Scheduler::run_thread (
            Ipc::Cap< Thread > thread,
            l4_sched_param_t const & sp)
```

Run a thread on a Scheduler.

Parameters

thread	Capability of the thread to run.
sp	Scheduling parameters.

Return values

0	Success.
-L4_EINVAL	Invalid size of the scheduling parameter.

This function launches a thread on a CPU determined by the scheduling parameter `sp.affinity`. A thread can be intentionally stopped by migrating it on an offline or an invalid CPU. The thread is only guaranteed to run if the CPU it is migrated to is currently online.

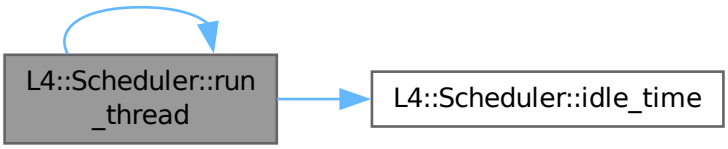
Note

If the target CPU is currently not online, there is no guarantee that the thread will ever run, even if the CPU comes online later on.

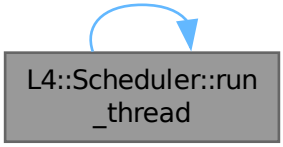
A scheduler may impose a policy with regard to selecting CPUs. However the scheduler is required to ensure the following two properties:

- Two threads with disjoint CPU sets must be scheduled to different CPUs.
- Two threads with identical CPU sets selecting only a single CPU must be scheduled to the same CPU.

References idle_time(), L4_SCHEDULER_IDLE_TIME_OP, and run_thread().
Referenced by run_thread().
Here is the call graph for this function:



Here is the caller graph for this function:



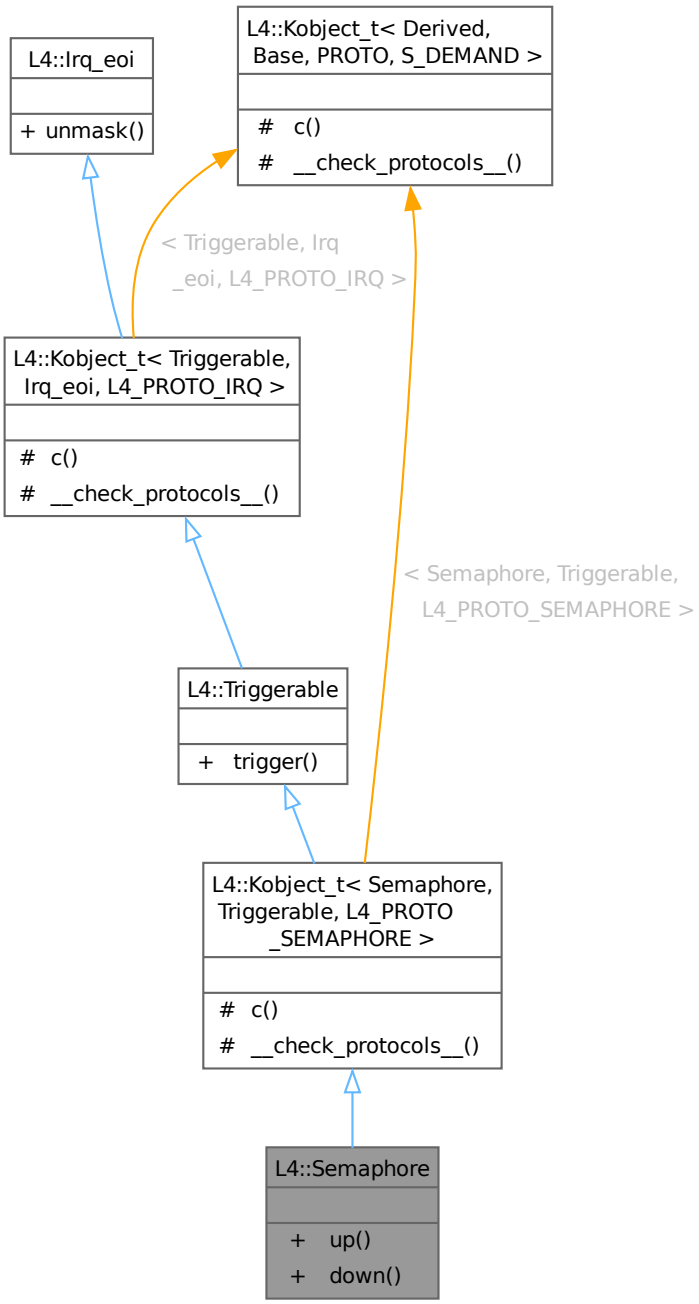
The documentation for this class was generated from the following file:

- l4/sys/scheduler

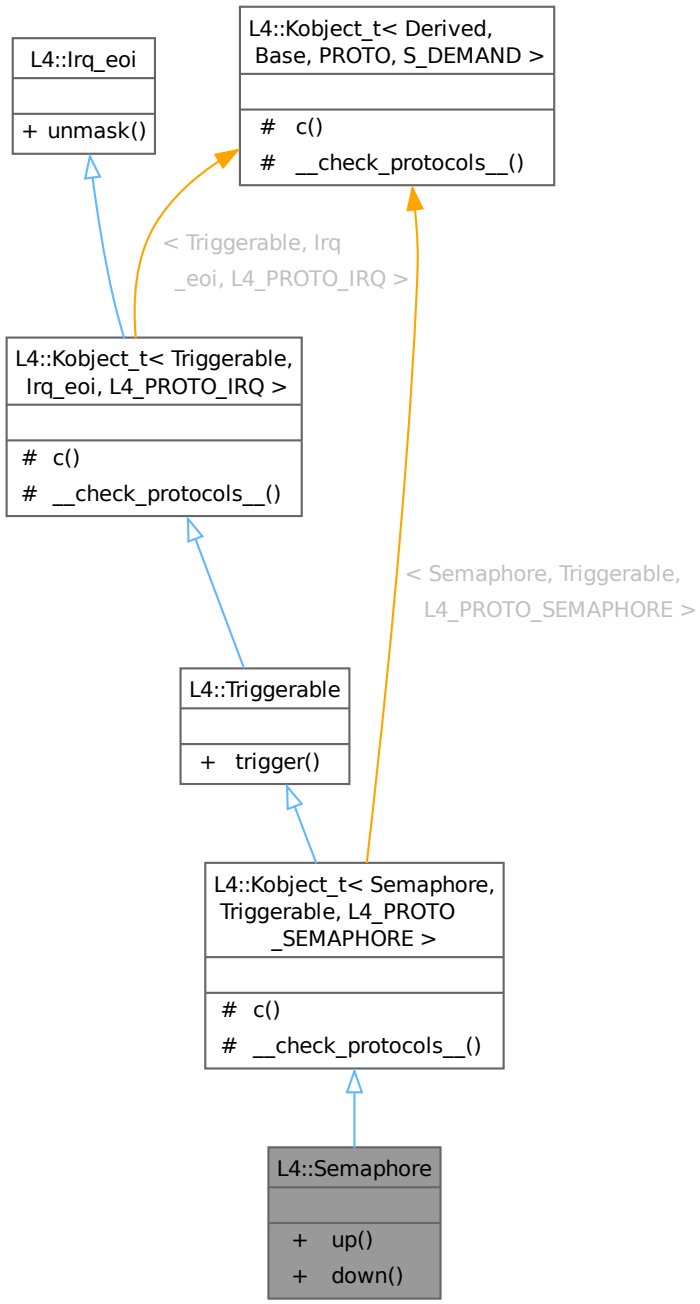
15.182 L4::Semaphore Struct Reference

C++ Kernel-provided semaphore interface, see Kernel-provided semaphore for the C interface.
`#include <semaphore>`

Inheritance diagram for L4::Semaphore:



Collaboration diagram for L4::Semaphore:



Public Member Functions

- l4_msgtag_t up (l4_utcb_t *utcb=l4_utcb()) noexcept

  Semaphore up operation (wrapper for trigger()).
- l4_msgtag_t down (l4_timeout_t timeout=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Semaphore down operation.

Public Member Functions inherited from L4::Triggerable

- l4_msgtag_t trigger (l4_utcb_t *utcb=l4_utcb()) noexcept

  Trigger the object.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Semaphore, Triggerable, L4_PROTO_SEMAPHORE >

- typedef Semaphore **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Semaphore > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Triggerable::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- typedef Triggerable **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Triggerable > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Semaphore, Triggerable, L4_PROTO_SEMAPHORE >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Semaphore, Triggerable, L4_PROTO_SEMAPHORE >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.182.1 Detailed Description

C++ Kernel-provided semaphore interface, see Kernel-provided semaphore for the C interface.
This is the interface for kernel-provided semaphore objects. The object provides the classical functions `up()` and `down()` for counting the semaphore and blocking. The semaphore is a Triggerable with respect to the `up()` function, this means that a semaphore can be bound to an interrupt line at an ICU (L4::Icu) and incoming interrupts increment the semaphore counter.
The `down()` method decrements the semaphore counter and blocks if the counter is already zero. Blocking on a semaphore may—as all blocking operations—either return successfully, or be aborted due to an expired timeout provided to the `down()` operation, or due to an L4::Thread::ex_regs() operation with the L4_THREAD_EX_REGS_CANCEL flag set.
A semaphore object is initialized with counter value 0.
The main reason for using a semaphore instead of an L4::Irq is to ensure that incoming trigger signals do not interfere with any open-wait operations, as used for example in a server loop.
Note that this is a kernel-level semaphore primitive that shall be used to implement user-level, application-usable synchronization primitives. For example, use pthread_mutex functions in applications if possible. When implementing a synchronization primitive, please ensure to only use L4::Semaphore in the case of contention, and use atomic operations for the non-contended case.
Definition at line 51 of file semaphore.

15.182.2 Member Function Documentation

15.182.2.1 down()

```
l4_msgtag_t L4::Semaphore::down (
             l4_timeout_t timeout = L4_IPC_NEVER,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Semaphore down operation.

Parameters

timeout	Timeout for blocking the semaphore down operation. Note: The receive timeout of this timeout-pair is significant for blocking, the send part is usually non-blocking.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag. Use l4_error() to check for errors.

Return values

-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The invoked Semaphore capability must have the permission L4_CAP_FPAGE_S.

This method decrements the semaphore counter by one, or blocks if the counter is already zero, until either a timeout or cancel condition hits or the counter is increased by an `up()` operation.
Definition at line 89 of file semaphore.
References L4::Kobject::cap(), and L4_IPC_NEVER.
Here is the call graph for this function:



15.182.2.2 up()

```
l4_msgtag_t L4::Semaphore::up (
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Semaphore up operation (wrapper for trigger()).

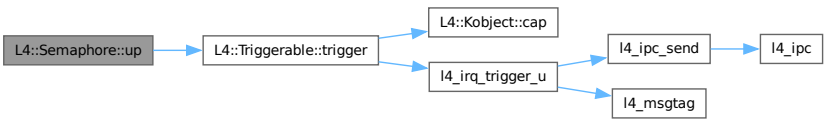
Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

Syscall return tag for a send-only operation, this means there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. Use l4_ipc_error() to check for errors and **do not** use l4_error().

Increases the semaphore counter by one if it is smaller than an unspecified limit. The unspecified limit is guaranteed to be at least 2^31-1.
Definition at line 67 of file semaphore.
References L4::Triggerable::trigger().
Here is the call graph for this function:



The documentation for this struct was generated from the following file:

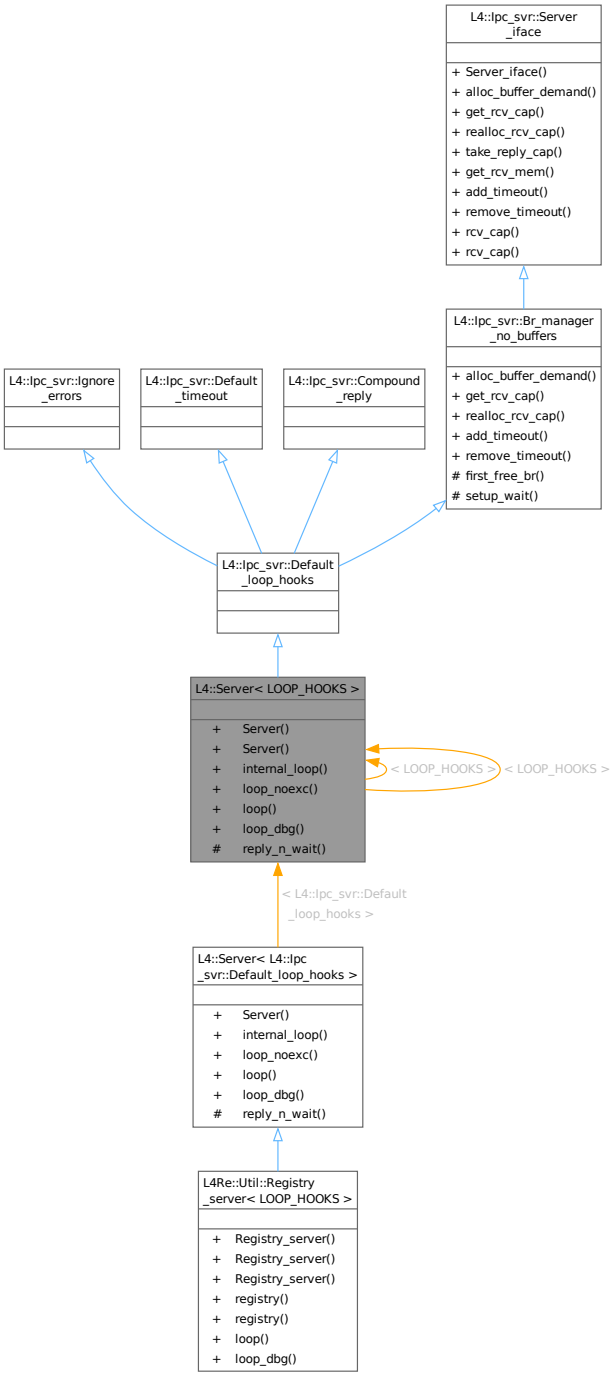
- l4/sys/semaphore

15.183 L4::Server< LOOP_HOOKS > Class Template Reference

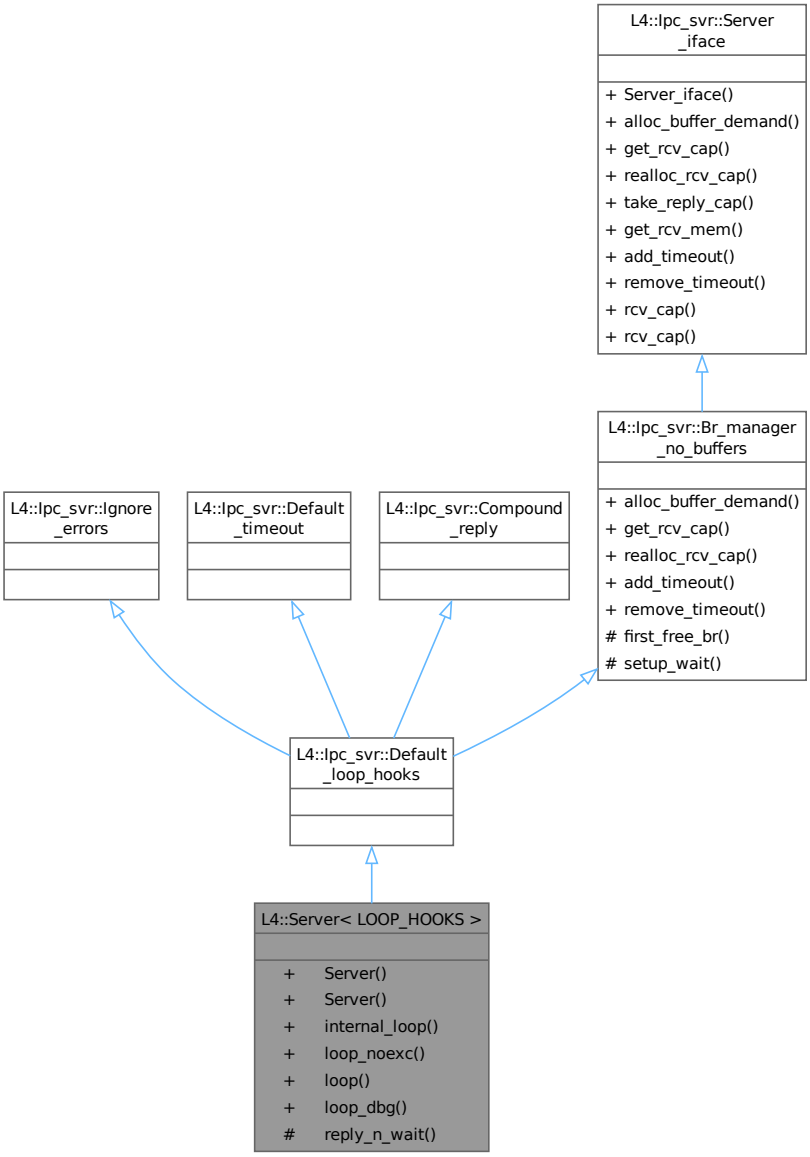
Basic server loop for handling client requests.

#include <ipc_server_loop>

Inheritance diagram for L4::Server< LOOP_HOOKS >:



Collaboration diagram for L4::Server< LOOP_HOOKS >:



Public Member Functions

- Server (l4_utcb_t ∗)

  Initializes the server loop.
- **Server** ()

  Initializes the server loop.
- template<typename DISPATCH>
  L4_NORETURN void internal_loop (DISPATCH dispatch, l4_utcb_t ∗)

  The server loop.
- template<typename R>
  L4_NORETURN void **loop_noexc** (R r, l4_utcb_t ∗u=l4_utcb())

  Server loop without exception handling.
- template<typename EXC, typename R>
  L4_NORETURN void loop (R r, l4_utcb_t ∗u=l4_utcb())

Server loop with internal exception handling.

- template<typename EXC, typename R, typename Printer>
  L4_NORETURN void loop_dbg (R r, Printer p, l4_utcb_t *u=l4_utcb())

  Server loop with internal exception handling including message printing.

Public Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- int alloc_buffer_demand (Demand const &demand) override

  Tells the server to allocate buffers for the given demand.
- L4::Cap< void > **get_rcv_cap** (int) const override

  Returns L4::Cap<void>::Invalid, we have no buffer management.
- int **realloc_rcv_cap** (int) override

  Returns -L4_ENOMEM, we have no buffer management.
- int **add_timeout** (Timeout *, l4_kernel_clock_t) override

  Returns -L4_ENOSYS, we have no timeout queue.
- int **remove_timeout** (Timeout *) override

  Returns -L4_ENOSYS, we have no timeout queue.

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- virtual cxx::Result< Mem_window > get_rcv_mem () noexcept

  Take the current memory receive window.
- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Protected Member Functions

- l4_msgtag_t **reply_n_wait** (l4_msgtag_t reply, l4_umword_t *p, l4_utcb_t *)

  Internal implementation for reply and wait.

Protected Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- unsigned **first_free_br** () const

  Returns 1 as first free buffer.
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)

  Setup wait function for the server loop (Server<>).

Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

15.183.1 Detailed Description

template<typename LOOP_HOOKS = Ipc_svr::Default_loop_hooks>
class L4::Server< LOOP_HOOKS >

Basic server loop for handling client requests.

Parameters

LOOP_HOOKS	the server inherits from LOOP_HOOKS and calls the hooks defined in LOOP_↩ HOOKS in the server loop. See Ipc_svr::Default_loop_hooks, Ipc_svr::Ignore_errors, Ipc_svr::Default_timeout, Ipc_svr::Compound_reply, and Ipc_svr::Br_manager_no_buffers.

This is basically a simple server loop that uses a single message buffer for receiving requests and sending replies. The dispatcher determines how incoming messages are handled.
Definition at line 307 of file ipc_server_loop.

15.183.2 Constructor & Destructor Documentation

15.183.2.1 Server()

```
template<typename LOOP_HOOKS = Ipc_svr::Default_loop_hooks>
L4::Server< LOOP_HOOKS >::Server (
            l4_utcb_t * )  [inline], [explicit]
```

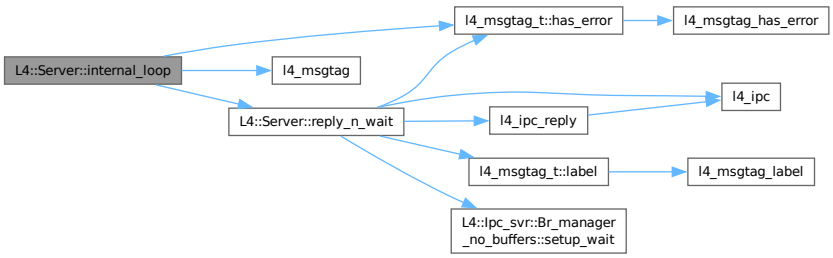
Initializes the server loop.
Note that this variant is deprecated. The UTCB can be specified with the server loop function (l4_utcb() is the default). (2021-10)
Definition at line 319 of file ipc_server_loop.

15.183.3 Member Function Documentation

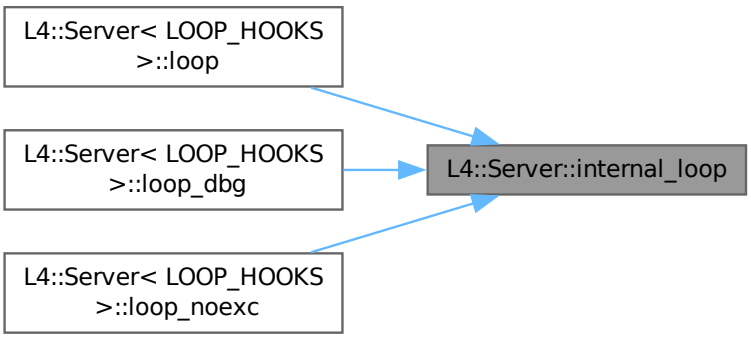
15.183.3.1 internal_loop()

```
template<typename L>
template<typename DISPATCH>
L4_NORETURN void L4::Server< L >::internal_loop (
            DISPATCH dispatch,
            l4_utcb_t * utcb)  [inline]
```

The server loop.
This function usually never returns, it waits for incoming messages calls the dispatcher, sends a reply and waits again.
Definition at line 424 of file ipc_server_loop.
References l4_msgtag_t::has_error(), L4_ENOREPLY, l4_msgtag(), and reply_n_wait().
Referenced by loop(), loop_dbg(), and loop_noexc().
Here is the call graph for this function:



Here is the caller graph for this function:



15.183.3.2 loop()

```
template<typename LOOP_HOOKS = Ipc_svr::Default_loop_hooks>
template<typename EXC, typename R>
L4_NORETURN void L4::Server< LOOP_HOOKS >::loop (
             R r,
             l4_utcb_t * u = l4_utcb())  [inline]
```

Server loop with internal exception handling.
This server loop translates L4::Runtime_error exceptions into negative error return codes sent to the caller.
Definition at line 355 of file ipc_server_loop.

15.183.3.3 loop_dbg()

```
template<typename LOOP_HOOKS = Ipc_svr::Default_loop_hooks>
template<typename EXC, typename R, typename Printer>
L4_NORETURN void L4::Server< LOOP_HOOKS >::loop_dbg (
             R r,
             Printer p,
             l4_utcb_t * u = l4_utcb())  [inline]
```

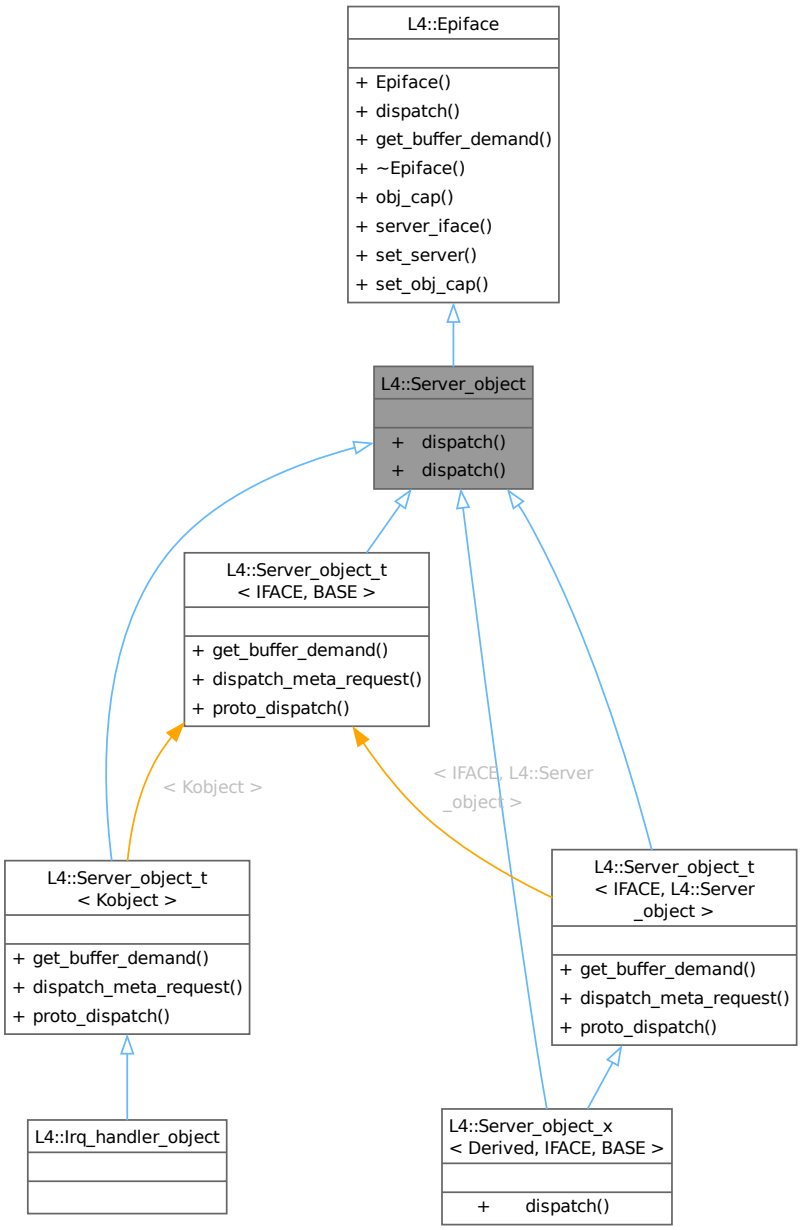
Server loop with internal exception handling including message printing.
Exceptions are translated into error codes, just like in loop(). In addition, error messages are printed using the Printer argument.
Definition at line 368 of file ipc_server_loop.
The documentation for this class was generated from the following file:

- l4/sys/cxx/ipc_server_loop

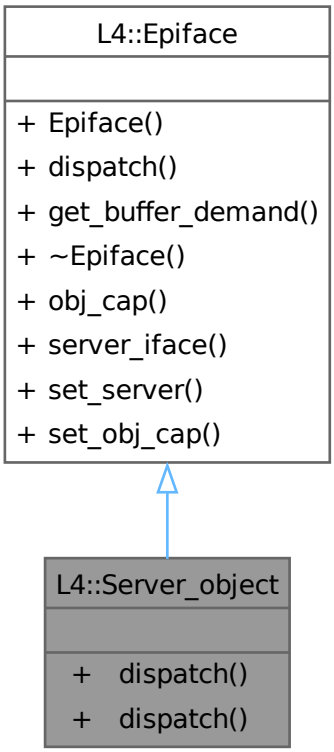
15.184 L4::Server_object Class Reference

Abstract server object to be used with L4::Server and L4::Basic_registry.
`#include <ipc_server>`

Inheritance diagram for L4::Server_object:



Collaboration diagram for L4::Server_object:



Public Member Functions

- virtual int dispatch (unsigned long rights, lpc::Iostream &ios)=0

  The abstract handler for client requests to the object.
- l4_msgtag_t dispatch (l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb) override

  The abstract handler for client requests to the object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual Demand get_buffer_demand () const =0

  Get the server-side receive buffer demand for this object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

15.184.1 Detailed Description

Abstract server object to be used with L4::Server and L4::Basic_registry.

Note

Usually L4::Server_object_t is used as a base class when writing server objects.

This server object provides an abstract interface that is used by the L4::Registry_dispatcher model. You can derive subclasses from this interface and implement application specific server objects.
Definition at line 38 of file ipc_server.

15.184.2 Member Function Documentation

15.184.2.1 dispatch() [1/2]

```
l4_msgtag_t L4::Server_object::dispatch (
            l4_msgtag_t tag,
            unsigned rights,
            l4_utcb_t * utcb)  [inline], [override], [virtual]
```

The abstract handler for client requests to the object.

Parameters

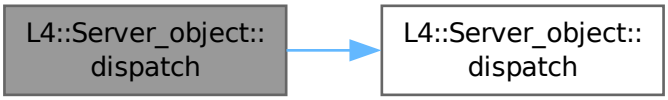
tag	The message tag for this invocation.
rights	The rights bits in the invoked capability.
utcb	The UTCB used for the invocation.

Return values

-L4_ENOREPLY	No reply message is sent.
<0	Error, reply with error code.
>=0	Success, reply with return value.

This function must be implemented by application specific server objects.
Implements L4::Epiface.
Definition at line 60 of file ipc_server.
References dispatch().

Here is the call graph for this function:



15.184.2.2 dispatch() [2/2]

```
virtual int L4::Server_object::dispatch (
            unsigned long rights,
            Ipc::Iostream & ios)  [pure virtual]
```

The abstract handler for client requests to the object.

Parameters

rights	The rights bits in the invoked capability.
ios	The Ipc::Iostream for reading the request and writing the reply.

Return values

-L4_ENOREPLY	Instructs the server loop to not send a reply.
<0	Error, reply with error code.
>=0	Success, reply with return value.

This function must be implemented by application specific server objects. The implementation must unmarshall data from the stream (`ios`) and create a reply by marshalling to the stream (`ios`). For details about the IPC stream see IPC stream operators.

Note

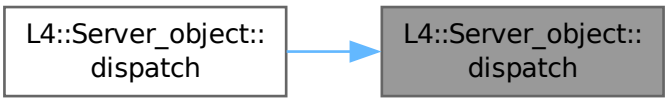
You need to extract the complete message from the *ios* stream before inserting any reply data or before doing any function call that may use the UTCB. Otherwise, the incoming message may get lost.

Implemented in L4::Server_object_x< Derived, IFACE, BASE >.

Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc, and examples/libs/l4re/streammap/server.cc.

Referenced by dispatch().
Here is the caller graph for this function:



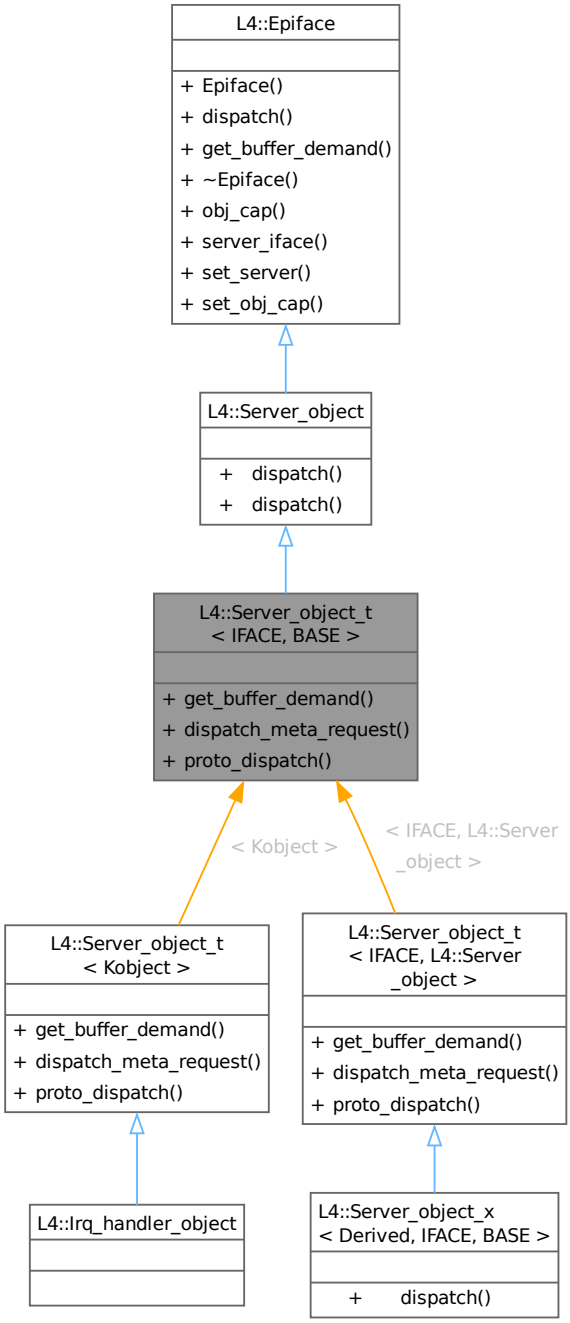
The documentation for this class was generated from the following file:

- l4/cxx/ipc_server

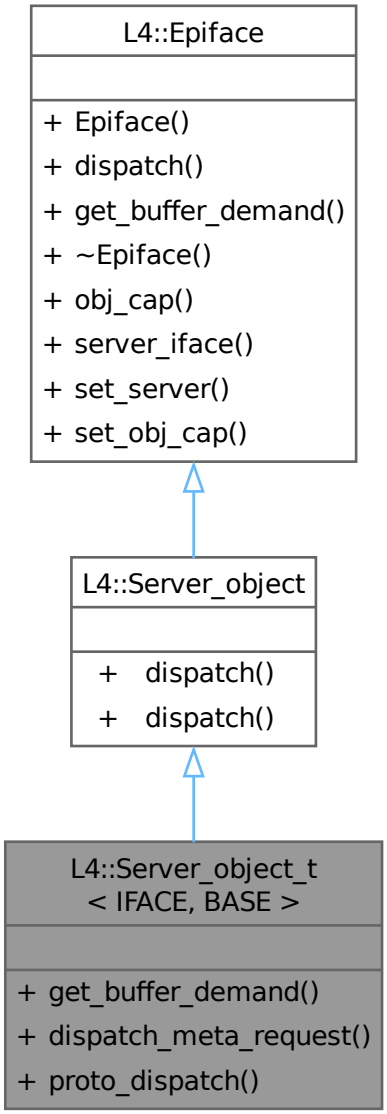
15.185 L4::Server_object_t< IFACE, BASE > Struct Template Reference

Base class (template) for server implementing server objects.
`#include <ipc_server>`

Inheritance diagram for L4::Server_object_t< IFACE, BASE >:



Collaboration diagram for L4::Server_object_t< IFACE, BASE >:



Public Types

- typedef IFACE **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions

- BASE::Demand get_buffer_demand () const override
- int dispatch_meta_request (L4::Ipc::Iostream &ios)

  Implementation of the meta protocol based on IFACE.

Public Member Functions inherited from L4::Server_object

- virtual int dispatch (unsigned long rights, Ipc::Iostream &ios)=0

  The abstract handler for client requests to the object.
- l4_msgtag_t dispatch (l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb) override

  The abstract handler for client requests to the object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Static Public Member Functions

- template<typename THIS>
  static int proto_dispatch (THIS *self, l4_umword_t rights, L4::Ipc::Iostream &ios)

  Implementation of protocol-based dispatch for this server object.

15.185.1 Detailed Description

template<typename IFACE, typename BASE = L4::Server_object>
struct L4::Server_object_t< IFACE, BASE >

Base class (template) for server implementing server objects.

Template Parameters

IFACE	The IPC interface class that defines the interface that shall be implemented.
BASE	The server object base class (usually L4::Server_object).

Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc, and examples/libs/l4re/streammap/server.cc.

Definition at line 80 of file ipc_server.

15.185.2 Member Function Documentation

15.185.2.1 dispatch_meta_request()

```
template<typename IFACE, typename BASE = L4::Server_object>
int L4::Server_object_t< IFACE, BASE >::dispatch_meta_request (
            L4::Ipc::Iostream & ios)  [inline]
```

Implementation of the meta protocol based on *IFACE*.

Parameters

ios	The IO stream used for receiving the message.

This function can be used to handle incoming L4_PROTO_META protocol requests. The implementation uses the L4::Type_info of *IFACE* to handle the requests. Call this function in the implementation of Server_object::dispatch() when the received message tag has protocol L4_PROTO_META (L4::Meta::Protocol).
Definition at line 99 of file ipc_server.

15.185.2.2 get_buffer_demand()

```
template<typename IFACE, typename BASE = L4::Server_object>
BASE::Demand L4::Server_object_t< IFACE, BASE >::get_buffer_demand () const  [inline], [override],
[virtual]
```

Returns

the server-side buffer demand based in *IFACE*.

Implements L4::Epiface.
Definition at line 86 of file ipc_server.

15.185.2.3 proto_dispatch()

```
template<typename IFACE, typename BASE = L4::Server_object>
template<typename THIS>
int L4::Server_object_t< IFACE, BASE >::proto_dispatch (
            THIS * self,
            l4_umword_t rights,
            L4::Ipc::Iostream & ios)  [inline], [static]
```

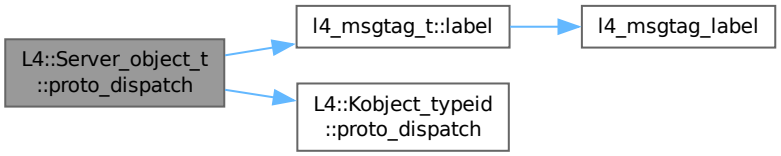
Implementation of protocol-based dispatch for this server object.

Parameters

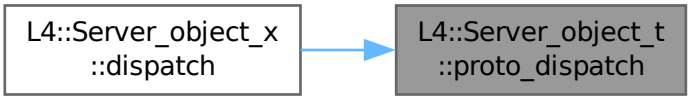
self	The this pointer for the object (inherits from Server_object_t).
rights	The rights from the received IPC (forwarded to p_dispatch()).
ios	The message stream for the incoming and the reply message.

Server objects may call this function from their dispatch() function. This function reads the protocol ID from the message tag and uses the p_dispatch code to dispatch to overloaded p_dispatch functions of self.
Definition at line 114 of file ipc_server.
References l4_msgtag_t::label(), and L4::Kobject_typeid< T >::proto_dispatch().
Referenced by L4::Server_object_x< Derived, IFACE, BASE >::dispatch().

Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this struct was generated from the following file:

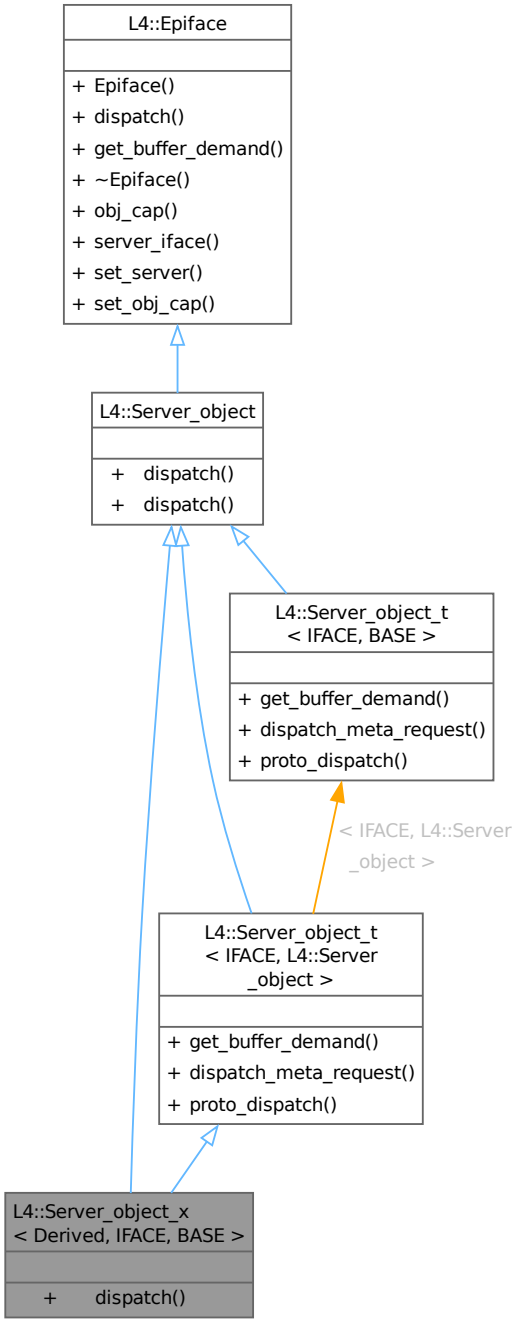
- l4/cxx/ipc_server

15.186 L4::Server_object_x< Derived, IFACE, BASE > Struct Template Reference

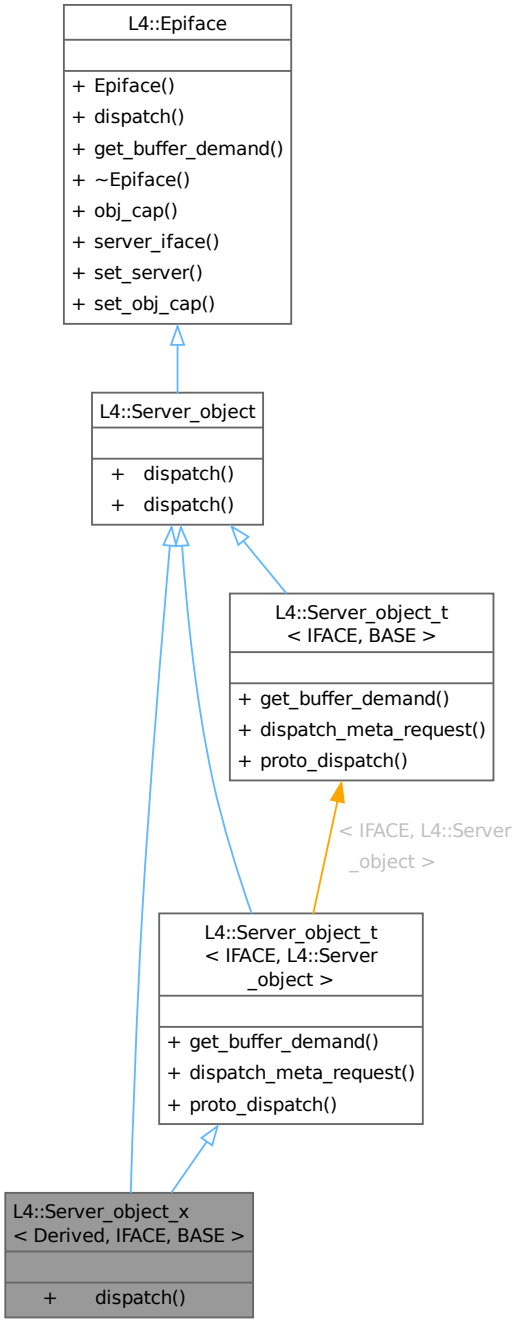
Helper class to implement p_dispatch based server objects.

`#include <ipc_server>`

Inheritance diagram for L4::Server_object_x< Derived, IFACE, BASE >:



Collaboration diagram for L4::Server_object_x< Derived, IFACE, BASE >:



Public Member Functions

- int **dispatch** (l4_umword_t r, L4::Ipc::Iostream &ios)

  Implementation forwarding to p_dispatch().

Public Member Functions inherited from L4::Server_object

- l4_msgtag_t dispatch (l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb) override

The abstract handler for client requests to the object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Public Member Functions inherited from L4::Server_object_t< IFACE, L4::Server_object >

- L4::Server_object::Demand get_buffer_demand () const override
- int dispatch_meta_request (L4::Ipc::Iostream &ios)

  Implementation of the meta protocol based on IFACE.

Additional Inherited Members

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Types inherited from L4::Server_object_t< IFACE, L4::Server_object >

- typedef IFACE **Interface**

  Data type of the IPC interface definition.

Static Public Member Functions inherited from L4::Server_object_t< IFACE, L4::Server_object >

- static int proto_dispatch (THIS *self, l4_umword_t rights, L4::Ipc::Iostream &ios)

  Implementation of protocol-based dispatch for this server object.

15.186.1 Detailed Description

template<typename Derived, typename IFACE, typename BASE = L4::Server_object>
struct L4::Server_object_x< Derived, IFACE, BASE >

Helper class to implement p_dispatch based server objects.

Template Parameters

Derived	The data type of your server object class.

IFACE	The data type providing the interface definition for the object.
BASE	Optional data-type of the base server object (usually L4::Server_object)

This class implements the standard dispatch() function of L4::Server_object and forwards incoming messages to a set of overloaded p_dispatch() functions. There must be a p_dispatch() function in Derived for each interface provided by IFACE with the signature

```
int p_dispatch(Iface *, unsigned rights, L4::Ipc::Iostream &)
```

that is called for messages with protocol == Iface::Protocol.
Example signature for L4Re::Dataspace is:

```
int p_dispatch(L4Re::Dataspace *, unsigned, L4::Ipc::Iostream &)
```

Definition at line 143 of file ipc_server.
The documentation for this struct was generated from the following file:

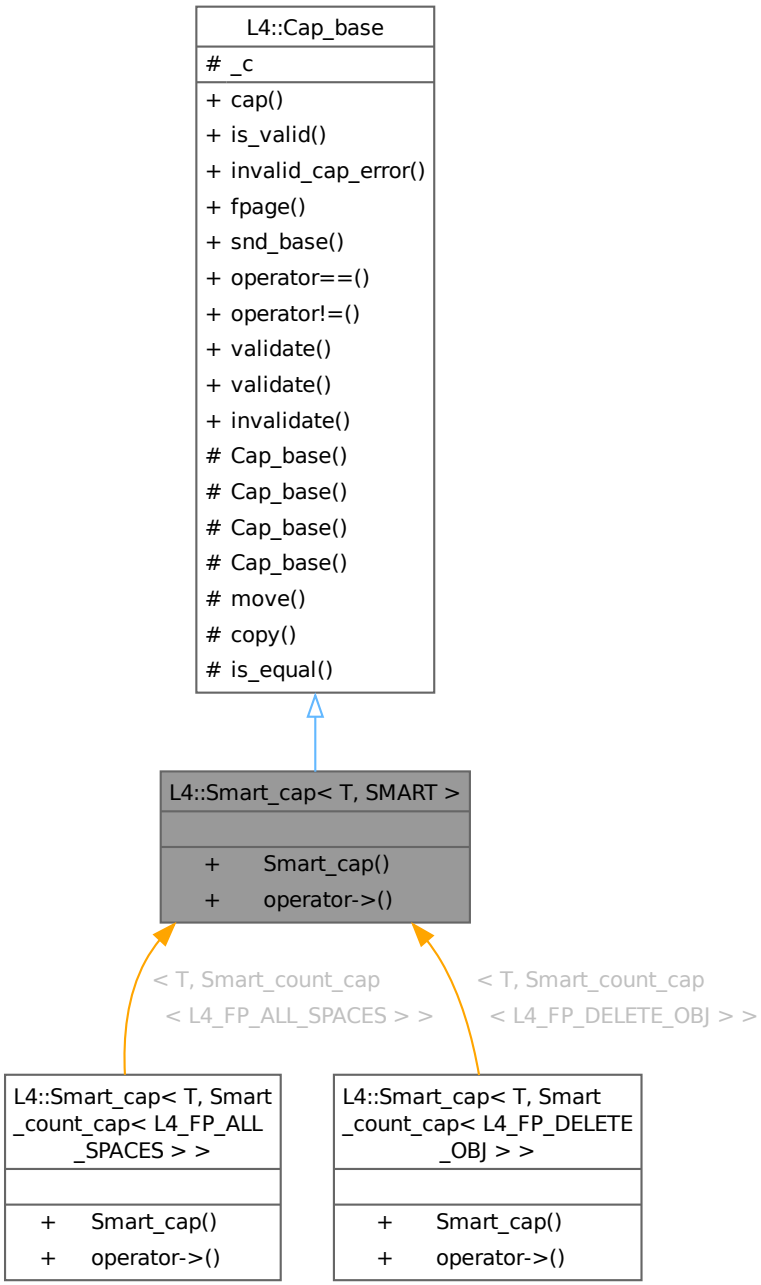
- l4/cxx/ipc_server

15.187 L4::Smart_cap< T, SMART > Class Template Reference

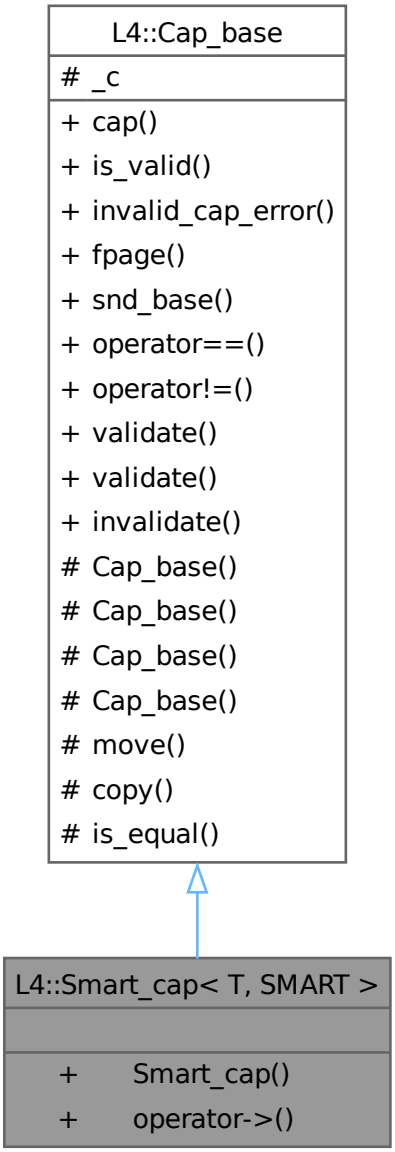
Smart capability class.

```
#include <smart_capability>
```

Inheritance diagram for L4::Smart_cap< T, SMART >:



Collaboration diagram for L4::Smart_cap< T, SMART >:



Public Member Functions

- template<typename O>
  Smart_cap (Cap< O > const &p) noexcept

  Internal constructor, use to generate a capability from a `this` pointer.
- Cap< T > **operator->** () const noexcept

  Member access of a `T`.

Public Member Functions inherited from L4::Cap_base

- l4_cap_idx_t cap () const noexcept

Return capability selector.

- bool is_valid () const noexcept

  Test whether the capability is a valid capability index (i.e., L4_INVALID_CAP_BIT is not set).
- int **invalid_cap_error** () const noexcept

  Return the transported error code in an invalid capability selector.
- l4_fpage_t fpage (unsigned rights=L4_CAP_FPAGE_RWS) const noexcept

  Return flexpage for the capability.
- l4_umword_t snd_base (unsigned grant=L4_MAP_ITEM_MAP, l4_cap_idx_t base=L4_INVALID_CAP) const noexcept

  Return send base.
- bool **operator==** (Cap_base const &o) const noexcept

  Test if two capabilities are equal.
- bool **operator!=** (Cap_base const &o) const noexcept

  Test if two capabilities are not equal.
- l4_msgtag_t validate (l4_utcb_t *u=l4_utcb()) const noexcept

  Check whether a capability is present (refers to an object).
- l4_msgtag_t validate (Cap< Task > task, l4_utcb_t *u=l4_utcb()) const noexcept

  Check whether a capability is present (refers to an object).
- void **invalidate** () noexcept

  Set this capability to invalid (L4_INVALID_CAP).

Additional Inherited Members

Public Types inherited from L4::Cap_base

- enum No_init_type { No_init }

  Special value for uninitialized capability objects.
- enum Cap_type { Invalid = L4_INVALID_CAP }

  Invalid capability type.

Protected Member Functions inherited from L4::Cap_base

- Cap_base (l4_cap_idx_t c) noexcept

  Generate a capability from its C representation.
- **Cap_base** (Cap_type cap) noexcept

  Constructor to create an invalid capability.
- Cap_base (l4_default_caps_t cap) noexcept

  Initialize capability with one of the default capabilities.
- **Cap_base** () noexcept

  Create an uninitialized instance.
- bool move (Cap_base const &src) const noexcept

  Replace this capability with the contents of `src`.
- bool copy (Cap_base const &src) const noexcept

  Copy a capability.
- bool is_equal (Cap_base const &other) const noexcept

  Test whether this capability points to the same object with the same permissions as `other`.

Protected Attributes inherited from L4::Cap_base

- l4_cap_idx_t **_c**

  The C representation of a capability selector.

15.187.1 Detailed Description

template<typename T, typename SMART>
class L4::Smart_cap< T, SMART >

Smart capability class.
Definition at line 25 of file smart_capability.

15.187.2 Constructor & Destructor Documentation

15.187.2.1 Smart_cap()

```
template<typename T, typename SMART>
template<typename O>
L4::Smart_cap< T, SMART >::Smart_cap (
             Cap< O > const & p)  [inline], [noexcept]
```

Internal constructor, use to generate a capability from a `this` pointer.

Attention

This constructor is only useful to generate a capability from the `this` pointer of an object that is an L4::Kobject. Do `never` use this constructor for something else!

Parameters

p	The `this` pointer of the Kobject or derived object

Definition at line 62 of file smart_capability.
The documentation for this class was generated from the following file:

- l4/sys/smart_capability

15.188 L4::String Class Reference

A null-terminated string container class.
`#include <string.h>`
Collaboration diagram for L4::String:



15.188.1 Detailed Description

A null-terminated string container class.
Definition at line 22 of file string.h.
The documentation for this class was generated from the following file:

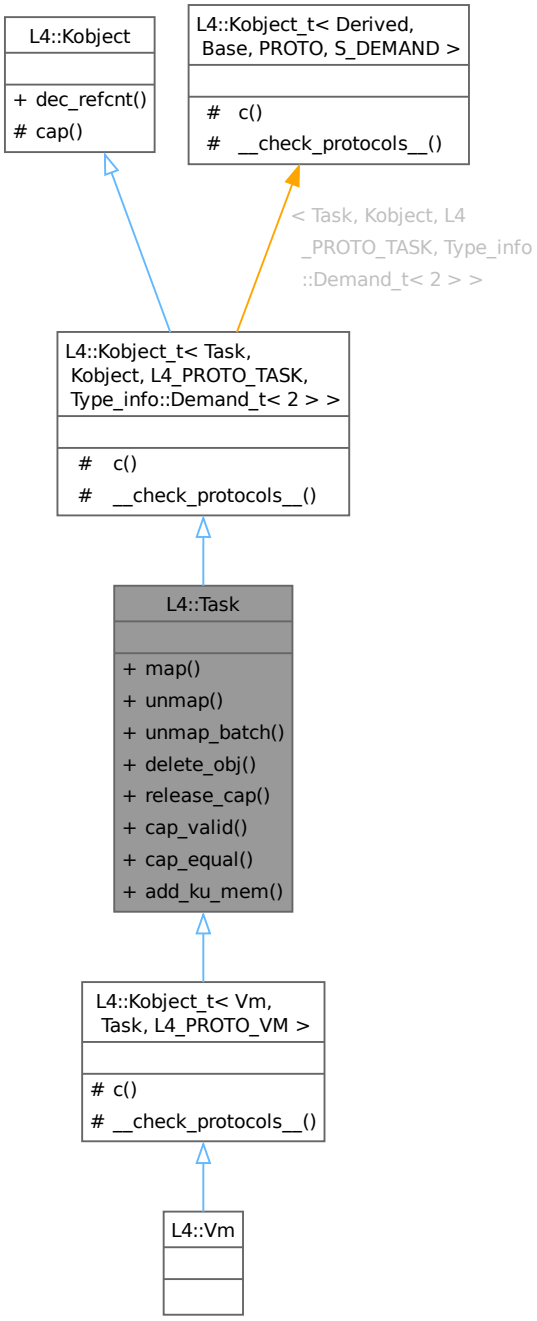
- l4/cxx/string.h

15.189 L4::Task Class Reference

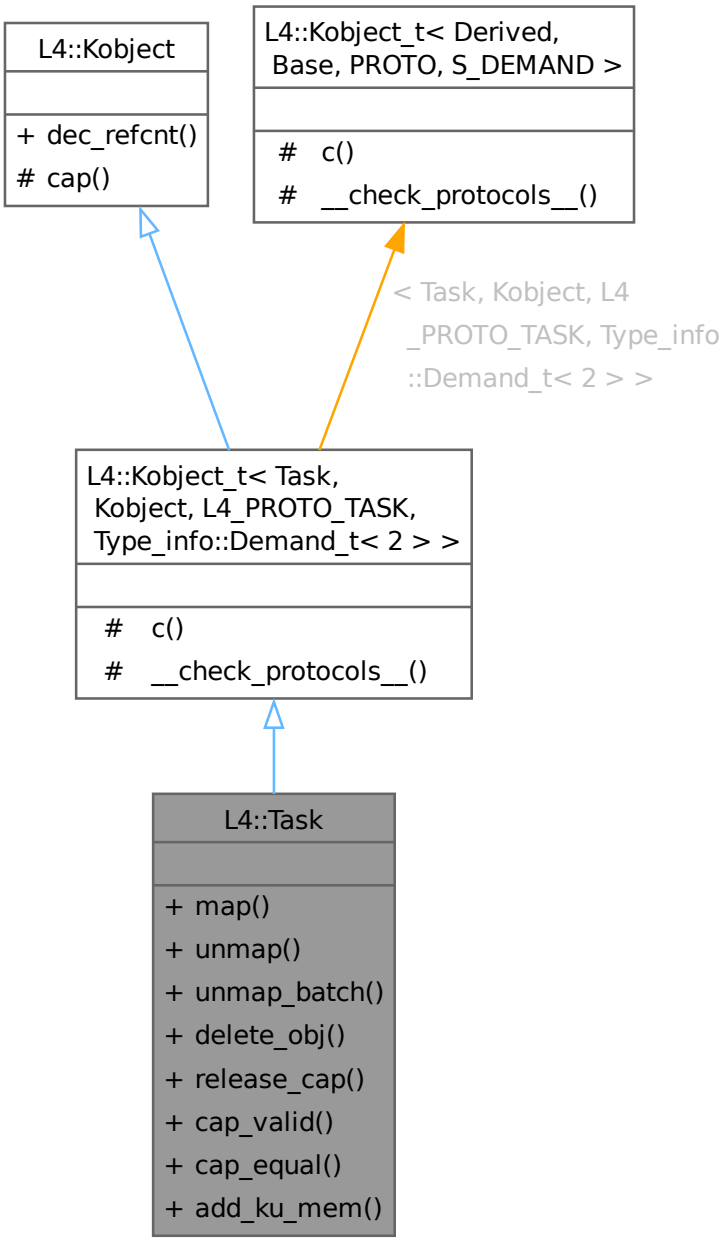
C++ interface of the Task kernel object, see Task for the C interface.

`#include <task>`

Inheritance diagram for L4::Task:



Collaboration diagram for L4::Task:



Public Member Functions

- l4_msgtag_t map (Cap< Task > const &src_task, l4_fpage_t const &snd_fpage, l4_umword_t snd_base, l4_utcb_t *utcb=l4_utcb()) noexcept

  Map resources available in the source task to a destination task.
- l4_msgtag_t unmap (l4_fpage_t const &fpage, l4_umword_t map_mask, l4_utcb_t *utcb=l4_utcb()) noexcept

  Revoke rights from the task.
- l4_msgtag_t unmap_batch (l4_fpage_t const *fpages, unsigned num_fpages, l4_umword_t map_mask, l4_utcb_t *utcb=l4_utcb()) noexcept

Revoke rights from a task.

- l4_msgtag_t delete_obj (L4::Cap< void > obj, l4_utcb_t *utcb=l4_utcb()) noexcept

  Release capability and delete object.

- l4_msgtag_t release_cap (L4::Cap< void > cap, l4_utcb_t *utcb=l4_utcb()) noexcept

  Release object capability.

- l4_msgtag_t cap_valid (Cap< void > const &cap, l4_utcb_t *utcb=l4_utcb()) noexcept

  Check whether a capability is present (refers to an object).

- l4_msgtag_t cap_equal (Cap< void > const &cap_a, Cap< void > const &cap_b, l4_utcb_t *utcb=l4_utcb()) noexcept

  Test whether two capabilities point to the same object with the same permissions (only considering selected permissions).

- l4_msgtag_t add_ku_mem (l4_fpage_t *fpage, l4_utcb_t *utcb=l4_utcb()) noexcept

  Add kernel-user memory.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Task, Kobject, L4_PROTO_TASK, Type_info::Demand_t< 2 > >

- typedef Task **Class**

  The target interface type (inheriting from Kobject_t).

- typedef Typeid::Iface< PROTO, Task > **__Iface**

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Task, Kobject, L4_PROTO_TASK, Type_info::Demand_t< 2 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Task, Kobject, L4_PROTO_TASK, Type_info::Demand_t< 2 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.189.1 Detailed Description

C++ interface of the Task kernel object, see Task for the C interface.
The L4::Task class represents a combination of the address spaces provided by the L4Re micro kernel. A task consists of at least a memory address space and an object address space. On IA32 there is also an IO-port address space associated with an L4::Task.
L4::Task objects are created using the L4::Factory interface.

Include File

```
#include <l4/sys/task>
```

Definition at line 33 of file task.

15.189.2 Member Function Documentation

15.189.2.1 add_ku_mem()

```
l4_msgtag_t L4::Task::add_ku_mem (
            l4_fpage_t * fpage,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Add kernel-user memory.

Parameters

in,out	*fpage*	Flexpage describing the virtual area the memory goes to. On systems without MMU, the flexpage is adjusted to reflect the actually allocated physical address.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag

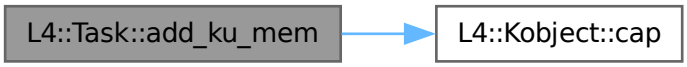
Kernel-user memory (ku_mem) is memory that is shared between the kernel and user-space. It is needed for the UTCB area of threads (see L4::Thread::Attr::bind()) and for (extended) vCPU state. Note that existing kernel-user memory cannot be unmapped or mapped somewhere else.

Note

The amount of kernel-user memory that can be allocated at once is limited by the used kernel implementation. The minimum allocatable amount is one page (L4_PAGESIZE). A portable implementation should not depend on allocations greater than 16KiB to succeed.

This function is only guaranteed to work on L4::Task objects. It might or might not work on L4::Vm objects or on L4Re::Dma_space objects but there is no practical use for adding kernel-user memory to L4::Vm objects or to L4Re::Dma_space objects.

Definition at line 281 of file task.
References L4::Kobject::cap().
Here is the call graph for this function:



15.189.2.2 cap_equal()

```
l4_msgtag_t L4::Task::cap_equal (
            Cap< void > const & cap_a,
            Cap< void > const & cap_b,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Test whether two capabilities point to the same object with the same permissions (only considering selected permissions).

Parameters

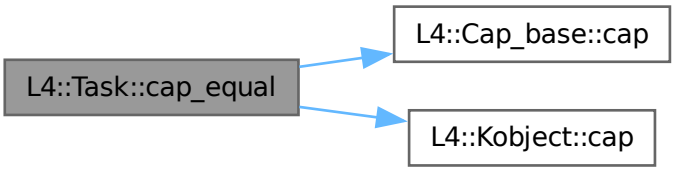
cap_a	Capability selector for the first capability to compare.
cap_b	Capability selector for the second capability to compare.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

l4_msgtag_t::label() = 1	The compared capabilities point to the same object with same considered permission.
l4_msgtag_t::label() = 0	The compared capabilities do **not** point to the same object or differ in the considered permission.

- For L4::Ipc_gate objects, only the permissions L4_CAP_FPAGE_W, L4_CAP_FPAGE_S, and L4_FPAGE_C_OBJ_RIGHT1 are considered for the comparison. Differences in other permissions are ignored.
- For other objects, only the permissions L4_CAP_FPAGE_W and L4_CAP_FPAGE_S are considered for the comparison. Differences in other permissions are ignored.

Note that having the L4_CAP_FPAGE_R permission is implicit in possessing the capability.
Definition at line 251 of file task.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.189.2.3 cap_valid()

```
l4_msgtag_t L4::Task::cap_valid (
            Cap< void > const & cap,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Check whether a capability is present (refers to an object).

Parameters

cap	Valid capability to check for presence.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

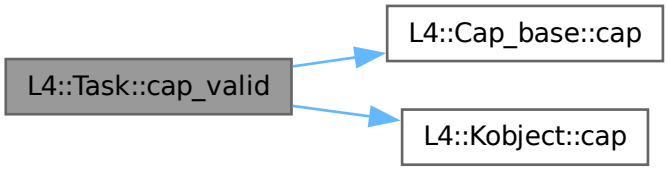
l4_msgtag_t::label() > 0	Capability is present (refers to an object).
l4_msgtag_t::label() == 0	No capability present (void object).

A capability is considered present when it refers to an existing kernel object.

Precondition

`cap` must be a valid capability (i.e. `cap.is_valid() == true`). If you are unsure about the validity of your capability use L4::Cap.validate() instead.

Definition at line 222 of file task.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.189.2.4 delete_obj()

```
l4_msgtag_t L4::Task::delete_obj (
            L4::Cap< void > obj,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Release capability and delete object.

Parameters

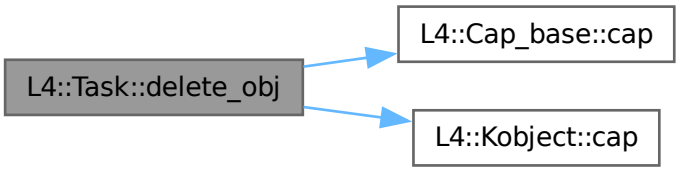
obj	Capability index of the object to delete.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag

If `obj` has the delete permission, initiates the deletion of the object. This implies that all capabilities for that object are gone afterwards. However, kernel-internally, objects are not destroyed until all other kernel objects holding a reference to it drop the reference. Hence, quota used by that object might not be freed immediately.
If `obj` does not have the delete permission, no error will be reported and only the capability `obj` is removed. (Note that, depending on the object's reference counter, this might still imply initiation of deletion.)
This operation is equivalent to unmap() with L4_FP_DELETE_OBJ flag.
Definition at line 180 of file task.
References L4::Cap_base::cap(), and L4::Kobject::cap().

Here is the call graph for this function:



15.189.2.5 map()

```
l4_msgtag_t L4::Task::map (
             Cap< Task > const & snd_task,
             l4_fpage_t const & snd_fpage,
             l4_umword_t snd_base,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Map resources available in the source task to a destination task.

Parameters

src_task	Capability index of the source task.
snd_fpage	Send flexpage that describes an area in the address space or object space of the source task.
snd_base	Send base that describes an offset in the receive window of the destination task. The lower bits contain additional map control flags (see l4_fpage_cacheability_opt_t for memory mappings, Attributes and additional permissions for object send items for object mappings, and L4_MAP_ITEM_GRANT; also see l4_map_control() and l4_map_obj_control()).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag. The function l4_error() shall be used to test if the map operation was successful.

Return values

L4_EOK	Operation successful (but see notes below).
-L4_EPERM	Insufficient permissions; see precondition.
-L4_EINVAL	Invalid source task capability.
-L4_IPC_SEMAPFAILED	The map operation failed due to limited quota.

Precondition

The invoked Task capability must have the permission L4_CAP_FPAGE_W.

This method allows for asynchronous transfer of capabilities, memory mappings, and IO-port mappings (on IA32) from one task to another. The destination task is the task referenced by the capability on which the map is invoked, and the receive window is the whole address space of that task. By specifying proper rights in the `snd_fpage` and `snd_base`, it is possible to remove rights during transfer.

Note

If the send flexpage is of type L4_FPAGE_OBJ, the L4_CAP_FPAGE_S right is removed from the transferred capability unless both the source and destination task capabilities possess the L4_CAP_FPAGE_S right themselves.

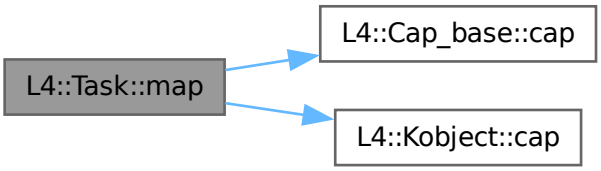
Even with l4_error() returning L4_EOK there might be cases where not all pages of the send flexpage were mapped respectively granted to the destination task, for instance, if the corresponding mapping in the destination task does already exist.

For more information on spaces and mappings, see Spaces and Mappings. The flexpage API is described in more detail at Flexpages.

Note

For peculiarities when using grant, see L4_MAP_ITEM_GRANT.

Definition at line 85 of file task.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.189.2.6 release_cap()

```
l4_msgtag_t L4::Task::release_cap (
            L4::Cap< void > cap,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Release object capability.

Parameters

cap	Capability index of the object to release.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag.

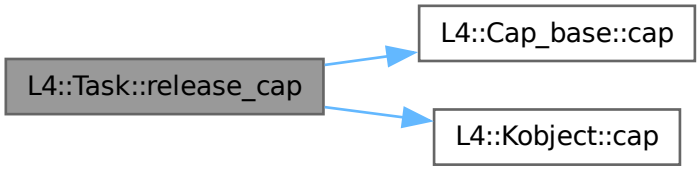
This operation unmaps the capability from `this` task. This operation is equivalent to unmapping a single object capability by specifying all object rights as unmap mask.

Note

If the reference counter of the kernel object referenced by `cap` goes down to zero, the deletion of the object is initiated. Objects are not destroyed until all other kernel objects holding a reference to it drop the reference.

Definition at line 201 of file task.
References L4::Cap_base::cap(), and L4::Kobject::cap().

Here is the call graph for this function:



15.189.2.7 unmap()

```
l4_msgtag_t L4::Task::unmap (
             l4_fpage_t const & fpage,
             l4_umword_t map_mask,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Revoke rights from the task.

Parameters

fpage	Flexpage that describes an area in one capability space of `this` task and the rights to revoke.
map_mask	Unmap mask, see l4_unmap_flags_t
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag

This method allows to revoke rights from the destination task. The rights to revoke are specified in the flexpage, see l4_fpage_rights(). For a flexpage describing IO ports or memory, it also revokes rights from all the tasks that got the rights delegated from the destination task (i.e., this operation does a recursive rights revocation). The capability is unmapped if certain rights are specified, see below for details. It is guaranteed that the rights revocation is completed before this function returns.
Note that this function cannot be used to revoke the reference counting permission (see L4_FPAGE_C_REF_CNT) or the IPC-gate server permission (see L4_FPAGE_C_IPCGATE_SVR) from object capabilities.
It depends on the platform and the object type which rights need to be specified in the `rights` field of `fpage` to unmap a capability:

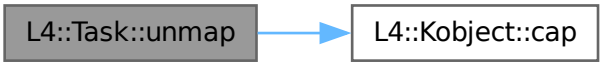
- An object capability is unmapped if and only if the L4_CAP_FPAGE_R right bit is set.
- An IO port is unmapped if and only if any right bit is set.
- Memory is unmapped if and only if the L4_FPAGE_RO right bit is set.

Note

Depending on the page-table features supported by the hardware, revocation of certain rights from a memory capability can be a no-op (i.e., the rights are not revoked). Further, revocation of certain rights may grant other rights which were not present before. For instance, on an architecture without support for NX, revoking X does nothing. For another example, revoking only X from an execute-only page grants read permission (because the mapping remains present in the page table).

If the reference counter of a kernel object referenced in `fpage` goes down to zero (as a result of deleting capabilities), the deletion of the object is initiated. Objects are not destroyed until all other kernel objects holding a reference to it drop the reference.

Definition at line 135 of file task.
References L4::Kobject::cap().
Here is the call graph for this function:



15.189.2.8 unmap_batch()

```
l4_msgtag_t L4::Task::unmap_batch (
            l4_fpage_t const * fpages,
            unsigned num_fpages,
            l4_umword_t map_mask,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Revoke rights from a task.

Parameters

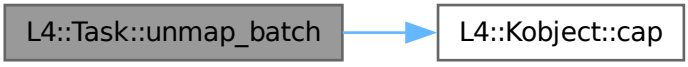
fpages	An array of flexpages. Each item describes an area in one capability space of `this` task.
num_fpages	Number of fpages in the `fpages` array.
map_mask	Unmap mask, see l4_unmap_flags_t.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Revoke rights for an array of flexpages, see unmap for details.

Precondition

The caller needs to take care that `num_fpages` is not bigger than L4_UTCB_GENERIC_DATA_SIZE - 2.

Definition at line 154 of file task.
References L4::Kobject::cap().
Here is the call graph for this function:



The documentation for this class was generated from the following file:

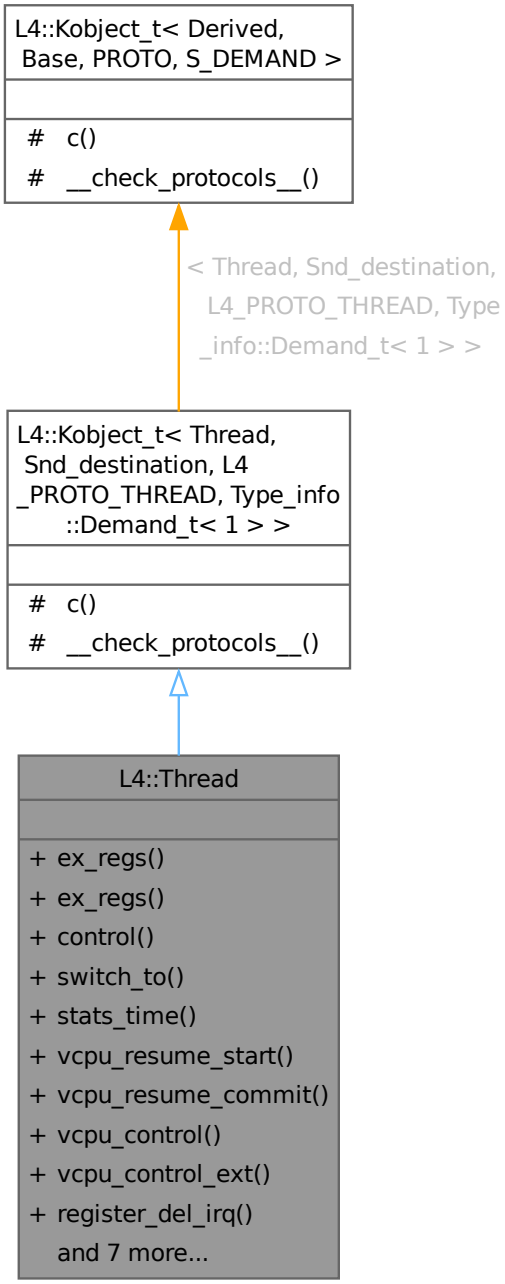
- l4/sys/task

15.190 L4::Thread Class Reference

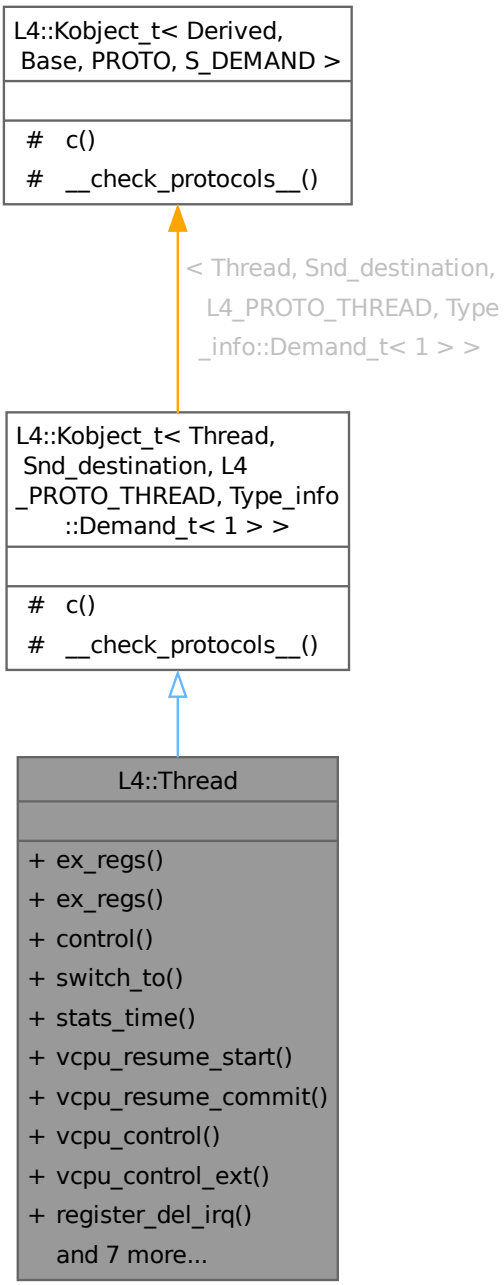
C++ L4 kernel thread interface, see Thread for the C interface.

`#include <thread>`

Inheritance diagram for L4::Thread:



Collaboration diagram for L4::Thread:



Data Structures

- class Attr

  Thread attributes used for control().
- class Modify_senders

  Class wrapping a list of rules which modify the sender label of IPC messages inbound to this thread.

Public Member Functions

- l4_msgtag_t ex_regs (l4_addr_t ip, l4_addr_t sp, l4_umword_t flags, l4_utcb_t *utcb=l4_utcb()) noexcept

  Exchange basic thread registers.
- l4_msgtag_t ex_regs (l4_addr_t *ip, l4_addr_t *sp, l4_umword_t *flags, l4_utcb_t *utcb=l4_utcb()) noexcept

  Exchange basic thread registers and return previous values.
- l4_msgtag_t control (Attr const &attr) noexcept

  Commit the given thread-attributes object.
- l4_msgtag_t switch_to (l4_utcb_t *utcb=l4_utcb()) noexcept

  Switch execution to this thread.
- l4_msgtag_t stats_time (l4_kernel_clock_t *us, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get consumed time of thread in us.
- l4_msgtag_t vcpu_resume_start (l4_utcb_t *utcb=l4_utcb()) noexcept

  Resume from vCPU asynchronous IPC handler, start.
- l4_msgtag_t vcpu_resume_commit (l4_msgtag_t tag, l4_utcb_t *utcb=l4_utcb()) noexcept

  Resume from vCPU asynchronous IPC handler, commit.
- l4_msgtag_t vcpu_control (l4_addr_t vcpu_state, l4_utcb_t *utcb=l4_utcb()) noexcept

  Enable the vCPU feature for the thread.
- l4_msgtag_t vcpu_control_ext (l4_addr_t ext_vcpu_state, l4_utcb_t *utcb=l4_utcb()) noexcept

  Enable the extended vCPU feature for the thread.
- l4_msgtag_t register_del_irq (Cap< Irq > irq, l4_utcb_t *u=l4_utcb()) noexcept

  Register an IRQ that will trigger upon deletion events.
- l4_msgtag_t modify_senders (Modify_senders const &todo) noexcept

  Apply sender modification rules.
- l4_msgtag_t register_doorbell_irq (Cap< Irq > irq, l4_utcb_t *u=l4_utcb()) noexcept

  Register an IRQ that will trigger when a forwarded virtual interrupt is pending.
- l4_msgtag_t pf_trampoline_setup (l4_addr_t pf_tramp_state, l4_utcb_t *u=l4_utcb()) noexcept

  Setup page fault trampoline handler.
- l4_msgtag_t pf_trampoline_resume (l4_utcb_t *u=l4_utcb()) noexcept

  Resume from page fault trampoline handler.
- l4_msgtag_t pf_trampoline_reflect (l4_utcb_t *u=l4_utcb()) noexcept

  Page fault trampoline handler reflects page fault to exception handler.
- l4_msgtag_t pf_trampoline_disable (int *was_enabled=nullptr, l4_utcb_t *u=l4_utcb()) noexcept

  Disable the page fault trampoline handling for this thread.
- l4_msgtag_t pf_trampoline_enable (l4_utcb_t *u=l4_utcb()) noexcept

  Re-enable the page fault trampoline handling for this thread.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Thread, Snd_destination, L4_PROTO_THREAD, Type_info::Demand_t< 1 > >

- typedef Thread **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Thread > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Snd_destination::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Thread, Snd_destination, L4_PROTO_THREAD, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Thread, Snd_destination, L4_PROTO_THREAD, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.190.1 Detailed Description

C++ L4 kernel thread interface, see Thread for the C interface.
The Thread class defines a thread of execution in the L4 context. Usually user-level and kernel threads are mapped 1:1 to each other. Thread kernel objects are created using a factory, see the L4::Factory API (L4::Factory::create()). Amongst other things an L4::Thread encapsulates:

- CPU state
  - General-purpose registers
  - Program counter
  - Stack pointer
- FPU state
- Scheduling parameters, see the L4::Scheduler API
- Execution state
  - Blocked, Runnable, Running

Thread objects provide an API for

- Thread configuration and manipulation
- Thread switching.

On ARM newly created threads run in EL0 by default and the exception level can be changed there with ex_regs().

Include File

```
#include <l4/sys/thread>
```

For the C interface see the Thread API. For more elaborated documentation on the vCPU feature see vCPU API.
Definition at line 52 of file thread.

15.190.2 Member Function Documentation

15.190.2.1 control()

```
l4_msgtag_t L4::Thread::control (
             Attr const & attr)  [inline], [noexcept]
```

Commit the given thread-attributes object.

Parameters

attr	the attribute object to commit to the thread.

Returns

Syscall return tag containing one of the following return codes.

Return values

L4_EOK	Operation successful.
-L4_EPERM	Insufficient permissions; see precondition.
-L4_EINVAL	Malformed thread-attributes.

Precondition

The invoked Thread capability must have the permission L4_CAP_FPAGE_S. When using Attr::bind(), also the respective Task capability must have the permission L4_CAP_FPAGE_S.

Definition at line 246 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.2 ex_regs() [1/2]

```
l4_msgtag_t L4::Thread::ex_regs (
             l4_addr_t * ip,
             l4_addr_t * sp,
             l4_umword_t * flags,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Exchange basic thread registers and return previous values.

Parameters

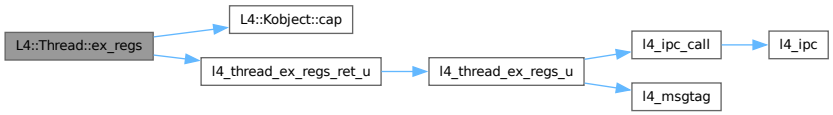
in,out	*ip*	New instruction pointer, use ~0UL to leave the instruction pointer unchanged, return previous instruction pointer.
in,out	*sp*	New stack pointer, use ~0UL to leave the stack pointer unchanged, returns previous stack pointer.
in,out	*flags*	Ex-regs flags, see L4_thread_ex_regs_flags, return previous CPU flags of the thread.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

System call return tag. [out] parameters are only valid if the function returns successfully. Use l4_error() to check.

This method allows to manipulate and start a thread. The basic functionality is to set the instruction pointer and the stack pointer of a thread. Additionally, this method allows also to cancel ongoing IPC operations

and to force the thread to raise an artificial exception (see `flags`). If the thread is in an IPC operation or if L4_THREAD_EX_REGS_TRIGGER_EXCEPTION forces an IPC then changes in IP and SP take effect directly after returning from this IPC. On ARM this method allows to change the exception level, see L4_thread_ex_regs_flags_arm and L4_thread_ex_regs_flags_arm64.
The thread is started using L4::Scheduler::run_thread(). However, if at the time L4::Scheduler::run_thread() is called, the instruction pointer of the thread is invalid, a later call to ex_regs() with a valid instruction pointer might start the thread.
Definition at line 119 of file thread.
References L4::Kobject::cap(), and l4_thread_ex_regs_ret_u().
Here is the call graph for this function:



15.190.2.3 ex_regs() [2/2]

```
l4_msgtag_t L4::Thread::ex_regs (
             l4_addr_t ip,
             l4_addr_t sp,
             l4_umword_t flags,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Exchange basic thread registers.

Parameters

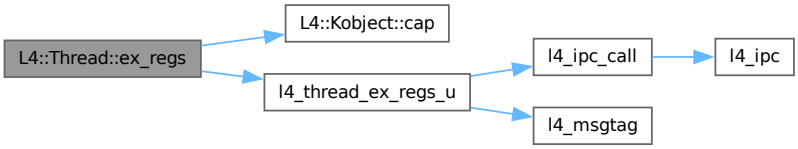
ip	New instruction pointer, use ~0UL to leave the instruction pointer unchanged.
sp	New stack pointer, use ~0UL to leave the stack pointer unchanged.
flags	Ex-regs flags, see L4_thread_ex_regs_flags.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

System call return tag.

This method allows to manipulate and start a thread. The basic functionality is to set the instruction pointer and the stack pointer of a thread. Additionally, this method allows also to cancel ongoing IPC operations and to force the thread to raise an artificial exception (see `flags`). If the thread is in an IPC operation or if L4_THREAD_EX_REGS_TRIGGER_EXCEPTION forces an IPC then changes in IP and SP take effect directly after returning from this IPC. On ARM this method allows to change the exception level, see L4_thread_ex_regs_flags_arm and L4_thread_ex_regs_flags_arm64.
The thread is started using L4::Scheduler::run_thread(). However, if at the time L4::Scheduler::run_thread() is called, the instruction pointer of the thread is invalid, a later call to ex_regs() with a valid instruction pointer might start the thread.
Definition at line 84 of file thread.
References L4::Kobject::cap(), and l4_thread_ex_regs_u().

Here is the call graph for this function:



15.190.2.4 modify_senders()

```
l4_msgtag_t L4::Thread::modify_senders (
            Modify_senders const & todo)  [inline], [noexcept]
```

Apply sender modification rules.

Parameters

todo	Prepared sender modification rules.

Returns

System call return tag.

The modification rules are applied to all IPCs to the thread (whether directly or by IPC gate) that are already in flight, that is that the sender is already blocking on.
See Modify_senders for a detailed description when applying sender modification rules is required.

Note

Modifying the senders of a thread running on a different CPU core is not supported.

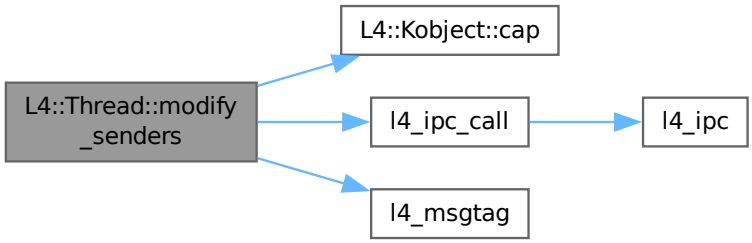
To ensure that no in-flight senders are missed, either the thread itself must execute modify_senders, or the thread executing the modify_senders must synchronize with the target thread. This synchronization must ensure the following:

1. Before modify_senders is executed the target thread must execute at least shortly (so that pending DRQs are handled).
2. The target thread must pause its IPC dispatch, until modify_senders is completed. In other words, the target thread must not be receive ready, because otherwise an IPC message with an unmodified label can be transferred to its UTCB or vCPU state.

See also

l4_thread_modify_sender_commit()

Definition at line 528 of file thread.
References L4::Kobject::cap(), l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), and L4_PROTO_THREAD.
Here is the call graph for this function:



15.190.2.5 pf_trampoline_disable()

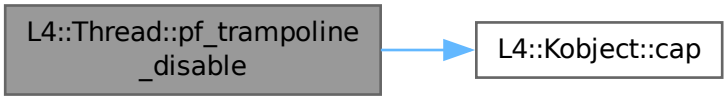
```
l4_msgtag_t L4::Thread::pf_trampoline_disable (
             int * was_enabled = nullptr,
             l4_utcb_t * u = l4_utcb())  [inline], [noexcept]
```

Disable the page fault trampoline handling for this thread.

Parameters

out	*was_enabled*	!= 0 if page fault trampoline handling was enabled, 0 if not. Optional, can be nullptr.
	u	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Definition at line 619 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.6 pf_trampoline_enable()

```
l4_msgtag_t L4::Thread::pf_trampoline_enable (
             l4_utcb_t * u = l4_utcb())  [inline], [noexcept]
```

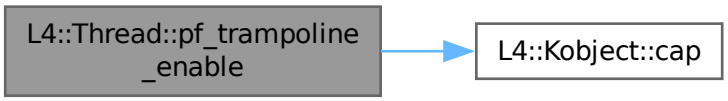
Re-enable the page fault trampoline handling for this thread.

Revert the effect of pf_trampoline_disable().

Parameters

u	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Definition at line 630 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.7 pf_trampoline_reflect()

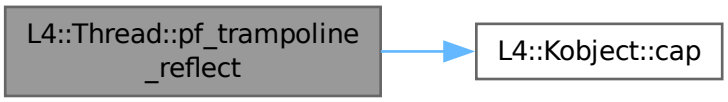
```
l4_msgtag_t L4::Thread::pf_trampoline_reflect (
            l4_utcb_t * u = l4_utcb())  [inline], [noexcept]
```

Page fault trampoline handler reflects page fault to exception handler.
Called by the trampoline page fault handler in case a page fault could not be resolved. The kernel will reflect the page fault as exception IPC to the exception handler of the faulting thread.

Parameters

u	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Definition at line 609 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.8 pf_trampoline_resume()

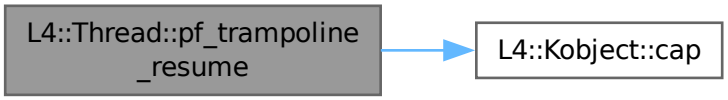
```
l4_msgtag_t L4::Thread::pf_trampoline_resume (
            l4_utcb_t * u = l4_utcb())  [inline], [noexcept]
```

Resume from page fault trampoline handler.
Called by the trampoline page fault handler after successfully resolving the page fault.

Parameters

u	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Definition at line 597 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.9 pf_trampoline_setup()

```
l4_msgtag_t L4::Thread::pf_trampoline_setup (
             l4_addr_t pf_tramp_state,
             l4_utcb_t * u = l4_utcb())  [inline], [noexcept]
```

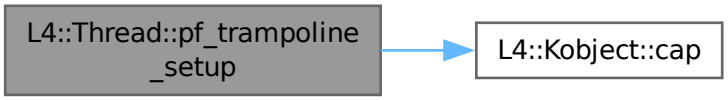
Setup page fault trampoline handler.
Instead of sending a page fault IPC to the pager, the kernel makes a single attempt to handle the page fault in the context of the faulting thread. For that purpose, the kernel saves the state of the faulting thread to the preallocated kernel-user memory `pf_tramp_state` and returns directly to the address of the page fault trampoline handler which is specified in l4_pf_trampoline_t::handler_ip. The page fault trampoline handler uses the stack and the stack pointer of the preempted context.
If the handler was able to resolve the page fault, it finishes using pf_trampoline_resume to resume to the preempted context.
If the page fault couldn't be resolved, the handler calls pf_trampoline_reflect which reflects the page fault to the exception handler of the thread.
If any page fault is triggered while the trampoline page fault handler is executed, a page fault IPC to the pager is generated.

Parameters

pf_tramp_state	State of the faulting thread at entry of page fault handler, see l4_pf_trampoline_t.
u	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Definition at line 585 of file thread.
References L4::Kobject::cap().

Here is the call graph for this function:



15.190.2.10 register_del_irq()

```
l4_msgtag_t L4::Thread::register_del_irq (
            Cap< Irq > irq,
            l4_utcb_t * u = l4_utcb())  [inline], [noexcept]
```

Register an IRQ that will trigger upon deletion events.

Parameters

irq	Capability index for the IRQ object to be triggered.
u	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

System call return tag containing the return code.

Return values

-L4_BUSY	A deletion IRQ is already bound to this thread.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The capability `irq` must have the permission L4_CAP_FPAGE_W.

In case the `irq` is already bound to an interrupt source, it is unbound first. When `irq` is deleted, it will be deregistered first. A registered deletion Irq can only be deregistered by deleting the Irq or the thread.
List of deletion events:

- deletion of one or several IPC gates bound to this thread.

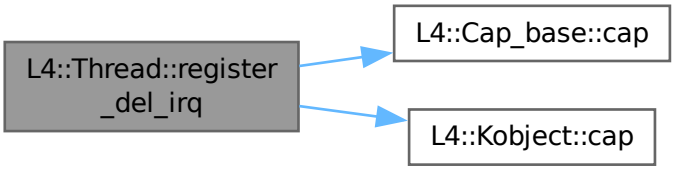
When the deletion event is delivered, there is no indication about which IPC gate was deleted.

See also

l4_thread_register_del_irq

Definition at line 430 of file thread.
References L4::Cap_base::cap(), and L4::Kobject::cap().

Here is the call graph for this function:



15.190.2.11 register_doorbell_irq()

```
l4_msgtag_t L4::Thread::register_doorbell_irq (
            Cap< Irq > irq,
            l4_utcb_t * u = l4_utcb())  [inline], [noexcept]
```

Register an IRQ that will trigger when a forwarded virtual interrupt is pending.

Parameters

irq	Capability index for the IRQ object to be triggered.
u	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

System call return tag containing the return code.

Return values

-L4_BUSY	A doorbell IRQ is already bound to this thread.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

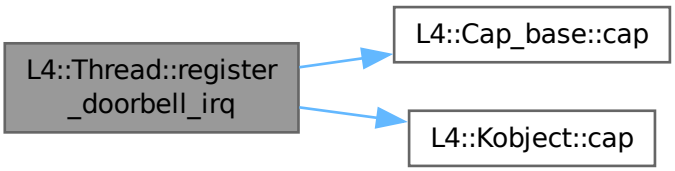
The capability `irq` must have the permission L4_CAP_FPAGE_W.

See Irq::bind_vcpu() for more details about how interrupts can be forwarded directly by the kernel to extended vCPU user mode.
In case the `irq` is already bound to an interrupt source, it is unbound first. When `irq` is deleted, it will be deregistered first. A registered doorbell Irq can only be deregistered by deleting the Irq or the thread.

See also

l4_thread_register_doorbell_irq

Definition at line 556 of file thread.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.12 stats_time()

```
l4_msgtag_t L4::Thread::stats_time (
            l4_kernel_clock_t * us,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Get consumed time of thread in us.

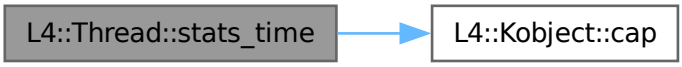
Parameters

out	*us*	Consumed time in µs.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag.

Definition at line 267 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.13 switch_to()

```
l4_msgtag_t L4::Thread::switch_to (
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Switch execution to this thread.

Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Note

The current time slice is inherited to this thread.

Definition at line 256 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.14 vcpu_control()

```
l4_msgtag_t L4::Thread::vcpu_control (
              l4_addr_t vcpu_state,
              l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Enable the vCPU feature for the thread.

Parameters

vcpu_state	A virtual address pointing to a l4_vcpu_state_t. It must be a valid kernel-user-memory address (see L4::Task::add_ku_mem()).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

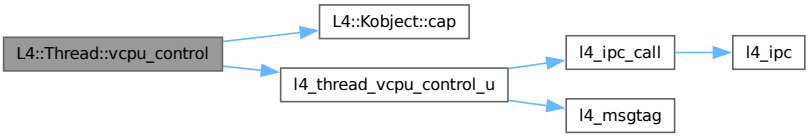
Syscall return tag.

This function enables the vCPU feature of `this` thread
The kernel-user memory starting at `vcpu_state` must be at least 128-byte aligned and must cover the size of l4_vcpu_state_t.
The asynchronous IPC handling is described at vCPU API.

Note

Disabling of the vCPU feature is optional and currently not supported.

Definition at line 361 of file thread.
References L4::Kobject::cap(), and l4_thread_vcpu_control_u().
Here is the call graph for this function:



15.190.2.15 vcpu_control_ext()

```
l4_msgtag_t L4::Thread::vcpu_control_ext (
            l4_addr_t ext_vcpu_state,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Enable the extended vCPU feature for the thread.

Parameters

ext_vcpu_state	The virtual address where the kernel shall store the vCPU state in case of vCPU exits. The address must be a valid kernel-user-memory address (see L4::Task::add_ku_mem()).
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag.

The extended vCPU feature allows the use of hardware-virtualization features such as Intel's VT-x (VMX) or AMD's AMD-V (SVM).
This function enables the extended vCPU feature of `this` thread. Enabling the extended vCPU feature also enables the vCPU feature.
The kernel-user memory area starting at `ext_vcpu_state` must be at least 4 KiB aligned and must cover a size of L4_PAGESIZE. It includes the data of l4_vcpu_state_t at offset 0, the extended vCPU state at offset L4_VCPU↩_OFFSET_EXT_STATE, and, on some platforms, the extended vCPU information at offset L4_VCPU_OFFSET_↩EXT_INFOS.
On Intel's VT-x (VMX), the extended vCPU state is l4_vm_vmx_vcpu_vmcs_t and the extended vCPU information is l4_vm_vmx_vcpu_infos_t. Furthermore, the extended vCPU state needs to be associated with a vCPU context (see l4_vm_vmx_set_hw_vmcs()).
On AMD's AMD-V (SVM), the extended vCPU state is l4_vm_svm_vmcb_t.

Note

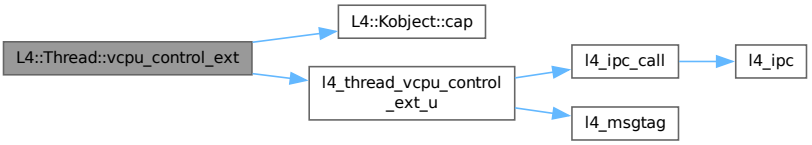
Enabling the extended vCPU feature for a thread running on a different CPU core is currently not supported.

Disabling of the extended vCPU feature is currently not supported.

Upgrading from non-extended vCPU feature to extended vCPU feature is currently not supported.

Definition at line 401 of file thread.
References L4::Kobject::cap(), and l4_thread_vcpu_control_ext_u().

Here is the call graph for this function:



15.190.2.16 vcpu_resume_commit()

```
l4_msgtag_t L4::Thread::vcpu_resume_commit (
             l4_msgtag_t tag,
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Resume from vCPU asynchronous IPC handler, commit.

Parameters

tag	Tag to use, returned by l4_thread_vcpu_resume_start().
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag containing one of the following return codes.

Return values

0	Indicates a VM exit, provided that `thread` is in extended vCPU mode with virtual interrupts cleared.
1	Indicates an incoming IPC message, provided that the `thread` is in extended vCPU mode with virtual interrupts cleared.
-L4_EPERM	The user task capability set in the vCPU state is missing the L4_CAP_FPAGE_S right. On Intel's VT-x (VMX): The vCPU context capability set in the extended vCPU state is missing the L4_CAP_FPAGE_S right.
-L4_ENOENT	The user task capability set in the vCPU state is invalid.
-L4_EINVAL	`thread` is not the current running thread, or does not have the vCPU feature enabled. On Intel's VT-x (VMX): No vCPU context associated with the extended vCPU state.
-L4_EBUSY	On Intel's VT-x (VMX): The vCPU context associated with the extended vCPU state is already active on a different CPU.
-L4_ENODEV	On Intel's VT-x (VMX): The vCPU context associated with the extended vCPU state cannot be initialized or activated.
<0	A supplied mapping failed.

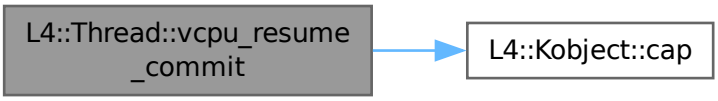
All flexpages in the UTCB (added with l4_sndfpage_add() after l4_thread_vcpu_resume_start()) are unconditionally mapped into the user task configured in the vCPU state.
To resume into another address space, the capability to the target Task (or L4::Vm) must be set in l4_vcpu_state_t::user_task together with L4_VCPU_F_USER_MODE. The capability selector must have all lower bits clear (see L4_CAP_MASK). The kernel adds the L4_SYSF_SEND flag there to indicate that the capability has been referenced in the kernel. Consecutive resumes will not reference the task capability again until all

lower bits are cleared again. To release a task use a different task capability or use an invalid capability with the L4_SYSF_REPLY flag set.
The asynchronous IPC handling is described at vCPU API.

See also

l4_thread_vcpu_resume_commit

Definition at line 337 of file thread.
References L4::Kobject::cap().
Here is the call graph for this function:



15.190.2.17 vcpu_resume_start()

```
l4_msgtag_t L4::Thread::vcpu_resume_start (
             l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Resume from vCPU asynchronous IPC handler, start.

Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Message tag to be used for l4_sndfpage_add() and l4_thread_vcpu_resume_commit()

The vCPU resume functionality is split in multiple functions to allow the specification of additional send-flexpages using l4_sndfpage_add().
The asynchronous IPC handling is described at vCPU API.

See also

l4_thread_vcpu_resume_start

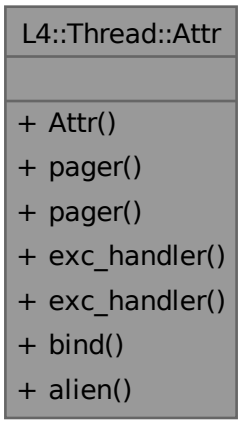
Definition at line 286 of file thread.
The documentation for this class was generated from the following file:

- l4/sys/thread

15.191 L4::Thread::Attr Class Reference

Thread attributes used for control().
`#include <thread>`

Collaboration diagram for L4::Thread::Attr:



Public Member Functions

- Attr (l4_utcb_t *utcb=l4_utcb()) noexcept
  Create a thread-attribute object with the given UTCB.
- void pager (Cap< void > const &pager) noexcept
  Set the pager capability index.
- Cap< void > pager () noexcept
  Get the capability index used for page-fault messages.
- void exc_handler (Cap< void > const &exc_handler) noexcept
  Set the exception-handler capability index.
- Cap< void > exc_handler () noexcept
  Get the capability index used for exception messages.
- void bind (l4_utcb_t *thread_utcb, Cap< Task > const &task) noexcept
  Bind the thread to a task.
- void alien (int on) noexcept
  Enable alien mode.

Friends

- class **L4::Thread**

15.191.1 Detailed Description

Thread attributes used for control().
This class is responsible for initializing various attributes of a thread in a UTCB for the control() method.

Note

Instantiation of this class starts the preparation of the UTCB. Do not invoke any non-Attr functions between the instantiation and the call to L4::Thread::control().

See also

Thread control for some more details.

Definition at line 137 of file thread.

15.191.2 Constructor & Destructor Documentation

15.191.2.1 Attr()

```
L4::Thread::Attr::Attr (
            l4_utcb_t * utcb = l4_utcb())  [inline], [explicit], [noexcept]
```

Create a thread-attribute object with the given UTCB.

Parameters

utcb	The UTCB to use for the later L4::Thread::control() function. Usually this is the UTCB of the calling thread. See l4_utcb().

Definition at line 151 of file thread.

15.191.3 Member Function Documentation

15.191.3.1 alien()

```
void L4::Thread::Attr::alien (
            int on)  [inline], [noexcept]
```

Enable alien mode.

Parameters

on	Boolean value defining the state of the feature.

For a thread in alien mode the kernel produces just an exception IPC for each IPC and exception caused by the alien thread instead of handling these events regularly. (Page faults of alien threads and interrupts occurring while the alien thread is running are always handled regularly.) While the alien thread is blocking, the exception handler can inspect and modify the state of the alien thread and potentially also the system call arguments. If the exception handler replies with L4_PROTO_ALLOW_SYSCALL as message tag, the kernel handles the next IPC or exception of the alien thread in a regular way. If the exception handler leaves certain thread state unchanged (in particular the instruction pointer), this will be the IPC or exception that caused the call of the exception handler. For a regularly processed IPC or exception of the alien thread the kernel also performs an exception IPC on kernel exit.
This feature can be used to attach a debugger to a thread and trace all object invocations and their results. It could also be used to handle other systems that use the same syscall instruction as L4Re.
Definition at line 227 of file thread.

15.191.3.2 bind()

```
void L4::Thread::Attr::bind (
            l4_utcb_t * thread_utcb,
            Cap< Task > const & task)  [inline], [noexcept]
```

Bind the thread to a task.

Parameters

thread_utcb	The thread's UTCB address within the task it shall be bound to. The address must be aligned (architecture dependent; at least word aligned) and it must point to at least L4_UTCB_OFFSET bytes of kernel-user memory.
task	The task the thread shall be bound to.

Precondition

The thread must not be bound to a task yet.

The capability `task` must have the permission L4_CAP_FPAGE_S, otherwise the later call to L4::Thread::control() with this Attr object will fail with L4_EPERM.

A thread may execute code in the context of a task if and only if the thread is bound to the task. To actually start execution, L4::Thread::ex_regs() needs to be used. Execution in the context of the task means that the code has access to all the task's resources (and only those). The executed code itself must be one of those resources. A thread can be bound at most once to a task.

Note

The UTCBs of different threads in the same task should not overlap in order to prevent data corruption.

Definition at line 221 of file thread.

15.191.3.3 exc_handler() [1/2]

```
Cap< void > L4::Thread::Attr::exc_handler ()  [inline], [noexcept]
```

Get the capability index used for exception messages.

Returns

The capability index used to send exception messages. At this capability index, there is a capability present in the task the thread is bound to.

Definition at line 192 of file thread.

15.191.3.4 exc_handler() [2/2]

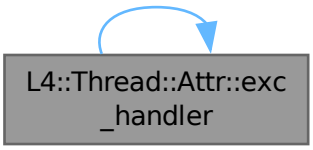
```
void L4::Thread::Attr::exc_handler (
            Cap< void > const & exc_handler)  [inline], [noexcept]
```

Set the exception-handler capability index.

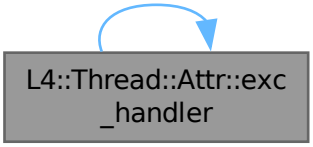
Parameters

exc_handler	The capability index that shall be used for exception messages. At this capability index, a capability must be present within the task the thread is bound to.

Definition at line 182 of file thread.
References exc_handler().
Referenced by exc_handler().
Here is the call graph for this function:



Here is the caller graph for this function:



15.191.3.5 pager() [1/2]

`Cap< void > L4::Thread::Attr::pager () [inline], [noexcept]`
Get the capability index used for page-fault messages.

Returns

The capability index used to send page-fault messages. At this capability index, there is a capability present in the task the thread is bound to.

Definition at line 171 of file thread.

15.191.3.6 pager() [2/2]

```
void L4::Thread::Attr::pager (
            Cap< void > const & pager) [inline], [noexcept]
```
Set the pager capability index.

Parameters

pager	The capability index that shall be used for page-fault messages. At this capability index, a capability must be present within the task the thread is bound to.

Definition at line 161 of file thread.
References pager().
Referenced by pager().
Here is the call graph for this function:



Here is the caller graph for this function:

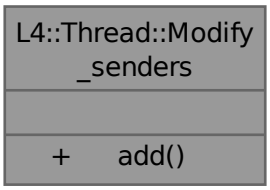


The documentation for this class was generated from the following file:

- l4/sys/thread

15.192 L4::Thread::Modify_senders Class Reference

Class wrapping a list of rules which modify the sender label of IPC messages inbound to this thread.
`#include <thread>`
Collaboration diagram for L4::Thread::Modify_senders:



Public Member Functions

- int add (l4_umword_t match_mask, l4_umword_t match, l4_umword_t del_bits, l4_umword_t add_bits) noexcept

  Add a rule.

15.192.1 Detailed Description

Class wrapping a list of rules which modify the sender label of IPC messages inbound to this thread.
Use the add() function to add modification rules, and use modify_senders() to commit. Do not use the UTCB in between as it is used by add() and modify_senders().
This mechanism shall be used to change the source object labels of every pending IPC of an IPC gate or an IRQ if the labels in such pending IPC become invalid for the receiving thread, potentially because:

- an IPC gate / IRQ was unbound from a thread, or
- an IPC gate / IRQ was removed, or
- the label of an IPC gate / IRQ bound to a thread was changed.

It is not required to perform the modify_sender mechanism after an IPC gate or an IRQ was bound to a thread for the first time.
Definition at line 451 of file thread.

15.192.2 Member Function Documentation

15.192.2.1 add()

```
int L4::Thread::Modify_senders::add (
             l4_umword_t match_mask,
             l4_umword_t match,
             l4_umword_t del_bits,
             l4_umword_t add_bits)  [inline], [noexcept]
```

Add a rule.

Parameters

match_mask	Bitmask of bits to match the label.
match	Bitmask that must be equal to the label after applying match_mask.
del_bits	Bits to be deleted from the label.
add_bits	Bits to be added to the label.

Returns

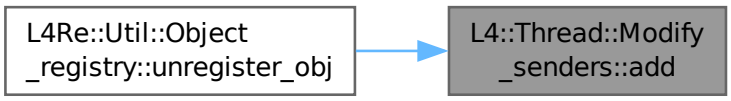
0 on success, <0 on error

In pseudo code: if ((sender_label & match_mask) == match) { sender_label = (sender_label & ~del_bits) | add_bits; }
Only the first match is applied.

See also

l4_thread_modify_sender_add()

Definition at line 484 of file thread.
References L4_ENOMEM, and l4_msg_regs_t::mr.
Referenced by L4Re::Util::Object_registry::unregister_obj().
Here is the caller graph for this function:



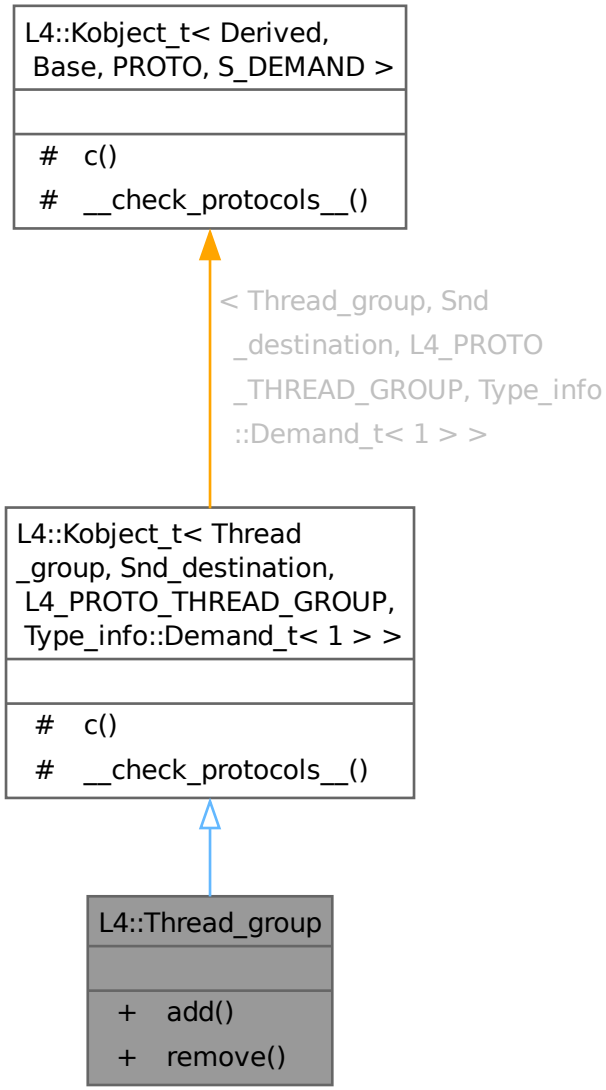
The documentation for this class was generated from the following file:

- l4/sys/thread

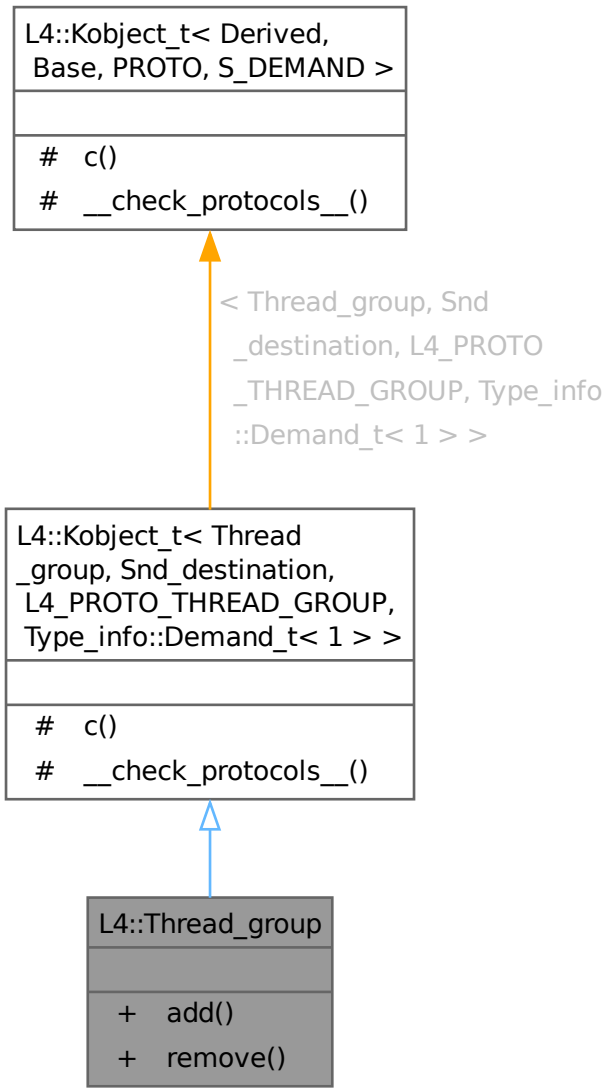
15.193 L4::Thread_group Class Reference

C++ L4 kernel thread group interface, see Thread groups for the C interface.
`#include <thread_group>`

Inheritance diagram for L4::Thread_group:



Collaboration diagram for L4::Thread_group:



Public Member Functions

- l4_msgtag_t add (Cap< Thread > thread, l4_utcb_t *utcb=l4_utcb()) noexcept

  Add thread to a thread group.
- l4_msgtag_t remove (Cap< Thread > thread, l4_utcb_t *utcb=l4_utcb()) noexcept

  Remove thread from a thread group.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Thread_group, Snd_destination, L4_PROTO_THREAD_GROUP, Type_info::Demand_t<

- typedef Thread_group **Class**

  The target interface type (inheriting from Kobject_t).

- typedef Typeid::Iface< PROTO, Thread_group > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Snd_destination::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Thread_group, Snd_destination, L4_PROTO_THREAD_GROUP, Type_info::Demand_t<

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Thread_group, Snd_destination, L4_PROTO_THREAD_GROUP, Type_info::Demand_t<

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.193.1 Detailed Description

C++ L4 kernel thread group interface, see Thread groups for the C interface.
An L4 thread group is a collection of threads used as indirection for IPC gate and IRQ objects such that these objects can have multiple receivers, from which the kernel selects one according to a policy.
The primary use case for thread groups are multi-threaded servers and CPU core local IRQ / IPC delivery.
A thread can be bound to at most one thread group. Before binding a thread to a thread group, the thread must be bound to a task. All threads bound to the same thread group must belong to the same task.
Definition at line 34 of file thread_group.

15.193.2 Member Function Documentation

15.193.2.1 add()

```
l4_msgtag_t L4::Thread_group::add (
            Cap< Thread > thread,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Add thread to a thread group.

Parameters

thread	Thread to add to the thread group.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

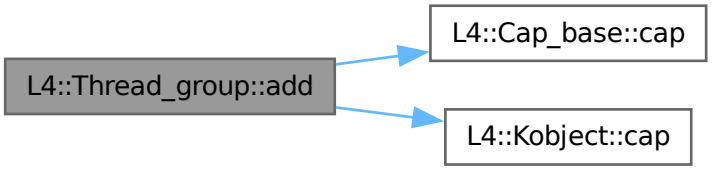
Syscall return tag containing one of the following return codes.

Return values

L4_EOK	No error occurred.
-L4_EINVAL	`thread` is not a thread object.
-L4_EEXIST	`thread` already bound to this thread group.
-L4_EBUSY	`thread` already bound to a different thread group.

-L4_ENOENT	Thread group doesn't exist.

Definition at line 53 of file thread_group.
References L4::Cap_base::cap(), and L4::Kobject::cap().
Here is the call graph for this function:



15.193.2.2 remove()

```
l4_msgtag_t L4::Thread_group::remove (
            Cap< Thread > thread,
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Remove thread from a thread group.

Parameters

thread	Thread to remove from the thread group.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

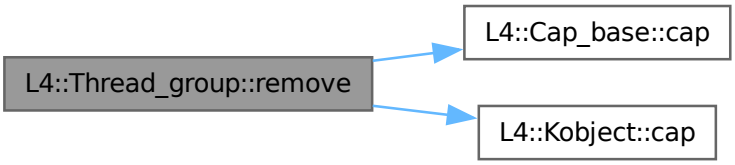
Syscall return tag containing one of the following return codes.

Return values

L4_EOK	No error occurred.
-L4_EINVAL	`thread` is not a thread object.

Definition at line 67 of file thread_group.
References L4::Cap_base::cap(), and L4::Kobject::cap().

Here is the call graph for this function:



The documentation for this class was generated from the following file:

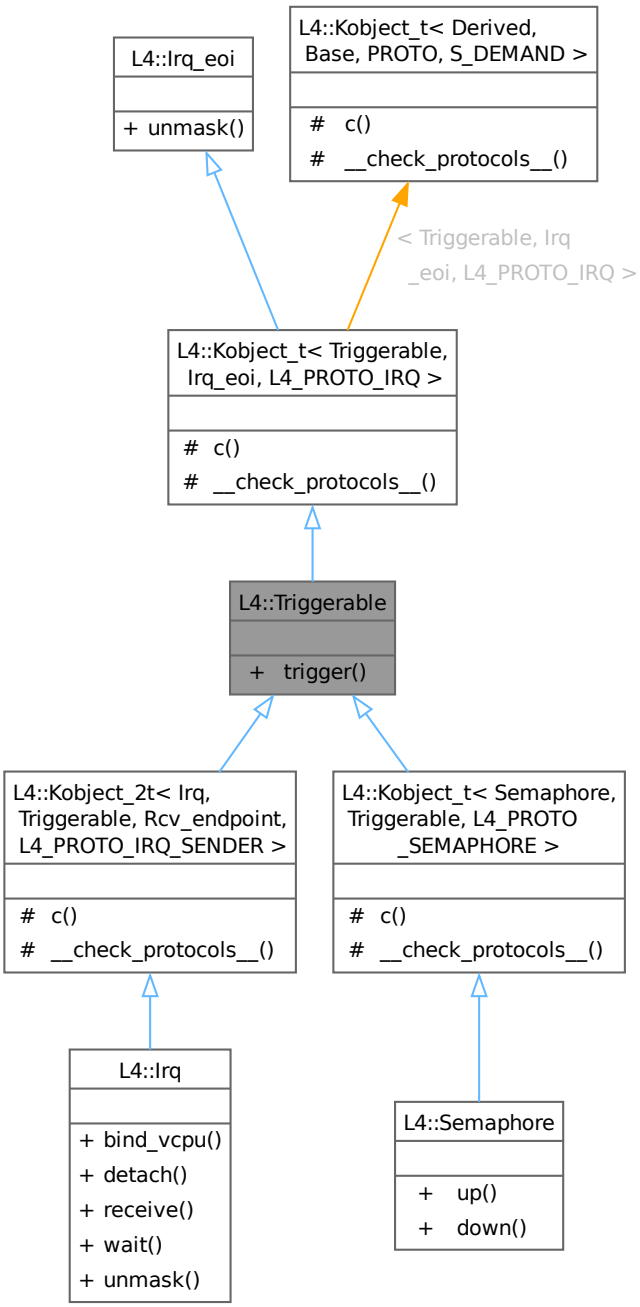
- l4/sys/thread_group

15.194 L4::Triggerable Struct Reference

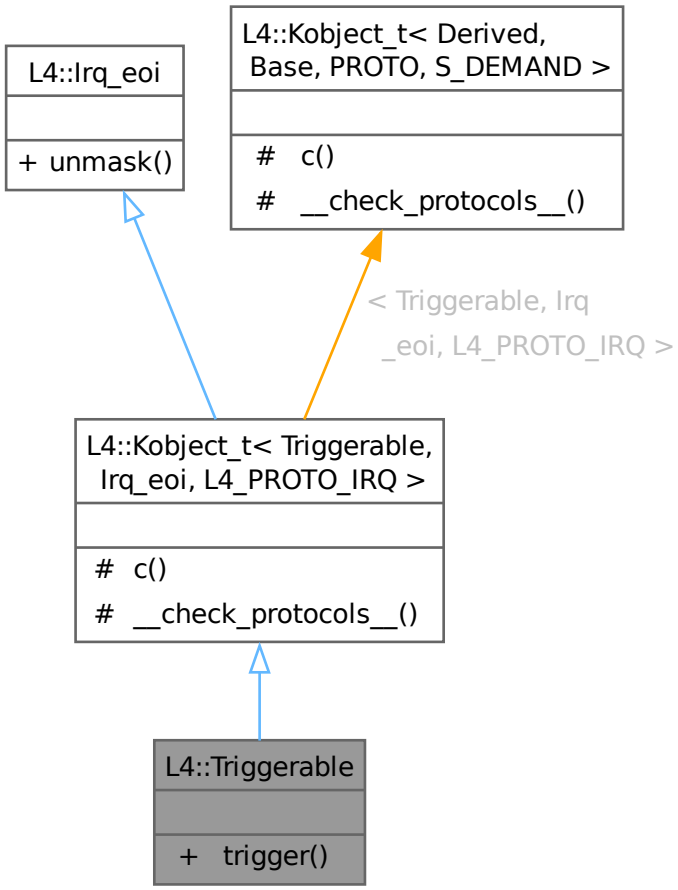
Interface that allows an object to be triggered by some source.

`#include <irq>`

Inheritance diagram for L4::Triggerable:



Collaboration diagram for L4::Triggerable:



Public Member Functions

- l4_msgtag_t trigger (l4_utcb_t *utcb=l4_utcb()) noexcept

  Trigger the object.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- typedef Triggerable **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Triggerable > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Triggerable, Irq_eoi, L4_PROTO_IRQ >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.194.1 Detailed Description

Interface that allows an object to be triggered by some source.
The interface specifies no semantics for the trigger operation, this is defined by derived objects.
This interface is usually used in conjunction with L4::Icu.
Definition at line 79 of file irq.

15.194.2 Member Function Documentation

15.194.2.1 trigger()

```
l4_msgtag_t L4::Triggerable::trigger (
            l4_utcb_t * utcb = l4_utcb())  [inline], [noexcept]
```

Trigger the object.

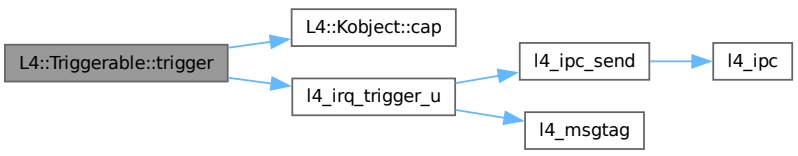
Parameters

utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

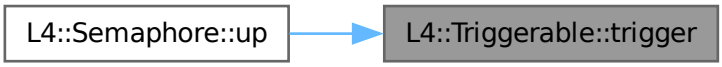
Returns

Syscall return tag for a send-only operation, this means there is no return value except L4_MSGTAG_ERROR indicating success or failure of the send operation. Use l4_ipc_error() to check for errors and **do not** use l4_error().

Definition at line 91 of file irq.
References L4::Kobject::cap(), and l4_irq_trigger_u().
Referenced by L4::Semaphore::up().
Here is the call graph for this function:



Here is the caller graph for this function:

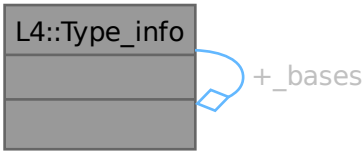


The documentation for this struct was generated from the following file:

- l4/sys/irq

15.195 L4::Type_info Struct Reference

Dynamic Type Information for L4Re Interfaces.
`#include <l4/sys/capability>`
Collaboration diagram for L4::Type_info:



Data Structures

- class Demand

  Data type for expressing the needed receive buffers at the server-side of an interface.
- struct Demand_t

  Template type statically describing demand of receive buffers.
- struct Demand_union_t

  Template type statically describing the combination of two Demand object.

15.195.1 Detailed Description

Dynamic Type Information for L4Re Interfaces.
This class represents the runtime-dynamic type information for L4Re interfaces, and is not intended to be used directly by applications.

Note

The interface of is subject to changes.

The main use for this info is to be used by the implementation of the L4::cap_dynamic_cast() function.
Definition at line 499 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

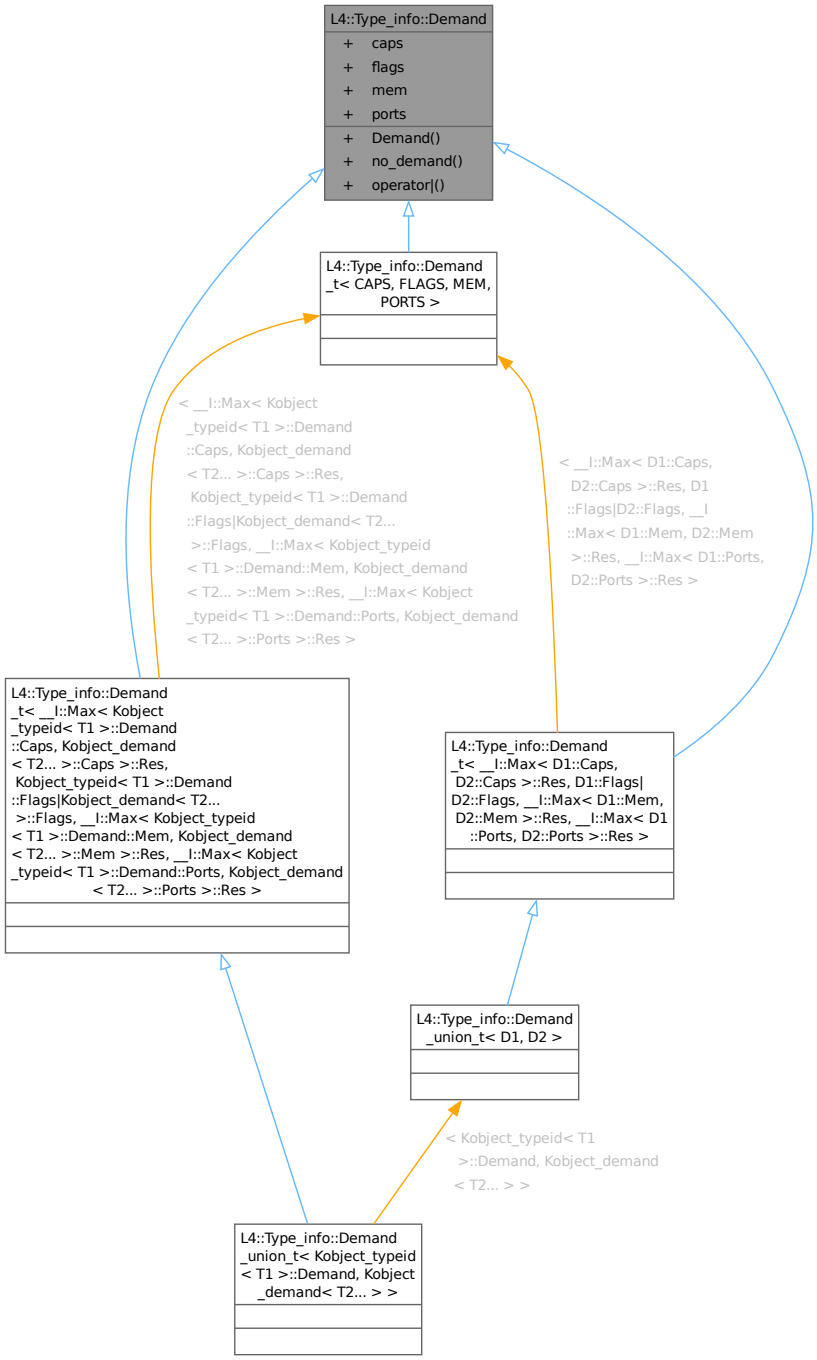
- l4/sys/__typeinfo.h

15.196 L4::Type_info::Demand Class Reference

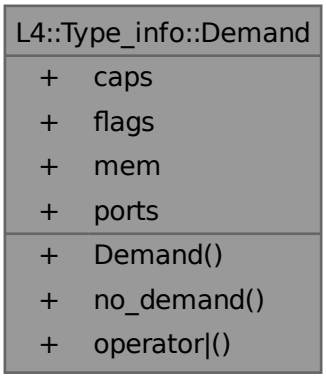
Data type for expressing the needed receive buffers at the server-side of an interface.

`#include <l4/sys/capability>`

Inheritance diagram for L4::Type_info::Demand:



Collaboration diagram for L4::Type_info::Demand:



Public Member Functions

- Demand (unsigned char caps=0, unsigned char flags=0, unsigned char mem=0, unsigned char ports=0) noexcept

  Make Demand object.
- bool no_demand () const noexcept
- Demand **operator|** (Demand const &rhs) const noexcept

  get the combined demand of this and rhs

Data Fields

- unsigned char **caps**

  number of capability receive buffers.
- unsigned char **flags**

  flags, such as the need for timeouts (TBD).
- unsigned char **mem**

  size (2^mem bytes) of memory receive buffer.
- unsigned char **ports**

  number of IO-port receive buffers.

15.196.1 Detailed Description

Data type for expressing the needed receive buffers at the server-side of an interface.
Definition at line 506 of file __typeinfo.h.

15.196.2 Constructor & Destructor Documentation

15.196.2.1 Demand()

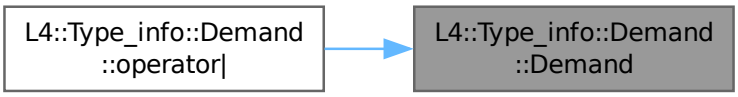
```
L4::Type_info::Demand::Demand (
            unsigned char caps = 0,
            unsigned char flags = 0,
            unsigned char mem = 0,
            unsigned char ports = 0)  [inline], [explicit], [noexcept]
```

Make Demand object.

Parameters

caps	number of capability receive buffers
flags	flags, such as the need for timeouts (TBD).
mem	size (2^mem bytes) of memory receive window.
ports	number of IO-port receive windows.

Definition at line 527 of file __typeinfo.h.
References caps, flags, mem, and ports.
Referenced by operator|().
Here is the caller graph for this function:



15.196.3 Member Function Documentation

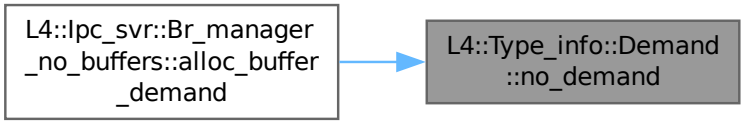
15.196.3.1 no_demand()

```
bool L4::Type_info::Demand::no_demand () const  [inline], [noexcept]
```

Returns

true if there is no demand at all

Definition at line 532 of file __typeinfo.h.
References caps, flags, mem, and ports.
Referenced by L4::Ipc_svr::Br_manager_no_buffers::alloc_buffer_demand().
Here is the caller graph for this function:



The documentation for this class was generated from the following file:

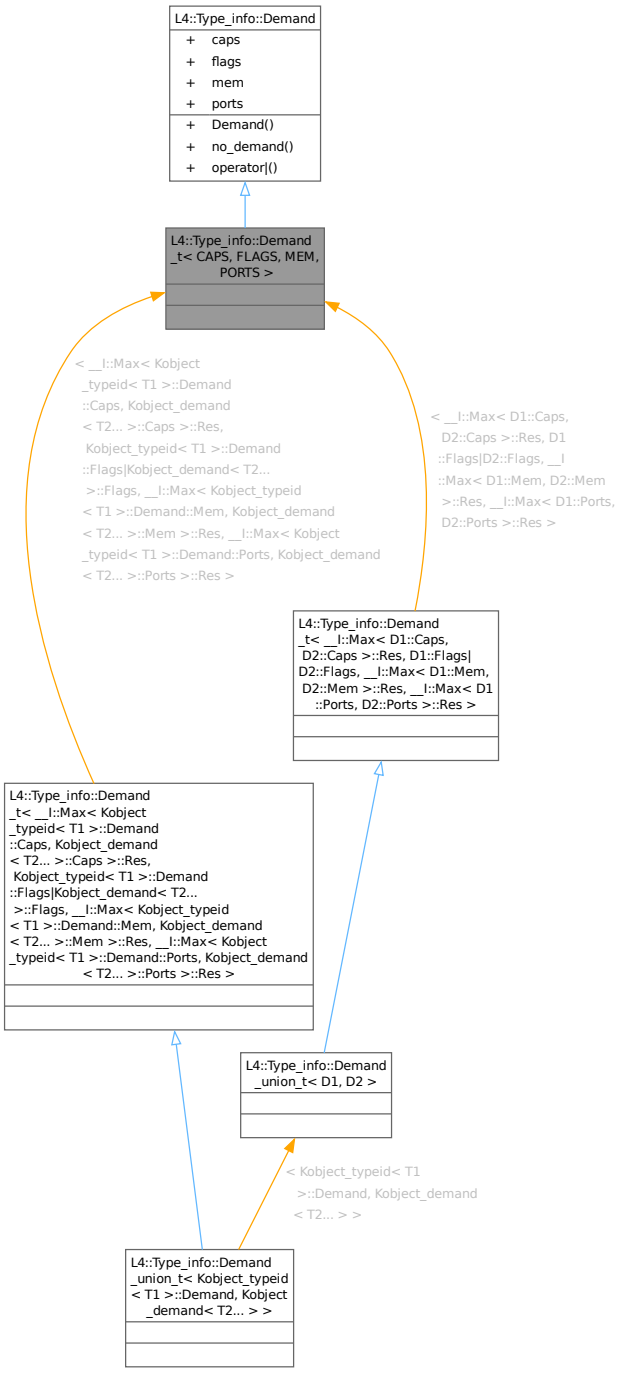
- l4/sys/__typeinfo.h

15.197 L4::Type_info::Demand_t< CAPS, FLAGS, MEM, PORTS > Struct Template Reference

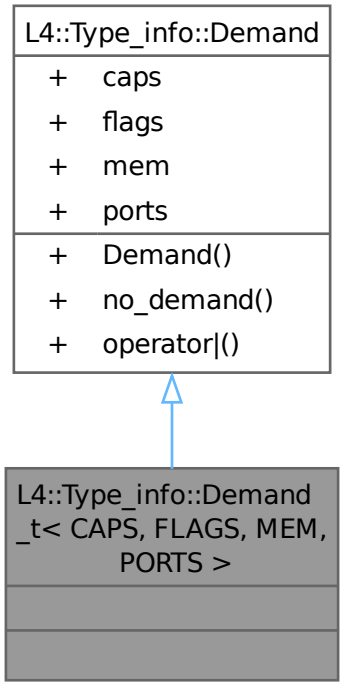
Template type statically describing demand of receive buffers.

#include <l4/sys/capability>

Inheritance diagram for L4::Type_info::Demand_t< CAPS, FLAGS, MEM, PORTS >:



Collaboration diagram for L4::Type_info::Demand_t< CAPS, FLAGS, MEM, PORTS >:



Public Types

- enum { Caps = CAPS , Flags = FLAGS , Mem = MEM , Ports = PORTS }

Additional Inherited Members

Public Member Functions inherited from L4::Type_info::Demand

- Demand (unsigned char caps=0, unsigned char flags=0, unsigned char mem=0, unsigned char ports=0) noexcept

  Make Demand object.
- bool no_demand () const noexcept
- Demand **operator|** (Demand const &rhs) const noexcept

  get the combined demand of this and rhs

Data Fields inherited from L4::Type_info::Demand

- unsigned char **caps**

  number of capability receive buffers.
- unsigned char **flags**

  flags, such as the need for timeouts (TBD).
- unsigned char **mem**

  size (2^mem bytes) of memory receive buffer.
- unsigned char **ports**

  number of IO-port receive buffers.

15.197.1 Detailed Description

template<unsigned char CAPS = 0, unsigned char FLAGS = 0, unsigned char MEM = 0, unsigned char PORTS = 0>
struct L4::Type_info::Demand_t< CAPS, FLAGS, MEM, PORTS >

Template type statically describing demand of receive buffers.

Template Parameters

CAPS	number of capability receive buffers needed.
FLAGS	flags, such as the need for timeouts (TBD).
MEM	size (2^MEM bytes) of memory receive window needed.
PORTS	number of IO-port receive windwows needed.

Definition at line 553 of file __typeinfo.h.

15.197.2 Member Enumeration Documentation

15.197.2.1 anonymous enum

```
template<unsigned char CAPS = 0, unsigned char FLAGS = 0, unsigned char MEM = 0, unsigned char
PORTS = 0>
anonymous enum
```

Enumerator

Caps	number of capability receive buffers.
Flags	flags, such as the need for timeouts.
Mem	size (2^MEM bytes) of memory receive window.
Ports	number of IO-port receive windows.

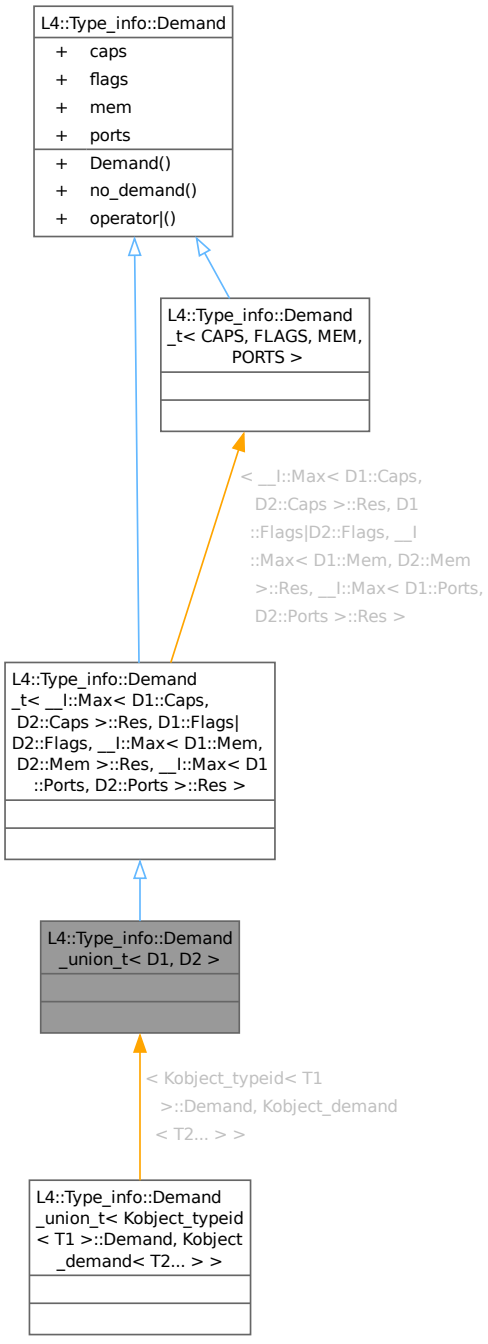
Definition at line 555 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

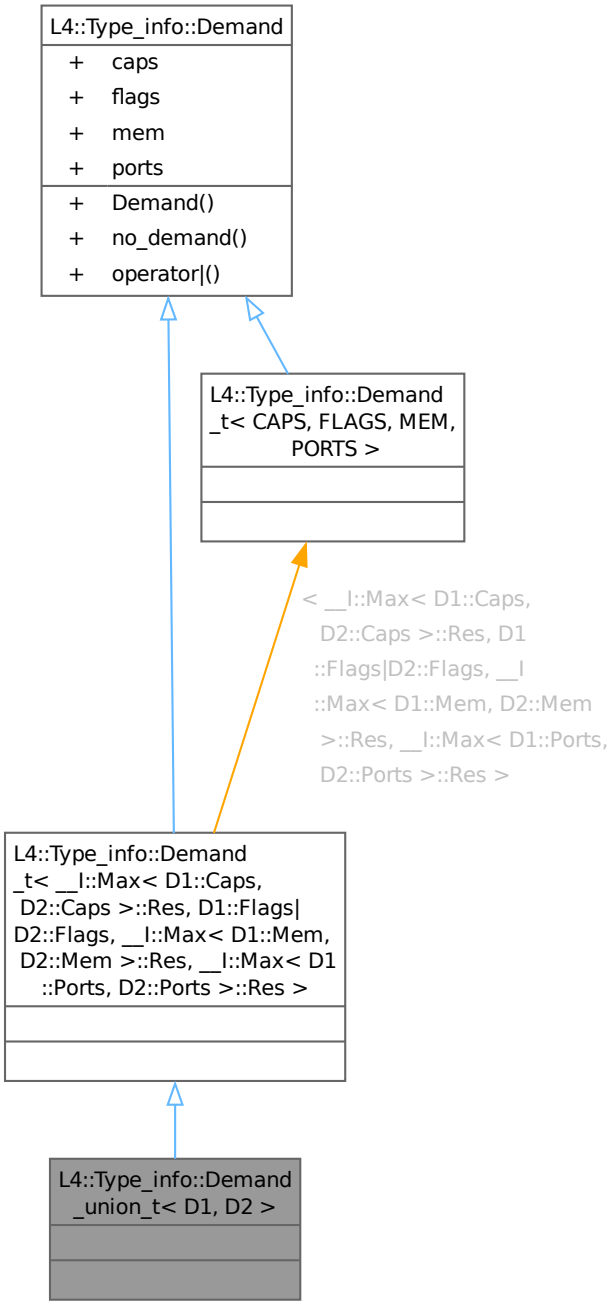
15.198 L4::Type_info::Demand_union_t< D1, D2 > Struct Template Reference

Template type statically describing the combination of two Demand object.
`#include <l4/sys/capability>`

Inheritance diagram for L4::Type_info::Demand_union_t< D1, D2 >:



Collaboration diagram for L4::Type_info::Demand_union_t< D1, D2 >:



Additional Inherited Members

Public Types inherited from L4::Type_info::Demand_t< __I::Max< D1::Caps, D2::Caps >::Res, D1::Flags|D2::Flags, __I::Max< D1::

Public Member Functions inherited from L4::Type_info::Demand

- Demand (unsigned char caps=0, unsigned char flags=0, unsigned char mem=0, unsigned char ports=0) noexcept

Make Demand object.

- bool no_demand () const noexcept
- Demand **operator**| (Demand const &rhs) const noexcept

  get the combined demand of this and rhs

Data Fields inherited from L4::Type_info::Demand

- unsigned char **caps**

  number of capability receive buffers.
- unsigned char **flags**

  flags, such as the need for timeouts (TBD).
- unsigned char **mem**

  size (2^ mem bytes) of memory receive buffer.
- unsigned char **ports**

  number of IO-port receive buffers.

15.198.1 Detailed Description

template<typename D1, typename D2>
struct L4::Type_info::Demand_union_t< D1, D2 >

Template type statically describing the combination of two Demand object.

Template Parameters

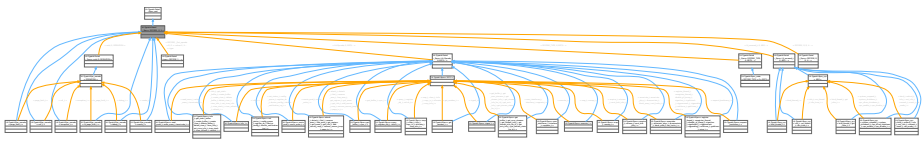
D1	first demand object.
D2	second demand object.

Definition at line 573 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

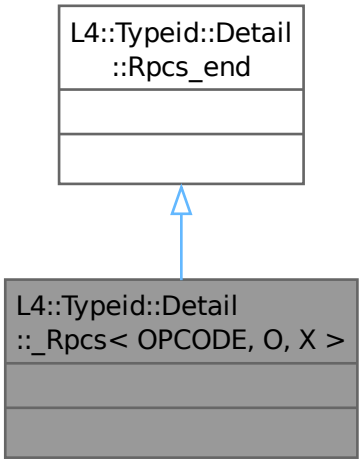
- l4/sys/__typeinfo.h

15.199 L4::Typeid::Detail::_Rpcs< OPCODE, O, X > Struct Template Reference

Empty list of RPCs.
`#include <__typeinfo.h>`
Inheritance diagram for L4::Typeid::Detail::_Rpcs< OPCODE, O, X >:



Collaboration diagram for L4::Typeid::Detail::_Rpcs< OPCODE, O, X >:



15.199.1 Detailed Description

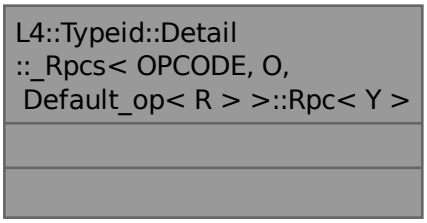
template<typename OPCODE, unsigned O, typename ... X>
struct L4::Typeid::Detail::_Rpcs< OPCODE, O, X >

Empty list of RPCs.
Definition at line 365 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

15.200 L4::Typeid::Detail::_Rpcs< OPCODE, O, Default_op< R > >::Rpc< Y > Struct Template Reference

Find the given RPC in the list.
`#include <__typeinfo.h>`
Collaboration diagram for L4::Typeid::Detail::_Rpcs< OPCODE, O, Default_op< R > >::Rpc< Y >:



15.200.1 Detailed Description

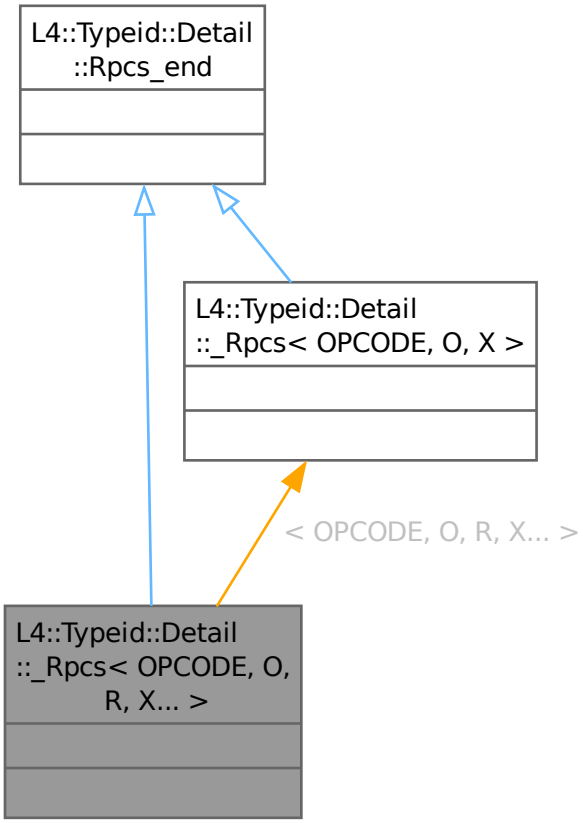
template<typename OPCODE, unsigned O, typename R>
template<typename Y>
struct L4::Typeid::Detail::_Rpcs< OPCODE, O, Default_op< R > >::Rpc< Y >

Find the given RPC in the list.
Definition at line 399 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

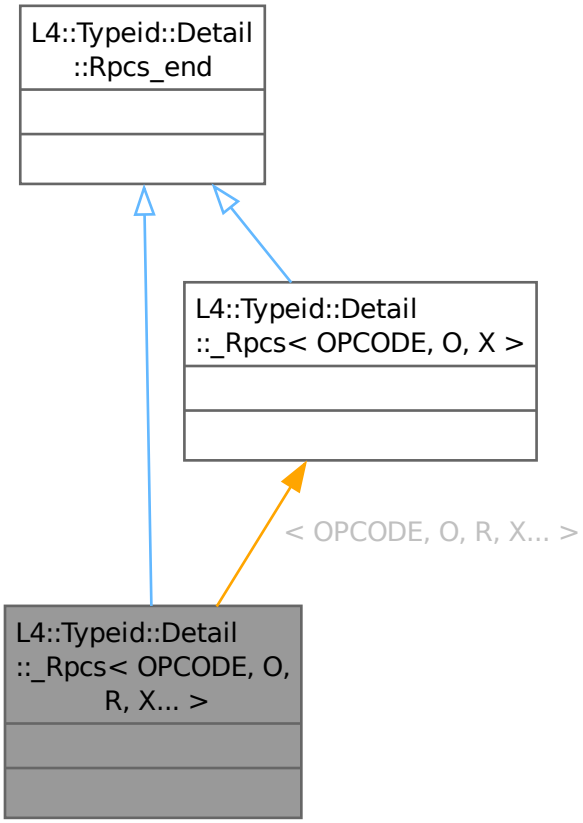
- l4/sys/__typeinfo.h

15.201 L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... > Struct Template Reference

Non-empty list of RPCs.
`#include <__typeinfo.h>`
Inheritance diagram for L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >:



Collaboration diagram for L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >:



Data Structures

- struct Rpc

  Find the given RPC in the list.

Public Types

- enum

  The opcode value to use for this RPC, may be bogus if the opcode_type is void.
- typedef _Rpcs **type**

  The list element itself.
- typedef OPCODE **opcode_type**

  The data type for the opcode.
- typedef R **rpc**

  The RPC type L4::Ipc::Msg::Rpc_call or L4::Ipc::Msg::Rpc_inline_call.
- typedef _Rpcs< OPCODE, _Get_opcode< R, O >::value+1, X... >::type **next**

  The next RPC in the list or Rpcs_end if this is the last.

15.201.1 Detailed Description

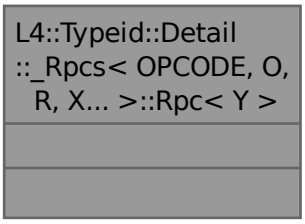
template<typename OPCODE, unsigned O, typename R, typename ... X>
struct L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >

Non-empty list of RPCs.
Definition at line 369 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

15.202 L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >::Rpc< Y > Struct Template Reference

Find the given RPC in the list.
`#include <__typeinfo.h>`
Collaboration diagram for L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >::Rpc< Y >:



15.202.1 Detailed Description

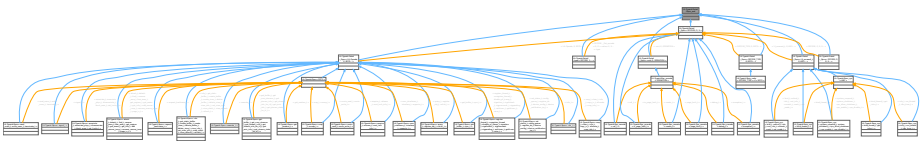
template<typename OPCODE, unsigned O, typename R, typename ... X>
template<typename Y>
struct L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >::Rpc< Y >

Find the given RPC in the list.
Definition at line 382 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

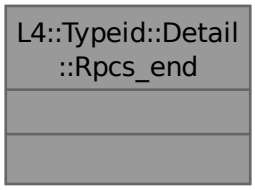
- l4/sys/__typeinfo.h

15.203 L4::Typeid::Detail::Rpcs_end Struct Reference

Internal end-of-list marker.
`#include <__typeinfo.h>`
Inheritance diagram for L4::Typeid::Detail::Rpcs_end:



Collaboration diagram for L4::Typeid::Detail::Rpcs_end:



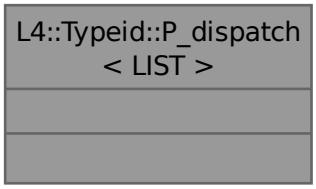
15.203.1 Detailed Description

Internal end-of-list marker.
Definition at line 317 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

15.204 L4::Typeid::P_dispatch< LIST > Struct Template Reference

Use for protocol based dispatch stage.
`#include <__typeinfo.h>`
Collaboration diagram for L4::Typeid::P_dispatch< LIST >:



15.204.1 Detailed Description

template<typename LIST>
struct L4::Typeid::P_dispatch< LIST >

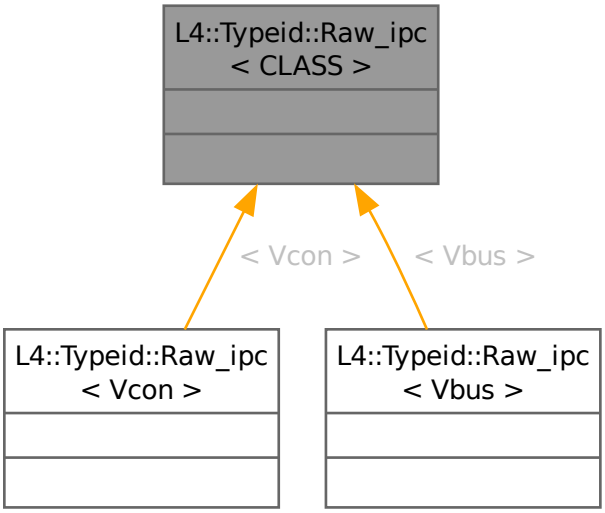
Use for protocol based dispatch stage.
Definition at line 308 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

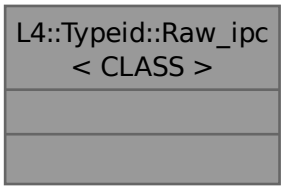
15.205 L4::Typeid::Raw_ipc< CLASS > Struct Template Reference

RPCs list for passing raw incoming IPC to the server object.

`#include <l4/sys/capability>`
Inheritance diagram for L4::Typeid::Raw_ipc< CLASS >:



Collaboration diagram for L4::Typeid::Raw_ipc< CLASS >:



15.205.1 Detailed Description

template<typename CLASS>
struct L4::Typeid::Raw_ipc< CLASS >

RPCs list for passing raw incoming IPC to the server object.

Template Parameters

CLASS	The type of the interface (e.g., L4::Icu)

This template allows to have fully handcrafted IPC protocols.
Definition at line 412 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

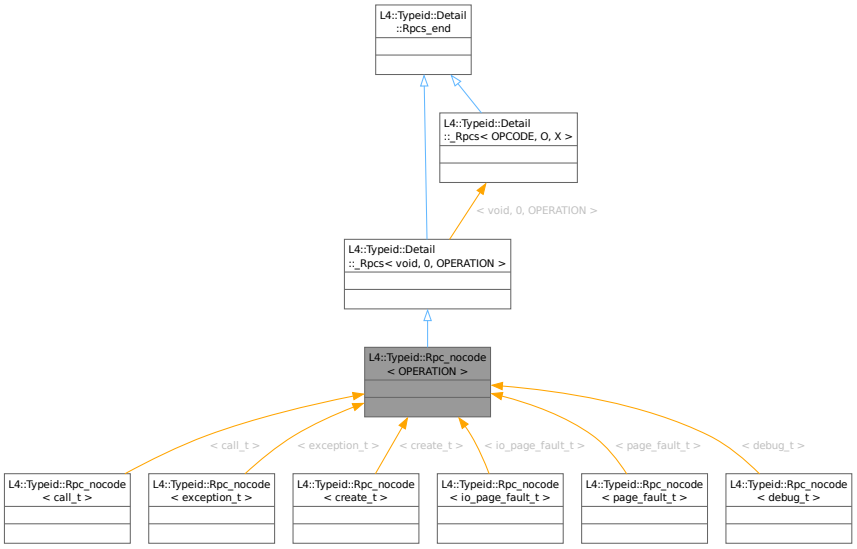
- l4/sys/__typeinfo.h

15.206 L4::Typeid::Rpc_nocode< OPERATION > Struct Template Reference

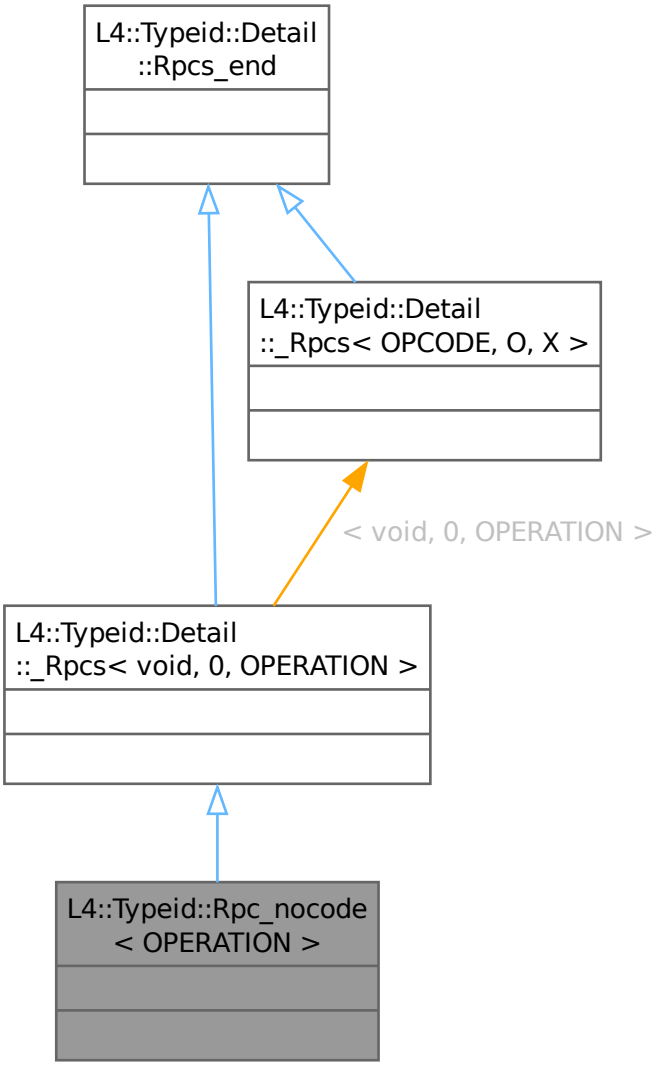
List of RPCs of an interface using a single operation without an opcode.

`#include <l4/sys/capability>`

Inheritance diagram for L4::Typeid::Rpc_nocode< OPERATION >:



Collaboration diagram for L4::Typeid::Rpc_nocode< OPERATION >:



15.206.1 Detailed Description

template<typename OPERATION>
struct L4::Typeid::Rpc_nocode< OPERATION >

List of RPCs of an interface using a single operation without an opcode.

Template Parameters

OPERATION	The RPC operation as defined by L4_RPC etc.

Definition at line 454 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

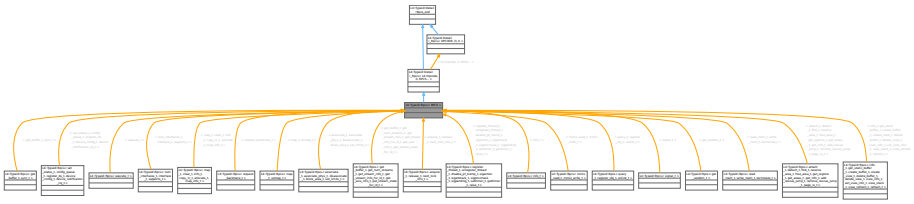
- l4/sys/__typeinfo.h

15.207 L4::Typeid::Rpcs< RPCS > Struct Template Reference

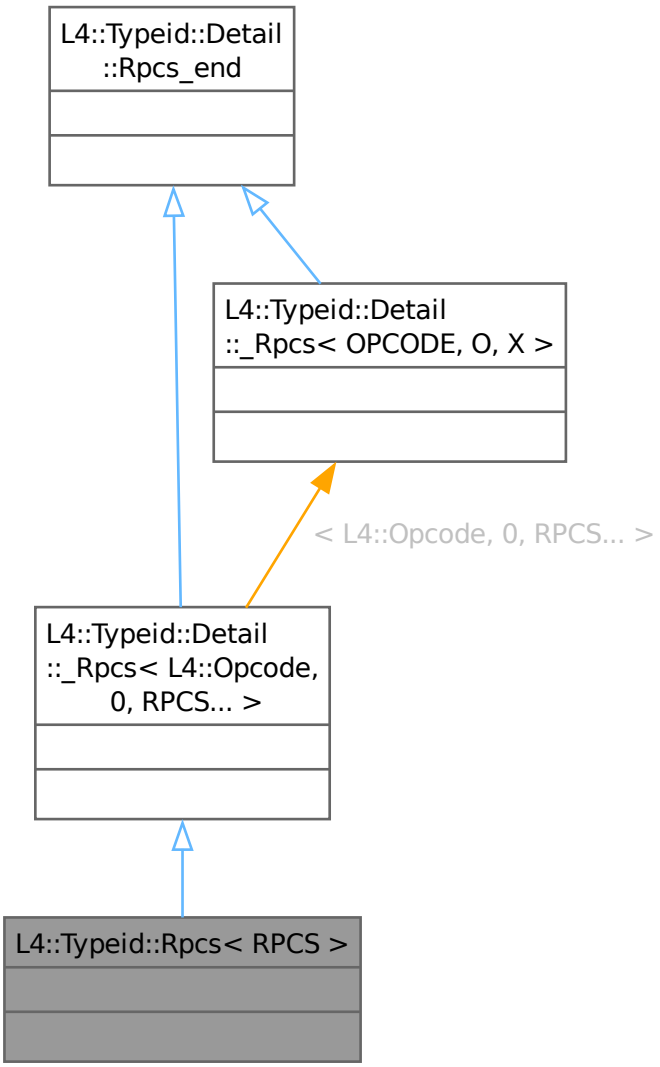
Standard list of RPCs of an interface.

`#include <l4/sys/capability>`

Inheritance diagram for L4::Typeid::Rpcs< RPCS >:



Collaboration diagram for L4::Typeid::Rpcs< RPCS >:



15.207.1 Detailed Description

template<typename ... RPCS>
struct L4::Typeid::Rpcs< RPCS >

Standard list of RPCs of an interface.

Template Parameters

RPCS	list of RPC types as defined by L4_RPC etc.

This is the default list for RPC functions of an interface, it uses L4::Opcode as opcode type and uses opcodes starting from 0.

Examples

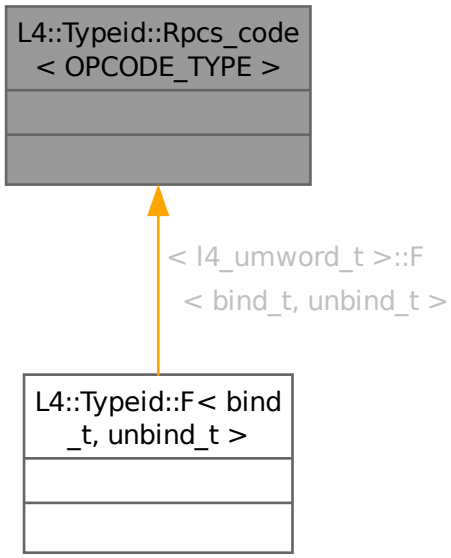
examples/clntsrv/src/shared.h.

Definition at line 428 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

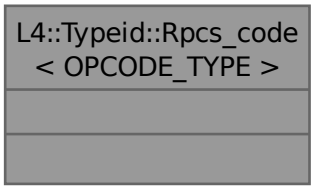
- l4/sys/__typeinfo.h

15.208 L4::Typeid::Rpcs_code< OPCODE_TYPE > Struct Template Reference

List of RPCs of an interface using a special opcode type.
`#include <l4/sys/capability>`
Inheritance diagram for L4::Typeid::Rpcs_code< OPCODE_TYPE >:



Collaboration diagram for L4::Typeid::Rpcs_code< OPCODE_TYPE >:



Data Structures

- struct F

15.208.1 Detailed Description

template<typename OPCODE_TYPE>
struct L4::Typeid::Rpcs_code< OPCODE_TYPE >

List of RPCs of an interface using a special opcode type.

Template Parameters

OPCODE_TYPE	The data type of the opcode.

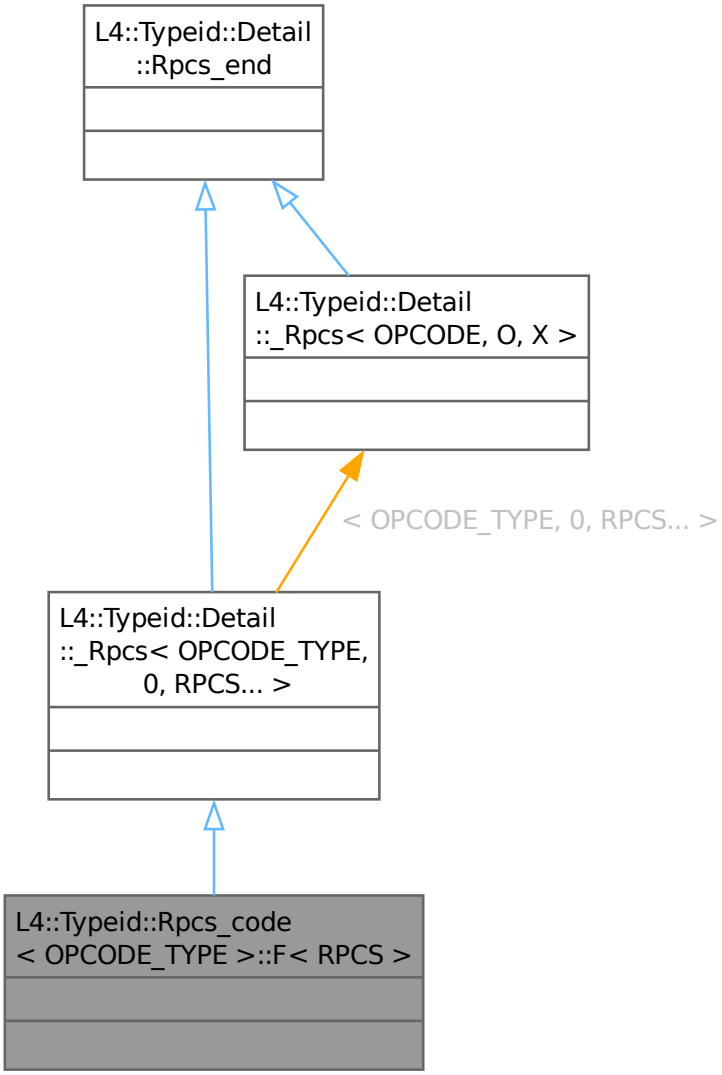
List for RPC functions of an interface, using OPCODE_TYPE as data type for the opcode, opcodes starting from 0.
Definition at line 439 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

- l4/sys/__typeinfo.h

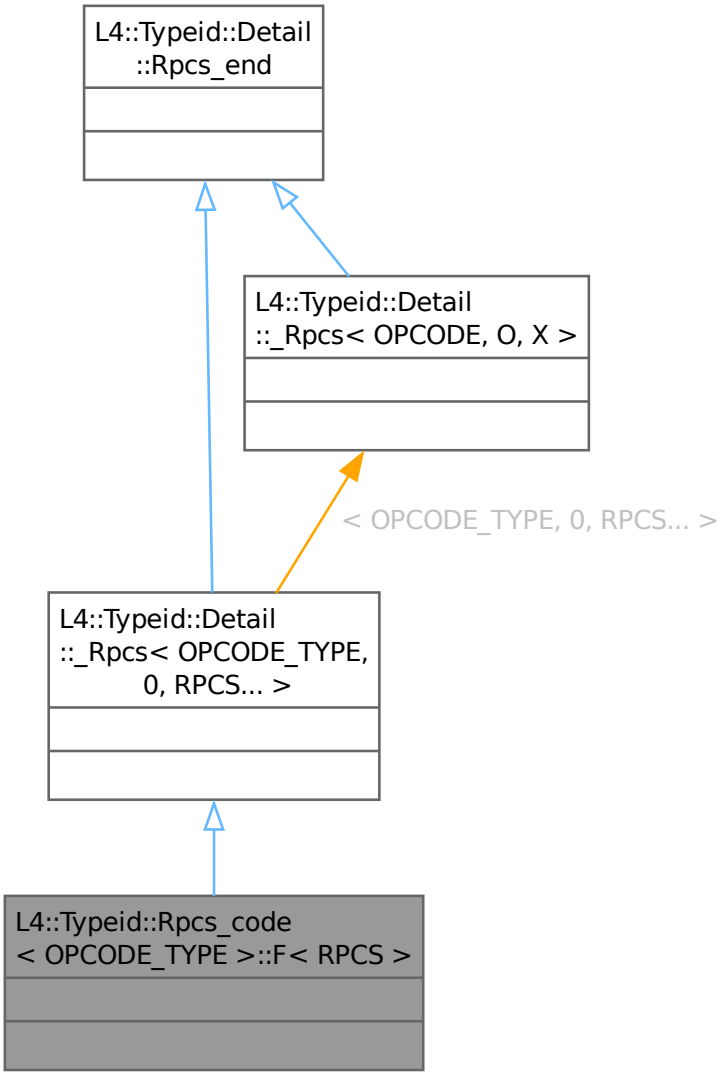
15.209 L4::Typeid::Rpcs_code< OPCODE_TYPE >::F< RPCS > Struct Template Reference

```
#include <__typeinfo.h>
```

Inheritance diagram for L4::Typeid::Rpcs_code< OPCODE_TYPE >::F< RPCS >:



Collaboration diagram for L4::Typeid::Rpcs_code< OPCODE_TYPE >::F< RPCS >:



15.209.1 Detailed Description

template<typename OPCODE_TYPE>
template<typename ... RPCS>
struct L4::Typeid::Rpcs_code< OPCODE_TYPE >::F< RPCS >

Template Parameters

RPCS	list of RPC types as defined by L4_RPC etc.

Definition at line 445 of file __typeinfo.h.
The documentation for this struct was generated from the following file:

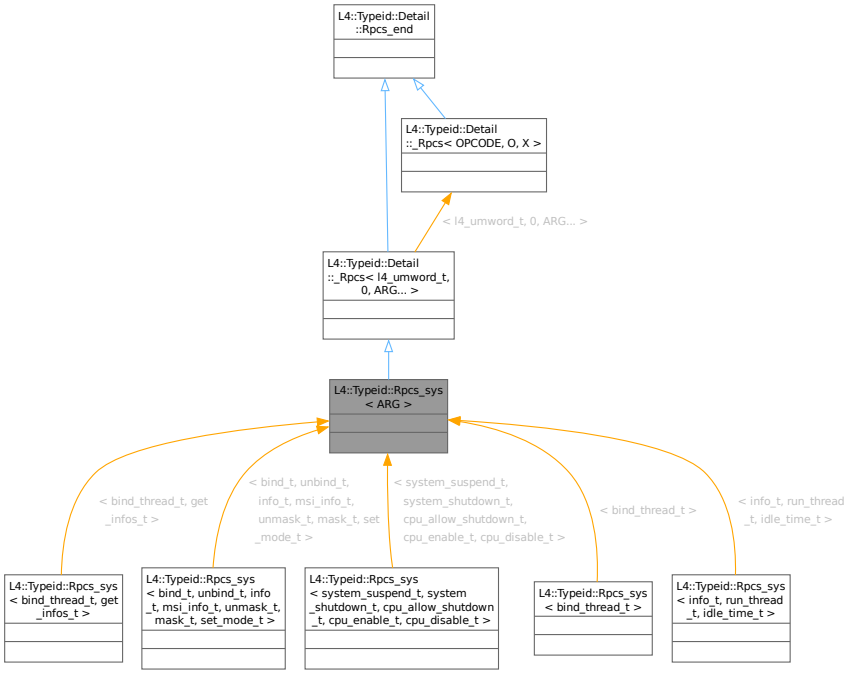
- l4/sys/__typeinfo.h

15.210 L4::Typeid::Rpcs_sys< ARG > Struct Template Reference

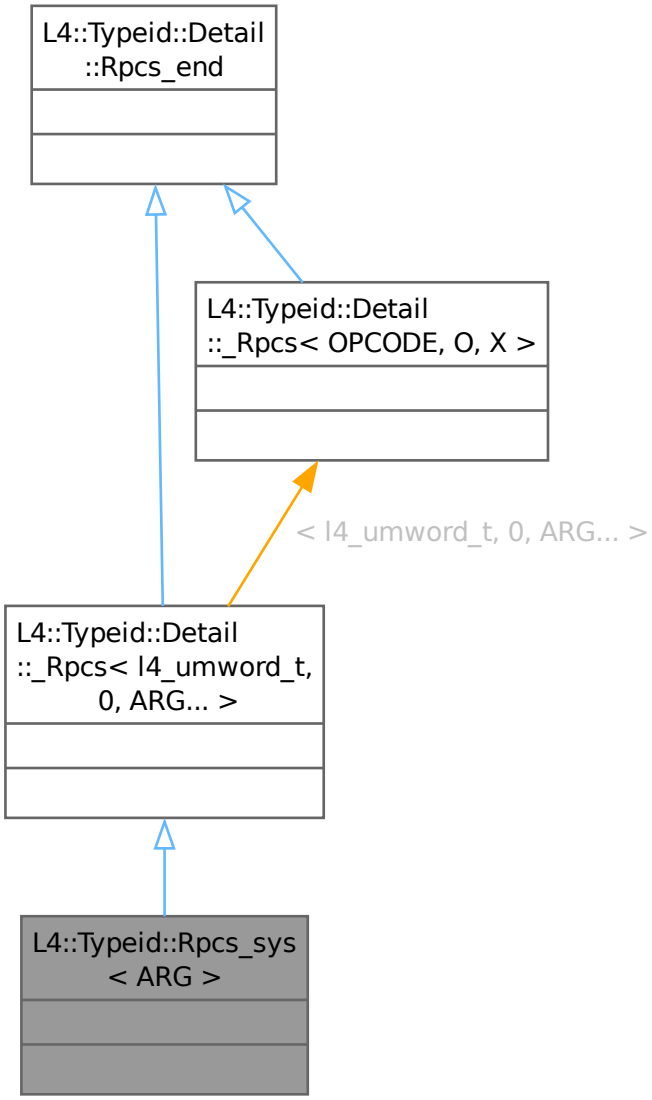
List of RPCs typically used for kernel interfaces.

`#include <l4/sys/capability>`

Inheritance diagram for L4::Typeid::Rpcs_sys< ARG >:



Collaboration diagram for L4::Typeid::Rpcs_sys< ARG >:



15.210.1 Detailed Description

template<typename ... ARG>
struct L4::Typeid::Rpcs_sys< ARG >

List of RPCs typically used for kernel interfaces.

Template Parameters

RPCS	list of RPC types as defined by L4_RPC etc.

This list of RPC functions uses l4_umword_t as type for the opcode as most kernel protocol do.
Definition at line 465 of file __typeinfo.h.

The documentation for this struct was generated from the following file:

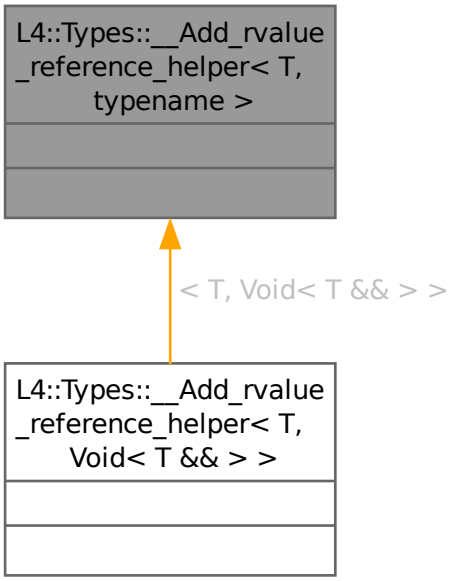
- l4/sys/__typeinfo.h

15.211 L4::Types::__Add_rvalue_reference_helper< T, typename > Struct Template Reference

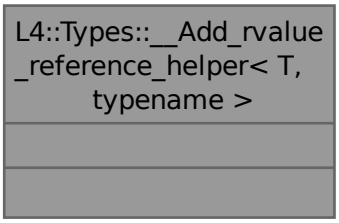
Helper template for Add_rvalue_reference.

`#include <types>`

Inheritance diagram for L4::Types::__Add_rvalue_reference_helper< T, typename >:



Collaboration diagram for L4::Types::__Add_rvalue_reference_helper< T, typename >:



15.211.1 Detailed Description

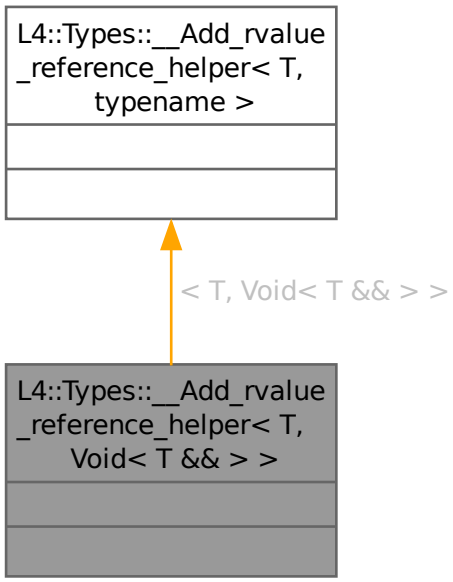
template<typename T, typename = void>
struct L4::Types::__Add_rvalue_reference_helper< T, typename >

Helper template for Add_rvalue_reference.
Definition at line 285 of file types.
The documentation for this struct was generated from the following file:

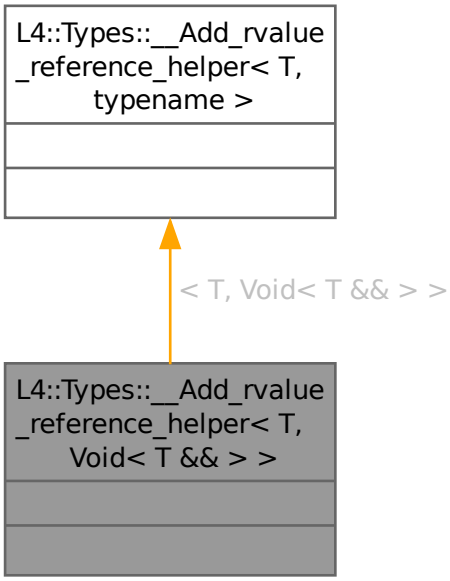
- l4/sys/cxx/types

15.212 L4::Types::__Add_rvalue_reference_helper< T, Void< T && > > Struct Template Reference

Helper template for Add_rvalue_reference.
`#include <types>`
Inheritance diagram for L4::Types::__Add_rvalue_reference_helper< T, Void< T && > >:



Collaboration diagram for L4::Types::__Add_rvalue_reference_helper< T, Void< T && > >:



15.212.1 Detailed Description

template<typename T>
struct L4::Types::__Add_rvalue_reference_helper< T, Void< T && > >

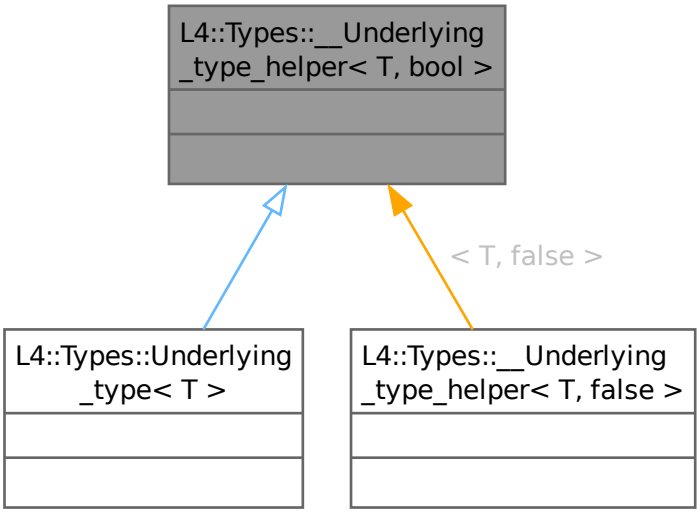
Helper template for Add_rvalue_reference.
Definition at line 289 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

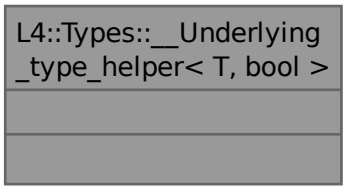
15.213 L4::Types::__Underlying_type_helper< T, bool > Struct Template Reference

Helper template for Underlying_type.
`#include <types>`

Inheritance diagram for L4::Types::__Underlying_type_helper< T, bool >:



Collaboration diagram for L4::Types::__Underlying_type_helper< T, bool >:



15.213.1 Detailed Description

template<typename T, bool = Is_enum<T>::value>
struct L4::Types::__Underlying_type_helper< T, bool >

Helper template for Underlying_type.

Note

The implementation relies on the intrinsic __underlying_type() compiler type trait that is provided by the mainstream C++ compilers. There is no fully portable and future-proof way of implementing this template (the only fragile and unmaintainable possibility is to evaluate all possible underlying types).

Template Parameters

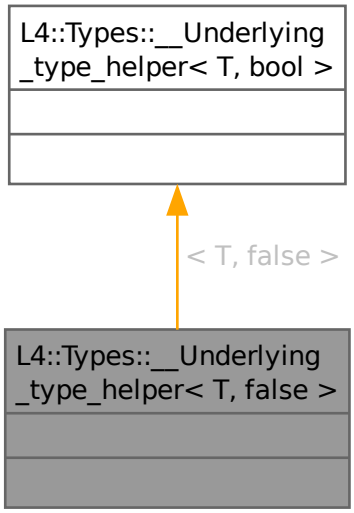
T	Enumeration type to get the underlying type of.

Definition at line 380 of file types.
The documentation for this struct was generated from the following file:

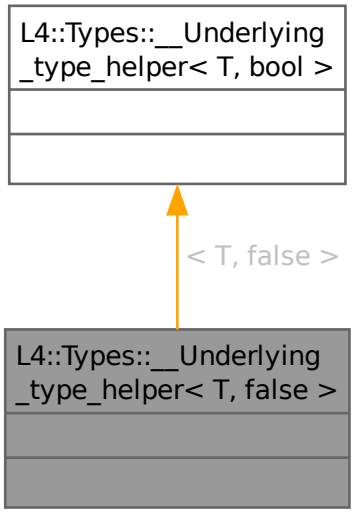
- l4/sys/cxx/types

15.214 L4::Types::__Underlying_type_helper< T, false > Struct Template Reference

Helper template for Underlying_type.
`#include <types>`
Inheritance diagram for L4::Types::__Underlying_type_helper< T, false >:



Collaboration diagram for L4::Types::__Underlying_type_helper< T, false >:



15.214.1 Detailed Description

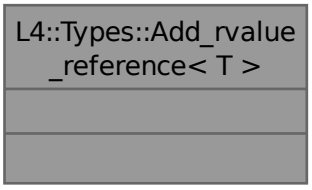
template<typename T>
struct L4::Types::__Underlying_type_helper< T, false >

Helper template for Underlying_type.
Definition at line 383 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

15.215 L4::Types::Add_rvalue_reference< T > Struct Template Reference

Create an rvalue reference of the given type.
`#include <types>`
Collaboration diagram for L4::Types::Add_rvalue_reference< T >:



15.215.1 Detailed Description

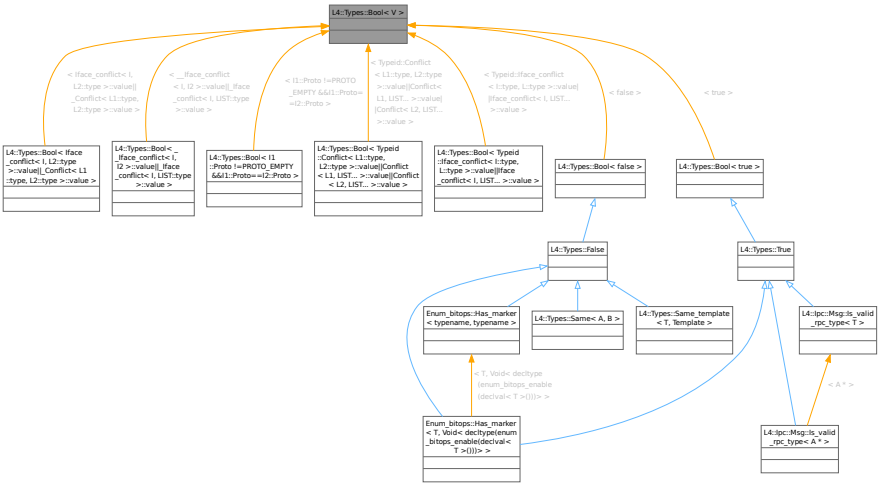
template<typename T>
struct L4::Types::Add_rvalue_reference< T >

Create an rvalue reference of the given type.
Definition at line 293 of file types.
The documentation for this struct was generated from the following file:

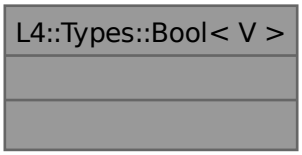
- l4/sys/cxx/types

15.216 L4::Types::Bool< V > Struct Template Reference

Boolean meta type.
`#include <types>`
Inheritance diagram for L4::Types::Bool< V >:



Collaboration diagram for L4::Types::Bool< V >:



Public Types

- using **type** = Bool<V>

  The meta type itself.

15.216.1 Detailed Description

template<bool V>
struct L4::Types::Bool< V >

Boolean meta type.

Template Parameters

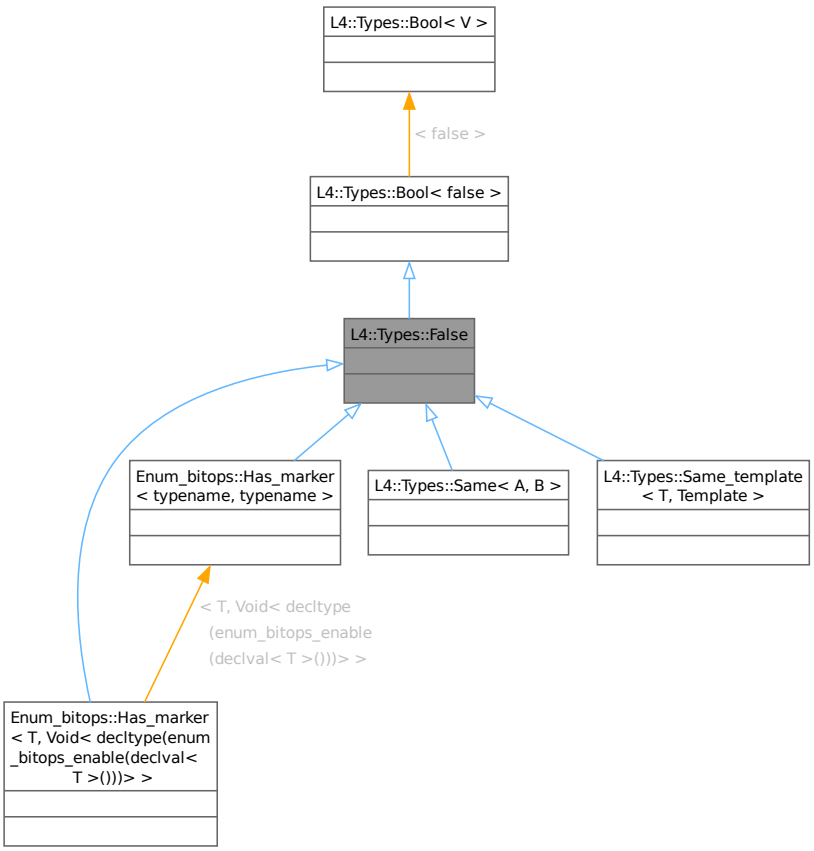
V	The boolean value

Definition at line 314 of file types.
The documentation for this struct was generated from the following file:

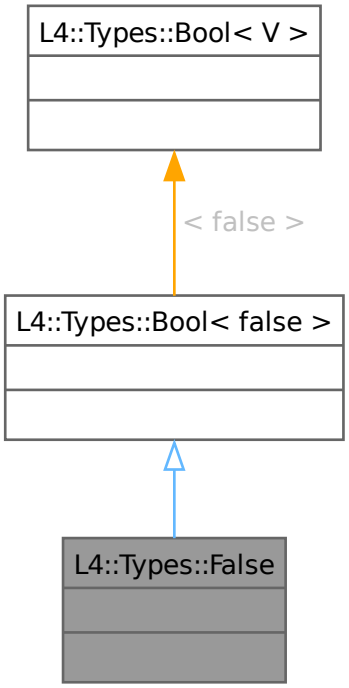
- l4/sys/cxx/types

15.217 L4::Types::False Struct Reference

False meta value.
`#include <types>`
Inheritance diagram for L4::Types::False:



Collaboration diagram for L4::Types::False:



Additional Inherited Members

Public Types inherited from L4::Types::Bool< false >

- using **type**

  The meta type itself.

15.217.1 Detailed Description

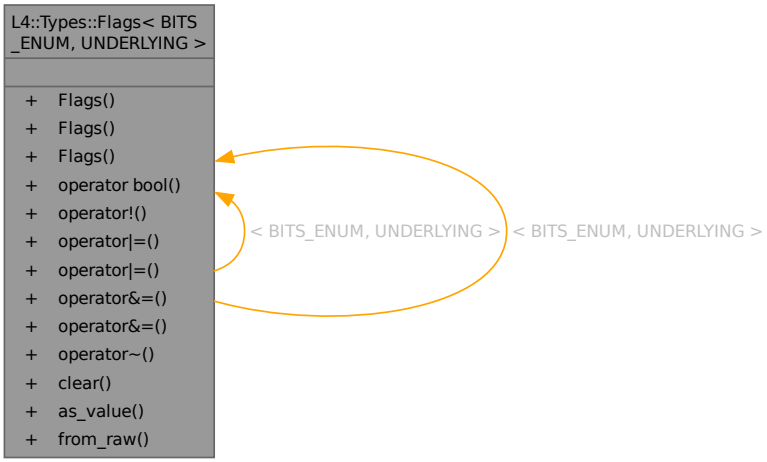
False meta value.
Definition at line 322 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

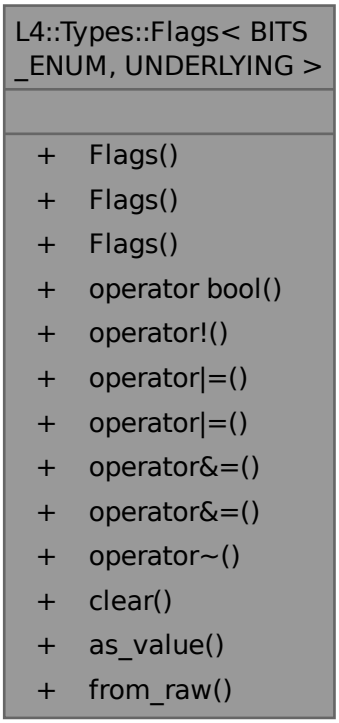
15.218 L4::Types::Flags< BITS_ENUM, UNDERLYING > Class Template Reference

Template for defining typical Flags bitmaps.
`#include <types>`

Inheritance diagram for L4::Types::Flags< BITS_ENUM, UNDERLYING >:



Collaboration diagram for L4::Types::Flags< BITS_ENUM, UNDERLYING >:



Public Types

- enum None_type { None }

The none type to get an empty bitmap.

- using **value_type** = UNDERLYING

  type of the underlying value

- using **bits_enum_type** = BITS_ENUM

  enum type defining a name for each bit

- using **type** = Flags<BITS_ENUM, UNDERLYING>

  the Flags<> type itself

Public Member Functions

- constexpr Flags (None_type) noexcept

  Make an empty bitmap.

- constexpr **Flags** () noexcept

  Make default Flags.

- constexpr Flags (BITS_ENUM e) noexcept

  Make flags from bit name.

- constexpr **operator bool** () const noexcept

  Support for `if (flags)` syntax (test for non-empty flags).

- constexpr bool **operator!** () const noexcept

  Support for `if (!flags)` syntax (test for empty flags).

- constexpr type & **operator|=** (type rhs) noexcept

  Support |= of two compatible Flags types.

- constexpr type & **operator|=** (bits_enum_type rhs)

  Support |= of Flags type and bit name.

- constexpr type & **operator&=** (type rhs)

  Support &= of two compatible Flags types.

- constexpr type & **operator&=** (bits_enum_type rhs)

  Support &= of Flags type and bit name.

- constexpr type **operator~** () const noexcept

  Support ~ for Flags types.

- constexpr type & clear (bits_enum_type flag) noexcept

  Clear the given flag.

- constexpr value_type **as_value** () const noexcept

  Get the underlying value.

Static Public Member Functions

- static constexpr type from_raw (value_type v) noexcept

  Make flags from a raw value of value_type.

Friends

- constexpr type **operator|** (type lhs, type rhs) noexcept

  Support | of two compatible Flags types.

- constexpr type **operator|** (type lhs, bits_enum_type rhs) noexcept

  Support | of Flags type and bit name.

- constexpr type **operator&** (type lhs, type rhs) noexcept

  Support & of two compatible Flags types.

- constexpr type **operator&** (type lhs, bits_enum_type rhs) noexcept

  Support & of Flags type and bit name.

15.218.1 Detailed Description

template<typename BITS_ENUM, typename UNDERLYING = unsigned long>
class L4::Types::Flags< BITS_ENUM, UNDERLYING >

Template for defining typical Flags bitmaps.

Template Parameters

BITS_ENUM	enum type that defines a name for each bit in the bitmap. The values of the enum members must be the number of the bit (*not* a mask).
UNDERLYING	The underlying data type used to represent the bitmap.

The resulting data type provides a type-safe version that allows bitwise `and` and `or` operations with the BITS_↩ ENUM members. As well as, test for `0`or `!0`.
Example:

```
enum Test_flag
{
  Do_weak_tests,
  Do_strong_tests
};

using Test_flags = L4::Types::Flags<Test_flag>;

Test_flags x = Do_weak_tests;

if (x & Do_strong_tests) { ... }
x |= Do_strong_tests;
if (x & Do_strong_tests) { ... }
```

Definition at line 52 of file types.

15.218.2 Member Enumeration Documentation

15.218.2.1 None_type

```
template<typename BITS_ENUM, typename UNDERLYING = unsigned long>
enum L4::Types::Flags::None_type
```

The none type to get an empty bitmap.

Enumerator

None	Use this to get an empty bitmap.

Definition at line 68 of file types.

15.218.3 Constructor & Destructor Documentation

15.218.3.1 Flags() [1/2]

```
template<typename BITS_ENUM, typename UNDERLYING = unsigned long>
L4::Types::Flags< BITS_ENUM, UNDERLYING >::Flags (
             None_type )  [inline], [constexpr], [noexcept]
```

Make an empty bitmap.
Usually used for implicit conversion from `Flags::None`.

```
Flags x = Flags::None;
```

Definition at line 78 of file types.

15.218.3.2 Flags() [2/2]

```
template<typename BITS_ENUM, typename UNDERLYING = unsigned long>
L4::Types::Flags< BITS_ENUM, UNDERLYING >::Flags (
             BITS_ENUM e)  [inline], [constexpr], [noexcept]
```

Make flags from bit name.
Usually used for implicit conversion for a bit name.
```
Test_flags f = Do_strong_tests;
```
Definition at line 91 of file types.

15.218.4 Member Function Documentation

15.218.4.1 clear()

```
template<typename BITS_ENUM, typename UNDERLYING = unsigned long>
type & L4::Types::Flags< BITS_ENUM, UNDERLYING >::clear (
            bits_enum_type flag)  [inline], [constexpr], [noexcept]
```
Clear the given flag.

Parameters

flag	The flag that shall be cleared.

`flags.clear(The_flag)` is a shortcut for `flags &= ~Flags(The_flag)`.
Definition at line 149 of file types.

15.218.4.2 from_raw()

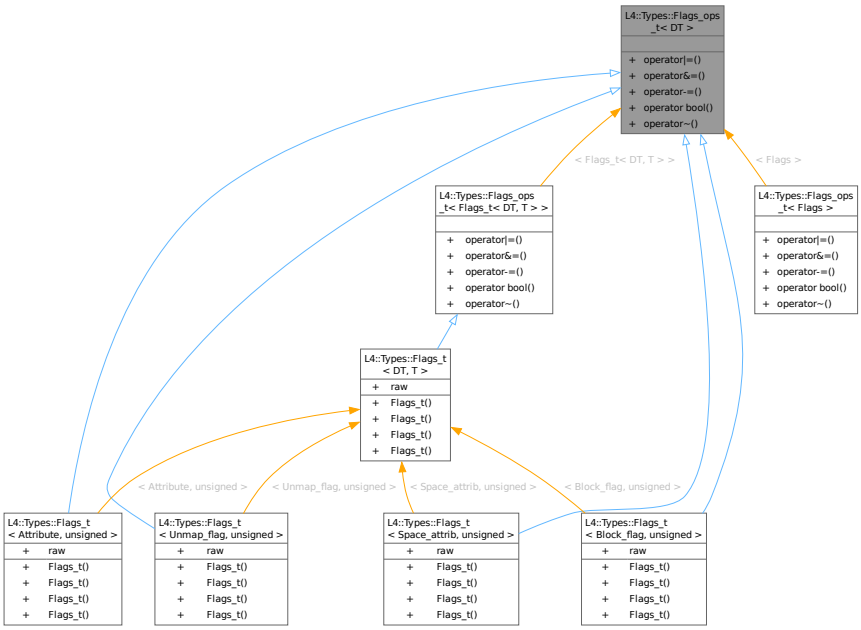
```
template<typename BITS_ENUM, typename UNDERLYING = unsigned long>
constexpr type L4::Types::Flags< BITS_ENUM, UNDERLYING >::from_raw (
            value_type v)  [inline], [static], [constexpr], [noexcept]
```
Make flags from a raw value of *value_type*.
This function may be used for example in C wrapper code.
Definition at line 100 of file types.
The documentation for this class was generated from the following file:

- l4/sys/cxx/types

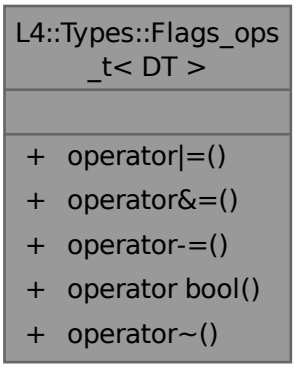
15.219 L4::Types::Flags_ops_t< DT > Struct Template Reference

Mixin class to define a set of friend bitwise operators on `DT`.
`#include <types>`

Inheritance diagram for L4::Types::Flags_ops_t< DT >:



Collaboration diagram for L4::Types::Flags_ops_t< DT >:



Public Member Functions

- constexpr DT & **operator|=** (DT const r)

  bitwise or assignment for DT
- constexpr DT & **operator&=** (DT const r)

  bitwise and assignment for DT
- constexpr DT & **operator-=** (DT const r)

  Bitwise difference (clear bits) assignment for DT.
- constexpr **operator bool** () const

  explicit conversion to bool for tests

- constexpr DT **operator∼** () const

  bitwise negation for DT

Friends

- constexpr DT **operator|** (DT l, DT r)

  bitwise or for DT
- constexpr DT **operator&** (DT l, DT r)

  bitwise and for DT
- constexpr DT **operator-** (DT l, DT r)

  Bitwise difference (clear bits) for DT.
- constexpr bool **operator==** (DT l, DT r)

  equality for DT
- constexpr bool **operator!=** (DT l, DT r)

  inequality for DT

15.219.1 Detailed Description

template<typename DT>
struct L4::Types::Flags_ops_t< DT >

Mixin class to define a set of friend bitwise operators on `DT`.

Template Parameters

DT	The type usually inheriting from Flags_ops_t with a member *raw* of enum or integral type.

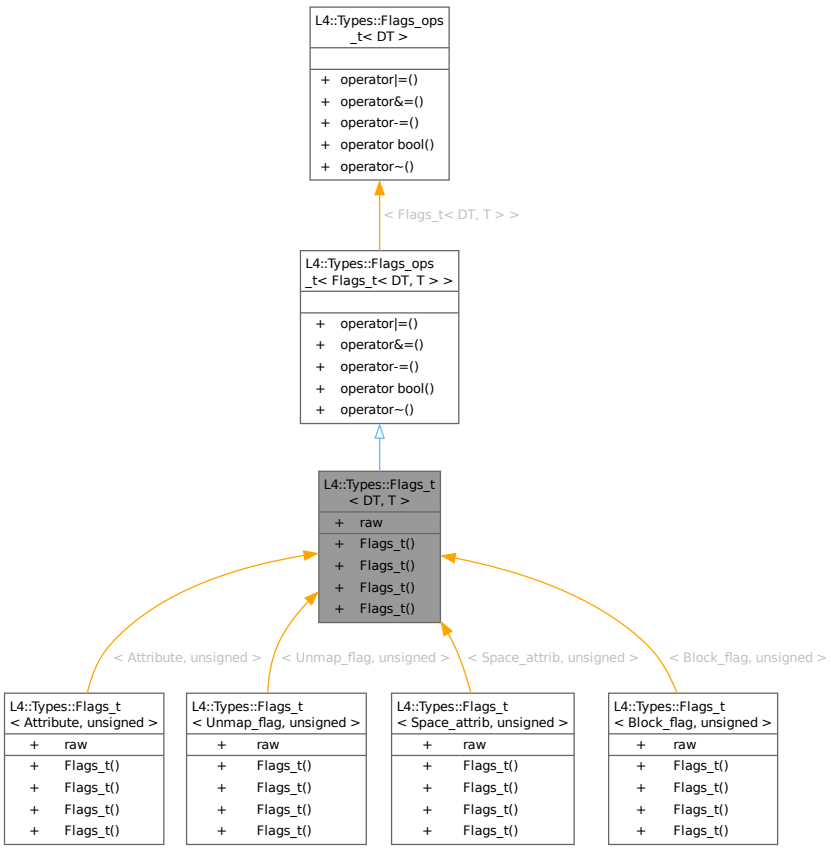
Definition at line 203 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

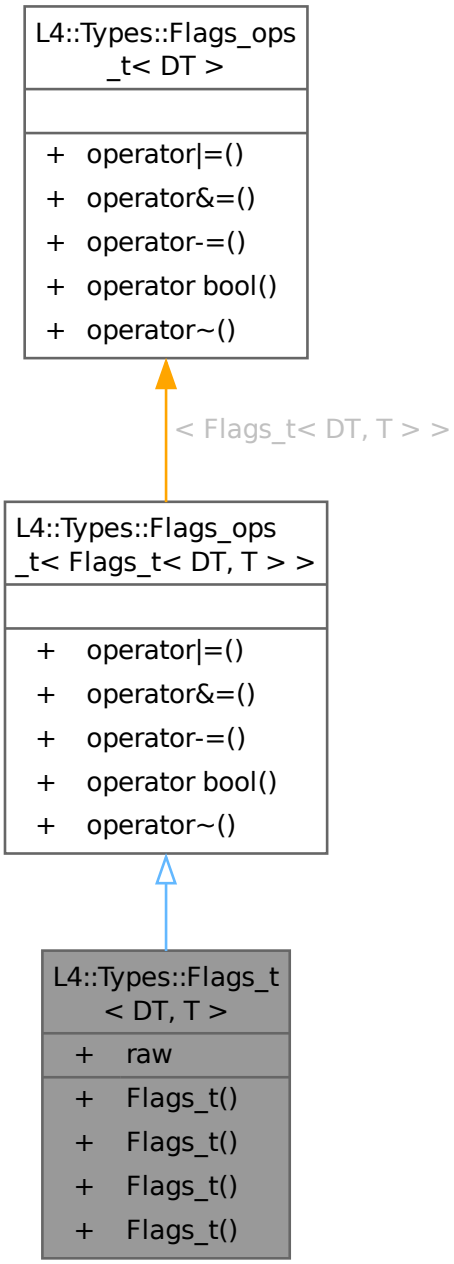
15.220 L4::Types::Flags_t< DT, T > Struct Template Reference

Template type to define a flags type with bitwise operations.
`#include <types>`

Inheritance diagram for L4::Types::Flags_t< DT, T >:



Collaboration diagram for L4::Types::Flags_t< DT, T >:



Public Types

- enum None_type { None }

  The none type to get an empty value.

Public Member Functions

- constexpr **Flags_t** ()=default

Default constructor with no flag set.

- constexpr **Flags_t** (None_type)

  Constructor to create an empty value.
- constexpr **Flags_t** (DT f)

  Initialization from determinator type.
- constexpr **Flags_t** (T f)

  Explicit initialization from the underlying type.

Public Member Functions inherited from L4::Types::Flags_ops_t< Flags_t< DT, T > >

- constexpr DT & **operator|=** (DT const r)

  bitwise or assignment for DT
- constexpr DT & **operator&=** (DT const r)

  bitwise and assignment for DT
- constexpr DT & **operator-=** (DT const r)

  Bitwise difference (clear bits) assignment for DT.
- constexpr **operator bool** () const

  explicit conversion to bool for tests
- constexpr DT **operator~** () const

  bitwise negation for DT

Data Fields

- T **raw** = 0

  Raw integral value.

15.220.1 Detailed Description

template<typename DT, typename T>
struct L4::Types::Flags_t< DT, T >

Template type to define a flags type with bitwise operations.

Template Parameters

DT	determinator type to make the resulting type unique (unused).
T	underlying type used to store the bits, usually an integral type.

Definition at line 264 of file types.

15.220.2 Member Enumeration Documentation

15.220.2.1 None_type

```
template<typename DT, typename T>
enum L4::Types::Flags_t::None_type
```

The none type to get an empty value.

Enumerator

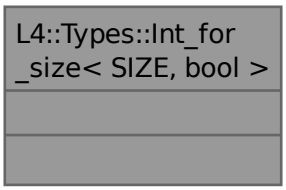
None	Use this to get an empty value.

Definition at line 267 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

15.221 L4::Types::Int_for_size< SIZE, bool > Struct Template Reference

Metafunction to get an unsigned integral type for the given size.
Collaboration diagram for L4::Types::Int_for_size< SIZE, bool >:



15.221.1 Detailed Description

template<unsigned SIZE, bool = true>
struct L4::Types::Int_for_size< SIZE, bool >

Metafunction to get an unsigned integral type for the given size.

Template Parameters

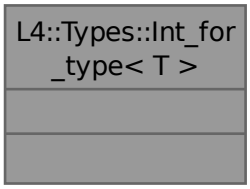
SIZE	The size of the integer in bytes.

Definition at line 161 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

15.222 L4::Types::Int_for_type< T > Struct Template Reference

Metafunction to get an integral type of the same size as `T`.
`#include <types>`
Collaboration diagram for L4::Types::Int_for_type< T >:



Public Types

- using **type** = typename Int_for_size<sizeof(T)>::type

The resulting unsigned integer type with the size like `T`.

15.222.1 Detailed Description

template<typename T>
struct L4::Types::Int_for_type< T >

Metafunction to get an integral type of the same size as `T`.

Template Parameters

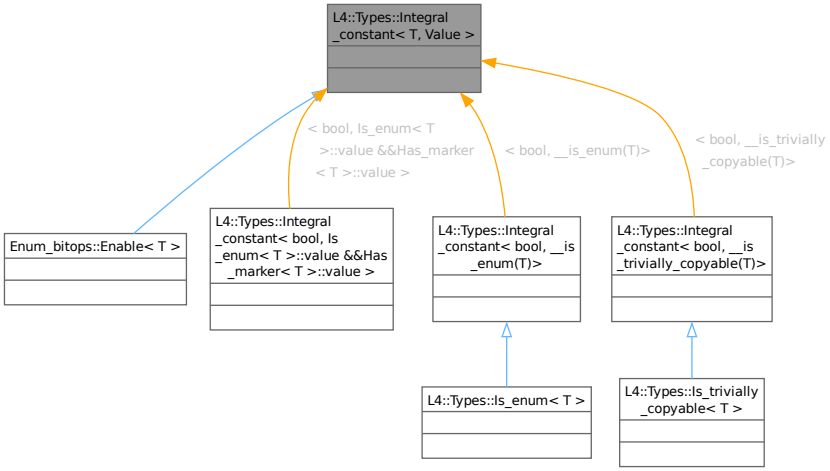
T	The type for which an unsigned integral type with the same size is needed.

Definition at line 188 of file types.
The documentation for this struct was generated from the following file:

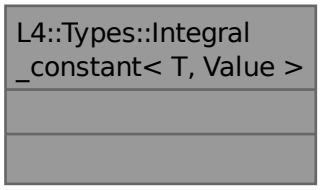
- l4/sys/cxx/types

15.223 L4::Types::Integral_constant< T, Value > Struct Template Reference

Wrapper for a static constant of the given type.
`#include <types>`
Inheritance diagram for L4::Types::Integral_constant< T, Value >:



Collaboration diagram for L4::Types::Integral_constant< T, Value >:



15.223.1 Detailed Description

template<typename T, T Value>
struct L4::Types::Integral_constant< T, Value >

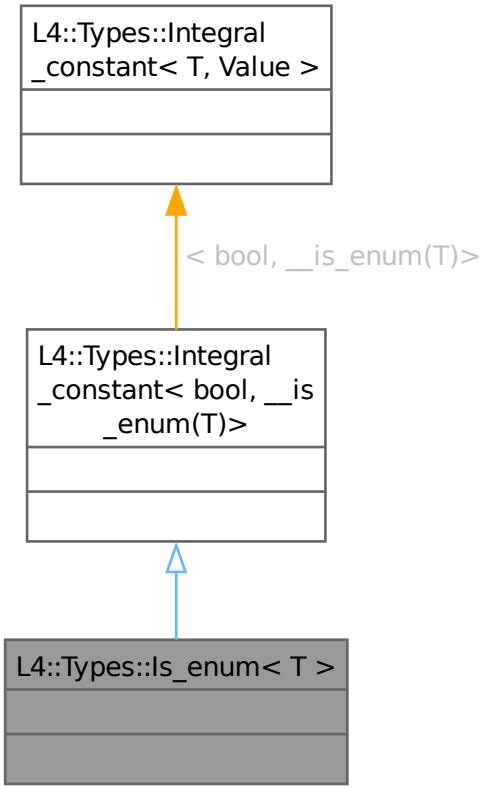
Wrapper for a static constant of the given type.
Definition at line 330 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

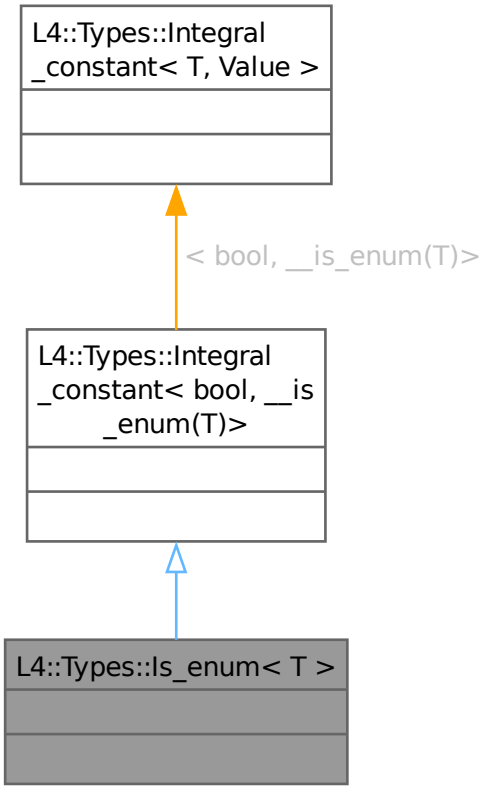
15.224 L4::Types::Is_enum< T > Struct Template Reference

Check whether the given type is an enumeration type.
`#include <types>`

Inheritance diagram for L4::Types::Is_enum< T >:



Collaboration diagram for L4::Types::Is_enum< T >:



15.224.1 Detailed Description

template<typename T>
struct L4::Types::Is_enum< T >

Check whether the given type is an enumeration type.

Note

The implementation relies on the intrinsic __is_enum() compiler type trait that is provided by the mainstream C++ compilers. There is no fully portable and future-proof way of implementing this template (the only fragile and unmaintainable possibility is to exclude all other types to identify the enumeration type).

Template Parameters

T	Type to check whether it is an enumeration type.

Definition at line 350 of file types.
The documentation for this struct was generated from the following file:

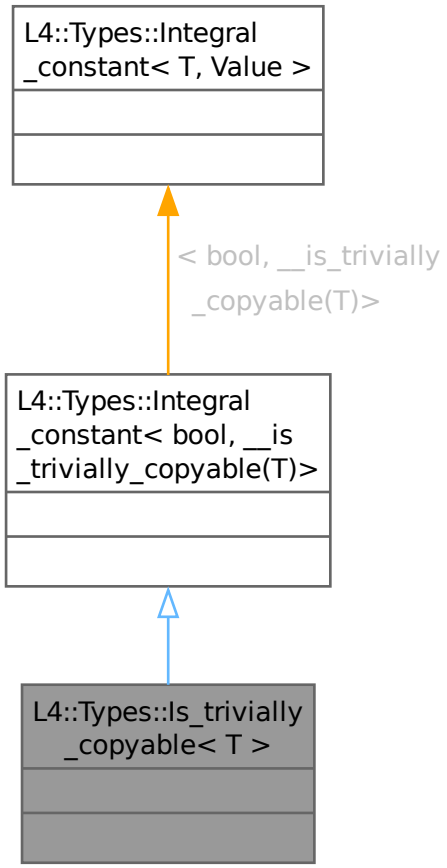
- l4/sys/cxx/types

15.225 L4::Types::Is_trivially_copyable< T > Struct Template Reference

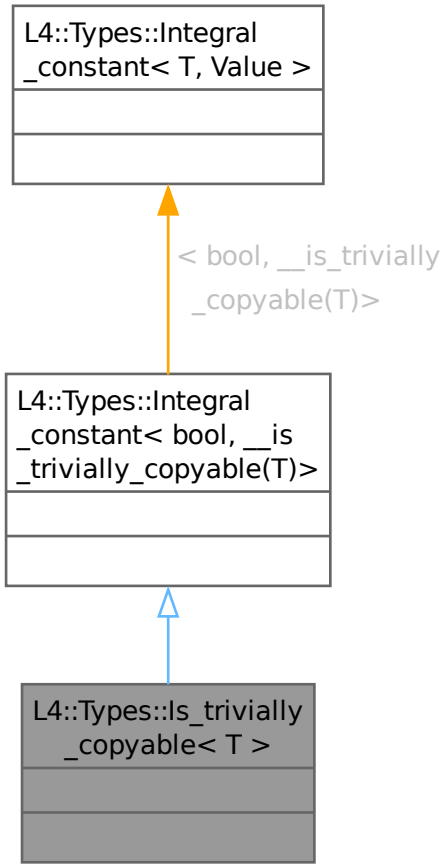
Check whether the given type is trivially copyable.

`#include <types>`

Inheritance diagram for L4::Types::Is_trivially_copyable< T >:



Collaboration diagram for L4::Types::Is_trivially_copyable< T >:



15.225.1 Detailed Description

template<typename T>
struct L4::Types::Is_trivially_copyable< T >

Check whether the given type is trivially copyable.
Objects of such types may be safely copied with memcpy() or serialized to/from binary files.

Template Parameters

T	Type to check whether it is trivially copyable.

Definition at line 361 of file types.
The documentation for this struct was generated from the following file:

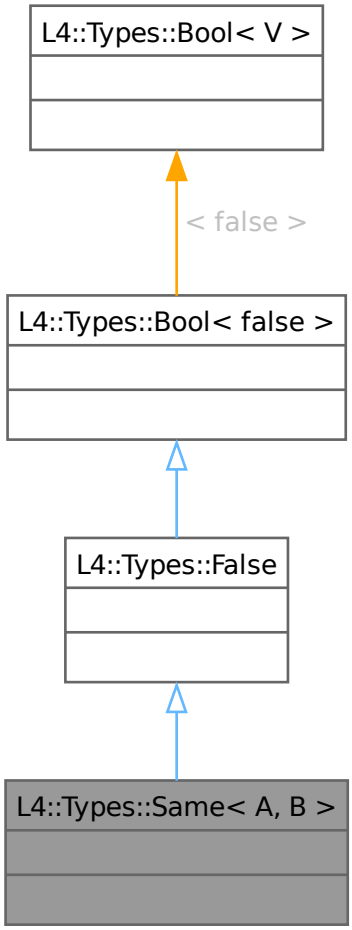
- l4/sys/cxx/types

15.226 L4::Types::Same< A, B > Struct Template Reference

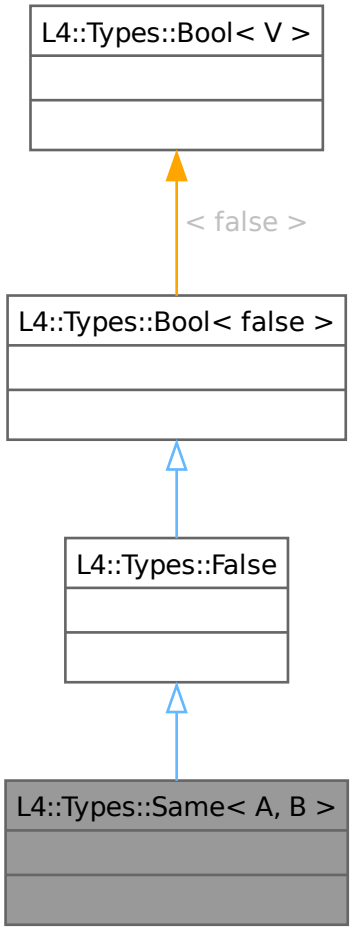
Compare two data types for equality.

`#include <types>`

Inheritance diagram for L4::Types::Same< A, B >:



Collaboration diagram for L4::Types::Same< A, B >:



Additional Inherited Members

Public Types inherited from L4::Types::Bool< false >

- using **type**

  The meta type itself.

15.226.1 Detailed Description

template<typename A, typename B>
struct L4::Types::Same< A, B >

Compare two data types for equality.

Template Parameters

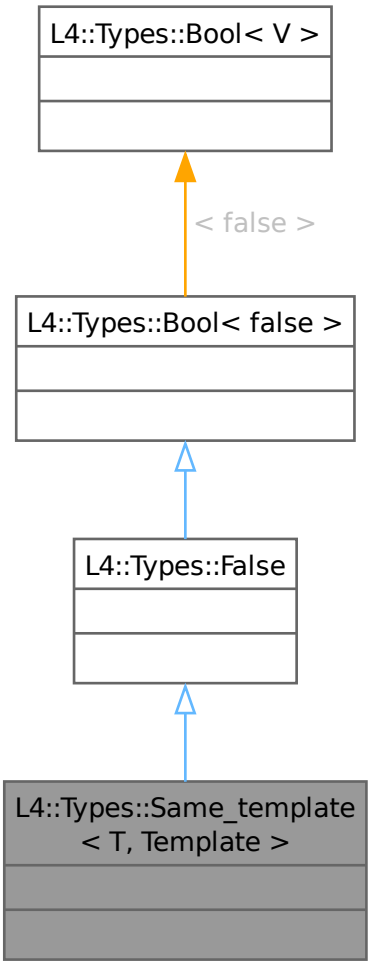
A	The first data type
B	The second data type

The result is the boolean True if A and B are the same types.
Definition at line 402 of file types.
The documentation for this struct was generated from the following file:

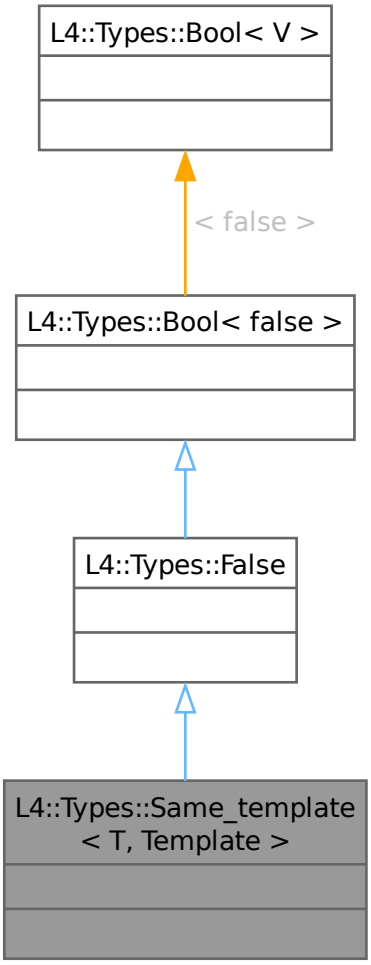
- l4/sys/cxx/types

15.227 L4::Types::Same_template< T, Template > Struct Template Reference

Check if a type T is an instantiation of a given template.
`#include <types>`
Inheritance diagram for L4::Types::Same_template< T, Template >:



Collaboration diagram for L4::Types::Same_template< T, Template >:



Additional Inherited Members

Public Types inherited from L4::Types::Bool< false >

- using **type**

  The meta type itself.

15.227.1 Detailed Description

template<typename T, template< typename... > typename Template>
struct L4::Types::Same_template< T, Template >

Check if a type T is an instantiation of a given template.
Definition at line 412 of file types.
The documentation for this struct was generated from the following file:

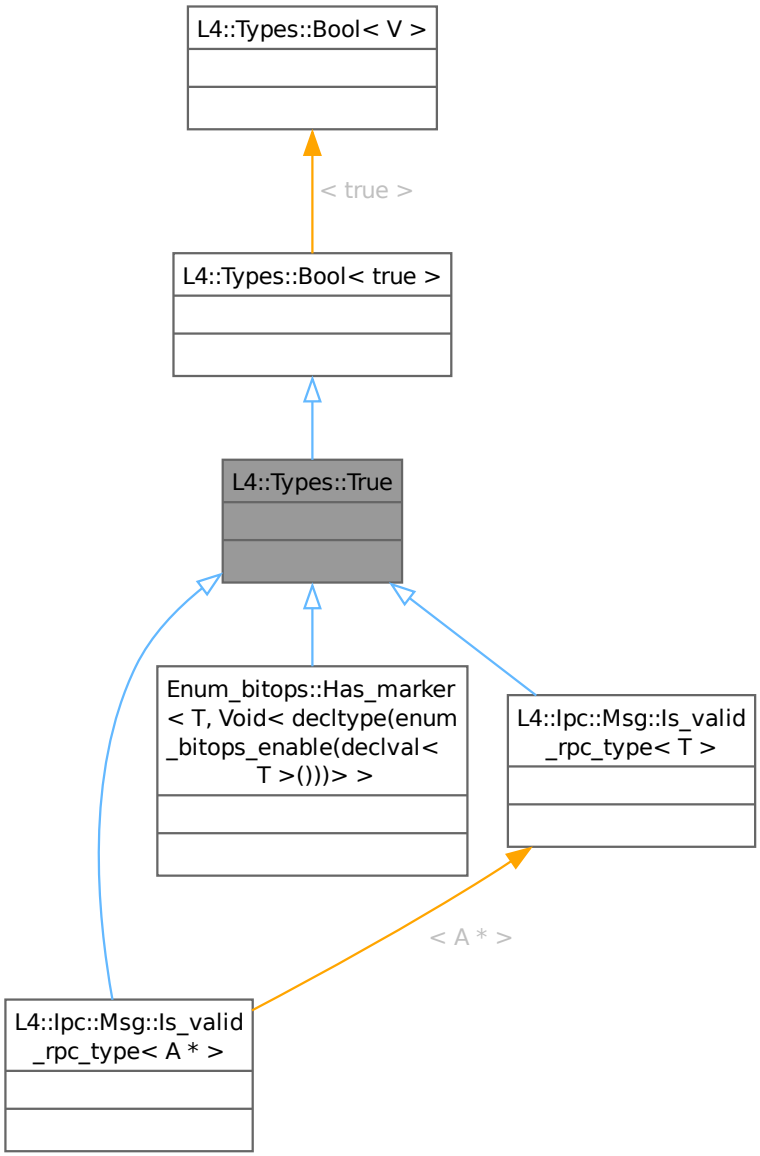
- l4/sys/cxx/types

15.228 L4::Types::True Struct Reference

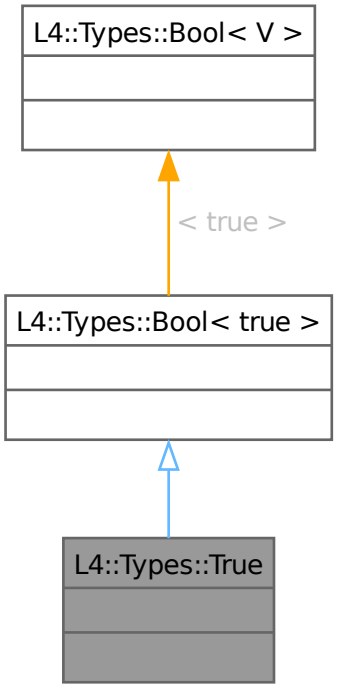
True meta value.

`#include <types>`

Inheritance diagram for L4::Types::True:



Collaboration diagram for L4::Types::True:



Additional Inherited Members

Public Types inherited from L4::Types::Bool< true >

- using **type**

  The meta type itself.

15.228.1 Detailed Description

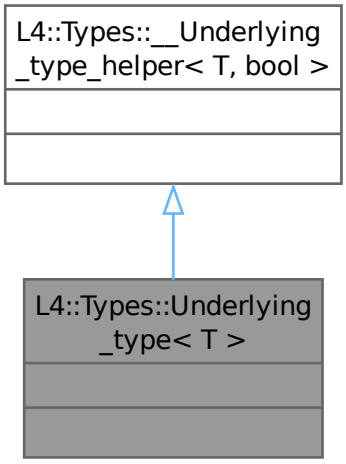
True meta value.
Definition at line 326 of file types.
The documentation for this struct was generated from the following file:

- l4/sys/cxx/types

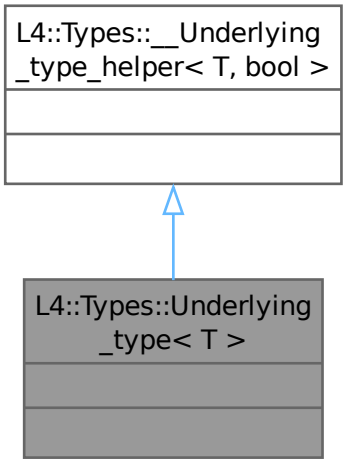
15.229 L4::Types::Underlying_type< T > Struct Template Reference

Get an underlying type of an enumeration type.
`#include <types>`

Inheritance diagram for L4::Types::Underlying_type< T >:



Collaboration diagram for L4::Types::Underlying_type< T >:



15.229.1 Detailed Description

template<typename T>
struct L4::Types::Underlying_type< T >

Get an underlying type of an enumeration type.
Definition at line 386 of file types.
The documentation for this struct was generated from the following file:

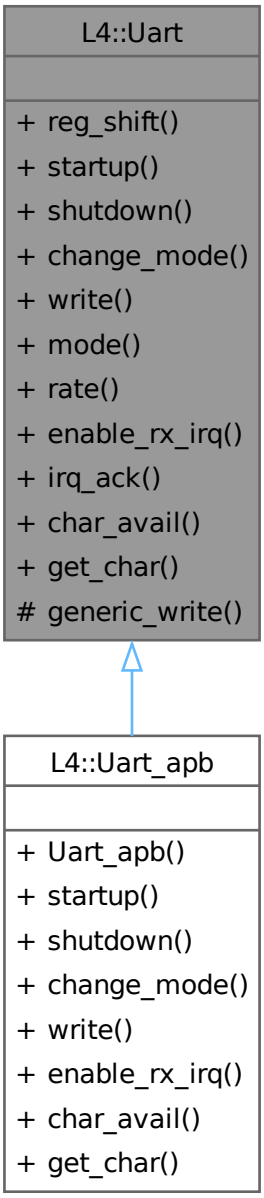
- l4/sys/cxx/types

15.230 L4::Uart Class Reference

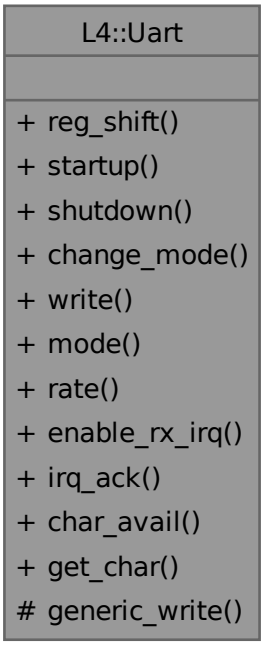
Uart driver abstraction.

`#include <uart_base.h>`

Inheritance diagram for L4::Uart:



Collaboration diagram for L4::Uart:



Public Member Functions

- virtual bool reg_shift (unsigned char ∗shift)) const

  Provide the reg_shift value for the UART's registers.
- virtual bool startup (Io_register_block const ∗regs)=0

  Start the UART driver.
- virtual void shutdown ()=0

  Terminate the UART driver.
- virtual bool change_mode (Transfer_mode m, Baud_rate r)=0

  Set certain parameters of the UART.
- virtual int write (char const ∗s, unsigned long count, bool blocking=true) const =0

  Transmit a number of characters.
- Transfer_mode mode () const

  Return the transfer mode.
- Baud_rate rate () const

  Return the baud rate.
- virtual bool enable_rx_irq (bool=true)

  Enable the receive IRQ.
- virtual void **irq_ack** ()

  Acknowledge a received interrupt.
- virtual int char_avail () const =0

  Check if there is at least one character available for reading from the UART.
- virtual int get_char (bool blocking=true) const =0

  Read a character from the UART.

Protected Member Functions

- template<typename Uart_driver, bool Timeout_guard = true>
  int generic_write (char const *s, unsigned long count, bool blocking=true) const

  Internal function transmitting each character one-after-another and finally waiting that the transmission did actually finish.

15.230.1 Detailed Description

Uart driver abstraction.
Definition at line 22 of file uart_base.h.

15.230.2 Member Function Documentation

15.230.2.1 change_mode()

```
virtual bool L4::Uart::change_mode (
             Transfer_mode m,
             Baud_rate r)  [pure virtual]
```

Set certain parameters of the UART.

Parameters

m	UART mode. Depends on the hardware.
r	Baud rate.

Return values

true	Mode setting succeeded (or was not performed at all).
false	Mode setting failed for some reason.

Note

Some drivers don't perform any mode setting at all and just return true.

Implemented in L4::Uart_apb.

15.230.2.2 char_avail()

```
virtual int L4::Uart::char_avail () const  [pure virtual]
```

Check if there is at least one character available for reading from the UART.

Returns

0 if there is no character available for reading, !=0 otherwise.

Implemented in L4::Uart_apb.

15.230.2.3 enable_rx_irq()

```
virtual bool L4::Uart::enable_rx_irq (
             bool  = true)  [inline], [virtual]
```

Enable the receive IRQ.

Return values

true	The RX IRQ was successfully enabled / disabled.
false	The RX IRQ couldn't be enabled / disabled. The driver does not support this operation.

Reimplemented in L4::Uart_apb.
Definition at line 115 of file uart_base.h.

15.230.2.4 generic_write()

```
template<typename Uart_driver, bool Timeout_guard = true>
int L4::Uart::generic_write (
             char const * s,
             unsigned long count,
             bool blocking = true) const  [inline], [protected]
```

Internal function transmitting each character one-after-another and finally waiting that the transmission did actually finish.

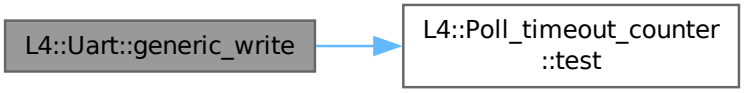
Parameters

s	Buffer containing the characters.
count	The number of characters to transmit.
blocking	If true, wait until there is space in the transmit buffer and also wait until every character was successful transmitted. Otherwise do not wait.

Returns

The number of successful written characters.

Definition at line 155 of file uart_base.h.
References L4::Poll_timeout_counter::test().
Here is the call graph for this function:



15.230.2.5 get_char()

```
virtual int L4::Uart::get_char (
             bool blocking = true) const  [pure virtual]
```

Read a character from the UART.

Parameters

blocking	If true, wait until a character is available for reading. Otherwise do not wait and just return -1 if no character is available.

Returns

The actual character read from the UART.

Implemented in L4::Uart_apb.

15.230.2.6 mode()

```
Transfer_mode L4::Uart::mode () const  [inline]
```

Return the transfer mode.

Returns

The transfer mode.

Definition at line 97 of file uart_base.h.

15.230.2.7 rate()

```
Baud_rate L4::Uart::rate () const  [inline]
```

Return the baud rate.

Returns

The baud rate.

Definition at line 104 of file uart_base.h.

15.230.2.8 reg_shift()

```
virtual bool L4::Uart::reg_shift (
            unsigned char * shift) const  [inline], [virtual]
```

Provide the reg_shift value for the UART's registers.

Parameters

out	*shift*	Register shift to be used for the UART's registers.

Return values

false	The output argument is not valid.
true	The output argument is valid.

Definition at line 47 of file uart_base.h.

15.230.2.9 shutdown()

```
virtual void L4::Uart::shutdown ()  [pure virtual]
```

Terminate the UART driver.
This includes disabling of interrupts.
Implemented in L4::Uart_apb.

15.230.2.10 startup()

```
virtual bool L4::Uart::startup (
            Io_register_block const * regs)  [pure virtual]
```

Start the UART driver.

Parameters

regs	IO register block of the UART.

Return values

true	Startup succeeded.
false	Startup failed.

Implemented in L4::Uart_apb.

15.230.2.11 write()

```
virtual int L4::Uart::write (
             char const * s,
             unsigned long count,
             bool blocking = true) const  [pure virtual]
```

Transmit a number of characters.

Parameters

s	Buffer containing the characters.
count	Number of characters to transmit.
blocking	If true, wait until there is space in the transmit buffer and also wait until every character was successful transmitted. Otherwise do not wait.

Returns

The number of successfully written characters.

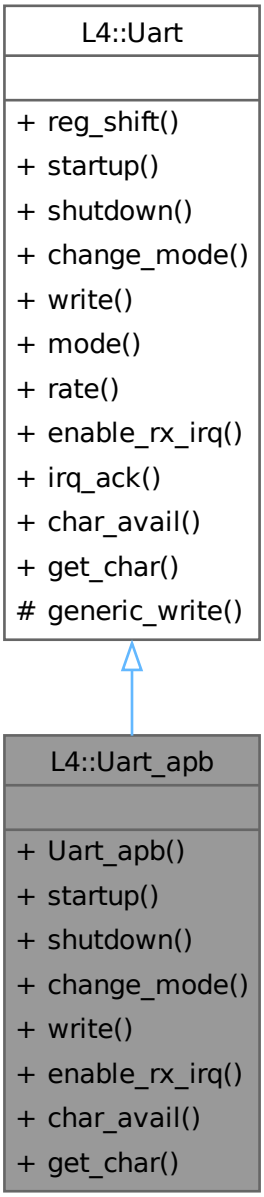
Implemented in L4::Uart_apb.
The documentation for this class was generated from the following file:

- pkg/drivers-frst/uart/include/uart_base.h

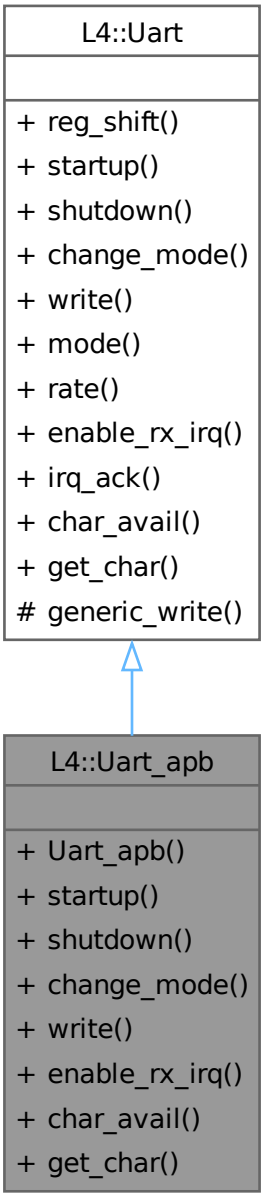
15.231 L4::Uart_apb Class Reference

Driver for the Advanced Peripheral Bus (APB) UART from the Cortex-M System Design Kit (CMSDK).
`#include <uart_apb.h>`

Inheritance diagram for L4::Uart_apb:



Collaboration diagram for L4::Uart_apb:



Public Member Functions

- **Uart_apb** (unsigned freq)

  freq == 0 means unknown and don't change baud rate
- bool startup (Io_register_block const ∗) override

  Start the UART driver.
- void shutdown () override

  Terminate the UART driver.
- bool change_mode (Transfer_mode m, Baud_rate r) override

  Set certain parameters of the UART.

- int write (char const *s, unsigned long count, bool blocking=true) const override

  Transmit a number of characters.
- bool enable_rx_irq (bool enable) override

  Enable the receive IRQ.
- int char_avail () const override

  Check if there is at least one character available for reading from the UART.
- int get_char (bool blocking=true) const override

  Read a character from the UART.

Public Member Functions inherited from L4::Uart

- virtual bool reg_shift (unsigned char *shift)) const

  Provide the reg_shift value for the UART's registers.
- Transfer_mode mode () const

  Return the transfer mode.
- Baud_rate rate () const

  Return the baud rate.
- virtual void **irq_ack** ()

  Acknowledge a received interrupt.

Additional Inherited Members

Protected Member Functions inherited from L4::Uart

- template<typename Uart_driver, bool Timeout_guard = true>
  int generic_write (char const *s, unsigned long count, bool blocking=true) const

  Internal function transmitting each character one-after-another and finally waiting that the transmission did actually finish.

15.231.1 Detailed Description

Driver for the Advanced Peripheral Bus (APB) UART from the Cortex-M System Design Kit (CMSDK).
Definition at line 17 of file uart_apb.h.

15.231.2 Member Function Documentation

15.231.2.1 change_mode()

```
bool L4::Uart_apb::change_mode (
            Transfer_mode m,
            Baud_rate r)  [override], [virtual]
```

Set certain parameters of the UART.

Parameters

m	UART mode. Depends on the hardware.
r	Baud rate.

Return values

true	Mode setting succeeded (or was not performed at all).
false	Mode setting failed for some reason.

Note

Some drivers don't perform any mode setting at all and just return true.

Implements L4::Uart.

15.231.2.2 char_avail()

```
int L4::Uart_apb::char_avail () const  [override], [virtual]
```

Check if there is at least one character available for reading from the UART.

Returns

0 if there is no character available for reading, !=0 otherwise.

Implements L4::Uart.

15.231.2.3 enable_rx_irq()

```
bool L4::Uart_apb::enable_rx_irq (
            bool )  [override], [virtual]
```

Enable the receive IRQ.

Return values

true	The RX IRQ was successfully enabled / disabled.
false	The RX IRQ couldn't be enabled / disabled. The driver does not support this operation.

Reimplemented from L4::Uart.

15.231.2.4 get_char()

```
int L4::Uart_apb::get_char (
            bool blocking = true) const  [override], [virtual]
```

Read a character from the UART.

Parameters

blocking	If true, wait until a character is available for reading. Otherwise do not wait and just return -1 if no character is available.

Returns

The actual character read from the UART.

Implements L4::Uart.

15.231.2.5 shutdown()

```
void L4::Uart_apb::shutdown ()  [override], [virtual]
```

Terminate the UART driver.
This includes disabling of interrupts.
Implements L4::Uart.

15.231.2.6 startup()

```
bool L4::Uart_apb::startup (
            Io_register_block const * regs)  [override], [virtual]
```

Start the UART driver.

Parameters

regs	IO register block of the UART.

Return values

true	Startup succeeded.
false	Startup failed.

Implements L4::Uart.

15.231.2.7 write()

```
int L4::Uart_apb::write (
            char const * s,
            unsigned long count,
            bool blocking = true) const  [override], [virtual]
```

Transmit a number of characters.

Parameters

s	Buffer containing the characters.
count	Number of characters to transmit.
blocking	If true, wait until there is space in the transmit buffer and also wait until every character was successful transmitted. Otherwise do not wait.

Returns

The number of successfully written characters.

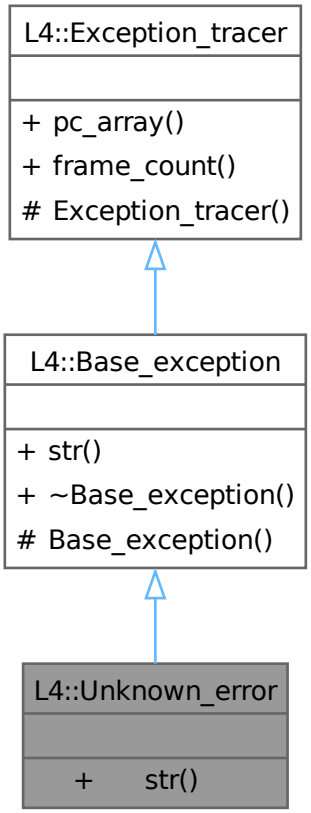
Implements L4::Uart.
The documentation for this class was generated from the following file:

- pkg/drivers-frst/uart/include/uart_apb.h

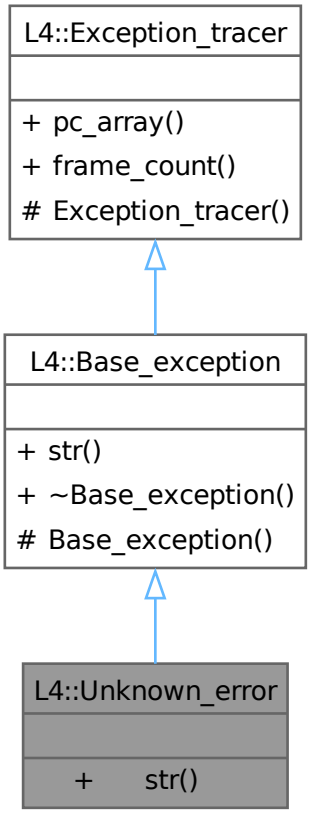
15.232 L4::Unknown_error Class Reference

Exception for an unknown condition.
`#include <l4/cxx/exceptions>`

Inheritance diagram for L4::Unknown_error:



Collaboration diagram for L4::Unknown_error:



Public Member Functions

- char const * **str** () const noexcept override

  Return a human readable string for the exception.

Public Member Functions inherited from L4::Base_exception

- virtual ~**Base_exception** () noexcept

  Destruction.

Public Member Functions inherited from L4::Exception_tracer

- void const *const * **pc_array** () const noexcept

  Get the array containing the call trace.
- int **frame_count** () const noexcept

  Get the number of entries that are valid in the call trace.

Additional Inherited Members

Protected Member Functions inherited from L4::Base_exception

- **Base_exception** () noexcept

Create a base exception.

Protected Member Functions inherited from L4::Exception_tracer

- **Exception_tracer** () noexcept

  Create a back trace.

15.232.1 Detailed Description

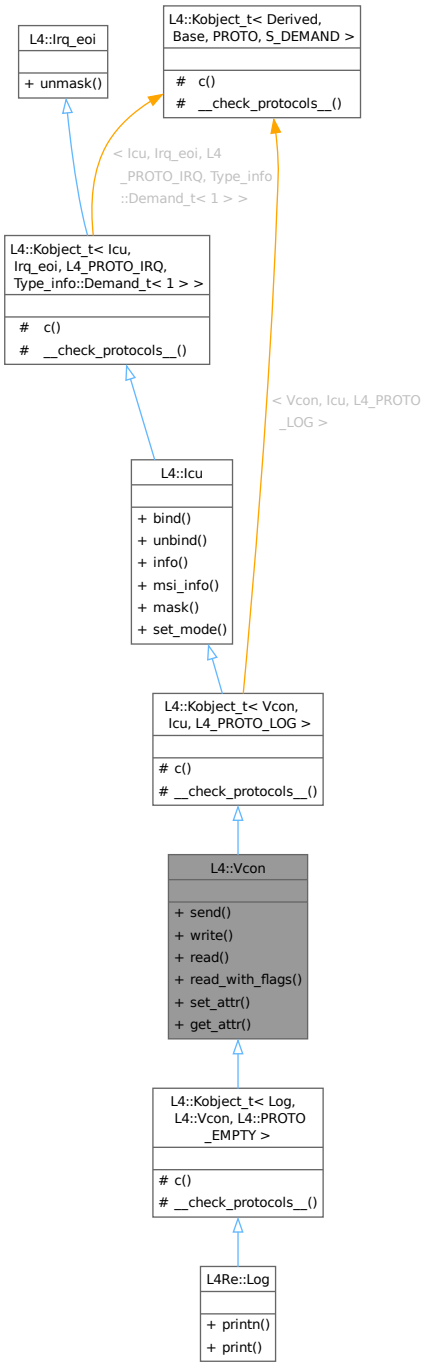
Exception for an unknown condition.
This error is usually used when a server returns an unknown return state to the client, this may indicate incompatible messages used by the client and the server.
Definition at line 208 of file exceptions.
The documentation for this class was generated from the following file:

- l4/cxx/exceptions

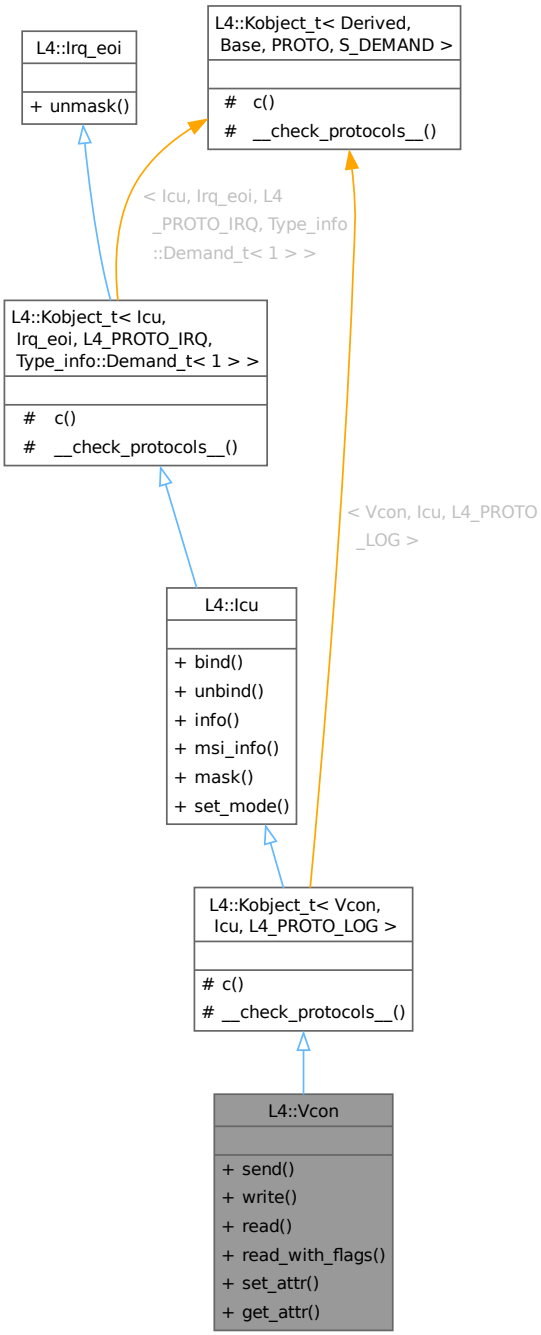
15.233 L4::Vcon Class Reference

C++ L4 Vcon interface, see Virtual Console for the C interface.
`#include <vcon>`

Inheritance diagram for L4::Vcon:



Collaboration diagram for L4::Vcon:



Public Member Functions

- l4_msgtag_t send (char const *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Send data to `this` virtual console.
- long write (char const *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Write data to `this` virtual console.
- int read (char *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Read data from `this` virtual console.

- int read_with_flags (char *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Read data from `this` virtual console which also returns flags.
- l4_msgtag_t set_attr (l4_vcon_attr_t const *attr, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Set the attributes of `this` virtual console.
- l4_msgtag_t get_attr (l4_vcon_attr_t *attr, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Get attributes of `this` virtual console.

Public Member Functions inherited from L4::Icu

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)

  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Vcon, Icu, L4_PROTO_LOG >

- typedef Vcon **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Vcon > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Icu::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Vcon, Icu, L4_PROTO_LOG >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Vcon, Icu, L4_PROTO_LOG >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.233.1 Detailed Description

C++ L4 Vcon interface, see Virtual Console for the C interface.
L4::Vcon is a virtual console for simple character-based input and output. The interrupt for read events is provided by the virtual key interrupt.
The Vcon interface inherits from L4::Icu and L4::Irq_eoi for managing the virtual key interrupt which, in contrast to hardware IRQs, implements a limited functionality:

- Only IRQ line 0 is supported, no MSI vectors.
- The IRQ is edge-triggered and the IRQ mode cannot be changed.
- As the IRQ is edge-triggered, it does not have to be explicitly unmasked.

A server implementing the virtual console protocol has a queue for input events. When the first input event is added to the empty queue, the virtual key interrupt is triggered. Further events are added to the queue without generating further interrupts. The queue is emptied when a client reads all queued input events.

Include File

```
#include <l4/sys/vcon>
```

See the Virtual Console for the C interface.
Definition at line 45 of file vcon.

15.233.2 Member Function Documentation

15.233.2.1 get_attr()

```
l4_msgtag_t L4::Vcon::get_attr (
            l4_vcon_attr_t * attr,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Get attributes of `this` virtual console.

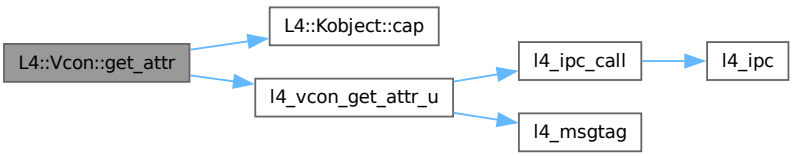
Parameters

out	*attr*	Attribute structure. Contains the attributes after a successful call of this function.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag.

Definition at line 151 of file vcon.
References L4::Kobject::cap(), and l4_vcon_get_attr_u().
Here is the call graph for this function:



15.233.2.2 read()

```
int L4::Vcon::read (
            char * buf,
            unsigned size,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Read data from `this` virtual console.

Parameters

`out`	*buf*	Pointer to data buffer.
	size	Size of the data buffer in bytes.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

-L4_EPERM	Insufficient permissions; see precondition.
>size	More bytes to read, `size` bytes are in the buffer `buf`.
<=size	Number of bytes read.

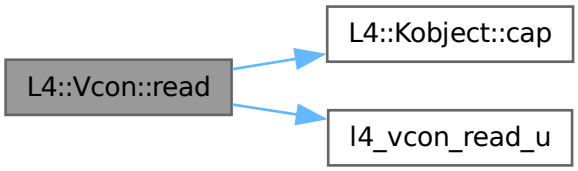
Precondition

The invoked Vcon capability must have the permission L4_CAP_FPAGE_W.

Note

Size must not exceed L4_VCON_READ_SIZE.

Definition at line 98 of file vcon.
References L4::Kobject::cap(), and l4_vcon_read_u().
Here is the call graph for this function:



15.233.2.3 read_with_flags()

```
int L4::Vcon::read_with_flags (
            char * buf,
            unsigned size,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Read data from `this` virtual console which also returns flags.

Parameters

out	*buf*	Pointer to data buffer.
	size	Size of the data buffer in bytes.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

-L4_EPERM	Insufficient permissions; see precondition.
>size	More bytes to read, `size` bytes are in the buffer `buf`.
<=size	Number of bytes read.

Precondition

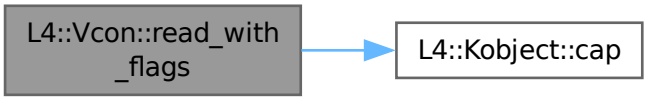
The invoked Vcon capability must have the permission L4_CAP_FPAGE_W.

If this function returns a positive value the caller can check the L4_VCON_READ_STAT_BREAK flag bit for a break condition. The bytes read can be obtained by masking the return value with L4_VCON_READ_SIZE_MASK.
If a break condition is signaled, it is always the first event in the transmitted content, i.e. all characters supplied by this read call follow the break condition.

Note

Size must not exceed L4_VCON_READ_SIZE.

Definition at line 125 of file vcon.
References L4::Kobject::cap().
Here is the call graph for this function:



15.233.2.4 send()

```
l4_msgtag_t L4::Vcon::send (
            char const * buf,
            unsigned size,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Send data to `this` virtual console.

Parameters

buf	Pointer to the data buffer.
size	Size of the data buffer in bytes.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

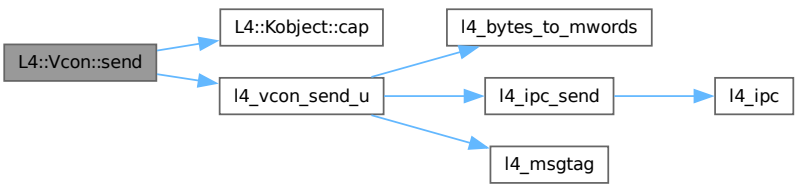
Returns

Syscall return tag

Note

Size must not exceed L4_VCON_WRITE_SIZE, a proper value of the `size` parameter is NOT checked. Also, this function is a send only operation, this means there is no return value except for a failed send operation. Use l4_ipc_error() to check for send errors, do not use l4_error(), as l4_error() will always return an error.

Definition at line 65 of file vcon.
References L4::Kobject::cap(), and l4_vcon_send_u().
Here is the call graph for this function:



15.233.2.5 set_attr()

```
l4_msgtag_t L4::Vcon::set_attr (
            l4_vcon_attr_t const * attr,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Set the attributes of `this` virtual console.

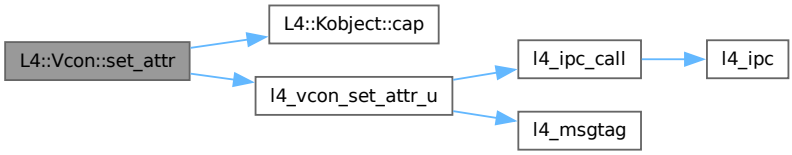
Parameters

attr	Attribute structure with the attributes for the virtual console.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Returns

Syscall return tag.

Definition at line 138 of file vcon.
References L4::Kobject::cap(), and l4_vcon_set_attr_u().
Here is the call graph for this function:



15.233.2.6 write()

```
long L4::Vcon::write (
            char const * buf,
            unsigned size,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Write data to `this` virtual console.

Parameters

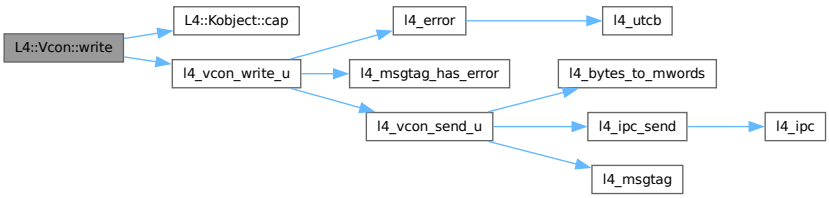
buf	Pointer to the data buffer.
size	Size of the data buffer in bytes.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. Defaults to l4_utcb.

Return values

<0	Error.
>=0	Number of bytes written to the virtual console.

Definition at line 79 of file vcon.
References L4::Kobject::cap(), and l4_vcon_write_u().

Here is the call graph for this function:



The documentation for this class was generated from the following file:

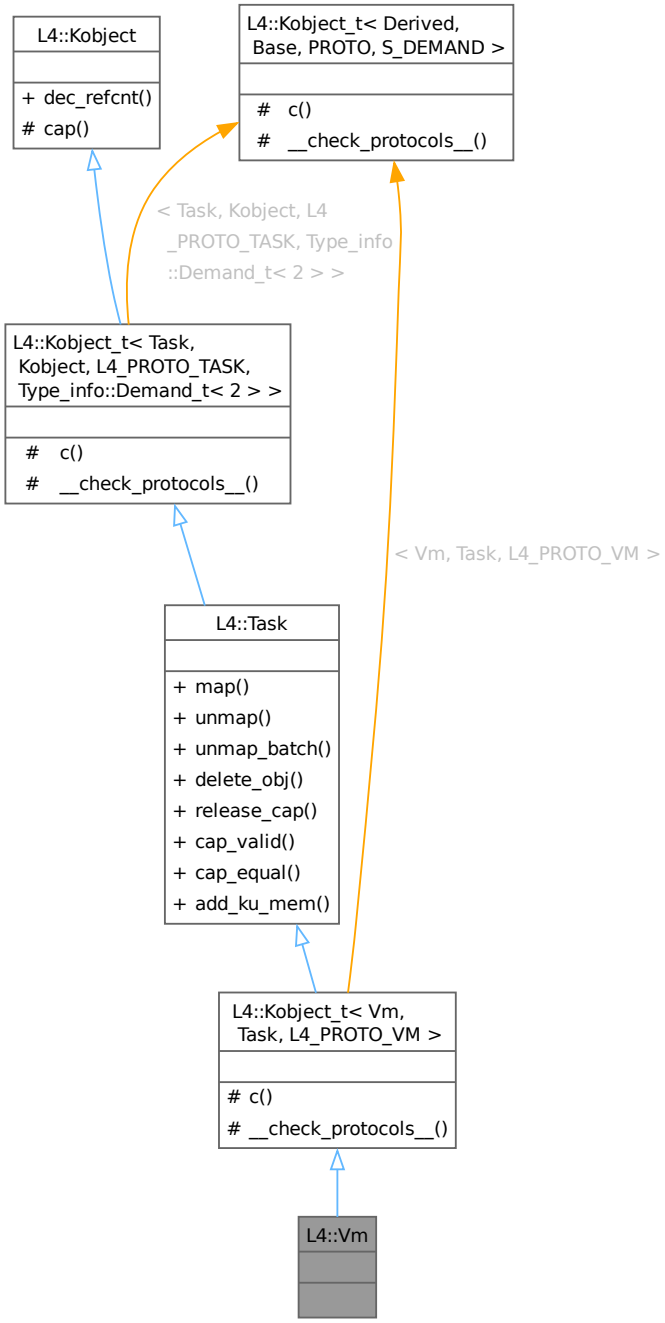
- l4/sys/vcon

15.234 L4::Vm Class Reference

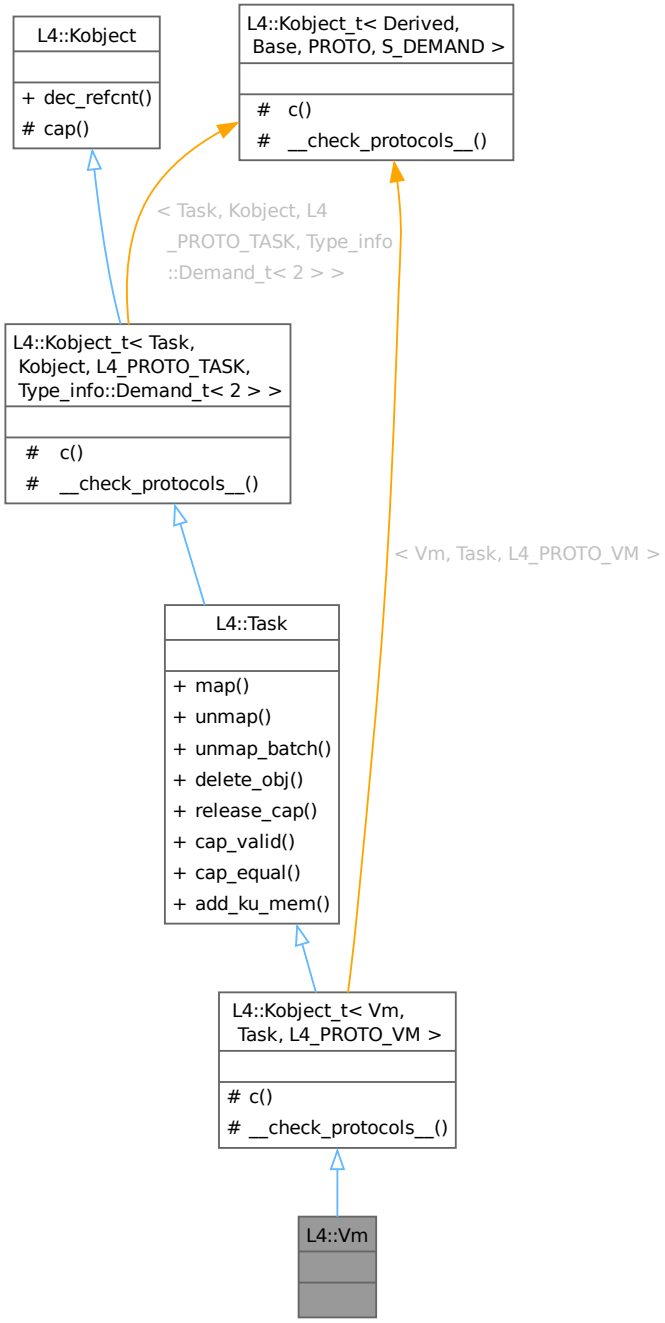
Virtual machine host address space.

`#include <vm>`

Inheritance diagram for L4::Vm:



Collaboration diagram for L4::Vm:



Additional Inherited Members

Public Member Functions inherited from L4::Task

- l4_msgtag_t map (Cap< Task > const &src_task, l4_fpage_t const &snd_fpage, l4_umword_t snd_base, l4_utcb_t *utcb=l4_utcb()) noexcept

  Map resources available in the source task to a destination task.
- l4_msgtag_t unmap (l4_fpage_t const &fpage, l4_umword_t map_mask, l4_utcb_t *utcb=l4_utcb()) noexcept

  Revoke rights from the task.

- l4_msgtag_t unmap_batch (l4_fpage_t const *fpages, unsigned num_fpages, l4_umword_t map_mask, l4_utcb_t *utcb=l4_utcb()) noexcept

  Revoke rights from a task.
- l4_msgtag_t delete_obj (L4::Cap< void > obj, l4_utcb_t *utcb=l4_utcb()) noexcept

  Release capability and delete object.
- l4_msgtag_t release_cap (L4::Cap< void > cap, l4_utcb_t *utcb=l4_utcb()) noexcept

  Release object capability.
- l4_msgtag_t cap_valid (Cap< void > const &cap, l4_utcb_t *utcb=l4_utcb()) noexcept

  Check whether a capability is present (refers to an object).
- l4_msgtag_t cap_equal (Cap< void > const &cap_a, Cap< void > const &cap_b, l4_utcb_t *utcb=l4_utcb()) noexcept

  Test whether two capabilities point to the same object with the same permissions (only considering selected permissions).
- l4_msgtag_t add_ku_mem (l4_fpage_t *fpage, l4_utcb_t *utcb=l4_utcb()) noexcept

  Add kernel-user memory.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Protected Types inherited from L4::Kobject_t< Vm, Task, L4_PROTO_VM >

- typedef Vm **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Vm > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Task::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Task, Kobject, L4_PROTO_TASK, Type_info::Demand_t< 2 > >

- typedef Task **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Task > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Vm, Task, L4_PROTO_VM >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Task, Kobject, L4_PROTO_TASK, Type_info::Demand_t< 2 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Vm, Task, L4_PROTO_VM >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Task, Kobject, L4_PROTO_TASK, Type_info::Demand_t< 2 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

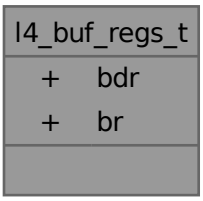
15.234.1 Detailed Description

Virtual machine host address space.
L4::Vm is a specialisation of L4::Task, used for virtual machines. The microkernel employs an appropriate page-table format for hosting VMs, such as ePT on VT-x. On Arm, it offers a call to make the virtual GICC area available to the VM.
Definition at line 30 of file vm.
The documentation for this class was generated from the following file:

- l4/sys/vm

15.235 l4_buf_regs_t Struct Reference

Encapsulation of the buffer-registers block in the UTCB.
`#include <utcb.h>`
Collaboration diagram for l4_buf_regs_t:



Data Fields

- l4_umword_t bdr

  Buffer descriptor.
- l4_umword_t **br** [L4_UTCB_GENERIC_BUFFERS_SIZE]

  Buffer registers.

15.235.1 Detailed Description

Encapsulation of the buffer-registers block in the UTCB.
Definition at line 147 of file utcb.h.

15.235.2 Field Documentation

15.235.2.1 bdr

`l4_umword_t l4_buf_regs_t::bdr`
Buffer descriptor.

See also

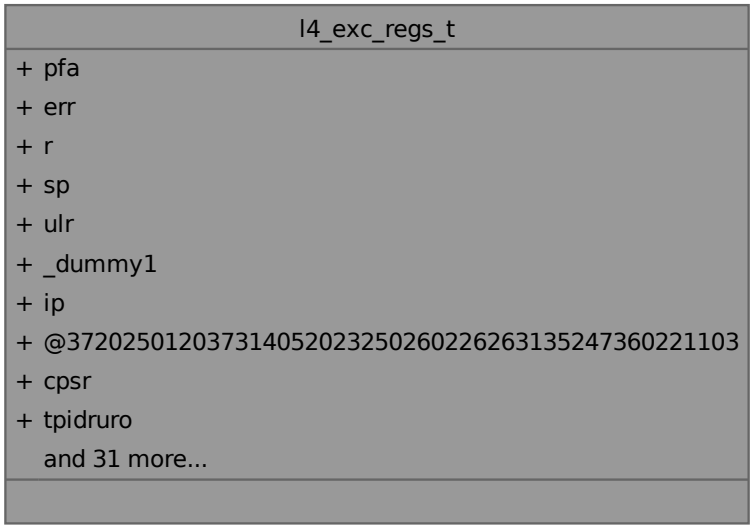
l4_bdr()

Definition at line 150 of file utcb.h.
Referenced by l4util_ioport_map(), L4::Ipc_svr::Br_manager_no_buffers::setup_wait(), and L4Re::Util::Br_manager::setup_wait().
The documentation for this struct was generated from the following file:

- l4/sys/utcb.h

15.236 l4_exc_regs_t Struct Reference

UTCB structure for exceptions.
`#include <utcb.h>`
Collaboration diagram for l4_exc_regs_t:



Data Fields

- l4_umword_t **pfa**
  page fault address
- l4_umword_t **err**
  error code
- l4_umword_t **r** [13]
  registers
- l4_umword_t **sp**
  stack pointer
- l4_umword_t **ulr**
  ulr

- l4_umword_t **_dummy1**
  dummy
- union {
  };

  aliases for PC
- l4_umword_t **cpsr**
  cpsr
- l4_umword_t **tpidruro**
  Thread-ID register.
- l4_umword_t **tpidrurw**
  Thread-ID register.
- l4_umword_t **r15**
  r15
- l4_umword_t **r14**
  r14
- l4_umword_t **r13**
  r13
- l4_umword_t **r12**
  r12
- l4_umword_t **r11**
  r11
- l4_umword_t **r10**
  r10
- l4_umword_t **r9**
  r9
- l4_umword_t **r8**
  r8
- l4_umword_t **rdi**
  rdi
- l4_umword_t **rsi**
  rsi
- l4_umword_t **rbp**
  rbp
- l4_umword_t **rbx**
  rbx
- l4_umword_t **rdx**
  rdx
- l4_umword_t **rcx**
  rcx
- l4_umword_t **rax**
  rax
- l4_umword_t **trapno**
  trap number
- l4_umword_t **dummy1**
  dummy
- l4_umword_t ss
  stack segment register
- l4_umword_t **es**
  es register
- l4_umword_t **ds**

ds register

- l4_umword_t **gs**

  gs register
- l4_umword_t **fs**

  fs register
- l4_umword_t **edi**

  edi register
- l4_umword_t **esi**

  esi register
- l4_umword_t **ebp**

  ebp register
- l4_umword_t **ebx**

  ebx register
- l4_umword_t **edx**

  edx register
- l4_umword_t **ecx**

  ecx register
- l4_umword_t **eax**

  eax register

15.236.1 Detailed Description

UTCB structure for exceptions.

Examples

examples/sys/aliens/main.c, examples/sys/singlestep/main.c, and examples/sys/start-with-exc/main.c.

Definition at line 27 of file utcb.h.

15.236.2 Field Documentation

15.236.2.1 flags

```
l4_umword_t l4_exc_regs_t::flags
```

rflags
eflags
Definition at line 37 of file utcb.h.

15.236.2.2 ss

```
l4_umword_t l4_exc_regs_t::ss
```

stack segment register
ss register
Definition at line 53 of file utcb.h.
The documentation for this struct was generated from the following files:

- arm/l4/sys/arch/utcb.h
- arm64/l4/sys/arch/utcb.h
- amd64/l4/sys/arch/utcb.h
- x86/l4/sys/arch/utcb.h
- riscv/l4/sys/arch/utcb.h

15.237 l4_fpage_t Union Reference

L4 flexpage type.
`#include <__l4_fpage.h>`
Collaboration diagram for l4_fpage_t:



Data Fields

- l4_umword_t **fpage**

  Raw value.
- l4_umword_t **raw**

  Raw value.

15.237.1 Detailed Description

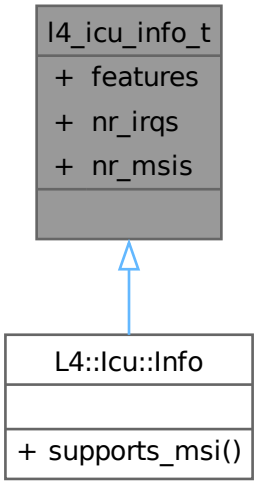
L4 flexpage type.
Definition at line 76 of file __l4_fpage.h.
The documentation for this union was generated from the following file:

- l4/sys/__l4_fpage.h

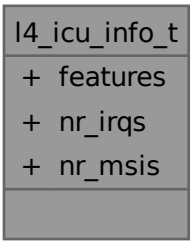
15.238 l4_icu_info_t Struct Reference

Info structure for an ICU.
`#include <icu.h>`

Inheritance diagram for l4_icu_info_t:



Collaboration diagram for l4_icu_info_t:



Data Fields

- unsigned features

  Feature flags.
- unsigned **nr_irqs**

  The number of IRQ lines supported by the ICU,.
- unsigned **nr_msis**

  The number of MSI vectors supported by the ICU,.

15.238.1 Detailed Description

Info structure for an ICU.
This structure contains information about the features of an ICU.

See also

l4_icu_info().

Definition at line 163 of file icu.h.

15.238.2 Field Documentation

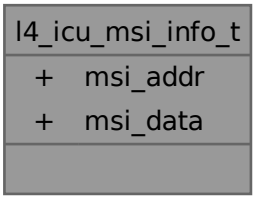
15.238.2.1 features

`unsigned l4_icu_info_t::features`
Feature flags.
If L4_ICU_FLAG_MSI is set the ICU supports MSIs.
Definition at line 170 of file icu.h.
Referenced by L4::Icu::Info::supports_msi().
The documentation for this struct was generated from the following file:

- l4/sys/icu.h

15.239 l4_icu_msi_info_t Struct Reference

Info to use for a specific MSI.
`#include <icu.h>`
Collaboration diagram for l4_icu_msi_info_t:



Data Fields

- l4_uint64_t **msi_addr**

  Value to use as address when sending this MSI.
- l4_uint32_t **msi_data**

  Value to use as data written to msi_addr, when sending this MSI.

15.239.1 Detailed Description

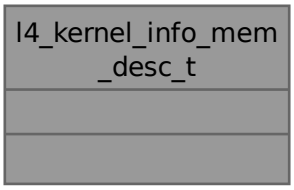
Info to use for a specific MSI.
Definition at line 184 of file icu.h.
The documentation for this struct was generated from the following file:

- l4/sys/icu.h

15.240 l4_kernel_info_mem_desc_t Struct Reference

Memory descriptor data structure.
`#include <memdesc.h>`

Collaboration diagram for l4_kernel_info_mem_desc_t:



15.240.1 Detailed Description

Memory descriptor data structure.

Note

This data type is opaque, and must be accessed by the accessor functions defined in this module.

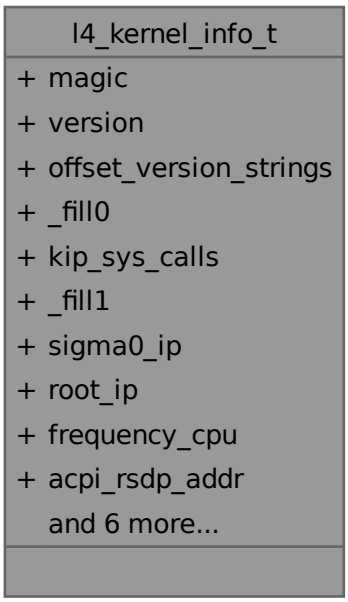
Definition at line 81 of file memdesc.h.
The documentation for this struct was generated from the following file:

- l4/sys/memdesc.h

15.241 l4_kernel_info_t Struct Reference

L4 Kernel Interface Page.
`#include <kip.h>`

Collaboration diagram for l4_kernel_info_t:



Data Fields

- l4_uint32_t **magic**
  Kernel Info Page identifier ("L4µK").
- l4_uint32_t **version**
  Kernel version.
- l4_uint8_t **offset_version_strings**
  offset to version string
- l4_uint8_t **_fill0** [3]
  reserved
- l4_uint8_t **kip_sys_calls**
  pointer to system calls
- l4_uint8_t **_fill1** [2]
  reserved
- l4_uint64_t **sigma0_ip**
  Sigma0 instruction pointer.
- l4_uint64_t **root_ip**
  Root task instruction pointer.
- l4_uint64_t **frequency_cpu**
  CPU frequency in kHz.
- l4_uint64_t **acpi_rsdp_addr**
  ACPI RSDP/XSDP.
- l4_uint64_t **dt_addr**
  Device Tree.
- l4_uint64_t **user_ptr**
  user_ptr

- l4_uint32_t **scheduler_granularity**

  for rounding time slices
- l4_uint32_t **mem_descs**

  memory descriptors relative to Kip
- l4_uint32_t **mem_descs_num**

  number of memory descriptors
- l4_uint64_t **_res2** [2]

  internal - spare space

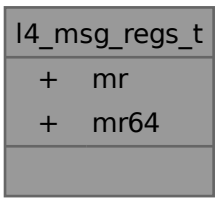
15.241.1 Detailed Description

L4 Kernel Interface Page.
32-bit architecture may assume that the upper 32 bits of addresses is 0
Definition at line 36 of file kip.h.
The documentation for this struct was generated from the following file:

- l4/sys/kip.h

15.242 l4_msg_regs_t Union Reference

Encapsulation of the message-register block in the UTCB.
`#include <utcb.h>`
Collaboration diagram for l4_msg_regs_t:



Data Fields

- l4_umword_t **mr** [L4_UTCB_GENERIC_DATA_SIZE]

  Message registers.
- l4_uint64_t **mr64** [L4_UTCB_GENERIC_DATA_SIZE/(sizeof(l4_uint64_t)/sizeof(l4_umword_t))]

  Message registers 64bit alias.

15.242.1 Detailed Description

Encapsulation of the message-register block in the UTCB.

Examples

examples/sys/utcb-ipc/main.c.

Definition at line 132 of file utcb.h.
The documentation for this union was generated from the following file:

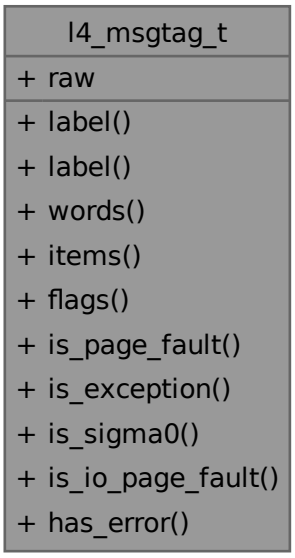
- l4/sys/utcb.h

15.243 l4_msgtag_t Struct Reference

Message tag data structure.

`#include <types.h>`

Collaboration diagram for l4_msgtag_t:



Public Member Functions

- long **label** () const L4_NOTHROW

  Get the protocol value.
- void **label** (long v) L4_NOTHROW

  Set the protocol value.
- unsigned **words** () const L4_NOTHROW

  Get the number of untyped words.
- unsigned **items** () const L4_NOTHROW

  Get the number of typed items.
- unsigned flags () const L4_NOTHROW

  Get the flags value.
- bool **is_page_fault** () const L4_NOTHROW

  Test if protocol indicates page-fault protocol.
- bool **is_exception** () const L4_NOTHROW

  Test if protocol indicates exception protocol.
- bool **is_sigma0** () const L4_NOTHROW

  Test if protocol indicates sigma0 protocol.
- bool **is_io_page_fault** () const L4_NOTHROW

  Test if protocol indicates IO-page-fault protocol.
- bool has_error () const L4_NOTHROW

  Test if flags indicate an error.

Data Fields

- l4_mword_t **raw**

  raw value

15.243.1 Detailed Description

Message tag data structure.

Include File

```
#include <l4/sys/types.h>
```

Describes the details of an IPC operation, in particular which parts of the UTCB have to be transmitted, and also flags to enable real-time and FPU extensions.
The message tag also contains a user-defined label that could be used to specify a protocol ID. Some negative values are reserved for kernel protocols such as page faults and exceptions.
The type must be treated completely opaque.

Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc, examples/libs/l4re/streammap/server.cc, examples/sys/aliens/main.c, examples/sys/ipc/ipc_example.c, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

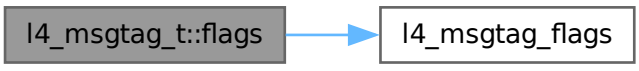
Definition at line 268 of file types.h.

15.243.2 Member Function Documentation

15.243.2.1 flags()

```
unsigned l4_msgtag_t::flags () const  [inline]
```

Get the flags value.
The flags are a combination of the flags defined by L4_msgtag_flags.
Definition at line 286 of file types.h.
References l4_msgtag_flags(), and L4_NOTHROW.
Here is the call graph for this function:



15.243.2.2 has_error()

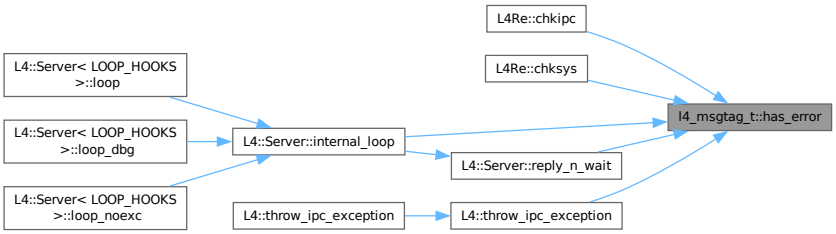
```
bool l4_msgtag_t::has_error () const  [inline]
```

Test if flags indicate an error.
If true, the error code is stored in the UTCB, see l4_utcb_tcr()->error.
Definition at line 302 of file types.h.
References l4_msgtag_has_error(), and L4_NOTHROW.
Referenced by L4Re::chkipc(), L4Re::chksys(), L4::Server< LOOP_HOOKS >::internal_loop(), L4::Server< LOOP_HOOKS >::reply and L4::throw_ipc_exception().

Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this struct was generated from the following file:

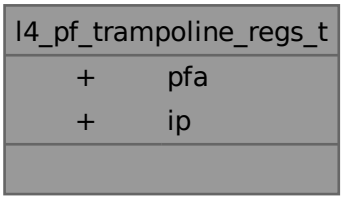
- l4/sys/types.h

15.244 l4_pf_trampoline_regs_t Struct Reference

Register state for page fault trampoline handlers.

`#include <pf_trampoline.h>`

Collaboration diagram for l4_pf_trampoline_regs_t:



Data Fields

- l4_umword_t **pfa**

  page fault address
- l4_umword_t **ip**

  instruction pointer of faulting instruction

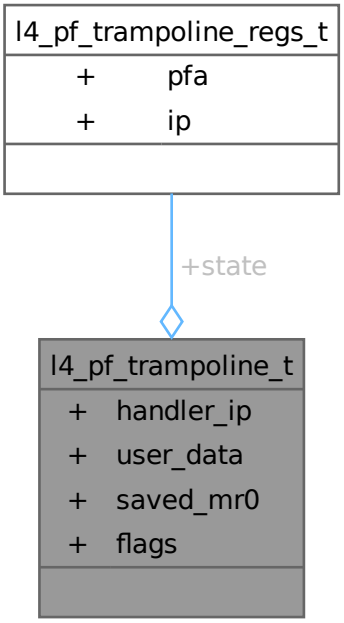
15.244.1 Detailed Description

Register state for page fault trampoline handlers.
Definition at line 24 of file pf_trampoline.h.
The documentation for this struct was generated from the following files:

- arm/l4/sys/arch/pf_trampoline.h
- arm64/l4/sys/arch/pf_trampoline.h
- amd64/l4/sys/arch/pf_trampoline.h
- x86/l4/sys/arch/pf_trampoline.h
- riscv/l4/sys/arch/pf_trampoline.h

15.245 l4_pf_trampoline_t Struct Reference

State for page fault trampoline handler.
`#include <pf_trampoline.h>`
Collaboration diagram for l4_pf_trampoline_t:



Data Fields

- l4_umword_t **handler_ip**
  instruction pointer of trampoline handler
- l4_umword_t **user_data** [2]
  for userland maintenance
- l4_umword_t **saved_mr0**
  MR[0] at entry of page fault handler.
- l4_umword_t **flags**
  See L4_pf_trampoline_flags.
- l4_pf_trampoline_regs_tl4_pf_trampoline_regs_t **state**
  register state at entry of PF handler

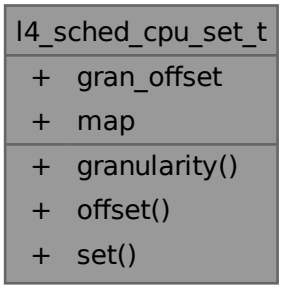
15.245.1 Detailed Description

State for page fault trampoline handler.
Definition at line 84 of file pf_trampoline.h.
The documentation for this struct was generated from the following file:

- l4/sys/pf_trampoline.h

15.246 l4_sched_cpu_set_t Struct Reference

CPU sets.
`#include <scheduler.h>`
Collaboration diagram for l4_sched_cpu_set_t:



Public Member Functions

- unsigned char granularity () const
- unsigned offset () const
- void set (unsigned char granularity, unsigned offset)

  Set offset and granularity.

Data Fields

- l4_umword_t gran_offset

  Combination of granularity and offset.
- l4_umword_t **map**

  Bitmap of CPUs.

15.246.1 Detailed Description

CPU sets.

Examples

examples/sys/migrate/thread_migrate.cc.

Definition at line 58 of file scheduler.h.

15.246.2 Member Function Documentation

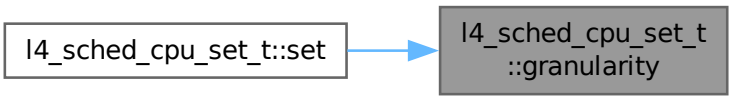
15.246.2.1 granularity()

```
unsigned char l4_sched_cpu_set_t::granularity () const  [inline]
```

Returns

Get granularity value

Definition at line 81 of file scheduler.h.
References gran_offset.
Referenced by set().
Here is the caller graph for this function:



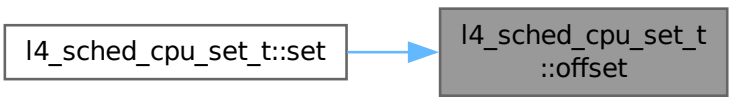
15.246.2.2 offset()

```
unsigned l4_sched_cpu_set_t::offset () const  [inline]
```

Returns

Get offset value

Definition at line 83 of file scheduler.h.
References gran_offset.
Referenced by set().
Here is the caller graph for this function:



15.246.2.3 set()

```
void l4_sched_cpu_set_t::set (
             unsigned char granularity,
             unsigned offset)  [inline]
```

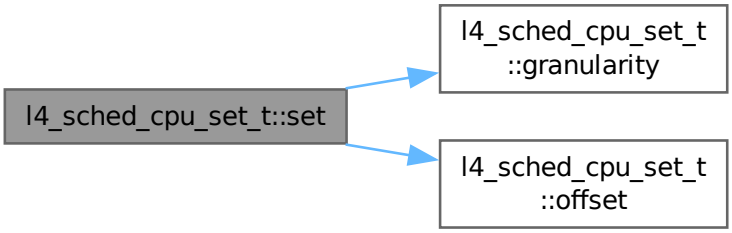
Set offset and granularity.

Parameters

granularity	Granularity in log2 notation.
offset	Offset. Must be a multiple of 2^granularity.

Definition at line 90 of file scheduler.h.

References gran_offset, granularity(), and offset().
Here is the call graph for this function:



15.246.3 Field Documentation

15.246.3.1 gran_offset

```
l4_umword_t l4_sched_cpu_set_t::gran_offset
```

Combination of granularity and offset.
The granularity defines how many CPUs each bit in map describes. And the offset is the number of the first CPU described by the first bit in the bitmap.

Precondition

offset must be a multiple of 2^granularity.

MSB	LSB
8bit granularity	24bit offset ..

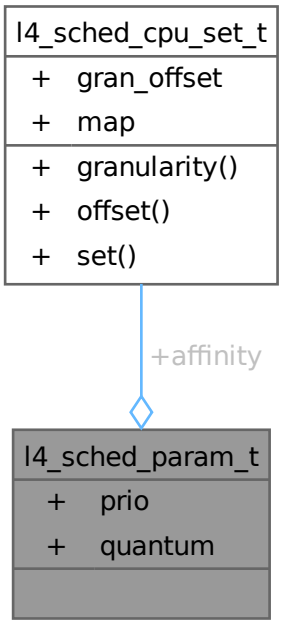
Definition at line 72 of file scheduler.h.
Referenced by granularity(), L4::Scheduler::info(), l4_sched_cpu_set(), offset(), and set().
The documentation for this struct was generated from the following file:

- l4/sys/scheduler.h

15.247 l4_sched_param_t Struct Reference

Scheduler parameter set.
`#include <scheduler.h>`

Collaboration diagram for l4_sched_param_t:



Data Fields

- l4_sched_cpu_set_t **affinity**

  CPU affinity.
- l4_umword_t prio

  Priority for scheduling.
- l4_umword_t **quantum**

  Timeslice in micro seconds.

15.247.1 Detailed Description

Scheduler parameter set.

Examples

examples/sys/aliens/main.c, examples/sys/migrate/thread_migrate.cc, examples/sys/singlestep/main.c, examples/sys/start-with-exc/main.c, and examples/sys/utcb-ipc/main.c.

Definition at line 173 of file scheduler.h.

15.247.2 Field Documentation

15.247.2.1 prio

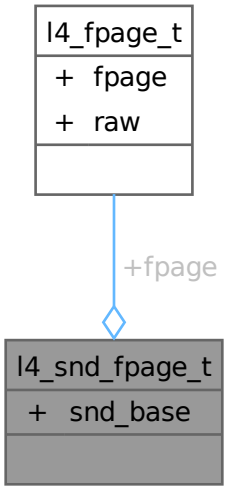
```
l4_umword_t l4_sched_param_t::prio
```

Priority for scheduling.
The kernel supports priorities for userland threads in the range of 1..255. Priority 0 is reserved for the kernel.
Definition at line 182 of file scheduler.h.
Referenced by l4_sched_param().
The documentation for this struct was generated from the following file:

- l4/sys/scheduler.h

15.248 l4_snd_fpage_t Struct Reference

Send-flexpage types.
`#include <__l4_fpage.h>`
Collaboration diagram for l4_snd_fpage_t:



Data Fields

- l4_umword_t **snd_base**

  Offset in receive window (send base).
- l4_fpage_t **fpage**

  Source flexpage descriptor.

15.248.1 Detailed Description

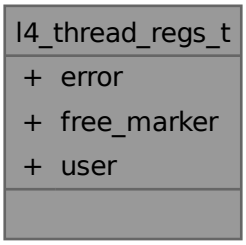
Send-flexpage types.
Definition at line 99 of file __l4_fpage.h.
The documentation for this struct was generated from the following file:

- l4/sys/__l4_fpage.h

15.249 l4_thread_regs_t Struct Reference

Encapsulation of the thread-control-register block of the UTCB.
`#include <utcb.h>`

Collaboration diagram for l4_thread_regs_t:



Data Fields

- l4_umword_t error

  System call error code (see l4_ipc_tcr_error_t).
- l4_umword_t free_marker

  Kernel free marker.
- l4_umword_t **user** [3]

  User values (ignored and preserved by the kernel).

15.249.1 Detailed Description

Encapsulation of the thread-control-register block of the UTCB.
Definition at line 164 of file utcb.h.

15.249.2 Field Documentation

15.249.2.1 error

```
l4_umword_t l4_thread_regs_t::error
```

System call error code (see l4_ipc_tcr_error_t).
If the kernel indicates an error in the message tag (see l4_msgtag_has_error() and l4_msgtag_t::has_error()), the kernel writes the error code to this field.
Definition at line 171 of file utcb.h.

15.249.2.2 free_marker

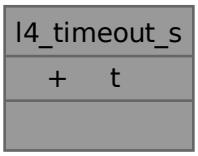
```
l4_umword_t l4_thread_regs_t::free_marker
```

Kernel free marker.
The kernel sets this field to zero as soon as it is guaranteed that the kernel does not use the UTCB anymore for the bound thread. This usually happens while a thread is deleted. However, it is not defined when exactly the kernel sets the field. In particular, the point in time is not necessarily related to any IPC.
Userland may use this field for determining if a UTCB can be re-used for another thread. Note that, in order to make use of that feature, userland has to set this field to a non-zero value when a thread is bound with this UTCB.
Definition at line 185 of file utcb.h.
The documentation for this struct was generated from the following file:

- l4/sys/utcb.h

15.250 l4_timeout_s Struct Reference

Basic timeout specification.
`#include <__timeout.h>`
Collaboration diagram for l4_timeout_s:



Data Fields

- l4_uint16_t **t**

  timeout value

15.250.1 Detailed Description

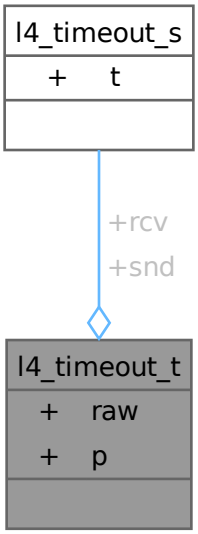
Basic timeout specification.
If bit 15 == 0, basically a floating point number with 10 bits mantissa and 5 bits exponent (t = m∗2^e).
If the mantissa is zero, the exponent encodes special values, see L4_IPC_TIMEOUT_0 and L4_IPC_TIMEOUT_NEVER.
If bit 15 == 1 the timeout is absolute and the lower 6 bits encode the index of the UTCB buffer register(s) holding the absolute 64-bit timeout value. On 32-bit systems, two consecutive UTCB buffer registers are used.
Definition at line 40 of file __timeout.h.
The documentation for this struct was generated from the following file:

- l4/sys/__timeout.h

15.251 l4_timeout_t Union Reference

Timeout pair.
`#include <__timeout.h>`

Collaboration diagram for l4_timeout_t:



Data Fields

- l4_uint32_t **raw**
  raw value
- struct {
  l4_timeout_s **rcv**
  receive timeout
  l4_timeout_s **snd**
  send timeout
  } **p**

  combined timeout

15.251.1 Detailed Description

Timeout pair.
For IPC there are usually a send and a receive timeout. So this structure contains a pair of timeouts.
Definition at line 52 of file __timeout.h.
The documentation for this union was generated from the following file:

- l4/sys/__timeout.h

15.252 l4_vcon_attr_t Struct Reference

Vcon attribute structure.
`#include <vcon.h>`

Collaboration diagram for l4_vcon_attr_t:



Public Member Functions

- void set_raw ()

  Set terminal attributes to disable all special processing.

Data Fields

- l4_umword_t **i_flags**

  input flags
- l4_umword_t **o_flags**

  output flags
- l4_umword_t **l_flags**

  local flags

15.252.1 Detailed Description

Vcon attribute structure.
The flags members can be a combination of their respective enums.

See also

L4_vcon_i_flags

L4_vcon_o_flags

L4_vcon_l_flags

Examples

examples/sys/isr/main.c.

Definition at line 187 of file vcon.h.

15.252.2 Member Function Documentation

15.252.2.1 set_raw()

```
void l4_vcon_attr_t::set_raw ()  [inline]
```

Set terminal attributes to disable all special processing.
Removes all flags that would mangle the read or written characters. Also disables echoing and any special processing of characters.
Definition at line 450 of file vcon.h.
References l4_vcon_set_attr_raw().

Here is the call graph for this function:

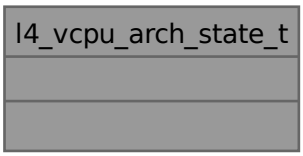


The documentation for this struct was generated from the following file:

- l4/sys/vcon.h

15.253 l4_vcpu_arch_state_t Struct Reference

Architecture-specific vCPU state.
`#include <__vcpu-arch.h>`
Collaboration diagram for l4_vcpu_arch_state_t:



15.253.1 Detailed Description

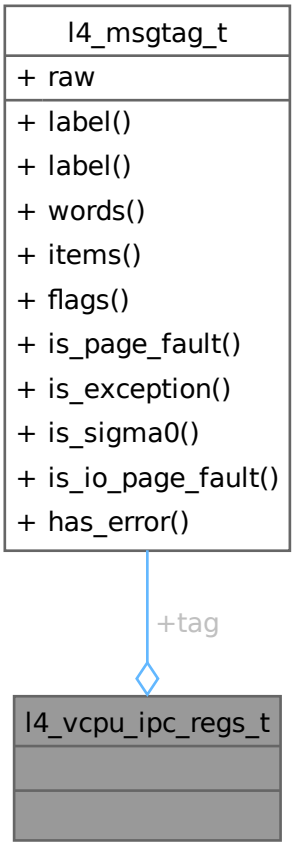
Architecture-specific vCPU state.
Definition at line 74 of file __vcpu-arch.h.
The documentation for this struct was generated from the following files:

- arm/l4/sys/__vcpu-arch.h
- arm64/l4/sys/__vcpu-arch.h
- amd64/l4/sys/__vcpu-arch.h
- riscv/l4/sys/__vcpu-arch.h

15.254 l4_vcpu_ipc_regs_t Struct Reference

vCPU message registers.
`#include <__vcpu-arch.h>`

Collaboration diagram for l4_vcpu_ipc_regs_t:



15.254.1 Detailed Description

vCPU message registers.
Definition at line 83 of file __vcpu-arch.h.
The documentation for this struct was generated from the following files:

- arm/l4/sys/__vcpu-arch.h
- arm64/l4/sys/__vcpu-arch.h
- amd64/l4/sys/__vcpu-arch.h
- x86/l4/sys/__vcpu-arch.h
- riscv/l4/sys/__vcpu-arch.h

15.255 l4_vcpu_regs_t Struct Reference

vCPU registers.
`#include <__vcpu-arch.h>`

Collaboration diagram for l4_vcpu_regs_t:



Data Fields

- l4_umword_t **pfa**
  page fault address
- l4_umword_t **err**
  error code
- l4_umword_t **sp**
  stack pointer
- l4_umword_t **ip**
  instruction pointer
- l4_umword_t **flags**
  eflags
- l4_umword_t **tpidruro**
  Thread-ID register.
- l4_umword_t **tpidrurw**
  Thread-ID register.
- l4_umword_t **r15**
  r15 register
- l4_umword_t **r14**
  r14 register
- l4_umword_t **r13**
  r13 register
- l4_umword_t **r12**
  r12 register
- l4_umword_t **r11**
  r11 register

- l4_umword_t **r10**
  r10 register
- l4_umword_t **r9**
  r9 register
- l4_umword_t **r8**
  r8 register
- l4_umword_t di
  rdi register
- l4_umword_t si
  rsi register
- l4_umword_t bp
  rbp register
- l4_umword_t bx
  rbx register
- l4_umword_t dx
  rdx register
- l4_umword_t cx
  rcx register
- l4_umword_t ax
  rax register
- l4_umword_t **trapno**
  trap number
- l4_umword_t **cs**
  dummy
- l4_umword_t **ss**
  ss register
- l4_umword_t **es**
  es register
- l4_umword_t **ds**
  ds register
- l4_umword_t **gs**
  gs register
- l4_umword_t **fs**
  fs register
- l4_umword_t **dummy1**
  dummy

15.255.1 Detailed Description

vCPU registers.
Definition at line 55 of file __vcpu-arch.h.

15.255.2 Field Documentation

15.255.2.1 ax

```
l4_umword_t l4_vcpu_regs_t::ax
```

rax register
eax register
Definition at line 77 of file __vcpu-arch.h.

15.255.2.2 bp

`l4_umword_t l4_vcpu_regs_t::bp`
rbp register
ebp register
Definition at line 72 of file __vcpu-arch.h.

15.255.2.3 bx

`l4_umword_t l4_vcpu_regs_t::bx`
rbx register
ebx register
Definition at line 74 of file __vcpu-arch.h.

15.255.2.4 cx

`l4_umword_t l4_vcpu_regs_t::cx`
rcx register
ecx register
Definition at line 76 of file __vcpu-arch.h.

15.255.2.5 di

`l4_umword_t l4_vcpu_regs_t::di`
rdi register
edi register
Definition at line 70 of file __vcpu-arch.h.

15.255.2.6 dx

`l4_umword_t l4_vcpu_regs_t::dx`
rdx register
edx register
Definition at line 75 of file __vcpu-arch.h.

15.255.2.7 si

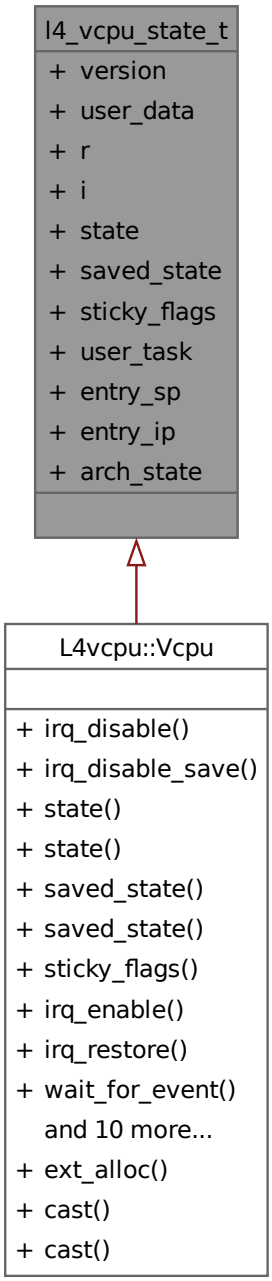
`l4_umword_t l4_vcpu_regs_t::si`
rsi register
esi register
Definition at line 71 of file __vcpu-arch.h.
The documentation for this struct was generated from the following files:

- arm/l4/sys/__vcpu-arch.h
- amd64/l4/sys/__vcpu-arch.h
- x86/l4/sys/__vcpu-arch.h

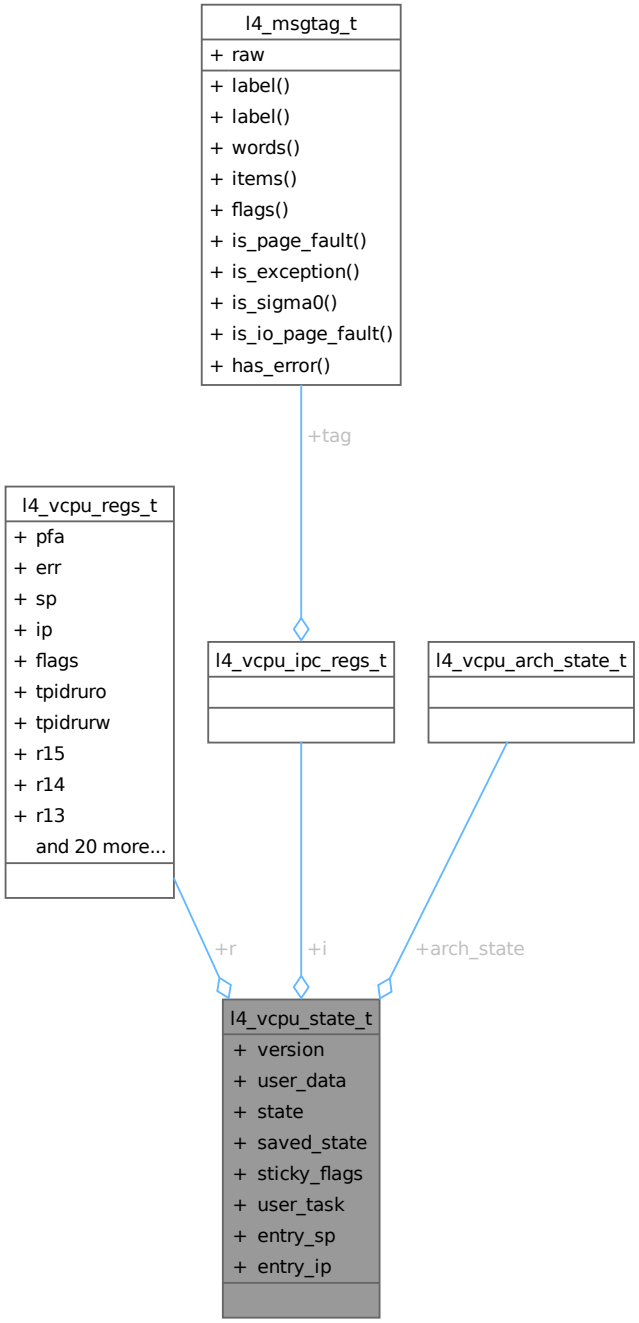
15.256 l4_vcpu_state_t Struct Reference

State of a vCPU.
`#include <vcpu.h>`

Inheritance diagram for l4_vcpu_state_t:



Collaboration diagram for l4_vcpu_state_t:



Data Fields

- l4_umword_t version

  vCPU ABI version.
- l4_umword_t **user_data** [7]

  User-specific data.
- l4_vcpu_regs_t **r**

  Register state.

- l4_vcpu_ipc_regs_t **i**

  IPC state.
- l4_uint16_t **state**

  Current vCPU state. See L4_vcpu_state_flags.
- l4_uint16_t **saved_state**

  Saved vCPU state. See L4_vcpu_state_flags.
- l4_uint16_t **sticky_flags**

  Pending flags. See L4_vcpu_sticky_flags.
- l4_cap_idx_t **user_task**

  User task to use.
- l4_umword_t **entry_sp**

  Stack pointer for entry (when coming from user task).
- l4_umword_t **entry_ip**

  IP for entry.
- l4_vcpu_arch_state_t **arch_state**

  Architecture-specific state.

15.256.1 Detailed Description

State of a vCPU.
Definition at line 75 of file vcpu.h.

15.256.2 Field Documentation

15.256.2.1 version

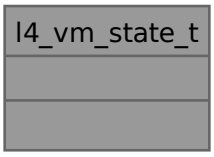
```
l4_umword_t l4_vcpu_state_t::version
```

vCPU ABI version.
Set by the kernel and must be checked by the user for equality with L4_VCPU_STATE_VERSION.
Definition at line 77 of file vcpu.h.
The documentation for this struct was generated from the following file:

- l4/sys/vcpu.h

15.257 l4_vm_state_t Struct Reference

L4 extended vCPU state for RISC-V.
`#include <vm.h>`
Collaboration diagram for l4_vm_state_t:



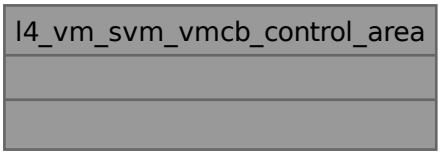
15.257.1 Detailed Description

L4 extended vCPU state for RISC-V.
Contains the additional RISC-V guest state accompanying the `l4_vcpu_state_t`.
Definition at line 50 of file vm.h.
The documentation for this struct was generated from the following file:

- riscv/l4/sys/vm.h

15.258 l4_vm_svm_vmcb_control_area Struct Reference

VMCB structure for SVM VMs.
`#include <__vm-svm.h>`
Collaboration diagram for l4_vm_svm_vmcb_control_area:



15.258.1 Detailed Description

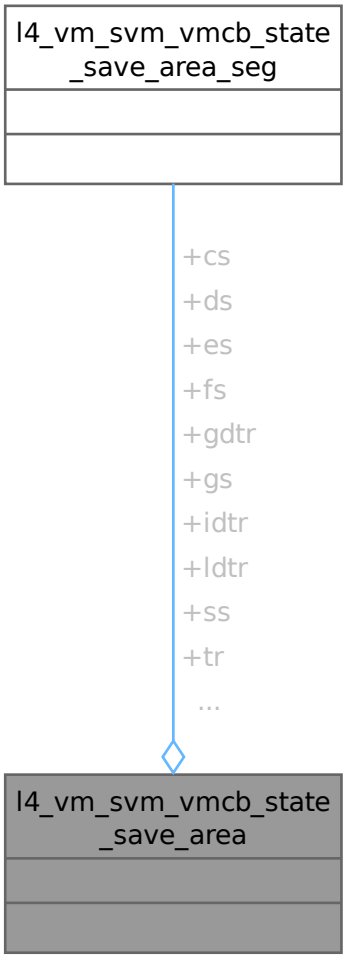
VMCB structure for SVM VMs.
Definition at line 28 of file __vm-svm.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-svm.h

15.259 l4_vm_svm_vmcb_state_save_area Struct Reference

State save area structure for SVM VMs.
`#include <__vm-svm.h>`

Collaboration diagram for l4_vm_svm_vmcb_state_save_area:



15.259.1 Detailed Description

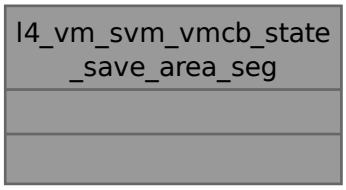
State save area structure for SVM VMs.
Definition at line 85 of file __vm-svm.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-svm.h

15.260 l4_vm_svm_vmcb_state_save_area_seg Struct Reference

State save area segment selector struct.
`#include <__vm-svm.h>`

Collaboration diagram for l4_vm_svm_vmcb_state_save_area_seg:



15.260.1 Detailed Description

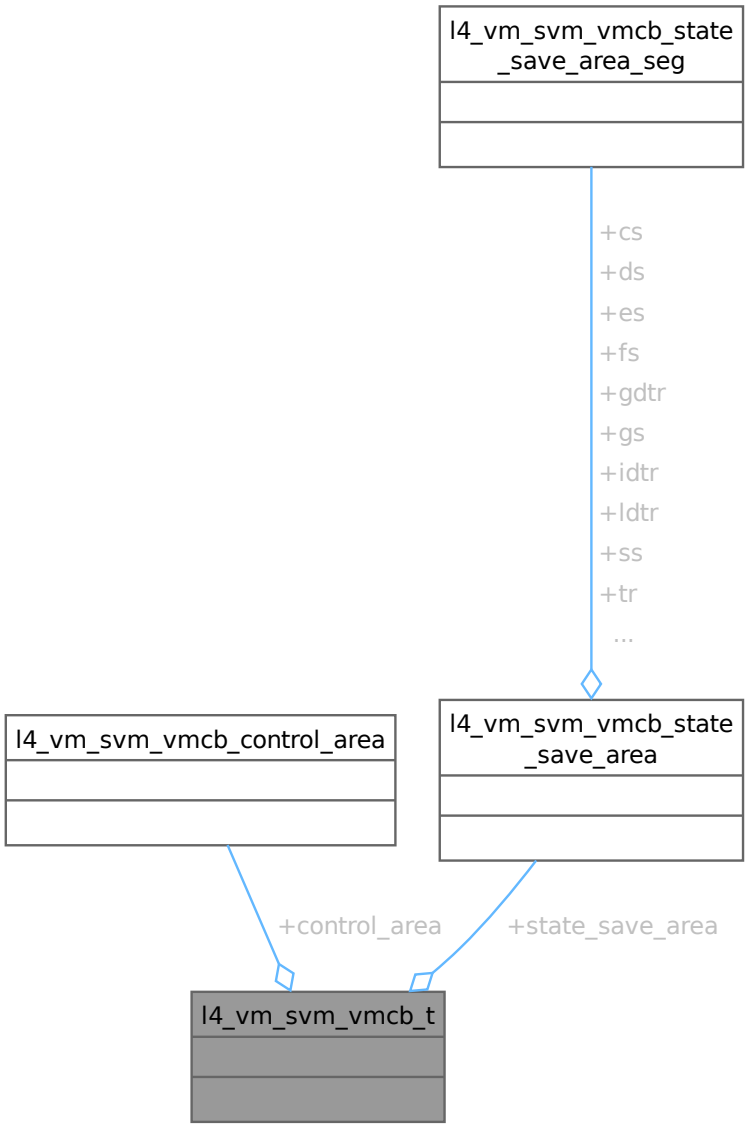
State save area segment selector struct.
Definition at line 73 of file __vm-svm.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-svm.h

15.261 l4_vm_svm_vmcb_t Struct Reference

Control structure for SVM VMs.
`#include <__vm-svm.h>`

Collaboration diagram for l4_vm_svm_vmcb_t:



15.261.1 Detailed Description

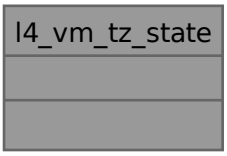
Control structure for SVM VMs.
Definition at line 154 of file __vm-svm.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-svm.h

15.262 l4_vm_tz_state Struct Reference

state structure for TrustZone VMs
`#include <vm.h>`

Collaboration diagram for l4_vm_tz_state:



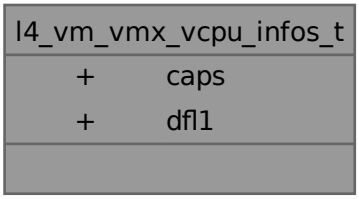
15.262.1 Detailed Description

state structure for TrustZone VMs
Definition at line 44 of file vm.h.
The documentation for this struct was generated from the following file:

- arm/l4/sys/vm.h

15.263 l4_vm_vmx_vcpu_infos_t Struct Reference

VMX information members.
`#include <__vm-vmx.h>`
Collaboration diagram for l4_vm_vmx_vcpu_infos_t:



Data Fields

- l4_uint64_t **caps** [L4_VM_VMX_NUM_CAPS_REGS]

  Exported VMX capability registers. See L4_vm_vmx_caps_regs.
- l4_uint32_t dfl1 [L4_VM_VMX_NUM_DFL1_REGS]

  Exported VMX capability registers (default to 1 bits).

15.263.1 Detailed Description

VMX information members.
Definition at line 239 of file __vm-vmx.h.

15.263.2 Field Documentation

15.263.2.1 dfl1

```
l4_uint32_t l4_vm_vmx_vcpu_infos_t::dfl1[L4_VM_VMX_NUM_DFL1_REGS]
```

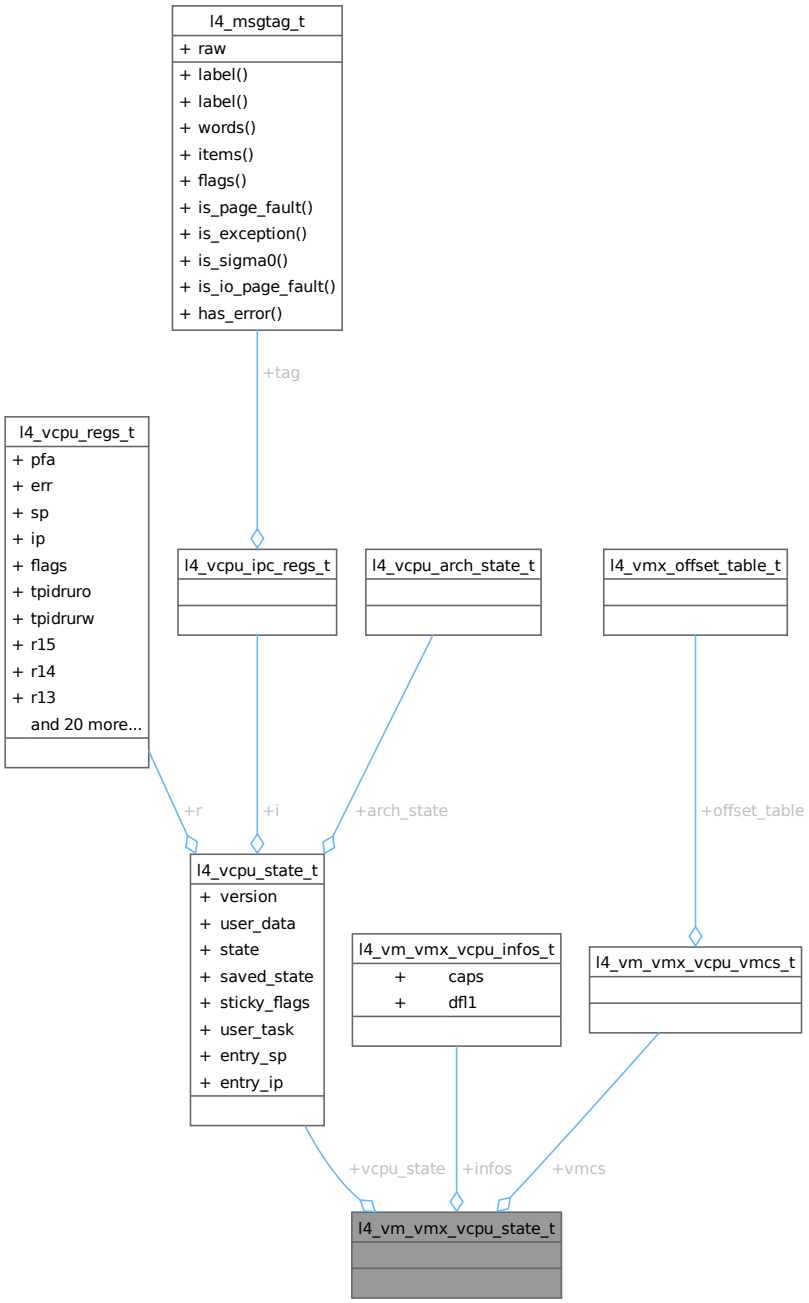
Exported VMX capability registers (default to 1 bits).
See L4_vm_vmx_dfl1_regs.
Definition at line 246 of file __vm-vmx.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-vmx.h

15.264 l4_vm_vmx_vcpu_state_t Struct Reference

VMX vCPU state.
`#include <__vm-vmx.h>`

Collaboration diagram for l4_vm_vmx_vcpu_state_t:



15.264.1 Detailed Description

VMX vCPU state.
This is a specialization of the generic vCPU state for VMX. This data structure represents the following memory layout:

- 0x000 - 0x1ff: Standard vCPU state (with padding). See l4_vcpu_state_t.
- 0x200 - 0x3ff: VMX information members (with padding). See l4_vm_vmx_vcpu_infos_t.
- 0x400 - 0xfff: VMX software VMCS. See l4_vm_vmx_vcpu_vmcs_t.

Note

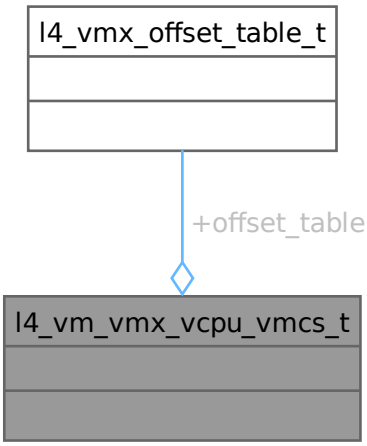
The memory layout is documented here for reference purposes. However, the users are strongly discouraged from accessing the data structure directly. The API functions defined in this file are the preferred way of achieving the functionality.

Definition at line 267 of file __vm-vmx.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-vmx.h

15.265 l4_vm_vmx_vcpu_vmcs_t Struct Reference

VMX software VMCS.
`#include <__vm-vmx.h>`
Collaboration diagram for l4_vm_vmx_vcpu_vmcs_t:



15.265.1 Detailed Description

VMX software VMCS.
This data structure represents the following memory layout:

- 0x000 - 0x007: Reserved (ignored by the kernel). In the hardware VMCS, the revision identifier and the abort indicator are stored in this area. Hereby we simply ignore these two entries.
- 0x008 - 0x00f: User space data (ignored by the kernel). This currently stores the pointer to a different software VMCS whose content has been loaded to this software VMCS.
- 0x010 - 0x013: VMCS field index of the software-defined CR2 field in the software VMCS.
- 0x014 - 0x017: Reserved.
- 0x018 - 0x01f: Capability of the vCPU context, i.e. the hardware VMCS object (with padding).
- 0x020 - 0x047: Software VMCS field offset table. See l4_vmx_offset_table_t.
- 0x048 - 0x0bf: Reserved.
- 0x0c0 - 0xabf: Software VMCS fields (with padding).
- 0xac0 - 0xbff: Software VMCS fields dirty bitmap (with padding).

Note

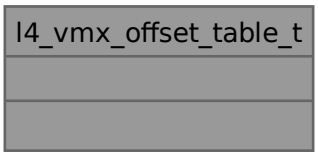
The memory layout is documented here for reference purposes. However, the users are strongly discouraged from accessing the data structure directly. The API functions defined in this file are the preferred way of achieving the functionality.

Definition at line 205 of file __vm-vmx.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-vmx.h

15.266 l4_vmx_offset_table_t Struct Reference

Software VMCS field offset table.
`#include <__vm-vmx.h>`
Collaboration diagram for l4_vmx_offset_table_t:



15.266.1 Detailed Description

Software VMCS field offset table.
This data structure represents the following memory layout:

- 0x00 - 0x02: 3 offsets for 16-bit fields.
- 0x03: Reserved.
- 0x04 - 0x06: 3 offsets for 64-bit fields.
- 0x07: Reserved.
- 0x08 - 0x0a: 3 offsets for 32-bit fields.
- 0x0b: Reserved.
- 0x0c - 0x0e: 3 offsets for natural-width fields.
- 0x0f: Reserved.
- 0x10 - 0x12: 3 limits for 16-bit fields.
- 0x13: Reserved.
- 0x14 - 0x16: 3 limits for 64-bit fields.
- 0x17: Reserved.
- 0x18 - 0x1a: 3 limits for 32-bit fields.
- 0x1b: Reserved.
- 0x1c - 0x1e: 3 limits for natural-width fields.

- 0x1f: Reserved.
- 0x20 - 0x23: 4 index shifts.
- 0x24: Offset of the first software VMCS field.
- 0x25: Size of the software VMCS fields.
- 0x26 - 0x27: Reserved.

The offsets/limits in each size category are in the following order:

- Control fields.
- Read-only fields.
- Guest fields.

The index shifts are in the following order:

- 16-bit.
- 64-bit.
- 32-bit.
- Natural-width.

All offsets/limits/sizes are represented in a 64-byte granule.
The offsets (after being multiplied by 64) are indexes in the values array in l4_vm_vmx_vcpu_vmcs_t and bit indexes in the dirty_bitmap array in l4_vm_vmx_vcpu_vmcs_t.
The limits (after being multiplied by 64) represent the range of the available indexes.

Note

The memory layout is documented here for reference purposes. However, the users are strongly discouraged from accessing the data structure directly. The API functions defined in this file are the preferred way of achieving the functionality.

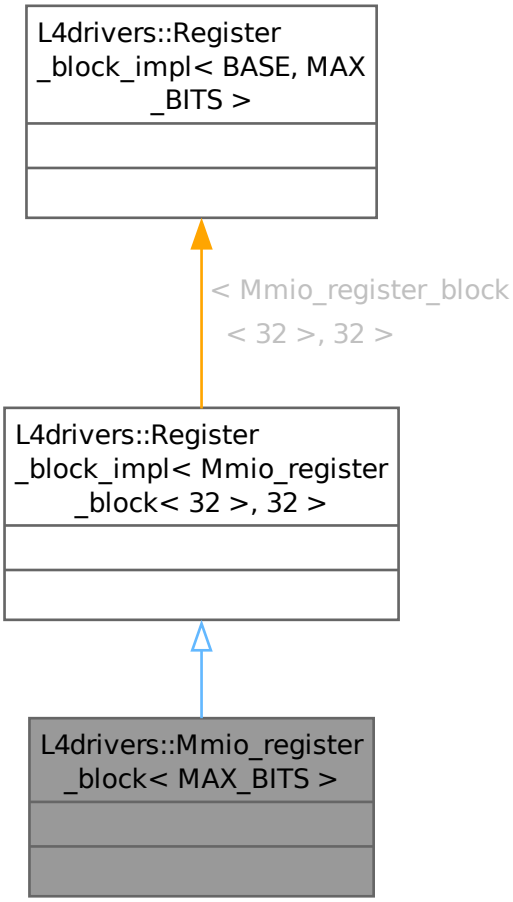
Definition at line 155 of file __vm-vmx.h.
The documentation for this struct was generated from the following file:

- l4/sys/__vm-vmx.h

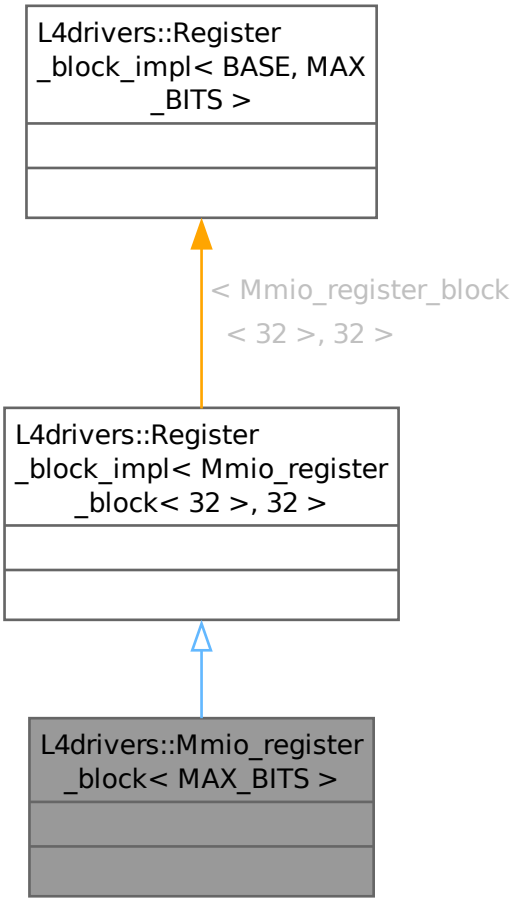
15.267 L4drivers::Mmio_register_block< MAX_BITS > Struct Template Reference

An MMIO block with up to 64-bit register access (32-bit default) and little endian byte order.
`#include <hw_mmio_register_block>`

Inheritance diagram for L4drivers::Mmio_register_block< MAX_BITS >:



Collaboration diagram for L4drivers::Mmio_register_block< MAX_BITS >:



15.267.1 Detailed Description

template<unsigned MAX_BITS = 32>
struct L4drivers::Mmio_register_block< MAX_BITS >

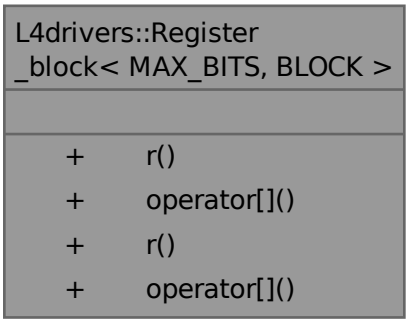
An MMIO block with up to 64-bit register access (32-bit default) and little endian byte order.
Definition at line 45 of file hw_mmio_register_block.
The documentation for this struct was generated from the following file:

- pkg/drivers-frst/include/hw_mmio_register_block

15.268 L4drivers::Register_block< MAX_BITS, BLOCK > Class Template Reference

Handles a reference to a register block of the given maximum access width.
`#include <hw_register_block>`

Collaboration diagram for L4drivers::Register_block< MAX_BITS, BLOCK >:



Public Member Functions

- template<unsigned BITS>
  Ro_register_tmpl< BITS, Block > r (unsigned offset) const

  Read only access to register at offset offset.
- Ro_register operator[ ] (unsigned offset) const

  Read only access to register at offset offset.
- template<unsigned BITS>
  Register_tmpl< BITS, Block > r (unsigned offset)

  Read/write access to register at offset offset.
- Register operator[ ] (unsigned offset)

  Read/write access to register at offset offset.

15.268.1 Detailed Description

template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩ BITS> >>
class L4drivers::Register_block< MAX_BITS, BLOCK >

Handles a reference to a register block of the given maximum access width.
Register block.

Template Parameters

MAX_BITS	Maximum access width for the registers in this block.
BLOCK	Type implementing the register accesses (`read<>()`, `write<>()`, `modify<>()`, `set<>()`, and `clear<>()`).

Provides access to registers in this block via r<WIDTH>() and operator[]().
Example usage:

```
void test()
{
  // create a register block reference for max. 16bit accesses, using a
  // MMIO register block implementation (at address 0x1000).
  Hw::Register_block<16> regs = new Hw::Mmio_register_block<16>(0x1000);

  // Alternatively it is allowed to use an implementation that allows
  // wider access than actually needed.
```

```
  Hw::Register_block<16> regs = new Hw::Mmio_register_block<32>(0x1000);

  // read a 16bit register at offset 8byte
  unsigned short x = regs.r<16>(8);
  unsigned short x1 = regs[8];      // alternative

  // read an 8bit register at offset 0byte
  unsigned v = regs.r<8>(0);

  // do a 16bit write to register at offset 2byte (four variants)
  regs[2] = 22;
  regs.r<16>(2) = 22;
  regs[2].write(22);
  regs.r<16>().write(22);

  // do an 8bit write (two variants)
  regs.r<8>(0) = 9;
  regs.r<8>(0).write(9);

  // do 16bit read-modify-write (two variants)
  regs[4].modify(0xf, 3); // clear 4 lowest bits and set them to 3
  regs.r<16>(4).modify(0xf, 3);

  // do 8bit read-modify-write
  regs.r<8>(0).modify(0xf, 3);

  // fails to compile, because of too wide access
  // (32 bit access but regs is Hw::Register_block<16>)
  unsigned long v = regs.r<32>(4)
}
```

Definition at line 330 of file hw_register_block.

15.268.2 Member Function Documentation

15.268.2.1 operator[]() [1/2]

```
template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩
BITS> >>
Register L4drivers::Register_block< MAX_BITS, BLOCK >::operator[] (
             unsigned offset)  [inline]
```

Read/write access to register at offset *offset*.

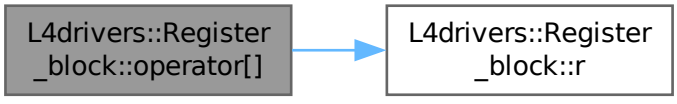
Parameters

offset	The offset of the register within the register file.

Returns

register object allowing read and write access with width *MAX_BITS*.

Definition at line 385 of file hw_register_block.
References r().
Here is the call graph for this function:



15.268.2.2 operator[]() [2/2]

```
template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩
BITS> >>
Ro_register L4drivers::Register_block< MAX_BITS, BLOCK >::operator[] (
            unsigned offset) const  [inline]
```

Read only access to register at offset *offset*.

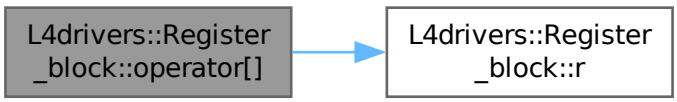
Parameters

offset	The offset of the register within the register file.

Returns

register object allowing read only access with width *MAX_BITS*.

Definition at line 365 of file hw_register_block.
References r().
Here is the call graph for this function:



15.268.2.3 r() [1/2]

```
template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩
BITS> >>
template<unsigned BITS>
Register_tmpl< BITS, Block > L4drivers::Register_block< MAX_BITS, BLOCK >::r (
            unsigned offset)  [inline]
```

Read/write access to register at offset *offset*.

Template Parameters

BITS	the access width in bits for the register.

Parameters

offset	The offset of the register within the register file.

Returns

register object allowing read and write access with width *BITS*.

Definition at line 376 of file hw_register_block.

15.268.2.4 r() [2/2]

```
template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩
BITS> >>
template<unsigned BITS>
Ro_register_tmpl< BITS, Block > L4drivers::Register_block< MAX_BITS, BLOCK >::r (
            unsigned offset) const  [inline]
```

Read only access to register at offset *offset*.

Template Parameters

BITS	the access width in bits for the register.

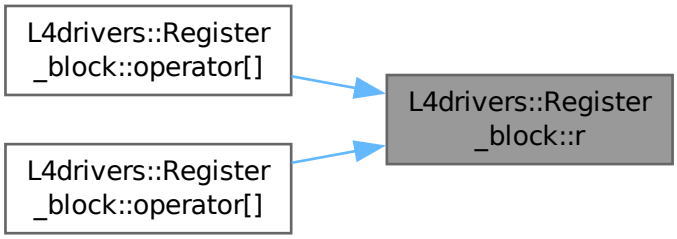
Parameters

offset	The offset of the register within the register file.

Returns

register object allowing read only access with width *BITS*.

Definition at line 357 of file hw_register_block.
Referenced by operator[ ](), and operator[ ]().
Here is the caller graph for this function:



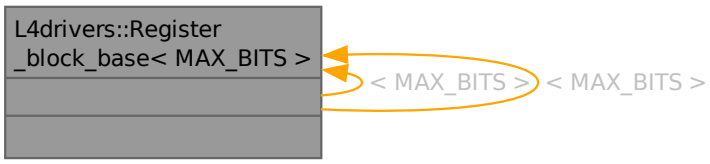
The documentation for this class was generated from the following file:

- pkg/drivers-frst/include/hw_register_block

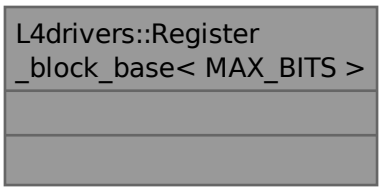
15.269 L4drivers::Register_block_base< MAX_BITS > Struct Template Reference

Abstract register block interface.

Inheritance diagram for L4drivers::Register_block_base< MAX_BITS >:



Collaboration diagram for L4drivers::Register_block_base< MAX_BITS >:



15.269.1 Detailed Description

template<unsigned MAX_BITS = 32>
struct L4drivers::Register_block_base< MAX_BITS >

Abstract register block interface.

Template Parameters

MAX_BITS	The maximum access width for the registers.

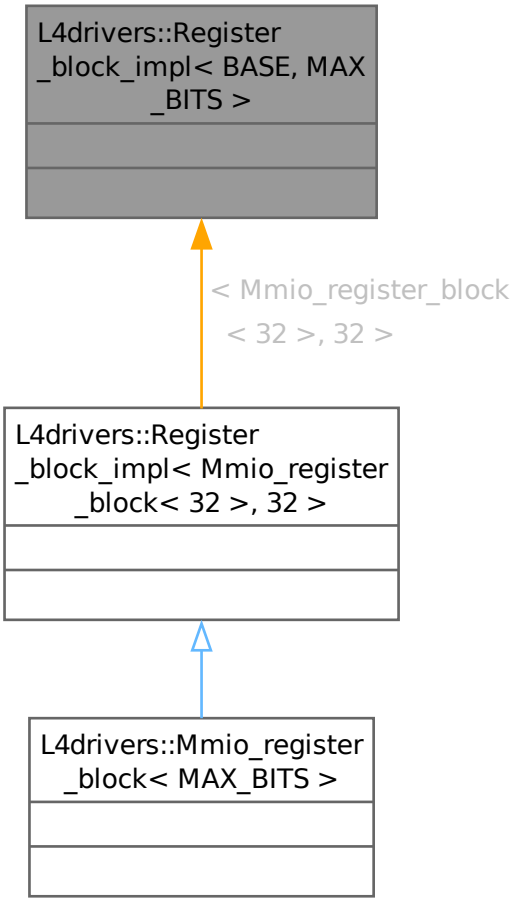
This interfaces is based on virtual do_read_<xx> and do_write_<xx> methods that have to be implemented up to the maximum access width.
Definition at line 72 of file hw_register_block.
The documentation for this struct was generated from the following file:

- pkg/drivers-frst/include/hw_register_block

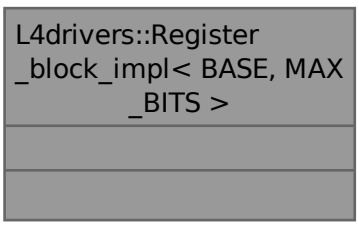
15.270 L4drivers::Register_block_impl< BASE, MAX_BITS > Struct Template Reference

Implementation helper for register blocks.

Inheritance diagram for L4drivers::Register_block_impl< BASE, MAX_BITS >:



Collaboration diagram for L4drivers::Register_block_impl< BASE, MAX_BITS >:



15.270.1 Detailed Description

template<typename BASE, unsigned MAX_BITS = 32>
struct L4drivers::Register_block_impl< BASE, MAX_BITS >

Implementation helper for register blocks.

Parameters

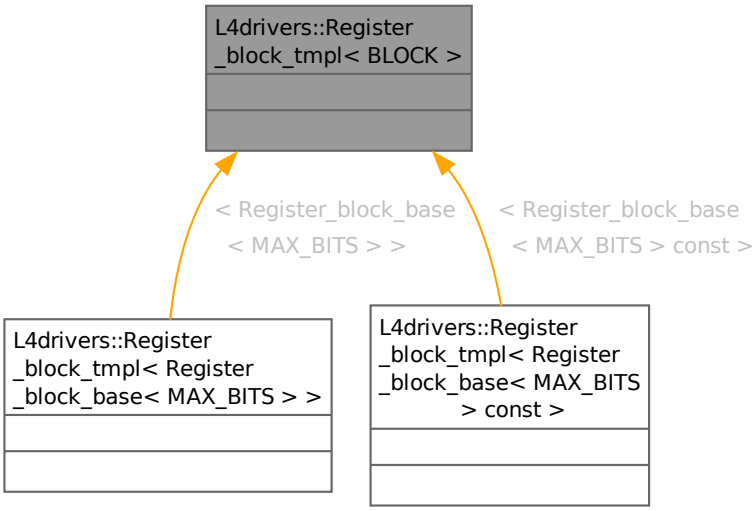
BASE	The class implementing read<> and write<> template functions for accessing the registers. This class must inherit from Register_block_impl.
MAX_BITS	The maximum access width for the register file. Supported values are 8, 16, 32, or 64.

This template allows easy implementation of register files by providing read<> and write<> template functions, see Mmio_register_block as an example.
Definition at line 455 of file hw_register_block.
The documentation for this struct was generated from the following file:

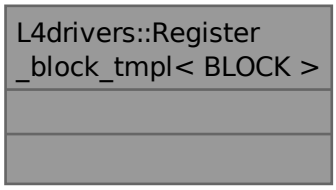
- pkg/drivers-frst/include/hw_register_block

15.271 L4drivers::Register_block_tmpl< BLOCK > Class Template Reference

Helper template that translates to the Register_block_base interface.
`#include <hw_register_block>`
Inheritance diagram for L4drivers::Register_block_tmpl< BLOCK >:



Collaboration diagram for L4drivers::Register_block_tmpl< BLOCK >:



15.271.1 Detailed Description

template<typename BLOCK>
class L4drivers::Register_block_tmpl< BLOCK >

Helper template that translates to the Register_block_base interface.

Template Parameters

BLOCK	The type of the Register_block_base interface to use.

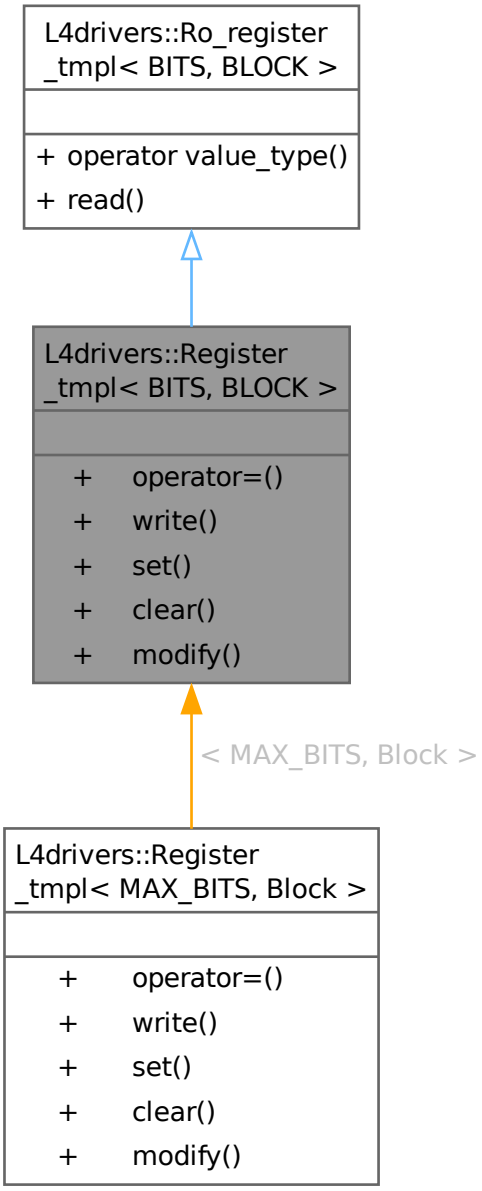
This helper translates read<T>(), write<T>(), set<T>(), clear<T>(), and modify<T>() calls to BLOCK::do_read_<xx> and BLOCK::do_write_<xx>.
Definition at line 156 of file hw_register_block.
The documentation for this class was generated from the following file:

- pkg/drivers-frst/include/hw_register_block

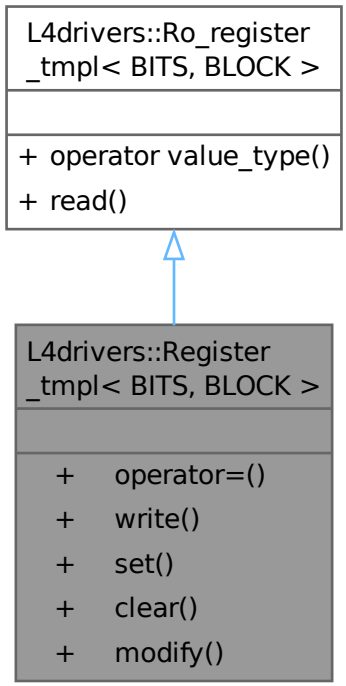
15.272 L4drivers::Register_tmpl< BITS, BLOCK > Class Template Reference

Single hardware register inside a Register_block_base interface.
`#include <hw_register_block>`

Inheritance diagram for L4drivers::Register_tmpl< BITS, BLOCK >:



Collaboration diagram for L4drivers::Register_tmpl< BITS, BLOCK >:



Public Member Functions

- Register_tmpl & operator= (value_type val)
  write val into the hardware register.
- void write (value_type val)
  write val into the hardware register.
- value_type set (value_type set_bits)
  set bits in set_bits in the hardware register.
- value_type clear (value_type clear_bits)
  clears bits in clear_bits in the hardware register.
- value_type modify (value_type clear_bits, value_type set_bits)
  clears bits in clear_bits and sets bits in set_bits in the hardware register.

Public Member Functions inherited from L4drivers::Ro_register_tmpl< BITS, BLOCK >

- operator value_type () const
  read the value from the hardware register.
- value_type read () const
  read the value from the hardware register.

15.272.1 Detailed Description

template<unsigned BITS, typename BLOCK>
class L4drivers::Register_tmpl< BITS, BLOCK >

Single hardware register inside a Register_block_base interface.

Template Parameters

BITS	The access width for the register in bits.
BLOCK	the type of the Register_block_base interface.

Note

Objects of this type must be used only in temporary contexts not in global, class, or object scope.

Definition at line 237 of file hw_register_block.

15.272.2 Member Function Documentation

15.272.2.1 clear()

```
template<unsigned BITS, typename BLOCK>
value_type L4drivers::Register_tmpl< BITS, BLOCK >::clear (
             value_type clear_bits)  [inline]
```

clears bits in *clear_bits* in the hardware register.

Parameters

clear_bits	bits to be cleared within the hardware register.

This is a read-modify-write function that does a logical and of the old value from the register with the negated value of *clear_bits*.

```
unsigned old_value = read();
write(old_value & ~clear_bits);
```

Definition at line 290 of file hw_register_block.
Referenced by L4drivers::Register_tmpl< MAX_BITS, Block >::clear().
Here is the caller graph for this function:



15.272.2.2 modify()

```
template<unsigned BITS, typename BLOCK>
value_type L4drivers::Register_tmpl< BITS, BLOCK >::modify (
             value_type clear_bits,
             value_type set_bits)  [inline]
```

clears bits in *clear_bits* and sets bits in *set_bits* in the hardware register.

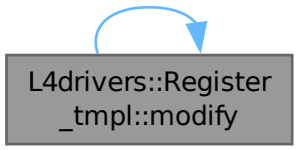
Parameters

clear_bits	bits to be cleared within the hardware register.
set_bits	bits to set in the hardware register.

This is a read-modify-write function that first does a logical and of the old value from the register with the negated value of *clear_bits* and then does a logical or with *set_bits*.

```
unsigned old_value = read();
write((old_value & ~clear_bits) | set_bits);
```

Definition at line 308 of file hw_register_block.
Referenced by L4drivers::Register_tmpl< MAX_BITS, Block >::modify().
Here is the caller graph for this function:



15.272.2.3 operator=()

```
template<unsigned BITS, typename BLOCK>
Register_tmpl & L4drivers::Register_tmpl< BITS, BLOCK >::operator= (
            value_type val)  [inline]
```

write *val* into the hardware register.

Parameters

val	the value to write into the hardware register.

Definition at line 252 of file hw_register_block.

15.272.2.4 set()

```
template<unsigned BITS, typename BLOCK>
value_type L4drivers::Register_tmpl< BITS, BLOCK >::set (
            value_type set_bits)  [inline]
```

set bits in *set_bits* in the hardware register.

Parameters

set_bits	bits to be set within the hardware register.

This is a read-modify-write function that does a logical or of the old value from the register with *set_bits*.

```
unsigned old_value = read();
write(old_value | set_bits);
```

Definition at line 274 of file hw_register_block.
Referenced by L4drivers::Register_tmpl< MAX_BITS, Block >::set().

Here is the caller graph for this function:



15.272.2.5 write()

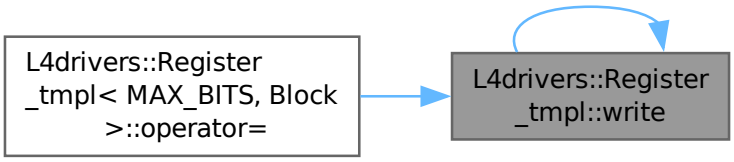
```
template<unsigned BITS, typename BLOCK>
void L4drivers::Register_tmpl< BITS, BLOCK >::write (
             value_type val)  [inline]
```

write *val* into the hardware register.

Parameters

val	the value to write into the hardware register.

Definition at line 259 of file hw_register_block.
Referenced by L4drivers::Register_tmpl< MAX_BITS, Block >::operator=(), and L4drivers::Register_tmpl< MAX_BITS, Block >::writ
Here is the caller graph for this function:



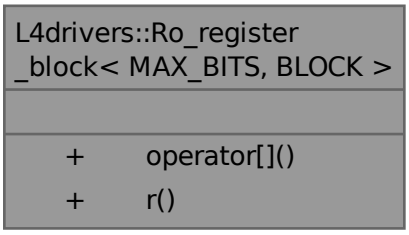
The documentation for this class was generated from the following file:

- pkg/drivers-frst/include/hw_register_block

15.273 L4drivers::Ro_register_block< MAX_BITS, BLOCK > Class Template Reference

Handles a reference to a read only register block of the given maximum access width.
`#include <hw_register_block>`

Collaboration diagram for L4drivers::Ro_register_block< MAX_BITS, BLOCK >:



Public Member Functions

- Ro_register operator[ ] (unsigned offset) const

  Read only access to register at offset offset.
- template<unsigned BITS>
  Ro_register_tmpl< BITS, Block > r (unsigned offset) const

  Read only access to register at offset offset.

15.273.1 Detailed Description

template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩ BITS> const >>
class L4drivers::Ro_register_block< MAX_BITS, BLOCK >

Handles a reference to a read only register block of the given maximum access width.

Template Parameters

MAX_BITS	Maximum access width for the registers in this block.
BLOCK	Type implementing the register accesses (read<>()),

Provides read only access to registers in this block via r<WIDTH>() and operator[ ]().
Definition at line 404 of file hw_register_block.

15.273.2 Member Function Documentation

15.273.2.1 operator[]()

```
template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩
BITS> const >>
Ro_register L4drivers::Ro_register_block< MAX_BITS, BLOCK >::operator[ ] (
            unsigned offset) const  [inline]
```

Read only access to register at offset *offset*.

Parameters

offset	The offset of the register within the register file.

Returns

register object allowing read only access with width *MAX_BITS*.

Definition at line 426 of file hw_register_block.

15.273.2.2 r()

```
template<unsigned MAX_BITS, typename BLOCK = Register_block_tmpl< Register_block_base<MAX_↩
BITS> const >>
template<unsigned BITS>
Ro_register_tmpl< BITS, Block > L4drivers::Ro_register_block< MAX_BITS, BLOCK >::r (
            unsigned offset) const  [inline]
```

Read only access to register at offset *offset*.

Template Parameters

BITS	the access width in bits for the register.

Parameters

offset	The offset of the register within the register file.

Returns

register object allowing read only access with width *BITS*.

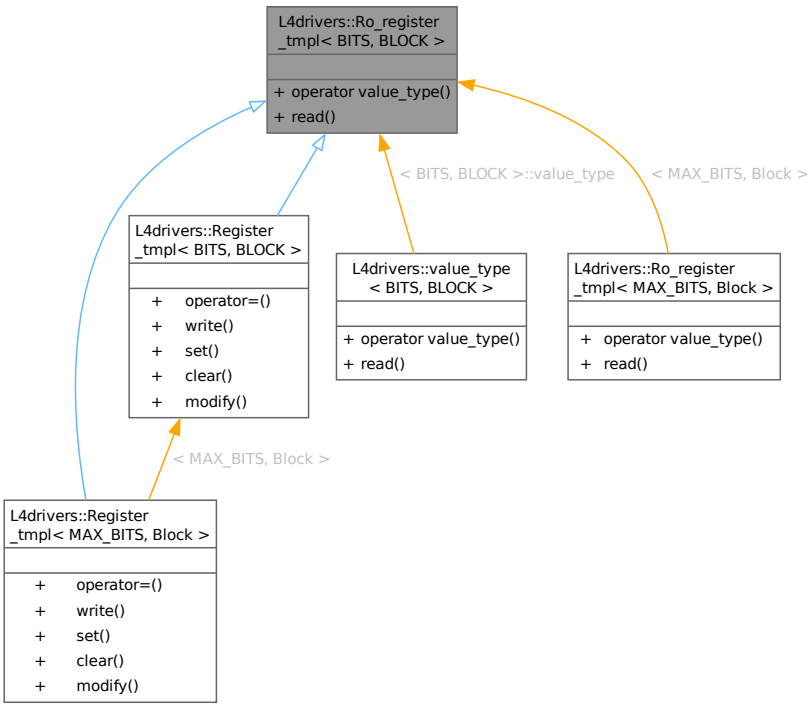
Definition at line 436 of file hw_register_block.
The documentation for this class was generated from the following file:

- pkg/drivers-frst/include/hw_register_block

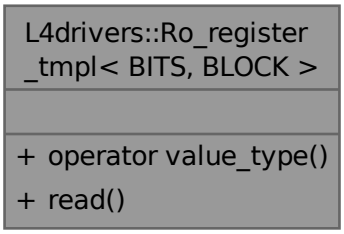
15.274 L4drivers::Ro_register_tmpl< BITS, BLOCK > Class Template Reference

Single read only register inside a Register_block_base interface.
`#include <hw_register_block>`

Inheritance diagram for L4drivers::Ro_register_tmpl< BITS, BLOCK >:



Collaboration diagram for L4drivers::Ro_register_tmpl< BITS, BLOCK >:



Public Member Functions

- operator value_type () const

  read the value from the hardware register.
- value_type read () const

  read the value from the hardware register.

15.274.1 Detailed Description

template<unsigned BITS, typename BLOCK>
class L4drivers::Ro_register_tmpl< BITS, BLOCK >

Single read only register inside a Register_block_base interface.

Template Parameters

BITS	The access with of the register in bits.
BLOCK	The type for the Register_block_base interface.

Note

Objects of this type must be used only in temporary contexts not in global, class, or object scope.

Allows simple read only access to a hardware register.
Definition at line 201 of file hw_register_block.

15.274.2 Member Function Documentation

15.274.2.1 operator value_type()

```
template<unsigned BITS, typename BLOCK>
L4drivers::Ro_register_tmpl< BITS, BLOCK >::operator value_type () const  [inline]
```

read the value from the hardware register.

Returns

value read from the hardware register.

Definition at line 217 of file hw_register_block.

15.274.2.2 read()

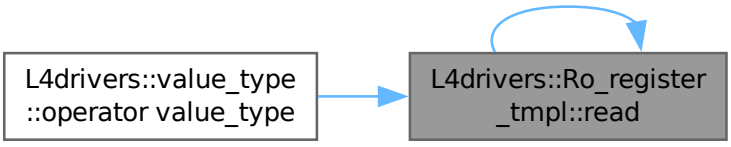
```
template<unsigned BITS, typename BLOCK>
value_type L4drivers::Ro_register_tmpl< BITS, BLOCK >::read () const  [inline]
```

read the value from the hardware register.

Returns

value from the hardware register.

Definition at line 224 of file hw_register_block.
Referenced by L4drivers::value_type< BITS, BLOCK >::operator value_type(), and L4drivers::value_type< BITS, BLOCK >::read().
Here is the caller graph for this function:



The documentation for this class was generated from the following file:

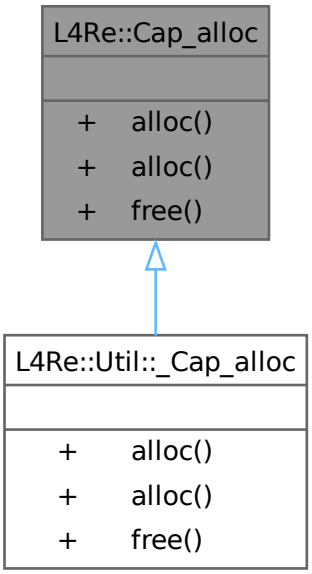
- pkg/drivers-frst/include/hw_register_block

15.275 L4Re::Cap_alloc Class Reference

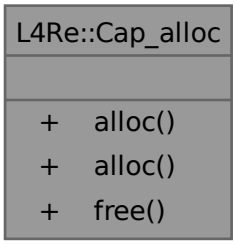
Capability allocator interface.

`#include <cap_alloc>`

Inheritance diagram for L4Re::Cap_alloc:



Collaboration diagram for L4Re::Cap_alloc:



Public Member Functions

- virtual L4::Cap< void > alloc () noexcept=0

  Allocate a capability.

- template<typename T>
  L4::Cap< T > alloc () noexcept

  Allocate a capability.

- virtual void free (L4::Cap< void > cap, l4_cap_idx_t task=L4_BASE_TASK_CAP, unsigned unmap_↩ flags=L4_FP_ALL_SPACES) noexcept=0

  Free a capability.

15.275.1 Detailed Description

Capability allocator interface.
Definition at line 30 of file cap_alloc.

15.275.2 Member Function Documentation

15.275.2.1 alloc() [1/2]

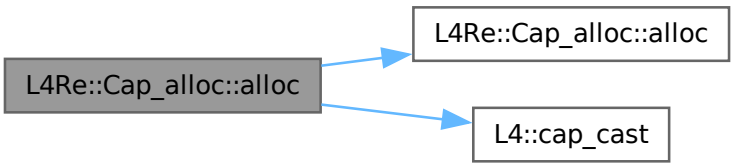
```
template<typename T>
L4::Cap< T > L4Re::Cap_alloc::alloc ()  [inline], [noexcept]
```

Allocate a capability.

Returns

Capability of type T

Definition at line 55 of file cap_alloc.
References alloc(), and L4::cap_cast().
Here is the call graph for this function:



15.275.2.2 alloc() [2/2]

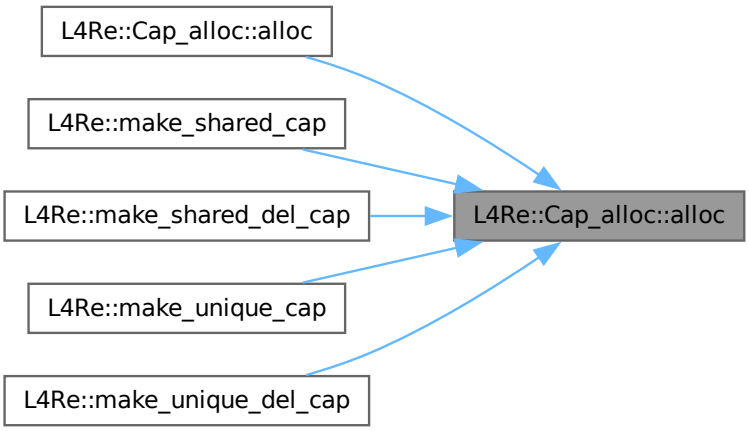
```
virtual L4::Cap< void > L4Re::Cap_alloc::alloc ()  [pure virtual], [noexcept]
```

Allocate a capability.

Returns

Capability of type void

Implemented in L4Re::Util::_Cap_alloc, and L4Re::Util::_Cap_alloc.
Referenced by alloc(), L4Re::make_shared_cap(), L4Re::make_shared_del_cap(), L4Re::make_unique_cap(), and L4Re::make_unique_del_cap().
Here is the caller graph for this function:



15.275.2.3 free()

```
virtual void L4Re::Cap_alloc::free (
            L4::Cap< void > cap,
            l4_cap_idx_t task = L4_BASE_TASK_CAP,
            unsigned unmap_flags = L4_FP_ALL_SPACES)  [pure virtual], [noexcept]
```

Free a capability.

Parameters

cap	Capability to free.
task	If set, task to unmap the capability from.
unmap_flags	Flags for unmap, see l4_unmap_flags_t.

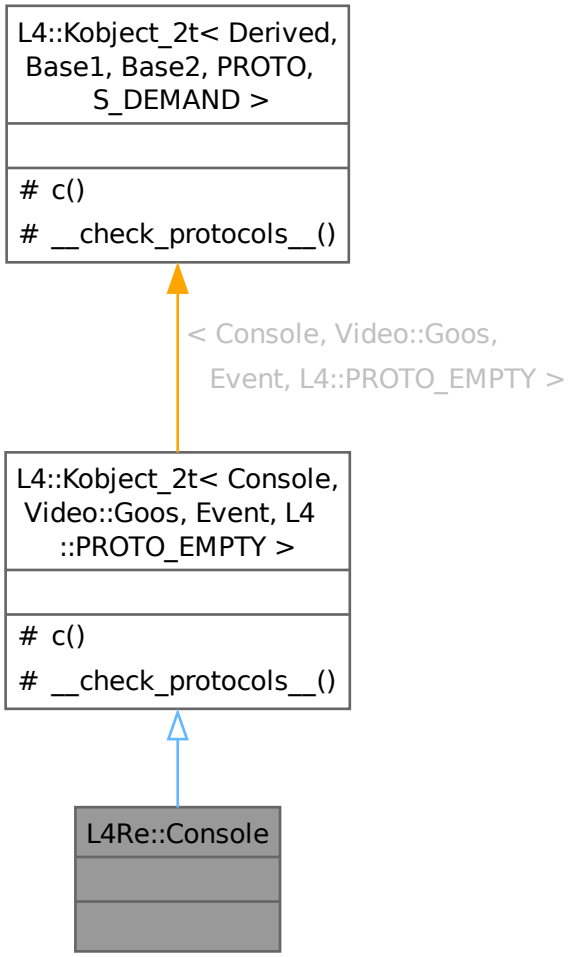
Implemented in L4Re::Util::_Cap_alloc.
References L4_BASE_TASK_CAP, and L4Re::L4_FP_ALL_SPACES.
The documentation for this class was generated from the following file:

- l4/re/cap_alloc

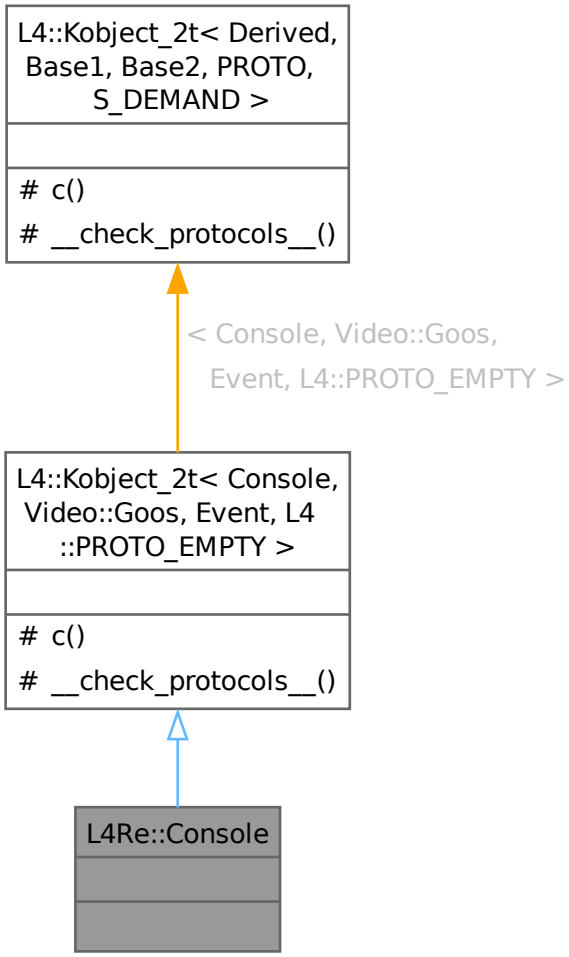
15.276 L4Re::Console Class Reference

Console class.
`#include <console>`

Inheritance diagram for L4Re::Console:



Collaboration diagram for L4Re::Console:



Additional Inherited Members

Protected Types inherited from L4::Kobject_2t< Console, Video::Goos, Event, L4::PROTO_EMPTY >

- typedef Console Class

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Console > __Iface

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, Typeid::Merge_list< typename Video::Goos::_↩ _Iface_list, typename Event::__Iface_list > > __Iface_list

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_2t< Console, Video::Goos, Event, L4::PROTO_EMPTY >

- L4::Cap< Class > c () const noexcept

Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_2t< Console, Video::Goos, Event, L4::PROTO_EMPTY >

- static void __check_protocols__ () noexcept

  Helper to check for protocol conflicts.

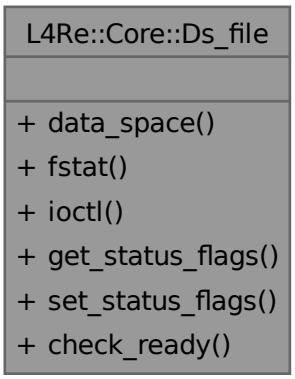
15.276.1 Detailed Description

Console class.
Definition at line 28 of file console.
The documentation for this class was generated from the following file:

- l4/re/console

15.277 L4Re::Core::Ds_file Class Reference

Implementation for files backed by an L4Re::Dataspace abstraction.
`#include <ds_file.h>`
Collaboration diagram for L4Re::Core::Ds_file:



Public Member Functions

- L4::Cap< L4Re::Dataspace > data_space () noexcept override

  Get an L4Re::Dataspace object for the file.
- int fstat (struct stat64 *buf) const noexcept override

  Get status information for the file.
- int ioctl (unsigned long, va_list) noexcept override

  The famous IO control.
- int get_status_flags () const noexcept override

  Get file status flags (fcntl F_GETFL).
- int set_status_flags (long) noexcept override

  Set file status flags (fcntl F_SETFL).
- bool check_ready (Ready_type rt) noexcept override

  Check whether the file is ready for an I/O operation/condition.

15.277.1 Detailed Description

Implementation for files backed by an L4Re::Dataspace abstraction.
Definition at line 17 of file ds_file.h.

15.277.2 Member Function Documentation

15.277.2.1 check_ready()

```
bool L4Re::Core::Ds_file::check_ready (
            Ready_type rt)  [inline], [override], [virtual], [noexcept]
```

Check whether the file is ready for an I/O operation/condition.
By definition, a dataspace-backed file is always ready for reading. If the file has write permissions, it is also always ready for writing.

Parameters

rt	Type of the I/O operation/condition to be ready.

Returns

Always true for reading. True for writing if writable. Always false otherwise.

Implements L4Re::Vfs::Generic_file.
Definition at line 65 of file ds_file.h.

15.277.2.2 data_space()

```
L4::Cap< L4Re::Dataspace > L4Re::Core::Ds_file::data_space ()  [inline], [override], [virtual],
[noexcept]
```

Get an L4Re::Dataspace object for the file.
This is used as a backend for POSIX mmap and mmap2 functions.

Note

mmap is not possible if the function returns an invalid capability.

Returns

A capability to an L4Re::Dataspace that represents the file contents in an L4Re way.

Implements L4Re::Vfs::Regular_file.
Definition at line 40 of file ds_file.h.

15.277.2.3 fstat()

```
int L4Re::Core::Ds_file::fstat (
            struct stat64 * buf) const  [override], [virtual], [noexcept]
```

Get status information for the file.
This is the backend for POSIX fstat, stat, fstat64 and friends.

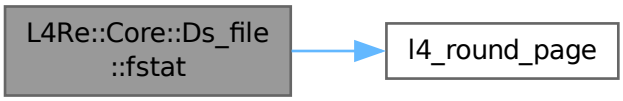
Parameters

out	*buf*	This buffer is filled with the status information.

Returns

0 on success, or <0 on error.

Implements L4Re::Vfs::Generic_file.
Definition at line 27 of file ds_file_impl.h.
References L4_PAGESIZE, and l4_round_page().
Here is the call graph for this function:



15.277.2.4 get_status_flags()

```
int L4Re::Core::Ds_file::get_status_flags () const  [inline], [override], [virtual], [noexcept]
```

Get file status flags (fcntl F_GETFL).
This function is used by the fcntl implementation for the F_GETFL command.

Returns

flags such as O_RDONLY, O_WRONLY, O_RDWR, O_DIRECT, O_ASYNC, O_NOATIME, O_NONBLOCK, or <0 on error.

Implements L4Re::Vfs::Generic_file.
Definition at line 48 of file ds_file.h.

15.277.2.5 ioctl()

```
int L4Re::Core::Ds_file::ioctl (
            unsigned long cmd,
            va_list args)  [override], [virtual], [noexcept]
```

The famous IO control.
Backend for POSIX generic object invocation ioctl.

Parameters

cmd	The ioctl command.
args	The arguments for the ioctl, usually some kind of pointer.

Returns

>=0 on success, or <0 on error.

Implements L4Re::Vfs::Special_file.
Definition at line 192 of file ds_file_impl.h.

15.277.2.6 set_status_flags()

```
int L4Re::Core::Ds_file::set_status_flags (
            long flags)  [inline], [override], [virtual], [noexcept]
```

Set file status flags (fcntl F_SETFL).
This function is used by the fcntl implementation for the F_SETFL command.

Parameters

flags	The file status flags to set. This must be a combination of O_RDONLY, O_WRONLY, O_RDWR, O_↩ APPEND, O_ASYNC, O_DIRECT, O_NOATIME, O_NONBLOCK.

Note

Creation flags such as O_CREAT, O_EXCL, O_NOCTTY, O_TRUNC are ignored.

Returns

0 on success, or <0 on error.

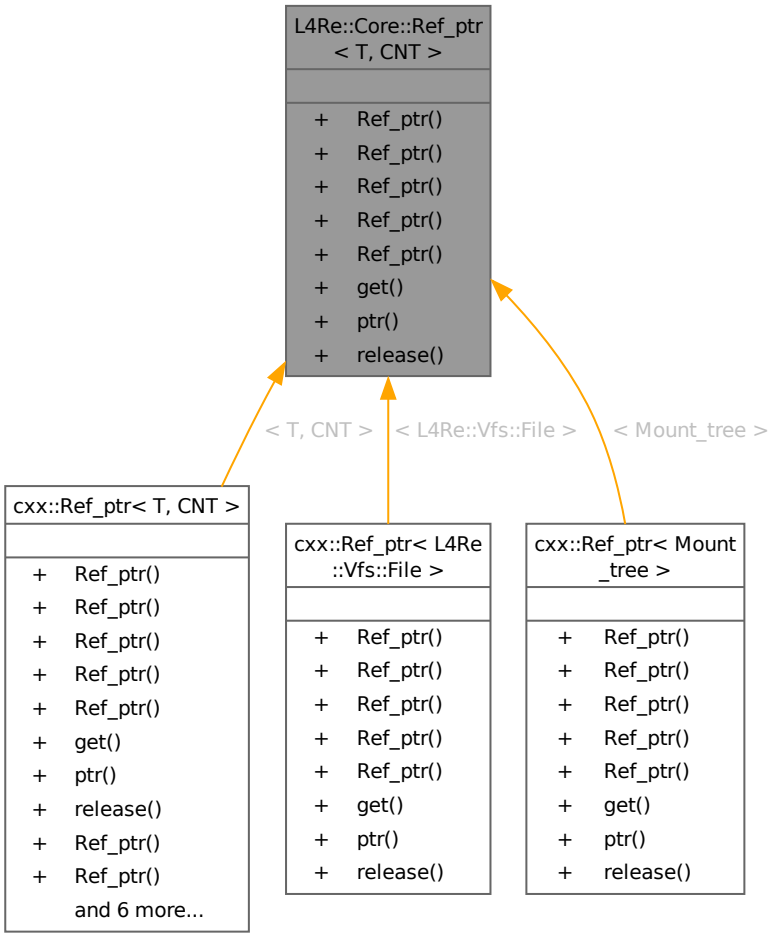
Implements L4Re::Vfs::Generic_file.
Definition at line 51 of file ds_file.h.
The documentation for this class was generated from the following files:

- l4/l4re_vfs/impl/ds_file.h
- l4/l4re_vfs/impl/ds_file_impl.h

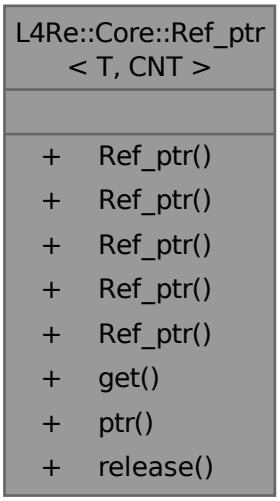
15.278 L4Re::Core::Ref_ptr< T, CNT > Class Template Reference

A reference-counting pointer with automatic cleanup.
`#include <ref_ptr>`

Inheritance diagram for L4Re::Core::Ref_ptr< T, CNT >:



Collaboration diagram for L4Re::Core::Ref_ptr< T, CNT >:



Public Member Functions

- **Ref_ptr** () noexcept

  Default constructor creates a pointer with no managed object.
- Ref_ptr (Wp const &o) noexcept

  Create a shared pointer from a weak pointer.
- **Ref_ptr** (decltype(nullptr) n) noexcept

  allow creation from `nullptr`
- template<typename X>
  Ref_ptr (X *o) noexcept

  Create a shared pointer from a raw pointer.
- Ref_ptr (T *o, bool d) noexcept

  Create a shared pointer from a raw pointer without creating a new reference.
- T * get () const noexcept

  Return a raw pointer to the object this shared pointer points to.
- T * ptr () const noexcept

  Return a raw pointer to the object this shared pointer points to.
- T * release () noexcept

  Release the shared pointer without removing the reference.

15.278.1 Detailed Description

template<typename T = void, template< typename X > class CNT = Default_ref_counter>
class L4Re::Core::Ref_ptr< T, CNT >

A reference-counting pointer with automatic cleanup.

Template Parameters

T	Type of object the pointer points to.
CNT	Type of management class that manages the life time of the object.

This pointer is similar to the standard C++-11 shared_ptr but it does the reference counting directly in the object being pointed to, so that no additional management structures need to be allocated from the heap.
Classes that use this pointer type must implement two functions:

```
int remove_ref()
```

is called when a reference is removed and must return 0 when there are no further references to the object.

```
void add_ref()
```

is called when another ref_ptr to the object is created.
Ref_obj provides a simple implementation of this interface from which classes may inherit.
Definition at line 70 of file ref_ptr.

15.278.2 Constructor & Destructor Documentation

15.278.2.1 Ref_ptr() [1/3]

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
cxx::Ref_ptr< T, CNT >::Ref_ptr (
            Wp const & o)  [inline], [noexcept]
```

Create a shared pointer from a weak pointer.
Increases references.
Definition at line 88 of file ref_ptr.

15.278.2.2 Ref_ptr() [2/3]

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
template<typename X>
cxx::Ref_ptr< T, CNT >::Ref_ptr (
            X * o)  [inline], [explicit], [noexcept]
```

Create a shared pointer from a raw pointer.
In contrast to C++11 shared_ptr it is safe to use this constructor multiple times and have the same reference counter.
Definition at line 101 of file ref_ptr.

15.278.2.3 Ref_ptr() [3/3]

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
cxx::Ref_ptr< T, CNT >::Ref_ptr (
            T * o,
            bool d)  [inline], [noexcept]
```

Create a shared pointer from a raw pointer without creating a new reference.

Parameters

o	Pointer to the object.
d	Dummy parameter to select this constructor at compile time. The value may be true or false.

This is the counterpart to release().
Definition at line 114 of file ref_ptr.

15.278.3 Member Function Documentation

15.278.3.1 get()

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
T * cxx::Ref_ptr< T, CNT >::get () const  [inline], [noexcept]
```

Return a raw pointer to the object this shared pointer points to.
This does not release the pointer or decrease the reference count.
Definition at line 121 of file ref_ptr.

15.278.3.2 ptr()

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
T * cxx::Ref_ptr< T, CNT >::ptr () const  [inline], [noexcept]
```

Return a raw pointer to the object this shared pointer points to.
This does not release the pointer or decrease the reference count.
Definition at line 127 of file ref_ptr.

15.278.3.3 release()

```
template<typename T = void, template< typename X > class CNT = Default_ref_counter>
T * cxx::Ref_ptr< T, CNT >::release ()  [inline], [noexcept]
```

Release the shared pointer without removing the reference.

Returns

A raw pointer to the managed object.

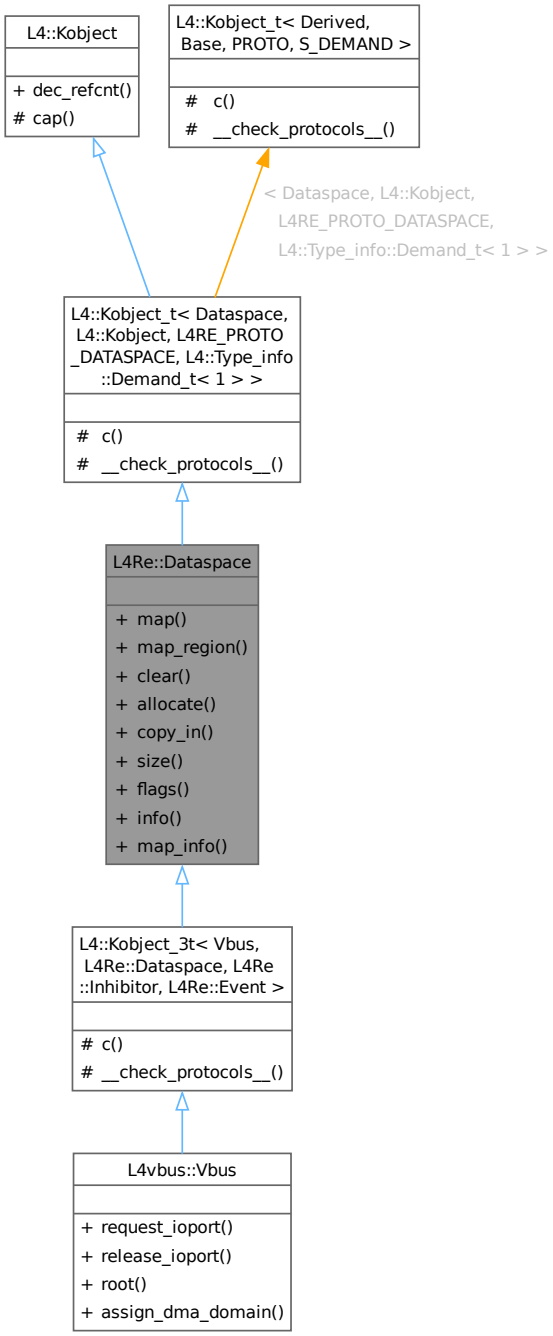
Definition at line 138 of file ref_ptr.
The documentation for this class was generated from the following file:

- l4/cxx/ref_ptr

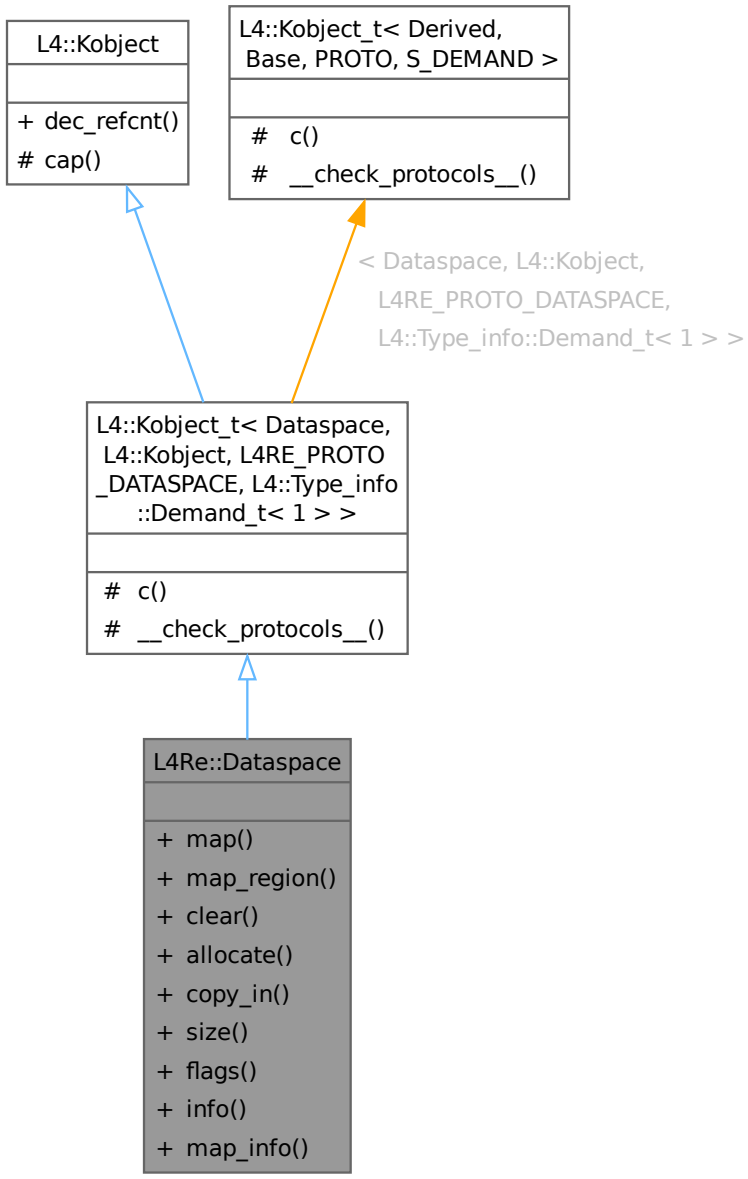
15.279 L4Re::Dataspace Class Reference

Interface for memory-like objects.
`#include <dataspace>`

Inheritance diagram for L4Re::Dataspace:



Collaboration diagram for L4Re::Dataspace:



Data Structures

- struct F

  Dataspace flags definitions.
- struct Stats

  Information about the dataspace.

Public Member Functions

- l4_ret_t map (Offset offset, Flags flags, Map_addr local_addr, Map_addr min_addr, Map_addr max_addr, L4::Cap< L4::Task > dst=L4::Cap< L4::Task >::Invalid) const noexcept

  Request a flexpage mapping from the dataspace.

- l4_ret_t map_region (Offset offset, Flags flags, Map_addr min_addr, Map_addr max_addr, L4::Cap< L4::Task > dst=L4::Cap< L4::Task >::Invalid) const noexcept

  Map a part of a dataspace into a local memory area.
- l4_ret_t clear (Offset offset, Size size)

  Clear parts of a dataspace.
- l4_ret_t allocate (Offset offset, Size size)

  Allocate a range in the dataspace.
- l4_ret_t copy_in (Offset dst_offs, L4::Ipc::Cap< Dataspace > src, Offset src_offs, Size size)

  Copy contents from another dataspace.
- Size size () const noexcept

  Get size of a dataspace.
- Flags flags () const noexcept

  Get flags of the dataspace.
- l4_ret_t info (Stats *stats)

  Get information on the dataspace.
- long map_info (l4_addr_t *start_addr, l4_addr_t *end_addr)

  Get mapping range of dataspace.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Dataspace, L4::Kobject, L4RE_PROTO_DATASPACE, L4::Type_info::Demand_t< 1 > >

- typedef Dataspace **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Dataspace > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Dataspace, L4::Kobject, L4RE_PROTO_DATASPACE, L4::Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Dataspace, L4::Kobject, L4RE_PROTO_DATASPACE, L4::Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.279.1 Detailed Description

Interface for memory-like objects.
Dataspaces are a central abstraction provided by L4Re. A dataspace is an abstraction for any thing that is available via usual memory access instructions. A dataspace can be a file, as well as the memory-mapped registers of a device, or anonymous memory, such as a heap.
The dataspace interface defines a set of methods that allow any kind of dataspace to be attached (mapped) to the virtual address space of an L4 task and then be accessed via memory-access instructions. The L4Re::Rm interface can be used to attach a dataspace to a virtual address space of a task paged by a certain instance of a region map.

Include File

```
#include <l4/re/dataspace>
```

Examples

examples/libs/l4re/c++/mem_alloc/ma+rm.cc, examples/libs/l4re/c++/shared_ds/ds_clnt.cc, and examples/libs/l4re/c++/shared_

Definition at line 50 of file dataspace.

15.279.2 Member Function Documentation

15.279.2.1 allocate()

```
l4_ret_t L4Re::Dataspace::allocate (
            Offset offset,
            Size size)
```

Allocate a range in the dataspace.

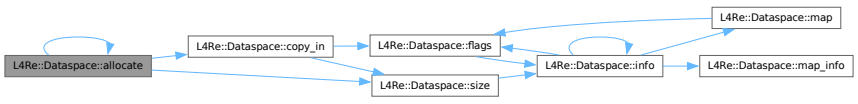
Parameters

offset	Offset in the dataspace, in bytes.
size	Size of the range, in bytes.

Return values

L4_EOK	Success
-L4_ERANGE	Given range is outside the dataspace. (A dataspace provider may also silently ignore areas outside the dataspace.)
-L4_ENOMEM	Not enough memory available.
<0	IPC errors

On success, at least the given range is guaranteed to be allocated. The dataspace manager may also allocate more memory due to page granularity.
The memory is allocated with the same rights as the dataspace capability.
References allocate(), copy_in(), and size().
Referenced by allocate().
Here is the call graph for this function:



Here is the caller graph for this function:



15.279.2.2 clear()

```
l4_ret_t L4Re::Dataspace::clear (
            Offset offset,
            Size size)
```

Clear parts of a dataspace.

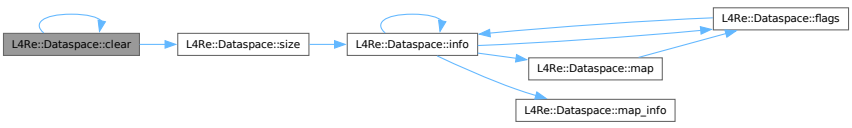
Parameters

offset	Offset within dataspace (in bytes).
size	Size of region to clear (in bytes).

Return values

>=0	Success.
-L4_ERANGE	Given range is outside the dataspace. (A dataspace provider may also silently ignore areas outside the dataspace.)
-L4_EACCESS	No L4_CAP_FPAGE_W right on dataspace capability.
<0	IPC errors

Zeroes out the memory. Depending on the type of memory the memory could also be deallocated and replaced by a shared zero-page.
References clear(), and size().
Referenced by clear().
Here is the call graph for this function:



Here is the caller graph for this function:



15.279.2.3 copy_in()

```
l4_ret_t L4Re::Dataspace::copy_in (
            Offset dst_offs,
            L4::Ipc::Cap< Dataspace > src,
            Offset src_offs,
            Size size)
```

Copy contents from another dataspace.

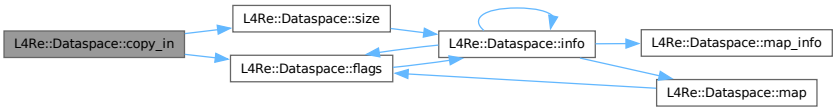
Parameters

dst_offs	Offset in destination dataspace.
src	Source dataspace to copy from.
src_offs	Offset in the source dataspace.
size	Size to copy (in bytes).

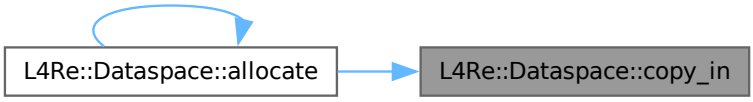
Return values

L4_EOK	Success
-L4_EACCESS	No L4_CAP_FPAGE_W right on the destination dataspace.
-L4_EINVAL	Invalid parameter supplied.
<0	IPC errors

The copy operation may use copy-on-write mechanisms. The operation may also fail if both dataspaces are not from the same dataspace manager or the dataspace managers do not cooperate.
References flags(), and size().
Referenced by allocate().
Here is the call graph for this function:



Here is the caller graph for this function:



15.279.2.4 flags()

```
Dataspace::Flags Dataspace::flags () const  [noexcept]
```

Get flags of the dataspace.

Return values

>=0	Flags of the dataspace
<0	IPC errors

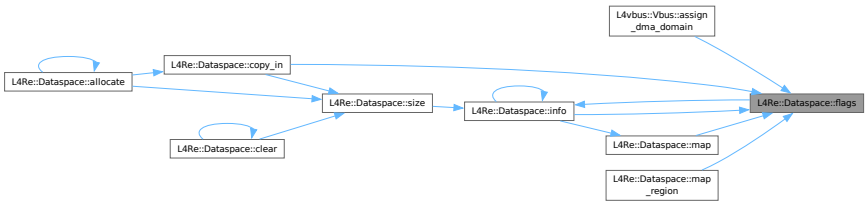
See also

L4Re::Dataspace::F::Flags

Definition at line 112 of file dataspace_impl.h.
References L4Re::Dataspace::Stats::flags, and info().
Referenced by L4vbus::Vbus::assign_dma_domain(), copy_in(), info(), map(), and map_region().
Here is the call graph for this function:



Here is the caller graph for this function:



15.279.2.5 info()

```
l4_ret_t L4Re::Dataspace::info (
            Stats * stats)
```

Get information on the dataspace.

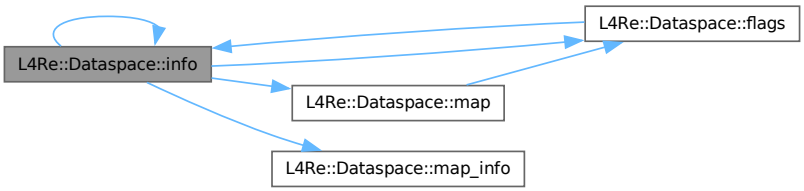
Parameters

out	*stats*	Dataspace information

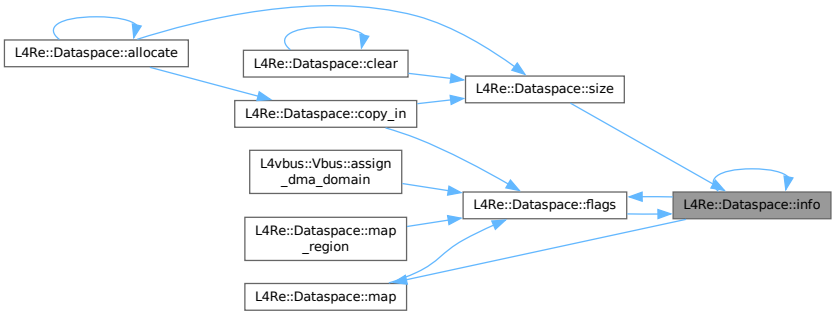
Return values

0	Success
<0	IPC errors

References flags(), info(), L4_RPC, L4_RPC_NF, map(), and map_info().
Referenced by flags(), info(), and size().
Here is the call graph for this function:



Here is the caller graph for this function:



15.279.2.6 map()

```
l4_ret_t Dataspace::map (
            Dataspace::Offset offset,
            Dataspace::Flags flags,
            Dataspace::Map_addr local_addr,
            Dataspace::Map_addr min_addr,
```

```
Dataspace::Map_addr max_addr,
L4::Cap< L4::Task > dst = L4::Cap<L4::Task>::Invalid) const  [noexcept]
```

Request a flexpage mapping from the dataspace.

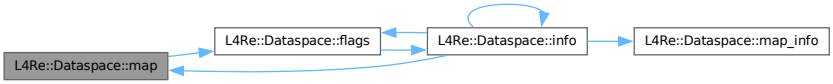
Parameters

offset	Offset to start within dataspace
flags	Dataspace flags, see L4Re::Dataspace::F::Flags.
local_addr	Local address to map to.
min_addr	Defines start of receive window. (Rounded down to page size.)
max_addr	Defines end of receive window. (Rounded up to page size.)
dst	Optional destination task of the mapping. If invalid, the callers task is implicitly the destination.

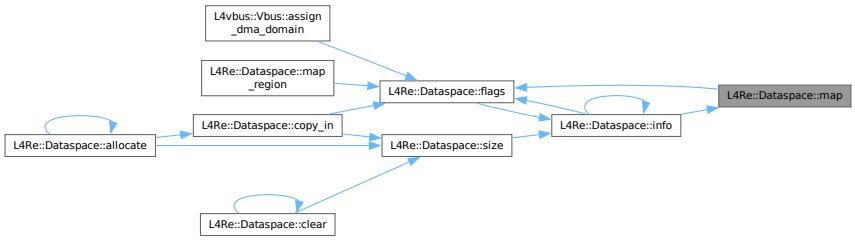
Return values

L4_EOK	Success
-L4_ERANGE	Invalid offset.
-L4_EPERM	Insufficient permission to map with requested rights.
<0	IPC errors

The map call will attempt to map the largest possible flexpage that covers the given local address and still fits into the region defined by `min_addr` and `max_addr`. If the given region is invalid or does not overlap the local address, the smallest valid page size is used.
Definition at line 84 of file dataspace_impl.h.
References flags(), and L4_LOG2_PAGESIZE.
Referenced by info().
Here is the call graph for this function:



Here is the caller graph for this function:



15.279.2.7 map_info()

```
long L4Re::Dataspace::map_info (
```

```
l4_addr_t * start_addr,
l4_addr_t * end_addr)  [inline]
```

Get mapping range of dataspace.
In case of a MMU-less system, the dataspace must be mapped at the correct address in the task because virtual and physical address must match. This method returns the start and end address of the physically contiguous buffer backing the dataspace.
On MMU-enabled system any page aligned address is permissible. On such systems the method is just a stub.

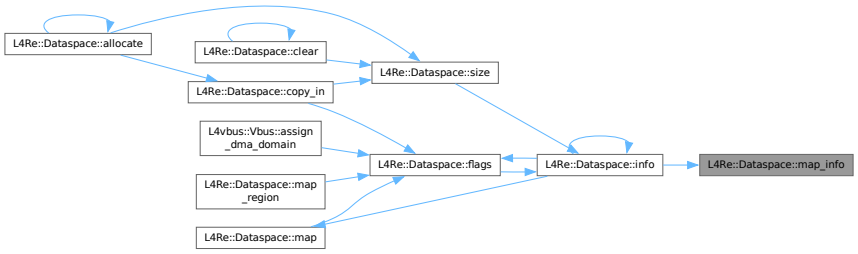
Parameters

out	*start_addr*	Start address of dataspace.
out	*end_addr*	End address (inclusive) of dataspace.

Return values

>0	Start/end address have been set and need to be obeyed.
0	No constraint of mapping address.
-L4_EPERM	Cannot infer mapping address. Dataspace not mappable.
<0	IPC errors.

Definition at line 306 of file dataspace.
Referenced by info().
Here is the caller graph for this function:



15.279.2.8 map_region()

```
l4_ret_t Dataspace::map_region (
            Dataspace::Offset offset,
            Dataspace::Flags flags,
            Dataspace::Map_addr min_addr,
            Dataspace::Map_addr max_addr,
            L4::Cap< L4::Task > dst = L4::Cap<L4::Task>::Invalid) const  [noexcept]
```

Map a part of a dataspace into a local memory area.

Parameters

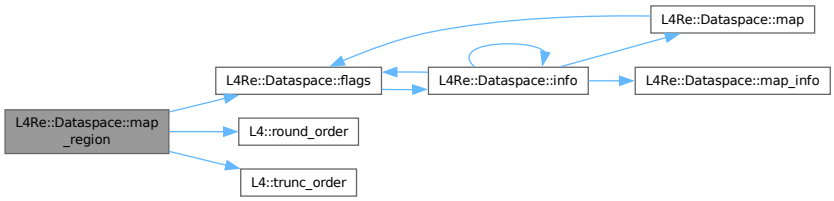
offset	Offset to start within dataspace.
flags	Dataspace flags, see L4Re::Dataspace::F::Flags.
min_addr	(Inclusive) start of the receive area.

max_addr	(Exclusive) end of receive area.
dst	Optional destination task of the mapping. If invalid, the callers task is implicitly the destination.

Return values

L4_EOK	Success
-L4_ERANGE	Invalid offset or receive area larger than the dataspace.
-L4_EPERM	Insufficient permission to map with requested rights.
<0	IPC errors

This is a convenience function which maps flexpages consecutively into the given memory area in the local task. The area is expected to be filled completely. If the dataspace is not large enough to provide the mappings for the entire size of the area, then an error is returned. Mappings may or may not have been already established at that point.
`offset` and `min_addr` are rounded down to the next `L4_PAGESIZE` boundary when necessary. `max_addr` is rounded up to the page boundary. If the resulting maximum address is less or equal than the minimum address, then the function is a noop.
Definition at line 45 of file dataspace_impl.h.
References flags(), L4_LOG2_PAGESIZE, L4_UNLIKELY, L4::round_order(), and L4::trunc_order().
Here is the call graph for this function:



15.279.2.9 size()

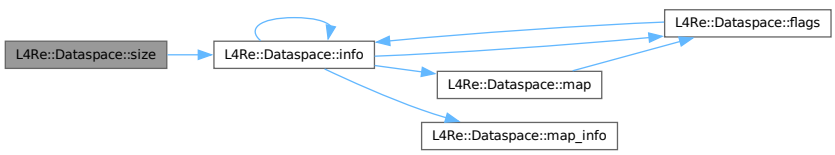
```
Dataspace::Size Dataspace::size () const  [noexcept]
```

Get size of a dataspace.

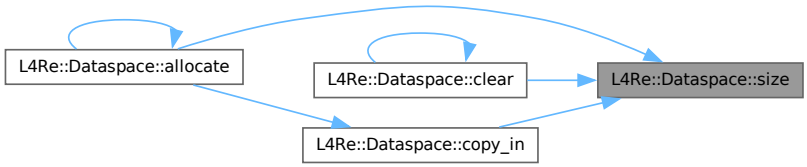
Returns

Size of the dataspace in bytes.

Definition at line 100 of file dataspace_impl.h.
References info(), and L4Re::Dataspace::Stats::size.
Referenced by allocate(), clear(), and copy_in().
Here is the call graph for this function:



Here is the caller graph for this function:

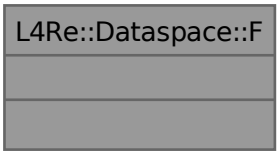


The documentation for this class was generated from the following files:

- l4/re/dataspace
- l4/re/impl/dataspace_impl.h

15.280 L4Re::Dataspace::F Struct Reference

Dataspace flags definitions.
`#include <dataspace>`
Collaboration diagram for L4Re::Dataspace::F:



Public Types

- enum { Caching_shift = 4 }
- enum Flags {
  R = L4_FPAGE_RO , Ro = L4_FPAGE_RO , RW = L4_FPAGE_RW , W = L4_FPAGE_W ,
  X = L4_FPAGE_X , RX = L4_FPAGE_RX , RWX = L4_FPAGE_RWX , Rights_mask = 0x0f ,
  Normal = 0x00 , Cacheable = Normal , Bufferable = 0x10 , Uncacheable = 0x20 ,
  Caching_mask = 0x30 }

  Flags for map operations.

15.280.1 Detailed Description

Dataspace flags definitions.
Definition at line 57 of file dataspace.

15.280.2 Member Enumeration Documentation

15.280.2.1 anonymous enum

`anonymous enum`

Enumerator

Caching_shift	shift value for caching flags

Definition at line 59 of file dataspace.

15.280.2.2 Flags

`enum L4Re::Dataspace::F::Flags`

Flags for map operations.

A dataspace implementation must check the requested flags during the map and other operations against the dataspace rights.

Enumerator

R	Request read-only mapping.
Ro	Request read-only mapping.
RW	Request read-write mapping.
W	Request write-only mapping.
X	Request execute-only mapping.
RX	Request read-execute mapping.
RWX	Request read-write-execute mapping.
Rights_mask	All rights bits available for mappings.
Normal	Request normal (cached) memory mapping. This is the default if no other cache-related flag was specified.
Cacheable	Request normal memory mapping.
Bufferable	Request bufferable (write buffered) mappings.
Uncacheable	Request uncacheable memory mappings.
Caching_mask	Mask for caching flags.

Definition at line 70 of file dataspace.

The documentation for this struct was generated from the following file:

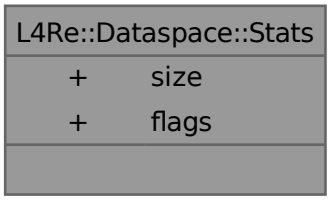
- l4/re/dataspace

15.281 L4Re::Dataspace::Stats Struct Reference

Information about the dataspace.

`#include <dataspace>`

Collaboration diagram for L4Re::Dataspace::Stats:



Data Fields

- Size **size**

  size
- Flags **flags**

  flags

15.281.1 Detailed Description

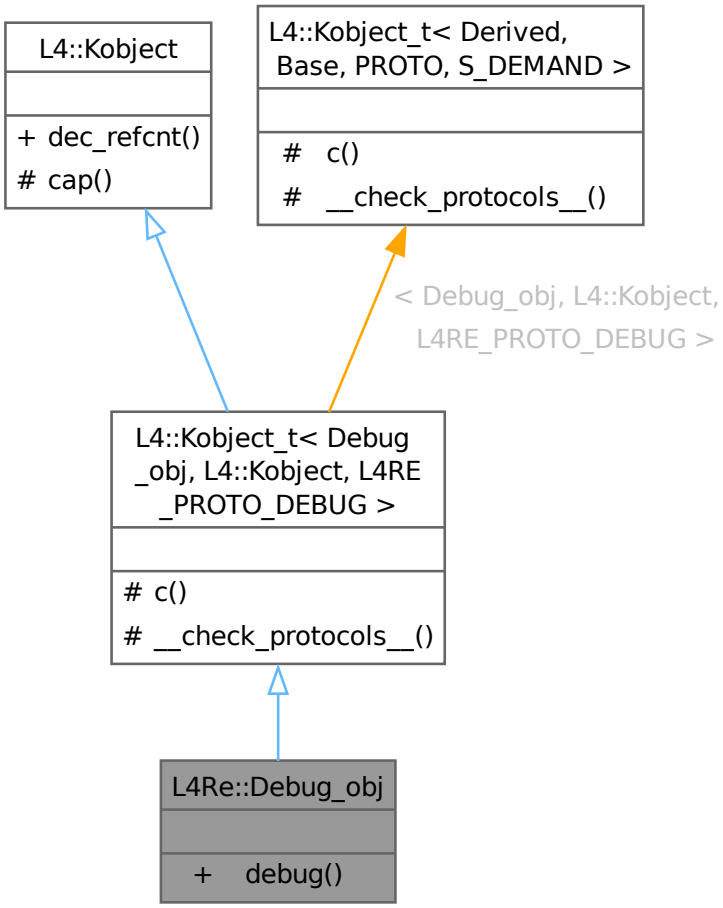
Information about the dataspace.
Definition at line 128 of file dataspace.
The documentation for this struct was generated from the following file:

- l4/re/dataspace

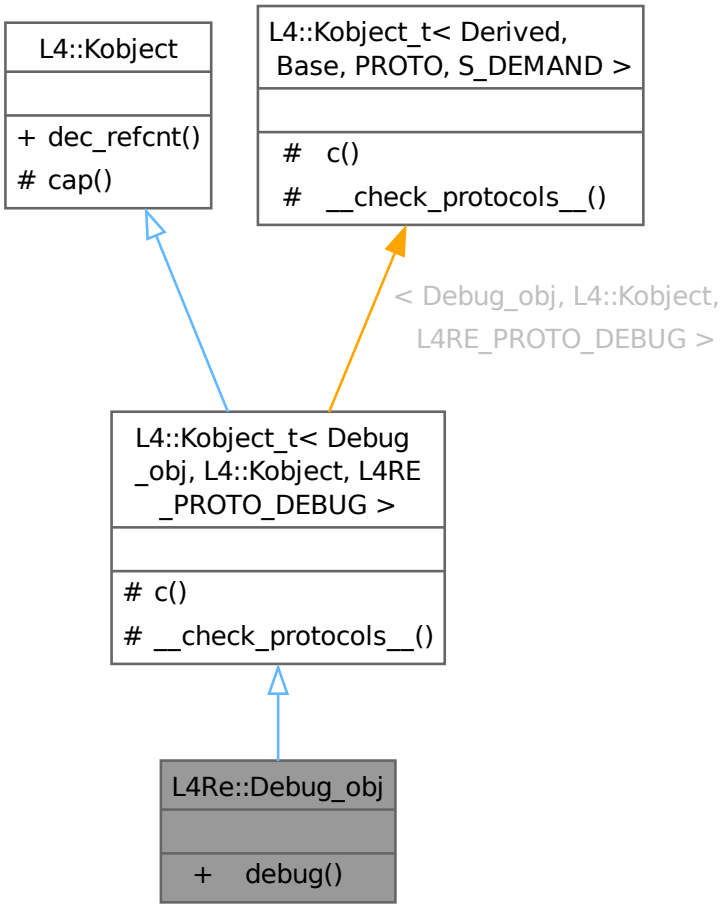
15.282 L4Re::Debug_obj Class Reference

Debug interface.
`#include <debug>`

Inheritance diagram for L4Re::Debug_obj:



Collaboration diagram for L4Re::Debug_obj:



Public Member Functions

- l4_ret_t debug (unsigned long function)

  Debug call.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Debug_obj, L4::Kobject, L4RE_PROTO_DEBUG >

- typedef Debug_obj **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Debug_obj > **__Iface**

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Debug_obj, L4::Kobject, L4RE_PROTO_DEBUG >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Debug_obj, L4::Kobject, L4RE_PROTO_DEBUG >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.282.1 Detailed Description

Debug interface.

See also

Debugging API .

Definition at line 40 of file debug.

15.282.2 Member Function Documentation

15.282.2.1 debug()

```
l4_ret_t L4Re::Debug_obj::debug (
            unsigned long function)
```

Debug call.

Parameters

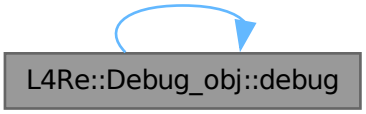
function	Function to call.

Returns

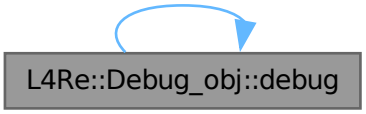
- L4_EOK
  - IPC errors

An object can provide a number of debug functions, each identified by some integer. This method is used to fan out to these functions from a common entry point.
References debug().
Referenced by debug().

Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this class was generated from the following file:

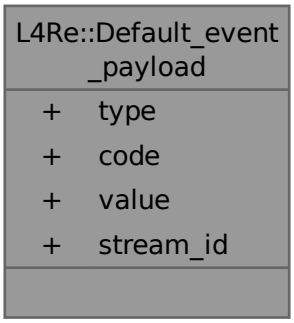
- l4/re/debug

15.283 L4Re::Default_event_payload Struct Reference

Default event stream payload.

`#include <event>`

Collaboration diagram for L4Re::Default_event_payload:



Data Fields

- unsigned short **type**

Type of event.

- unsigned short **code**

  Code of event.

- int **value**

  Value of event.

- l4_umword_t **stream_id**

  Stream ID.

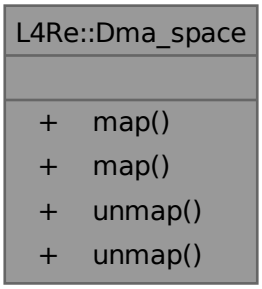
15.283.1 Detailed Description

Default event stream payload.
Definition at line 234 of file event.
The documentation for this struct was generated from the following file:

- l4/re/event

15.284 L4Re::Dma_space Class Reference

Managed DMA Address Space.
`#include <dma_space>`
Collaboration diagram for L4Re::Dma_space:



Public Types

- enum Direction { Bidirectional , To_device , From_device , None }

  Direction of the DMA transfers.

- enum Attribute : unsigned { Search_addr = 1U << 0 , Partial_map = 1U << 1 , Reserve = 1U << 2 , Replace = 1U << 3 }

  Attributes used for the memory region.

- enum Unmap_flag : unsigned { Cancel_reservation = 1U << 0 }

  Flags used by Dma_space::unmap().

- typedef l4_uint64_t **Dma_addr**

  Data type for DMA addresses.

- using Attributes = L4::Types::Flags_t<Attribute, unsigned>

  Attributes for DMA mappings.

- using Unmap_flags = L4::Types::Flags_t<Unmap_flag, unsigned>

  Flags for Dma_space::unmap().

Public Member Functions

- l4_ret_t map (L4::Ipc::Cap< L4Re::Dataspace > src, L4Re::Dataspace::Offset offset, l4_size_t *size, Attributes attrs, Direction dir, Dma_addr *dma_addr)

  Map the given part of this data space into the DMA address space.
- l4_ret_t map (L4::Ipc::Cap< L4Re::Dataspace > src, L4Re::Dataspace::Offset offset, Dma_size *size, Dma_addr *dma_addr, Dma_addr dma_max=-1, Attributes attrs=Search_addr, unsigned char align=L4_SUPERPAGESHIFT)

  Map the given part of this data space into the DMA address space.
- l4_ret_t unmap (Dma_addr dma_addr, Dma_size size, Attributes attrs, Direction dir)

  Unmap the given part of this data space from the DMA address space.
- l4_ret_t unmap (Dma_addr dma_addr, Dma_size size, Unmap_flags flags=Unmap_flags())

  Unmap the given part of this data space from the DMA address space.

15.284.1 Detailed Description

Managed DMA Address Space.
A managed Dma_space represents the L4Re abstraction of an DMA address space of one or several devices. Devices are assigned to a managed Dma_space by binding the Dma_space to the respective DMA domain (see L4vbus::Vbus::assign_dma_domain()), which might link the Dma_space with a kernel DMA space. Note that several DMA domains can be bound to the same Dma_space. Whenever a device needs direct access to parts of an L4Re::Dataspace, that part of the data space must be mapped to the managed Dma_space that is assigned to that device. Binding to DMA domains must happen before mapping. After the DMA accesses to the memory are finished the memory must be unmapped from the device's DMA address space.
Mapping to a managed DMA address space, using map(), makes the given parts of the data space visible to the associated device at the returned DMA address. As long as the memory is mapped into a DMA space it is 'pinned' and cannot be subject to dynamic memory management such as swapping.
unmap() is the reverse operation to map() and unmaps the given data-space part for the DMA address space.
Definition at line 50 of file dma_space.

15.284.2 Member Typedef Documentation

15.284.2.1 Attributes

```
using L4Re::Dma_space::Attributes = L4::Types::Flags_t<Attribute, unsigned>
```

Attributes for DMA mappings.

See also

Attribute

Definition at line 144 of file dma_space.

15.284.2.2 Unmap_flags

```
using L4Re::Dma_space::Unmap_flags = L4::Types::Flags_t<Unmap_flag, unsigned>
```

Flags for Dma_space::unmap().

See also

Unmap_flag

Definition at line 303 of file dma_space.

15.284.3 Member Enumeration Documentation

15.284.3.1 Attribute

```
enum L4Re::Dma_space::Attribute :  unsigned
```

Attributes used for the memory region.

See also

Attributes

Enumerator

Search_addr	Search for suitable address. A spot for the whole mapping is searched, starting from the passed start address. Without this flag, the start address is taken literally. Can be combined with Attribute::Partial_map. If no address remapping is possible (i.e., the Dma_space was associated by Dma_space_mgr::associate_phys()), the flag has no effect. The Dma_space::map() call will always return the physical address.
Partial_map	Truncate mapping if it does not fit. If there is not enough room after the chosen start address, truncate the mapping instead of failing.
Reserve	Reserve a region instead of mapping pages. If set, the dataspace argument of Dma_space::map() is ignored. Use the Attribute::Replace flag to place dataspace mappings in a reserved region later. The reservation is released with Dma_space::unmap() carrying Unmap_flag::Cancel_reservation. If no address remapping is possible (i.e., the Dma_space was associated by Dma_space_mgr::associate_phys()), Dma_space::map() will always fail with -L4_EPERM if this flag is present.
Replace	Replace mappings. The pages in the map region are replaced with mappings from the dataspace. Without this flag, existing mappings cause Dma_space::map() to fail. Areas previously claimed by Dma_space_mgr::block_area() are never replaced and still cause Dma_space::map() to fail. If combined with Attribute::Reserve, no dataspace mapping is established. Instead, the reservation reference count is increased. Only after the matching number of Dma_space::unmap(↩ Cancel_reservation) calls, the reservation is released. If no address remapping is possible (i.e., the Dma_space was associated by Dma_space_mgr::associate_phys()), the flag has no effect. The Dma_space::map() call will always return the physical address. Cannot be combined with Attribute::Search_addr or Attribute::Partial_map.

Definition at line 78 of file dma_space.

15.284.3.2 Direction

`enum L4Re::Dma_space::Direction`
Direction of the DMA transfers.

Deprecated Ignored by the API. Use function overloads without the direction parameter instead.

Enumerator

Bidirectional	device reads and writes to the memory
To_device	device reads the memory
From_device	device writes to the memory
None	device is coherently connected to the memory

Definition at line 66 of file dma_space.

15.284.3.3 Unmap_flag

`enum L4Re::Dma_space::Unmap_flag : unsigned`
Flags used by Dma_space::unmap().

See also

Unmap_flags

Enumerator

Cancel_reservation	Cancel a prior Attribute::Reserve claim instead of unmapping a dataspace mapping. Without this flag, unmap() releases one dataspace mapping that was previously established by map() (with or without Attribute::Replace). With this flag, unmap() releases one previous Attribute::Reserve claim and does not touch any active dataspace mappings in the range.

Definition at line 282 of file dma_space.

15.284.4 Member Function Documentation

15.284.4.1 map() [1/2]

```
l4_ret_t L4Re::Dma_space::map (
             L4::Ipc::Cap< L4Re::Dataspace > src,
             L4Re::Dataspace::Offset offset,
             Dma_size * size,
             Dma_addr * dma_addr,
             Dma_addr dma_max = -1,
             Attributes attrs = Search_addr,
             unsigned char align = L4_SUPERPAGESHIFT)  [inline]
```

Map the given part of this data space into the DMA address space.

Parameters

in	*src*	Source data space (that describes the memory).
in	*offset*	The offset (bytes) within src. Must be zero in case Attribute::Reserve is passed in attrs.
in,out	*size*	The size (bytes) of the region to be mapped for DMA, after successful mapping the size returned is the size mapped for DMA as a single block. This size might be smaller than the original input size, in this case the caller might call map() again with a new offset and the remaining size.
in,out	*dma_addr*	The DMA address to use for DMA with the associated device. Either taken literally (in which case it must be page aligned) or used as starting address if Attribute::Search_addr is passed.
in	*dma_max*	Highest allowed DMA address of the mapping (inclusive).
in	*attrs*	The attributes used for this DMA mapping (a combination of Dma_space::Attribute values).
in	*align*	Alignment of mapping (log2 based). Only used if Attribute::Search_addr is passed.

Return values

L4_EOK	Operation successful.
-L4_EADDRNOTAVAIL	The specified region overlaps an existing mapping/blocking or no space left in search area.
-L4_EPERM	Insufficient permissions; see precondition.

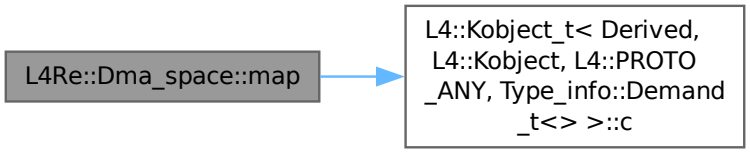
-L4_EINVAL	The capability `src` is invalid or does not refer to a valid dataspace.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.
-L4_ERANGE	`offset` is larger than the size of the dataspace.

The DMA mapping is created writable if capability `src` has the permission L4_CAP_FPAGE_W. Otherwise, a read-only DMA mapping is established.
If no address remapping is possible (i.e., the Dma_space was associated by Dma_space_mgr::associate_phys()), Dma_space::map() will always return the physical address. The caller should therefore be prepared that a desired DMA address is ignored.

Note

Dma_space_mgr::associate() or Dma_space_mgr::associate_phys() must be called prior to mapping memory. Usually this is done implicitly when binding the managed Dma_space to a DMA domain (see L4vbus::Vbus::assign_dma_domain()).

Definition at line 260 of file dma_space.
References L4::Kobject_t< Derived, L4::Kobject, L4::PROTO_ANY, Type_info::Demand_t<> >::c(), L4_SUPERPAGESHIFT, and Search_addr.
Here is the call graph for this function:



15.284.4.2 map() [2/2]

```
l4_ret_t L4Re::Dma_space::map (
             L4::Ipc::Cap< L4Re::Dataspace > src,
             L4Re::Dataspace::Offset offset,
             l4_size_t * size,
             Attributes attrs,
             Direction dir,
             Dma_addr * dma_addr)  [inline]
```

Map the given part of this data space into the DMA address space.
A suitable address in the DMA task will be chosen automatically.

Parameters

`in`	*src*	Source data space (that describes the memory).
`in`	*offset*	The offset (bytes) within `src`.
`in,out`	*size*	The size (bytes) of the region to be mapped for DMA, after successful mapping the size returned is the size mapped for DMA as a single block. This size might be smaller than the original input size, in this case the caller might call map() again with a new offset and the remaining size.
`in`	*attrs*	The attributes used for this DMA mapping (a combination of Dma_space::Attribute values). The Search_addr attribute is forced by this overload!

in	*dir*	The direction of the DMA transfer issued with this mapping. The same value must later be passed to unmap(). (ignored)
out	*dma_addr*	The DMA address to use for DMA with the associated device.

Return values

L4_EOK	Operation successful.
-L4_EADDRNOTAVAIL	The specified region overlaps an existing mapping.
-L4_EINVAL	The capability src is invalid or does not refer to a valid dataspace.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.
-L4_ERANGE	offset is larger than the size of the dataspace.

The DMA mapping is created writable if capability src has the permission L4_CAP_FPAGE_W. Otherwise, a read-only DMA mapping is established.

Note

Dma_space_mgr::associate() or Dma_space_mgr::associate_phys() must be called prior to mapping memory. Usually this is done implicitly when binding the managed Dma_space to a DMA domain (see L4vbus::Vbus::assign_dma_domain()).

Deprecated Use the other overload without dir parameter.

Definition at line 190 of file dma_space.
References map(), and Search_addr.
Referenced by map().
Here is the call graph for this function:



Here is the caller graph for this function:



15.284.4.3 unmap() [1/2]

```
l4_ret_t L4Re::Dma_space::unmap (
             Dma_addr dma_addr,
             Dma_size size,
             Attributes attrs,
             Direction dir)  [inline]
```

Unmap the given part of this data space from the DMA address space.
The calls to map() and unmap() must be balanced. That is, each page of a mapping that was established by `map()` previously must be unmapped exactly once.
Sub-ranges that do not currently hold a mapping are silently skipped. That is, unmapping the same region too often, is not treated as an error.

Parameters

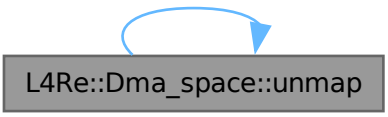
dma_addr	The DMA address (returned by Dma_space::map()).
size	The size (bytes) of the memory region to unmap.
attrs	The attributes for the unmap (currently none, ignored).
dir	The direction of the finished DMA operation (ignored).

Return values

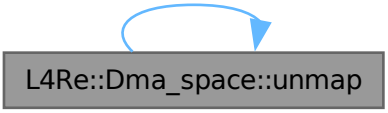
L4_EOK	Operation successful.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.

Deprecated Use the overload without `attrs` and `dir` because they are ignored.

Definition at line 326 of file dma_space.
References unmap().
Referenced by unmap().
Here is the call graph for this function:



Here is the caller graph for this function:



15.284.4.4 unmap() [2/2]

```
l4_ret_t L4Re::Dma_space::unmap (
             Dma_addr dma_addr,
             Dma_size size,
             Unmap_flags flags = Unmap_flags())  [inline]
```

Unmap the given part of this data space from the DMA address space.
The calls to map() and unmap() must be balanced. That is, each page of a mapping that was established by `map()` previously must be unmapped exactly once. Likewise, every Attribute::Reserve claim must be released by exactly one unmap() call carrying Unmap_flag::Cancel_reservation.
Sub-ranges that do not currently hold a claim of the requested kind are silently skipped. That is, unmapping the same region too often, is not treated as an error. This behaviour applies both to actual mappings, as well as reservations.

Parameters

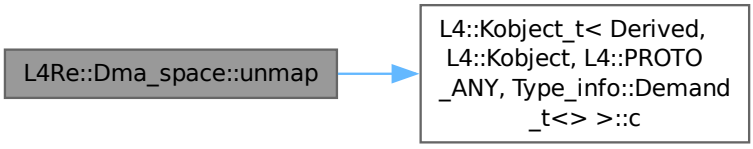
dma_addr	The DMA address (returned by Dma_space::map()).
size	The size (bytes) of the memory region to unmap.
flags	A combination of Dma_space::Unmap_flag values.

Return values

L4_EOK	Operation successful.
-L4_EPERM	The range overlaps with a privileged Dma_space_mgr::block_area() claim.
-L4_EINVAL	Invalid arguments. Can be caused by unknown `flags`, size of 0 or an address overflow.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.

Definition at line 358 of file dma_space.
References L4::Kobject_t< Derived, L4::Kobject, L4::PROTO_ANY, Type_info::Demand_t<> >::c().

Here is the call graph for this function:

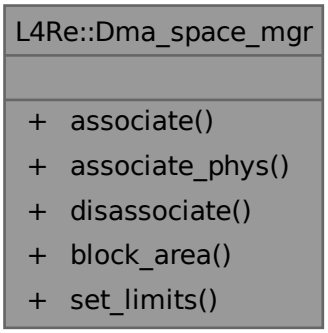


The documentation for this class was generated from the following file:

- l4/re/dma_space

15.285 L4Re::Dma_space_mgr Class Reference

A privileged interface to manage Dma_space associations for the clients.
`#include <dma_space>`
Collaboration diagram for L4Re::Dma_space_mgr:



Public Types

- enum Space_attrib : unsigned { Identity_map = 1U << 0 }

  Attributes assigned to the DMA space when associated with a specific device.
- enum Block_flag : unsigned { Search_addr = 1U << 0 }

  Attributes used when blocking an area.
- using **Space_attribs** = L4::Types::Flags_t<Space_attrib, unsigned>

  Attributes used when associating the DMA space.
- using **Block_flags** = L4::Types::Flags_t<Block_flag, unsigned>

  Attributes used when blocking an area.

Public Member Functions

- l4_ret_t associate (L4::Ipc::Cap< Dma_space > dma_space, L4::Ipc::Cap< L4::Task > dma_task, Space_attribs attr)

Associate a (kernel) DMA space for a device to a Dma_space.

- l4_ret_t associate_phys (L4::Ipc::Cap< Dma_space > dma_space, Space_attribs attr)

  Register a Dma_space to use for DMA.
- l4_ret_t disassociate (L4::Ipc::Cap< Dma_space > dma_space)

  Disassociate the (kernel) DMA space from this Dma_space.
- l4_ret_t block_area (L4::Ipc::Cap< Dma_space > dma_space, L4::Ipc::In_out< Dma_addr * > addr, Dma↩ _size size, Dma_addr max_addr=-1, Block_flags flags=Block_flags(), unsigned char align=L4_SUPERPAGESHIFT)

  Block an area in a Dma_space.
- l4_ret_t set_limits (L4::Ipc::Cap< Dma_space > dma_space, Dma_addr min_addr, Dma_addr max_addr)

  Set lower and upper bound of DMA addresses.

15.285.1 Detailed Description

A privileged interface to manage Dma_space associations for the clients.
This interface is provided as a singleton by Moe.
Definition at line 375 of file dma_space.

15.285.2 Member Enumeration Documentation

15.285.2.1 Block_flag

```
enum L4Re::Dma_space_mgr::Block_flag :  unsigned
```

Attributes used when blocking an area.

See also

Block_flags

Enumerator

Search_addr	Search suitable address. With this flag, the start address is taken as a lower bound. Without the flag, `start` and `size` are taken literally.

Definition at line 408 of file dma_space.

15.285.2.2 Space_attrib

```
enum L4Re::Dma_space_mgr::Space_attrib :  unsigned
```

Attributes assigned to the DMA space when associated with a specific device.

See also

Space_attribs

Enumerator

Identity_map	Request identity mappings. This is needed if some devices are not connected to an IOMMU and need physical addresses.

Definition at line 388 of file dma_space.

15.285.3 Member Function Documentation

15.285.3.1 associate()

```
l4_ret_t L4Re::Dma_space_mgr::associate (
            L4::Ipc::Cap< Dma_space > dma_space,
```

```
L4::Ipc::Cap< L4::Task > dma_task,
Space_attribs attr)
```

Associate a (kernel) DMA space for a device to a Dma_space.

Parameters

in	*dma_space*	The Dma_space to associate the (kernel) DMA space with.
in	*dma_task*	The (kernel) DMA space used for the device that shall be associated with this DMA space.
in	*attr*	Attributes for this DMA space. See L4Re::Dma_space::Space_attrib.

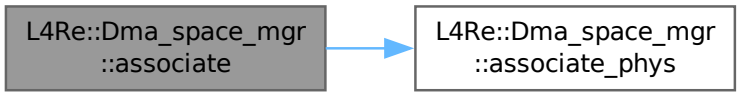
Return values

L4_EOK	Operation successful.
-L4_EBUSY	The Dma_space is already associated.
-L4_EINVAL	Invalid arguments, e.g. no `dma_task` capability passed. In particular, when Space_attrib::Identity_map is requested, the Dma_space must not have any pre-existing blockings (see Dma_space_mgr::block_area()) and must not have custom address limits set (see Dma_space_mgr::set_limits()).
-L4_ENOENT	Invalid `dma_space` was passed.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The `dma_space` and `dma_task` capabilities must have the permission L4_CAP_FPAGE_W.

References associate_phys().
Here is the call graph for this function:



15.285.3.2 associate_phys()

```
l4_ret_t L4Re::Dma_space_mgr::associate_phys (
L4::Ipc::Cap< Dma_space > dma_space,
Space_attribs attr)
```

Register a Dma_space to use for DMA.
This function should be used, in case no IOMMU is present or configured. The CPU's physical memory is used as DMA address space.

Parameters

in	*dma_space*	The Dma_space to register.
in	*attr*	Attributes for the provided DMA space. Currently not used; must be the default-constructed Space_attribs() value.

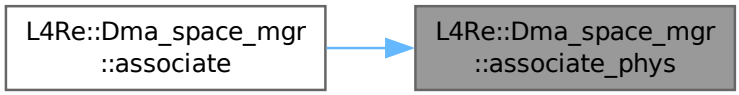
Return values

L4_EOK	Operation successful.
-L4_EBUSY	The Dma_space is already associated.
-L4_EINVAL	Invalid arguments, for example a non-zero `attr`, pre-existing blockings on `dma_space` (see Dma_space_mgr::block_area()), or custom address limits set on `dma_space` (see Dma_space_mgr::set_limits()).
-L4_ENOENT	Invalid `dma_space` was passed.
-L4_ENOMEM	Not enough memory to allocate internal datastructures.
-L4_EPERM	Insufficient permissions; see precondition.

Precondition

The `dma_space` capability must have the permission L4_CAP_FPAGE_W.

Referenced by associate().
Here is the caller graph for this function:



15.285.3.3 block_area()

```
l4_ret_t L4Re::Dma_space_mgr::block_area (
             L4::Ipc::Cap< Dma_space > dma_space,
             L4::Ipc::In_out< Dma_addr * > addr,
             Dma_size size,
             Dma_addr max_addr = -1,
             Block_flags flags = Block_flags(),
             unsigned char align = L4_SUPERPAGESHIFT)  [inline]
```

Block an area in a Dma_space.
The blocked area cannot be used for mappings in the given `dma_space` after the call. The call will fail if there are already mappings in the requested range. It is allowed to add block areas before associate() or associate_phys() has been called.
Blocked areas are allowed to overlap.

Parameters

in	*dma_space*	The Dma_space to add blocked areas.

in,out	*addr*	The DMA address of the blocked area. Either taken literally (in which case it must be page aligned) or as start address if Block_flag::Search_addr is passed.
in	*size*	Size of the blocked region. Must be page aligned.
in	*max_addr*	Highest allowed DMA address of the region (inclusive).
in	*flags*	The attributes used for this blocking (a combination of Dma_space_mgr::Block_flag values).
in	*align*	The log2 alignment of the blocked area. Only used if Block_flag::Search_addr is passed.

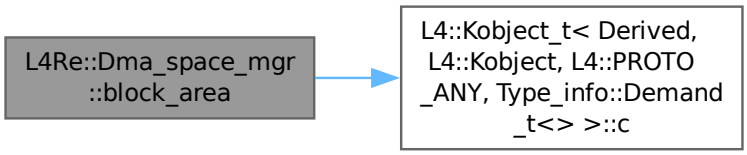
Return values

L4_EOK	Operation successful.
-L4_EADDRNOTAVAIL	The specified region overlaps an existing mapping or no space left for the blocking.
-L4_EINVAL	Invalid address, alignment or flag passed. Block_flag::Search_addr passed but dma_space is not associated yet.
-L4_EPERM	Dma_space is associated with physical DMA domain or insufficient permissions; see precondition.
-L4_ENOMEM	There is not enough memory to allocate internal data structures.

Precondition

The dma_space capability must have the permission L4_CAP_FPAGE_W.

Definition at line 542 of file dma_space.
References L4::Kobject_t< Derived, L4::Kobject, L4::PROTO_ANY, Type_info::Demand_t<> >::c(), and L4_SUPERPAGESHIFT.
Here is the call graph for this function:



15.285.3.4 disassociate()

```
l4_ret_t L4Re::Dma_space_mgr::disassociate (
            L4::Ipc::Cap< Dma_space > dma_space)
```

Disassociate the (kernel) DMA space from this Dma_space.

Parameters

in	*dma_space*	The Dma_space to de-register.

Return values

L4_EOK	Operation successful.
-L4_ENOENT	Invalid `dma_space` was passed or disassociate() called without prior calling associate()/associate_phys().
-L4_EPERM	Insufficient permissions; see precondition.

Attention

This will remove all mappings, reservations and blockings from `dma_space`.

Precondition

The `dma_space` capability must have the permission L4_CAP_FPAGE_W.

References disassociate().
Referenced by disassociate().
Here is the call graph for this function:



Here is the caller graph for this function:



15.285.3.5 set_limits()

```
l4_ret_t L4Re::Dma_space_mgr::set_limits (
             L4::Ipc::Cap< Dma_space > dma_space,
             Dma_addr min_addr,
             Dma_addr max_addr)
```

Set lower and upper bound of DMA addresses.
Mappings and blockings are only allowed in the given range.

If multiple Dma_spaces share the same kernel DMA space (i.e., were associated by passing the same `dma_task` to associate()), all DMA address allocations, reservations and blockings performed through any of these Dma_spaces use the intersection of all their individual limits. Tightening the limits on one Dma_space therefore also constrains all other Dma_spaces sharing the same DMA task; loosening the limits on one Dma_space has no effect beyond what the most-restrictive peer Dma_space allows.

Parameters

`in`	*dma_space*	The Dma_space whose limits shall be changed.
`in`	*min_addr*	The lowest usable address in the Dma_space.
`in`	*max_addr*	The highest usable address in the Dma_space (inclusive).

Return values

L4_EOK	Operation successful.
-L4_EADDRNOTAVAIL	There are existing mappings or blocking outside the bounds.
-L4_EPERM	Dma_space is associated with physical DMA domain or insufficient permissions; see precondition.
-L4_EINVAL	Invalid address passed.

Precondition

The `dma_space` capability must have the permission L4_CAP_FPAGE_W.

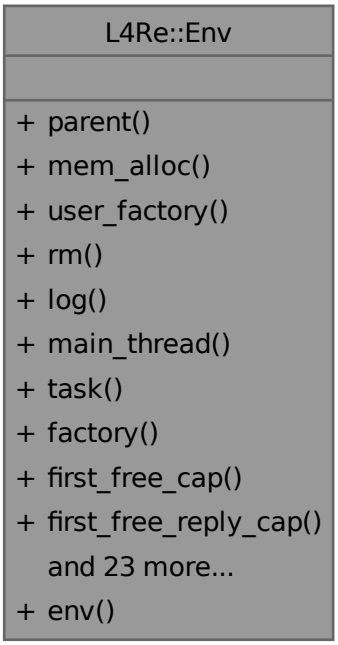
The documentation for this class was generated from the following file:

- l4/re/dma_space

15.286 L4Re::Env Class Reference

C++ interface of the initial environment that is provided to an L4 task.
`#include <env>`

Collaboration diagram for L4Re::Env:



Public Types

- typedef l4re_env_cap_entry_t **Cap_entry**

  C++ type for an entry in the initial objects array.

Public Member Functions

- L4::Cap< Parent > parent () const noexcept

  Object-capability to the parent.
- L4::Cap< Mem_alloc > mem_alloc () const noexcept

  Object-capability to the memory allocator.
- L4::Cap< L4::Factory > **user_factory** () const noexcept

  Object-capability to the user-level object factory.
- L4::Cap< Rm > rm () const noexcept

  Object-capability to the region map.
- L4::Cap< Log > log () const noexcept

  Object-capability to the logging service.
- L4::Cap< L4::Thread > main_thread () const noexcept

  Object-capability of the first user thread.
- L4::Cap< L4::Task > task () const noexcept

  Object-capability of the user task.
- L4::Cap< L4::Factory > factory () const noexcept

  Object-capability to the factory object available to the task.
- l4_cap_idx_t first_free_cap () const noexcept

  *First available object capability index (**not** shifted by L4_CAP_SHIFT).*

- l4_umword_t first_free_reply_cap () const noexcept

  *First available reply capability index (**not** shifted by L4_CAP_SHIFT).*
- l4_fpage_t utcb_area () const noexcept

  UTCB area of the task.
- l4_addr_t first_free_utcb () const noexcept

  First free UTCB.
- Cap_entry const * initial_caps () const noexcept

  Get a pointer to the first entry in the initial objects array.
- Cap_entry const * get (char const *name, unsigned l) const noexcept

  Get the Cap_entry for the object named name.
- template<typename T>
  L4::Cap< T > get_cap (char const *name, unsigned l) const noexcept

  Get the capability index for the object named name.
- template<typename T>
  L4::Cap< T > get_cap (char const *name) const noexcept

  Get the capability index for the object named name.
- void parent (L4::Cap< Parent > const &c) noexcept

  Set parent object-capability.
- void mem_alloc (L4::Cap< Mem_alloc > const &c) noexcept

  Set memory allocator object-capability.
- void rm (L4::Cap< Rm > const &c) noexcept

  Set region map object-capability.
- void log (L4::Cap< Log > const &c) noexcept

  Set log object-capability.
- void main_thread (L4::Cap< L4::Thread > const &c) noexcept

  Set object-capability of first user thread.
- void factory (L4::Cap< L4::Factory > const &c) noexcept

  Set factory object-capability.
- void first_free_cap (l4_cap_idx_t c) noexcept

  *Set first available object capability index (**not** shifted by L4_CAP_SHIFT).*
- void first_free_reply_cap (l4_umword_t c) noexcept

  *Set first available reply capability index (**not** shifted by L4_CAP_SHIFT).*
- void utcb_area (l4_fpage_t utcbs) noexcept

  Set UTCB area of the task.
- void first_free_utcb (l4_addr_t u) noexcept

  Set first free UTCB.
- L4::Cap< L4::Scheduler > scheduler () const noexcept

  Get the scheduler capability for the task.
- void scheduler (L4::Cap< L4::Scheduler > const &c) noexcept

  Set the scheduler capability.
- L4::Cap< Itas > itas () const noexcept

  Object-capability to the ITAS services.
- void itas (L4::Cap< Itas > const &c) noexcept

  Set the ITAS capability.
- L4::Cap< Dbg_events > dbg_events () const noexcept

  Object-capability to a debugger events service.
- void dbg_events (L4::Cap< Dbg_events > const &dbg_events) noexcept

  Set the dbg_events capability.
- void initial_caps (Cap_entry *first) noexcept

  Set the pointer to the first Cap_entry in the initial objects array.

Static Public Member Functions

- static Env const * env () noexcept

  Returns the initial environment for the current task.

15.286.1 Detailed Description

C++ interface of the initial environment that is provided to an L4 task.
The initial environment is provided to each L4 task that is started by an L4Re conform loader, such as the Moe root task. The initial environment provides access to a set of initial capabilities and some additional information about the available resources, such as free UTCBs (see Virtual Registers) and available entries in capability table (provided by the micro kernel).
Each of the initial capabilities is stored at a fixed index in the task's capability table and the L4 runtime environment provides convenience functions to retrieve the capabilities. See the table below for an comprehensive overview.

Name	Object Type	Convenience Function
parent	L4Re::Parent	L4Re::Env::parent()
user_factory	L4::Factory	L4Re::Env::user_factory()
log	L4Re::Log	L4Re::Env::log()
main_thread	L4::Thread	L4Re::Env::main_thread()
rm	L4Re::Rm	L4Re::Env::rm()
factory	L4::Factory	L4Re::Env::factory()
task	L4::Task	L4Re::Env::task()
scheduler	L4::Scheduler	L4Re::Env::scheduler()
itas	L4Re::Itas	L4Re::Env::itas()

Additional information found in the initial environment is:

- First free entry in capability table
- The UTCB area (as flexpage)
- First free UTCB (address in the UTCB area)

Include File

```
#include <l4/re/env>
```

For an explanation of the default task capabilities see l4_default_caps_t.
For the C interface refer to Initial Environment.
Definition at line 78 of file env.

15.286.2 Member Function Documentation

15.286.2.1 dbg_events() [1/2]

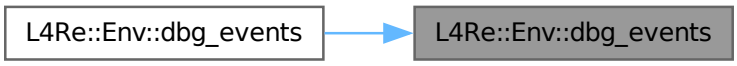
`L4::Cap< Dbg_events > L4Re::Env::dbg_events () const [inline], [noexcept]`
Object-capability to a debugger events service.

Returns

Dbg_events object-capability

This capability can be invalid.
Definition at line 336 of file env.
Referenced by dbg_events().

Here is the caller graph for this function:



15.286.2.2 dbg_events() [2/2]

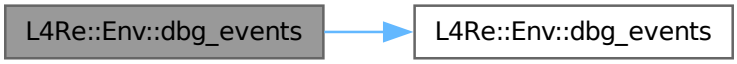
```
void L4Re::Env::dbg_events (
            L4::Cap< Dbg_events > const & dbg_events)  [inline], [noexcept]
```

Set the dbg_events capability.

Parameters

dbg_events	is the capability to be set for the debug events service.

Note that the capability can be invalid.
Definition at line 346 of file env.
References dbg_events().
Here is the call graph for this function:



15.286.2.3 env()

```
Env const * L4Re::Env::env ()  [inline], [static], [noexcept]
```

Returns the initial environment for the current task.

Returns

Pointer to the initial environment class.

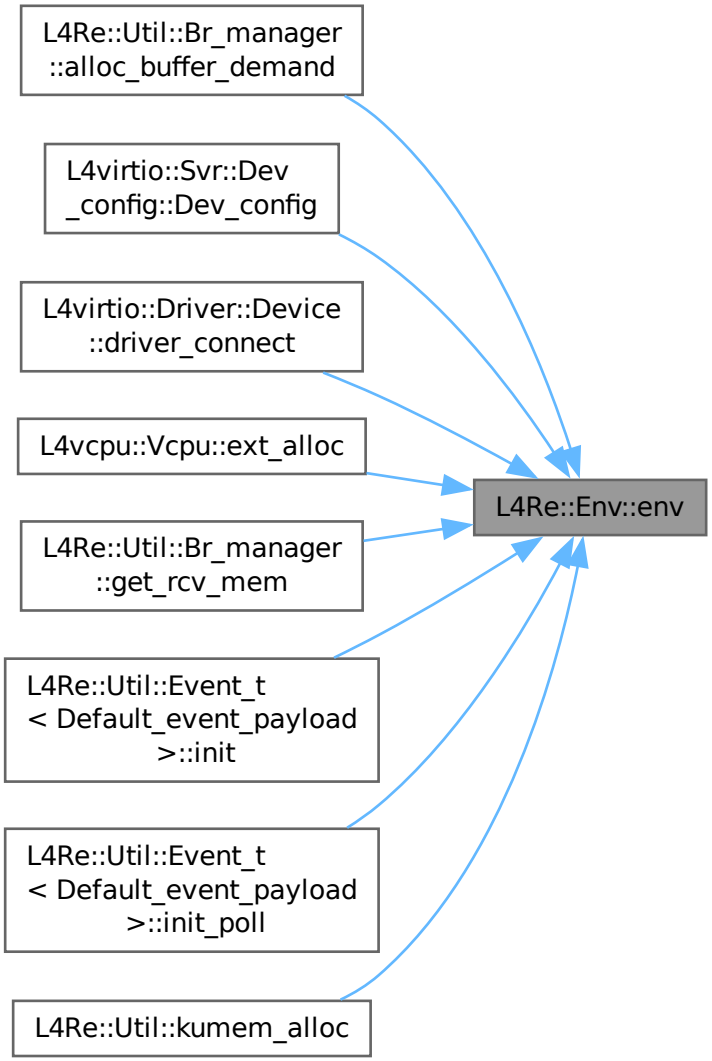
A typical use of this function is L4Re::Env::env()-><member>()

Examples

examples/clntsrv/src/client.cc, examples/libs/l4re/c++/mem_alloc/ma+rm.cc, examples/libs/l4re/c++/shared_ds/ds_clnt.cc, examples/libs/l4re/c++/shared_ds/ds_srv.cc, examples/libs/l4re/streammap/client.cc, and examples/sys/migrate/thread_migrate

Definition at line 96 of file env.
Referenced by L4Re::Util::Br_manager::alloc_buffer_demand(), L4virtio::Svr::Dev_config::Dev_config(), L4virtio::Driver::Device::driver
L4vcpu::Vcpu::ext_alloc(), L4Re::Util::Br_manager::get_rcv_mem(), L4Re::Util::Event_t< Default_event_payload >::init(), L4Re::Util::Event_t< Default_event_payload >::init_poll(), and L4Re::Util::kumem_alloc().

Here is the caller graph for this function:



15.286.2.4 factory() [1/2]

`L4::Cap< L4::Factory > L4Re::Env::factory () const [inline], [noexcept]`

Object-capability to the factory object available to the task.

Returns

Factory object-capability

Definition at line 148 of file env.

15.286.2.5 factory() [2/2]

```
void L4Re::Env::factory (
            L4::Cap< L4::Factory > const & c) [inline], [noexcept]
```

Set factory object-capability.

Parameters

c	Factory object-capability

Definition at line 265 of file env.

15.286.2.6 first_free_cap() [1/2]

```
l4_cap_idx_t L4Re::Env::first_free_cap () const  [inline], [noexcept]
```

First available object capability index (***not*** shifted by L4_CAP_SHIFT).

Returns

First available object capability index (*not* shifted).

First object capability index (*not* shifted) available for use for in the application.
Definition at line 158 of file env.

15.286.2.7 first_free_cap() [2/2]

```
void L4Re::Env::first_free_cap (
            l4_cap_idx_t c)  [inline], [noexcept]
```

Set first available object capability index (***not*** shifted by L4_CAP_SHIFT).

Parameters

c	First object capability index (*not* shifted) available to the application.

Definition at line 273 of file env.

15.286.2.8 first_free_reply_cap() [1/2]

```
l4_umword_t L4Re::Env::first_free_reply_cap () const  [inline], [noexcept]
```

First available reply capability index (***not*** shifted by L4_CAP_SHIFT).

Returns

First available reply capability index (*not* shifted).

First reply capability index (*not* shifted) for use for in the application.
Definition at line 168 of file env.

15.286.2.9 first_free_reply_cap() [2/2]

```
void L4Re::Env::first_free_reply_cap (
            l4_umword_t c)  [inline], [noexcept]
```

Set first available reply capability index (***not*** shifted by L4_CAP_SHIFT).

Parameters

c	First reply capability index (*not* shifted) available to the application.

Definition at line 281 of file env.

15.286.2.10 first_free_utcb() [1/2]

```
l4_addr_t L4Re::Env::first_free_utcb () const  [inline], [noexcept]
```

First free UTCB.

Returns

object-capability

First free UTCB within the UTCB area available for the application to use.
Definition at line 183 of file env.

15.286.2.11 first_free_utcb() [2/2]

```
void L4Re::Env::first_free_utcb (
            l4_addr_t u)  [inline], [noexcept]
```

Set first free UTCB.

Parameters

u	First UTCB available for the application to use.

Definition at line 293 of file env.

15.286.2.12 get()

```
Cap_entry const * L4Re::Env::get (
            char const * name,
            unsigned l) const  [inline], [noexcept]
```

Get the Cap_entry for the object named *name*.

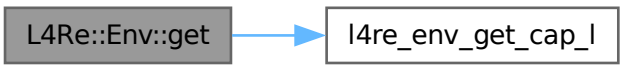
Parameters

name	is the name of the object.
l	is the length of the name, thus *name* might not be zero terminated.

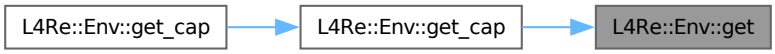
Returns

A pointer to the Cap_entry for the object named *name*, or NULL if no such object was found.

Definition at line 201 of file env.
References l4re_env_get_cap_l().
Referenced by get_cap().
Here is the call graph for this function:



Here is the caller graph for this function:



15.286.2.13 get_cap() [1/2]

```
template<typename T>
L4::Cap< T > L4Re::Env::get_cap (
            char const * name) const  [inline], [noexcept]
```

Get the capability index for the object named *name*.

Parameters

name	is the name of the object (zero terminated).

Returns

A capability index for the object named *name*, or an invalid capability selector if no such object was found.

Definition at line 228 of file env.
References get_cap().
Here is the call graph for this function:



15.286.2.14 get_cap() [2/2]

```
template<typename T>
L4::Cap< T > L4Re::Env::get_cap (
            char const * name,
            unsigned l) const  [inline], [noexcept]
```

Get the capability index for the object named *name*.

Parameters

name	is the name of the object.
l	is the length of the name, thus *name* might not be zero terminated.

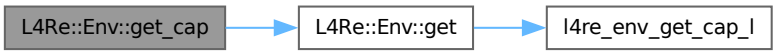
Returns

A capability index for the object named *name*, or an invalid capability selector if no such object was found.

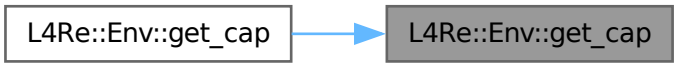
Examples

examples/clntsrv/src/client.cc, examples/libs/l4re/c++/shared_ds/ds_clnt.cc, and examples/libs/l4re/streammap/client.cc.

Definition at line 213 of file env.
References get(), and L4_ENOENT.
Referenced by get_cap().
Here is the call graph for this function:



Here is the caller graph for this function:



15.286.2.15 initial_caps() [1/2]

```
Cap_entry const * L4Re::Env::initial_caps () const  [inline], [noexcept]
```

Get a pointer to the first entry in the initial objects array.

Returns

A pointer to the first entry in the initial objects array.

Definition at line 190 of file env.

15.286.2.16 initial_caps() [2/2]

```
void L4Re::Env::initial_caps (
            Cap_entry * first)  [inline], [noexcept]
```

Set the pointer to the first Cap_entry in the initial objects array.

Parameters

first	is the first element in the array.

Definition at line 353 of file env.

15.286.2.17 itas() [1/2]

```
L4::Cap< Itas > L4Re::Env::itas () const  [inline], [noexcept]
```

Object-capability to the ITAS services.

Returns

ITAS object-capability

Attention: this capability might be invalid, depending on the system configuration. Regular applications must not use it directly as it is an implementation detail of the L4Re libc that is subject to change without notice!
Definition at line 320 of file env.

15.286.2.18 itas() [2/2]

```
void L4Re::Env::itas (
            L4::Cap< Itas > const & c)  [inline], [noexcept]
```

Set the ITAS capability.

Parameters

c	is the capability to be set as ITAS.

Definition at line 327 of file env.

15.286.2.19 log() [1/2]

```
L4::Cap< Log > L4Re::Env::log () const  [inline], [noexcept]
```

Object-capability to the logging service.
Might be invalid if there is no logging service available to the application!

Returns

Log object-capability

Definition at line 130 of file env.

15.286.2.20 log() [2/2]

```
void L4Re::Env::log (
            L4::Cap< Log > const & c)  [inline], [noexcept]
```

Set log object-capability.

Parameters

c	Log object-capability

Definition at line 253 of file env.

15.286.2.21 main_thread() [1/2]

```
L4::Cap< L4::Thread > L4Re::Env::main_thread () const  [inline], [noexcept]
```

Object-capability of the first user thread.

Returns

Object-capability of the first user thread.

Definition at line 136 of file env.

15.286.2.22 main_thread() [2/2]

```
void L4Re::Env::main_thread (
            L4::Cap< L4::Thread > const & c)  [inline], [noexcept]
```

Set object-capability of first user thread.

Parameters

c	First thread's object-capability

Definition at line 259 of file env.

15.286.2.23 mem_alloc() [1/2]

```
L4::Cap< Mem_alloc > L4Re::Env::mem_alloc () const  [inline], [noexcept]
```

Object-capability to the memory allocator.

Returns

Memory allocator object-capability

Examples

examples/libs/l4re/c++/shared_ds/ds_srv.cc.

Definition at line 109 of file env.

15.286.2.24 mem_alloc() [2/2]

```
void L4Re::Env::mem_alloc (
            L4::Cap< Mem_alloc > const & c)  [inline], [noexcept]
```

Set memory allocator object-capability.

Parameters

c	Memory allocator object-capability

Definition at line 241 of file env.

15.286.2.25 parent() [1/2]

```
L4::Cap< Parent > L4Re::Env::parent () const  [inline], [noexcept]
```

Object-capability to the parent.

Returns

Parent object-capability

Definition at line 103 of file env.

15.286.2.26 parent() [2/2]

```
void L4Re::Env::parent (
            L4::Cap< Parent > const & c)  [inline], [noexcept]
```

Set parent object-capability.

Parameters

c	Parent object-capability

Definition at line 235 of file env.

15.286.2.27 rm() [1/2]

```
L4::Cap< Rm > L4Re::Env::rm () const  [inline], [noexcept]
```

Object-capability to the region map.

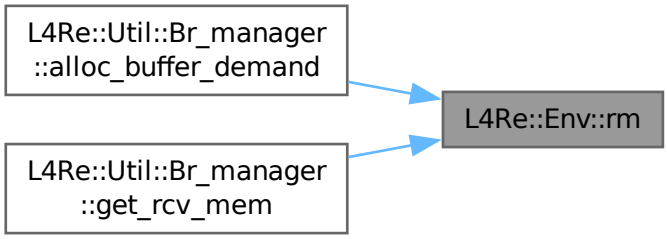
Returns

Region map object-capability

Examples

examples/libs/l4re/c++/shared_ds/ds_clnt.cc, and examples/libs/l4re/c++/shared_ds/ds_srv.cc.

Definition at line 120 of file env.
Referenced by L4Re::Util::Br_manager::alloc_buffer_demand(), and L4Re::Util::Br_manager::get_rcv_mem().
Here is the caller graph for this function:



15.286.2.28 rm() [2/2]

```
void L4Re::Env::rm (
            L4::Cap< Rm > const & c)  [inline], [noexcept]
```

Set region map object-capability.

Parameters

c	Region map object-capability

Definition at line 247 of file env.

15.286.2.29 scheduler() [1/2]

```
L4::Cap< L4::Scheduler > L4Re::Env::scheduler () const  [inline], [noexcept]
```

Get the scheduler capability for the task.

Returns

The capability index for the default scheduler used for this task.

Definition at line 301 of file env.

15.286.2.30 scheduler() [2/2]

```
void L4Re::Env::scheduler (
            L4::Cap< L4::Scheduler > const & c)  [inline], [noexcept]
```

Set the scheduler capability.

Parameters

c	is the capability to be set as scheduler.

Definition at line 308 of file env.

15.286.2.31 task()

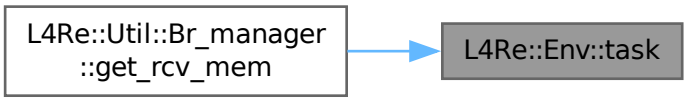
```
L4::Cap< L4::Task > L4Re::Env::task () const  [inline], [noexcept]
```

Object-capability of the user task.

Returns

Object-capability of the user task.

Definition at line 142 of file env.
Referenced by L4Re::Util::Br_manager::get_rcv_mem().
Here is the caller graph for this function:



15.286.2.32 utcb_area() [1/2]

```
l4_fpage_t L4Re::Env::utcb_area () const  [inline], [noexcept]
```

UTCB area of the task.

Returns

UTCB area

Definition at line 174 of file env.

15.286.2.33 utcb_area() [2/2]

```
void L4Re::Env::utcb_area (
            l4_fpage_t utcbs)  [inline], [noexcept]
```

Set UTCB area of the task.

Parameters

utcbs	UTCB area

Definition at line 287 of file env.
The documentation for this class was generated from the following file:

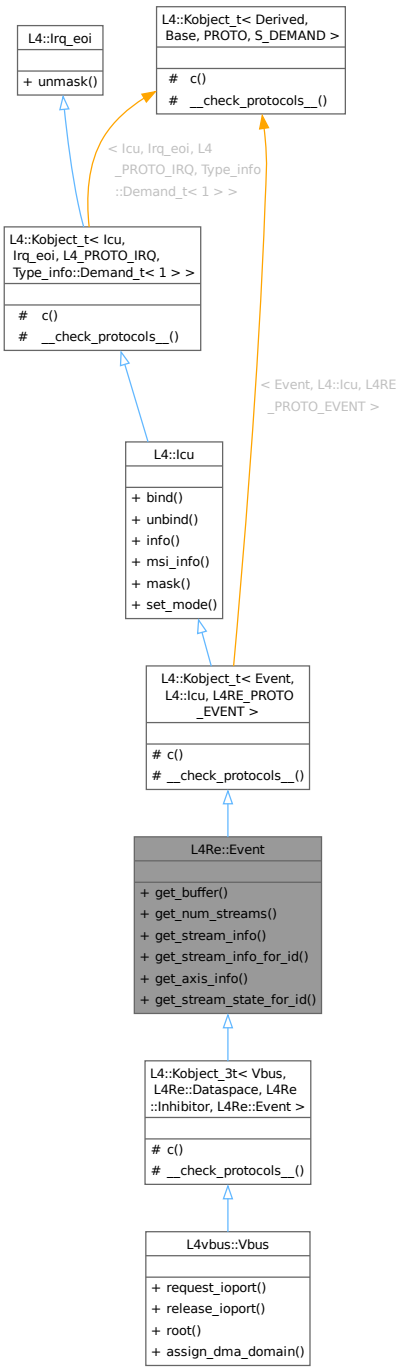
- l4/re/env

15.287 L4Re::Event Class Reference

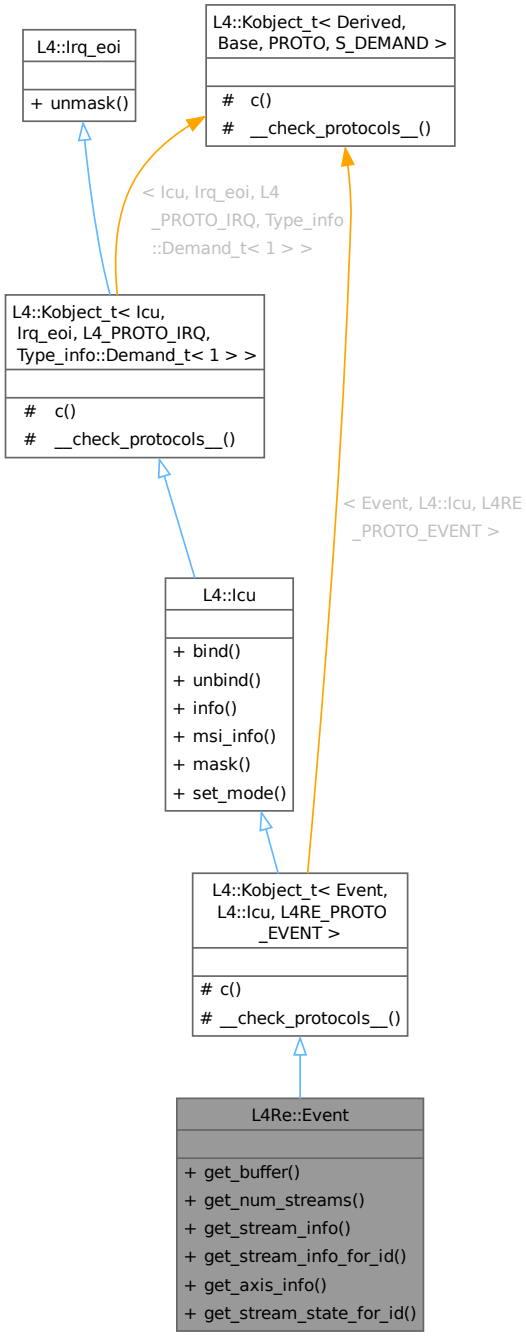
Event class.

```
#include <event>
```

Inheritance diagram for L4Re::Event:



Collaboration diagram for L4Re::Event:



Public Member Functions

- l4_ret_t get_buffer (L4::Ipc::Out< L4::Cap< Dataspace > > ds)

  Get event signal buffer.
- l4_ret_t get_num_streams ()

  Get number of event streams.
- l4_ret_t get_stream_info (int idx, Event_stream_info *info)

  Get event stream infos.

- l4_ret_t get_stream_info_for_id (l4_umword_t stream_id, Event_stream_info *info)

  Get event stream infos.
- l4_ret_t get_axis_info (l4_umword_t stream_id, unsigned naxes, unsigned const *axis, Event_absinfo *info) const noexcept

  Get event stream axis infos.
- l4_ret_t get_stream_state_for_id (l4_umword_t stream_id, Event_stream_state *state)

  Get event stream state.

Public Member Functions inherited from L4::Icu

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)

  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Event, L4::Icu, L4RE_PROTO_EVENT >

- typedef Event **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Event > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Icu::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Event, L4::Icu, L4RE_PROTO_EVENT >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Event, L4::Icu, L4RE_PROTO_EVENT >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.287.1 Detailed Description

Event class.

See also

L4Re Event API

Definition at line 137 of file event.

15.287.2 Member Function Documentation

15.287.2.1 get_axis_info()

```
l4_ret_t L4Re::Event::get_axis_info (
             l4_umword_t stream_id,
             unsigned naxes,
             unsigned const * axis,
             Event_absinfo * info) const  [inline], [noexcept]
```

Get event stream axis infos.

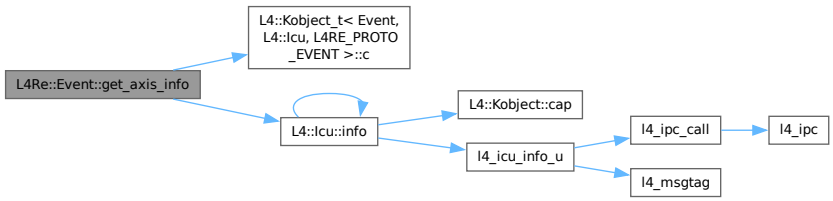
Parameters

	stream_id	ID of the event stream.
in	*naxes*	Number of axis IDs and axis infos.
in	*axis*	Array of axis IDs.
out	*info*	Array of axis infos.

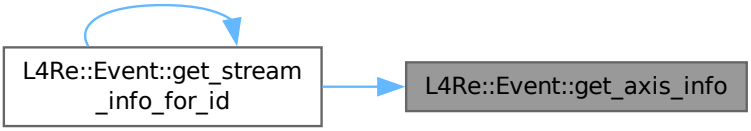
Return values

>=0	Number of returned axes infos.
<0	Error code.

Definition at line 200 of file event.
References L4::Kobject_t< Event, L4::Icu, L4RE_PROTO_EVENT >::c(), and L4::Icu::info().
Referenced by get_stream_info_for_id().
Here is the call graph for this function:



Here is the caller graph for this function:



15.287.2.2 get_buffer()

```
l4_ret_t L4Re::Event::get_buffer (
            L4::Ipc::Out< L4::Cap< Dataspace > > ds)
```

Get event signal buffer.

Parameters

out	*ds*	Event buffer.

Return values

0	Success
<0	Error

References get_buffer().
Referenced by get_buffer().

Here is the call graph for this function:



Here is the caller graph for this function:



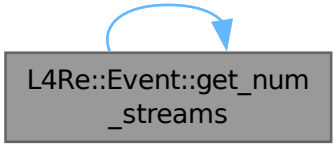
15.287.2.3 get_num_streams()

`l4_ret_t L4Re::Event::get_num_streams ()`
Get number of event streams.

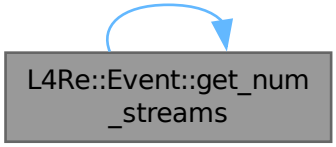
Return values

>=0	Number of streams.
<0	Error code.

References get_num_streams().
Referenced by get_num_streams().
Here is the call graph for this function:



Here is the caller graph for this function:



15.287.2.4 get_stream_info()

```
l4_ret_t L4Re::Event::get_stream_info (
            int idx,
            Event_stream_info * info)
```

Get event stream infos.
Deprecated. Use get_stream_info_for_id().

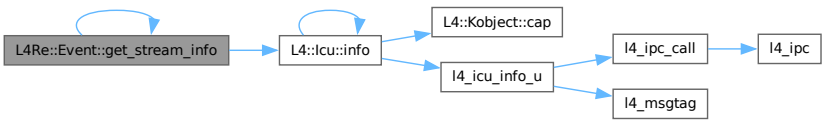
Parameters

	idx	ID of the event stream.
out	*info*	Event stream info.

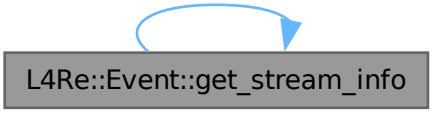
Return values

0	Success
<0	Error

References get_stream_info(), and L4::Icu::info().
Referenced by get_stream_info().
Here is the call graph for this function:



Here is the caller graph for this function:



15.287.2.5 get_stream_info_for_id()

```
l4_ret_t L4Re::Event::get_stream_info_for_id (
            l4_umword_t stream_id,
            Event_stream_info * info)
```

Get event stream infos.

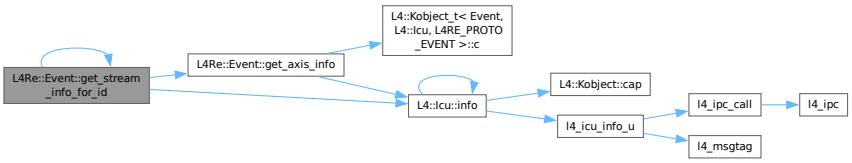
Parameters

	stream↩ _id	ID of the event stream.
out	*info*	Event stream info.

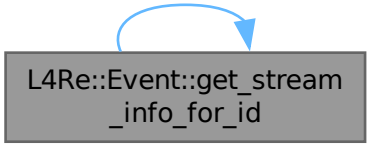
Return values

0	Success
<0	Error

References get_axis_info(), get_stream_info_for_id(), and L4::Icu::info().
Referenced by get_stream_info_for_id().
Here is the call graph for this function:



Here is the caller graph for this function:



15.287.2.6 get_stream_state_for_id()

```
l4_ret_t L4Re::Event::get_stream_state_for_id (
            l4_umword_t stream_id,
            Event_stream_state * state)
```

Get event stream state.

Parameters

	stream↩ _id	ID of the event stream.
out	*state*	Event stream state.

Return values

0	Success
<0	Error

The documentation for this class was generated from the following file:

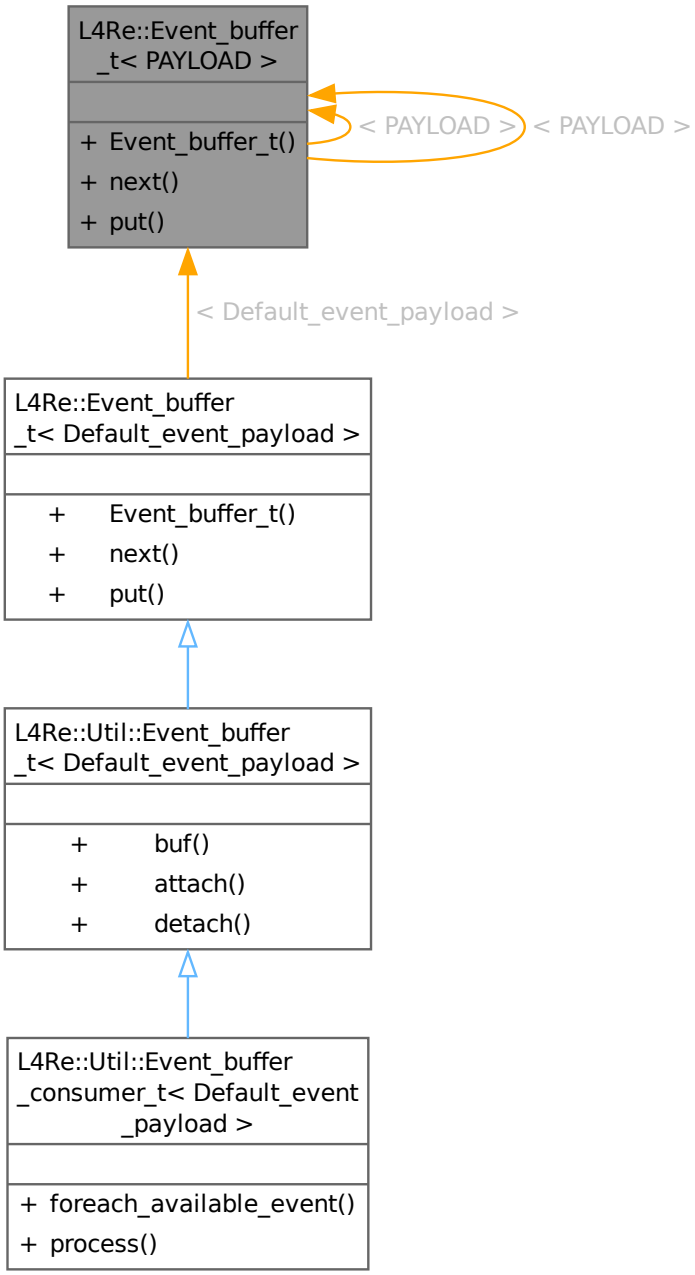
- l4/re/event

15.288 L4Re::Event_buffer_t< PAYLOAD > Class Template Reference

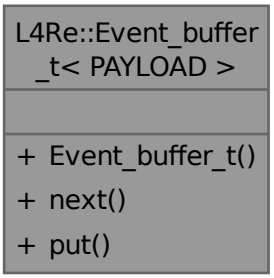
Event buffer class.

`#include <event>`

Inheritance diagram for L4Re::Event_buffer_t< PAYLOAD >:



Collaboration diagram for L4Re::Event_buffer_t< PAYLOAD >:



Data Structures

- struct Event

  Event structure used in buffer.

Public Member Functions

- Event_buffer_t (void *buffer, l4_addr_t size)

  Initialize event buffer.
- Event * next () noexcept

  Next event in buffer.
- bool put (Event const &ev) noexcept

  Put event into buffer at current position.

15.288.1 Detailed Description

template<typename PAYLOAD = Default_event_payload>
class L4Re::Event_buffer_t< PAYLOAD >

Event buffer class.
Definition at line 248 of file event.

15.288.2 Constructor & Destructor Documentation

15.288.2.1 Event_buffer_t()

```
template<typename PAYLOAD = Default_event_payload>
L4Re::Event_buffer_t< PAYLOAD >::Event_buffer_t (
            void * buffer,
            l4_addr_t size)  [inline]
```

Initialize event buffer.

Parameters

buffer	Pointer to buffer.
size	Size of buffer in bytes.

Definition at line 295 of file event.

15.288.3 Member Function Documentation

15.288.3.1 next()

```
template<typename PAYLOAD = Default_event_payload>
Event * L4Re::Event_buffer_t< PAYLOAD >::next ()  [inline], [noexcept]
```

Next event in buffer.

Returns

0 if no event available, event otherwise.

Definition at line 305 of file event.

15.288.3.2 put()

```
template<typename PAYLOAD = Default_event_payload>
bool L4Re::Event_buffer_t< PAYLOAD >::put (
            Event const & ev)  [inline], [noexcept]
```

Put event into buffer at current position.

Parameters

ev	Event to put into the buffer.

Returns

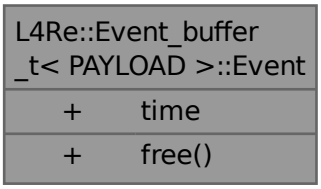
false if buffer is full and entry could not be added.

Definition at line 322 of file event.
The documentation for this class was generated from the following file:

- l4/re/event

15.289 L4Re::Event_buffer_t< PAYLOAD >::Event Struct Reference

Event structure used in buffer.
`#include <event>`
Collaboration diagram for L4Re::Event_buffer_t< PAYLOAD >::Event:



Public Member Functions

- void **free** () noexcept

  Free the entry.

Data Fields

- long long **time**

  Event time stamp.

15.289.1 Detailed Description

template<typename PAYLOAD = Default_event_payload>
struct L4Re::Event_buffer_t< PAYLOAD >::Event

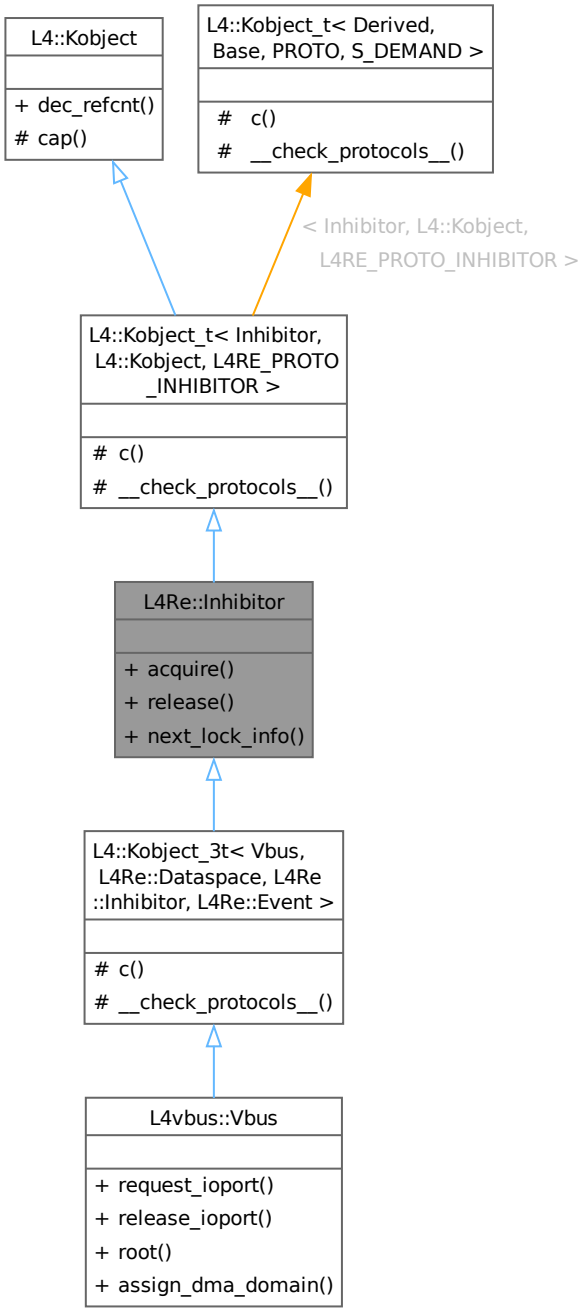
Event structure used in buffer.
Definition at line 255 of file event.
The documentation for this struct was generated from the following file:

- l4/re/event

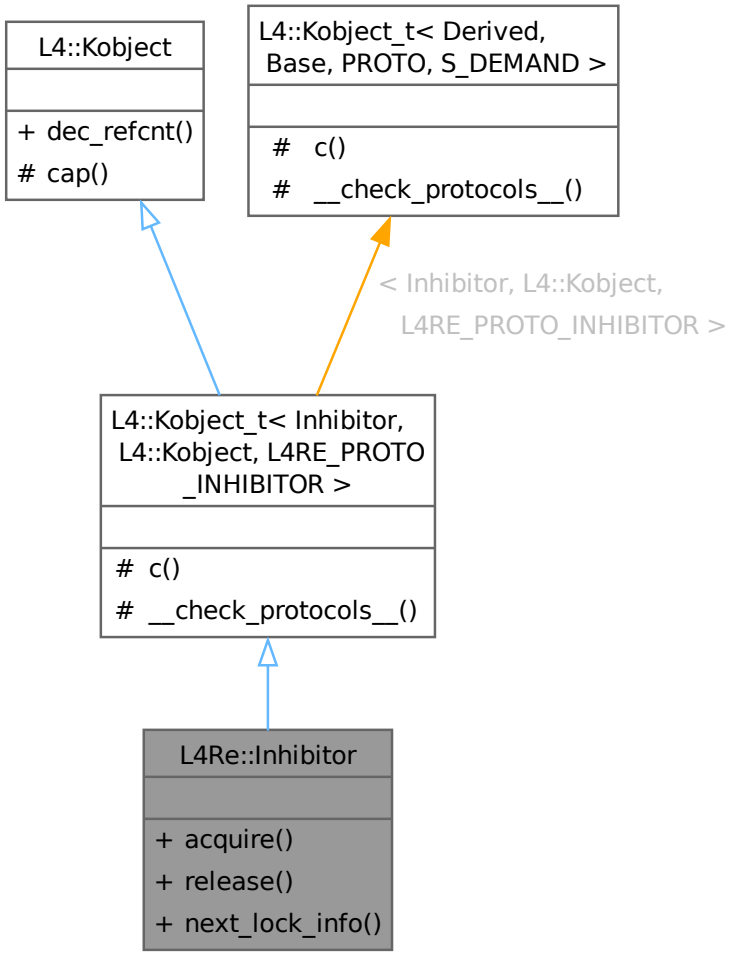
15.290 L4Re::Inhibitor Class Reference

Set of inhibitor locks, which inhibit specific actions when held.
`#include <inhibitor>`

Inheritance diagram for L4Re::Inhibitor:



Collaboration diagram for L4Re::Inhibitor:



Public Types

- enum { Name_max = 20 }

Public Member Functions

- l4_ret_t acquire (l4_umword_t id, L4::Ipc::String<> reason)

  Acquire a specific inhibitor lock.
- l4_ret_t release (l4_umword_t id)

  Release a specific inhibitor lock.
- l4_ret_t next_lock_info (char *name, unsigned len, l4_mword_t current_id=-1, l4_utcb_t *utcb=l4_utcb())

  Get information for the next available inhibitor lock.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR >

- typedef Inhibitor **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Inhibitor > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.290.1 Detailed Description

Set of inhibitor locks, which inhibit specific actions when held.
This interface provides access to a set of inhibitor locks, each determined by an ID that is specific to the Inhibitor object. Each individual lock shall prevent, a specific (implementation defined) action to be executed, as long as the lock is held.
For example there can be an inhibitor lock to prevent a transition to suspend-to-RAM state and a different one to prevent shutdown.
A client shall take an inhibitor lock if it needs to execute code before the action is taken. For example a lock-screen application shall grab an inhibitor lock for the suspend action to be able to lock the screen before the system goes to sleep.
Inhibitor locks are usually closely related to specific events. Usually a server automatically subscribes a client holding a lock to the corresponding event. The server shall send the event to inform the client that an action is pending. Upon reception of the event, the client is supposed to release the corresponding inhibitor lock.
Definition at line 38 of file inhibitor.

15.290.2 Member Enumeration Documentation

15.290.2.1 anonymous enum

```
anonymous enum
```

Enumerator

Name_max	The maximum length of a lock's name.

Definition at line 42 of file inhibitor.

15.290.3 Member Function Documentation

15.290.3.1 acquire()

```
l4_ret_t L4Re::Inhibitor::acquire (
            l4_umword_t id,
            L4::Ipc::String<> reason)
```

Acquire a specific inhibitor lock.

Parameters

id	ID of the inhibitor lock that the client intends to acquire
reason	The reason why you need the lock. Used for informing the user or debugging.

Return values

0	Success
-L4_ENODEV	The specified `id` does not exist.

References acquire().
Referenced by acquire().
Here is the call graph for this function:



Here is the caller graph for this function:



15.290.3.2 next_lock_info()

```
l4_ret_t L4Re::Inhibitor::next_lock_info (
            char * name,
            unsigned len,
```

```
            l4_mword_t current_id = -1,
            l4_utcb_t * utcb = l4_utcb())  [inline]
```

Get information for the next available inhibitor lock.

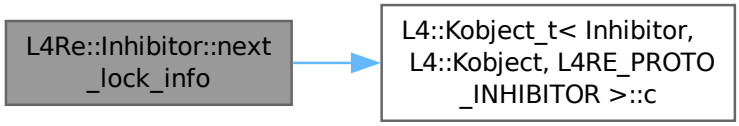
Parameters

name	A pointer to a buffer for the name of the lock.
len	The length of the available buffer (usually Name_max is used).
current_id	The ID of the last available lock, use -1 to get the first lock.
utcb	The UTCB to use for the message.

Return values

>0	The ID of the next available lock if there is one (in this case `name` shall contain the name of the inhibitor lock).
-L4_ENODEV	There are no more locks.

Definition at line 84 of file inhibitor.
References L4::Kobject_t< Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR >::c().
Here is the call graph for this function:



15.290.3.3 release()

```
l4_ret_t L4Re::Inhibitor::release (
            l4_umword_t id)
```

Release a specific inhibitor lock.

Parameters

id	The ID of the inhibitor lock to release.

Return values

0	Success
-L4_ENODEV	Lock with the given `id` does not exist.

References release().

Referenced by release().
Here is the call graph for this function:



Here is the caller graph for this function:



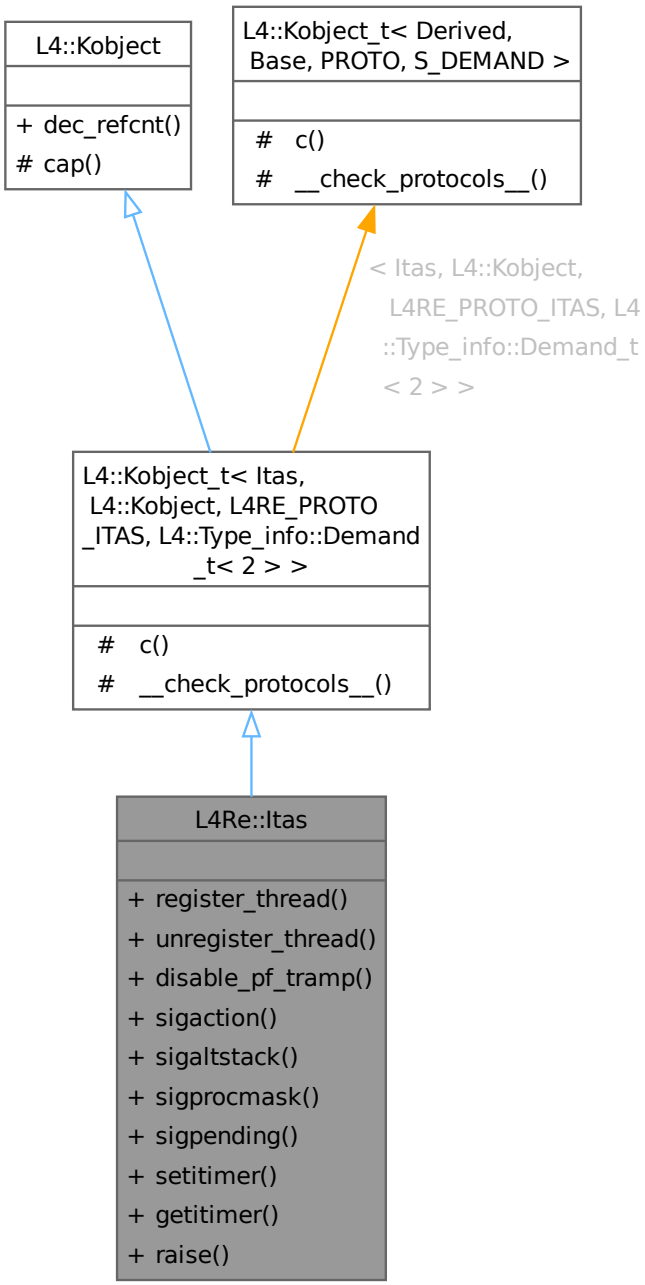
The documentation for this class was generated from the following file:

- l4/re/inhibitor

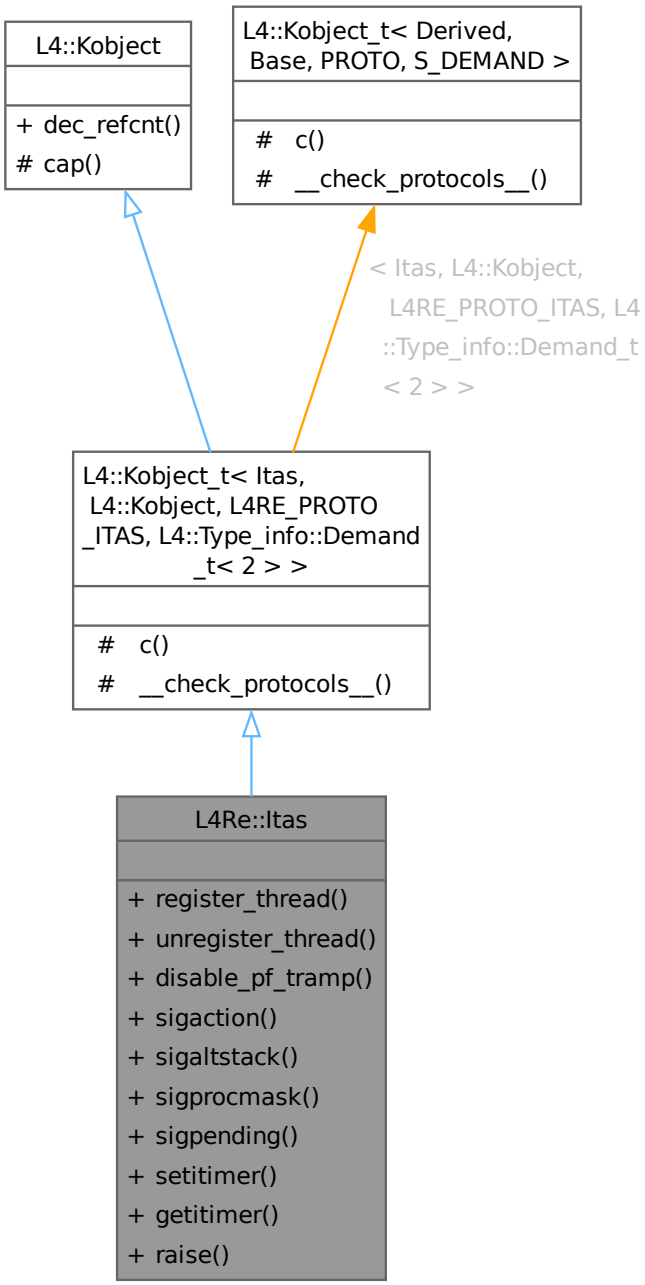
15.291 L4Re::Itas Class Reference

Interface to the ITAS.
`#include <itas>`

Inheritance diagram for L4Re::Itas:



Collaboration diagram for L4Re::Itas:



Public Types

- enum : unsigned { Ignore_sigaction = ~0U }

Public Member Functions

- l4_ret_t register_thread (L4::Ipc::Cap< L4::Thread > parent, L4::Ipc::Cap< L4::Thread > thread_cap, l4_addr_t thread_utcb)

  Register new thread.

- l4_ret_t unregister_thread (L4::Ipc::Cap< L4::Thread > thread)

  Unregister a thread.
- l4_ret_t disable_pf_tramp ()

  Disable page fault trampolines for the whole process.
- l4_ret_t sigaction (int signum, const struct sigaction *act, struct sigaction *oldact)

  Examine and change a POSIX signal action.
- l4_ret_t sigaltstack (L4::Ipc::Cap< L4::Thread > thread, const struct sigaltstack *ss, struct sigaltstack *oss)

  Examine or set alternate POSIX signal stack.
- l4_ret_t sigprocmask (L4::Ipc::Cap< L4::Thread > thread, int how, sigset_t const *set, sigset_t *oldset)

  Examine or set process signal mask.
- l4_ret_t sigpending (L4::Ipc::Cap< L4::Thread > thread, sigset_t *set)

  Query pending signals.
- l4_ret_t setitimer (int which, const struct itimerval *new_value, struct itimerval *old_value)

  Set process interval timer.
- l4_ret_t getitimer (int which, struct itimerval *curr_value)

  Get process interval timer.
- l4_ret_t raise (L4::Ipc::Cap< L4::Thread > thread, int sig)

  Send a signal to the calling thread.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Itas, L4::Kobject, L4RE_PROTO_ITAS, L4::Type_info::Demand_t< 2 > >

- typedef Itas **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Itas > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Itas, L4::Kobject, L4RE_PROTO_ITAS, L4::Type_info::Demand_t< 2 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Itas, L4::Kobject, L4RE_PROTO_ITAS, L4::Type_info::Demand_t< 2 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.291.1 Detailed Description

Interface to the ITAS.
This is an internal interface between libc and the l4re_itas. Do not use it. It is subject to change.
Definition at line 30 of file itas.

15.291.2 Member Enumeration Documentation

15.291.2.1 anonymous enum

```
anonymous enum :  unsigned
```

Enumerator

Ignore_sigaction	Ignore new action of `sigaction()` call.

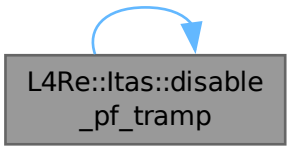
Definition at line 76 of file itas.

15.291.3 Member Function Documentation

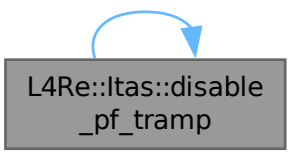
15.291.3.1 disable_pf_tramp()

```
l4_ret_t L4Re::Itas::disable_pf_tramp ()
```

Disable page fault trampolines for the whole process.
Once disabled, page faults of all threads of the process (including threads registered in the future) are reflected as page fault IPC to the pager instead of being handled by an in-thread trampoline handler. This also stops the ITAS from handing out its page_in() helper function to be called directly from within the client thread.
This operation cannot be reverted.
References disable_pf_tramp().
Referenced by disable_pf_tramp().
Here is the call graph for this function:



Here is the caller graph for this function:



15.291.3.2 getitimer()

```
l4_ret_t L4Re::Itas::getitimer (
            int which,
            struct itimerval * curr_value)
```

Get process interval timer.
See IEEE Std 1003.1-2017 getitimer() for details.

Parameters

in	*which*	Timer type (ITIMER_REAL).
out	*curr_value*	Old timer value.

References getitimer().
Referenced by getitimer().
Here is the call graph for this function:



Here is the caller graph for this function:



15.291.3.3 raise()

```
l4_ret_t L4Re::Itas::raise (
            L4::Ipc::Cap< L4::Thread > thread,
            int sig)
```

Send a signal to the calling thread.

Parameters

in	*thread*	Thread cap of the calling thread.
in	*sig*	Signal that shall be raised.

References raise().

Referenced by raise().
Here is the call graph for this function:



Here is the caller graph for this function:



15.291.3.4 register_thread()

```
l4_ret_t L4Re::Itas::register_thread (
            L4::Ipc::Cap< L4::Thread > parent,
            L4::Ipc::Cap< L4::Thread > thread_cap,
            l4_addr_t thread_utcb)
```

Register new thread.
Makes the newly created thread known to ITAS. The ITAS will do the `thread_cap->control()` to bind the thread to the task and attach the gates for pager and exception handler.

Parameters

parent	The capability of the thread that created the new thread.
thread_cap	The capability of the new thread.
thread_utcb	The address of the allocated UTCB of the new thread.

15.291.3.5 setitimer()

```
l4_ret_t L4Re::Itas::setitimer (
            int which,
            const struct itimerval * new_value,
            struct itimerval * old_value)
```

Set process interval timer.
See IEEE Std 1003.1-2017 setitimer() for details.

Parameters

in	*which*	Timer type (ITIMER_REAL).
in	*new_value*	New timer value.
out	*old_value*	Old timer value.

Referenced by sigpending().
Here is the caller graph for this function:



15.291.3.6 sigaction()

```
l4_ret_t L4Re::Itas::sigaction (
            int signum,
            const struct sigaction * act,
            struct sigaction * oldact)
```

Examine and change a POSIX signal action.
See IEEE Std 1003.1-2024 sigaction() for the behaviour of the method.
If act->sa_flags is Ignore_sigaction, the new action is ignored.

Parameters

in	*signum*	Signal number to be examined and/or modified.
in	*act*	New signal action.
out	*oldact*	Old signal action.

References sigaction(), and sigaltstack().
Referenced by sigaction().
Here is the call graph for this function:



Here is the caller graph for this function:



15.291.3.7 sigaltstack()

```
l4_ret_t L4Re::Itas::sigaltstack (
            L4::Ipc::Cap< L4::Thread > thread,
            const struct sigaltstack * ss,
            struct sigaltstack * oss)
```

Examine or set alternate POSIX signal stack.
See IEEE Std 1003.1-2024 sigaltstack() for the behaviour of the method.
If `ss->ss_flags` is -1, the new sigaltstack will be ignored.

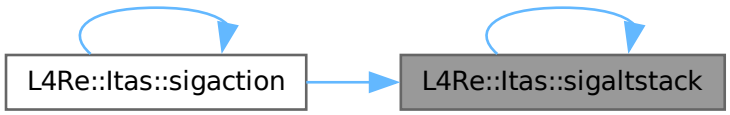
Parameters

in	*thread*	Thread cap of the thread whose sigaltstack is examined and/or modified.
in	*ss*	The new sigaltstack.
out	*oss*	The old sigaltstack.

References sigaltstack(), and sigprocmask().
Referenced by sigaction(), and sigaltstack().
Here is the call graph for this function:



Here is the caller graph for this function:



15.291.3.8 sigpending()

```
l4_ret_t L4Re::Itas::sigpending (
            L4::Ipc::Cap< L4::Thread > thread,
            sigset_t * set)
```

Query pending signals.
See IEEE Std 1003.1-2024 sigpending() for details.

Parameters

in	*thread*	Thread cap of the thread whose pending signal are examined.
out	*set*	Pending signals of thread.

References setitimer().

Referenced by sigprocmask().
Here is the call graph for this function:



Here is the caller graph for this function:



15.291.3.9 sigprocmask()

```
l4_ret_t L4Re::Itas::sigprocmask (
            L4::Ipc::Cap< L4::Thread > thread,
            int how,
            sigset_t const * set,
            sigset_t * oldset)
```

Examine or set process signal mask.
See IEEE Std 1003.1-2024 sigprocmask() for the behaviour or the method.
If `how` is -1, the signal mask is left unchanged.

Parameters

in	*thread*	Thread cap of the thread whose signal mask is examined and/or modified.
in	*how*	Operation (`SIG_BLOCK`, `SIG_UNBLOCK`, `SIG_SETMASK` or -1).
in	*set*	The new signal mask.
out	*oldset*	The old signal mask.

References sigpending().
Referenced by sigaltstack().
Here is the call graph for this function:



Here is the caller graph for this function:



15.291.3.10 unregister_thread()

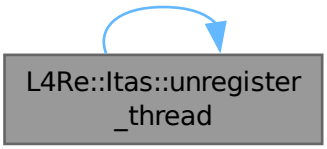
```
l4_ret_t L4Re::Itas::unregister_thread (
            L4::Ipc::Cap< L4::Thread > thread)
```

Unregister a thread.
The gates for the thread's pager and exception hander will be destroyed. Thus, the thread must be destroyed after the call.

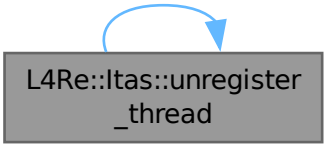
Parameters

thread	The destroyed thread.

References unregister_thread().
Referenced by unregister_thread().
Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this class was generated from the following file:

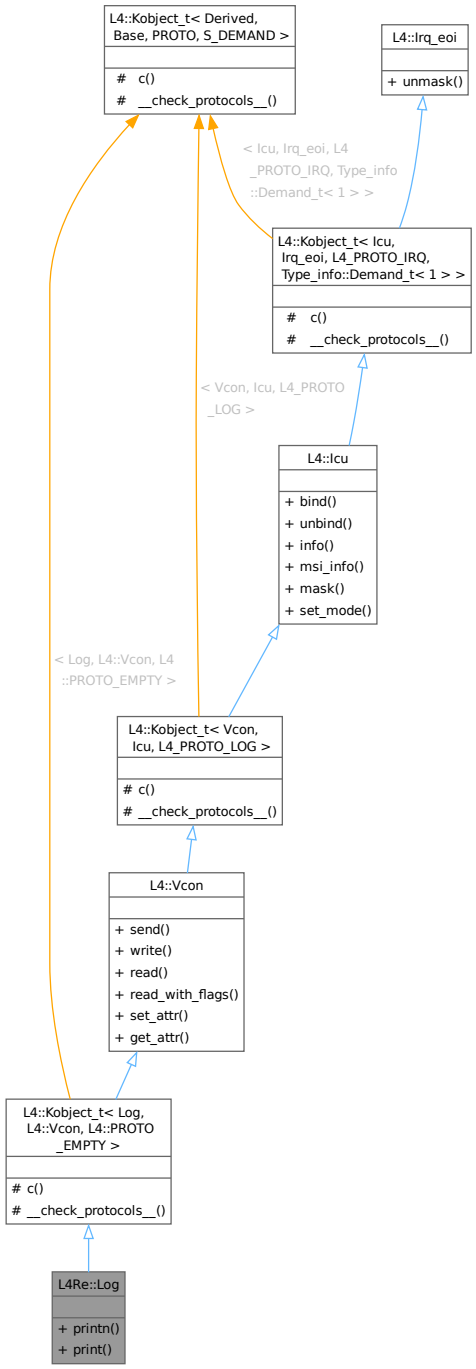
- l4/re/itas

15.292 L4Re::Log Class Reference

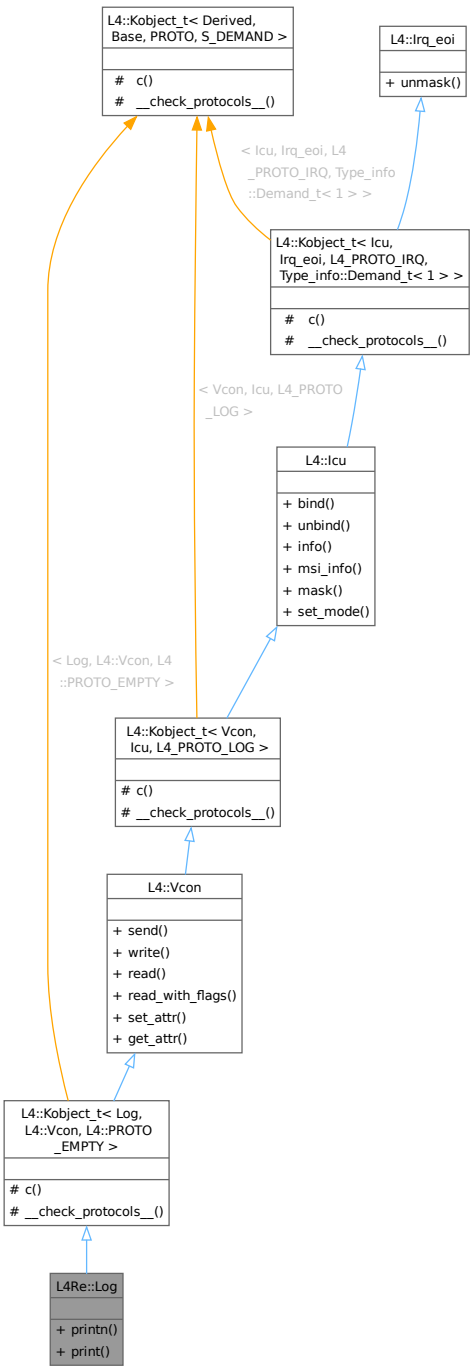
Log interface class.

`#include <log>`

Inheritance diagram for L4Re::Log:



Collaboration diagram for L4Re::Log:



Public Member Functions

- void printn (char const *string, unsigned len) const noexcept

  Print string with length len, NULL characters don't matter.
- void print (char const *string) const noexcept

  Print NULL-terminated string.

Public Member Functions inherited from L4::Vcon

- l4_msgtag_t send (char const *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept
  Send data to `this` virtual console.
- long write (char const *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept
  Write data to `this` virtual console.
- int read (char *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept
  Read data from `this` virtual console.
- int read_with_flags (char *buf, unsigned size, l4_utcb_t *utcb=l4_utcb()) const noexcept
  Read data from `this` virtual console which also returns flags.
- l4_msgtag_t set_attr (l4_vcon_attr_t const *attr, l4_utcb_t *utcb=l4_utcb()) const noexcept
  Set the attributes of `this` virtual console.
- l4_msgtag_t get_attr (l4_vcon_attr_t *attr, l4_utcb_t *utcb=l4_utcb()) const noexcept
  Get attributes of `this` virtual console.

Public Member Functions inherited from L4::Icu

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept
  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept
  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept
  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)
  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept
  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept
  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept
  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Log, L4::Vcon, L4::PROTO_EMPTY >

- typedef Log **Class**
  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Log > **__Iface**
  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Vcon::__Iface_list > **__Iface_list**
  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Vcon, Icu, L4_PROTO_LOG >

- typedef Vcon **Class**
  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Vcon > **__Iface**
  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Icu::__Iface_list > **__Iface_list**
  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Log, L4::Vcon, L4::PROTO_EMPTY >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Vcon, Icu, L4_PROTO_LOG >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Log, L4::Vcon, L4::PROTO_EMPTY >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Vcon, Icu, L4_PROTO_LOG >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.292.1 Detailed Description

Log interface class.
Definition at line 33 of file log.

15.292.2 Member Function Documentation

15.292.2.1 print()

```
void L4Re::Log::print (
            char const * string) const  [noexcept]
```

Print NULL-terminated string.

Parameters

string	string to print

15.292.2.2 printn()

```
void L4Re::Log::printn (
            char const * string,
            unsigned len) const  [noexcept]
```

Print string with length len, NULL characters don't matter.

Parameters

string	string to print
len	length of string

The documentation for this class was generated from the following file:

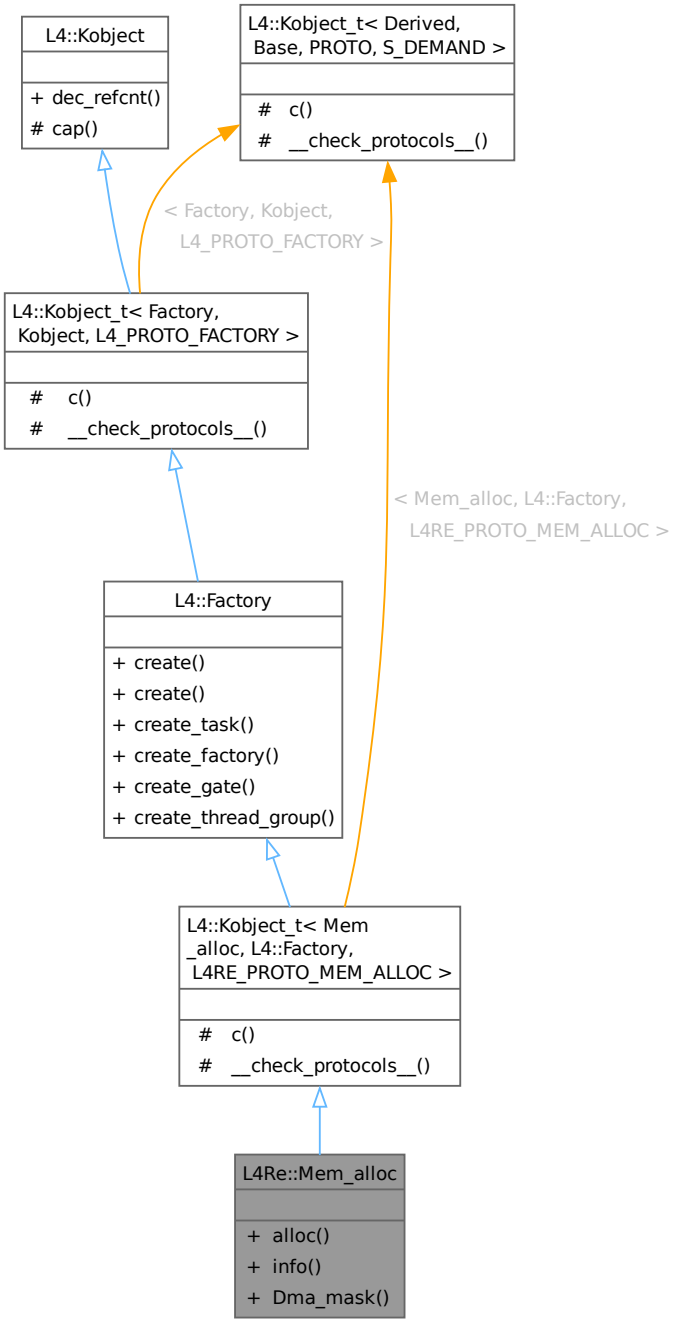
- l4/re/log

15.293 L4Re::Mem_alloc Class Reference

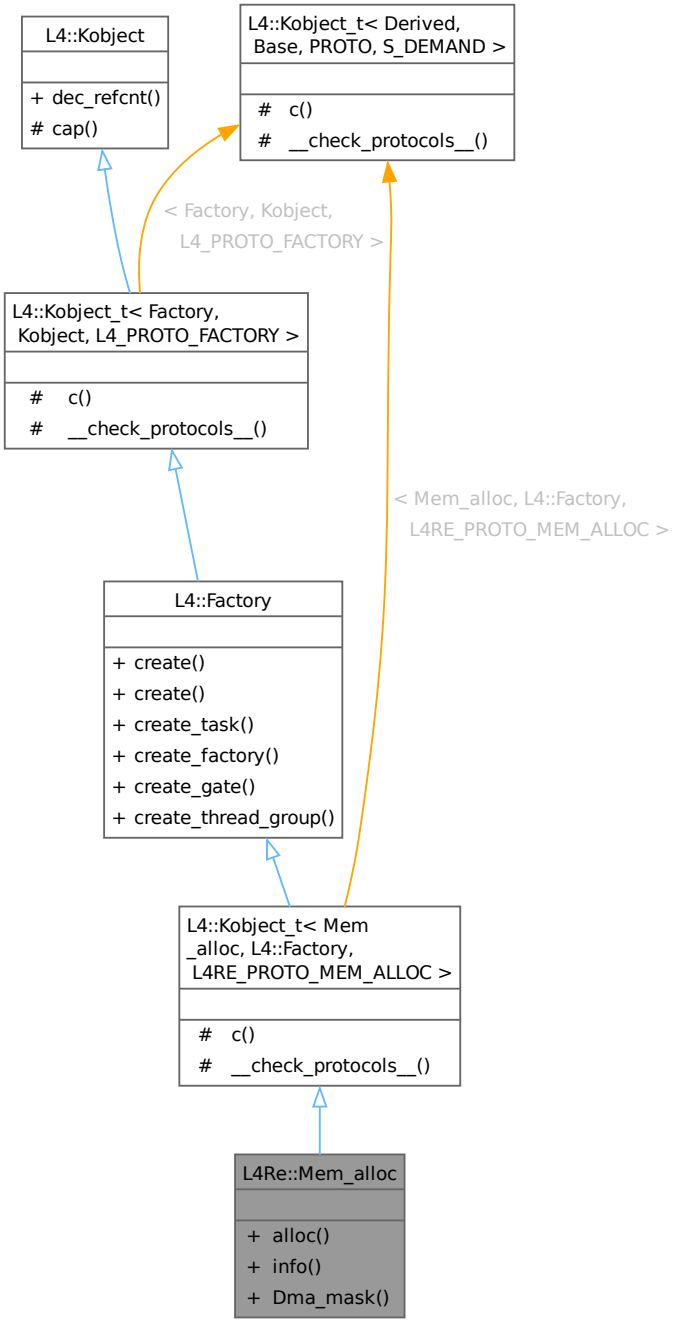
Memory allocation interface.

`#include <mem_alloc>`

Inheritance diagram for L4Re::Mem_alloc:



Collaboration diagram for L4Re::Mem_alloc:



Data Structures

- struct Stats

  Statistics about memory-allocator.

Public Types

- enum Mem_alloc_flags : unsigned long {
  Continuous = 0x01 , Pinned = 0x02 , Super_pages = 0x04 , Fixed_paddr = 0x08 ,

Dma_mask_bits = 0x3f0 , Invert_dma_mask = 0x400 }

Flags for the allocator.

Public Member Functions

- l4_ret_t alloc (long size, L4::Cap< Dataspace > mem, unsigned long flags=0, unsigned long align=0, l4_addr_t paddr=0, char const *type=nullptr) const noexcept

  Allocate anonymous memory.
- long info (Stats &stats)

  Get allocator information.

Public Member Functions inherited from L4::Factory

- S create (Cap< void > target, long obj, l4_utcb_t *utcb=l4_utcb()) noexcept

  Generic create call to the factory.
- template<typename OBJ>
  S create (Cap< OBJ > target, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create call for typed capabilities.
- l4_msgtag_t create_task (Cap< Task > const &target_cap, l4_fpage_t *utcb_area, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new task.
- l4_msgtag_t create_factory (Cap< Factory > const &target_cap, unsigned long limit, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new factory.
- l4_msgtag_t create_gate (Cap< void > const &target_cap, Cap< Snd_destination > const &snd_dst_cap, l4_umword_t label, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new IPC gate, optionally bound to a send destination (a thread or thread group).
- l4_msgtag_t create_thread_group (Cap< Thread_group > const &target_cap, unsigned policy, l4_utcb_t *utcb=l4_utcb()) noexcept

  Create a new thread group.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Static Public Member Functions

- static L4_CONSTEXPR unsigned Dma_mask (unsigned bits)

  Constrain allocations to physical addresses below given bits.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Mem_alloc, L4::Factory, L4RE_PROTO_MEM_ALLOC >

- typedef Mem_alloc **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Mem_alloc > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Factory::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Factory, Kobject, L4_PROTO_FACTORY >

- typedef Factory **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Factory > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Mem_alloc, L4::Factory, L4RE_PROTO_MEM_ALLOC >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Factory, Kobject, L4_PROTO_FACTORY >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Mem_alloc, L4::Factory, L4RE_PROTO_MEM_ALLOC >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Factory, Kobject, L4_PROTO_FACTORY >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.293.1 Detailed Description

Memory allocation interface.
The memory-allocator API is the basic API to allocate memory from the L4Re subsystem. The memory is allocated in terms of dataspaces (see L4Re::Dataspace). The provided dataspaces have at least the property that data written to such a dataspace is available as long as the dataspace is not freed or the data is not overwritten. In particular, the memory backing a dataspace from an allocator need not be allocated instantly, but may be allocated lazily on demand.
A memory allocator can provide dataspaces with additional properties, such as physically contiguous memory, pre-allocated memory, or pinned memory. To request memory with an additional property the L4Re::Mem_alloc::alloc() method provides a flags parameter. If the concrete implementation of a memory allocator does not support or allow allocation of memory with a certain property, the allocation may be refused.
Definition at line 52 of file mem_alloc.

15.293.2 Member Enumeration Documentation

15.293.2.1 Mem_alloc_flags

```
enum L4Re::Mem_alloc::Mem_alloc_flags : unsigned long
```

Flags for the allocator.

They describe requested properties of the allocated memory. Support of these properties by the dataspace provider is optional.

Enumerator

Continuous	Allocate physically contiguous memory.
Pinned	Deprecated, use L4Re::Dma_space instead.
Super_pages	Allocate super pages.
Fixed_paddr	Allocate at fixed physical address. Only honored on no-MMU systems. Will fail on MMU systems.
Dma_mask_bits	See Dma_mask().
Invert_dma_mask	Effectively says to allocate above the Dma_mask().

Definition at line 62 of file mem_alloc.

15.293.3 Member Function Documentation

15.293.3.1 alloc()

```
l4_ret_t L4Re::Mem_alloc::alloc (
            long size,
            L4::Cap< Dataspace > mem,
            unsigned long flags = 0,
            unsigned long align = 0,
            l4_addr_t paddr = 0,
            char const * type = nullptr) const  [noexcept]
```

Allocate anonymous memory.

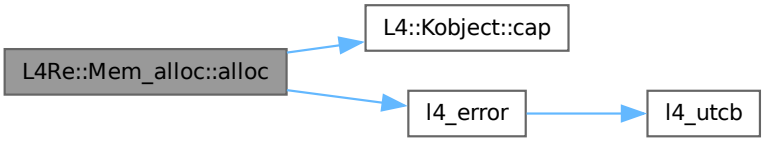
Parameters

	size	Size in bytes to be requested. Allocation granularity is (super)pages, however, the allocator will store the byte-granular given size as the size of the dataspace and consecutively will use this byte-granular size for servicing the dataspace. Allocators may optionally also implement a maximum allocation strategy: if `size` is a negative value and `flags` set the Mem_alloc_flags::Continuous bit, the allocator tries to allocate as much memory as possible leaving an amount of at least `-size` bytes within the associated quota.
`out`	*mem*	Capability slot where the capability to the dataspace is received.
	flags	Special dataspace properties, see Mem_alloc_flags
	align	Log2 alignment of dataspace if supported by allocator, will be at least L4_PAGESHIFT, with Super_pages flag set at least L4_SUPERPAGESHIFT
	paddr	The physical address where the dataspace should be allocated if Mem_alloc_flags::Fixed flag is set.
	type	Allocate the dataspace from a typed memory with the given name. Otherwise the dataspace is allocated from untyped memory.

Return values

0	Success
-L4_EINVAL	Invalid `size`, `flags` or `align`.
-L4_ENOMEM	Not enough memory available.
-L4_EPERM	Dma_mask() passed in `flags` but factory lacks the *DMA constraints* permission.
-L4_ERANGE	Given size not supported.
<0	IPC error

Definition at line 23 of file mem_alloc_impl.h.
References L4::Kobject::cap(), Fixed_paddr, L4_EINVAL, and l4_error().
Here is the call graph for this function:



15.293.3.2 Dma_mask()

```
L4_CONSTEXPR unsigned L4Re::Mem_alloc::Dma_mask (
            unsigned bits)  [inline], [static]
```

Constrain allocations to physical addresses below given bits.
Requires the Mem_alloc_flags::Continuous flag to be set. Requires a factory that holds the *DMA constraints* permission.
Definition at line 80 of file mem_alloc.
References L4_CONSTEXPR, L4_INLINE, and L4_UNLIKELY.

15.293.3.3 info()

```
long L4Re::Mem_alloc::info (
            Stats & stats)
```

Get allocator information.

Parameters

`out`	*stats*	Allocator information

Return values

0	Success
<0	IPC error

References info(), and L4_INLINE_RPC.
Referenced by info().

Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this class was generated from the following files:

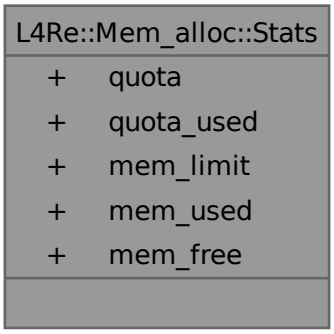
- l4/re/mem_alloc
- l4/re/impl/mem_alloc_impl.h

15.294 L4Re::Mem_alloc::Stats Struct Reference

Statistics about memory-allocator.

`#include <mem_alloc>`

Collaboration diagram for L4Re::Mem_alloc::Stats:



Data Fields

- l4_size_t quota

  Memory quota of this allocator.
- l4_size_t quota_used

  Amount of currently used quota of this allocator.
- l4_size_t mem_limit

  Maximum amount of memory that can be allocated by this allocator.
- l4_size_t mem_used

  Amount of currently allocated memory.
- l4_size_t mem_free

  Amount of memory that is still available for allocation.

15.294.1 Detailed Description

Statistics about memory-allocator.
Definition at line 95 of file mem_alloc.

15.294.2 Field Documentation

15.294.2.1 mem_free

`l4_size_t L4Re::Mem_alloc::Stats::mem_free`
Amount of memory that is still available for allocation.
This field can be lower than `mem_limit - mem_used`. In this case the system may be over-committed and there is globally not enough memory left. Also, if the quota is already used up for sub-factories (see `quota_used`), there may be not enough quota left.
Definition at line 147 of file mem_alloc.

15.294.2.2 mem_limit

`l4_size_t L4Re::Mem_alloc::Stats::mem_limit`
Maximum amount of memory that can be allocated by this allocator.
Will never exceed the `quota` but may be smaller if the system has less memory installed.
Definition at line 123 of file mem_alloc.

15.294.2.3 mem_used

`l4_size_t L4Re::Mem_alloc::Stats::mem_used`
Amount of currently allocated memory.
This field represents the amount of memory that is in use by this allocator. It recursively includes the memory used by sub-factories, if any.
Will never exceed `mem_limit` or `quota_used`.

Note

Dataspaces may allocate memory lazily! As such, the field will increase only after pages have been allocated to a dataspace.

Definition at line 137 of file mem_alloc.

15.294.2.4 quota

`l4_size_t L4Re::Mem_alloc::Stats::quota`
Memory quota of this allocator.
Strictly limits the amount of memory that can be allocated. This may be larger than there is actual physical memory available. In particular, the root factory has an artificial quota and returns -1 in this field.
Definition at line 104 of file mem_alloc.

15.294.2.5 quota_used

`l4_size_t L4Re::Mem_alloc::Stats::quota_used`

Amount of currently used quota of this allocator.

The amount of used quota is not necessarily linked to the current memory usage. See `mem_used` for this information. The quota of a factory is immediately and fully accounted to the parent factory quota.

This value may even exceed `mem_limit` if the system is over-committed.

Definition at line 115 of file mem_alloc.

The documentation for this struct was generated from the following file:

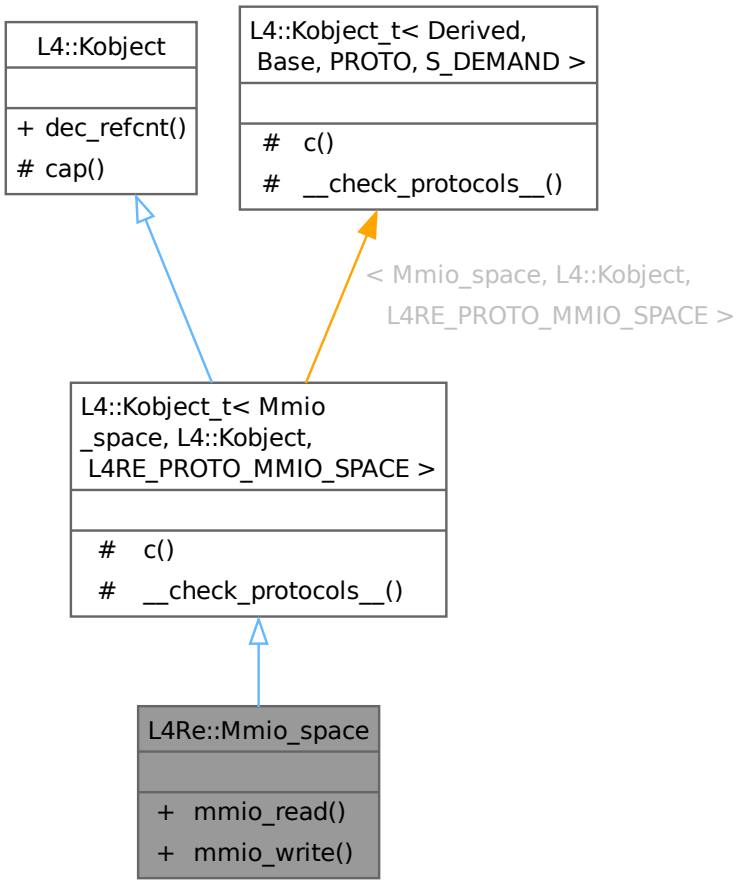
- l4/re/mem_alloc

15.295 L4Re::Mmio_space Struct Reference

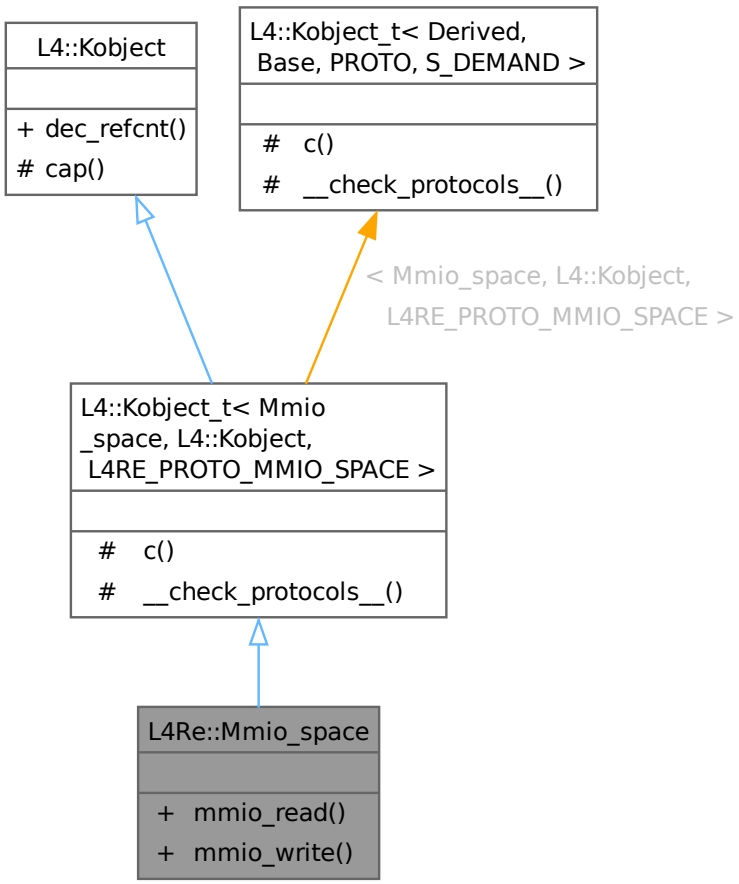
Interface for memory-like address space accessible via IPC.

`#include <mmio_space>`

Inheritance diagram for L4Re::Mmio_space:



Collaboration diagram for L4Re::Mmio_space:



Public Types

- enum Access_width { Wd_8bit = 0 , Wd_16bit = 1 , Wd_32bit = 2 , Wd_64bit = 3 }

  Actual size of the value to read or write.
- typedef l4_uint64_t **Addr**

  Device address.

Public Member Functions

- l4_ret_t mmio_read (Addr addr, char width, l4_uint64_t *value)

  Read a value from the given address.
- l4_ret_t mmio_write (Addr addr, char width, l4_uint64_t value)

  Write a value to the given address.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Mmio_space, L4::Kobject, L4RE_PROTO_MMIO_SPACE >

- typedef Mmio_space **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Mmio_space > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Mmio_space, L4::Kobject, L4RE_PROTO_MMIO_SPACE >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Mmio_space, L4::Kobject, L4RE_PROTO_MMIO_SPACE >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.295.1 Detailed Description

Interface for memory-like address space accessible via IPC.
This interface defines methods for indirect access to MMIO regions.
Memory mapped IO (MMIO) is used by device drivers to control hardware devices. Access to MMIO regions is assigned to user-level device drivers via mappings of memory pages.
However, there are hardware platforms where MMIO regions for different devices share the same memory page. With respect to security and safety, it is often not allowed to map a memory page to multiple device drivers because the driver of one device could then influence operation of another device, which violates security boundaries.
A solution to that problem is to implement a third (trusted) component that gets exclusive access to the shared memory page, and that drivers can access via IPC with the Mmio_space protocol. This proxy-component can then enforce an access policy.

Include File

```
#include <l4/re/mmio_space>
```

Definition at line 45 of file mmio_space.

15.295.2 Member Enumeration Documentation

15.295.2.1 Access_width

`enum L4Re::Mmio_space::Access_width`
Actual size of the value to read or write.

Enumerator

Wd_8bit	Value is a byte.
Wd_16bit	Value is a 2-byte word.
Wd_32bit	Value is a 4-byte word.
Wd_64bit	Value is a 8-byte word.

Definition at line 49 of file mmio_space.

15.295.3 Member Function Documentation

15.295.3.1 mmio_read()

```
l4_ret_t L4Re::Mmio_space::mmio_read (
             Addr addr,
             char width,
             l4_uint64_t * value)
```

Read a value from the given address.

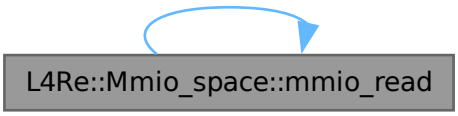
Parameters

	addr	Device virtual address to read from. The address must be aligned relative to the access width.
	width	Access width of value to be read, see Access_width.
out	*value*	Return value. If width is smaller than 64 bit,the upper bits are guaranteed to be 0.

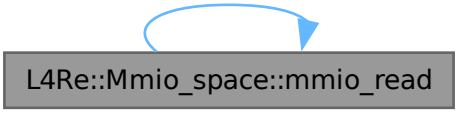
Return values

L4_EOK	Success.
-L4_EPERM	Insufficient read rights.
-L4_EINVAL	Address does not exist or cannot be accessed with the given width.

References mmio_read().
Referenced by mmio_read().
Here is the call graph for this function:



Here is the caller graph for this function:



15.295.3.2 mmio_write()

```
l4_ret_t L4Re::Mmio_space::mmio_write (
             Addr addr,
             char width,
             l4_uint64_t value)
```

Write a value to the given address.

Parameters

addr	Device virtual address to write to. The address must be aligned relative to the access width.
width	Access width of value to write, see Access_width.
value	Value to write. If width is smaller than 64 bit, the upper bits are ignored.

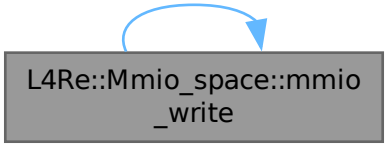
Return values

L4_EOK	Success.
-L4_EPERM	Insufficient write rights.
-L4_EINVAL	Address does not exist or cannot be accessed with the given width.

References mmio_write().
Referenced by mmio_write().
Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this struct was generated from the following file:

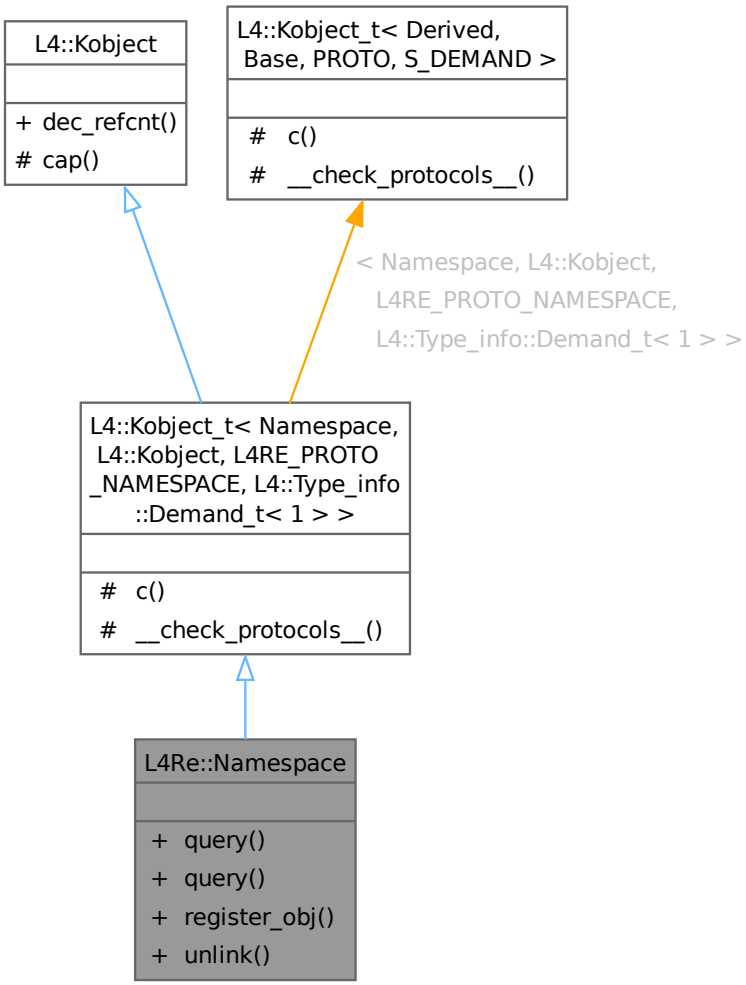
- l4/re/mmio_space

15.296 L4Re::Namespace Class Reference

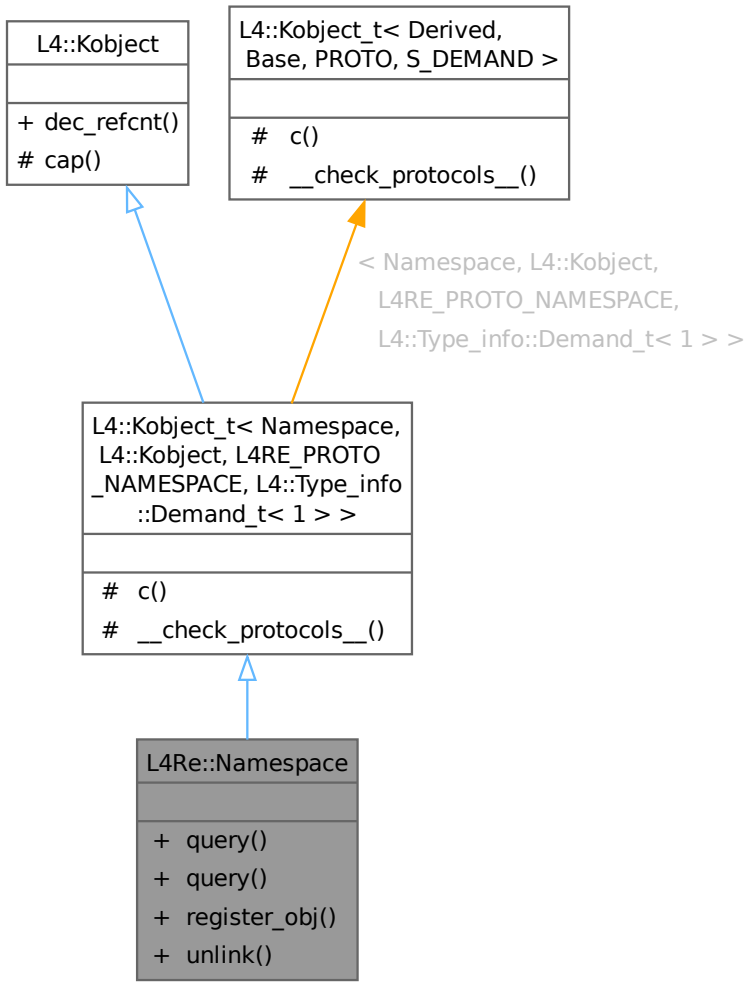
Name-space interface.

`#include <namespace>`

Inheritance diagram for L4Re::Namespace:



Collaboration diagram for L4Re::Namespace:



Public Types

- enum Register_flags {
  Ro = L4_CAP_FPAGE_RO , Rw = L4_CAP_FPAGE_RW , Rs = L4_CAP_FPAGE_RS , Rws = L4_CAP_↩
  FPAGE_RWS ,
  Strong = L4_CAP_FPAGE_S , Trusted = 0x008 , **Cap_flags** = Ro | Rw | Strong | Trusted , Link = 0x100 ,
  Overwrite = 0x200 }

  Flags for registering name spaces.
- enum Query_result_flags { Partly_resolved = 0x020 }

  Flags returned by query IPC, only used internally.
- enum Query_timeout { To_default = 3600000 , To_non_blocking = 0 }

  Timeout values for query operation.

Public Member Functions

- l4_ret_t query (char const *name, L4::Cap< void > const &cap, int timeout=To_default, l4_umword_t *local↩
  _id=0, bool iterate=true) const noexcept

Query the name space for a named object.

- l4_ret_t query (char const *name, unsigned len, L4::Cap< void > const &cap, int timeout=To_default, l4_umword_t *local_id=0, bool iterate=true) const noexcept

  Query the name space for a named object.

- l4_ret_t register_obj (char const *name, L4::Ipc::Cap< void > obj, unsigned flags=Rw) const noexcept

  Register an object with a name.

- l4_ret_t unlink (char const *name)

  Remove an entry from the name space.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Namespace, L4::Kobject, L4RE_PROTO_NAMESPACE, L4::Type_info::Demand_t< 1 > >

- typedef Namespace **Class**

  The target interface type (inheriting from Kobject_t).

- typedef Typeid::Iface< PROTO, Namespace > **__Iface**

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Namespace, L4::Kobject, L4RE_PROTO_NAMESPACE, L4::Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Namespace, L4::Kobject, L4RE_PROTO_NAMESPACE, L4::Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.296.1 Detailed Description

Name-space interface.
All name space objects must provide this interface. However, it is not mandatory that a name space object allows to register new capabilities.
The name lookup is done iteratively, this means the hierarchical names are resolved component wise by the client itself.
Definition at line 49 of file namespace.

15.296.2 Member Enumeration Documentation

15.296.2.1 Query_result_flags

enum L4Re::Namespace::Query_result_flags
Flags returned by query IPC, only used internally.

Enumerator

Partly_resolved	Name was only partly resolved.

Definition at line 77 of file namespace.

15.296.2.2 Query_timeout

enum L4Re::Namespace::Query_timeout
Timeout values for query operation.

Enumerator

To_default	Default timeout.
To_non_blocking	Expect callee to answer immediately.

Definition at line 83 of file namespace.

15.296.2.3 Register_flags

enum L4Re::Namespace::Register_flags
Flags for registering name spaces.

Enumerator

Ro	Read-only.
Rw	Read-write.
Rs	Read-only + strong.
Rws	Read-write + strong.
Strong	Strong.
Trusted	Obsolete, do not use.
Link	Obsolete, do not use.
Overwrite	If entry already exists, overwrite it.

Definition at line 57 of file namespace.

15.296.3 Member Function Documentation

15.296.3.1 query() [1/2]

```
l4_ret_t L4Re::Namespace::query (
             char const * name,
             L4::Cap< void > const & cap,
             int timeout = To_default,
             l4_umword_t * local_id = 0,
             bool iterate = true) const  [noexcept]
```

Query the name space for a named object.

Parameters

in	*name*	String to query (without any leading slashes).
out	*cap*	Capability slot where the received capability will be put.
in	*timeout*	Timeout of query in milliseconds. The client will only wait if a name has already been registered with the server but no object has yet been attached.
out	*local_id*	If given, L4_RCV_ITEM_LOCAL_ID will be set for the IPC from the name space, so that if the capability that was received is a local item, the capability ID will be returned with this parameter.
in	*iterate*	If true, the client will try to resolve names by iteratively calling the name spaces until the name is fully resolved.

Return values

0	Name could be fully resolved.
>0	Name could only be partly resolved. The number of remaining characters is returned.
-L4_ENOENT	Entry could not be found.
-L4_EAGAIN	Entry exists but no object is yet attached. Try again later.
<0	IPC errors, see l4_error_code_t.

Definition at line 114 of file namespace_impl.h.
References query().
Referenced by query().
Here is the call graph for this function:



Here is the caller graph for this function:



15.296.3.2 query() [2/2]

```
l4_ret_t L4Re::Namespace::query (
            char const * name,
            unsigned len,
            L4::Cap< void > const & cap,
            int timeout = To_default,
            l4_umword_t * local_id = 0,
            bool iterate = true) const  [noexcept]
```

Query the name space for a named object.
The query string does not necessarily need to be null-terminated.

Parameters

in	*len*	Length of the string to query without any terminating null characters.
in	*name*	String to query (without any leading slashes).
out	*cap*	Capability slot where the received capability will be put.
in	*timeout*	Timeout of query in milliseconds. The client will only wait if a name has already been registered with the server but no object has yet been attached.
out	*local_id*	If given, L4_RCV_ITEM_LOCAL_ID will be set for the IPC from the name space, so that if the capability that was received is a local item, the capability ID will be returned with this parameter.
in	*iterate*	If true, the client will try to resolve names by iteratively calling the name spaces until the name is fully resolved.

Return values

0	Name could be fully resolved.
>0	Name could only be partly resolved. The number of remaining characters is returned.
-L4_ENOENT	Entry could not be found.
-L4_EAGAIN	Entry exists but no object is yet attached. Try again later.
<0	IPC errors, see l4_error_code_t.

Definition at line 66 of file namespace_impl.h.
References L4_EAGAIN, L4_EINVAL, l4_sleep(), and L4_UNLIKELY.
Here is the call graph for this function:



15.296.3.3 register_obj()

```
l4_ret_t L4Re::Namespace::register_obj (
            char const * name,
```

```
L4::Ipc::Cap< void > obj,
unsigned flags = Rw) const  [inline], [noexcept]
```

Register an object with a name.

Parameters

name	Name under which the object should be registered.
obj	Capability to object to register. An invalid capability may be given to only reserve the name for later use.
flags	Flags to assign to the entry, see L4Re::Namespace::Register_flags. Note that the rights that are assigned to a capability are not only determined by the rights given in these flags but also by the rights with which the `obj` capability was mapped to the name space.

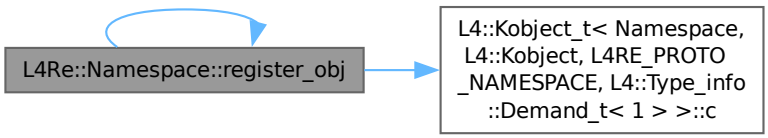
Return values

0	Object was successfully registered with *name*.
-L4_EEXIST	Name already registered.
-L4_EPERM	Insufficient permissions; see precondition.
-L4_ENOMEM	Server has insufficient resources.
-L4_EINVAL	Invalid parameter.
<0	IPC errors, see l4_error_code_t.

Precondition

The invoked Namespace capability must have the permission L4_CAP_FPAGE_W.

Definition at line 167 of file namespace.
References L4::Kobject_t< Namespace, L4::Kobject, L4RE_PROTO_NAMESPACE, L4::Type_info::Demand_t< 1 > >::c(), register_obj(), and Rw.
Referenced by register_obj().
Here is the call graph for this function:



Here is the caller graph for this function:



15.296.3.4 unlink()

```
l4_ret_t L4Re::Namespace::unlink (
            char const * name)  [inline]
```

Remove an entry from the name space.

Parameters

name	Name of the entry to remove.

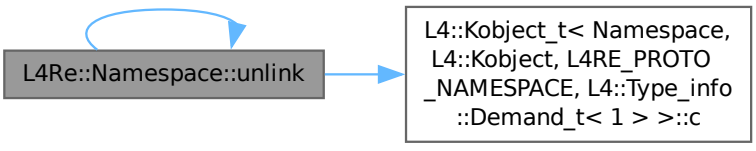
Return values

0	Entry successfully removed.
-L4_ENOENT	Given name does not exist.
-L4_EPERM	Insufficient permissions; see precondition.
-L4_EACCESS	Name cannot be removed.
<0	IPC errors, see l4_error_code_t.

Precondition

The invoked Namespace capability must have the permission L4_CAP_FPAGE_W.

Definition at line 193 of file namespace.
References L4::Kobject_t< Namespace, L4::Kobject, L4RE_PROTO_NAMESPACE, L4::Type_info::Demand_t< 1 > >::c(), and unlink().
Referenced by unlink().
Here is the call graph for this function:



Here is the caller graph for this function:

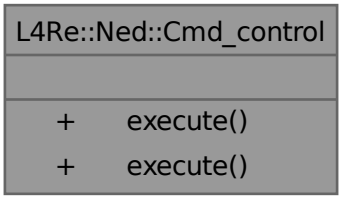


The documentation for this class was generated from the following files:

- l4/re/namespace
- l4/re/impl/namespace_impl.h

15.297 L4Re::Ned::Cmd_control Class Reference

Direct control interface for Ned.
`#include <cmd_control>`
Collaboration diagram for L4Re::Ned::Cmd_control:



Public Member Functions

- long execute (L4::Ipc::String<> cmd) noexcept

  Execute the given Lua code.
- long execute (L4::Ipc::String<> cmd, L4::Ipc::String< char > *result) noexcept

  Execute the given Lua code.

15.297.1 Detailed Description

Direct control interface for Ned.
Definition at line 19 of file cmd_control.

15.297.2 Member Function Documentation

15.297.2.1 execute() [1/2]

```
long L4Re::Ned::Cmd_control::execute (
            L4::Ipc::String<> cmd)  [inline], [noexcept]
```

Execute the given Lua code.

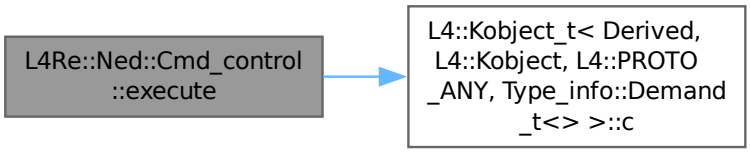
Parameters

in	*cmd*	String with Lua code to execute.

Return values

L4_EOK	Code was successfully executed.
-L4_EINVAL	Code could not be parsed.
-L4_EIO	Error during code execution.

The code is executed using the global Lua state of ned which is retained between successive calls to execute. Thus you may define data in one call to execute and use it in a subsequent call.
This function does not return any results from the execution of the Lua code itself.
Definition at line 42 of file cmd_control.
References L4::Kobject_t< Derived, L4::Kobject, L4::PROTO_ANY, Type_info::Demand_t<> >::c().
Here is the call graph for this function:



15.297.2.2 execute() [2/2]

```
long L4Re::Ned::Cmd_control::execute (
            L4::Ipc::String<> cmd,
            L4::Ipc::String< char > * result)  [inline], [noexcept]
```

Execute the given Lua code.

Parameters

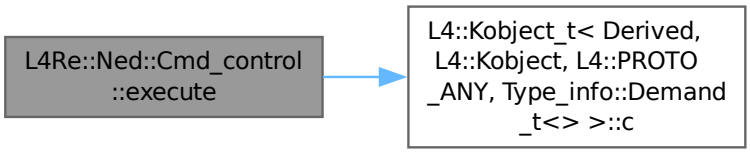
in	*cmd*	String with Lua code to execute.
out	*result*	The first return value of the Lua code block as string.

Return values

L4_EOK	Code was successfully executed.
-L4_EINVAL	Code could not be parsed.
-L4_EIO	Error during code execution.

The code is executed using the global Lua state of ned which is retained between successive calls to execute. Thus

you may define data in one call to execute and use it in a subsequent call.
Definition at line 64 of file cmd_control.
References L4::Kobject_t< Derived, L4::Kobject, L4::PROTO_ANY, Type_info::Demand_t<> >::c().
Here is the call graph for this function:



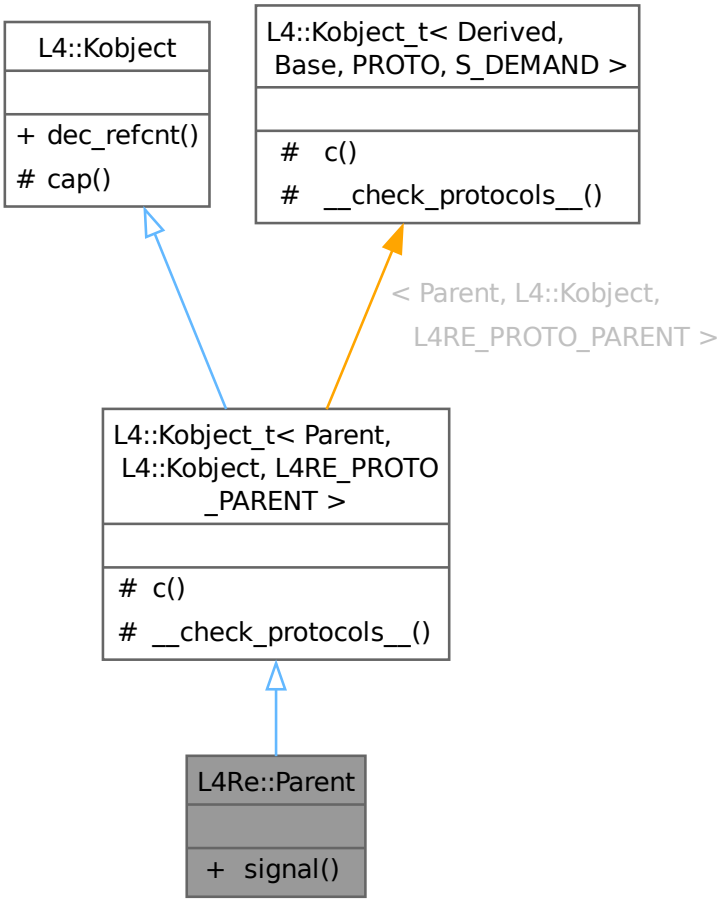
The documentation for this class was generated from the following file:

- pkg/l4re-core/ned/lib/include/cmd_control

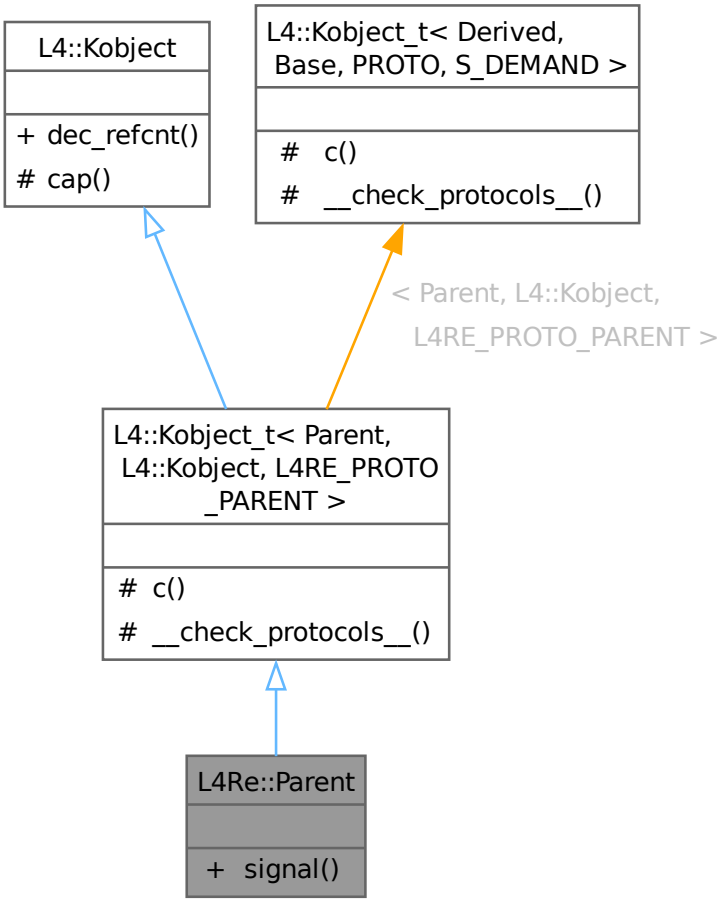
15.298 L4Re::Parent Class Reference

Parent interface.
`#include <parent>`

Inheritance diagram for L4Re::Parent:



Collaboration diagram for L4Re::Parent:



Public Member Functions

- l4_ret_t signal (unsigned long sig, unsigned long val)

  Send a signal to the parent.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Parent, L4::Kobject, L4RE_PROTO_PARENT >

- typedef Parent **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Parent > **__Iface**

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Parent, L4::Kobject, L4RE_PROTO_PARENT >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Parent, L4::Kobject, L4RE_PROTO_PARENT >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.298.1 Detailed Description

Parent interface.

See also

Parent API for more details about the purpose.

Definition at line 42 of file parent.

15.298.2 Member Function Documentation

15.298.2.1 signal()

```
l4_ret_t L4Re::Parent::signal (
             unsigned long sig,
             unsigned long val)
```

Send a signal to the parent.

Parameters

sig	Signal to send
val	Value of the signal

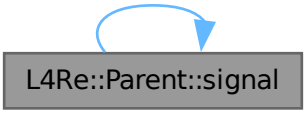
Return values

0	Success
<0	IPC error

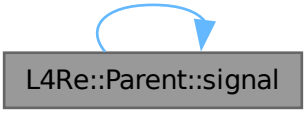
Note

The implementations of this interface in Moe and Ned only recognize the signal 0, in which case they will terminate the application from which the interface was invoked and not return. In this case, `val` is treated as the application's return code. For any other value of `sig`, the method just returns successfully.

References signal().
Referenced by signal().
Here is the call graph for this function:



Here is the caller graph for this function:



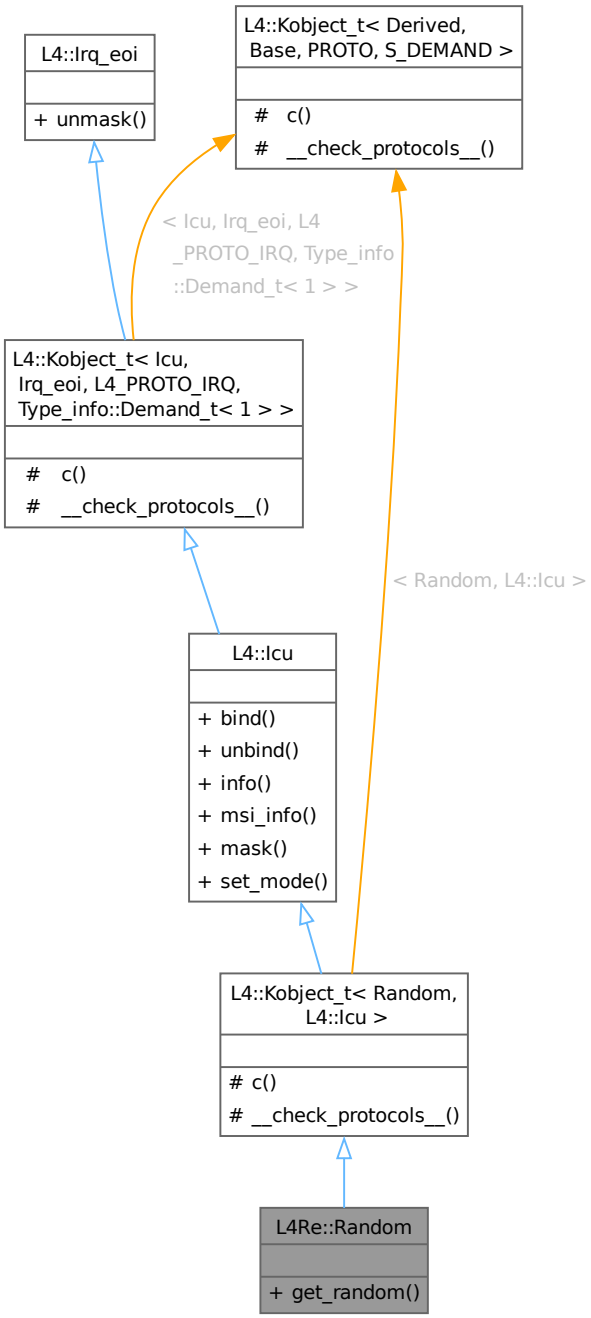
The documentation for this class was generated from the following file:

- l4/re/parent

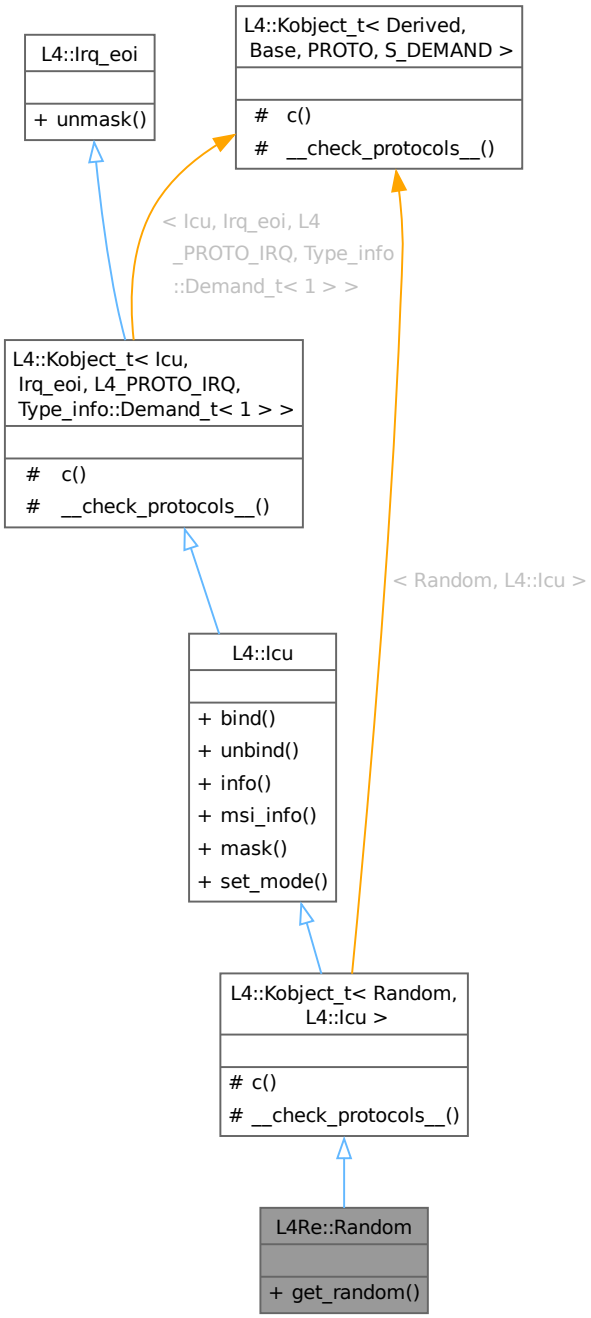
15.299 L4Re::Random Struct Reference

Low-bandwidth interface for random number generators.
`#include <random>`

Inheritance diagram for L4Re::Random:



Collaboration diagram for L4Re::Random:



Public Member Functions

- long get_random (l4_size_t size, L4::Ipc::Array< char, unsigned long > *buffer)

  Get a random number.

Public Member Functions inherited from L4::Icu

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

Bind an interrupt line of an interrupt controller to an interrupt object.

- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)

  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Random, L4::Icu >

- typedef Random **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO_ANY, Random > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Icu::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Random, L4::Icu >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Random, L4::Icu >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.299.1 Detailed Description

Low-bandwidth interface for random number generators.
The interface offers an ICU interface where a client can register an interrupt to get notified when entropy is available. Support for notifications is optional. If a service does not implement notification, it must return 0 for the number of interrupts in the info() call. The notification interrupt must have index 0.

Include File

```
#include <l4/re/random>
```

Definition at line 33 of file random.

15.299.2 Member Function Documentation

15.299.2.1 get_random()

```
long L4Re::Random::get_random (
            l4_size_t size,
            L4::Ipc::Array< char, unsigned long > * buffer)
```

Get a random number.

Parameters

	size	Number of bytes of entropy requested.
out	*buffer*	Buffer containing the random number. Each byte in the buffer contains 8 bits of randomness.

Return values

>=0	Actual size of the returned random number in bytes. This may be less than the requested size. The return value may also be 0 if temporarily no entropy is available.
-L4_EIO	Source of randomness permanently unavailable.
<0	IPC error.

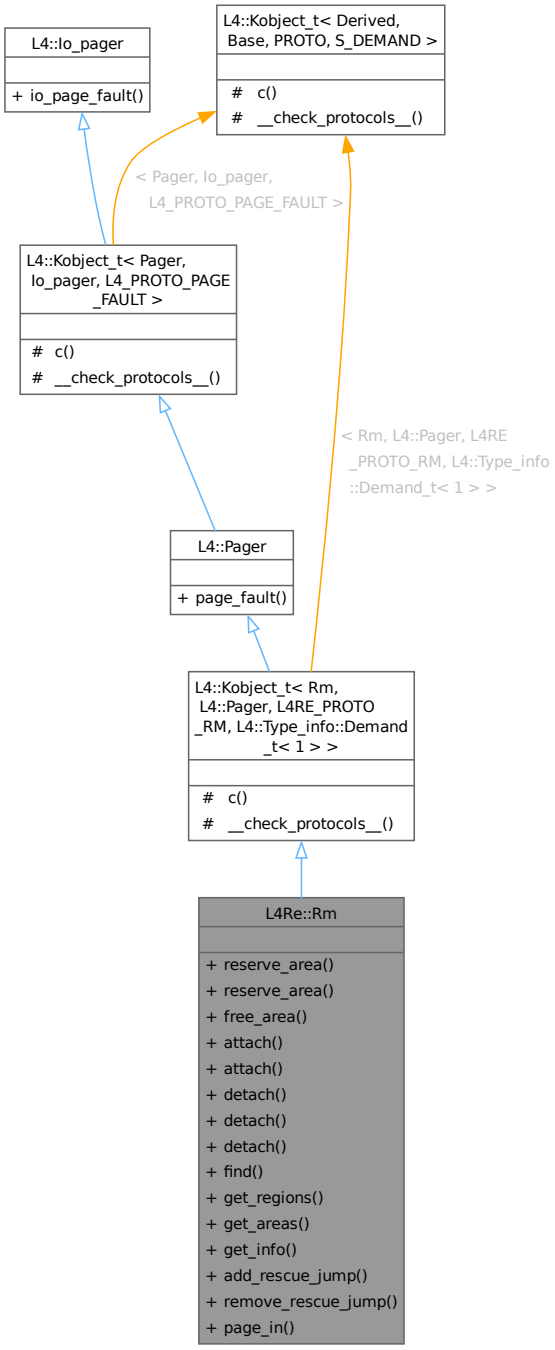
This function should never block. It should immediately return as much entropy as is available. If the call returns less than the requested bytes and a notification interrupt was installed, then the service triggers an interrupt as soon as the remaining entropy is available. That means that when an interrupt is triggered, the service must guarantee that the next call to get_random() returns at least the number of missing bytes for the call that initially triggered the notification.
If get_random() is called while a notification is pending, then the behaviour is implementation-defined.
The documentation for this struct was generated from the following file:

- l4/re/random

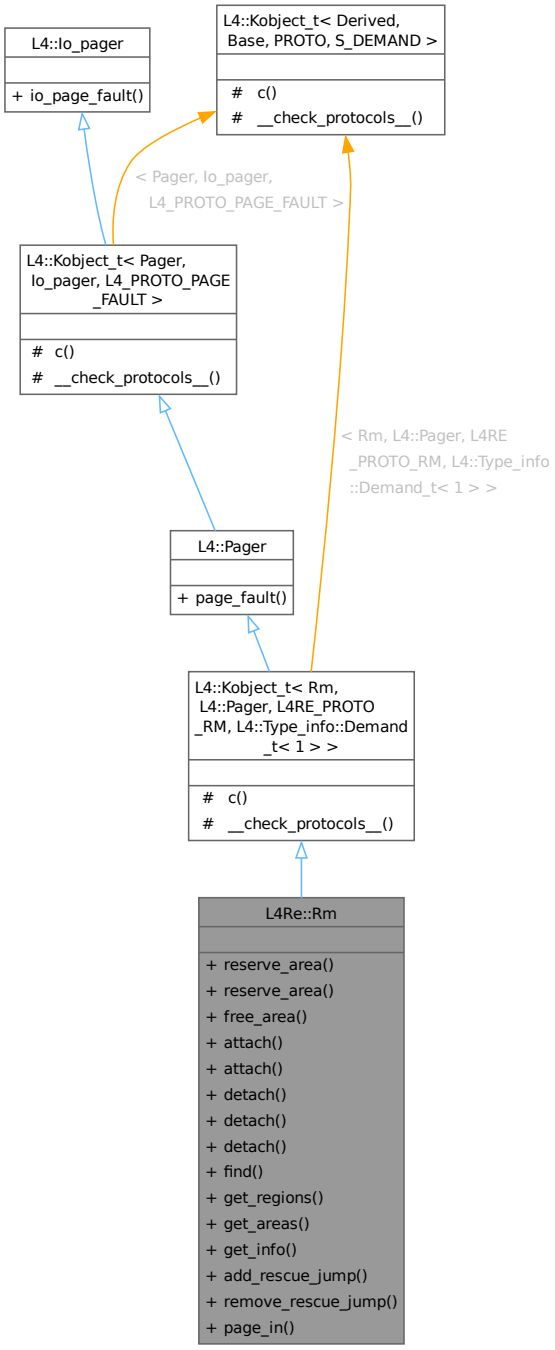
15.300 L4Re::Rm Class Reference

Region map.
`#include <l4/re/rm>`

Inheritance diagram for L4Re::Rm:



Collaboration diagram for L4Re::Rm:



Data Structures

- struct F

  Rm flags definitions.
- class Unique_region

  Unique region.
- struct Region

  A region is a range of virtual addresses which is backed by content.

- struct Area

  An area is a range of virtual addresses which is reserved, see L4Re::Rm::reserve_area().

Public Types

- enum Detach_result {
  Detached_ds = 0 , Kept_ds = 1 , Split_ds = 2 , **Detach_result_mask** = 3 ,
  Detach_again = 4 , Unmapped_range = 8 }

  Result values for detach operation.
- enum Region_flag_shifts { Caching_shift = Dataspace::F::Caching_shift }

  Region flag shifts.
- enum Detach_flags { Detach_exact = 1 , Detach_overlap = 2 }

  Flags for detach operation.
- typedef l4_ret_t(* **page_in_fn**) (l4_addr_t min_addr, l4_addr_t max_addr, Region_flags rights)

  In-thread eager paging function.
- typedef L4::Typeid::Rpcs< attach_t, detach_t, find_t, reserve_area_t, free_area_t, get_regions_t, get_areas_t, get_info_t, add_rescue_jump_t, remove_rescue_jump_t, page_in_t > **Rpcs**

  Eager paging RPC call.

Public Member Functions

- l4_ret_t reserve_area (l4_addr_t *start, unsigned long size, Flags flags=Flags(0), unsigned char align=L4_PAGESHIFT) const noexcept

  Reserve the given area in the region map.
- template<typename T>
  l4_ret_t reserve_area (T **start, unsigned long size, Flags flags=Flags(0), unsigned char align=L4_PAGESHIFT) const noexcept

  Reserve the given area in the region map.
- l4_ret_t free_area (l4_addr_t addr)

  Free an area from the region map.
- l4_ret_t attach (l4_addr_t *start, unsigned long size, Flags flags, L4::Ipc::Cap< Dataspace > mem, Offset offs=0, unsigned char align=L4_PAGESHIFT, L4::Cap< L4::Task > const task=L4::Cap< L4::Task >::Invalid, char const *name=nullptr, Offset backing_offset=0) const noexcept

  Attach a data space to a region.
- template<typename T>
  l4_ret_t attach (T **start, unsigned long size, Flags flags, L4::Ipc::Cap< Dataspace > mem, Offset offs=0, unsigned char align=L4_PAGESHIFT, L4::Cap< L4::Task > const task=L4::Cap< L4::Task >::Invalid, char const *name=nullptr, Offset backing_offset=0) const noexcept

  Attach a data space to a region.
- l4_ret_t detach (l4_addr_t addr, L4::Cap< Dataspace > *mem, L4::Cap< L4::Task > const &task=This_task) const noexcept

  Detach and unmap a region from the address space.
- l4_ret_t detach (void *addr, L4::Cap< Dataspace > *mem, L4::Cap< L4::Task > const &task=This_task) const noexcept

  Detach and unmap a region from the address space.
- l4_ret_t detach (l4_addr_t start, unsigned long size, L4::Cap< Dataspace > *mem, L4::Cap< L4::Task > const &task=This_task) const noexcept

  Detach and unmap all parts of the regions within the specified interval.
- l4_ret_t find (l4_addr_t *addr, unsigned long *size, Offset *offset, L4Re::Rm::Flags *flags, L4::Cap< Dataspace > *m) noexcept

  Find a region given an address and size.
- l4_ret_t get_regions (l4_addr_t start, L4::Ipc::Array_ref< Region > &regions)

  Return the list of regions whose starting addresses are higher or equal to `start` in the address space managed by this region map.

- long get_areas (l4_addr_t start, L4::Ipc::Array_ref< Area > &areas)

  Return the list of areas whose starting addresses are higher or equal to `start` in the address space managed by this region map.
- l4_ret_t get_info (l4_addr_t addr, L4::Ipc::String< char > &name, Offset &backing_offset)

  Return auxiliary information of a region.
- l4_ret_t add_rescue_jump (l4_addr_t pc_begin, l4_addr_t pc_end, l4_addr_t rescue_pc)

  Register a rescue jump for a range of program counters.
- l4_ret_t remove_rescue_jump (l4_addr_t pc)

  Remove a previously registered rescue jump.
- l4_ret_t page_in (l4_addr_t start, unsigned long size, Region_flags rights, L4::Cap< L4::Task > dst=L4::Cap< L4::Task >::Invalid) const noexcept

  Allocate and map pages for the given region.

Public Member Functions inherited from L4::Pager

- l4_msgtag_t page_fault (l4_umword_t pfa, l4_umword_t pc, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  Page-fault protocol message.

Public Member Functions inherited from L4::Io_pager

- l4_msgtag_t io_page_fault (l4_fpage_t io_pfa, l4_umword_t pc, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  IO page fault protocol message.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >

- typedef Rm **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Rm > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Pager::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- typedef Pager **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Pager > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Io_pager::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- L4::Cap< Class > **c** () const noexcept
  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept
  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- static void **__check_protocols__** () noexcept
  Helper to check for protocol conflicts.

15.300.1 Detailed Description

Region map.

See also

Region map API .

Definition at line 81 of file rm.

15.300.2 Member Enumeration Documentation

15.300.2.1 Detach_flags

`enum L4Re::Rm::Detach_flags`
Flags for detach operation.

Enumerator

Detach_exact	Do an unmap of the exact region given.
Detach_overlap	Do an unmap of all overlapping regions.

Definition at line 223 of file rm.

15.300.2.2 Detach_result

`enum L4Re::Rm::Detach_result`
Result values for detach operation.

Enumerator

Detached_ds	Detached data space.
Kept_ds	Kept data space.
Split_ds	Split data space, and done.
Detach_again	Detached data space, more to do.
Unmapped_range	The region mananager has already unmapped the pages.

Definition at line 89 of file rm.

15.300.2.3 Region_flag_shifts

enum L4Re::Rm::Region_flag_shifts
Region flag shifts.

Enumerator

Caching_shift	Start of Rm cache bits.

Definition at line 102 of file rm.

15.300.3 Member Function Documentation

15.300.3.1 add_rescue_jump()

```
l4_ret_t L4Re::Rm::add_rescue_jump (
             l4_addr_t pc_begin,
             l4_addr_t pc_end,
             l4_addr_t rescue_pc)
```

Register a rescue jump for a range of program counters.
If a synchronous exception (e.g. a SIGSEGV with SEGV_MAPERR) is raised by an instruction whose program counter lies in the half-open range `[pc_begin, pc_end)`, execution is diverted to `rescue_pc` instead of delivering the signal to the application.
The registered rescue jumps must not overlap.

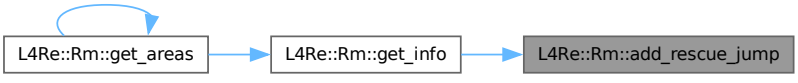
Parameters

pc_begin	Inclusive start of the instruction range.
pc_end	Exclusive end of the instruction range.
rescue_pc	Program counter to jump to on a fault in the range.

Return values

0	Success
-L4_EINVAL	Invalid arguments (e.g. `pc_begin >= pc_end`).
-L4_EEXIST	The given range overlaps with an already registered rescue jump.
-L4_ENOMEM	Out of memory.
<0	IPC errors

Referenced by get_info().
Here is the caller graph for this function:



15.300.3.2 attach() [1/2]

```
l4_ret_t L4Re::Rm::attach (
            l4_addr_t * start,
            unsigned long size,
            Rm::Flags flags,
            L4::Ipc::Cap< Dataspace > mem,
            Rm::Offset offs = 0,
            unsigned char align = L4_PAGESHIFT,
            L4::Cap< L4::Task > const task = L4::Cap<L4::Task>::Invalid,
            char const * name = nullptr,
            Rm::Offset backing_offset = 0) const  [noexcept]
```

Attach a data space to a region.

Parameters

in,out	*start*	Virtual start address where the region manager shall attach the data space. Will be rounded down to the nearest start of a page. If L4Re::Rm::F::Search_addr is given this value is used as the start address to search for a free virtual memory region and the resulting address is returned here. If L4Re::Rm::F::In_area is given the value is used as a selector for the area (see L4Re::Rm::reserve_area) to attach the data space to.
	size	Size of the data space to attach (in bytes). Will be rounded up to the nearest multiple of the page size.
	flags	The flags control how and with which rights the dataspace is attached to the region. See L4Re::Rm::F::Attach_flags and L4Re::Rm::F::Region_flags. The caller must specify the desired rights of the attached region explicitly. The default set of rights is empty.
	mem	Data space.
	offs	Offset into the data space to use.
	align	Alignment of the virtual region, log2-size, default: a page (L4_PAGESHIFT). This is only meaningful if the L4Re::Rm::F::Search_addr flag is used.
	task	Optional destination task of mapping if `F::Eager_map` flag was passed. If invalid, the mapping is established in the current task. This parameter is only useful if the region manager is for a foreign task.
	name	Optional name of the region.
	backing_offset	Optional value describing an offset into the backing store of this region.

Return values

0	Success
-L4_ENOENT	No area could be found (see L4Re::Rm::F::In_area)
-L4_EPERM	Operation not allowed.
-L4_EINVAL	
-L4_EADDRNOTAVAIL	The given address is not available.
<0	IPC errors

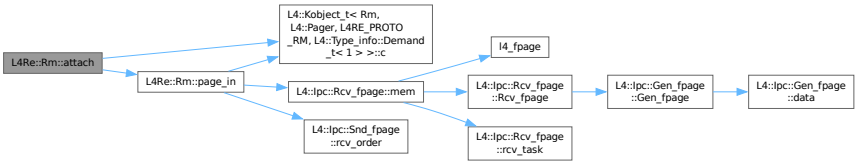
Makes the whole or parts of a data space visible in the virtual memory of the corresponding task. The corresponding region in the virtual address space is backed with the contents of the dataspace.

Note

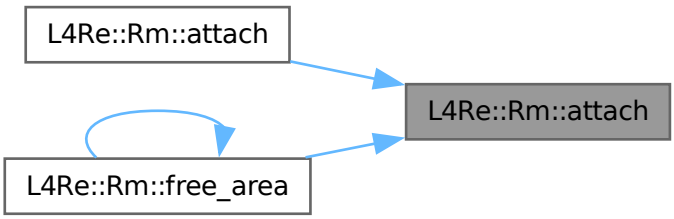
When searching for a free place in the virtual address space, the space between *start* and the end of the virtual address space is searched.

There is no region object created, instead the region is defined by a virtual address within this range (see L4Re::Rm::find).

Definition at line 38 of file rm_impl.h.
References L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >::c(), L4Re::Rm::F::Eager_map, L4Re::Rm::F::Kernel, L4Re::Rm::F::No_eager_map, page_in(), L4Re::Rm::F::Reserved, L4Re::Rm::F::Rights_mask, and L4Re::Rm::F::RWX.
Referenced by attach(), and free_area().
Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.3 attach() [2/2]

```
template<typename T>
l4_ret_t L4Re::Rm::attach (
             T ** start,
             unsigned long size,
             Flags flags,
             L4::Ipc::Cap< Dataspace > mem,
             Offset offs = 0,
             unsigned char align = L4_PAGESHIFT,
             L4::Cap< L4::Task > const task = L4::Cap<L4::Task>::Invalid,
             char const * name = nullptr,
             Offset backing_offset = 0) const  [inline], [noexcept]
```

Attach a data space to a region.

Parameters

in,out	*start*	Virtual start address where the region manager shall attach the data space. Will be rounded down to the nearest start of a page. If L4Re::Rm::F::Search_addr is given this value is used as the start address to search for a free virtual memory region and the resulting address is returned here. If L4Re::Rm::F::In_area is given the value is used as a selector for the area (see L4Re::Rm::reserve_area) to attach the data space to.
	size	Size of the data space to attach (in bytes). Will be rounded up to the nearest multiple of the page size.
	flags	The flags control how and with which rights the dataspace is attached to the region. See L4Re::Rm::F::Attach_flags and L4Re::Rm::F::Region_flags. The caller must specify the desired rights of the attached region explicitly. The default set of rights is empty.
	mem	Data space.
	offs	Offset into the data space to use.
	align	Alignment of the virtual region, log2-size, default: a page (L4_PAGESHIFT). This is only meaningful if the L4Re::Rm::F::Search_addr flag is used.
	task	Optional destination task of mapping if `F::Eager_map` flag was passed. If invalid, the mapping is established in the current task. This parameter is only useful if the region manager is for a foreign task.
	name	Optional name of the region.
	backing_offset	Optional value describing an offset into the backing store of this region.

Return values

0	Success
-L4_ENOENT	No area could be found (see L4Re::Rm::F::In_area)
-L4_EPERM	Operation not allowed.
-L4_EINVAL	
-L4_EADDRNOTAVAIL	The given address is not available.
<0	IPC errors

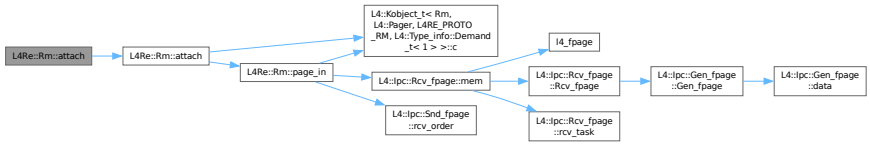
Makes the whole or parts of a data space visible in the virtual memory of the corresponding task. The corresponding region in the virtual address space is backed with the contents of the dataspace.

Note

When searching for a free place in the virtual address space, the space between *start* and the end of the virtual address space is searched.

There is no region object created, instead the region is defined by a virtual address within this range (see L4Re::Rm::find).

Definition at line 405 of file rm.
References attach(), and L4_PAGESHIFT.
Here is the call graph for this function:



15.300.3.4 detach() [1/3]

```
l4_ret_t L4Re::Rm::detach (
            l4_addr_t addr,
            L4::Cap< Dataspace > * mem,
            L4::Cap< L4::Task > const & task = This_task) const  [inline], [noexcept]
```

Detach and unmap a region from the address space.

Parameters

	addr	Virtual address of region, any address within the region is valid.
out	*mem*	Dataspace that is affected. Give 0 if not interested.
	task	This argument specifies the task where the pages are unmapped. Provide L4::Cap<L4::Task>::Invalid for none. The default is the current task.

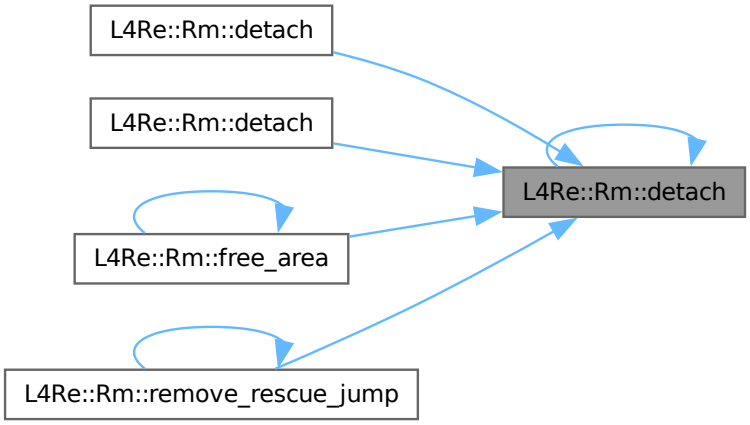
Return values

L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees a region in the virtual address space given by addr (address type). The corresponding part of the address space is now available again.
Definition at line 895 of file rm.
References detach(), and Detach_overlap.
Referenced by detach(), detach(), detach(), free_area(), and remove_rescue_jump().
Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.5 detach() [2/3]

```
l4_ret_t L4Re::Rm::detach (
            l4_addr_t start,
            unsigned long size,
            L4::Cap< Dataspace > * mem,
            L4::Cap< L4::Task > const & task = This_task) const  [inline], [noexcept]
```

Detach and unmap all parts of the regions within the specified interval.

Parameters

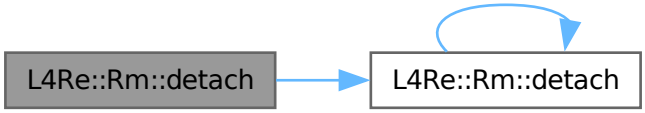
	start	Start of area to detach, must be within region.
	size	Size of of area to detach (in bytes).
out	*mem*	Dataspace that is affected. Give 0 if not interested.
	task	This argument specifies the task where the pages are unmapped. Provide L4::Cap<L4::Task>::Invalid for none. The default is the current task.

Return values

L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees all regions within the interval given by start and size. If a region overlaps the start or the end of the interval this region is only detached partly. If the interval is within one region the original region is split up into two separate regions.
Definition at line 908 of file rm.
References detach(), and Detach_exact.

Here is the call graph for this function:



15.300.3.6 detach() [3/3]

```
l4_ret_t L4Re::Rm::detach (
            void * addr,
            L4::Cap< Dataspace > * mem,
            L4::Cap< L4::Task > const & task = This_task) const  [inline], [noexcept]
```

Detach and unmap a region from the address space.

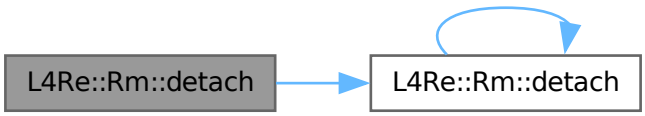
Parameters

	addr	Virtual address of region, any address within the region is valid.
out	*mem*	Dataspace that is affected. Give 0 if not interested.
	task	This argument specifies the task where the pages are unmapped. Provide L4::Cap<L4::Task>::Invalid for none. The default is the current task.

Return values

L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees a region in the virtual address space given by addr (address type). The corresponding part of the address space is now available again.
Definition at line 900 of file rm.
References detach(), and Detach_overlap.
Here is the call graph for this function:



15.300.3.7 find()

```
l4_ret_t L4Re::Rm::find (
            l4_addr_t * addr,
            unsigned long * size,
            Offset * offset,
            L4Re::Rm::Flags * flags,
            L4::Cap< Dataspace > * m)  [inline], [noexcept]
```

Find a region given an address and size.

Parameters

in,out	*addr*	Address to look for. Returns the start address of the found region.
in,out	*size*	Size of the area to look for (in bytes). Returns the size of the found region (in bytes).
out	*offset*	Offset at the beginning of the region within the associated dataspace.
out	*flags*	Region flags, see F::Region_flags (and F::In_area).
out	*m*	Associated dataspace or paging service. May be an invalid capability, see below.

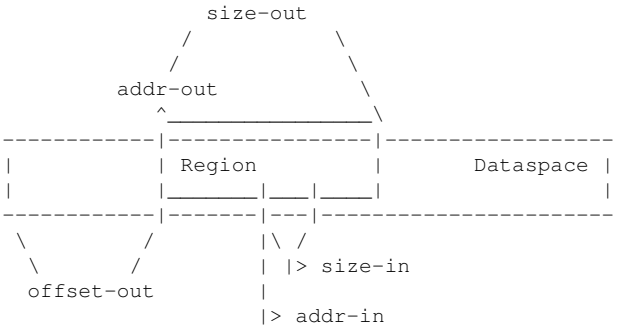
Return values

0	Success
-L4_EPERM	Operation not allowed.
-L4_ENOENT	No region found.
<0	IPC errors

This function returns the properties of the region that contains the area described by the addr and size parameter. If no such region is found but a reserved area, the area is returned and F::In_area is set in `flags`. Note, in the case of an area the `offset` and `m` return values are invalid.

Note

`m` is the dataspace that was passed when the region was attached. It is L4_INVALID_CAP whenever the region has no such dataspace, which is the case for regions attached with F::Anonymous because the memory is provided by the region manager itself. Additionally, the capability slot may have been reused by the application in the meantime. Thus, callers must be careful when using `m` of regions that have been created or manipulated by other code.

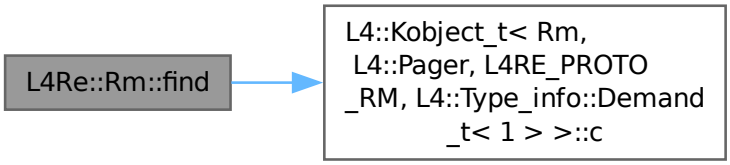


Note

The value of the size input parameter should be 1 to assure that a region can be determined unambiguously.

Definition at line 680 of file rm.
References L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >::c().

Here is the call graph for this function:



15.300.3.8 free_area()

```
l4_ret_t L4Re::Rm::free_area (
            l4_addr_t addr)
```

Free an area from the region map.

Parameters

addr	An address within the area to free.

Return values

0	Success
-L4_ENOENT	No area found.
<0	IPC errors

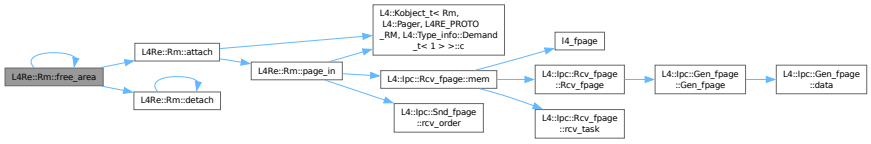
Note

The data spaces that are attached to that area are not detached by this operation.

See also

reserve_area() for more information about areas.

References attach(), detach(), free_area(), L4::Cap_base::Invalid, and L4_PAGESHIFT.
Referenced by free_area().
Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.9 get_areas()

```
long L4Re::Rm::get_areas (
            l4_addr_t start,
            L4::Ipc::Array_ref< Area > & areas)
```

Return the list of areas whose starting addresses are higher or equal to `start` in the address space managed by this region map.

Parameters

	start	Virtual address from where to start searching.
out	*areas*	List of areas found in this region map.

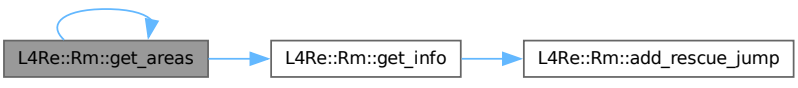
Return values

>=0	Number of returned areas in the `areas` array.
<0	IPC errors

Note

The returned list of areas might not be complete and the caller shall use the function repeatedly with a start address one larger than the end address of the last area from the previous call.

References get_areas(), and get_info().
Referenced by get_areas().
Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.10 get_info()

```
l4_ret_t L4Re::Rm::get_info (
             l4_addr_t addr,
             L4::Ipc::String< char > & name,
             Offset & backing_offset)
```

Return auxiliary information of a region.
This is a debugging feature and might not be available.

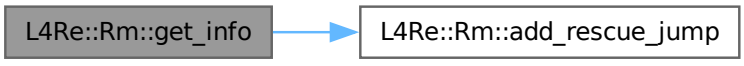
Parameters

	addr	Virtual address of the region.
out	*name*	Name of the region.
out	*backing_offset*	Backing offset information.

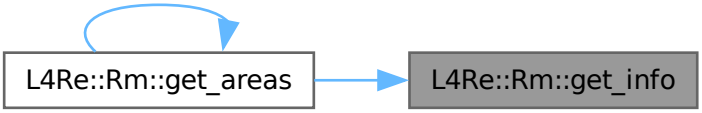
Return values

0	Success
-L4_ENOENT	Region not found.
-L4_ENOSYS	Function not available.
<0	IPC errors

References add_rescue_jump().
Referenced by get_areas().
Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.11 get_regions()

```
l4_ret_t L4Re::Rm::get_regions (
            l4_addr_t start,
            L4::Ipc::Array_ref< Region > & regions)
```

Return the list of regions whose starting addresses are higher or equal to `start` in the address space managed by this region map.

Parameters

	start	Virtual address from where to start searching.
out	*regions*	List of regions found in this region map.

Return values

>=0	Number of returned regions in the `regions` array.
<0	IPC errors

Note

The returned list of regions might not be complete and the caller shall use the function repeatedly with a start address one larger that the end address of the last region from the previous call.

References get_regions().
Referenced by get_regions().
Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.12 page_in()

```
l4_ret_t L4Re::Rm::page_in (
            l4_addr_t start,
            unsigned long size,
            Rm::Region_flags rights,
            L4::Cap< L4::Task > dst = L4::Cap<L4::Task>::Invalid) const  [noexcept]
```

Allocate and map pages for the given region.
Establish mappings of all pages in a region so that no page faults should happen after the call returned. Note that dataspace providers may unmap pages at their own discretion. This call is therefore no guarantee that page faults cannot happen.
The whole range must be backed by attached regions. It is not possible to request more rights than with what the region was attached in the first place.

Parameters

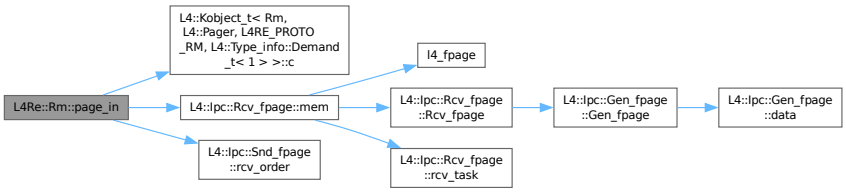
start	Start address.
size	Size of region.
rights	Requested mapping attributes (any combination of F::R, F::W and F::X).
dst	Optional destination task of mapping. If invalid, the mapping is established in the current task. This parameter is only useful if the region manager is for a foreign task.

Return values

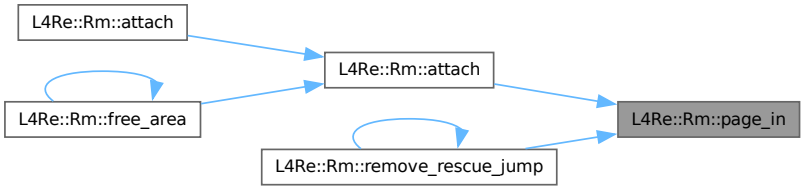
0	Success
-L4_EACCESS	More rights requested than attached region.
-L4_ENOENT	At least some part of the range was not covered by a region.
-L4_ENODEV	Region was not backed by a dataspace.
<0	IPC errors and other errors from dataspace provider (see L4Re::Dataspace::map).

Definition at line 116 of file rm_impl.h.
References L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >::c(), L4_EINVAL, L4_WHOLE_ADDRESS_SPACE, L4::Ipc::Rcv_fpage::mem(), L4Re::Rm::F::R, L4::Ipc::Snd_fpage::rcv_order(), and L4Re::Rm::F::RWX.
Referenced by attach(), and remove_rescue_jump().

Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.13 remove_rescue_jump()

```
l4_ret_t L4Re::Rm::remove_rescue_jump (
            l4_addr_t pc)
```

Remove a previously registered rescue jump.
The rescue jump whose instruction range contains `pc` is removed.

Parameters

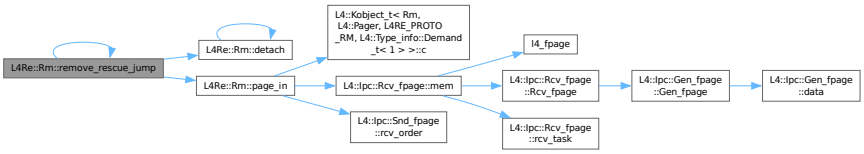
pc	Any program counter inside the registered range.

Return values

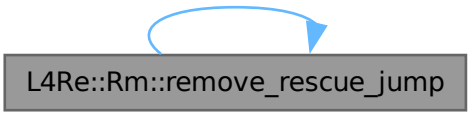
0	Success
-L4_ENOENT	No rescue jump covers `pc`.
<0	IPC errors

References detach(), L4::Cap_base::Invalid, page_in(), and remove_rescue_jump().
Referenced by remove_rescue_jump().

Here is the call graph for this function:



Here is the caller graph for this function:



15.300.3.14 reserve_area() [1/2]

```
l4_ret_t L4Re::Rm::reserve_area (
            l4_addr_t * start,
            unsigned long size,
            Flags flags = Flags(0),
            unsigned char align = L4_PAGESHIFT) const  [inline], [noexcept]
```

Reserve the given area in the region map.

Parameters

in,out	*start*	The virtual start address of the area to reserve. Returns the start address of the area.
	size	The size of the area to reserve (in bytes).
	flags	Flags for the reserved area (see F::Search_addr, F::Kernel and F::Reserved).
	align	Alignment of area if searched as bits (log2 value).

Return values

0	Success
-L4_EADDRNOTAVAIL	The given area cannot be reserved.
-L4_EINVAL	Invalid parameters
<0	IPC errors

This function reserves an area within the virtual address space managed by the region map. There are two kinds of areas available:

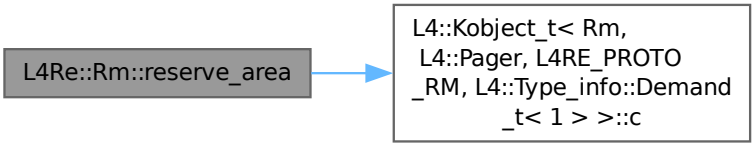
- Reserved areas (*flags* = L4Re::Rm::F::Reserved), where no data spaces can be attached

- Special purpose areas (*flags* = 0), where data spaces can be attached to the area via the L4Re::Rm::F::In_area flag and a start address within the area itself.

Note

When searching for a free place in the virtual address space (with *flags* = L4Re::Rm::F::Search_addr), the space between *start* and the end of the virtual address space is searched.

Definition at line 275 of file rm.
References L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >::c(), and L4_PAGESHIFT.
Here is the call graph for this function:



15.300.3.15 reserve_area() [2/2]

```
template<typename T>
l4_ret_t L4Re::Rm::reserve_area (
            T ** start,
            unsigned long size,
            Flags flags = Flags(0),
            unsigned char align = L4_PAGESHIFT) const  [inline], [noexcept]
```

Reserve the given area in the region map.

Parameters

in,out	*start*	The virtual start address of the area to reserve. Returns the start address of the area.
	size	The size of the area to reserve (in bytes).
	flags	Flags for the reserved area (see F::Search_addr, F::Kernel and F::Reserved).
	align	Alignment of area if searched as bits (log2 value).

Return values

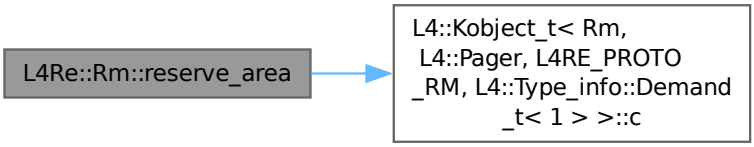
0	Success
-L4_EADDRNOTAVAIL	The given area cannot be reserved.
-L4_EINVAL	Invalid parameters
<0	IPC errors

For more information, please refer to the analogous function

See also

L4Re::Rm::reserve_area.

Definition at line 304 of file rm.
References L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >::c(), and L4_PAGESHIFT.
Here is the call graph for this function:

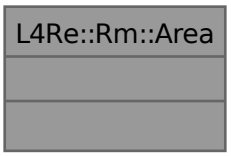


The documentation for this class was generated from the following files:

- l4/re/rm
- l4/re/impl/rm_impl.h

15.301 L4Re::Rm::Area Struct Reference

An area is a range of virtual addresses which is reserved, see L4Re::Rm::reserve_area().
`#include <rm>`
Collaboration diagram for L4Re::Rm::Area:



15.301.1 Detailed Description

An area is a range of virtual addresses which is reserved, see L4Re::Rm::reserve_area().

See also

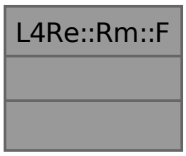
Region map API

Definition at line 713 of file rm.
The documentation for this struct was generated from the following file:

- l4/re/rm

15.302 L4Re::Rm::F Struct Reference

Rm flags definitions.
`#include <rm>`
Collaboration diagram for L4Re::Rm::F:



Public Types

- enum Attach_flags : l4_uint32_t {
  Search_addr = 0x20000 , In_area = 0x40000 , Eager_map = 0x80000 , No_eager_map = 0x100000 ,
  Attach_mask = 0x1f0000 }

  Flags for attach operation.
- enum Region_flags : l4_uint16_t {
  Rights_mask = 0x0f , R = Dataspace::F::R , W = Dataspace::F::W , X = Dataspace::F::X ,
  RW = Dataspace::F::RW , RX = Dataspace::F::RX , RWX = Dataspace::F::RWX , Kernel = 0x100 ,
  Pager = 0x400 , Reserved = 0x800 , Private = 0x1000 , Anonymous = 0x2000 ,
  Caching_mask = Dataspace::F::Caching_mask , Cache_normal = Dataspace::F::Normal , Cache_buffered =
  Dataspace::F::Bufferable , Cache_uncached = Dataspace::F::Uncacheable ,
  Ds_map_mask = 0xff , Region_flags_mask = 0xffff }

  Region flags (permissions, cacheability, special).

15.302.1 Detailed Description

Rm flags definitions.
Definition at line 109 of file rm.

15.302.2 Member Enumeration Documentation

15.302.2.1 Attach_flags

`enum L4Re::Rm::F::Attach_flags : l4_uint32_t`
Flags for attach operation.

Enumerator

Search_addr	Search for a suitable address range.
In_area	Search only in area, or map into area.
Eager_map	Eagerly map the attached data space in.
No_eager_map	Prevent eager mapping of the attached data space.
Attach_mask	Mask of all attach flags.

Definition at line 112 of file rm.

15.302.2.2 Region_flags

`enum L4Re::Rm::F::Region_flags : l4_uint16_t`
Region flags (permissions, cacheability, special).

Enumerator

Rights_mask	Region rights.
R	Readable region.
W	Writable region.
X	Executable region.
RW	Readable and writable region.
RX	Readable and executable region.
RWX	Readable, writable and executable region.
Kernel	Kernel-provided memory (KUMEM).
Pager	Region has a pager. Page faults in this region are not handled by ITAS but rather forwarded to the external region manager / pager.
Reserved	Region is reserved (blocked).
Private	Attach the dataspace privately with copy-on-write semantics. That is, updates to the mapping are not visible in the underlying dataspace.
Anonymous	Attach anonymous memory in the region. The caller must not pass a dataspace. Instead, the region manager provides anonymous memory for the region.
Caching_mask	Mask of all Rm cache bits.
Cache_normal	Cache bits for normal cacheable memory. This is the default if no other cache-related flag was specified.
Cache_buffered	Cache bits for buffered (write combining) memory.
Cache_uncached	Cache bits for uncached memory.
Ds_map_mask	Mask for all bits for cache options and rights.
Region_flags_mask	Mask of all region flags.

Definition at line 130 of file rm.
The documentation for this struct was generated from the following file:

- l4/re/rm

15.303 L4Re::Rm::Region Struct Reference

A region is a range of virtual addresses which is backed by content.
`#include <rm>`

Collaboration diagram for L4Re::Rm::Region:



15.303.1 Detailed Description

A region is a range of virtual addresses which is backed by content.

See also

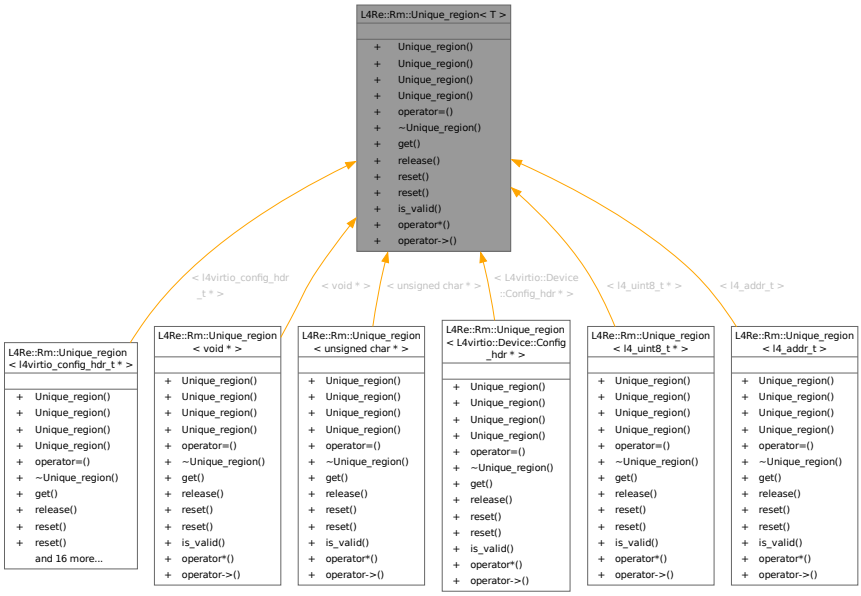
Region map API

Definition at line 700 of file rm.
The documentation for this struct was generated from the following file:

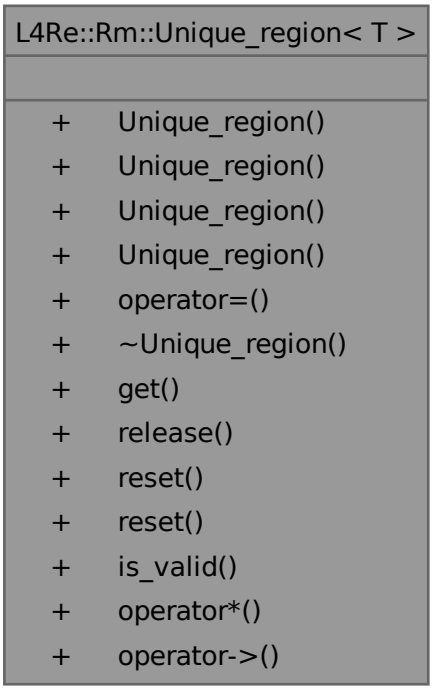
- l4/re/rm

15.304 L4Re::Rm::Unique_region< T > Class Template Reference

Unique region.
`#include <rm>`
Inheritance diagram for L4Re::Rm::Unique_region< T >:



Collaboration diagram for L4Re::Rm::Unique_region< T >:



Public Member Functions

- **Unique_region** () noexcept

  Construct an invalid `Unique_region`.
- Unique_region (T addr) noexcept

  Construct a `Unique_region` from an address.
- Unique_region (T addr, L4::Cap< Rm > const &rm) noexcept

  Construct a valid `Unique_region` from an address and a region manager.
- Unique_region (Unique_region &&o) noexcept

  Move-Construct a `Unique_region`.
- Unique_region & operator= (Unique_region &&o) noexcept

  Move-assign a `Unique_region`.
- ~Unique_region () noexcept

  Destructor.
- T get () const noexcept

  Return the address.
- T release () noexcept

  Return the address and invalidate the `Unique_region`.
- void reset (T addr, L4::Cap< Rm > const &rm) noexcept

  Set new address and region manager.
- void **reset** () noexcept

  Make the `Unique_region` invalid.
- bool is_valid () const noexcept

Check if the Unique_region is valid.

- T **operator∗** () const noexcept

  Dereference the address.

- T **operator->** () const noexcept

  Member access for the address.

15.304.1 Detailed Description

template<typename T>
class L4Re::Rm::Unique_region< T >

Unique region.
Capture a single region with automatic detach on destruction and unique ownership. Stores the start address and the region-mapper capability internally. A unique region is valid precisely if the internal region-mapper capability is valid. The features for unique ownership and automatic detach are only active for valid unique regions.
Definition at line 431 of file rm.

15.304.2 Constructor & Destructor Documentation

15.304.2.1 Unique_region() [1/3]

```
template<typename T>
L4Re::Rm::Unique_region< T >::Unique_region (
            T addr)  [inline], [explicit], [noexcept]
```

Construct a Unique_region from an address.
No region manager is set.

Parameters

addr	The new address

Definition at line 452 of file rm.

15.304.2.2 Unique_region() [2/3]

```
template<typename T>
L4Re::Rm::Unique_region< T >::Unique_region (
            T addr,
            L4::Cap< Rm > const & rm)  [inline], [noexcept]
```

Construct a valid Unique_region from an address and a region manager.

Parameters

addr	The address
rm	The region manager

Definition at line 461 of file rm.

15.304.2.3 Unique_region() [3/3]

```
template<typename T>
L4Re::Rm::Unique_region< T >::Unique_region (
            Unique_region< T > && o)  [inline], [noexcept]
```

Move-Construct a Unique_region.

Parameters

o	L-value reference to other region.

Definition at line 469 of file rm.

15.304.2.4 ~Unique_region()

```
template<typename T>
L4Re::Rm::Unique_region< T >::~Unique_region ()  [inline], [noexcept]
```

Destructor.
If the region is valid, call `detach`.
Definition at line 494 of file rm.

15.304.3 Member Function Documentation

15.304.3.1 get()

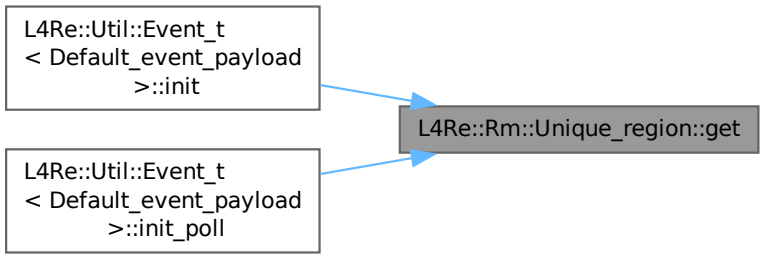
```
template<typename T>
T L4Re::Rm::Unique_region< T >::get () const  [inline], [noexcept]
```

Return the address.

Returns

the address

Definition at line 505 of file rm.
Referenced by L4Re::Util::Event_t< Default_event_payload >::init(), and L4Re::Util::Event_t< Default_event_payload >::init_poll().
Here is the caller graph for this function:



15.304.3.2 is_valid()

```
template<typename T>
bool L4Re::Rm::Unique_region< T >::is_valid () const  [inline], [noexcept]
```

Check if the `Unique_region` is valid.

Returns

true iff the `Unique_region` is valid

Definition at line 545 of file rm.

15.304.3.3 operator=()

```
template<typename T>
Unique_region & L4Re::Rm::Unique_region< T >::operator= (
            Unique_region< T > && o)  [inline], [noexcept]
```

Move-assign a Unique_region.

Parameters

o	L-value reference to region to assign from

Definition at line 477 of file rm.

15.304.3.4 release()

```
template<typename T>
T L4Re::Rm::Unique_region< T >::release ()  [inline], [noexcept]
```

Return the address and invalidate the Unique_region.

Returns

the address

Definition at line 513 of file rm.

15.304.3.5 reset()

```
template<typename T>
void L4Re::Rm::Unique_region< T >::reset (
            T addr,
            L4::Cap< Rm > const & rm)  [inline], [noexcept]
```

Set new address and region manager.

Parameters

addr	The new address
rm	The new region manager

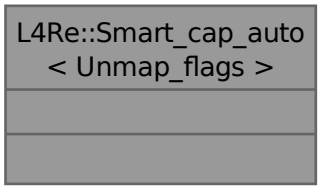
Definition at line 525 of file rm.
The documentation for this class was generated from the following file:

- l4/re/rm

15.305 L4Re::Smart_cap_auto< Unmap_flags > Class Template Reference

Helper for Unique_cap and Unique_del_cap.
`#include <cap_alloc>`

Collaboration diagram for L4Re::Smart_cap_auto< Unmap_flags >:



15.305.1 Detailed Description

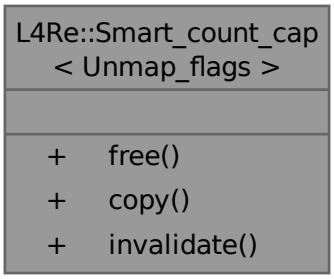
template<unsigned long Unmap_flags = L4_FP_ALL_SPACES>
class L4Re::Smart_cap_auto< Unmap_flags >

Helper for Unique_cap and Unique_del_cap.
Definition at line 103 of file cap_alloc.
The documentation for this class was generated from the following file:

- l4/re/cap_alloc

15.306 L4Re::Smart_count_cap< Unmap_flags > Class Template Reference

Helper for Ref_cap and Ref_del_cap.
`#include <cap_alloc>`
Collaboration diagram for L4Re::Smart_count_cap< Unmap_flags >:



Public Member Functions

- void **free** (L4::Cap_base &c) noexcept

  Free operation for L4::Smart_cap (decrement ref count and delete if 0).
- L4::Cap_base **copy** (L4::Cap_base const &src)

  Copy operation for L4::Smart_cap (increment ref count).

Static Public Member Functions

- static void **invalidate** (L4::Cap_base &c) noexcept

  Invalidate operation for L4::Smart_cap.

15.306.1 Detailed Description

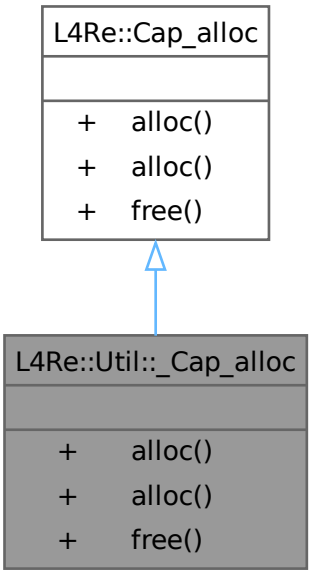
template<unsigned long Unmap_flags = L4_FP_ALL_SPACES>
class L4Re::Smart_count_cap< Unmap_flags >

Helper for Ref_cap and Ref_del_cap.
Definition at line 132 of file cap_alloc.
The documentation for this class was generated from the following file:

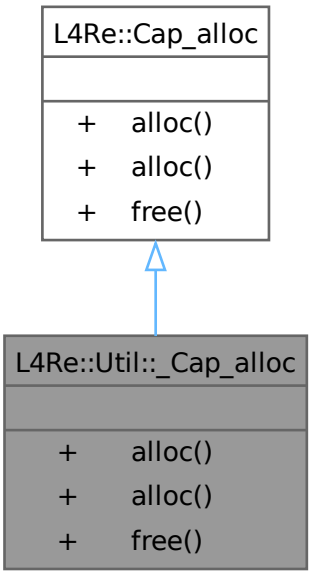
- l4/re/cap_alloc

15.307 L4Re::Util::_Cap_alloc Class Reference

Adapter to expose the cap allocator implementation as L4Re::Cap_alloc compatible class.
`#include <cap_alloc_impl.h>`
Inheritance diagram for L4Re::Util::_Cap_alloc:



Collaboration diagram for L4Re::Util::_Cap_alloc:



Public Member Functions

- L4::Cap< void > alloc () noexcept override
  Allocate a capability.
- template<typename T>
  L4::Cap< T > alloc () noexcept
  Allocate a capability.
- void free (L4::Cap< void > cap, l4_cap_idx_t task=L4_BASE_TASK_CAP, unsigned unmap_↩ flags=L4_FP_ALL_SPACES) noexcept override
  Free a capability.

Public Member Functions inherited from L4Re::Cap_alloc

- template<typename T>
  L4::Cap< T > alloc () noexcept
  Allocate a capability.

15.307.1 Detailed Description

Adapter to expose the cap allocator implementation as L4Re::Cap_alloc compatible class.
Not intended to be used in application code.
Definition at line 66 of file cap_alloc_impl.h.

15.307.2 Member Function Documentation

15.307.2.1 alloc() [1/2]

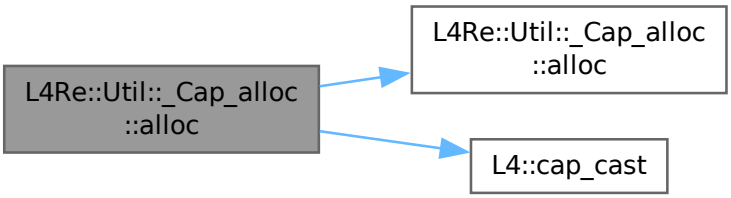
```
template<typename T>
L4::Cap< T > L4Re::Util::_Cap_alloc::alloc ()  [inline], [virtual], [noexcept]
```

Allocate a capability.

Returns

Capability of type void

Implements L4Re::Cap_alloc.
Definition at line 79 of file cap_alloc_impl.h.
References alloc(), and L4::cap_cast().
Here is the call graph for this function:



15.307.2.2 alloc() [2/2]

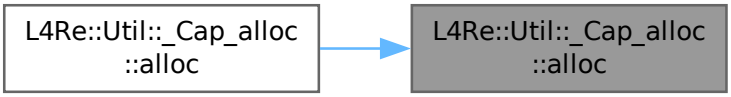
```
L4::Cap< void > L4Re::Util::_Cap_alloc::alloc ()  [inline], [override], [virtual], [noexcept]
```

Allocate a capability.

Returns

Capability of type void

Implements L4Re::Cap_alloc.
Definition at line 75 of file cap_alloc_impl.h.
Referenced by alloc().
Here is the caller graph for this function:



15.307.2.3 free()

```
void L4Re::Util::_Cap_alloc::free (
            L4::Cap< void > cap,
            l4_cap_idx_t task = L4_BASE_TASK_CAP,
            unsigned unmap_flags = L4_FP_ALL_SPACES)  [inline], [override], [virtual], [noexcept]
```

Free a capability.

Parameters

cap	Capability to free.
task	If set, task to unmap the capability from.
unmap_flags	Flags for unmap, see l4_unmap_flags_t.

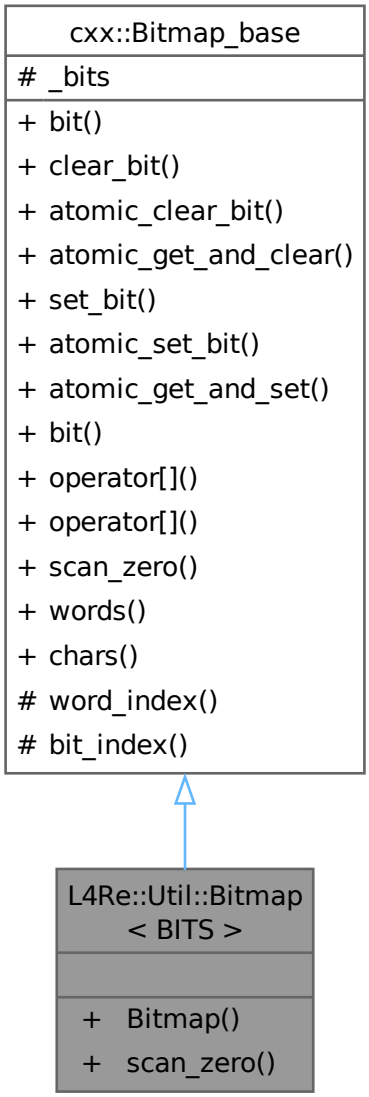
Implements L4Re::Cap_alloc.
Definition at line 85 of file cap_alloc_impl.h.
References L4_BASE_TASK_CAP, and L4Re::Util::L4_FP_ALL_SPACES.
The documentation for this class was generated from the following file:

- l4/re/util/cap_alloc_impl.h

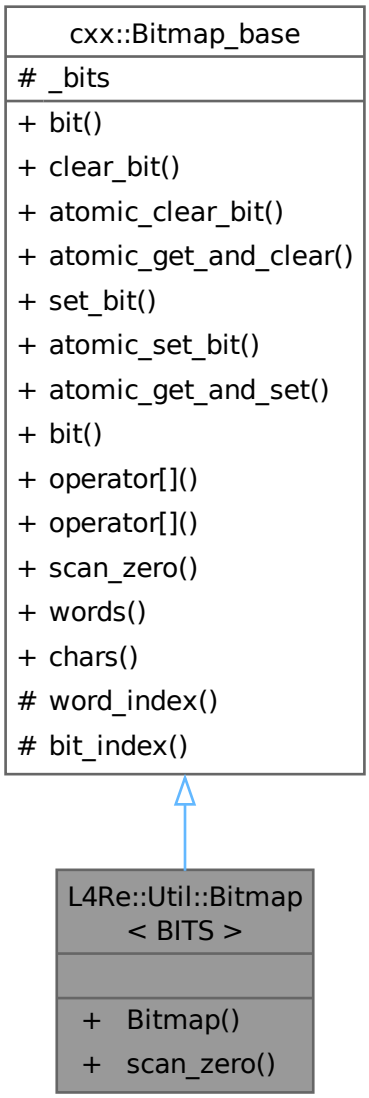
15.308 L4Re::Util::Bitmap< BITS > Class Template Reference

A static bitmap.
`#include <bitmap>`

Inheritance diagram for L4Re::Util::Bitmap< BITS >:



Collaboration diagram for L4Re::Util::Bitmap< BITS >:



Public Member Functions

- **Bitmap** () noexcept

  Create a bitmap with `BITS` *bits.*
- long scan_zero (long start_bit=0) const noexcept

  Scan for the first zero bit.

Public Member Functions inherited from cxx::Bitmap_base

- void bit (long bit, bool on) noexcept

  Set the value of bit `bit` *to* `on`*.*
- void clear_bit (long bit) noexcept

  Clear bit `bit`*.*

- void atomic_clear_bit (long bit) noexcept

  Clear bit `bit` atomically.
- word_type atomic_get_and_clear (long bit) noexcept

  Clear bit `bit` atomically and return old state.
- void set_bit (long bit) noexcept

  Set bit `bit`.
- void atomic_set_bit (long bit) noexcept

  Set bit `bit` atomically.
- word_type atomic_get_and_set (long bit) noexcept

  Set bit `bit` atomically and return old state.
- word_type bit (long bit) const noexcept

  Get the truth value of a bit.
- word_type operator[ ] (long bit) const noexcept

  Get the bit at index `bit`.
- Bit operator[ ] (long bit) noexcept

  Get the lvalue for the bit at index `bit`.
- long scan_zero (long max_bit, long start_bit=0) const noexcept

  Scan for the first zero bit.

Additional Inherited Members

Static Public Member Functions inherited from cxx::Bitmap_base

- static long **words** (long bits) noexcept

  Get the number of `Words` that are used for the bitmap.
- static long **chars** (long bits) noexcept

  Get the number of chars that are used for the bitmap.

Protected Types inherited from cxx::Bitmap_base

- enum { W_bits = sizeof(word_type) * 8 , C_bits = 8 }
- typedef unsigned long **word_type**

  Data type for each element of the bit buffer.

Static Protected Member Functions inherited from cxx::Bitmap_base

- static unsigned word_index (unsigned bit)

  Get the word index for the given bit.
- static unsigned bit_index (unsigned bit)

  Get the bit index within word_type for the given bit.

Protected Attributes inherited from cxx::Bitmap_base

- word_type * **_bits**

  Pointer to the buffer storing the bits.

15.308.1 Detailed Description

template<int BITS>
class L4Re::Util::Bitmap< BITS >

A static bitmap.

Template Parameters

BITS	The number of bits that shall be in the bitmap.

Definition at line 220 of file bitmap.

15.308.2 Member Function Documentation

15.308.2.1 scan_zero()

```
template<int BITS>
long cxx::Bitmap< BITS >::scan_zero (
             long start_bit = 0) const  [inline], [noexcept]
```

Scan for the first zero bit.

Parameters

start_bit	Hint at the number of the first bit to look at. Zero bits below `start_bit` may or may not be taken into account by the implementation.

Return values

>=	0 Number of first zero bit found.
-1	All bits at `start_bit` or higher are set.

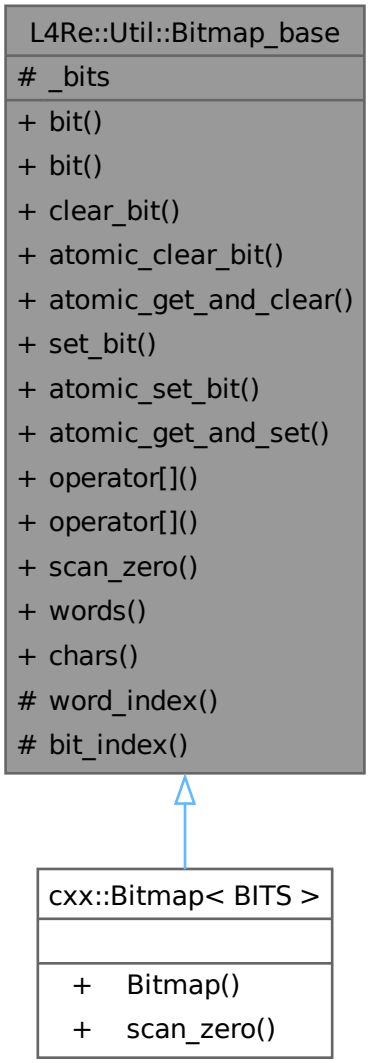
Compared to Bitmap_base::scan_zero(), the upper bound is set to BITS.
Definition at line 365 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

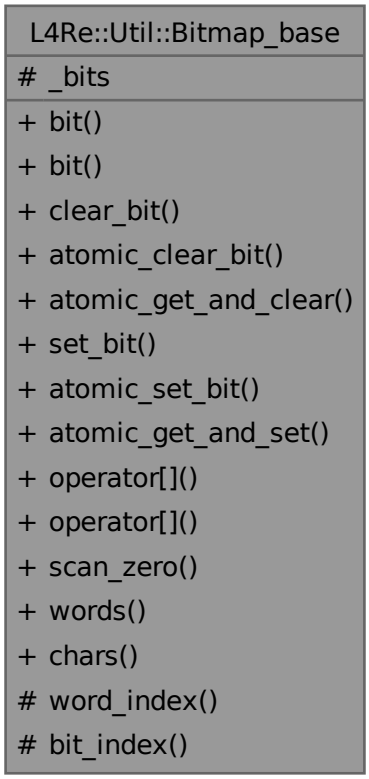
15.309 L4Re::Util::Bitmap_base Class Reference

Basic bitmap abstraction.
`#include <bitmap>`

Inheritance diagram for L4Re::Util::Bitmap_base:



Collaboration diagram for L4Re::Util::Bitmap_base:



Data Structures

- class Bit

  A writable bit in a bitmap.
- class Word

  Helper abstraction for a word contained in the bitmap.
- class Char

  Helper abstraction for a byte contained in the bitmap.

Public Member Functions

- void bit (long bit, bool on) noexcept

  Set the value of bit `bit` *to* `on`.
- word_type bit (long bit) const noexcept

  Get the truth value of a bit.
- void clear_bit (long bit) noexcept

  Clear bit `bit`.
- void atomic_clear_bit (long bit) noexcept

  Clear bit `bit` *atomically.*
- word_type atomic_get_and_clear (long bit) noexcept

  Clear bit `bit` *atomically and return old state.*

- void set_bit (long bit) noexcept
  Set bit `bit`.
- void atomic_set_bit (long bit) noexcept
  Set bit `bit` atomically.
- word_type atomic_get_and_set (long bit) noexcept
  Set bit `bit` atomically and return old state.
- word_type operator[ ] (long bit) const noexcept
  Get the bit at index `bit`.
- Bit operator[ ] (long bit) noexcept
  Get the lvalue for the bit at index `bit`.
- long scan_zero (long max_bit, long start_bit=0) const noexcept
  Scan for the first zero bit.

Static Public Member Functions

- static long **words** (long bits) noexcept
  Get the number of `Words` that are used for the bitmap.
- static long **chars** (long bits) noexcept
  Get the number of chars that are used for the bitmap.

Protected Types

- enum { W_bits = sizeof(word_type) * 8 , C_bits = 8 }
- typedef unsigned long **word_type**
  Data type for each element of the bit buffer.

Static Protected Member Functions

- static unsigned word_index (unsigned bit)
  Get the word index for the given bit.
- static unsigned bit_index (unsigned bit)
  Get the bit index within word_type for the given bit.

Protected Attributes

- word_type * **_bits**
  Pointer to the buffer storing the bits.

15.309.1 Detailed Description

Basic bitmap abstraction.
This abstraction keeps a pointer to a memory area that is used as bitmap.
Definition at line 18 of file bitmap.

15.309.2 Member Enumeration Documentation

15.309.2.1 anonymous enum

```
anonymous enum  [protected]
```

Enumerator

W_bits	number of bits in word_type
C_bits	number of bits in char

Definition at line 26 of file bitmap.

15.309.3 Member Function Documentation

15.309.3.1 atomic_clear_bit()

```
void cxx::Bitmap_base::atomic_clear_bit (
            long bit)  [inline], [noexcept]
```

Clear bit `bit` atomically.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to clear.

Definition at line 269 of file bitmap.

15.309.3.2 atomic_get_and_clear()

```
Bitmap_base::word_type cxx::Bitmap_base::atomic_get_and_clear (
            long bit)  [inline], [noexcept]
```

Clear bit `bit` atomically and return old state.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to clear.

Definition at line 279 of file bitmap.

15.309.3.3 atomic_get_and_set()

```
Bitmap_base::word_type cxx::Bitmap_base::atomic_get_and_set (
            long bit)  [inline], [noexcept]
```

Set bit `bit` atomically and return old state.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to set.

Definition at line 308 of file bitmap.

15.309.3.4 atomic_set_bit()

```
void cxx::Bitmap_base::atomic_set_bit (
            long bit)  [inline], [noexcept]
```

Set bit `bit` atomically.
Use this function for multi-threaded access to the bitmap.

Parameters

bit	The number of the bit to set.

Definition at line 298 of file bitmap.

15.309.3.5 bit() [1/2]

```
Bitmap_base::word_type cxx::Bitmap_base::bit (
```

```
            long bit) const  [inline], [noexcept]
```

Get the truth value of a bit.

Parameters

bit	The number of the bit to read.

Return values

0	Bit is not set.
!=	0 Bit is set.

Definition at line 318 of file bitmap.

15.309.3.6 bit() [2/2]

```
void cxx::Bitmap_base::bit (
            long bit,
            bool on)  [inline], [noexcept]
```

Set the value of bit `bit` to `on`.

Parameters

bit	The number of the bit.
on	The boolean value that shall be assigned to the bit.

Definition at line 251 of file bitmap.

15.309.3.7 bit_index()

```
unsigned cxx::Bitmap_base::bit_index (
            unsigned bit)  [inline], [static], [protected]
```

Get the bit index within word_type for the given bit.

Parameters

bit	The bit index in the bitmap.

Returns

the bit index within word_type (bit % W_bits).

Definition at line 53 of file bitmap.

15.309.3.8 clear_bit()

```
void cxx::Bitmap_base::clear_bit (
            long bit)  [inline], [noexcept]
```

Clear bit `bit`.

Parameters

bit	The number of the bit to clear.

Definition at line 260 of file bitmap.

15.309.3.9 operator[]() [1/2]

```
word_type cxx::Bitmap_base::operator[] (
            long bit) const  [inline], [noexcept]
```

Get the bit at index `bit`.

Parameters

bit	The number of the bit to read.

Return values

0	Bit is not set.
!=	0 Bit is set.

Definition at line 181 of file bitmap.

15.309.3.10 operator[]() [2/2]

```
Bit cxx::Bitmap_base::operator[] (
            long bit)  [inline], [noexcept]
```

Get the lvalue for the bit at index `bit`.

Parameters

bit	The number.

Returns

lvalue for `bit`

Definition at line 191 of file bitmap.

15.309.3.11 scan_zero()

```
long cxx::Bitmap_base::scan_zero (
            long max_bit,
            long start_bit = 0) const  [inline], [noexcept]
```

Scan for the first zero bit.

Parameters

max_bit	Upper bound (exclusive) for the scanning operation.
start_bit	Hint at the number of the first bit to look at. Zero bits below `start_bit` may or may not be taken into account by the implementation.

Return values

>=	0 Number of first zero bit found.

-1	All bits between `start_bit` and `max_bit` are set.

Definition at line 339 of file bitmap.

15.309.3.12 set_bit()

```
void cxx::Bitmap_base::set_bit (
            long bit)  [inline], [noexcept]
```

Set bit `bit`.

Parameters

bit	The number of the bit to set.

Definition at line 289 of file bitmap.

15.309.3.13 word_index()

```
unsigned cxx::Bitmap_base::word_index (
            unsigned bit)  [inline], [static], [protected]
```

Get the word index for the given bit.

Parameters

bit	The index of the bit in question.

Returns

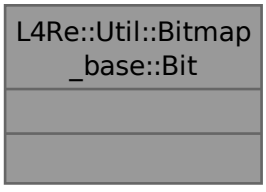
the index in Bitmap_base::_bits for the given bit (bit / W_bits).

Definition at line 44 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

15.310 L4Re::Util::Bitmap_base::Bit Class Reference

A writable bit in a bitmap.
`#include <bitmap>`
Collaboration diagram for L4Re::Util::Bitmap_base::Bit:



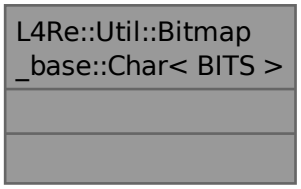
15.310.1 Detailed Description

A writable bit in a bitmap.
Definition at line 58 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

15.311 L4Re::Util::Bitmap_base::Char< BITS > Class Template Reference

Helper abstraction for a byte contained in the bitmap.
`#include <bitmap>`
Collaboration diagram for L4Re::Util::Bitmap_base::Char< BITS >:



15.311.1 Detailed Description

template<long BITS>
class L4Re::Util::Bitmap_base::Char< BITS >

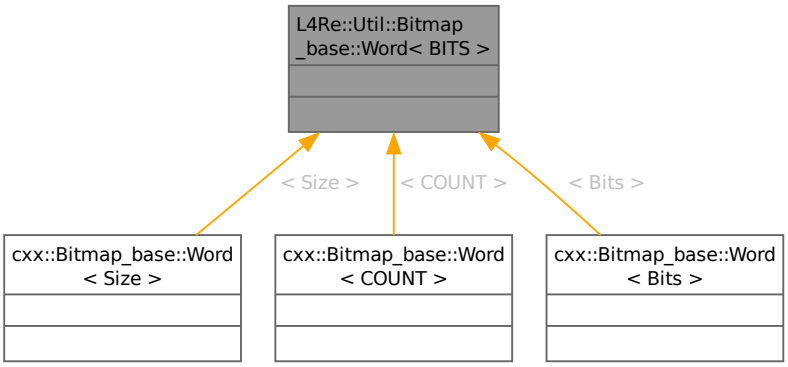
Helper abstraction for a byte contained in the bitmap.
Definition at line 95 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

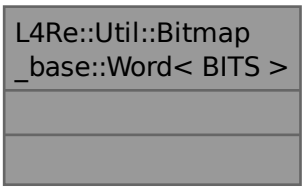
15.312 L4Re::Util::Bitmap_base::Word< BITS > Class Template Reference

Helper abstraction for a word contained in the bitmap.
`#include <bitmap>`

Inheritance diagram for L4Re::Util::Bitmap_base::Word< BITS >:



Collaboration diagram for L4Re::Util::Bitmap_base::Word< BITS >:



15.312.1 Detailed Description

template<long BITS>
class L4Re::Util::Bitmap_base::Word< BITS >

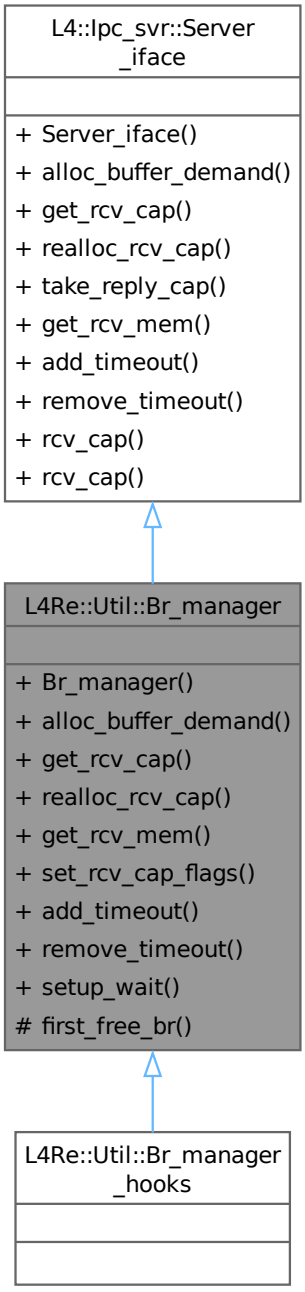
Helper abstraction for a word contained in the bitmap.
Definition at line 79 of file bitmap.
The documentation for this class was generated from the following file:

- l4/cxx/bitmap

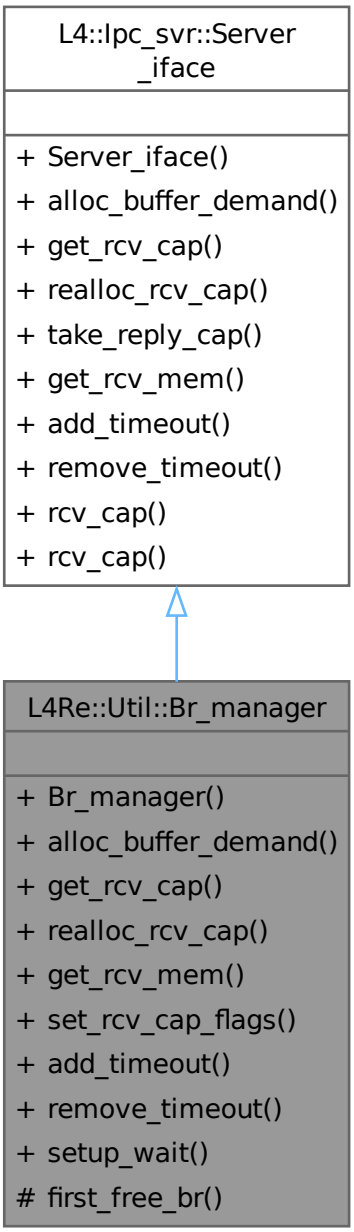
15.313 L4Re::Util::Br_manager Class Reference

Buffer-register (BR) manager for L4::Server.
`#include <br_manager>`

Inheritance diagram for L4Re::Util::Br_manager:



Collaboration diagram for L4Re::Util::Br_manager:



Public Member Functions

- **Br_manager** ()

  Make a buffer-register (BR) manager.
- int alloc_buffer_demand (Demand const &d) override

  Tells the server to allocate buffers for the given demand.
- L4::Cap< void > get_rcv_cap (int i) const override

  Get capability slot allocated to the given receive buffer.
- int realloc_rcv_cap (int i) override

Allocate a new capability for the given receive buffer.

- cxx::Result< L4::Ipc_svr::Server_iface::Mem_window > get_rcv_mem () noexcept override

  Take the current memory receive window.
- void set_rcv_cap_flags (unsigned long flags)

  Set the receive flags for the buffers.
- int **add_timeout** (L4::Ipc_svr::Timeout *, l4_kernel_clock_t) override

  No timeouts handled by us.
- int **remove_timeout** (L4::Ipc_svr::Timeout *) override

  No timeouts handled by us.
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)

  setup_wait() used the server loop (L4::Server)

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Protected Member Functions

- unsigned **first_free_br** () const

  Used for assigning BRs for a timeout.

Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

15.313.1 Detailed Description

Buffer-register (BR) manager for L4::Server.
Implementation of the L4::Ipc_svr::Server_iface API for managing the server-side receive buffers needed for a set of server objects running within a server.
Definition at line 27 of file br_manager.

15.313.2 Member Function Documentation

15.313.2.1 alloc_buffer_demand()

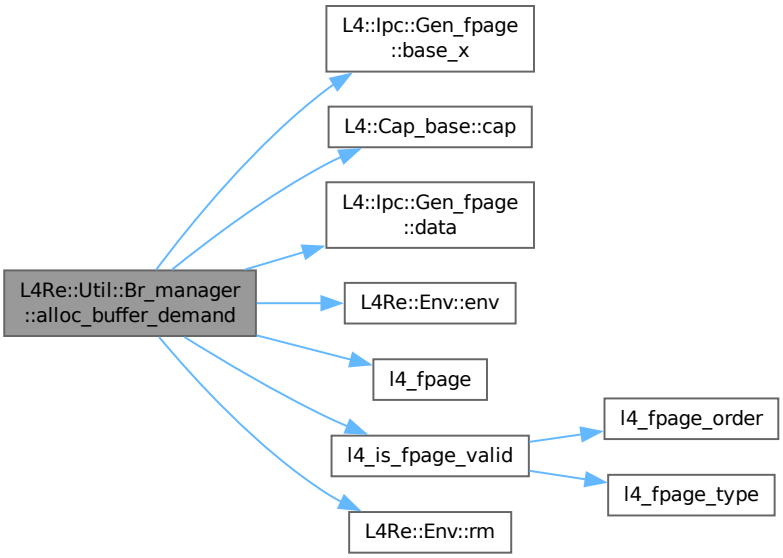
```
int L4Re::Util::Br_manager::alloc_buffer_demand (
            Demand const & demand)  [inline], [override], [virtual]
```

Tells the server to allocate buffers for the given demand.

Parameters

demand	The total server-side demand of receive buffers needed for a given interface, see Demand.

This function is not called by user applications directly. Usually the server implementation or the registry implementation calls this function whenever a new object is registered at the server.
Implements L4::Ipc_svr::Server_iface.
Definition at line 72 of file br_manager.
References L4::Ipc::Gen_fpage::base_x(), L4::Cap_base::cap(), L4Re::Util::cap_alloc, L4::Type_info::Demand::caps, L4::Ipc::Gen_fpage::data(), L4Re::Env::env(), L4_EINVAL, L4_ENOMEM, L4_EOK, L4_ERANGE, l4_fpage(), L4_FPAGE_RWX, l4_is_fpage_valid(), L4::Type_info::Demand::mem, L4::Type_info::Demand::ports, L4Re::Rm::F::Reserved, L4Re::Env::rm(), and L4Re::Rm::F::Search_addr.
Here is the call graph for this function:



15.313.2.2 get_rcv_cap()

```
L4::Cap< void > L4Re::Util::Br_manager::get_rcv_cap (
            int index) const  [inline], [override], [virtual]
```

Get capability slot allocated to the given receive buffer.

Parameters

index	The receive buffer index of the expected capability argument (0 <= `index` < `caps` registered with alloc_buffer_demand()).

Precondition

0 <= `index` < `caps` registered with alloc_buffer_demand()

Returns

Capability slot currently allocated to the given receive buffer.

Implements L4::Ipc_svr::Server_iface.
Definition at line 139 of file br_manager.
References L4::Cap_base::Invalid, and L4_CAP_MASK.

15.313.2.3 get_rcv_mem()

```
cxx::Result< L4::Ipc_svr::Server_iface::Mem_window > L4Re::Util::Br_manager::get_rcv_mem ()
[inline], [override], [virtual], [noexcept]
```

Take the current memory receive window.

The caller takes the ownership of the memory receive window. A new receive window will be allocated for the next call.

Attention

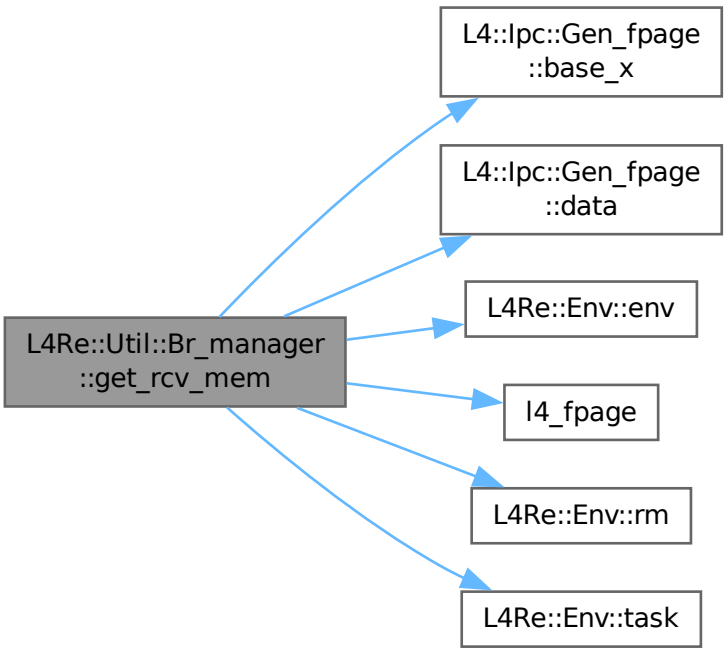
The caller has to ensure that the received IPC call actually mapped some memory flexpage. Still, the IPC client can revoke the pages at any time. Thus, any access into the memory window could create unresolved page faults.

Reimplemented from L4::Ipc_svr::Server_iface.

Definition at line 165 of file br_manager.

References L4::Ipc::Gen_fpage::base_x(), L4::Ipc::Gen_fpage::data(), L4Re::Env::env(), L4_EINVAL, L4_ENOMEM, L4Re::Util::L4_FP_ALL_SPACES, l4_fpage(), L4_FPAGE_RWX, L4Re::Rm::F::Reserved, L4Re::Env::rm(), L4Re::Rm::F::Search_addr, and L4Re::Env::task().

Here is the call graph for this function:



15.313.2.4 realloc_rcv_cap()

```
int L4Re::Util::Br_manager::realloc_rcv_cap (
            int index) [inline], [override], [virtual]
```

Allocate a new capability for the given receive buffer.

Parameters

index	The receive buffer index of the expected capability argument (0 <= `index` < `caps` registered with alloc_buffer_demand()).

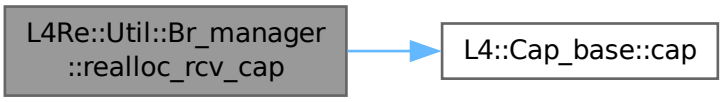
Precondition

0 <= `index` < `caps` registered with alloc_buffer_demand()

Returns

0 on success, < 0 on error.

On success, the caller implicitly takes ownership of the former rcv_cap(`index`) prior to the call. On error, rcv_cap(`index`) remains unchanged and will be reused for the next IPC receive of the server.
Implements L4::Ipc_svr::Server_iface.
Definition at line 147 of file br_manager.
References L4::Cap_base::cap(), L4Re::Util::cap_alloc, L4_EINVAL, L4_ENOMEM, and L4_EOK.
Here is the call graph for this function:



15.313.2.5 set_rcv_cap_flags()

```
void L4Re::Util::Br_manager::set_rcv_cap_flags (
            unsigned long flags)  [inline]
```

Set the receive flags for the buffers.

Precondition

Must be called before any handlers are registered.

Parameters

flags	New receive capability flags, see l4_msg_item_consts_t.

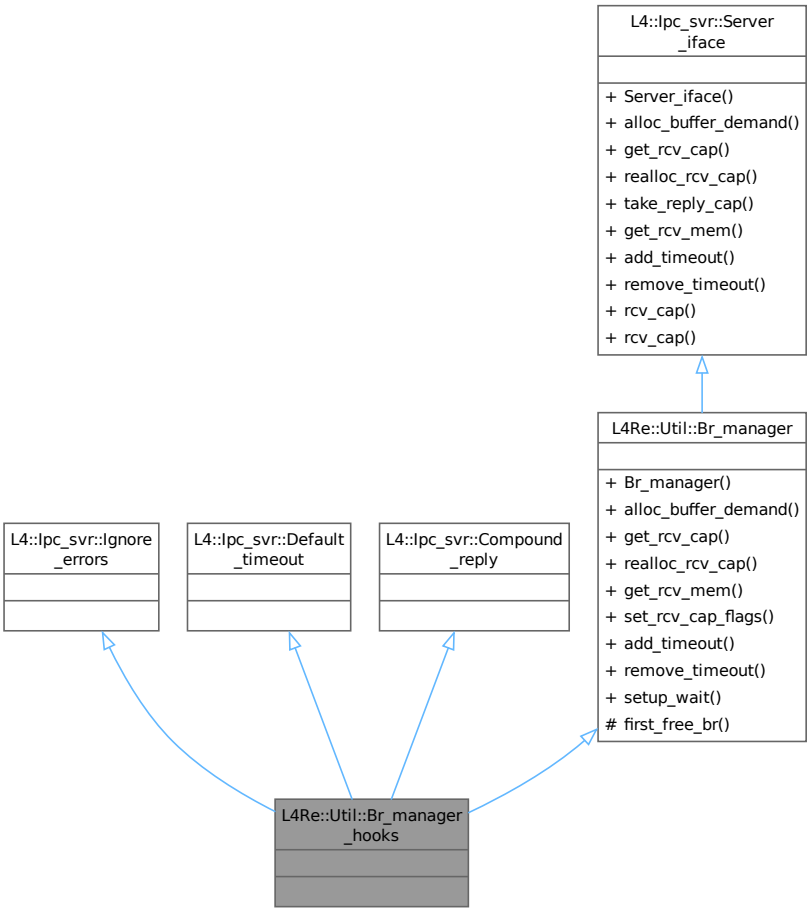
Definition at line 200 of file br_manager.
References l4_assert.
The documentation for this class was generated from the following file:

- l4/re/util/br_manager

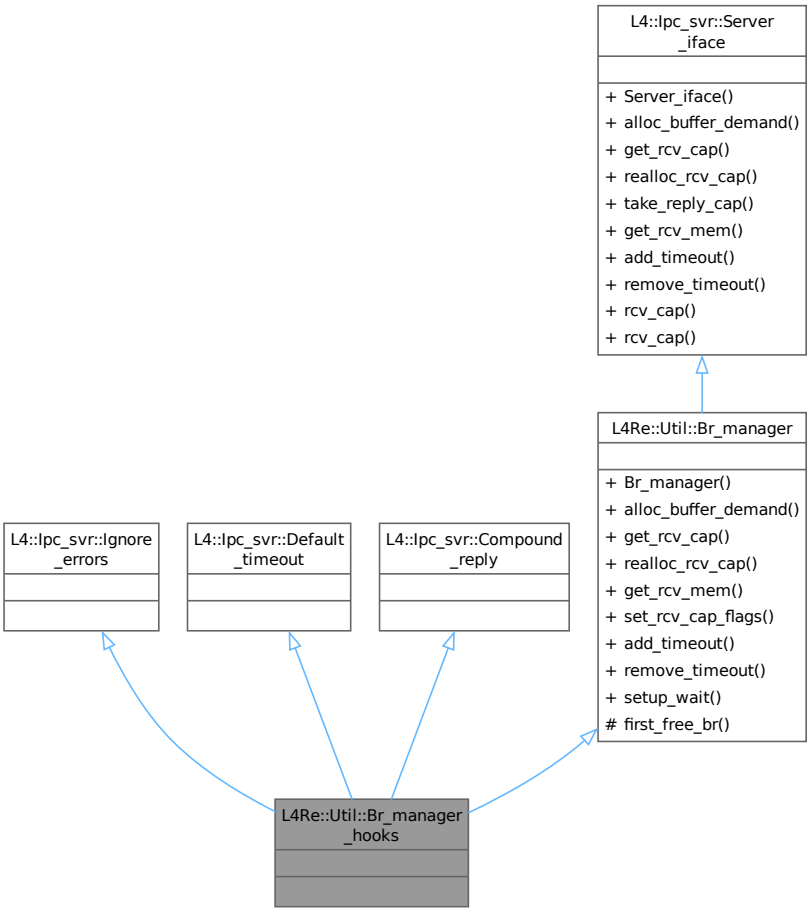
15.314 L4Re::Util::Br_manager_hooks Struct Reference

Predefined server-loop hooks for a server loop using the Br_manager.
`#include <br_manager>`

Inheritance diagram for L4Re::Util::Br_manager_hooks:



Collaboration diagram for L4Re::Util::Br_manager_hooks:



Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

Public Member Functions inherited from L4Re::Util::Br_manager

- **Br_manager** ()

  Make a buffer-register (BR) manager.
- int alloc_buffer_demand (Demand const &d) override

  Tells the server to allocate buffers for the given demand.
- L4::Cap< void > get_rcv_cap (int i) const override

  Get capability slot allocated to the given receive buffer.
- int realloc_rcv_cap (int i) override

  Allocate a new capability for the given receive buffer.
- cxx::Result< L4::Ipc_svr::Server_iface::Mem_window > get_rcv_mem () noexcept override

  Take the current memory receive window.
- void set_rcv_cap_flags (unsigned long flags)

Set the receive flags for the buffers.

- int **add_timeout** (L4::Ipc_svr::Timeout *, l4_kernel_clock_t) override

  No timeouts handled by us.

- int **remove_timeout** (L4::Ipc_svr::Timeout *) override

  No timeouts handled by us.

- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)

  setup_wait() used the server loop (L4::Server)

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.

- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.

- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.

- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Protected Member Functions inherited from L4Re::Util::Br_manager

- unsigned **first_free_br** () const

  Used for assigning BRs for a timeout.

15.314.1 Detailed Description

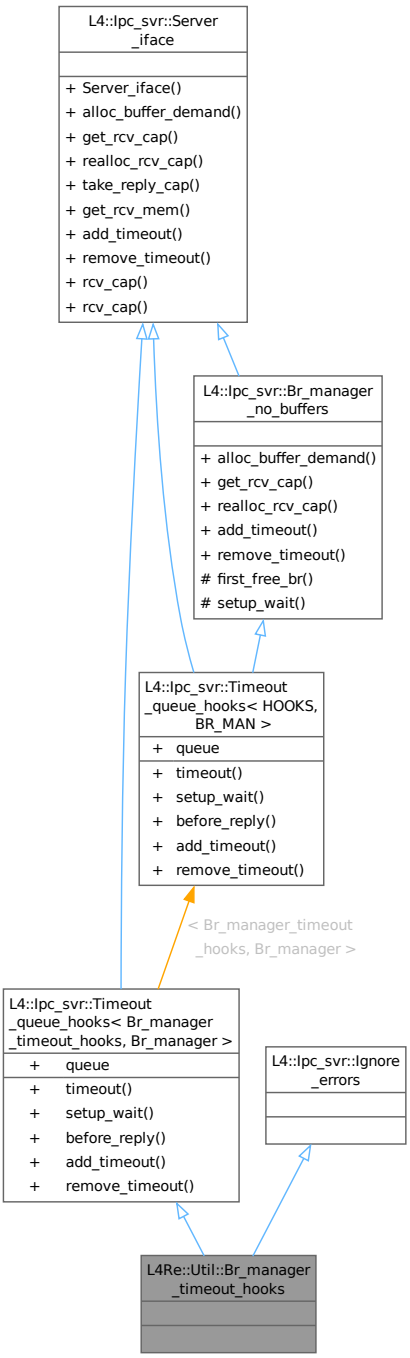
Predefined server-loop hooks for a server loop using the Br_manager.
This class can be used whenever a server loop including full management of receive buffer resources is needed.
Definition at line 250 of file br_manager.
The documentation for this struct was generated from the following file:

- l4/re/util/br_manager

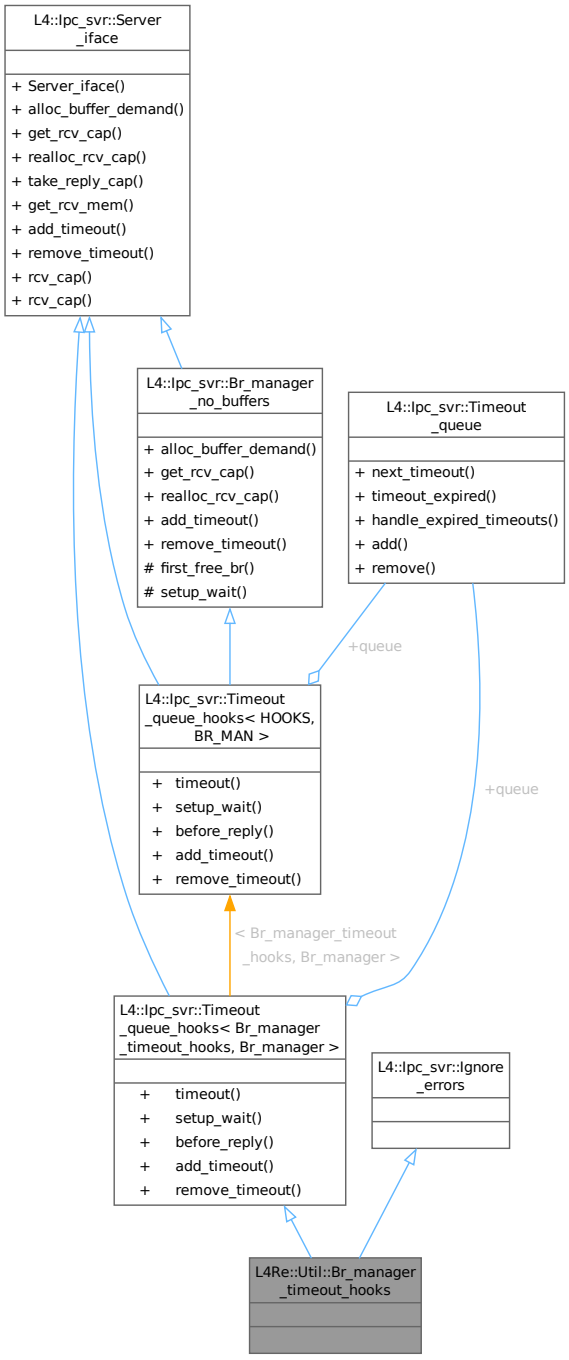
15.315 L4Re::Util::Br_manager_timeout_hooks Struct Reference

Predefined server-loop hooks for a server with using the Br_manager and a timeout queue.
`#include <br_manager>`

Inheritance diagram for L4Re::Util::Br_manager_timeout_hooks:



Collaboration diagram for L4Re::Util::Br_manager_timeout_hooks:



Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

Public Member Functions inherited from L4::Ipc_svr::Timeout_queue_hooks< Br_manager_timeout_hooks, Br_manager >

- l4_timeout_t **timeout** ()

  get the time for the next timeout
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode mode)

  setup_wait() for the server loop
- L4::Ipc_svr::Reply_mode **before_reply** (l4_msgtag_t, l4_utcb_t *)

  server loop hook
- int add_timeout (Timeout *timeout, l4_kernel_clock_t time) override

  Add a timeout to the queue for time time.
- int remove_timeout (Timeout *timeout) override

  Remove timeout from the queue.

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.
- virtual int alloc_buffer_demand (Demand const &demand)=0

  Tells the server to allocate buffers for the given demand.
- virtual L4::Cap< void > get_rcv_cap (int index) const =0

  Get capability slot allocated to the given receive buffer.
- virtual int realloc_rcv_cap (int index)=0

  Allocate a new capability for the given receive buffer.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- virtual cxx::Result< Mem_window > get_rcv_mem () noexcept

  Take the current memory receive window.
- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Data Fields inherited from L4::Ipc_svr::Timeout_queue_hooks< Br_manager_timeout_hooks, Br_manager >

- Timeout_queue **queue**

  Use this timeout queue.

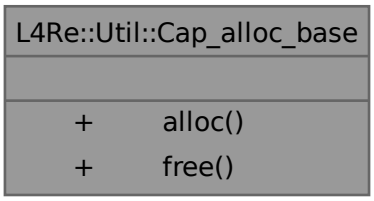
15.315.1 Detailed Description

Predefined server-loop hooks for a server with using the Br_manager and a timeout queue.
This class can be used for server loops that need the full package of buffer-register management and a timeout queue.
Definition at line 264 of file br_manager.
The documentation for this struct was generated from the following file:

- l4/re/util/br_manager

15.316 L4Re::Util::Cap_alloc_base Class Reference

Capability allocator.
`#include <bitmap_cap_alloc>`
Collaboration diagram for L4Re::Util::Cap_alloc_base:



Public Member Functions

- template<typename T>
  L4::Cap< T > **alloc** () noexcept

  Allocate a capability slot.
- template<typename T>
  void **free** (L4::Cap< T > const &cap, l4_cap_idx_t task=L4_INVALID_CAP, l4_umword_t unmap_↩ flags=L4_FP_ALL_SPACES) noexcept

  Free a capability slot.

15.316.1 Detailed Description

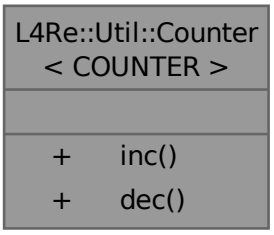
Capability allocator.
Definition at line 28 of file bitmap_cap_alloc.
The documentation for this class was generated from the following file:

- l4/re/util/bitmap_cap_alloc

15.317 L4Re::Util::Counter< COUNTER > Struct Template Reference

Counter for Counting_cap_alloc with variable data width.
`#include <counting_cap_alloc>`

Collaboration diagram for L4Re::Util::Counter< COUNTER >:



Public Member Functions

- bool inc ()

  Increment counter if not yet saturated.
- Type dec ()

  Decrement counter if not saturated.

15.317.1 Detailed Description

template<typename COUNTER = unsigned char>
struct L4Re::Util::Counter< COUNTER >

Counter for Counting_cap_alloc with variable data width.
This version is not thread safe.
Definition at line 27 of file counting_cap_alloc.

15.317.2 Member Function Documentation

15.317.2.1 dec()

```
template<typename COUNTER = unsigned char>
Type L4Re::Util::Counter< COUNTER >::dec ()  [inline]
```

Decrement counter if not saturated.
Once the counter reached the saturated state, the counter value isn't changed.
Definition at line 67 of file counting_cap_alloc.

15.317.2.2 inc()

```
template<typename COUNTER = unsigned char>
bool L4Re::Util::Counter< COUNTER >::inc ()  [inline]
```

Increment counter if not yet saturated.
Once the counter reached the saturated state, the counter value isn't changed.

Return values

false	The counter just went saturated after it was increased.
true	Either the counter was already saturated – in that case the counter value was not changed, or the counter was not saturated – in that case the counter was increased.

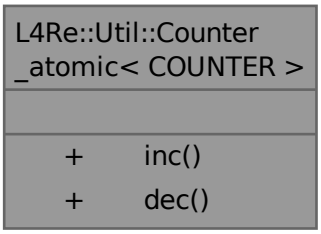
Definition at line 50 of file counting_cap_alloc.

The documentation for this struct was generated from the following file:

- l4/re/util/counting_cap_alloc

15.318 L4Re::Util::Counter_atomic< COUNTER > Struct Template Reference

Thread safe version of counter for Counting_cap_alloc.
`#include <counting_cap_alloc>`
Collaboration diagram for L4Re::Util::Counter_atomic< COUNTER >:



Public Member Functions

- bool inc ()

  Increment counter if not yet saturated.
- Type dec ()

  Decrement counter if not saturated.

15.318.1 Detailed Description

template<typename COUNTER = unsigned char>
struct L4Re::Util::Counter_atomic< COUNTER >

Thread safe version of counter for Counting_cap_alloc.
Despite using atomic instructions, this version has to make sure that capability slots are not reused too early. If the last reference is gone, the capability slot has to be unmapped. The slot must only be allocated again when the unmap has completed. This is accomplished by starting with an initial count of 2. The last reference will decrease the counter to 1. Only then, after the slot was unmapped, will the counter be set to 0. This will allow other threads to reallocate the slot.
Definition at line 98 of file counting_cap_alloc.

15.318.2 Member Function Documentation

15.318.2.1 dec()

```
template<typename COUNTER = unsigned char>
Type L4Re::Util::Counter_atomic< COUNTER >::dec ()  [inline]
```

Decrement counter if not saturated.
Once the counter reached the saturated state, the counter value isn't changed.
Definition at line 142 of file counting_cap_alloc.

15.318.2.2 inc()

```
template<typename COUNTER = unsigned char>
bool L4Re::Util::Counter_atomic< COUNTER >::inc ()  [inline]
```

Increment counter if not yet saturated.
Once the counter reached the saturated state, the counter value isn't changed.

Return values

false	The counter just went saturated after it was increased.
true	Either the counter was already saturated – in that case the counter value was not changed, or the counter was not saturated – in that case the counter was increased.

Definition at line 121 of file counting_cap_alloc.
The documentation for this struct was generated from the following file:

- l4/re/util/counting_cap_alloc

15.319 L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg > Class Template Reference

Internal reference-counting cap allocator.
`#include <counting_cap_alloc>`
Collaboration diagram for L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >:



Public Member Functions

- L4::Cap< void > alloc () noexcept

  Allocate a new capability slot.
- template<typename T>
  L4::Cap< T > alloc () noexcept

Allocate a new capability slot.

- void take (L4::Cap< void > cap) noexcept

  Increase the reference counter for the capability.

- bool free (L4::Cap< void > cap, l4_cap_idx_t task=L4_BASE_TASK_CAP, unsigned unmap_↩ flags=L4_FP_ALL_SPACES) noexcept

  Free the capability.

- bool release (L4::Cap< void > cap, l4_cap_idx_t task=L4_BASE_TASK_CAP, unsigned unmap_↩ flags=L4_FP_ALL_SPACES) noexcept

  Decrease the reference counter for a capability.

- long **last** () noexcept

  Return highest capability id managed by this allocator.

Protected Member Functions

- Counting_cap_alloc () noexcept

  Create a new, empty allocator.

- void setup (void *m, long capacity, long bias, Dbg *dbg) noexcept

  Set up the backing memory for the allocator and the area of managed capability slots.

15.319.1 Detailed Description

template<typename COUNTERTYPE, typename Dbg>
class L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >

Internal reference-counting cap allocator.
This is intended for internal use only. L4Re applications should use L4Re::Util::cap_alloc().
Allocator for capability slots that automatically frees the slot and optionally unmaps the capability when the reference count goes down to zero. Reference counting must be done manually via take() and release(). The backing store for the reference counters must be provided in the setup() method. The allocator can recognize capability slots that are not managed by itself and does nothing on such slots.

Note

The user must ensure that the backing store is zero-initialized.

The user must ensure that the capability slots managed by this allocator are not used by a different allocator, see setup().

The operations in this class are not thread-safe.

Definition at line 191 of file counting_cap_alloc.

15.319.2 Constructor & Destructor Documentation

15.319.2.1 Counting_cap_alloc()

```
template<typename COUNTERTYPE, typename Dbg>
L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::Counting_cap_alloc ()  [inline], [protected],
[noexcept]
```

Create a new, empty allocator.
Needs to be initialized with setup() before it can be used.
Definition at line 224 of file counting_cap_alloc.

15.319.3 Member Function Documentation

15.319.3.1 alloc() [1/2]

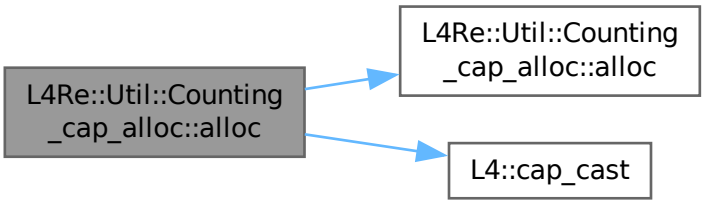
```
template<typename COUNTERTYPE, typename Dbg>
template<typename T>
L4::Cap< T > L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::alloc ()  [inline], [noexcept]
```

Allocate a new capability slot.

Returns

The newly allocated capability slot, invalid if the allocator was exhausted.

Definition at line 282 of file counting_cap_alloc.
References alloc(), and L4::cap_cast().
Here is the call graph for this function:



15.319.3.2 alloc() [2/2]

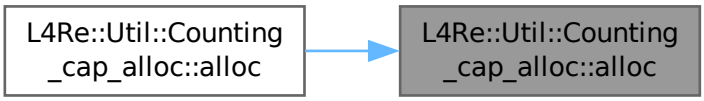
```
template<typename COUNTERTYPE, typename Dbg>
L4::Cap< void > L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::alloc ()  [inline], [noexcept]
```

Allocate a new capability slot.

Returns

The newly allocated capability slot, invalid if the allocator was exhausted.

Definition at line 257 of file counting_cap_alloc.
References L4::Cap_base::Invalid, and L4_CAP_SHIFT.
Referenced by alloc().
Here is the caller graph for this function:



15.319.3.3 free()

```
template<typename COUNTERTYPE, typename Dbg>
bool L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::free (
            L4::Cap< void > cap,
            l4_cap_idx_t task = L4_BASE_TASK_CAP,
            unsigned unmap_flags = L4_FP_ALL_SPACES)  [inline], [noexcept]
```

Free the capability.

Parameters

cap	Capability to free.
task	If set, task to unmap the capability from.
unmap_flags	Flags for unmap, see l4_unmap_flags_t.

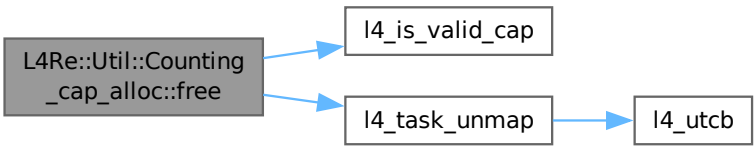
Precondition

The capability has been allocated. Calling free twice on a capability managed by this allocator results in undefined behaviour.

Returns

True, if the capability was managed by this allocator.

Definition at line 321 of file counting_cap_alloc.
References l4_assert, L4_BASE_TASK_CAP, L4Re::Util::L4_FP_ALL_SPACES, l4_is_valid_cap(), and l4_task_unmap().
Here is the call graph for this function:



15.319.3.4 release()

```
template<typename COUNTERTYPE, typename Dbg>
bool L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::release (
            L4::Cap< void > cap,
            l4_cap_idx_t task = L4_BASE_TASK_CAP,
            unsigned unmap_flags = L4_FP_ALL_SPACES)  [inline], [noexcept]
```

Decrease the reference counter for a capability.

Parameters

cap	Capability to release.
task	If set, task to unmap the capability from.
unmap_flags	Flags for unmap, see l4_unmap_flags_t.

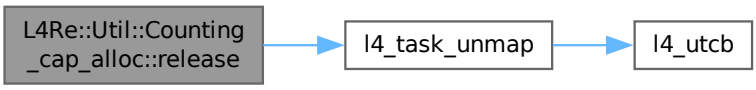
Precondition

The capability has been allocated. Calling release on a free capability results in undefined behaviour.

Returns

True, if the capability was freed as a result of this operation. If false is returned the capability is either still in use or is not managed by this allocator.

Does nothing apart from returning false if the capability is not managed by this allocator.
Definition at line 359 of file counting_cap_alloc.
References l4_assert, L4_BASE_TASK_CAP, L4Re::Util::L4_FP_ALL_SPACES, L4_INVALID_CAP, and l4_task_unmap().
Here is the call graph for this function:



15.319.3.5 setup()

```
template<typename COUNTERTYPE, typename Dbg>
void L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::setup (
             void * m,
             long capacity,
             long bias,
             Dbg * dbg)  [inline], [protected], [noexcept]
```

Set up the backing memory for the allocator and the area of managed capability slots.

Parameters

m	Pointer to backing memory.
capacity	Number of capabilities that can be stored.
bias	First capability id to use by this allocator.
dbg	Logger for warnings if counter got saturated.

The allocator will manage the capability slots between `bias` and `bias` + `capacity` - 1 (inclusive). It is the responsibility of the user to ensure that these slots are not used otherwise.
Definition at line 242 of file counting_cap_alloc.

15.319.3.6 take()

```
template<typename COUNTERTYPE, typename Dbg>
void L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::take (
             L4::Cap< void > cap)  [inline], [noexcept]
```

Increase the reference counter for the capability.

Parameters

cap	Capability, whose reference counter should be increased.

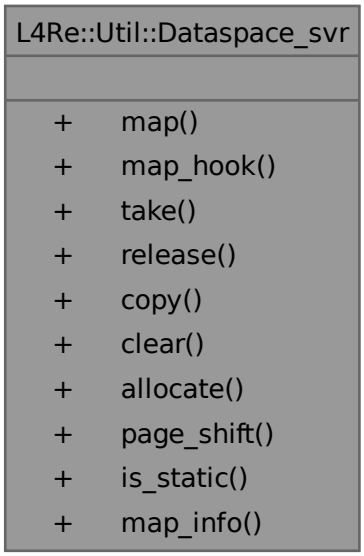
If the capability was still free, it will be automatically allocated. Silently does nothing if the capability is not managed by this allocator.
Definition at line 296 of file counting_cap_alloc.

References L4_CAP_SHIFT, and L4_UNLIKELY.
The documentation for this class was generated from the following file:

- l4/re/util/counting_cap_alloc

15.320 L4Re::Util::Dataspace_svr Class Reference

Dataspace server class.
`#include <dataspace_svr>`
Collaboration diagram for L4Re::Util::Dataspace_svr:



Public Member Functions

- l4_ret_t map (Dataspace::Offset offset, Dataspace::Map_addr local_addr, Dataspace::Flags flags, Dataspace::Map_addr min_addr, Dataspace::Map_addr max_addr, L4::Ipc::Snd_fpage &memory)

  Map a region of the dataspace.
- virtual l4_ret_t map_hook (Dataspace::Offset offs, unsigned order, Dataspace::Flags flags, Dataspace::↩ Map_addr *base, unsigned *send_order)

  A hook that is called for acquiring the data to be mapped.
- virtual void take () noexcept

  Take a reference to this dataspace.
- virtual unsigned long release () noexcept

  Release a reference to this dataspace.
- virtual l4_ret_t copy (l4_addr_t dst_offs, l4_umword_t src_id, l4_addr_t src_offs, unsigned long size) noexcept

  Copy from src dataspace to this destination dataspace.
- virtual l4_ret_t clear (unsigned long offs, unsigned long size) const noexcept

  Clear a region in the dataspace.
- virtual l4_ret_t allocate (l4_addr_t offset, l4_size_t size, unsigned access) noexcept

  Allocate a region within a dataspace.
- virtual unsigned long page_shift () const noexcept

Define the size of the flexpage to map.

- virtual bool is_static () const noexcept

  Return whether the dataspace is static.

- virtual l4_ret_t map_info (l4_addr_t &start_addr, l4_addr_t &end_addr) noexcept

  Return mapping information for no-MMU systems.

15.320.1 Detailed Description

Dataspace server class.
The default implementation of the interface provides a continuous dataspace with contiguous pages.
Definition at line 29 of file dataspace_svr.

15.320.2 Member Function Documentation

15.320.2.1 allocate()

```
virtual l4_ret_t L4Re::Util::Dataspace_svr::allocate (
             l4_addr_t offset,
             l4_size_t size,
             unsigned access)  [inline], [virtual], [noexcept]
```

Allocate a region within a dataspace.

Parameters

offset	Offset in the dataspace, in bytes.
size	Size of the range, in bytes.
access	Access mode with which the memory backing the dataspace region should be allocated.

Return values

0	Success
<0	Error

Definition at line 213 of file dataspace_svr.
References L4_ENODEV.

15.320.2.2 clear()

```
virtual l4_ret_t L4Re::Util::Dataspace_svr::clear (
             unsigned long offs,
             unsigned long size) const  [inline], [virtual], [noexcept]
```

Clear a region in the dataspace.

Parameters

offs	Start of the region
size	Size of the region

Return values

0	Success

<0	Error

Definition at line 192 of file dataspace_svr.
References L4_ERANGE.

15.320.2.3 copy()

```
virtual l4_ret_t L4Re::Util::Dataspace_svr::copy (
            l4_addr_t dst_offs,
            l4_umword_t src_id,
            l4_addr_t src_offs,
            unsigned long size)  [inline], [virtual], [noexcept]
```

Copy from src dataspace to this destination dataspace.

Parameters

dst_offs	Offset into the destination dataspace
src_id	Local id of the source dataspace
src_offs	Offset into the source dataspace
size	Number of bytes to copy

Return values

>=0	Number of bytes copied
<0	An error occurred. The error code may depend on the implementation.

Definition at line 175 of file dataspace_svr.
References L4_ENODEV.

15.320.2.4 is_static()

```
virtual bool L4Re::Util::Dataspace_svr::is_static () const  [inline], [virtual], [noexcept]
```

Return whether the dataspace is static.

Returns

True if dataspace is static

Definition at line 233 of file dataspace_svr.

15.320.2.5 map()

```
l4_ret_t L4Re::Util::Dataspace_svr::map (
            Dataspace::Offset offset,
            Dataspace::Map_addr local_addr,
            Dataspace::Flags flags,
            Dataspace::Map_addr min_addr,
            Dataspace::Map_addr max_addr,
            L4::Ipc::Snd_fpage & memory)  [inline]
```

Map a region of the dataspace.

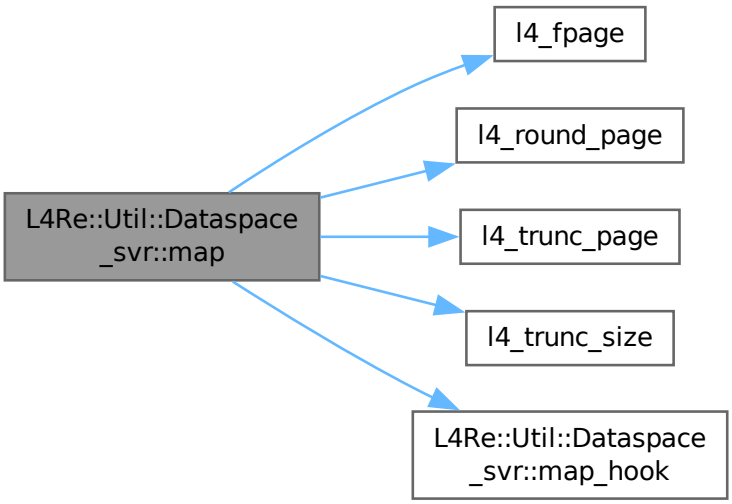
Parameters

	offset	Offset to start within data space
	local_addr	Local address to map to.
	flags	Dataspace flags, see L4Re::Dataspace::F::Flags.
	min_addr	Defines start of receive window.
	max_addr	Defines end of receive window.
out	*memory*	Send fpage to map

Return values

0	Success
<0	Error

Definition at line 57 of file dataspace_svr.
References L4_EOK, L4_ERANGE, l4_fpage(), L4_PAGESHIFT, l4_round_page(), l4_trunc_page(), l4_trunc_size(), and map_hook().
Here is the call graph for this function:



15.320.2.6 map_hook()

```
virtual l4_ret_t L4Re::Util::Dataspace_svr::map_hook (
            Dataspace::Offset offs,
            unsigned order,
            Dataspace::Flags flags,
            Dataspace::Map_addr * base,
            unsigned * send_order)  [inline], [virtual]
```

A hook that is called for acquiring the data to be mapped.

Parameters

offs	Offset in dataspace to supply
order	Log2-size of data to supply
flags	Flags for the mapping
base	Start address of the flexpage to be mapped
send_order	Order (log2 of size) of the flexpage to be mapped

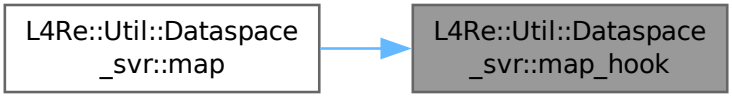
Return values

<0	Error and the map request will be aborted with that error.
>=0	Success

See also

map

Definition at line 136 of file dataspace_svr.
Referenced by map().
Here is the caller graph for this function:



15.320.2.7 map_info()

```
virtual l4_ret_t L4Re::Util::Dataspace_svr::map_info (
             l4_addr_t & start_addr,
             l4_addr_t & end_addr)  [inline], [virtual], [noexcept]
```

Return mapping information for no-MMU systems.
The method is only called on no-MMU systems. It should return the address of the underlying backing buffer so that the caller might map the dataspace.
The default implementation always returns an error because the derived class must provide the required information.

See also

L4Re::Dataspace::map_info()

Definition at line 248 of file dataspace_svr.
References L4_EPERM.

15.320.2.8 page_shift()

```
virtual unsigned long L4Re::Util::Dataspace_svr::page_shift () const  [inline], [virtual],
[noexcept]
```

Define the size of the flexpage to map.

Returns

flexpage size

Definition at line 225 of file dataspace_svr.
References L4_LOG2_PAGESIZE.

15.320.2.9 release()

`virtual unsigned long L4Re::Util::Dataspace_svr::release () [inline], [virtual], [noexcept]`
Release a reference to this dataspace.

Returns

Number of references to the dataspace

Default does nothing and returns always zero.
Definition at line 160 of file dataspace_svr.

15.320.2.10 take()

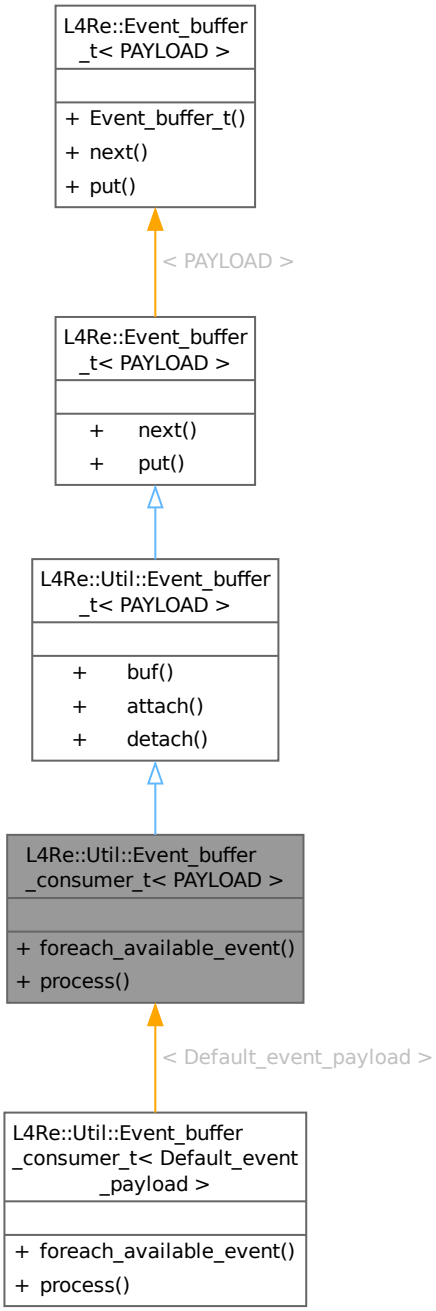
`virtual void L4Re::Util::Dataspace_svr::take () [inline], [virtual], [noexcept]`
Take a reference to this dataspace.
Default does nothing.
Definition at line 150 of file dataspace_svr.
The documentation for this class was generated from the following file:

- l4/re/util/dataspace_svr

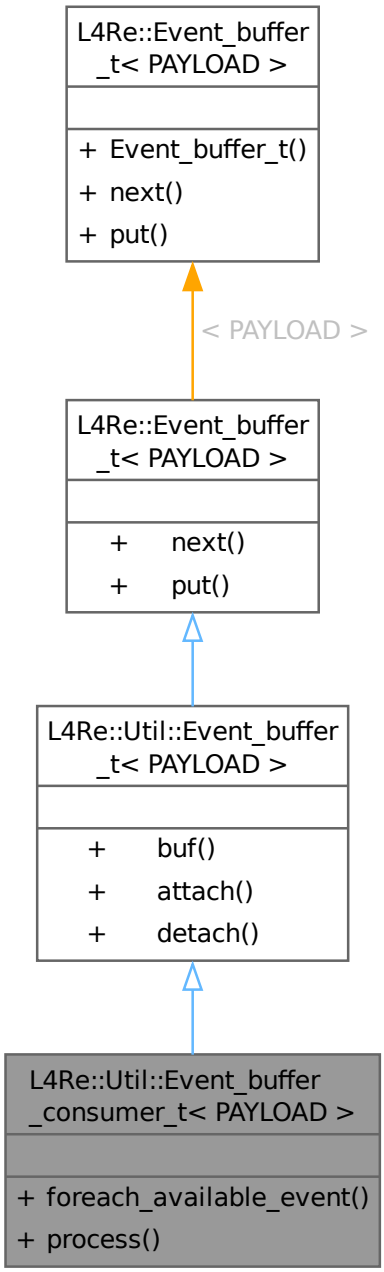
15.321 L4Re::Util::Event_buffer_consumer_t< PAYLOAD > Class Template Reference

An event buffer consumer.
`#include <event_buffer>`

Inheritance diagram for L4Re::Util::Event_buffer_consumer_t< PAYLOAD >:



Collaboration diagram for L4Re::Util::Event_buffer_consumer_t< PAYLOAD >:



Public Member Functions

- template<typename CB, typename D>
  void foreach_available_event (CB const &cb, D data=D())

  Call function on every available event.
- template<typename CB, typename D>
  void process (L4::Cap< L4::Irq > irq, L4::Cap< L4::Thread > thread, CB const &cb, D data=D())

  Continuously wait for events and process them.

Public Member Functions inherited from L4Re::Util::Event_buffer_t< PAYLOAD >

- void * buf () const noexcept

  Return the buffer.
- long attach (L4::Cap< L4Re::Dataspace > ds, L4::Cap< L4Re::Rm > rm) noexcept

  Attach event buffer from address space.
- long detach (L4::Cap< L4Re::Rm > rm) noexcept

  Detach event buffer from address space.

Public Member Functions inherited from L4Re::Event_buffer_t< PAYLOAD >

- Event * next () noexcept

  Next event in buffer.
- bool put (Event const &ev) noexcept

  Put event into buffer at current position.

15.321.1 Detailed Description

template<typename PAYLOAD>
class L4Re::Util::Event_buffer_consumer_t< PAYLOAD >

An event buffer consumer.
Definition at line 82 of file event_buffer.

15.321.2 Member Function Documentation

15.321.2.1 foreach_available_event()

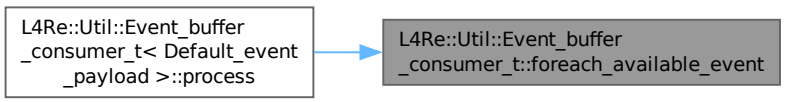
```
template<typename PAYLOAD>
template<typename CB, typename D>
void L4Re::Util::Event_buffer_consumer_t< PAYLOAD >::foreach_available_event (
            CB const & cb,
            D data = D())  [inline]
```

Call function on every available event.

Parameters

cb	Function callback.
data	Data to pass as an argument to the callback.

Definition at line 93 of file event_buffer.
Referenced by L4Re::Util::Event_buffer_consumer_t< Default_event_payload >::process().
Here is the caller graph for this function:



15.321.2.2 process()

```
template<typename PAYLOAD>
template<typename CB, typename D>
void L4Re::Util::Event_buffer_consumer_t< PAYLOAD >::process (
             L4::Cap< L4::Irq > irq,
             L4::Cap< L4::Thread > thread,
             CB const & cb,
             D data = D())  [inline]
```

Continuously wait for events and process them.

Parameters

irq	Event signal to wait for.
thread	Thread capability of the thread calling this function.
cb	Callback function that is called for each received event.
data	Data to pass as an argument to the processing callback.

Note

This function never returns.

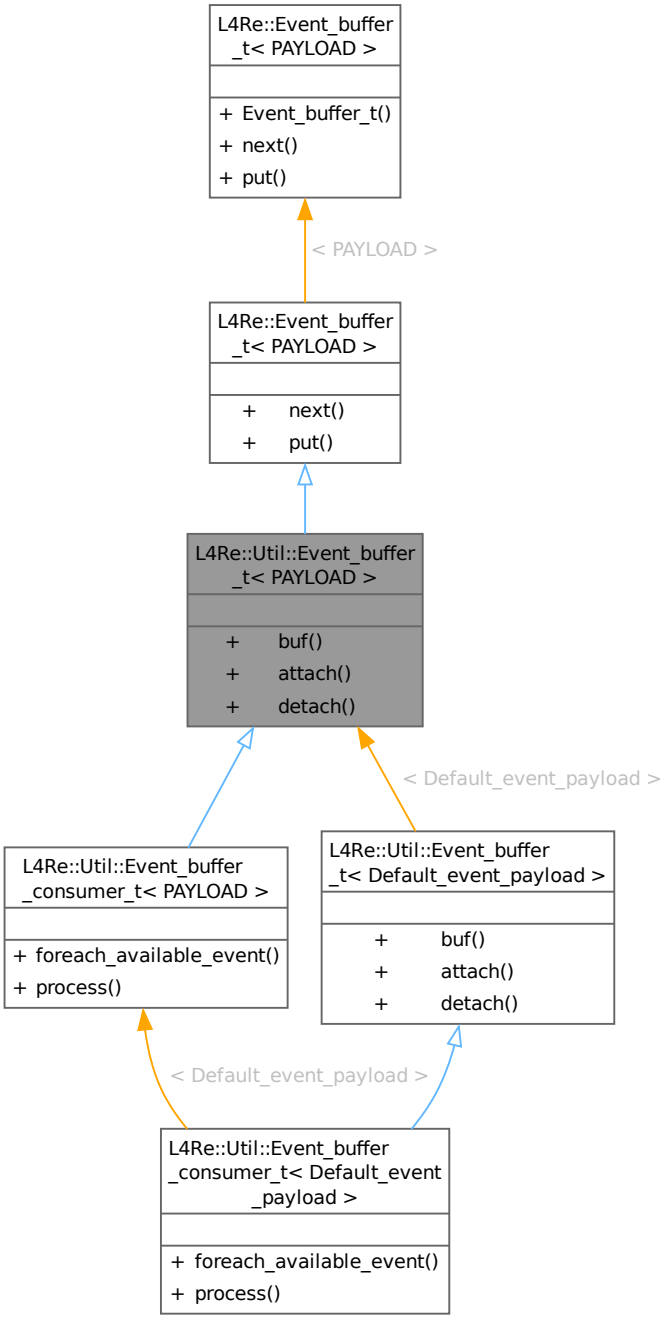
Definition at line 114 of file event_buffer.
The documentation for this class was generated from the following file:

- l4/re/util/event_buffer

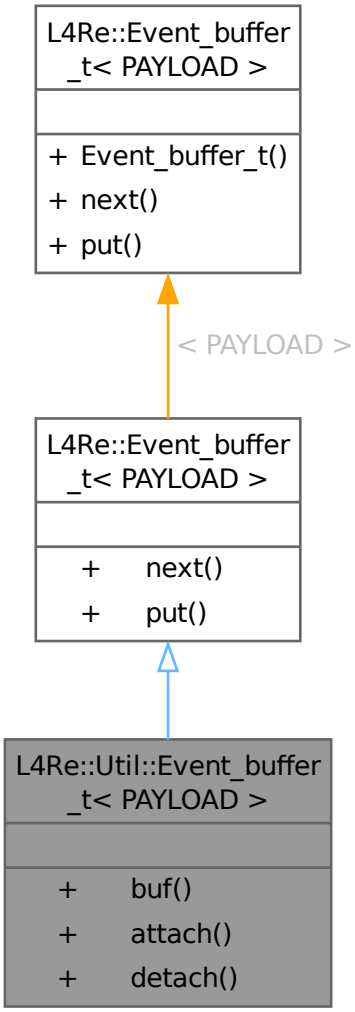
15.322 L4Re::Util::Event_buffer_t< PAYLOAD > Class Template Reference

Event_buffer utility class.
`#include <event_buffer>`

Inheritance diagram for L4Re::Util::Event_buffer_t< PAYLOAD >:



Collaboration diagram for L4Re::Util::Event_buffer_t< PAYLOAD >:



Public Member Functions

- void * buf () const noexcept

  Return the buffer.
- long attach (L4::Cap< L4Re::Dataspace > ds, L4::Cap< L4Re::Rm > rm) noexcept

  Attach event buffer from address space.
- long detach (L4::Cap< L4Re::Rm > rm) noexcept

  Detach event buffer from address space.

Public Member Functions inherited from L4Re::Event_buffer_t< PAYLOAD >

- Event * next () noexcept

  Next event in buffer.
- bool put (Event const &ev) noexcept

  Put event into buffer at current position.

15.322.1 Detailed Description

template<typename PAYLOAD>
class L4Re::Util::Event_buffer_t< PAYLOAD >

Event_buffer utility class.
Definition at line 24 of file event_buffer.

15.322.2 Member Function Documentation

15.322.2.1 attach()

```
template<typename PAYLOAD>
long L4Re::Util::Event_buffer_t< PAYLOAD >::attach (
             L4::Cap< L4Re::Dataspace > ds,
             L4::Cap< L4Re::Rm > rm)  [inline], [noexcept]
```

Attach event buffer from address space.

Parameters

ds	Dataspace of the event buffer.
rm	Region manager to attach buffer to.

Returns

0 on success, negative error code otherwise.

Definition at line 44 of file event_buffer.

15.322.2.2 buf()

```
template<typename PAYLOAD>
void * L4Re::Util::Event_buffer_t< PAYLOAD >::buf () const  [inline], [noexcept]
```

Return the buffer.

Returns

Pointer to the event buffer.

Definition at line 34 of file event_buffer.

15.322.2.3 detach()

```
template<typename PAYLOAD>
long L4Re::Util::Event_buffer_t< PAYLOAD >::detach (
             L4::Cap< L4Re::Rm > rm)  [inline], [noexcept]
```

Detach event buffer from address space.

Parameters

rm	Region manager to detach buffer from.

Returns

0 on success, negative error code otherwise.

Definition at line 67 of file event_buffer.
The documentation for this class was generated from the following file:

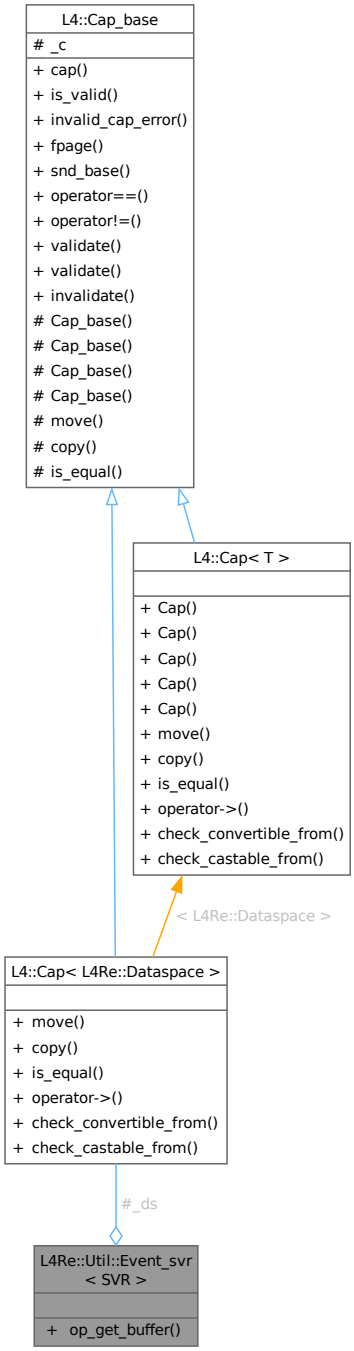
- l4/re/util/event_buffer

15.323 L4Re::Util::Event_svr< SVR > Class Template Reference

Convenience wrapper for implementing an event server.

`#include <event_svr>`

Collaboration diagram for L4Re::Util::Event_svr< SVR >:



Public Member Functions

- l4_ret_t **op_get_buffer** (L4Re::Event::Rights, L4::Ipc::Cap< L4Re::Dataspace > &ds)

  Handle L4Re::Event protocol.

15.323.1 Detailed Description

template<typename SVR>
class L4Re::Util::Event_svr< SVR >

Convenience wrapper for implementing an event server.

See also

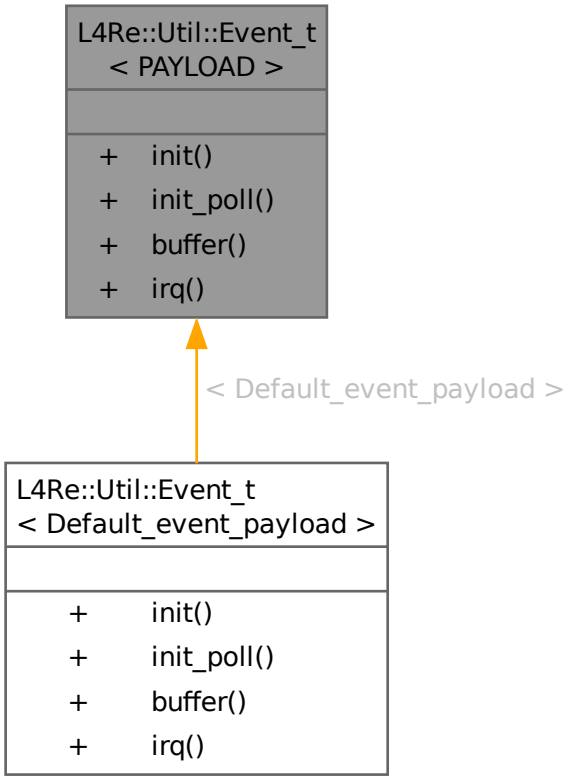
L4Re::Event, L4Re::Util::Event_t

Definition at line 27 of file event_svr.
The documentation for this class was generated from the following file:

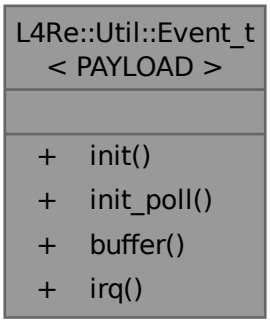
- l4/re/util/event_svr

15.324 L4Re::Util::Event_t< PAYLOAD > Class Template Reference

Convenience wrapper for getting access to an event object.
`#include <event>`
Inheritance diagram for L4Re::Util::Event_t< PAYLOAD >:



Collaboration diagram for L4Re::Util::Event_t< PAYLOAD >:



Public Types

- enum Mode { Mode_irq , Mode_polling }

  Modes of operation.

Public Member Functions

- template<typename IRQ_TYPE>
  int init (L4::Cap< L4Re::Event > event, L4Re::Env const *env=L4Re::Env::env(), L4Re::Cap_alloc *ca=&L4Re::Util::cap_alloc)

  Initialise an event object.
- int init_poll (L4::Cap< L4Re::Event > event, L4Re::Env const *env=L4Re::Env::env(), L4Re::Cap_alloc *ca=&L4Re::Util::cap_alloc)

  Initialise an event object in polling mode.
- L4Re::Event_buffer_t< PAYLOAD > & buffer ()

  Get event buffer.
- L4::Cap< L4::Triggerable > irq () const

  Get event IRQ.

15.324.1 Detailed Description

template<typename PAYLOAD>
class L4Re::Util::Event_t< PAYLOAD >

Convenience wrapper for getting access to an event object.
After calling init() the class supplies the event-buffer and the associated IRQ object.
Definition at line 32 of file event.

15.324.2 Member Enumeration Documentation

15.324.2.1 Mode

```
template<typename PAYLOAD>
enum L4Re::Util::Event_t::Mode
```

Modes of operation.

Enumerator

Mode_irq	Create an IRQ and attach, to get notifications.
Mode_polling	Do not use an IRQ.

Definition at line 38 of file event.

15.324.3 Member Function Documentation

15.324.3.1 buffer()

```
template<typename PAYLOAD>
L4Re::Event_buffer_t< PAYLOAD > & L4Re::Util::Event_t< PAYLOAD >::buffer ()  [inline]
```

Get event buffer.

Returns

Event buffer object.

Definition at line 148 of file event.

15.324.3.2 init()

```
template<typename PAYLOAD>
template<typename IRQ_TYPE>
int L4Re::Util::Event_t< PAYLOAD >::init (
            L4::Cap< L4Re::Event > event,
            L4Re::Env const * env = L4Re::Env::env(),
            L4Re::Cap_alloc * ca = &L4Re::Util::cap_alloc)  [inline]
```

Initialise an event object.

Template Parameters

IRQ_TYPE	Type used for handling notifications from the event provider. This must be derived from L4::Triggerable.

Parameters

event	Capability to event.
env	Pointer to L4Re-Environment
ca	Pointer to capability allocator.

Return values

0	Success
-L4_ENOMEM	No memory to allocate required capabilities.
<0	Other IPC errors.

Definition at line 59 of file event.

15.324.3.3 init_poll()

```
template<typename PAYLOAD>
int L4Re::Util::Event_t< PAYLOAD >::init_poll (
```

```
L4::Cap< L4Re::Event > event,
L4Re::Env const * env = L4Re::Env::env(),
L4Re::Cap_alloc * ca = &L4Re::Util::cap_alloc)  [inline]
```

Initialise an event object in polling mode.

Parameters

event	Capability to event.
env	Pointer to L4Re-Environment
ca	Pointer to capability allocator.

Return values

0	Success
-L4_ENOMEM	No memory to allocate required capabilities.
<0	Other IPC errors.

Definition at line 112 of file event.

15.324.3.4 irq()

```
template<typename PAYLOAD>
L4::Cap< L4::Triggerable > L4Re::Util::Event_t< PAYLOAD >::irq () const  [inline]
```

Get event IRQ.

Returns

Event IRQ.

Definition at line 155 of file event.

The documentation for this class was generated from the following file:

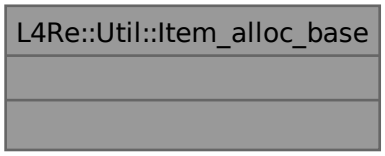
- l4/re/util/event

15.325 L4Re::Util::Item_alloc_base Class Reference

Item allocator.

`#include <item_alloc>`

Collaboration diagram for L4Re::Util::Item_alloc_base:



15.325.1 Detailed Description

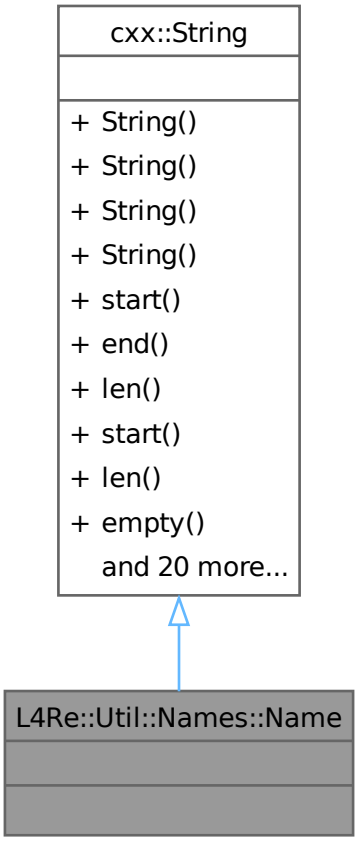
Item allocator.

Definition at line 27 of file item_alloc.
The documentation for this class was generated from the following file:

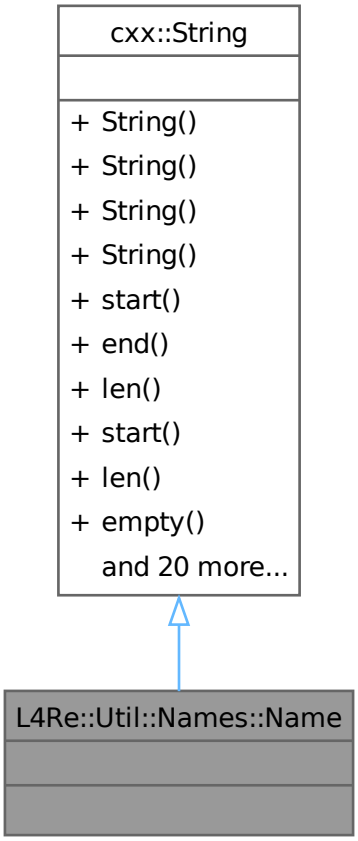
- l4/re/util/item_alloc

15.326 L4Re::Util::Names::Name Class Reference

Name class.
`#include <name_space_svr>`
Inheritance diagram for L4Re::Util::Names::Name:



Collaboration diagram for L4Re::Util::Names::Name:



Additional Inherited Members

Public Types inherited from cxx::String

- typedef char const ∗ **Index**

  Character index type.

Public Member Functions inherited from cxx::String

- **String** (char const ∗s) noexcept

  Initialize from a zero-terminated string.
- **String** (char const ∗s, unsigned long len) noexcept

  Initialize from a pointer to first character and a length.
- String (char const ∗s, char const ∗e) noexcept

  Initialize with start and end pointer.
- **String** ()

  Zero-initialize. Create an invalid string.
- Index **start** () const

  Pointer to first character.
- Index **end** () const

Pointer to first byte behind the string.

- int **len** () const

  Length.
- void **start** (char const *s)

  Set start.
- void **len** (unsigned long len)

  Set length.
- bool **empty** () const

  Check if the string has length zero.
- String **head** (Index end) const

  Return prefix up to index.
- String **head** (unsigned long end) const

  Prefix of length `end`.
- String **substr** (unsigned long idx, unsigned long len=~0UL) const

  Substring of length `len` starting at `idx`.
- String **substr** (char const *start, unsigned long len=0) const

  Substring of length `len` starting at `start`.
- template<typename F>
  char const * **find_match** (F &&match) const

  Find matching character. `match` should be a function such as `isspace`.
- char const * **find** (char const *c) const

  Find character. Return end() if not found.
- char const * **find** (int c) const

  Find character. Return end() if not found.
- char const * **rfind** (char const *c) const

  Find right-most character. Return end() if not found.
- Index starts_with (cxx::String const &c) const

  Check if `c` is a prefix of string.
- char const * **find** (int c, char const *s) const

  Find character `c` starting at position `s`. Return end() if not found.
- char const * find (char const *c, char const *s) const

  Find character set at position.
- char const & **operator[ ]** (unsigned long idx) const

  Get character at `idx`.
- char const & **operator[ ]** (int idx) const

  Get character at `idx`.
- char const & **operator[ ]** (Index idx) const

  Get character at `idx`.
- bool **eof** (char const *s) const

  Check if pointer `s` points behind string.
- template<typename INT>
  int from_dec (INT *v) const

  Convert decimal string to integer.
- template<typename INT>
  int from_hex (INT *v) const

  Convert hex string to integer.
- template<typename INT>
  int from_number (INT *v, unsigned base=0) const

  Convert a number string to an integer.
- bool **operator==** (String const &o) const

  Equality.
- bool **operator!=** (String const &o) const

  Inequality.

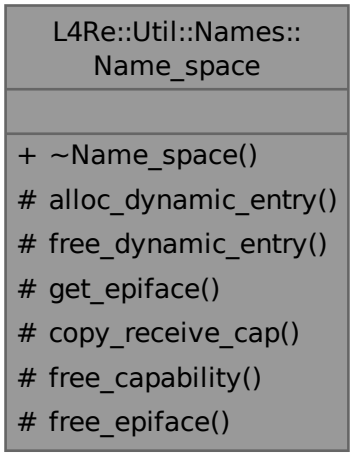
15.326.1 Detailed Description

Name class.
Definition at line 28 of file name_space_svr.
The documentation for this class was generated from the following file:

- l4/re/util/name_space_svr

15.327 L4Re::Util::Names::Name_space Class Reference

Abstract server-side implementation of the L4::Namespace interface.
`#include <name_space_svr>`
Collaboration diagram for L4Re::Util::Names::Name_space:



Public Member Functions

- virtual ~**Name_space** ()

  The destructor of the derived class is responsible for freeing resources.

Protected Member Functions

- virtual Entry * alloc_dynamic_entry (Name const &n, unsigned flags)=0

  Allocate a new entry for the given name.
- virtual void free_dynamic_entry (Entry *e)=0

  Free an entry previously allocated with alloc_dynamic_entry().
- virtual l4_ret_t get_epiface (l4_umword_t data, bool is_local, L4::Epiface **lo)=0

  Return a pointer to the epiface assigned to a given label.
- virtual l4_ret_t copy_receive_cap (L4::Cap< void > *cap)=0

  Return the receive capability for permanent use.
- virtual void free_capability (L4::Cap< void > cap)=0

  Free a capability previously acquired with copy_receive_cap().
- virtual void free_epiface (L4::Epiface *epiface)=0

  Free epiface previously acquired with get_epiface().

15.327.1 Detailed Description

Abstract server-side implementation of the L4::Namespace interface.

Note

The derived class is responsible for resource management through the provided interfaces. This includes freeing all resources on destruction!

Definition at line 180 of file name_space_svr.

15.327.2 Member Function Documentation

15.327.2.1 alloc_dynamic_entry()

```
virtual Entry * L4Re::Util::Names::Name_space::alloc_dynamic_entry (
            Name const & n,
            unsigned flags)  [protected], [pure virtual]
```

Allocate a new entry for the given name.

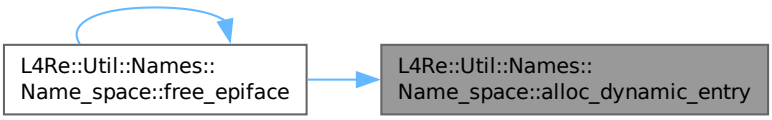
Parameters

n	Name of the entry, must be copied.
flags	Entry flags, see Obj::Flags.

Returns

A pointer to the newly allocated entry or NULL on error.

This method is called when a new entry was received. It must allocate memory, copy `n` out of the receive buffer and wrap everything in an Entry.
Referenced by free_epiface().
Here is the caller graph for this function:



15.327.2.2 copy_receive_cap()

```
virtual l4_ret_t L4Re::Util::Names::Name_space::copy_receive_cap (
            L4::Cap< void > * cap)  [protected], [pure virtual]
```

Return the receive capability for permanent use.

Parameters

`out`	*cap*	Capability slot with the received capability. Must be permanently available until free_capability() is called.

This method is called when a new entry is registered together with a capability mapping. It must decide whether and where to store the capability and return the final capability slot. Typical implementations return the capability slot in the receive window and allocate a new receive window.

15.327.2.3 free_capability()

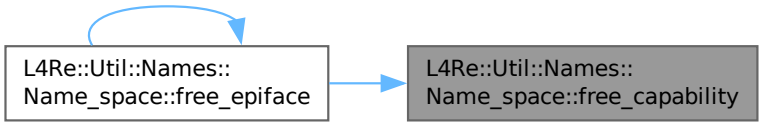
```
virtual void L4Re::Util::Names::Name_space::free_capability (
            L4::Cap< void > cap)  [protected], [pure virtual]
```

Free a capability previously acquired with copy_receive_cap().

Parameters

in	*cap*	Capability to free.

Counterpart of copy_receive_cap. Free the capability slot when the entry is deleted or changed.
Referenced by free_epiface().
Here is the caller graph for this function:



15.327.2.4 free_dynamic_entry()

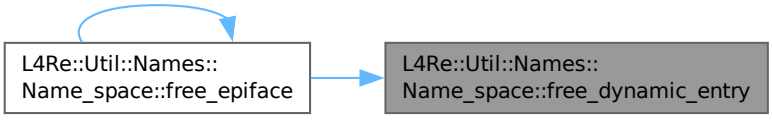
```
virtual void L4Re::Util::Names::Name_space::free_dynamic_entry (
            Entry * e)  [protected], [pure virtual]
```

Free an entry previously allocated with alloc_dynamic_entry().

Parameters

e	Entry to free.

Referenced by free_epiface().
Here is the caller graph for this function:



15.327.2.5 free_epiface()

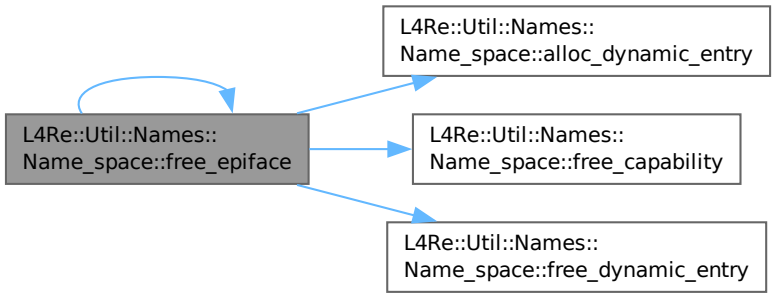
```
virtual void L4Re::Util::Names::Name_space::free_epiface (
            L4::Epiface * epiface)  [protected], [pure virtual]
```

Free epiface previously acquired with get_epiface().

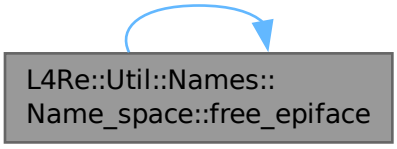
Parameters

in	*epiface*	Epiface to free.

Called when an entry that points to an epiface is deleted allowing implementations that hold resources to free them.
References alloc_dynamic_entry(), free_capability(), free_dynamic_entry(), free_epiface(), L4_BASE_TASK_CAP, L4_EEXIST, L4_ENOMEM, and L4Re::Namespace::Overwrite.
Referenced by free_epiface().
Here is the call graph for this function:



Here is the caller graph for this function:



15.327.2.6 get_epiface()

```
virtual l4_ret_t L4Re::Util::Names::Name_space::get_epiface (
            l4_umword_t data,
            bool is_local,
            L4::Epiface ** lo)  [protected], [pure virtual]
```

Return a pointer to the epiface assigned to a given label.

Parameters

in	*data*	Label or in the local case the capability slot of the receiving capability.
in	*is_local*	If true, a local capability slot was supplied, if false the label of a locally bound IPC gate.
out	*lo*	Pointer to epiface responsible for the capability.

Returns

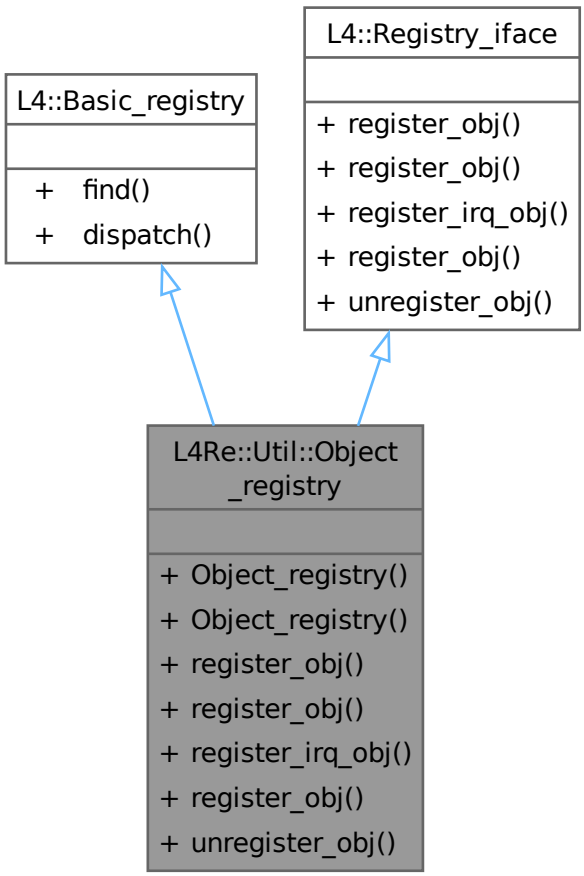
L4_EOK if a valid interface could be found or an error message otherwise.

This method is called when a new entry is registered and some local ID was received for the capability. In this case, the generic implementation needs to get the epiface in order to get the capability.
The callee must make sure that the epiface remains valid until free_epiface is called. In particular, the capability slot must not be reallocated as long as the namespace server holds a reference to the epiface.
The documentation for this class was generated from the following file:

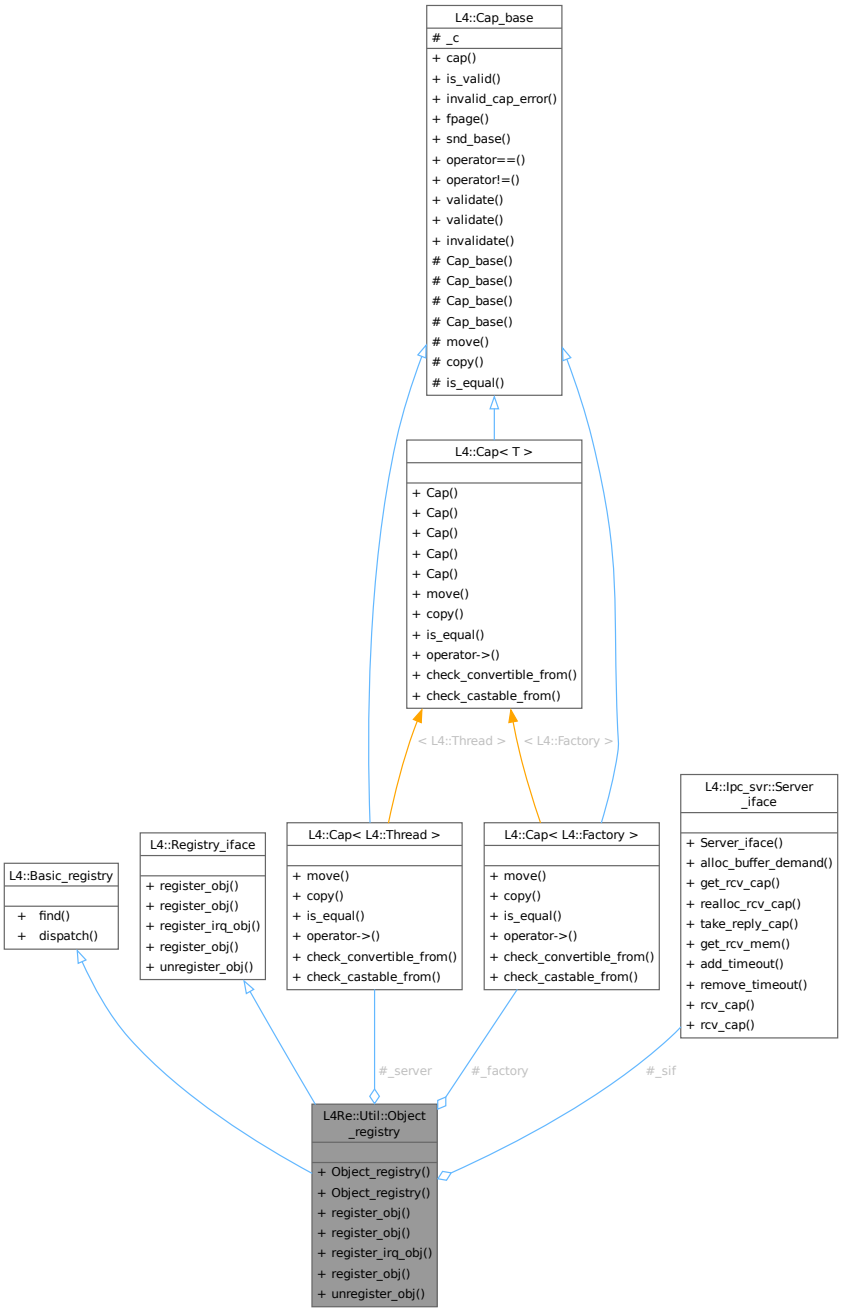
- l4/re/util/name_space_svr

15.328 L4Re::Util::Object_registry Class Reference

A registry that manages server objects and their attached IPC gates for a single server loop for a specific thread.
`#include <object_registry>`
Inheritance diagram for L4Re::Util::Object_registry:



Collaboration diagram for L4Re::Util::Object_registry:



Public Member Functions

- Object_registry (L4::Ipc_svr::Server_iface ∗sif)

  Create a registry for the main thread of the task using the default factory.
- Object_registry (L4::Ipc_svr::Server_iface ∗sif, L4::Cap< L4::Thread > server, L4::Cap< L4::Factory > factory)

  Create a registry for arbitrary threads.
- L4::Cap< void > register_obj (L4::Epiface ∗o, char const ∗service) override

  Register a new server object to a pre-allocated receive endpoint.
- L4::Cap< void > register_obj (L4::Epiface ∗o) override

Register a new server object on a newly allocated capability.

- L4::Cap< L4::Irq > register_irq_obj (L4::Epiface *o) override

  Register a handler for an interrupt.

- L4::Cap< L4::Rcv_endpoint > register_obj (L4::Epiface *o, L4::Cap< L4::Rcv_endpoint > ep) override

  Register a handler for an already existing interrupt.

- void unregister_obj (L4::Epiface *o, bool unmap=true) override

  Remove a server object from the handler list.

Additional Inherited Members

Static Public Member Functions inherited from L4::Basic_registry

- static Value * find (l4_umword_t label)

  Get the server object for an Ipc_gate label.

- static l4_msgtag_t dispatch (l4_msgtag_t tag, l4_umword_t label, l4_utcb_t *utcb)

  The dispatch function called by the server loop.

15.328.1 Detailed Description

A registry that manages server objects and their attached IPC gates for a single server loop for a specific thread.
This class manages most of the setup of a server object. If necessary, an IPC gate is created, the specified thread is bound to the IPC gate. Incoming IPC is dispatched to the server object based on the label of the IPC gate.
The object registry is also able to manage IRQ endpoints. They require a different method for the object creation. Otherwise they are handled in the same way as IPC gates: a server object is responsible to process the incoming interrupts.
Definition at line 41 of file object_registry.

15.328.2 Constructor & Destructor Documentation

15.328.2.1 Object_registry() [1/2]

```
L4Re::Util::Object_registry::Object_registry (
            L4::Ipc_svr::Server_iface * sif)  [inline], [explicit]
```

Create a registry for the main thread of the task using the default factory.

Parameters

sif	Server loop interface.

Definition at line 67 of file object_registry.

15.328.2.2 Object_registry() [2/2]

```
L4Re::Util::Object_registry::Object_registry (
            L4::Ipc_svr::Server_iface * sif,
            L4::Cap< L4::Thread > server,
            L4::Cap< L4::Factory > factory)  [inline]
```

Create a registry for arbitrary threads.

Parameters

sif	Server loop interface.
server	Capability to the thread that executes the server objects.
factory	Capability to a factory object capable of creating new IPC gates.

Definition at line 81 of file object_registry.

15.328.3 Member Function Documentation

15.328.3.1 register_irq_obj()

```
L4::Cap< L4::Irq > L4Re::Util::Object_registry::register_irq_obj (
            L4::Epiface * o)  [inline], [override], [virtual]
```

Register a handler for an interrupt.

Parameters

o	Server object that handles IRQs.

Return values

L4::Cap<L4::Irq>	Capability to a new IRQ object on success.
L4::Cap<L4::Irq>::Invalid	The allocation of the IRQ has failed.

The IRQ will be newly allocated using the registry's factory object. The caller must call unregister_obj() to free all resources.
Implements L4::Registry_iface.
Definition at line 227 of file object_registry.

15.328.3.2 register_obj() [1/3]

```
L4::Cap< void > L4Re::Util::Object_registry::register_obj (
            L4::Epiface * o)  [inline], [override], [virtual]
```

Register a new server object on a newly allocated capability.

Parameters

o	Server object that handles IPC requests.

Return values

L4::Cap<void>	A valid capability to a new IPC gate.
L4::Cap<void>::Invalid	The allocation of the IPC gate has failed.

The IPC gate will be allocated using the registry's factory. The caller must call unregister_obj() to free all resources.
Implements L4::Registry_iface.
Definition at line 211 of file object_registry.

15.328.3.3 register_obj() [2/3]

```
L4::Cap< void > L4Re::Util::Object_registry::register_obj (
            L4::Epiface * o,
            char const * service)  [inline], [override], [virtual]
```

Register a new server object to a pre-allocated receive endpoint.

Parameters

o	Server object that handles IPC requests.

service	Name of a pre-allocated receive endpoint.

Return values

L4::Cap<void>	The capability known as `service` on success.
L4::Cap<void>::Invalid	No capability with the given name found.

The interface must be freed with unregister_obj() by the caller to unbind the thread from the capability.
Implements L4::Registry_iface.
Definition at line 194 of file object_registry.

15.328.3.4 register_obj() [3/3]

```
L4::Cap< L4::Rcv_endpoint > L4Re::Util::Object_registry::register_obj (
            L4::Epiface * o,
            L4::Cap< L4::Rcv_endpoint > ep)  [inline], [override], [virtual]
```

Register a handler for an already existing interrupt.

Parameters

o	Server object that handles the IPC.
ep	Capability to a receive endpoint, may be a hardware or software interrupt or an IPC gate.

Return values

L4::Cap<L4::Rcv_endpoint>	Capability `ep` on success.
L4::Cap<L4::Rcv_endpoint>::Invalid	The IRQ attach operation has failed.

The interface must be freed with unregister_obj() by the caller to unbind the thread from the capability.
Implements L4::Registry_iface.
Definition at line 246 of file object_registry.

15.328.3.5 unregister_obj()

```
void L4Re::Util::Object_registry::unregister_obj (
            L4::Epiface * o,
            bool unmap = true)  [inline], [override], [virtual]
```

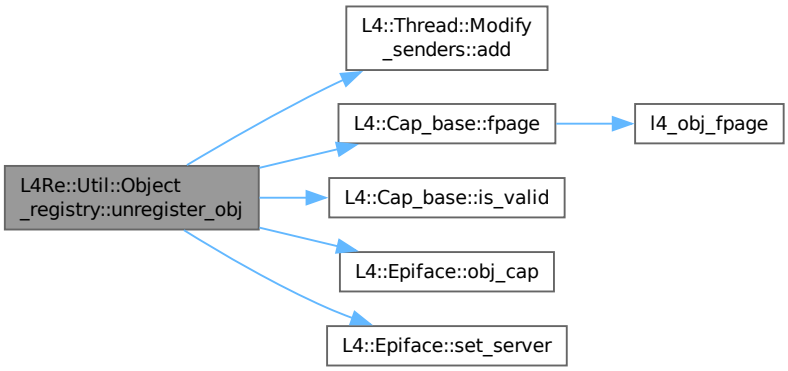
Remove a server object from the handler list.

Parameters

o	Server object to unbind.
unmap	Specifies if the object capability shall be unmapped (true) or not. The default (true) is to unmap the capability.

The capability used by the server object will be unmapped if `unmap` is true.
Implements L4::Registry_iface.
Definition at line 262 of file object_registry.
References L4::Thread::Modify_senders::add(), L4Re::Util::cap_alloc, L4::Cap_base::fpage(), L4::Cap_base::Invalid, L4::Cap_base::is_valid(), L4Re::Util::L4_FP_ALL_SPACES, L4_INVALID_CAP, L4::Epiface::obj_cap(), and L4::Epiface::set_server().

Here is the call graph for this function:

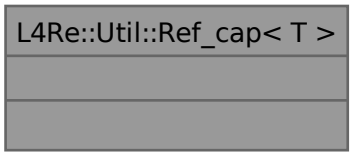


The documentation for this class was generated from the following file:

- l4/re/util/object_registry

15.329 L4Re::Util::Ref_cap< T > Struct Template Reference

Automatic capability that implements automatic free and unmap of the capability slot.
`#include <cap_alloc>`
Collaboration diagram for L4Re::Util::Ref_cap< T >:



15.329.1 Detailed Description

template<typename T>
struct L4Re::Util::Ref_cap< T >

Automatic capability that implements automatic free and unmap of the capability slot.

Template Parameters

T	Type of the object that is referred by the capability.

This kind of automatic capability implements a counted reference to a capability slot. The capability shall be unmapped and freed when the reference count in the allocator goes to zero.
Usage:

```
L4Re::Util::Ref_cap<L4Re::Dataspace>::Cap global_ds_cap;

{
  L4Re::Util::Ref_cap<L4Re::Dataspace>::Cap
    ds_cap(L4Re::Util::cap_alloc.alloc<L4Re::Dataspace>());
  // reference count for the allocated capability slot is now 1

  // use the dataspace cap
  L4Re::chksys(mem_alloc->alloc(4096, ds_cap.get()));

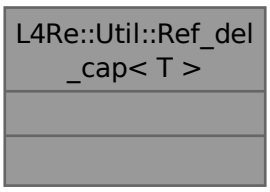
  global_ds_cap = ds_cap;
  // reference count is now 2
  ...
}
// reference count dropped to 1 (ds_cap is no longer existing).
```

Definition at line 184 of file cap_alloc.
The documentation for this struct was generated from the following file:

- l4/re/util/cap_alloc

15.330 L4Re::Util::Ref_del_cap< T > Struct Template Reference

Automatic capability that implements automatic free and unmap+delete of the capability slot.
`#include <cap_alloc>`
Collaboration diagram for L4Re::Util::Ref_del_cap< T >:



15.330.1 Detailed Description

template<typename T>
struct L4Re::Util::Ref_del_cap< T >

Automatic capability that implements automatic free and unmap+delete of the capability slot.

Template Parameters

T	Type of the object that is referred by the capability.

This kind of automatic capability implements a counted reference to a capability slot. The capability shall be unmapped and freed when the reference count in the allocator goes to zero. The main difference to Ref_cap is that the unmap is done with the deletion flag enabled and this leads to the deletion of the object if the current task holds appropriate deletion rights.
Usage:

```
L4Re::Util::Ref_del_cap<L4Re::Dataspace>::Cap global_ds_cap;

{
  L4Re::Util::Ref_del_cap<L4Re::Dataspace>::Cap
    ds_cap(L4Re::Util::cap_alloc.alloc<L4Re::Dataspace>());
  // reference count for the allocated capability slot is now 1

  // use the dataspace cap
```

```
  L4Re::chksys(mem_alloc->alloc(4096, ds_cap.get()));

  global_ds_cap = ds_cap;
  // reference count is now 2
  ...
}
// reference count dropped to 1 (ds_cap is no longer existing).
...
global_ds_cap = L4_INVALID_CAP;
// reference count dropped to 0 (data space shall be deleted).
```

Definition at line 225 of file cap_alloc.

The documentation for this struct was generated from the following file:

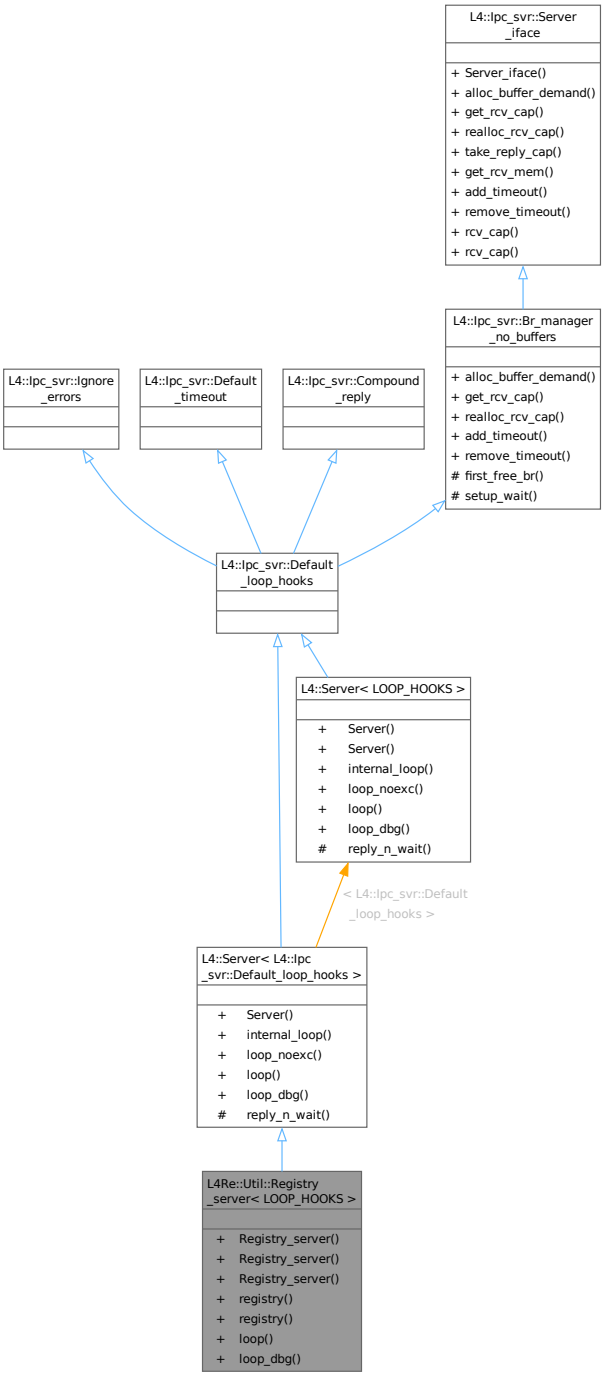
- l4/re/util/cap_alloc

15.331 L4Re::Util::Registry_server< LOOP_HOOKS > Class Template Reference

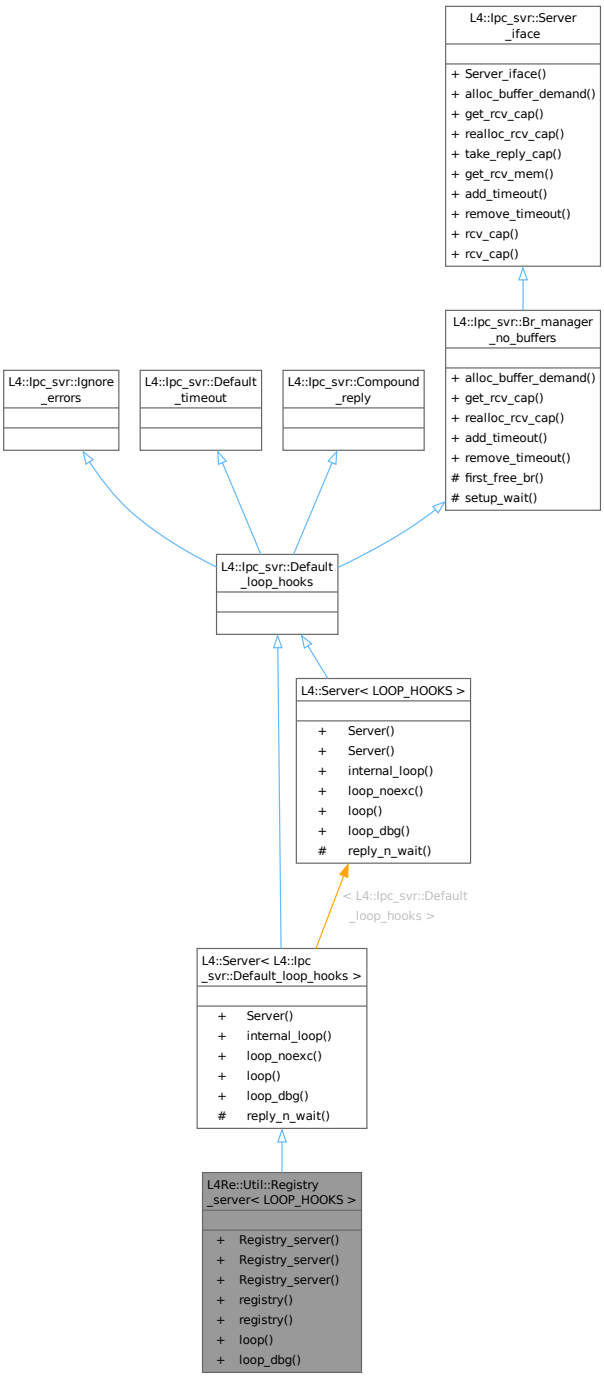
A server loop object which has a Object_registry included.

`#include <object_registry>`

Inheritance diagram for L4Re::Util::Registry_server< LOOP_HOOKS >:



Collaboration diagram for L4Re::Util::Registry_server< LOOP_HOOKS >:



Public Member Functions

- Registry_server ()

  Create a new server loop object for the main thread of the task.
- Registry_server (l4_utcb_t *, L4::Cap< L4::Thread > server, L4::Cap< L4::Factory > factory)

  Create a new server loop object for an arbitrary thread and factory.
- Registry_server (L4::Cap< L4::Thread > server, L4::Cap< L4::Factory > factory)

  Create a new server loop object for an arbitrary thread and factory.

- Object_registry const * **registry** () const

  Return registry of this server loop.
- Object_registry * **registry** ()

  Return registry of this server loop.
- void L4_NORETURN loop (l4_utcb_t *utcb=l4_utcb())

  Start the server loop.
- template<typename Printer>
  void L4_NORETURN loop_dbg (Printer printer, l4_utcb_t *utcb=l4_utcb())

  Start the server loop with error printing.

Public Member Functions inherited from L4::Server< L4::Ipc_svr::Default_loop_hooks >

- Server (l4_utcb_t *)

  Initializes the server loop.
- L4_NORETURN void internal_loop (DISPATCH dispatch, l4_utcb_t *)

  The server loop.
- L4_NORETURN void **loop_noexc** (R r, l4_utcb_t *u=l4_utcb())

  Server loop without exception handling.
- L4_NORETURN void loop (R r, l4_utcb_t *u=l4_utcb())

  Server loop with internal exception handling.
- L4_NORETURN void loop_dbg (R r, Printer p, l4_utcb_t *u=l4_utcb())

  Server loop with internal exception handling including message printing.

Public Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- int alloc_buffer_demand (Demand const &demand) override

  Tells the server to allocate buffers for the given demand.
- L4::Cap< void > **get_rcv_cap** (int) const override

  Returns L4::Cap<void>::Invalid, we have no buffer management.
- int **realloc_rcv_cap** (int) override

  Returns -L4_ENOMEM, we have no buffer management.
- int **add_timeout** (Timeout *, l4_kernel_clock_t) override

  Returns -L4_ENOSYS, we have no timeout queue.
- int **remove_timeout** (Timeout *) override

  Returns -L4_ENOSYS, we have no timeout queue.

Public Member Functions inherited from L4::Ipc_svr::Server_iface

- **Server_iface** ()

  Make a server interface.
- virtual cxx::Result< L4::Reply_cap > take_reply_cap () noexcept

  Take the currently used reply capability.
- virtual cxx::Result< Mem_window > get_rcv_mem () noexcept

  Take the current memory receive window.
- template<typename T>
  L4::Cap< T > rcv_cap (int index) const

  Get given receive buffer as typed capability.
- L4::Cap< void > rcv_cap (int index) const

  Get receive cap with the given index as generic (void) type.

Additional Inherited Members

Public Types inherited from L4::Ipc_svr::Server_iface

- using **Demand** = L4::Type_info::Demand

  Data type expressing server-side demand for receive buffers.

Protected Member Functions inherited from L4::Server< L4::Ipc_svr::Default_loop_hooks >

- l4_msgtag_t **reply_n_wait** (l4_msgtag_t reply, l4_umword_t *p, l4_utcb_t *)

  Internal implementation for reply and wait.

Protected Member Functions inherited from L4::Ipc_svr::Br_manager_no_buffers

- unsigned **first_free_br** () const

  Returns 1 as first free buffer.
- void **setup_wait** (l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)

  Setup wait function for the server loop (Server<>).

15.331.1 Detailed Description

template<typename LOOP_HOOKS = L4::Ipc_svr::Default_loop_hooks>
class L4Re::Util::Registry_server< LOOP_HOOKS >

A server loop object which has a Object_registry included.

Examples

examples/clntsrv/src/server.cc, examples/libs/l4re/c++/shared_ds/ds_srv.cc, and examples/libs/l4re/streammap/server.cc.

Definition at line 293 of file object_registry.

15.331.2 Constructor & Destructor Documentation

15.331.2.1 Registry_server() [1/3]

```
template<typename LOOP_HOOKS = L4::Ipc_svr::Default_loop_hooks>
L4Re::Util::Registry_server< LOOP_HOOKS >::Registry_server ()  [inline]
```

Create a new server loop object for the main thread of the task.

Precondition

Must be called from the main thread or behaviour is undefined.

Definition at line 305 of file object_registry.

15.331.2.2 Registry_server() [2/3]

```
template<typename LOOP_HOOKS = L4::Ipc_svr::Default_loop_hooks>
L4Re::Util::Registry_server< LOOP_HOOKS >::Registry_server (
            l4_utcb_t * ,
            L4::Cap< L4::Thread > server,
            L4::Cap< L4::Factory > factory)  [inline]
```

Create a new server loop object for an arbitrary thread and factory.

Parameters

server	Capability to thread running the server loop.
factory	Capability to factory object used to create new IPC gates.

Deprecated Note that this variant of the constructor is deprecated, please do not supply the UTCB pointer, it's not used.

Definition at line 317 of file object_registry.

15.331.2.3 Registry_server() [3/3]

```
template<typename LOOP_HOOKS = L4::Ipc_svr::Default_loop_hooks>
L4Re::Util::Registry_server< LOOP_HOOKS >::Registry_server (
            L4::Cap< L4::Thread > server,
            L4::Cap< L4::Factory > factory)  [inline]
```

Create a new server loop object for an arbitrary thread and factory.

Parameters

server	Capability to thread running the server loop.
factory	Capability to factory object used to create new IPC gates.

Definition at line 328 of file object_registry.

15.331.3 Member Function Documentation

15.331.3.1 loop()

```
template<typename LOOP_HOOKS = L4::Ipc_svr::Default_loop_hooks>
void L4_NORETURN L4Re::Util::Registry_server< LOOP_HOOKS >::loop (
            l4_utcb_t * utcb = l4_utcb())  [inline]
```

Start the server loop.

Parameters

utcb	The UTCB of the thread running the server loop, defaults to l4_utcb().

Definition at line 344 of file object_registry.
References L4_NORETURN, and loop().
Referenced by loop().
Here is the call graph for this function:



Here is the caller graph for this function:



15.331.3.2 loop_dbg()

```
template<typename LOOP_HOOKS = L4::Ipc_svr::Default_loop_hooks>
template<typename Printer>
void L4_NORETURN L4Re::Util::Registry_server< LOOP_HOOKS >::loop_dbg (
            Printer printer,
            l4_utcb_t * utcb = l4_utcb())  [inline]
```

Start the server loop with error printing.

Template Parameters

Printer	The printer type.

Parameters

printer	The printer object on which printf() is called.
utcb	The UTCB of the thread running the server loop, defaults to l4_utcb().

Definition at line 356 of file object_registry.
References L4_NORETURN, and loop_dbg().
Referenced by loop_dbg().
Here is the call graph for this function:



Here is the caller graph for this function:

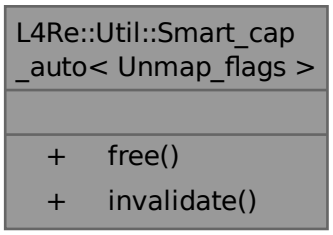


The documentation for this class was generated from the following file:

- l4/re/util/object_registry

15.332 L4Re::Util::Smart_cap_auto< Unmap_flags > Class Template Reference

Helper for Unique_cap and Unique_del_cap.
`#include <cap_alloc>`
Collaboration diagram for L4Re::Util::Smart_cap_auto< Unmap_flags >:



Static Public Member Functions

- static void **free** (L4::Cap_base &c)

  Free the provided capability.
- static void **invalidate** (L4::Cap_base &c)

  Invalidate the provided capability.

15.332.1 Detailed Description

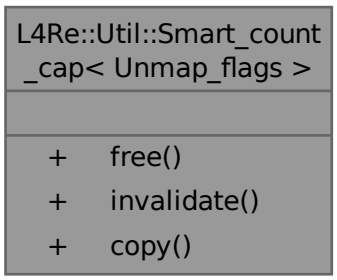
template<unsigned long Unmap_flags = L4_FP_ALL_SPACES>
class L4Re::Util::Smart_cap_auto< Unmap_flags >

Helper for Unique_cap and Unique_del_cap.
Definition at line 87 of file cap_alloc.
The documentation for this class was generated from the following file:

- l4/re/util/cap_alloc

15.333 L4Re::Util::Smart_count_cap< Unmap_flags > Class Template Reference

Helper for Ref_cap and Ref_del_cap.
`#include <cap_alloc>`
Collaboration diagram for L4Re::Util::Smart_count_cap< Unmap_flags >:



Static Public Member Functions

- static void **free** (L4::Cap_base &c) noexcept

  Free operation for L4::Smart_cap (decrement ref count and delete if 0).
- static void **invalidate** (L4::Cap_base &c) noexcept

  Invalidate operation for L4::Smart_cap.
- static L4::Cap_base **copy** (L4::Cap_base const &src)

  Copy operation for L4::Smart_cap (increment ref count).

15.333.1 Detailed Description

template<unsigned long Unmap_flags = L4_FP_ALL_SPACES>
class L4Re::Util::Smart_count_cap< Unmap_flags >

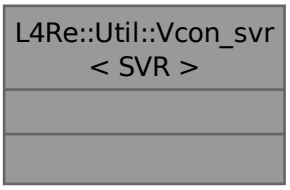
Helper for Ref_cap and Ref_del_cap.
Definition at line 118 of file cap_alloc.
The documentation for this class was generated from the following file:

- l4/re/util/cap_alloc

15.334 L4Re::Util::Vcon_svr< SVR > Class Template Reference

Console server template class.
`#include <vcon_svr>`

Collaboration diagram for L4Re::Util::Vcon_svr< SVR >:



15.334.1 Detailed Description

template<typename SVR>
class L4Re::Util::Vcon_svr< SVR >

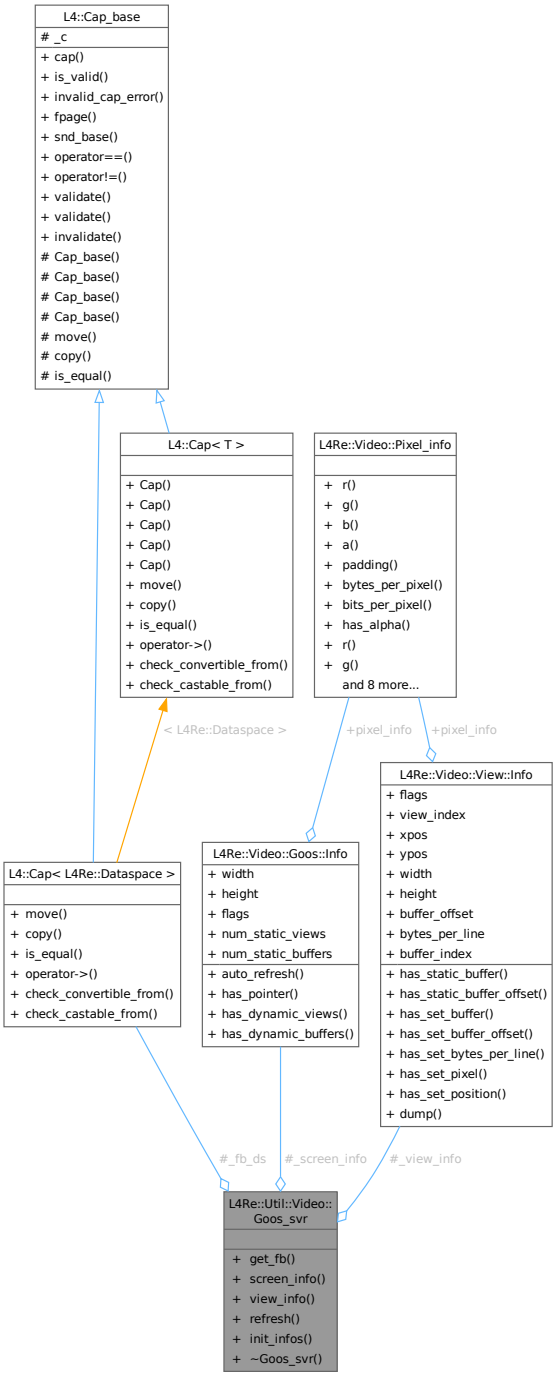
Console server template class.
This template uses vcon_write() and vcon_read() to get and deliver data from the implementor.
vcon_read() needs to update the status argument with the L4_vcon_read_stat flags, especially the L4_VCON_↩READ_STAT_DONE flag to indicate that there's nothing more to read for the other end.
vcon_write() gets the live data from the UTCB. Make sure to copy out the data before using the UTCB again.
The size parameter of both functions is given in bytes.
Definition at line 36 of file vcon_svr.
The documentation for this class was generated from the following file:

- l4/re/util/vcon_svr

15.335 L4Re::Util::Video::Goos_svr Class Reference

Goos server class.
`#include <goos_svr>`

Collaboration diagram for L4Re::Util::Video::Goos_svr:



Public Member Functions

- L4::Cap< L4Re::Dataspace > get_fb () const

  Return framebuffer memory dataspace.
- L4Re::Video::Goos::Info const * screen_info () const

  Goos information structure.
- L4Re::Video::View::Info const * view_info () const

  View information structure.

- virtual int refresh (int x, int y, int w, int h)

  Refresh area of the framebuffer.
- void init_infos ()

  Initialize the view information structure of this object.
- virtual ~**Goos_svr** ()

  Destructor.

Protected Attributes

- L4::Cap< L4Re::Dataspace > **_fb_ds**

  Goos memory dataspace.
- L4Re::Video::Goos::Info **_screen_info**

  Goos information.
- L4Re::Video::View::Info **_view_info**

  View information.

15.335.1 Detailed Description

Goos server class.
Definition at line 24 of file goos_svr.

15.335.2 Member Function Documentation

15.335.2.1 get_fb()

```
L4::Cap< L4Re::Dataspace > L4Re::Util::Video::Goos_svr::get_fb () const  [inline]
```

Return framebuffer memory dataspace.

Returns

Goos memory dataspace

Definition at line 41 of file goos_svr.
References _fb_ds.

15.335.2.2 init_infos()

```
void L4Re::Util::Video::Goos_svr::init_infos ()  [inline]
```

Initialize the view information structure of this object.
This function initializes the view info structure of this goos object based on the information in the goos information, i.e. the width, height and pixel_info of the goos information has to contain valid values before calling init_info().
Definition at line 77 of file goos_svr.
References _screen_info, and _view_info.

15.335.2.3 refresh()

```
virtual int L4Re::Util::Video::Goos_svr::refresh (
            int x,
            int y,
            int w,
            int h)  [inline], [virtual]
```

Refresh area of the framebuffer.

Parameters

x	X coordinate (pixels)
y	Y coordinate (pixels)

w	Width of area in pixels
h	Height of area in pixels

Returns

0 on success, negative error code otherwise

Definition at line 65 of file goos_svr.
References L4_ENOSYS.

15.335.2.4 screen_info()

```
L4Re::Video::Goos::Info const * L4Re::Util::Video::Goos_svr::screen_info () const  [inline]
```

Goos information structure.

Returns

Return goos information structure.

Definition at line 47 of file goos_svr.
References _screen_info.

15.335.2.5 view_info()

```
L4Re::Video::View::Info const * L4Re::Util::Video::Goos_svr::view_info () const  [inline]
```

View information structure.

Returns

Return view information structure.

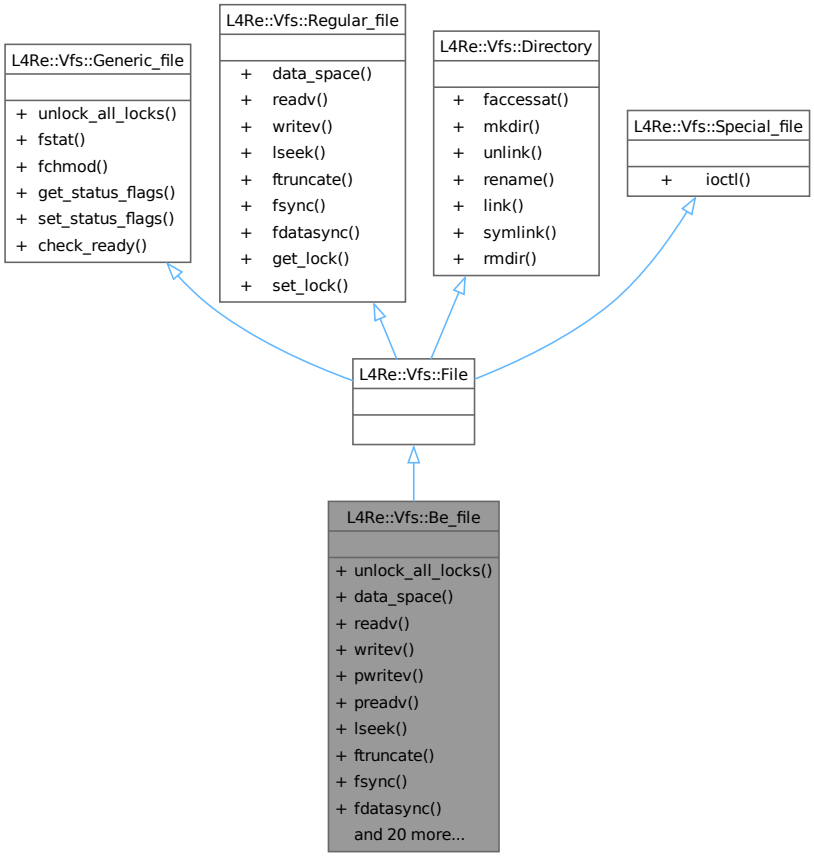
Definition at line 53 of file goos_svr.
References _view_info.
The documentation for this class was generated from the following file:

- l4/re/util/video/goos_svr

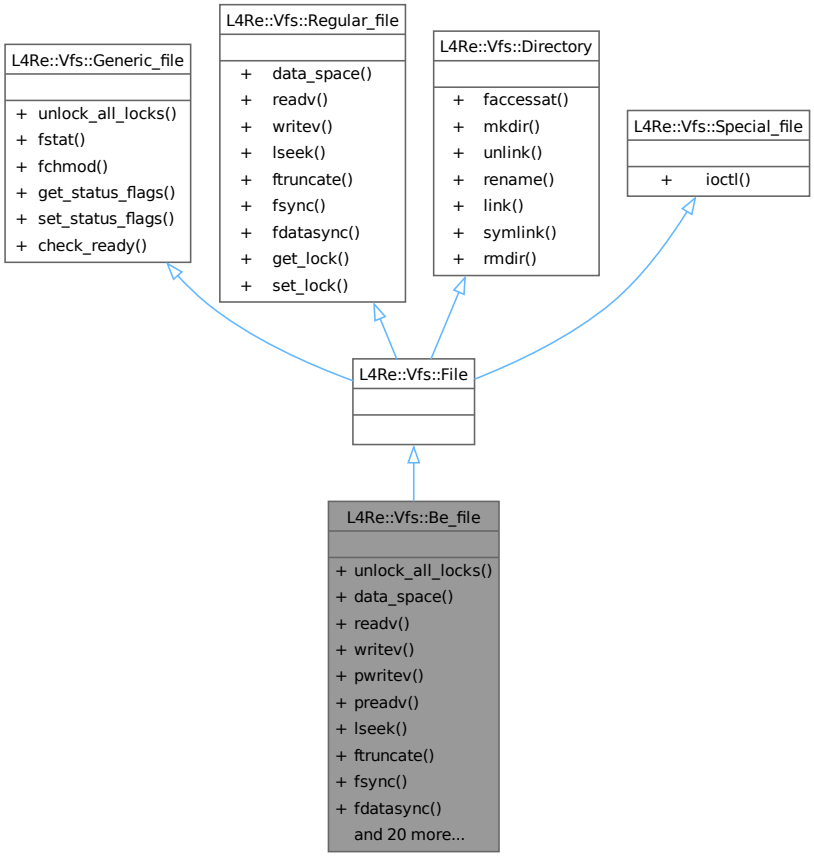
15.336 L4Re::Vfs::Be_file Class Reference

Boiler plate class for implementing an open file for L4Re::Vfs.
`#include <backend>`

Inheritance diagram for L4Re::Vfs::Be_file:



Collaboration diagram for L4Re::Vfs::Be_file:



Public Member Functions

- int unlock_all_locks () noexcept override

  Unlock all locks on the file.
- L4::Cap< L4Re::Dataspace > data_space () noexcept override

  Get an L4Re::Dataspace object for the file.
- ssize_t **readv** (const struct iovec *, int) noexcept override

  Default backend for POSIX read and readv functions.
- ssize_t **writev** (const struct iovec *, int) noexcept override

  Default backend for POSIX write and writev functions.
- ssize_t **pwritev** (const struct iovec *, int, off64_t) noexcept override

  Default backend for POSIX pwrite and pwritev functions.
- ssize_t **preadv** (const struct iovec *, int, off64_t) noexcept override

  Default backend for POSIX pread and preadv functions.
- off64_t **lseek** (off64_t, int) noexcept override

  Default backend for POSIX seek and lseek functions.
- int **ftruncate** (off64_t) noexcept override

  Default backend for the POSIX truncate, ftruncate and similar functions.
- int **fsync** () const noexcept override

  Default backend for POSIX fsync.
- int **fdatasync** () const noexcept override

Default backend for POSIX fdatasync.

- int **ioctl** (unsigned long, va_list) noexcept override

  Default backend for POSIX ioctl.

- int fstat (struct stat64 ∗) const noexcept override

  Get status information for the file.

- int **fchmod** (mode_t) noexcept override

  Default backend for POSIX chmod and fchmod.

- int **get_status_flags** () const noexcept override

  Default backend for POSIX fcntl subfunctions.

- int **set_status_flags** (long) noexcept override

  Default backend for POSIX fcntl subfunctions.

- int **get_lock** (struct flock64 ∗) noexcept override

  Default backend for POSIX fcntl subfunctions.

- int **set_lock** (struct flock64 ∗, bool) noexcept override

  Default backend for POSIX fcntl subfunctions.

- int **faccessat** (const char ∗, int, int) noexcept override

  Default backend for POSIX access and faccessat functions.

- int **fchmodat** (const char ∗, mode_t, int) noexcept override

  Default backend for POSIX fchmodat function.

- int **utime** (const struct utimbuf ∗) noexcept override

  Default backend for POSIX utime.

- int **utimes** (const struct timeval[2]) noexcept override

  Default backend for POSIX utimes.

- int **utimensat** (const char ∗, const struct timespec[2], int) noexcept override

  Default backend for POSIX utimensat.

- int **mkdir** (const char ∗, mode_t) noexcept override

  Default backend for POSIX mkdir and mkdirat.

- int **unlink** (const char ∗) noexcept override

  Default backend for POSIX unlink, unlinkat.

- int **rename** (const char ∗, const char ∗) noexcept override

  Default backend for POSIX rename, renameat.

- int **link** (const char ∗, const char ∗) noexcept override

  Default backend for POSIX link, linkat.

- int **symlink** (const char ∗, const char ∗) noexcept override

  Default backend for POSIX symlink, symlinkat.

- int **rmdir** (const char ∗) noexcept override

  Default backend for POSIX rmdir, rmdirat.

- ssize_t **readlink** (char ∗, size_t) override

  Default backend for POSIX readlink, readlinkat.

- bool check_ready (Ready_type) noexcept override

  Default implementation of a readiness check.

Additional Inherited Members

Public Types inherited from L4Re::Vfs::Generic_file

- enum Ready_type : unsigned

  Type of I/O operation/condition a file can indicate readiness.

15.336.1 Detailed Description

Boiler plate class for implementing an open file for L4Re::Vfs.
This class may be used as a base class for everything that a POSIX file descriptor may point to. This are things such as regular files, directories, special device files, streams, pipes, and so on.

Examples

tmpfs/lib/src/fs.cc.

Definition at line 30 of file backend.

15.336.2 Member Function Documentation

15.336.2.1 check_ready()

```
bool L4Re::Vfs::Be_file::check_ready (
            Ready_type )  [inline], [override], [virtual], [noexcept]
```

Default implementation of a readiness check.
By default, we assume a file is not ready for an I/O operation/condition since the proper semantics of that relies on the backend.

Returns

Always false.

Implements L4Re::Vfs::Generic_file.
Definition at line 217 of file backend.

15.336.2.2 data_space()

```
L4::Cap< L4Re::Dataspace > L4Re::Vfs::Be_file::data_space ()  [inline], [override], [virtual],
[noexcept]
```

Get an L4Re::Dataspace object for the file.
This is used as a backend for POSIX mmap and mmap2 functions.

Note

mmap is not possible if the function returns an invalid capability.

Returns

A capability to an L4Re::Dataspace that represents the file contents in an L4Re way.

Implements L4Re::Vfs::Regular_file.
Definition at line 47 of file backend.
References L4::Cap_base::Invalid.

15.336.2.3 fstat()

```
int L4Re::Vfs::Be_file::fstat (
            struct stat64 * buf) const  [inline], [override], [virtual], [noexcept]
```

Get status information for the file.
This is the backend for POSIX fstat, stat, fstat64 and friends.

Parameters

out	*buf*	This buffer is filled with the status information.

Returns

0 on success, or <0 on error.

Implements L4Re::Vfs::Generic_file.
Definition at line 86 of file backend.

15.336.2.4 unlock_all_locks()

`int L4Re::Vfs::Be_file::unlock_all_locks () [inline], [override], [virtual], [noexcept]`
Unlock all locks on the file.

Note

All locks means all locks independent of which file the locks were taken by.

This method is called by the POSIX close implementation to get the POSIX semantics of releasing all locks taken by this application on a close for any fd referencing the real file.

Returns

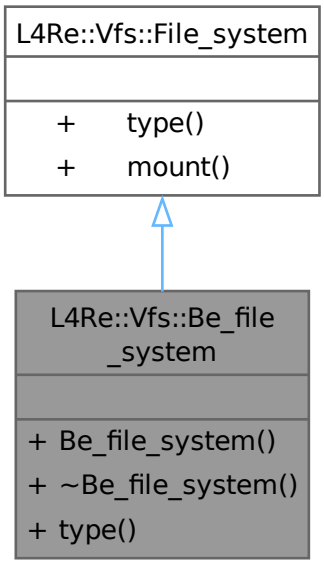
0 on success, or <0 on error.

Implements L4Re::Vfs::Generic_file.
Definition at line 43 of file backend.
The documentation for this class was generated from the following file:

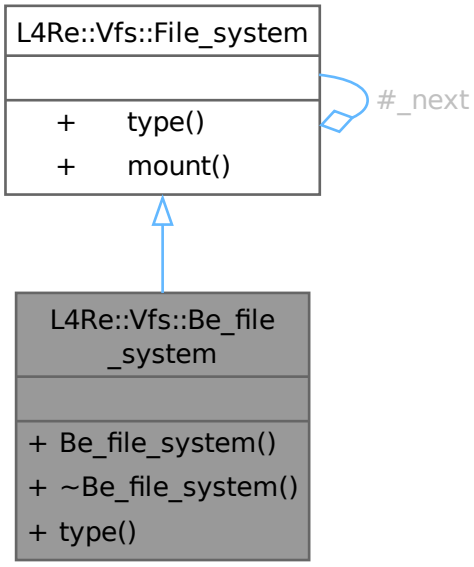
- l4/l4re_vfs/backend

15.337 L4Re::Vfs::Be_file_system Class Reference

Boilerplate class for implementing a L4Re::Vfs::File_system.
`#include <backend>`
Inheritance diagram for L4Re::Vfs::Be_file_system:



Collaboration diagram for L4Re::Vfs::Be_file_system:



Public Member Functions

- Be_file_system (char const ∗fstype) noexcept

  Create a file-system object for the given fstype.
- ∼Be_file_system () noexcept

  Destroy a file-system object.
- char const ∗ type () const noexcept override

  Return the file-system type.

Public Member Functions inherited from L4Re::Vfs::File_system

- virtual int mount (char const ∗source, unsigned long mountflags, void const ∗data, cxx::Ref_ptr< File > ∗dir) noexcept=0

  Create a directory object dir representing source mounted with this file system.

15.337.1 Detailed Description

Boilerplate class for implementing a L4Re::Vfs::File_system.
This class already takes care of registering and unregistering the file system in the global registry and implements the type() method.

Examples

tmpfs/lib/src/fs.cc.

Definition at line 310 of file backend.

15.337.2 Constructor & Destructor Documentation

15.337.2.1 Be_file_system()

```
L4Re::Vfs::Be_file_system::Be_file_system (
            char const * fstype)  [inline], [explicit], [noexcept]
```

Create a file-system object for the given *fstype*.

Parameters

fstype	The type that type() shall return.

This constructor takes care of registering the file system in the registry of L4Re::Vfs::vfs_ops.
Definition at line 324 of file backend.

15.337.2.2 ~Be_file_system()

```
L4Re::Vfs::Be_file_system::~Be_file_system ()  [inline], [noexcept]
```

Destroy a file-system object.
This destructor takes care of removing this file system from the registry of L4Re::Vfs::vfs_ops.
Definition at line 336 of file backend.

15.337.3 Member Function Documentation

15.337.3.1 type()

```
char const * L4Re::Vfs::Be_file_system::type () const  [inline], [override], [virtual], [noexcept]
```

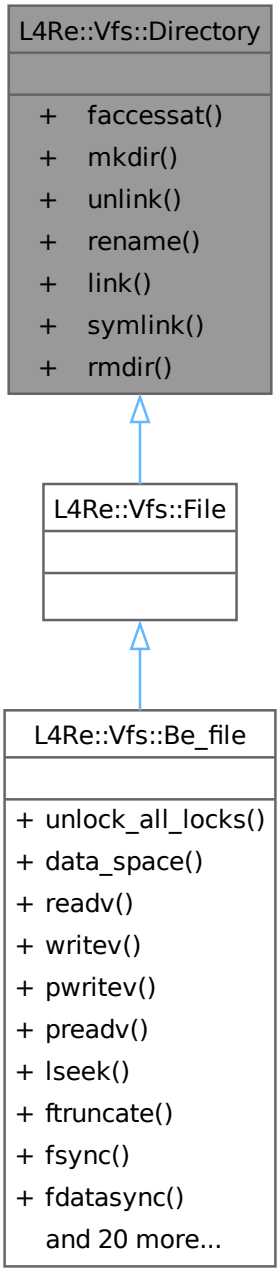
Return the file-system type.
Returns the file-system type given as *fstype* in the constructor.
Implements L4Re::Vfs::File_system.
Definition at line 346 of file backend.
The documentation for this class was generated from the following file:

- l4/l4re_vfs/backend

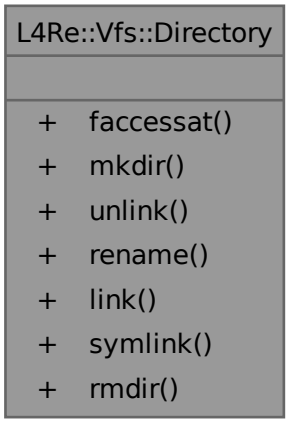
15.338 L4Re::Vfs::Directory Class Reference

Interface for a POSIX file that is a directory.
`#include <vfs.h>`

Inheritance diagram for L4Re::Vfs::Directory:



Collaboration diagram for L4Re::Vfs::Directory:



Public Member Functions

- virtual int faccessat (const char ∗path, int mode, int flags) noexcept=0

  Check access permissions on the given file.
- virtual int mkdir (const char ∗path, mode_t mode) noexcept=0

  Create a new subdirectory.
- virtual int unlink (const char ∗path) noexcept=0

  Unlink the given file from that directory.
- virtual int rename (const char ∗src_path, const char ∗dst_path) noexcept=0

  Rename the given file.
- virtual int link (const char ∗src_path, const char ∗dst_path) noexcept=0

  Create a hard link (second name) for the given file.
- virtual int symlink (const char ∗src_path, const char ∗dst_path) noexcept=0

  Create a symbolic link for the given file.
- virtual int rmdir (const char ∗path) noexcept=0

  Delete an empty directory.

15.338.1 Detailed Description

Interface for a POSIX file that is a directory.
This interface provides functionality for directory files in the L4Re::Vfs. However, real objects always use the combined L4Re::Vfs::File interface.
Definition at line 160 of file vfs.h.

15.338.2 Member Function Documentation

15.338.2.1 faccessat()

```
virtual int L4Re::Vfs::Directory::faccessat (
            const char * path,
            int mode,
            int flags)  [pure virtual], [noexcept]
```

Check access permissions on the given file.

Backend function for POSIX access and faccessat functions.

Parameters

path	The path relative to this directory. Note: *path* is relative to this directory and may contain subdirectories.
mode	The access mode to check.
flags	The flags as in POSIX faccessat (AT_EACCESS, AT_SYMLINK_NOFOLLOW).

Returns

0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.

15.338.2.2 link()

```
virtual int L4Re::Vfs::Directory::link (
            const char * src_path,
            const char * dst_path)  [pure virtual], [noexcept]
```

Create a hard link (second name) for the given file.
Backend for the POSIX link and linkat functions.

Parameters

src_path	The old name of the file. Note: *src_path* is relative to this directory and may contain subdirectories.
dst_path	The new (second) name for the file. Note: *dst_path* is relative to this directory and may contain subdirectories.

Returns

0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.

15.338.2.3 mkdir()

```
virtual int L4Re::Vfs::Directory::mkdir (
            const char * path,
            mode_t mode)  [pure virtual], [noexcept]
```

Create a new subdirectory.
Backend for POSIX mkdir and mkdirat function calls.

Parameters

path	The name of the subdirectory to create. Note: *path* is relative to this directory and may contain subdirectories.
mode	The file mode to use for the new directory.

Returns

0 on success, or <0 on error. -ENOTDIR if this or some component in path is not a directory.

Implemented in L4Re::Vfs::Be_file.

15.338.2.4 rename()

```
virtual int L4Re::Vfs::Directory::rename (
            const char * src_path,
            const char * dst_path)  [pure virtual], [noexcept]
```

Rename the given file.
Backend for the POSIX rename, renameat functions.

Parameters

src_path	The old name of the file to rename. Note: *src_path* is relative to this directory and may contain subdirectories.
dst_path	The new name for the file. Note: *dst_path* is relative to this directory and may contain subdirectories.

Returns

0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.

15.338.2.5 rmdir()

```
virtual int L4Re::Vfs::Directory::rmdir (
            const char * path)  [pure virtual], [noexcept]
```

Delete an empty directory.
Backend for POSIX rmdir, rmdirat functions.

Parameters

path	The name of the directory to remove. Note: *path* is relative to this directory and may contain subdirectories.

Returns

0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.

15.338.2.6 symlink()

```
virtual int L4Re::Vfs::Directory::symlink (
            const char * src_path,
            const char * dst_path)  [pure virtual], [noexcept]
```

Create a symbolic link for the given file.
Backend for the POSIX symlink and symlinkat functions.

Parameters

src_path	The old name of the file. Note: *src_path* shall be an absolute path.
dst_path	The name for symlink. Note: *dst_path* is relative to this directory and may contain subdirectories.

Returns

0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.

15.338.2.7 unlink()

```
virtual int L4Re::Vfs::Directory::unlink (
            const char * path)  [pure virtual], [noexcept]
```

Unlink the given file from that directory.
Backend for the POSIX unlink and unlinkat functions.

Parameters

path	The name of the file to unlink. Note: *path* is relative to this directory and may contain subdirectories.

Returns

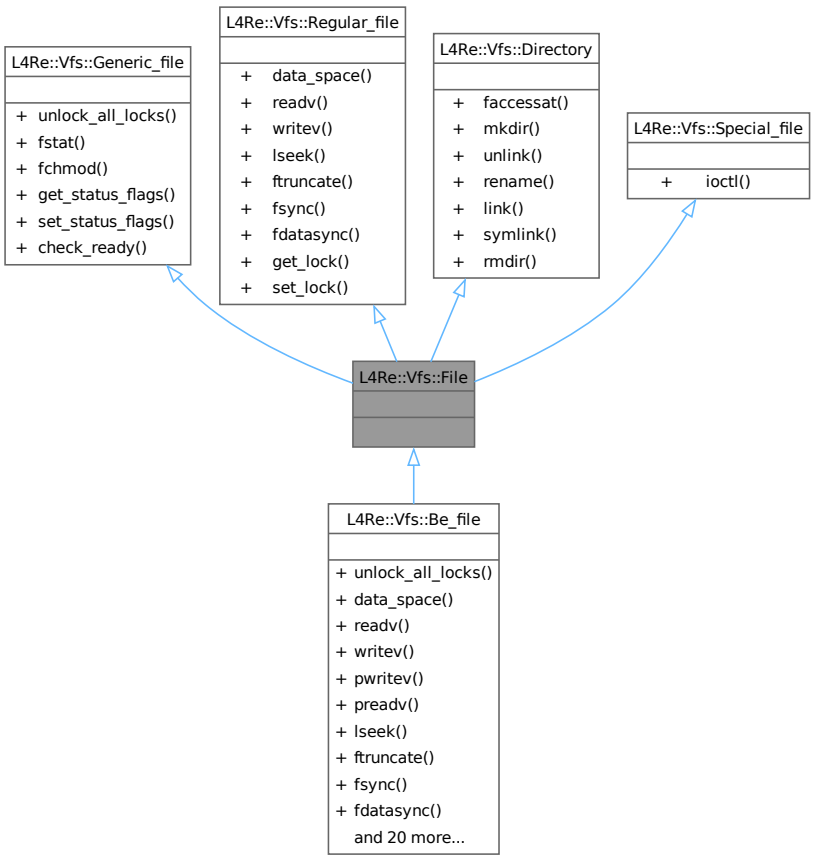
0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.
The documentation for this class was generated from the following file:

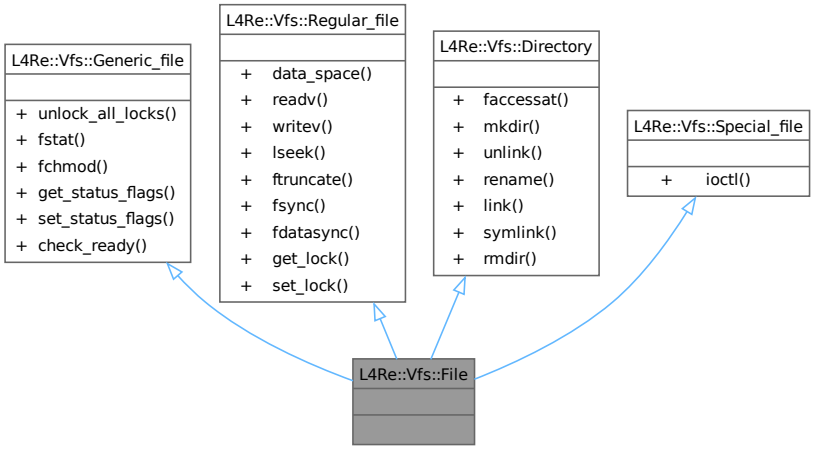
- l4/l4re_vfs/vfs.h

15.339 L4Re::Vfs::File Class Reference

The basic interface for an open POSIX file.
`#include <vfs.h>`
Inheritance diagram for L4Re::Vfs::File:



Collaboration diagram for L4Re::Vfs::File:



Additional Inherited Members

Public Types inherited from L4Re::Vfs::Generic_file

- enum Ready_type : unsigned

  Type of I/O operation/condition a file can indicate readiness.

Public Member Functions inherited from L4Re::Vfs::Generic_file

- virtual int unlock_all_locks () noexcept=0

  Unlock all locks on the file.
- virtual int fstat (struct stat64 ∗buf) const noexcept=0

  Get status information for the file.
- virtual int fchmod (mode_t) noexcept=0

  Change POSIX access rights on the file.
- virtual int get_status_flags () const noexcept=0

  Get file status flags (fcntl F_GETFL).
- virtual int set_status_flags (long flags) noexcept=0

  Set file status flags (fcntl F_SETFL).
- virtual bool check_ready (Ready_type rt) noexcept=0

  Check whether the file is ready for an I/O operation/condition.

Public Member Functions inherited from L4Re::Vfs::Regular_file

- virtual L4::Cap< L4Re::Dataspace > data_space () noexcept=0

  Get an L4Re::Dataspace object for the file.
- virtual ssize_t readv (const struct iovec ∗, int iovcnt) noexcept=0

  Read one or more blocks of data from the file.
- virtual ssize_t writev (const struct iovec ∗, int iovcnt) noexcept=0

  Write one or more blocks of data to the file.
- virtual off64_t lseek (off64_t, int) noexcept=0

  Change the file pointer.
- virtual int ftruncate (off64_t pos) noexcept=0

Truncate the file at the given position.

- virtual int fsync () const noexcept=0

  Sync the data and meta data to persistent storage.

- virtual int fdatasync () const noexcept=0

  Sync the data to persistent storage.

- virtual int get_lock (struct flock64 *lock) noexcept=0

  Test if the given lock can be placed in the file.

- virtual int set_lock (struct flock64 *lock, bool wait) noexcept=0

  Acquire or release the given lock on the file.

Public Member Functions inherited from L4Re::Vfs::Directory

- virtual int faccessat (const char *path, int mode, int flags) noexcept=0

  Check access permissions on the given file.

- virtual int mkdir (const char *path, mode_t mode) noexcept=0

  Create a new subdirectory.

- virtual int unlink (const char *path) noexcept=0

  Unlink the given file from that directory.

- virtual int rename (const char *src_path, const char *dst_path) noexcept=0

  Rename the given file.

- virtual int link (const char *src_path, const char *dst_path) noexcept=0

  Create a hard link (second name) for the given file.

- virtual int symlink (const char *src_path, const char *dst_path) noexcept=0

  Create a symbolic link for the given file.

- virtual int rmdir (const char *path) noexcept=0

  Delete an empty directory.

Public Member Functions inherited from L4Re::Vfs::Special_file

- virtual int ioctl (unsigned long cmd, va_list args) noexcept=0

  The famous IO control.

15.339.1 Detailed Description

The basic interface for an open POSIX file.
An open POSIX file can be anything that hides behind a POSIX file descriptor. This means that even directories are files. An open file can be anything from a directory to a special device file so see Generic_file, Regular_file, Directory, and Special_file for more information.

Note

For implementing a backend for the L4Re::Vfs L4Re::Vfs::Be_file may be used as a base class.

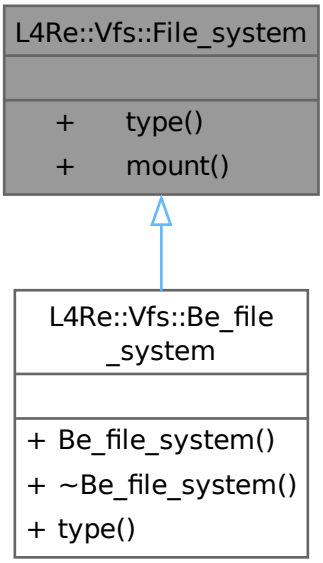
Definition at line 455 of file vfs.h.
The documentation for this class was generated from the following file:

- l4/l4re_vfs/vfs.h

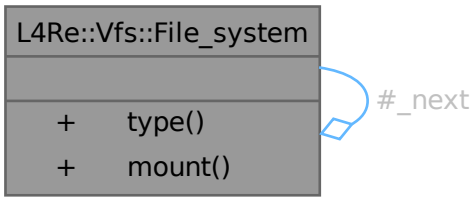
15.340 L4Re::Vfs::File_system Class Reference

Basic interface for an L4Re::Vfs file system.
`#include <vfs.h>`

Inheritance diagram for L4Re::Vfs::File_system:



Collaboration diagram for L4Re::Vfs::File_system:



Public Member Functions

- virtual char const ∗ type () const noexcept=0

  Returns the type of the file system used in mount as fstype argument.
- virtual int mount (char const ∗source, unsigned long mountflags, void const ∗data, cxx::Ref_ptr< File > ∗dir) noexcept=0

  Create a directory object dir representing source mounted with this file system.

15.340.1 Detailed Description

Basic interface for an L4Re::Vfs file system.

Note

For implementing a special file system L4Re::Vfs::Be_file_system may be used as a base class.

The main purpose of this interface is to have a single object for each supported file-system type (e.g., ext2, vfat) that exists in the application and is registered at the L4Re::Vfs::Fs singleton available via L4Re::Vfs::vfs_ops. Ultimately, the POSIX mount function calls the File_system::mount method matching the file-system type given in mount.
Definition at line 854 of file vfs.h.

15.340.2 Member Function Documentation

15.340.2.1 mount()

```
virtual int L4Re::Vfs::File_system::mount (
             char const * source,
             unsigned long mountflags,
             void const * data,
             cxx::Ref_ptr< File > * dir)  [pure virtual], [noexcept]
```

Create a directory object *dir* representing *source* mounted with this file system.

Parameters

	source	The path to the source device to mount. This may also be some URL or anything file-system specific.
	mountflags	The mount flags as specified in the POSIX mount call.
	data	The data as specified in the POSIX mount call. The contents are file-system specific.
out	*dir*	A new directory object representing the file-system root directory.

Returns

0 on success, and <0 on error (e.g. -EINVAL).

References mount().
Referenced by mount().
Here is the call graph for this function:



Here is the caller graph for this function:



15.340.2.2 type()

```
virtual char const * L4Re::Vfs::File_system::type () const  [pure virtual], [noexcept]
```

Returns the type of the file system used in mount as fstype argument.

Note

This method is already provided by Be_file_system.

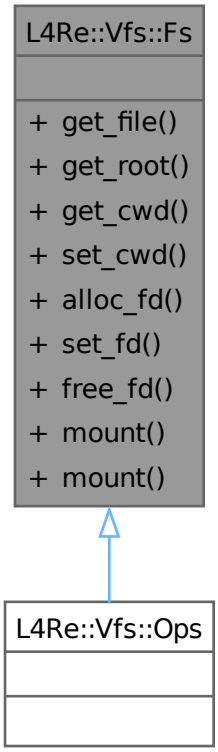
Implemented in L4Re::Vfs::Be_file_system.
The documentation for this class was generated from the following file:

- l4/l4re_vfs/vfs.h

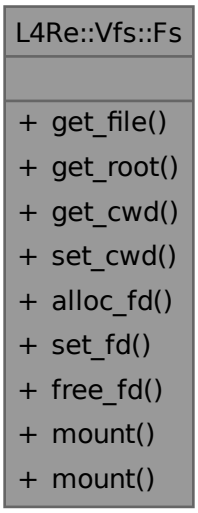
15.341 L4Re::Vfs::Fs Class Reference

POSIX File-system related functionality.
`#include <vfs.h>`

Inheritance diagram for L4Re::Vfs::Fs:



Collaboration diagram for L4Re::Vfs::Fs:



Public Member Functions

- virtual cxx::Ref_ptr< File > get_file (int fd) noexcept=0

  Get the L4Re::Vfs::File for the file descriptor fd.
- virtual cxx::Ref_ptr< File > **get_root** () noexcept=0

  Get the directory object for the application's root directory.
- virtual cxx::Ref_ptr< File > **get_cwd** () noexcept

  Get the directory object for the application's current working directory.
- virtual void **set_cwd** (cxx::Ref_ptr< File > const &) noexcept

  Set the current working directory for the application.
- virtual int alloc_fd (cxx::Ref_ptr< File > const &f=cxx::Ref_ptr<>::Nil) noexcept=0

  Allocate the next free file descriptor.
- virtual cxx::Pair< cxx::Ref_ptr< File >, int > set_fd (int fd, cxx::Ref_ptr< File > const &f=cxx::Ref_ptr<>↩ ::Nil) noexcept=0

  Set the file object referenced by the file descriptor fd.
- virtual cxx::Ref_ptr< File > free_fd (int fd) noexcept=0

  Free the file descriptor fd.
- virtual int mount (char const *path, cxx::Ref_ptr< File > const &dir) noexcept=0

  Mount a given file object at the given global path in the VFS.
- int **mount** (char const *source, char const *target, char const *fstype, unsigned long mountflags, void const *data) noexcept

  Backend for the POSIX mount call.

15.341.1 Detailed Description

POSIX File-system related functionality.

Note

This class usually exists as a singleton and as a superclass of L4Re::Vfs::Ops (

See also

L4Re::Vfs::vfs_ops).

Definition at line 943 of file vfs.h.

15.341.2 Member Function Documentation

15.341.2.1 alloc_fd()

```
virtual int L4Re::Vfs::Fs::alloc_fd (
            cxx::Ref_ptr< File > const & f = cxx::Ref_ptr<>::Nil)  [pure virtual], [noexcept]
```

Allocate the next free file descriptor.

Parameters

f	The file to assign to that file descriptor.

Returns

The allocated file descriptor, or -EMFILE on error.

15.341.2.2 free_fd()

```
virtual cxx::Ref_ptr< File > L4Re::Vfs::Fs::free_fd (
            int fd)  [pure virtual], [noexcept]
```

Free the file descriptor *fd*.

Parameters

fd	The file descriptor to free.

Returns

A pointer to the file object that was assigned to the fd.

15.341.2.3 get_file()

```
virtual cxx::Ref_ptr< File > L4Re::Vfs::Fs::get_file (
            int fd)  [pure virtual], [noexcept]
```

Get the L4Re::Vfs::File for the file descriptor *fd*.

Parameters

fd	The POSIX file descriptor number.

Returns

A pointer to the File object, or 0 if *fd* is not open.

15.341.2.4 mount()

```
virtual int L4Re::Vfs::Fs::mount (
            char const * path,
            cxx::Ref_ptr< File > const & dir)  [pure virtual], [noexcept]
```

Mount a given file object at the given global path in the VFS.

Parameters

path	The global path to mount *dir* at.
dir	A pointer to the file/directory object that shall be mounted at *path*.

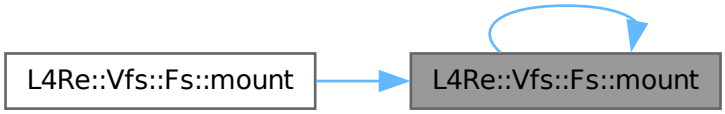
Returns

0 on success, or <0 on error.

References mount().
Referenced by mount(), and mount().
Here is the call graph for this function:



Here is the caller graph for this function:



15.341.2.5 set_fd()

```
virtual cxx::Pair< cxx::Ref_ptr< File >, int > L4Re::Vfs::Fs::set_fd (
            int fd,
            cxx::Ref_ptr< File > const & f = cxx::Ref_ptr<>::Nil)  [pure virtual], [noexcept]
```

Set the file object referenced by the file descriptor *fd*.

Parameters

fd	The file descriptor to set to *f*.
f	The file object to assign.

Returns

A pair of a pointer to the file object that was previously assigned to fd (`first`) and a return value (`second`). `second` contains `-#EBADF` if the passed file descriptor is outside the valid range. `first` contains a Nil pointer in that case. On success, `second` contains 0.

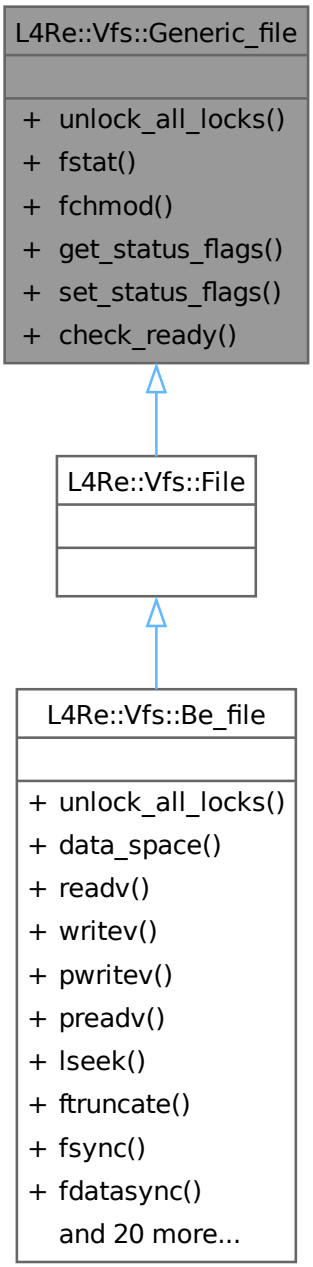
The documentation for this class was generated from the following files:

- l4/l4re_vfs/vfs.h
- l4/l4re_vfs/impl/vfs_impl.h

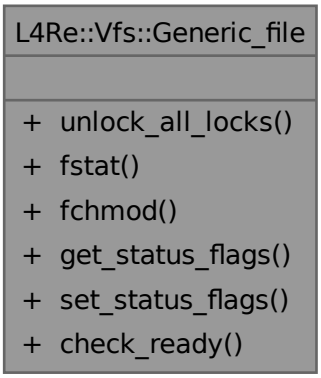
15.342 L4Re::Vfs::Generic_file Class Reference

The common interface for an open POSIX file.
`#include <vfs.h>`

Inheritance diagram for L4Re::Vfs::Generic_file:



Collaboration diagram for L4Re::Vfs::Generic_file:



Public Types

- enum Ready_type : unsigned

  Type of I/O operation/condition a file can indicate readiness.

Public Member Functions

- virtual int unlock_all_locks () noexcept=0

  Unlock all locks on the file.
- virtual int fstat (struct stat64 *buf) const noexcept=0

  Get status information for the file.
- virtual int fchmod (mode_t) noexcept=0

  Change POSIX access rights on the file.
- virtual int get_status_flags () const noexcept=0

  Get file status flags (fcntl F_GETFL).
- virtual int set_status_flags (long flags) noexcept=0

  Set file status flags (fcntl F_SETFL).
- virtual bool check_ready (Ready_type rt) noexcept=0

  Check whether the file is ready for an I/O operation/condition.

15.342.1 Detailed Description

The common interface for an open POSIX file.
This interface is common to all kinds of open files, independent of the file type (e.g., directory, regular file etc.). However, in the L4Re::Vfs the interface File is used for every real object.

See also

L4Re::Vfs::File for more information.

Definition at line 52 of file vfs.h.

15.342.2 Member Enumeration Documentation

15.342.2.1 Ready_type

```
enum L4Re::Vfs::Generic_file::Ready_type :  unsigned
```

Type of I/O operation/condition a file can indicate readiness.
As defined by select() and similar functions.
Definition at line 60 of file vfs.h.

15.342.3 Member Function Documentation

15.342.3.1 check_ready()

```
virtual bool L4Re::Vfs::Generic_file::check_ready (
            Ready_type rt)  [pure virtual], [noexcept]
```

Check whether the file is ready for an I/O operation/condition.
This method is used by the implementation of select() and similar functions.

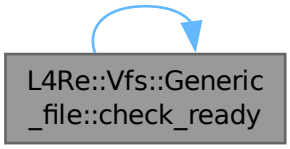
Parameters

rt	Type of the I/O operation/condition to be ready, as defined by the select() and similar functions (Read, Write, Exception).

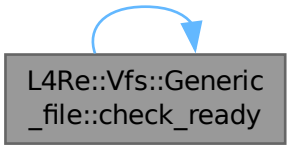
Return values

true	The file is ready for the given type of I/O operation/condition.
false	The file is not ready for the given type of I/O operation/condition.

Implemented in L4Re::Core::Ds_file, and L4Re::Vfs::Be_file.
References check_ready().
Referenced by check_ready().
Here is the call graph for this function:



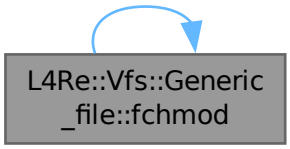
Here is the caller graph for this function:



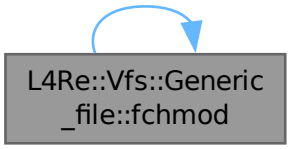
15.342.3.2 fchmod()

```
virtual int L4Re::Vfs::Generic_file::fchmod (
            mode_t )  [pure virtual], [noexcept]
```

Change POSIX access rights on the file.
Backend for POSIX chmod and fchmod.
Implemented in L4Re::Vfs::Be_file.
References fchmod().
Referenced by fchmod().
Here is the call graph for this function:



Here is the caller graph for this function:



15.342.3.3 fstat()

```
virtual int L4Re::Vfs::Generic_file::fstat (
```

```
struct stat64 * buf) const  [pure virtual], [noexcept]
```

Get status information for the file.
This is the backend for POSIX fstat, stat, fstat64 and friends.

Parameters

out	*buf*	This buffer is filled with the status information.

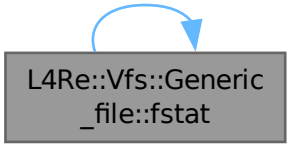
Returns

0 on success, or <0 on error.

Implemented in L4Re::Core::Ds_file, and L4Re::Vfs::Be_file.
References fstat().
Referenced by fstat().
Here is the call graph for this function:



Here is the caller graph for this function:



15.342.3.4 get_status_flags()

```
virtual int L4Re::Vfs::Generic_file::get_status_flags () const  [pure virtual], [noexcept]
```

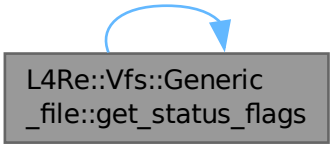
Get file status flags (fcntl F_GETFL).
This function is used by the fcntl implementation for the F_GETFL command.

Returns

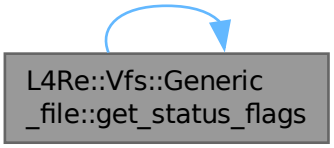
flags such as O_RDONLY, O_WRONLY, O_RDWR, O_DIRECT, O_ASYNC, O_NOATIME, O_NONBLOCK, or <0 on error.

Implemented in L4Re::Core::Ds_file, and L4Re::Vfs::Be_file.
References get_status_flags().

Referenced by get_status_flags().
Here is the call graph for this function:



Here is the caller graph for this function:



15.342.3.5 set_status_flags()

```
virtual int L4Re::Vfs::Generic_file::set_status_flags (
            long flags)  [pure virtual], [noexcept]
```

Set file status flags (fcntl F_SETFL).
This function is used by the fcntl implementation for the F_SETFL command.

Parameters

flags	The file status flags to set. This must be a combination of O_RDONLY, O_WRONLY, O_RDWR, O_↩ APPEND, O_ASYNC, O_DIRECT, O_NOATIME, O_NONBLOCK.

Note

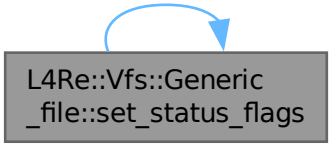
Creation flags such as O_CREAT, O_EXCL, O_NOCTTY, O_TRUNC are ignored.

Returns

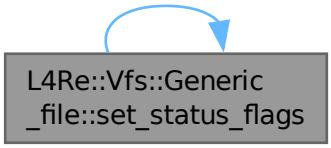
0 on success, or $<$0 on error.

Implemented in L4Re::Core::Ds_file, and L4Re::Vfs::Be_file.
References set_status_flags().
Referenced by set_status_flags().

Here is the call graph for this function:



Here is the caller graph for this function:



15.342.3.6 unlock_all_locks()

`virtual int L4Re::Vfs::Generic_file::unlock_all_locks () [pure virtual], [noexcept]`
Unlock all locks on the file.

Note

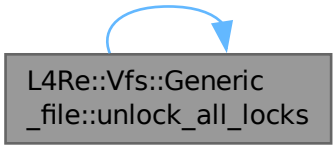
All locks means all locks independent of which file the locks were taken by.

This method is called by the POSIX close implementation to get the POSIX semantics of releasing all locks taken by this application on a close for any fd referencing the real file.

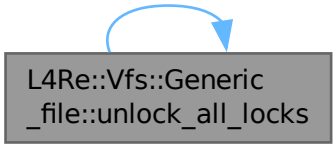
Returns

0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.
References unlock_all_locks().
Referenced by unlock_all_locks().
Here is the call graph for this function:



Here is the caller graph for this function:



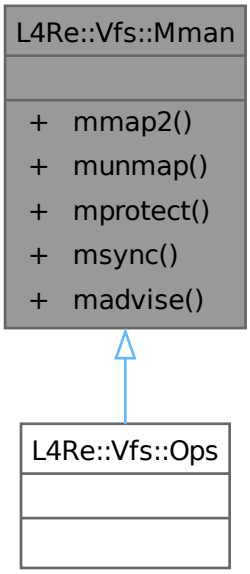
The documentation for this class was generated from the following file:

- l4/l4re_vfs/vfs.h

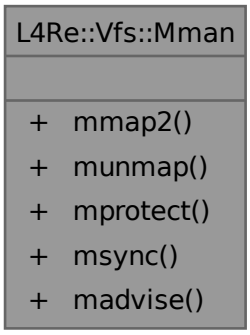
15.343 L4Re::Vfs::Mman Class Reference

Interface for POSIX memory management.
`#include <vfs.h>`

Inheritance diagram for L4Re::Vfs::Mman:



Collaboration diagram for L4Re::Vfs::Mman:



Public Member Functions

- virtual int **mmap2** (void ∗start, size_t len, int prot, int flags, int fd, off_t offset, void ∗∗ptr) noexcept=0

  Backend for the mmap2 system call.
- virtual int **munmap** (void ∗start, size_t len) noexcept=0

  Backend for the munmap system call.
- virtual int **mprotect** (const void ∗a, size_t sz, int prot) noexcept=0

  Backend for the mprotect system call.

- virtual int **msync** (void *addr, size_t len, int flags) noexcept=0

  Backend for the msync system call.
- virtual int **madvise** (void *addr, size_t len, int advice) noexcept=0

  Backend for the madvice system call.

15.343.1 Detailed Description

Interface for POSIX memory management.

Note

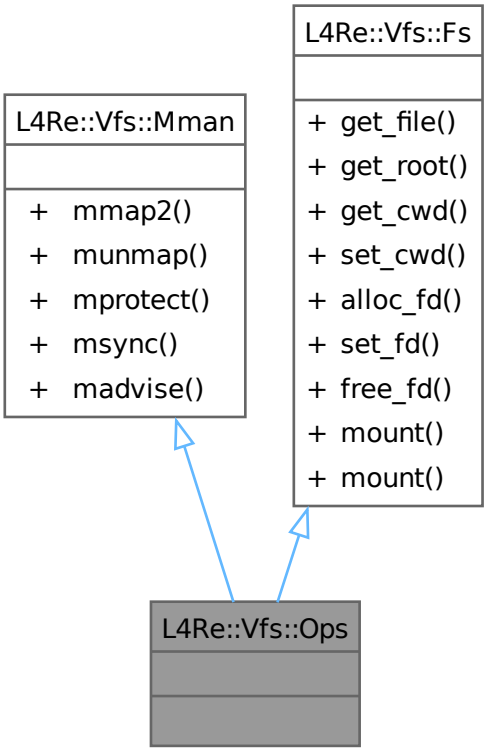
This interface usually exists as a singleton and as a superclass of L4Re::Vfs::Ops.

An implementation for this interface is in l4/l4re_vfs/impl/vfs_impl.h and used by the l4re_vfs library or by the VFS implementation in ldso.
Definition at line 774 of file vfs.h.
The documentation for this class was generated from the following file:

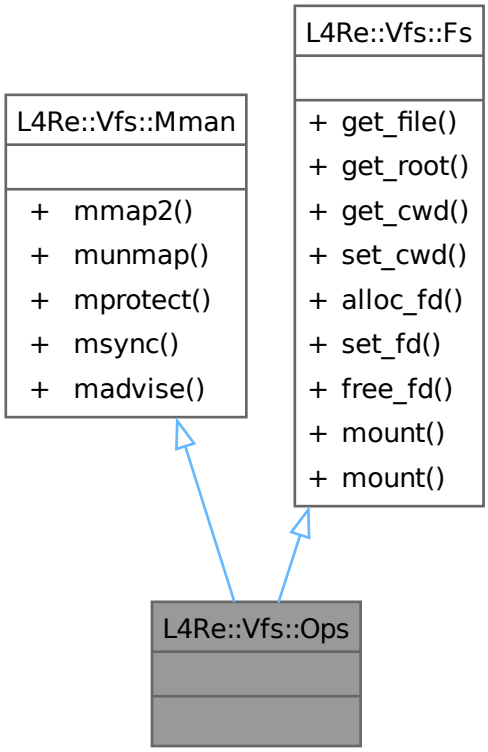
- l4/l4re_vfs/vfs.h

15.344 L4Re::Vfs::Ops Class Reference

Interface for the POSIX backends of an application.
`#include <vfs.h>`
Inheritance diagram for L4Re::Vfs::Ops:



Collaboration diagram for L4Re::Vfs::Ops:



Additional Inherited Members

Public Member Functions inherited from L4Re::Vfs::Mman

- virtual int **mmap2** (void ∗start, size_t len, int prot, int flags, int fd, off_t offset, void ∗∗ptr) noexcept=0

  Backend for the mmap2 system call.
- virtual int **munmap** (void ∗start, size_t len) noexcept=0

  Backend for the munmap system call.
- virtual int **mprotect** (const void ∗a, size_t sz, int prot) noexcept=0

  Backend for the mprotect system call.
- virtual int **msync** (void ∗addr, size_t len, int flags) noexcept=0

  Backend for the msync system call.
- virtual int **madvise** (void ∗addr, size_t len, int advice) noexcept=0

  Backend for the madvice system call.

Public Member Functions inherited from L4Re::Vfs::Fs

- virtual cxx::Ref_ptr< File > get_file (int fd) noexcept=0

  Get the L4Re::Vfs::File for the file descriptor fd.
- virtual cxx::Ref_ptr< File > **get_root** () noexcept=0

  Get the directory object for the application's root directory.
- virtual cxx::Ref_ptr< File > **get_cwd** () noexcept

Get the directory object for the application's current working directory.

- virtual void **set_cwd** (cxx::Ref_ptr< File > const &) noexcept

  Set the current working directory for the application.

- virtual int alloc_fd (cxx::Ref_ptr< File > const &f=cxx::Ref_ptr<>::Nil) noexcept=0

  Allocate the next free file descriptor.

- virtual cxx::Pair< cxx::Ref_ptr< File >, int > set_fd (int fd, cxx::Ref_ptr< File > const &f=cxx::Ref_ptr<>↩ ::Nil) noexcept=0

  Set the file object referenced by the file descriptor fd.

- virtual cxx::Ref_ptr< File > free_fd (int fd) noexcept=0

  Free the file descriptor fd.

- virtual int mount (char const *path, cxx::Ref_ptr< File > const &dir) noexcept=0

  Mount a given file object at the given global path in the VFS.

- int **mount** (char const *source, char const *target, char const *fstype, unsigned long mountflags, void const *data) noexcept

  Backend for the POSIX mount call.

15.344.1 Detailed Description

Interface for the POSIX backends of an application.

Note

There usually exists a single instance of this interface available via L4Re::Vfs::vfs_ops that is used for all kinds of C-Library functions.

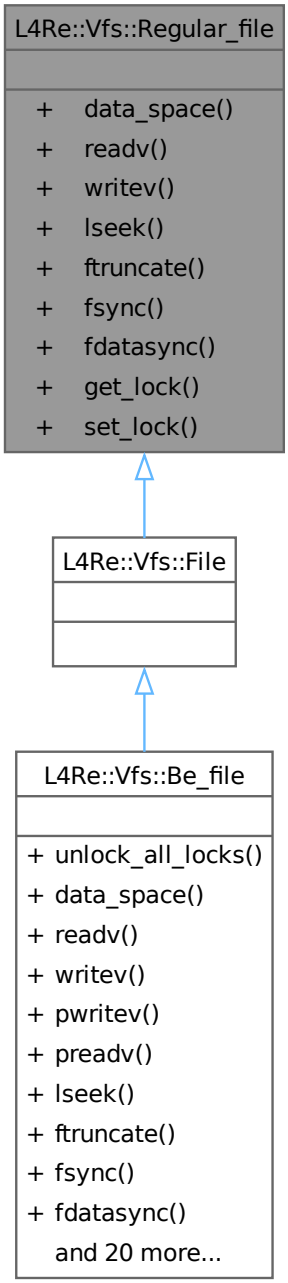
Definition at line 1106 of file vfs.h.
The documentation for this class was generated from the following file:

- l4/l4re_vfs/vfs.h

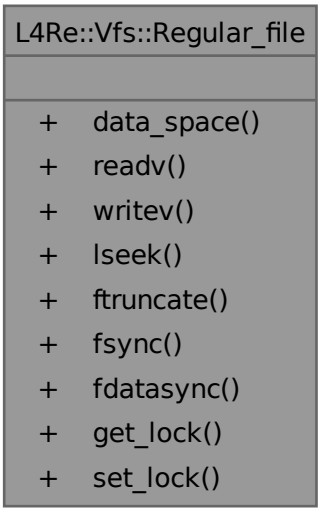
15.345 L4Re::Vfs::Regular_file Class Reference

Interface for a POSIX file that provides regular file semantics.
`#include <vfs.h>`

Inheritance diagram for L4Re::Vfs::Regular_file:



Collaboration diagram for L4Re::Vfs::Regular_file:



Public Member Functions

- virtual L4::Cap< L4Re::Dataspace > data_space () noexcept=0

  Get an L4Re::Dataspace object for the file.
- virtual ssize_t readv (const struct iovec *, int iovcnt) noexcept=0

  Read one or more blocks of data from the file.
- virtual ssize_t writev (const struct iovec *, int iovcnt) noexcept=0

  Write one or more blocks of data to the file.
- virtual off64_t lseek (off64_t, int) noexcept=0

  Change the file pointer.
- virtual int ftruncate (off64_t pos) noexcept=0

  Truncate the file at the given position.
- virtual int fsync () const noexcept=0

  Sync the data and meta data to persistent storage.
- virtual int fdatasync () const noexcept=0

  Sync the data to persistent storage.
- virtual int get_lock (struct flock64 *lock) noexcept=0

  Test if the given lock can be placed in the file.
- virtual int set_lock (struct flock64 *lock, bool wait) noexcept=0

  Acquire or release the given lock on the file.

15.345.1 Detailed Description

Interface for a POSIX file that provides regular file semantics.
Real objects always use the combined L4Re::Vfs::File interface.
Definition at line 287 of file vfs.h.

15.345.2 Member Function Documentation

15.345.2.1 data_space()

```
virtual L4::Cap< L4Re::Dataspace > L4Re::Vfs::Regular_file::data_space ()  [pure virtual],
[noexcept]
```

Get an L4Re::Dataspace object for the file.
This is used as a backend for POSIX mmap and mmap2 functions.

Note

mmap is not possible if the function returns an invalid capability.

Returns

A capability to an L4Re::Dataspace that represents the file contents in an L4Re way.

Implemented in L4Re::Core::Ds_file, and L4Re::Vfs::Be_file.

15.345.2.2 fdatasync()

```
virtual int L4Re::Vfs::Regular_file::fdatasync () const  [pure virtual], [noexcept]
```

Sync the data to persistent storage.
This is the backend for POSIX fdatasync.
Implemented in L4Re::Vfs::Be_file.
References fdatasync().
Referenced by fdatasync().
Here is the call graph for this function:



Here is the caller graph for this function:



15.345.2.3 fsync()

```
virtual int L4Re::Vfs::Regular_file::fsync () const  [pure virtual], [noexcept]
```

Sync the data and meta data to persistent storage.
This is the backend for POSIX fsync.
Implemented in L4Re::Vfs::Be_file.
References fsync().
Referenced by fsync().
Here is the call graph for this function:



Here is the caller graph for this function:



15.345.2.4 ftruncate()

```
virtual int L4Re::Vfs::Regular_file::ftruncate (
            off64_t pos)  [pure virtual], [noexcept]
```

Truncate the file at the given position.
This function is the backend for truncate and friends.

Parameters

pos	The offset at which the file shall be truncated.

Returns

0 on success, or <0 on error.

Implemented in L4Re::Vfs::Be_file.
References ftruncate().
Referenced by ftruncate().
Here is the call graph for this function:



Here is the caller graph for this function:



15.345.2.5 get_lock()

```
virtual int L4Re::Vfs::Regular_file::get_lock (
             struct flock64 * lock)  [pure virtual], [noexcept]
```

Test if the given lock can be placed in the file.
This function is used as backend for fcntl F_GETLK commands.

Parameters

lock	The lock that shall be placed on the file. The *l_type* member will contain `F_UNLCK` if the lock could be placed.

Returns

0 on success, <0 on error.

Implemented in L4Re::Vfs::Be_file.
References get_lock().
Referenced by get_lock().

Here is the call graph for this function:



Here is the caller graph for this function:



15.345.2.6 lseek()

```
virtual off64_t L4Re::Vfs::Regular_file::lseek (
            off64_t ,
            int )  [pure virtual], [noexcept]
```

Change the file pointer.
This is the backend for POSIX seek, lseek and friends.

Returns

The new file position, or <0 on error.

Implemented in L4Re::Vfs::Be_file.
References lseek().
Referenced by lseek().
Here is the call graph for this function:



Here is the caller graph for this function:



15.345.2.7 readv()

```
virtual ssize_t L4Re::Vfs::Regular_file::readv (
            const struct iovec * ,
            int iovcnt)  [pure virtual], [noexcept]
```

Read one or more blocks of data from the file.
This function acts as backend for POSIX read and readv calls and reads data starting from the f_pos pointer of that open file. The file pointer is advanced according to the number of bytes read.

Returns

The number of bytes read from the file, or <0 on error.

Implemented in L4Re::Vfs::Be_file.
References readv().
Referenced by readv().
Here is the call graph for this function:



Here is the caller graph for this function:



15.345.2.8 set_lock()

```
virtual int L4Re::Vfs::Regular_file::set_lock (
            struct flock64 * lock,
            bool wait)  [pure virtual], [noexcept]
```

Acquire or release the given lock on the file.
This function is used as backend for fcntl F_SETLK and F_SETLKW commands.

Parameters

lock	The lock that shall be placed on the file.
wait	If true, then block if there is a conflicting lock on the file.

Returns

0 on success, <0 on error.

Implemented in L4Re::Vfs::Be_file.
References set_lock().
Referenced by set_lock().
Here is the call graph for this function:



Here is the caller graph for this function:



15.345.2.9 writev()

```
virtual ssize_t L4Re::Vfs::Regular_file::writev (
            const struct iovec * ,
            int iovcnt)  [pure virtual], [noexcept]
```

Write one or more blocks of data to the file.
This function acts as backend for POSIX write and writev calls. The data is written starting at the current file pointer and the file pointer must be advanced according to the number of written bytes.

Returns

The number of bytes written to the file, or <0 on error.

Implemented in L4Re::Vfs::Be_file.
References writev().
Referenced by writev().
Here is the call graph for this function:



Here is the caller graph for this function:



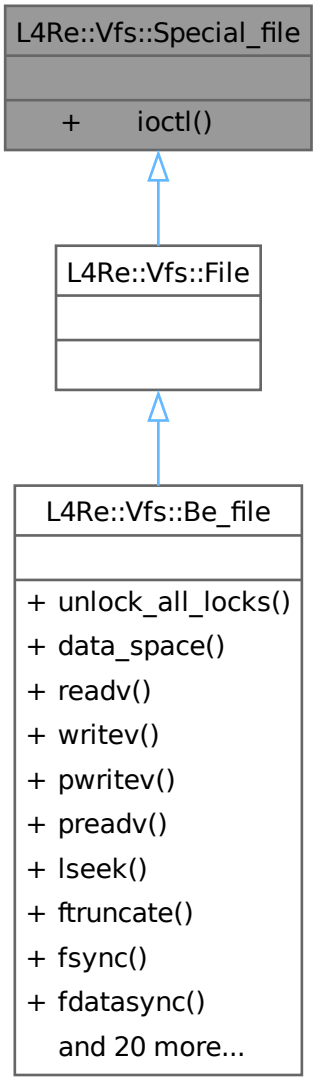
The documentation for this class was generated from the following file:

- l4/l4re_vfs/vfs.h

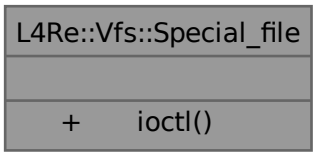
15.346 L4Re::Vfs::Special_file Class Reference

Interface for a POSIX file that provides special file semantics.
`#include <vfs.h>`

Inheritance diagram for L4Re::Vfs::Special_file:



Collaboration diagram for L4Re::Vfs::Special_file:



Public Member Functions

- virtual int ioctl (unsigned long cmd, va_list args) noexcept=0

  The famous IO control.

15.346.1 Detailed Description

Interface for a POSIX file that provides special file semantics.
Real objects always use the combined L4Re::Vfs::File interface.
Definition at line 420 of file vfs.h.

15.346.2 Member Function Documentation

15.346.2.1 ioctl()

```
virtual int L4Re::Vfs::Special_file::ioctl (
            unsigned long cmd,
            va_list args)  [pure virtual], [noexcept]
```

The famous IO control.
Backend for POSIX generic object invocation ioctl.

Parameters

cmd	The ioctl command.
args	The arguments for the ioctl, usually some kind of pointer.

Returns

>=0 on success, or <0 on error.

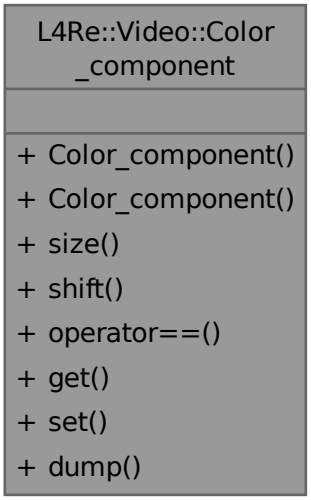
Implemented in L4Re::Core::Ds_file, and L4Re::Vfs::Be_file.
The documentation for this class was generated from the following file:

- l4/l4re_vfs/vfs.h

15.347 L4Re::Video::Color_component Class Reference

A color component.
`#include <colors>`

Collaboration diagram for L4Re::Video::Color_component:



Public Member Functions

- **Color_component** ()
  Constructor.
- Color_component (unsigned char bits, unsigned char shift)
  Constructor.
- unsigned char size () const
  Return the number of bits used by the component.
- unsigned char shift () const
  Return the position of the component in the pixel.
- bool operator== (Color_component const &o) const
  Compare for equality.
- int get (unsigned long v) const
  Get component from value (normalized to 16bits).
- long unsigned set (int v) const
  Transform 16bit normalized value to the component in the color space.
- template<typename OUT>
  void dump (OUT &s) const
  Dump information on the view information to a stream.

15.347.1 Detailed Description

A color component.
Definition at line 21 of file colors.

15.347.2 Constructor & Destructor Documentation

15.347.2.1 Color_component()

```
L4Re::Video::Color_component::Color_component (
            unsigned char bits,
            unsigned char shift)  [inline]
```

Constructor.

Parameters

bits	Number of bits used by the component
shift	Position in bits of the component in the pixel

Definition at line 36 of file colors.
References shift().
Here is the call graph for this function:



15.347.3 Member Function Documentation

15.347.3.1 dump()

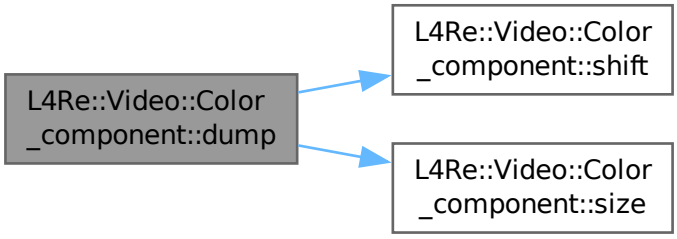
```
template<typename OUT>
void L4Re::Video::Color_component::dump (
             OUT & s) const  [inline]
```

Dump information on the view information to a stream.

Parameters

s	Stream

Definition at line 81 of file colors.
References shift(), and size().
Here is the call graph for this function:



15.347.3.2 get()

```
int L4Re::Video::Color_component::get (
            unsigned long v) const  [inline]
```

Get component from value (normalized to 16bits).

Parameters

v	Value

Returns

Converted value

Definition at line 63 of file colors.

15.347.3.3 operator==()

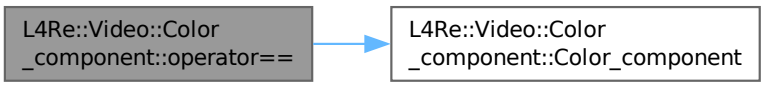
```
bool L4Re::Video::Color_component::operator== (
            Color_component const & o) const  [inline]
```

Compare for equality.

Returns

True if the same components are described, false if not.

Definition at line 55 of file colors.
References Color_component().
Here is the call graph for this function:



15.347.3.4 set()

```
long unsigned L4Re::Video::Color_component::set (
            int v) const  [inline]
```

Transform 16bit normalized value to the component in the color space.

Parameters

v	Value return Converted value.

Definition at line 73 of file colors.

15.347.3.5 shift()

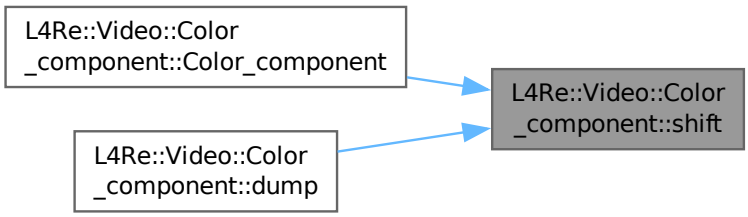
```
unsigned char L4Re::Video::Color_component::shift () const  [inline]
```

Return the position of the component in the pixel.

Returns

Position in bits of the component in the pixel

Definition at line 49 of file colors.
Referenced by Color_component(), and dump().
Here is the caller graph for this function:



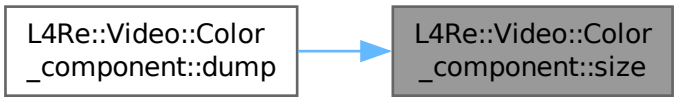
15.347.3.6 size()

`unsigned char L4Re::Video::Color_component::size () const [inline]`
Return the number of bits used by the component.

Returns

Number of bits used by the component

Definition at line 43 of file colors.
Referenced by dump().
Here is the caller graph for this function:



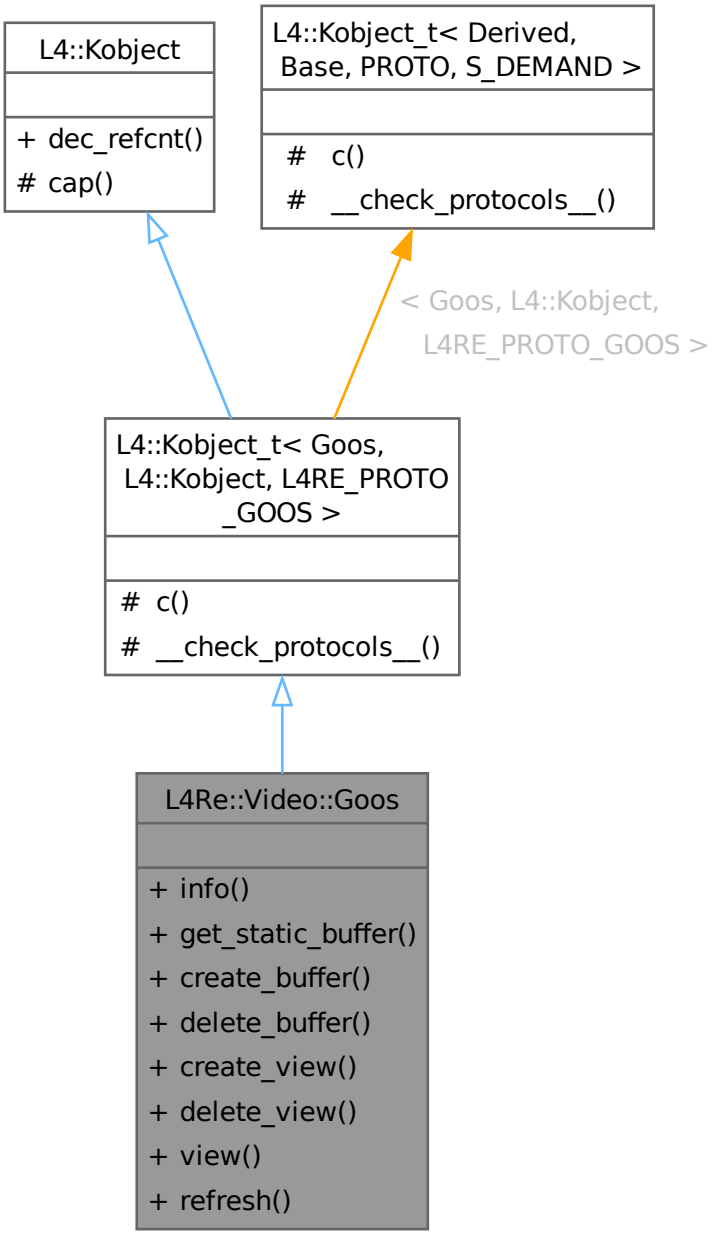
The documentation for this class was generated from the following file:

- l4/re/video/colors

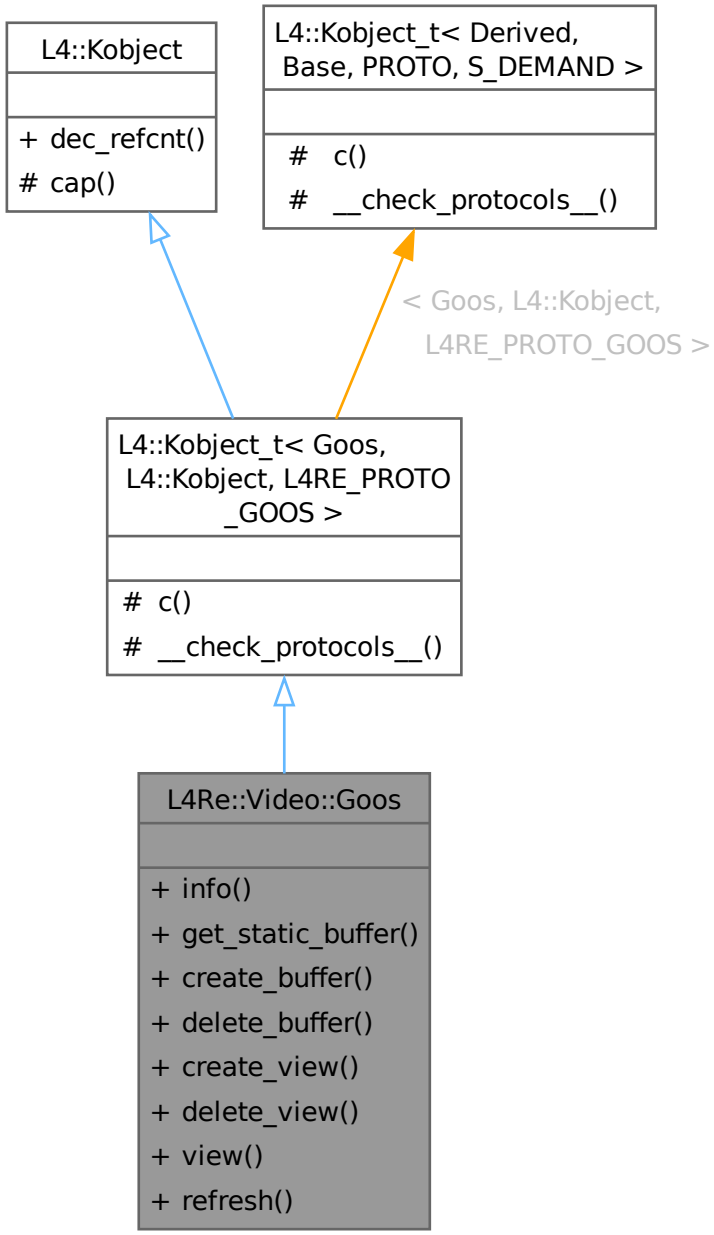
15.348 L4Re::Video::Goos Class Reference

Class that abstracts framebuffers.
`#include <goos>`

Inheritance diagram for L4Re::Video::Goos:



Collaboration diagram for L4Re::Video::Goos:



Data Structures

- struct Info

  Information structure of a Goos.

Public Types

- enum Flags { F_auto_refresh = 0x01 , F_pointer = 0x02 , F_dynamic_views = 0x04 , F_dynamic_buffers = 0x08 }

Flags for a Goos.

Public Member Functions

- l4_ret_t info (Info *info)

  Return the Goos information of the Goos.
- l4_ret_t get_static_buffer (unsigned idx, L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > rbuf)

  Return a static buffer of a Goos.
- l4_ret_t create_buffer (unsigned long size, L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > rbuf)

  Create a buffer.
- l4_ret_t delete_buffer (unsigned idx)

  Delete a buffer.
- l4_ret_t create_view (View *view, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Create a view.
- l4_ret_t delete_view (View const &v, l4_utcb_t *utcb=l4_utcb()) const noexcept

  Delete a view.
- View view (unsigned index) const noexcept

  Return a view.
- l4_ret_t **refresh** (int x, int y, int w, int h)

  Trigger refreshing of the given area on the virtual screen.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Goos, L4::Kobject, L4RE_PROTO_GOOS >

- typedef Goos **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Goos > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Goos, L4::Kobject, L4RE_PROTO_GOOS >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Goos, L4::Kobject, L4RE_PROTO_GOOS >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.348.1 Detailed Description

Class that abstracts framebuffers.
A framebuffer is the pixel data that is displayed on a screen and a Goos object lets the user manipulate that data. A Goos makes use of two kinds of objects:

- Buffers in the form of L4Re::Dataspace objects. These hold the bytes for the pixel data.
- L4Re::Video::View objects.

Both can either be static, that is their number and configuration is fixed and determined by the framebuffer, or they can be dynamic, with the user allocating them.
Definition at line 223 of file goos.

15.348.2 Member Enumeration Documentation

15.348.2.1 Flags

```
enum L4Re::Video::Goos::Flags
```
Flags for a Goos.

Enumerator

F_auto_refresh	The graphics display is automatically refreshed.
F_pointer	We have a mouse pointer.
F_dynamic_views	Supports dynamically allocated views.
F_dynamic_buffers	Supports dynamically allocated buffers.

Definition at line 228 of file goos.

15.348.3 Member Function Documentation

15.348.3.1 create_buffer()

```
l4_ret_t L4Re::Video::Goos::create_buffer (
             unsigned long size,
             L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > rbuf)
```
Create a buffer.

Parameters

size	Size of buffer in bytes.
rbuf	Capability slot to point the buffer dataspace to.

Return values

>=0	Success, the value returned is the buffer index.
<0	Error

Referenced by get_static_buffer().

Here is the caller graph for this function:



15.348.3.2 create_view()

```
l4_ret_t L4Re::Video::Goos::create_view (
            View * view,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Create a view.

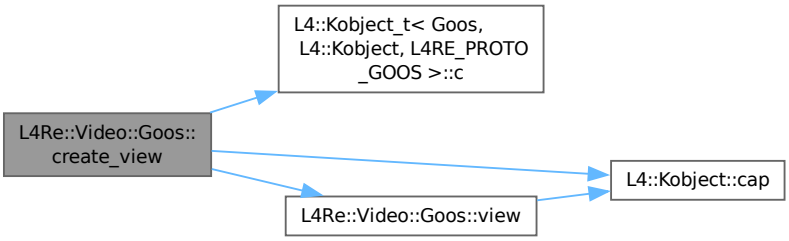
Parameters

out	*view*	A view object.
	utcb	UTCB of the caller. This is a default parameter.

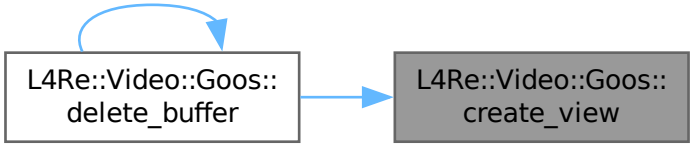
Return values

>=0	Success, the value returned is the view index.
<0	Error

Definition at line 312 of file goos.
References L4::Kobject_t< Goos, L4::Kobject, L4RE_PROTO_GOOS >::c(), L4::Kobject::cap(), and view().
Referenced by delete_buffer().
Here is the call graph for this function:



Here is the caller graph for this function:



15.348.3.3 delete_buffer()

```
l4_ret_t L4Re::Video::Goos::delete_buffer (
            unsigned idx)
```

Delete a buffer.

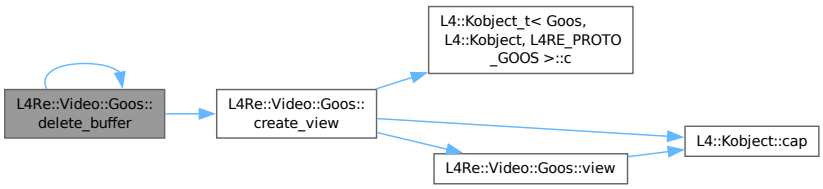
Parameters

idx	Buffer to delete.

Return values

0	Success
<0	Error

References create_view(), and delete_buffer().
Referenced by delete_buffer().
Here is the call graph for this function:



Here is the caller graph for this function:



15.348.3.4 delete_view()

```
l4_ret_t L4Re::Video::Goos::delete_view (
            View const & v,
            l4_utcb_t * utcb = l4_utcb()) const  [inline], [noexcept]
```

Delete a view.

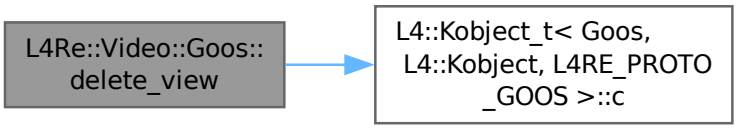
Parameters

v	The view object to delete.
utcb	UTCB of the caller. This is a default parameter.

Return values

0	Success
<0	Error

Definition at line 332 of file goos.
References L4::Kobject_t< Goos, L4::Kobject, L4RE_PROTO_GOOS >::c().
Here is the call graph for this function:



15.348.3.5 get_static_buffer()

```
l4_ret_t L4Re::Video::Goos::get_static_buffer (
            unsigned idx,
            L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > rbuf)
```

Return a static buffer of a Goos.

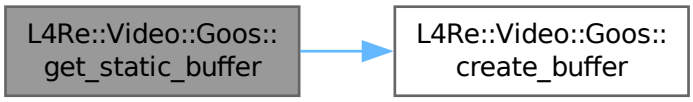
Parameters

idx	Index of the static buffer.
rbuf	Capability slot to point the buffer dataspace to.

Return values

0	Success
<0	Error

References create_buffer().
Referenced by info().
Here is the call graph for this function:



Here is the caller graph for this function:



15.348.3.6 info()

```
l4_ret_t L4Re::Video::Goos::info (
            Info * info)
```

Return the Goos information of the Goos.

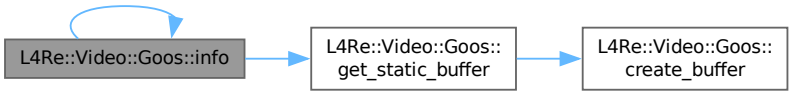
Parameters

out	*info*	Goos information structure pointer.

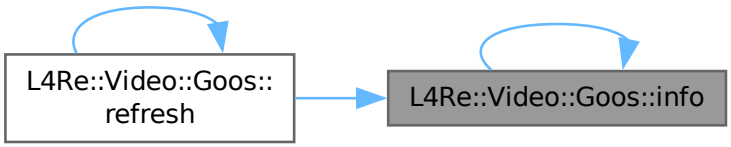
Return values

0	Success
<0	Error

References get_static_buffer(), and info().
Referenced by info(), and refresh().
Here is the call graph for this function:



Here is the caller graph for this function:



15.348.3.7 view()

```
View L4Re::Video::Goos::view (
            unsigned index) const  [inline], [noexcept]
```

Return a view.

Parameters

index	Index of the view to return.

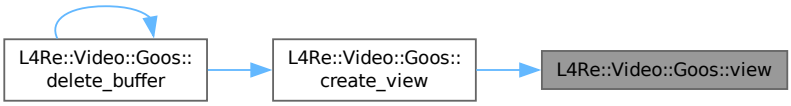
Returns

The view.

Definition at line 363 of file goos.
References L4::Kobject::cap().
Referenced by create_view().
Here is the call graph for this function:



Here is the caller graph for this function:



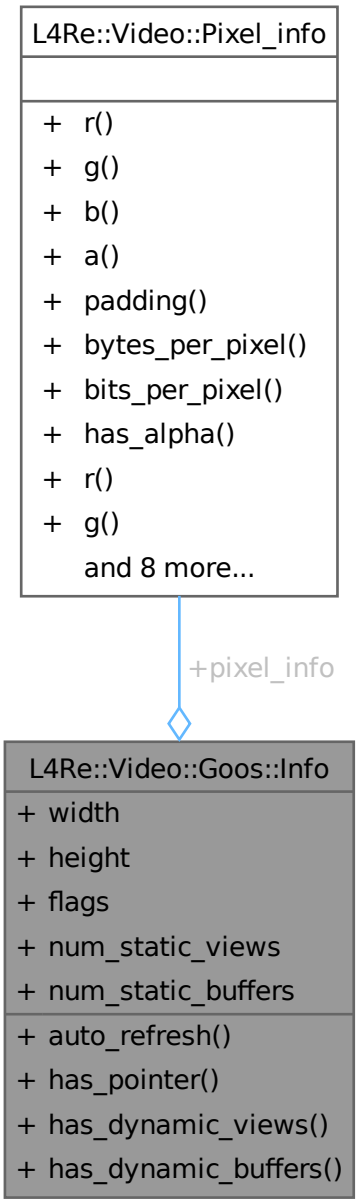
The documentation for this class was generated from the following file:

- l4/re/video/goos

15.349 L4Re::Video::Goos::Info Struct Reference

Information structure of a Goos.
`#include <goos>`

Collaboration diagram for L4Re::Video::Goos::Info:



Public Member Functions

- bool **auto_refresh** () const

  Return whether this Goos does auto refreshing or the view refresh functions must be used to make changes visible.
- bool **has_pointer** () const

  Return whether a pointer is used by the provider of the Goos.
- bool **has_dynamic_views** () const

  Return whether dynamic view are supported.
- bool **has_dynamic_buffers** () const

  Return whether dynamic buffers are supported.

Data Fields

- unsigned long **width**

  Width.
- unsigned long **height**

  Height.
- unsigned **flags**

  Flags, see Flags.
- unsigned **num_static_views**

  Number of static view.
- unsigned **num_static_buffers**

  Number of static buffers.
- Pixel_info **pixel_info**

  Pixel information.

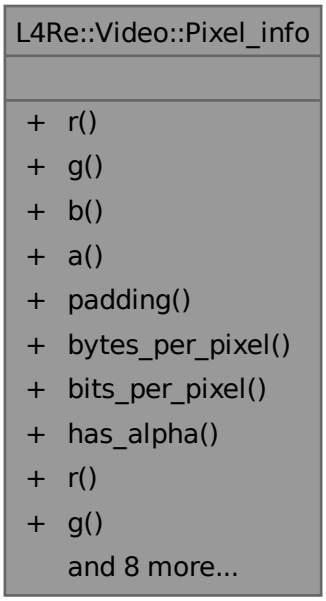
15.349.1 Detailed Description

Information structure of a Goos.
Definition at line 237 of file goos.
The documentation for this struct was generated from the following file:

- l4/re/video/goos

15.350 L4Re::Video::Pixel_info Class Reference

Pixel information.
`#include <colors>`
Collaboration diagram for L4Re::Video::Pixel_info:



Public Member Functions

- Color_component const & r () const

  Return the red color component of the pixel.
- Color_component const & g () const

  Return the green color component of the pixel.
- Color_component const & b () const

  Return the blue color component of the pixel.
- Color_component const & a () const

  Return the alpha color component of the pixel.
- Color_component const padding () const

  Compute the padding pseudo component.
- unsigned char bytes_per_pixel () const

  Query size of pixel in bytes.
- unsigned char bits_per_pixel () const

  Number of bits of the pixel.
- bool has_alpha () const

  Return whether the pixel has an alpha channel.
- void r (Color_component const &c)

  Set the red color component of the pixel.
- void g (Color_component const &c)

  Set the green color component of the pixel.
- void b (Color_component const &c)

  Set the blue color component of the pixel.
- void a (Color_component const &c)

  Set the alpha color component of the pixel.
- void bytes_per_pixel (unsigned char bpp)

  Set the size of the pixel in bytes.
- **Pixel_info** ()

  Constructor.
- Pixel_info (unsigned char bpp, char r, char rs, char g, char gs, char b, char bs, char a=0, char as=0)

  Constructor.
- template<typename VBI>
  Pixel_info (VBI const *vbi)

  Convenience constructor.
- bool operator== (Pixel_info const &o) const

  Compare for complete equality of the color space.
- template<typename OUT>
  void dump (OUT &s) const

  Dump information on the pixel to a stream.

15.350.1 Detailed Description

Pixel information.
This class wraps the information on a pixel, such as the size and position of each color component in the pixel.
Definition at line 94 of file colors.

15.350.2 Constructor & Destructor Documentation

15.350.2.1 Pixel_info() [1/2]

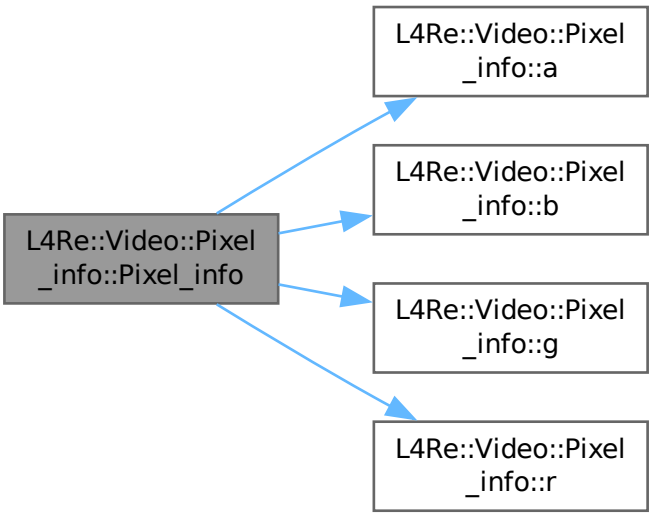
```
L4Re::Video::Pixel_info::Pixel_info (
            unsigned char bpp,
            char r,
            char rs,
            char g,
            char gs,
            char b,
            char bs,
            char a = 0,
            char as = 0)  [inline]
```

Constructor.

Parameters

bpp	Size of pixel in bytes.
r	Red component size.
rs	Red component shift.
g	Green component size.
gs	Green component shift.
b	Blue component size.
bs	Blue component shift.
a	Alpha component size, defaults to 0.
as	Alpha component shift, defaults to 0.

Definition at line 212 of file colors.
References a(), b(), g(), and r().
Here is the call graph for this function:



15.350.2.2 Pixel_info() [2/2]

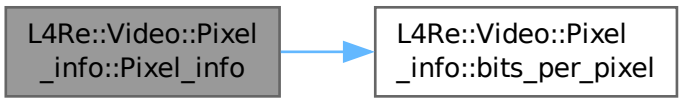
```
template<typename VBI>
L4Re::Video::Pixel_info::Pixel_info (
            VBI const * vbi)  [inline], [explicit]
```

Convenience constructor.

Parameters

vbi	Suitable information structure. Convenience constructor to create the pixel info from a VESA Framebuffer Info.

Definition at line 224 of file colors.
References bits_per_pixel().
Here is the call graph for this function:



15.350.3 Member Function Documentation

15.350.3.1 a() [1/2]

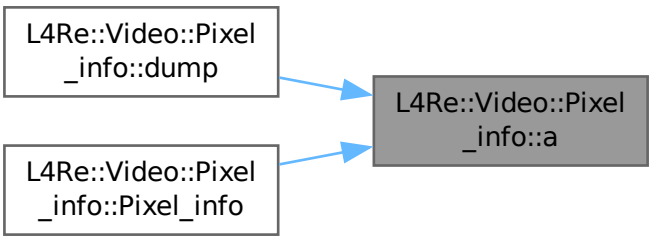
```
Color_component const & L4Re::Video::Pixel_info::a () const  [inline]
```

Return the alpha color component of the pixel.

Returns

Alpha color component.

Definition at line 123 of file colors.
Referenced by dump(), and Pixel_info().
Here is the caller graph for this function:



15.350.3.2 a() [2/2]

```
void L4Re::Video::Pixel_info::a (
            Color_component const & c)  [inline]
```

Set the alpha color component of the pixel.

Parameters

c	Alpha color component.

Definition at line 187 of file colors.

15.350.3.3 b() [1/2]

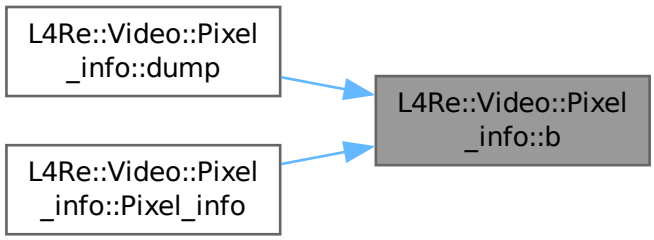
```
Color_component const & L4Re::Video::Pixel_info::b () const  [inline]
```

Return the blue color component of the pixel.

Returns

Blue color component.

Definition at line 117 of file colors.
Referenced by dump(), and Pixel_info().
Here is the caller graph for this function:



15.350.3.4 b() [2/2]

```
void L4Re::Video::Pixel_info::b (
            Color_component const & c)  [inline]
```

Set the blue color component of the pixel.

Parameters

c	Blue color component.

Definition at line 181 of file colors.

15.350.3.5 bits_per_pixel()

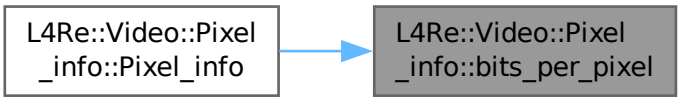
```
unsigned char L4Re::Video::Pixel_info::bits_per_pixel () const  [inline]
```

Number of bits of the pixel.

Returns

Number of bits used by the pixel.

Definition at line 156 of file colors.
Referenced by Pixel_info().
Here is the caller graph for this function:



15.350.3.6 bytes_per_pixel() [1/2]

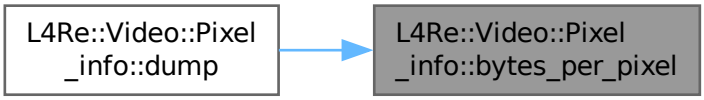
```
unsigned char L4Re::Video::Pixel_info::bytes_per_pixel () const  [inline]
```

Query size of pixel in bytes.

Returns

Size of pixel in bytes.

Definition at line 150 of file colors.
Referenced by dump().
Here is the caller graph for this function:



15.350.3.7 bytes_per_pixel() [2/2]

```
void L4Re::Video::Pixel_info::bytes_per_pixel (
            unsigned char bpp)  [inline]
```

Set the size of the pixel in bytes.

Parameters

bpp	Size of pixel in bytes.

Definition at line 193 of file colors.

15.350.3.8 dump()

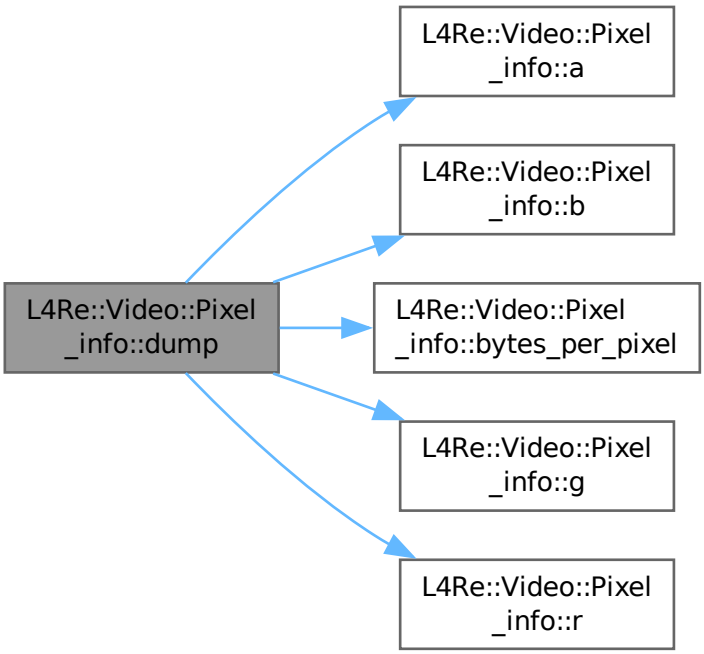
```
template<typename OUT>
void L4Re::Video::Pixel_info::dump (
             OUT & s) const  [inline]
```

Dump information on the pixel to a stream.

Parameters

s	Stream

Definition at line 246 of file colors.
References a(), b(), bytes_per_pixel(), g(), and r().
Here is the call graph for this function:



15.350.3.9 g() [1/2]

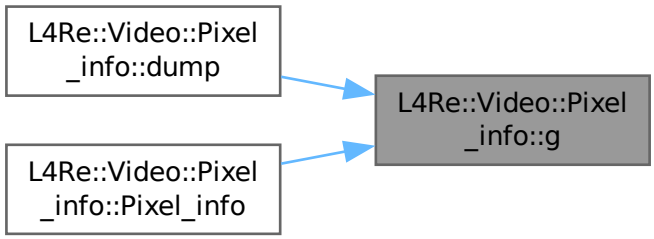
```
Color_component const & L4Re::Video::Pixel_info::g () const  [inline]
```

Return the green color component of the pixel.

Returns

Green color component.

Definition at line 111 of file colors.
Referenced by dump(), and Pixel_info().
Here is the caller graph for this function:



15.350.3.10 g() [2/2]

```
void L4Re::Video::Pixel_info::g (
            Color_component const & c)  [inline]
```

Set the green color component of the pixel.

Parameters

c	Green color component.

Definition at line 175 of file colors.

15.350.3.11 has_alpha()

```
bool L4Re::Video::Pixel_info::has_alpha () const  [inline]
```

Return whether the pixel has an alpha channel.

Returns

True if the pixel has an alpha channel, false if not.

Definition at line 163 of file colors.

15.350.3.12 operator==()

```
bool L4Re::Video::Pixel_info::operator== (
            Pixel_info const & o) const  [inline]
```

Compare for complete equality of the color space.

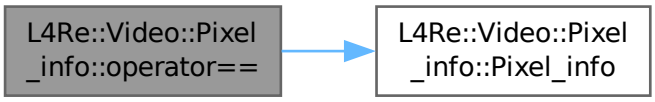
Parameters

o	A Pixel_info to compare to.

Returns

true if the both Pixel_info's are equal, false if not.

Definition at line 236 of file colors.
References Pixel_info().
Here is the call graph for this function:



15.350.3.13 padding()

```
Color_component const L4Re::Video::Pixel_info::padding () const  [inline]
```

Compute the padding pseudo component.
The padding pseudo component represents the trailing bits that are reserved in RGB32 and similar pixel formats.

Returns

Padding pseudo component.

Definition at line 131 of file colors.

15.350.3.14 r() [1/2]

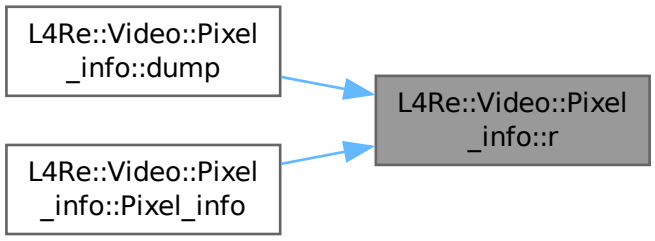
```
Color_component const & L4Re::Video::Pixel_info::r () const  [inline]
```

Return the red color component of the pixel.

Returns

Red color component.

Definition at line 105 of file colors.
Referenced by dump(), and Pixel_info().
Here is the caller graph for this function:



15.350.3.15 r() [2/2]

```
void L4Re::Video::Pixel_info::r (
            Color_component const & c)  [inline]
```

Set the red color component of the pixel.

Parameters

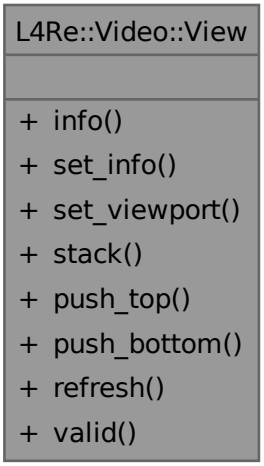
c	Red color component.

Definition at line 169 of file colors.
The documentation for this class was generated from the following file:

- l4/re/video/colors

15.351 L4Re::Video::View Class Reference

View of a framebuffer.
`#include <goos>`
Collaboration diagram for L4Re::Video::View:



Data Structures

- struct Info

  Information structure of a view.

Public Types

- enum Flags {
  F_none = 0x00 , F_set_buffer = 0x01 , F_set_buffer_offset = 0x02 , F_set_bytes_per_line = 0x04 ,
  F_set_pixel = 0x08 , F_set_position = 0x10 , F_dyn_allocated = 0x20 , F_set_background = 0x40 ,
  F_set_flags = 0x80 , F_fully_dynamic }

  Flags on a view.
- enum V_flags { F_above = 0x1000 , F_flags_mask = 0xff000 }

  Property flags of a view.

Public Member Functions

- int info (Info *info) const noexcept

  Return the view information of the view.
- int set_info (Info const &info) const noexcept

  Set the information structure for this view.
- int set_viewport (int scr_x, int scr_y, int w, int h, unsigned long buf_offset) const noexcept

  Set the position of the view in the Goos.
- int stack (View const &pivot, bool behind=true) const noexcept

  Move this view in the view stack.
- int **push_top** () const noexcept

  Make this view the top-most view.
- int **push_bottom** () const noexcept

  Push this view the back.
- int refresh (int x, int y, int w, int h) const noexcept

  Refresh/Redraw the view.
- bool **valid** () const

  Return whether this view is valid.

15.351.1 Detailed Description

View of a framebuffer.
A view is a rectangular subset of a framebuffer managed by a Goos object. The Goos orders multiple views in a stack which determines which view is on top in case they overlap. The view's pixel data is provided by a backing buffer, which must belong to the Goos. It can be static or dynamically allocated, depending on the framebuffer.

See also

L4Re::Video::Goos

Definition at line 39 of file goos.

15.351.2 Member Enumeration Documentation

15.351.2.1 Flags

`enum L4Re::Video::View::Flags`
Flags on a view.

Enumerator

F_none	everything for this view is static (the BOOT-FB case)
F_set_buffer	buffer object for this view can be changed
F_set_buffer_offset	buffer offset can be set
F_set_bytes_per_line	bytes per line can be set
F_set_pixel	pixel type can be set
F_set_position	position on screen can be set
F_dyn_allocated	View is dynamically allocated.
F_set_background	Set view as background for session.
F_set_flags	Set view flags (. **See also** V_flags)

F_fully_dynamic	Flags for a fully dynamic view.

Definition at line 59 of file goos.

15.351.2.2 V_flags

```
enum L4Re::Video::View::V_flags
```

Property flags of a view.
Such flags can be set or deleted with the F_set_flags operation using the `set_info()` method.

Enumerator

F_above	Flag the view as stay on top.
F_flags_mask	Mask containing all possible property flags.

Definition at line 82 of file goos.

15.351.3 Member Function Documentation

15.351.3.1 info()

```
int L4Re::Video::View::info (
            Info * info) const  [inline], [noexcept]
```

Return the view information of the view.

Parameters

out	*info*	Information structure pointer.

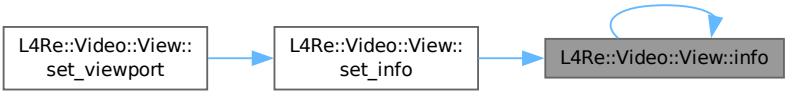
Return values

0	Success
<0	Error

Definition at line 367 of file goos.
References info().
Referenced by info(), and set_info().
Here is the call graph for this function:



Here is the caller graph for this function:



15.351.3.2 refresh()

```
int L4Re::Video::View::refresh (
             int x,
             int y,
             int w,
             int h) const  [inline], [noexcept]
```

Refresh/Redraw the view.

Parameters

x	X position.
y	Y position.
w	Width.
h	Height.

Return values

0	Success
<0	Error

Definition at line 379 of file goos.

15.351.3.3 set_info()

```
int L4Re::Video::View::set_info (
             Info const & info) const  [inline], [noexcept]
```

Set the information structure for this view.

Parameters

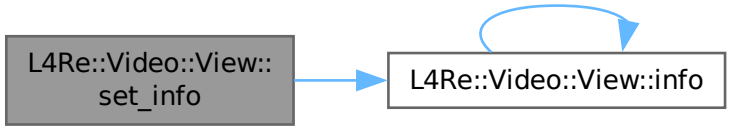
info	Information structure.

Return values

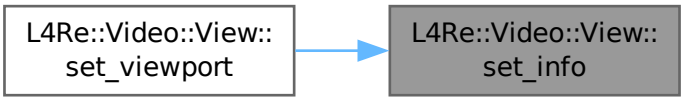
0	Success
<0	Error

The function will also set the view port according to the values given in the information structure.

Definition at line 371 of file goos.
References info().
Referenced by set_viewport().
Here is the call graph for this function:



Here is the caller graph for this function:



15.351.3.4 set_viewport()

```
int L4Re::Video::View::set_viewport (
            int scr_x,
            int scr_y,
            int w,
            int h,
            unsigned long buf_offset) const  [inline], [noexcept]
```

Set the position of the view in the Goos.

Parameters

scr_x	X position
scr_y	Y position
w	Width
h	Height
buf_offset	Offset in the buffer in bytes

Return values

0	Success
<0	Error

Definition at line 383 of file goos.
References L4Re::Video::View::Info::buffer_index, L4Re::Video::View::Info::buffer_offset, L4Re::Video::View::Info::bytes_per_line, F_set_buffer_offset, F_set_position, L4Re::Video::View::Info::flags, L4Re::Video::View::Info::height, L4Re::Video::View::Info::pixel_inf set_info(), L4Re::Video::View::Info::view_index, L4Re::Video::View::Info::width, L4Re::Video::View::Info::xpos, and L4Re::Video::View::Info::ypos.
Here is the call graph for this function:



15.351.3.5 stack()

```
int L4Re::Video::View::stack (
            View const & pivot,
            bool behind = true) const  [inline], [noexcept]
```

Move this view in the view stack.

Parameters

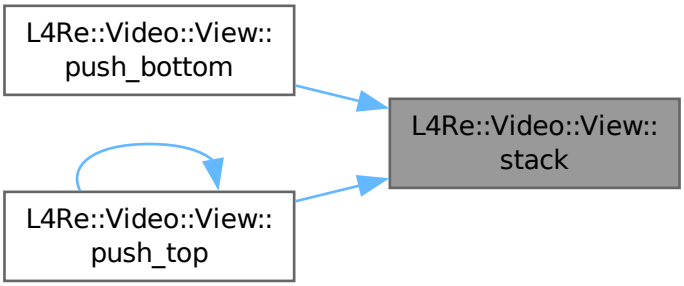
pivot	View to move relative to
behind	When true move the view behind the pivot view, if false move the view before the pivot view.

Return values

0	Success
<0	Error

Definition at line 375 of file goos.
Referenced by push_bottom(), and push_top().

Here is the caller graph for this function:



The documentation for this class was generated from the following file:

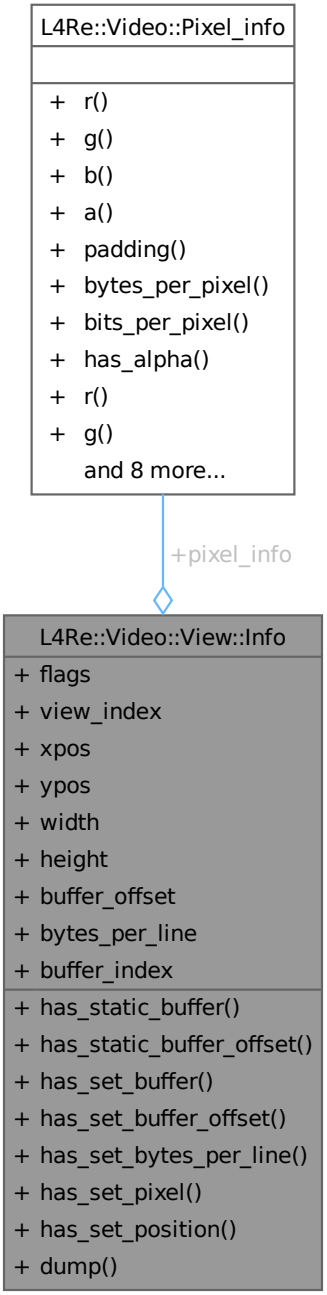
- l4/re/video/goos

15.352 L4Re::Video::View::Info Struct Reference

Information structure of a view.

`#include <goos>`

Collaboration diagram for L4Re::Video::View::Info:



Public Member Functions

- bool **has_static_buffer** () const

  Return whether the view has a static buffer.
- bool **has_static_buffer_offset** () const

  Return whether the static buffer offset is available.
- bool **has_set_buffer** () const

  Return whether a buffer is set.

- bool **has_set_buffer_offset** () const

  Return whether the given buffer offset is valid.
- bool **has_set_bytes_per_line** () const

  Return whether the given bytes-per-line value is valid.
- bool **has_set_pixel** () const

  Return whether the given pixel information is valid.
- bool **has_set_position** () const

  Return whether the position information given is valid.
- template<typename OUT>
  void **dump** (OUT &s) const

  Dump information on the view information to a stream.

Data Fields

- unsigned **flags** = 0

  Flags, see Flags and V_flags.
- unsigned **view_index** = 0

  Index of the view.
- unsigned long **xpos** = 0

  X position in pixels of the view in the Goos.
- unsigned long **ypos** = 0

  Y position in pixels of the view in the Goos.
- unsigned long **width** = 0

  Width of the view in pixels.
- unsigned long **height** = 0

  Height of the view in pixels.
- unsigned long **buffer_offset** = 0

  Offset in the memory buffer in bytes.
- unsigned long **bytes_per_line** = 0

  Bytes per line.
- Pixel_info **pixel_info**

  Pixel information.
- unsigned **buffer_index** = 0

  Number of the buffer used for this view.

15.352.1 Detailed Description

Information structure of a view.
Definition at line 91 of file goos.
The documentation for this struct was generated from the following file:

- l4/re/video/goos

15.353 l4re_aux_t Struct Reference

Auxiliary descriptor.
`#include <l4aux.h>`

Collaboration diagram for l4re_aux_t:



Data Fields

- char const ∗ **binary**

  Binary name.
- l4_cap_idx_t **kip_ds**

  Data space of the KIP.
- l4_umword_t **dbg_lvl**

  Debug levels for l4re.
- l4_umword_t **ldr_flags**

  Flags for l4re, see l4re_aux_ldr_flags_t.
- l4_addr_t **ldr_base**

  Load offset of executable.

15.353.1 Detailed Description

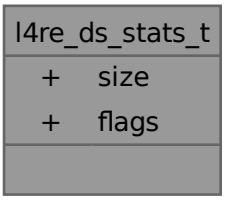
Auxiliary descriptor.
Definition at line 40 of file l4aux.h.
The documentation for this struct was generated from the following file:

- l4/re/l4aux.h

15.354 l4re_ds_stats_t Struct Reference

Information about the data space.
`#include <dataspace.h>`

Collaboration diagram for l4re_ds_stats_t:



Data Fields

- l4re_ds_size_t **size**

  size
- l4re_ds_flags_t **flags**

  flags

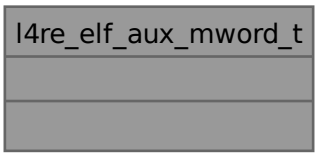
15.354.1 Detailed Description

Information about the data space.
Definition at line 39 of file dataspace.h.
The documentation for this struct was generated from the following file:

- l4/re/c/dataspace.h

15.355 l4re_elf_aux_mword_t Struct Reference

Auxiliary vector element for a single unsigned data word.
`#include <elf_aux.h>`
Collaboration diagram for l4re_elf_aux_mword_t:



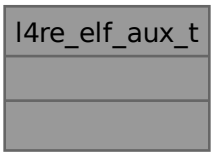
15.355.1 Detailed Description

Auxiliary vector element for a single unsigned data word.
Definition at line 118 of file elf_aux.h.
The documentation for this struct was generated from the following file:

- l4/re/elf_aux.h

15.356 l4re_elf_aux_t Struct Reference

Generic header for each auxiliary vector element.
`#include <elf_aux.h>`
Collaboration diagram for l4re_elf_aux_t:



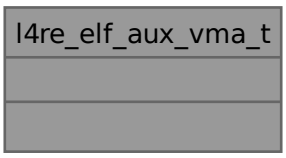
15.356.1 Detailed Description

Generic header for each auxiliary vector element.
Definition at line 98 of file elf_aux.h.
The documentation for this struct was generated from the following file:

- l4/re/elf_aux.h

15.357 l4re_elf_aux_vma_t Struct Reference

Auxiliary vector element for a reserved virtual memory area.
`#include <elf_aux.h>`
Collaboration diagram for l4re_elf_aux_vma_t:



15.357.1 Detailed Description

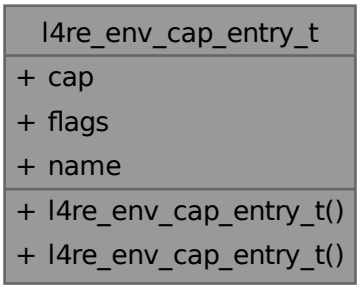
Auxiliary vector element for a reserved virtual memory area.
Definition at line 107 of file elf_aux.h.
The documentation for this struct was generated from the following file:

- l4/re/elf_aux.h

15.358 l4re_env_cap_entry_t Struct Reference

Entry in the L4Re environment array for the named initial objects.

`#include <env.h>`
Collaboration diagram for l4re_env_cap_entry_t:



Public Member Functions

- **l4re_env_cap_entry_t** () L4_NOTHROW

  Create an invalid entry.
- l4re_env_cap_entry_t (char const ∗n, l4_cap_idx_t c, l4_umword_t f=0) L4_NOTHROW

  Create an entry with the name n, capability c, and flags f.

Data Fields

- l4_cap_idx_t **cap**

  The capability index for the object or L4_INVALID_CAP.
- l4_umword_t flags

  Flags for the object.
- char **name** [16]

  The name of the object.

15.358.1 Detailed Description

Entry in the L4Re environment array for the named initial objects.
Definition at line 43 of file env.h.

15.358.2 Constructor & Destructor Documentation

15.358.2.1 l4re_env_cap_entry_t()

```
l4re_env_cap_entry_t::l4re_env_cap_entry_t (
            char const * n,
            l4_cap_idx_t c,
            l4_umword_t f = 0)  [inline]
```

Create an entry with the name *n*, capability *c*, and flags *f*.

Parameters

n	is the name of the initial object.
c	is the capability index that refers the initial object.

f	are the additional flags for the object.

Definition at line 74 of file env.h.
References cap, flags, L4_NOTHROW, and name.

15.358.3 Field Documentation

15.358.3.1 flags

```
l4_umword_t l4re_env_cap_entry_t::flags
```

Flags for the object.

Note

Currently unused, except as an end marker for the entry list.

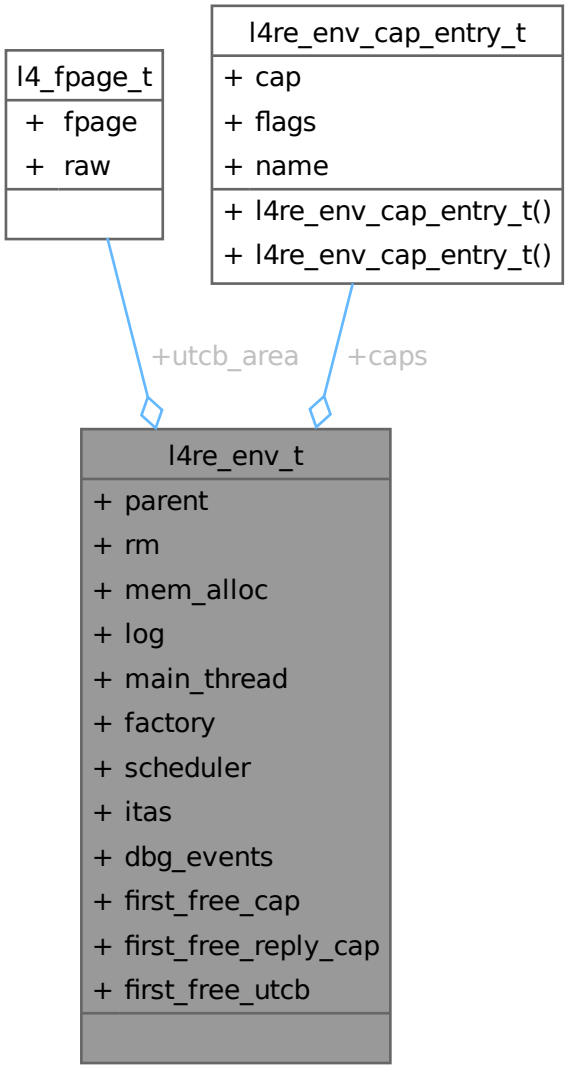
Definition at line 54 of file env.h.
Referenced by l4re_env_cap_entry_t(), l4re_env_cap_entry_t(), and l4re_env_get_cap_l().
The documentation for this struct was generated from the following file:

- l4/re/env.h

15.359 l4re_env_t Struct Reference

Initial environment data structure.
`#include <env.h>`

Collaboration diagram for l4re_env_t:



Data Fields

- l4_cap_idx_t **parent**

  Parent object-capability.
- l4_cap_idx_t **rm**

  Region map object-capability.
- l4_cap_idx_t **mem_alloc**

  Memory allocator object-capability.
- l4_cap_idx_t **log**

  Logging object-capability.
- l4_cap_idx_t **main_thread**

  Object-capability of the first user thread.
- l4_cap_idx_t **factory**

Object-capability of the factory available to the task.

- l4_cap_idx_t **scheduler**

  Object capability for the scheduler set to use.

- l4_cap_idx_t **itas**

  ITAS services object-capability.

- l4_cap_idx_t **dbg_events**

  Object-capability of the debug events service.

- l4_cap_idx_t **first_free_cap**

  *First object capability index available to the application (**not** shifted by L4_CAP_SHIFT).*

- l4_umword_t **first_free_reply_cap**

  *First reply capability index available to the application (**not** shifted by L4_CAP_SHIFT).*

- l4_fpage_t **utcb_area**

  UTCB area of the task.

- l4_addr_t **first_free_utcb**

  First UTCB within the UTCB area available to the application.

- l4re_env_cap_entry_t * caps

  Pointer to the first entry in the initial objects array which contains l4re_env_cap_entry_t elements.

15.359.1 Detailed Description

Initial environment data structure.

See also

Initial environment

Definition at line 114 of file env.h.

15.359.2 Field Documentation

15.359.2.1 caps

`l4re_env_cap_entry_t* l4re_env_t::caps`

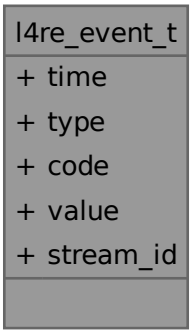
Pointer to the first entry in the initial objects array which contains l4re_env_cap_entry_t elements.
The array is terminated by an invalid entry with a `flags` value of `~0ul`.
Definition at line 138 of file env.h.
The documentation for this struct was generated from the following file:

- l4/re/env.h

15.360 l4re_event_t Struct Reference

Event structure used in buffer.
`#include <event.h>`

Collaboration diagram for l4re_event_t:



Data Fields

- long long **time**

  Time stamp of the event.
- unsigned short **type**

  Type of the event.
- unsigned short **code**

  Code of the event.
- int **value**

  Value of the event.
- l4_umword_t **stream_id**

  Stream ID.

15.360.1 Detailed Description

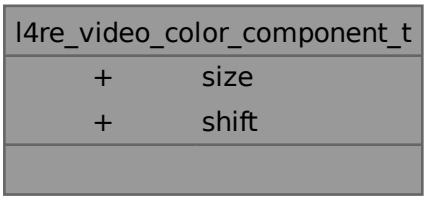
Event structure used in buffer.
Definition at line 30 of file event.h.
The documentation for this struct was generated from the following file:

- l4/re/c/event.h

15.361 l4re_video_color_component_t Struct Reference

Color component structure.
`#include <colors.h>`

Collaboration diagram for l4re_video_color_component_t:



Data Fields

- unsigned char **size**

  Size in bits.
- unsigned char **shift**

  offset in pixel

15.361.1 Detailed Description

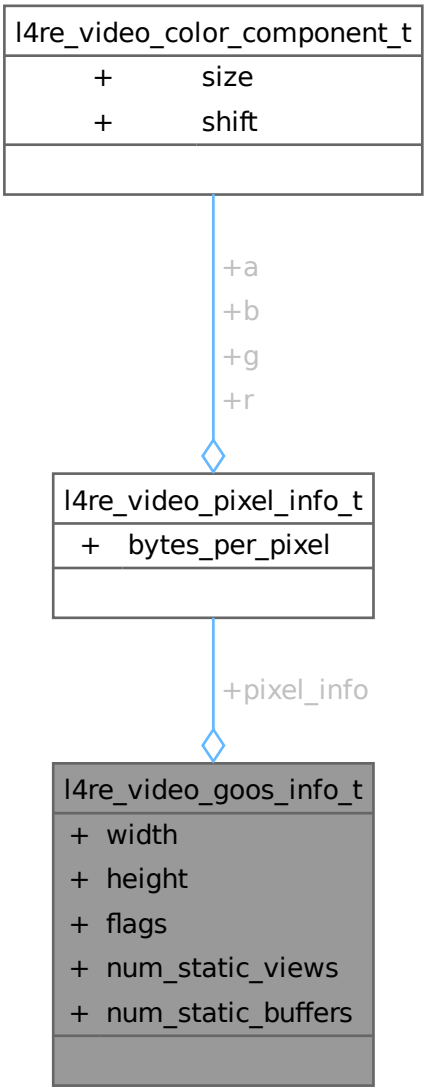
Color component structure.
Definition at line 20 of file colors.h.
The documentation for this struct was generated from the following file:

- l4/re/c/video/colors.h

15.362 l4re_video_goos_info_t Struct Reference

Goos information structure.
`#include <goos.h>`

Collaboration diagram for l4re_video_goos_info_t:



Data Fields

- unsigned long **width**

  Width of the goos.
- unsigned long **height**

  Height of the goos.
- unsigned **flags**

  Flags of the framebuffer, see l4re_video_goos_info_flags_t.
- unsigned **num_static_views**

  Number of static views.
- unsigned **num_static_buffers**

  Number of static buffers.

- l4re_video_pixel_info_t **pixel_info**

  Pixel layout of the goos.

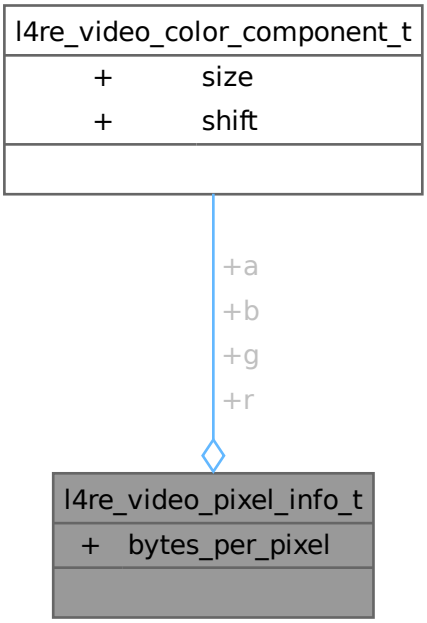
15.362.1 Detailed Description

Goos information structure.
Definition at line 41 of file goos.h.
The documentation for this struct was generated from the following file:

- l4/re/c/video/goos.h

15.363 l4re_video_pixel_info_t Struct Reference

Pixel_info structure.
`#include <colors.h>`
Collaboration diagram for l4re_video_pixel_info_t:



Data Fields

- l4re_video_color_component_t **a**

  Colors.
- unsigned char **bytes_per_pixel**

  Bytes per pixel.

15.363.1 Detailed Description

Pixel_info structure.
Definition at line 30 of file colors.h.
The documentation for this struct was generated from the following file:

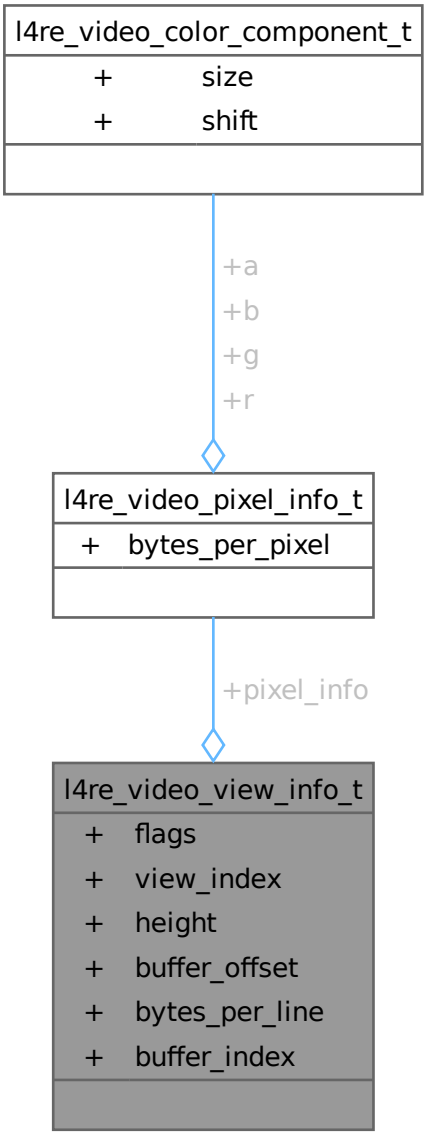
- l4/re/c/video/colors.h

15.364 l4re_video_view_info_t Struct Reference

View information structure.

`#include <view.h>`

Collaboration diagram for l4re_video_view_info_t:



Data Fields

- unsigned **flags**

  Flags.
- unsigned **view_index**

  Number of view in the goos.
- unsigned long **height**

  Position in goos and size of view.

- unsigned long **buffer_offset**

  Memory offset in goos buffer.
- unsigned long **bytes_per_line**

  Size of line in view.
- l4re_video_pixel_info_t **pixel_info**

  Pixel info.
- unsigned **buffer_index**

  Number of buffer of goos.

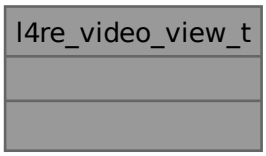
15.364.1 Detailed Description

View information structure.
Definition at line 49 of file view.h.
The documentation for this struct was generated from the following file:

- l4/re/c/video/view.h

15.365 l4re_video_view_t Struct Reference

C representation of a goos view.
`#include <view.h>`
Collaboration diagram for l4re_video_view_t:



15.365.1 Detailed Description

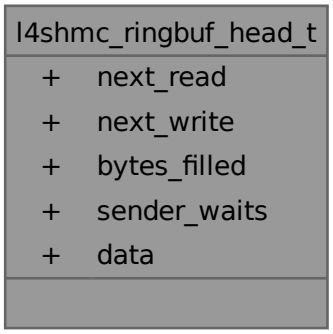
C representation of a goos view.
A view is a visible rectangle that provides a view to the contents of a buffer (frame buffer) memory object and is placed on a real screen.
Definition at line 68 of file view.h.
The documentation for this struct was generated from the following file:

- l4/re/c/video/view.h

15.366 l4shmc_ringbuf_head_t Struct Reference

Head field of a ring buffer.
`#include <ringbuf.h>`

Collaboration diagram for l4shmc_ringbuf_head_t:



Data Fields

- unsigned **next_read**
  offset to next read packet
- unsigned **next_write**
  offset to next write packet
- unsigned **bytes_filled**
  bytes filled in buffer
- unsigned **sender_waits**
  sender waiting?
- char **data** [ ]
  tail pointer -> data

15.366.1 Detailed Description

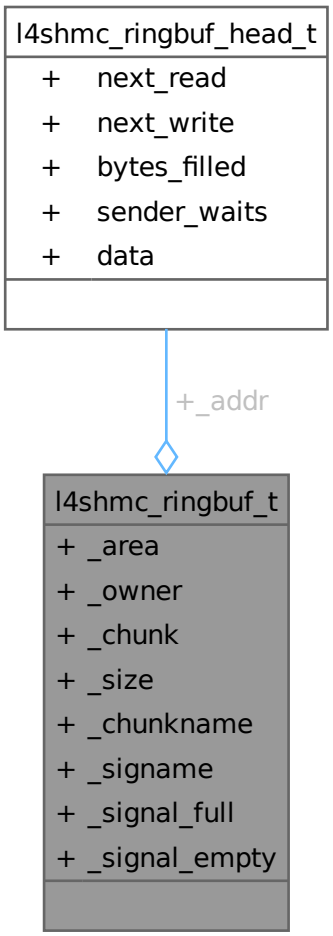
Head field of a ring buffer.
Definition at line 59 of file ringbuf.h.
The documentation for this struct was generated from the following file:

- l4/shmc/ringbuf.h

15.367 l4shmc_ringbuf_t Struct Reference

Ring buffer.
`#include <ringbuf.h>`

Collaboration diagram for l4shmc_ringbuf_t:



Data Fields

- l4shmc_area_t * **_area**

  L4SHM area this buffer is located in.
- l4_cap_idx_t **_owner**

  owner (attached to send/recv signal)
- l4shmc_chunk_t **_chunk**

  chunk descriptor
- unsigned **_size**

  chunk size // XXX do we need this?
- char * **_chunkname**

  name of the ring buffer chunk
- char * **_signame**

  base name of the ring buffer signals
- l4shmc_ringbuf_head_t * **_addr**

  pointer to ring buffer head
- l4shmc_signal_t **_signal_full**

"full" signal - triggered when data is produced

- l4shmc_signal_t **_signal_empty**

  "empty" signal - triggered when data is consumed

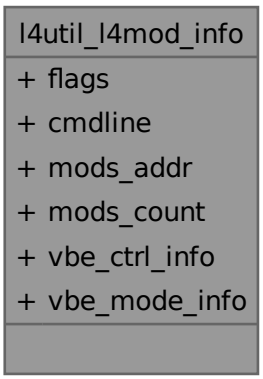
15.367.1 Detailed Description

Ring buffer.
Definition at line 85 of file ringbuf.h.
The documentation for this struct was generated from the following file:

- l4/shmc/ringbuf.h

15.368 l4util_l4mod_info Struct Reference

Base module structure.
`#include <l4mod.h>`
Collaboration diagram for l4util_l4mod_info:



Data Fields

- l4_uint64_t **flags**

  Flags.

- l4_uint64_t **cmdline**

  Pointer to kernel command line.

- l4_uint64_t **mods_addr**

  Module list.

- l4_uint32_t **mods_count**

  Number of modules.

- l4_uint64_t vbe_ctrl_info

  VESA video info, valid if one of vbe_ctrl_info or vbe_mode_info is not zero.

- l4_uint64_t **vbe_mode_info**

  VESA video mode info.

15.368.1 Detailed Description

Base module structure.
Definition at line 43 of file l4mod.h.

15.368.2 Field Documentation

15.368.2.1 vbe_ctrl_info

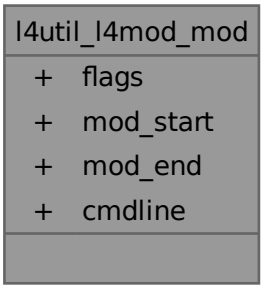
```
l4_uint64_t l4util_l4mod_info::vbe_ctrl_info
```

VESA video info, valid if one of vbe_ctrl_info or vbe_mode_info is not zero.
VESA video controller info
Definition at line 55 of file l4mod.h.
The documentation for this struct was generated from the following file:

- l4/util/l4mod.h

15.369 l4util_l4mod_mod Struct Reference

A single module.
`#include <l4mod.h>`
Collaboration diagram for l4util_l4mod_mod:



Data Fields

- l4_uint64_t **flags**

  Module flags (l4util_l4mod_mod_info_flag).
- l4_uint64_t **mod_start**

  Starting address of module in memory.
- l4_uint64_t **mod_end**

  End address of module in memory.
- l4_uint64_t **cmdline**

  Module command line.

15.369.1 Detailed Description

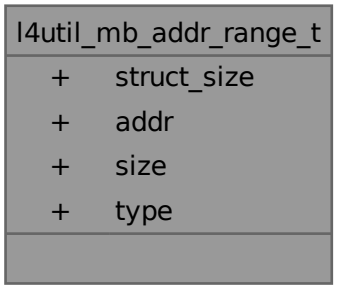
A single module.
Definition at line 34 of file l4mod.h.
The documentation for this struct was generated from the following file:

- l4/util/l4mod.h

15.370 l4util_mb_addr_range_t Struct Reference

INT-15, AX=E820 style "AddressRangeDescriptor" ...with a "size" parameter on the front which is the structure size - 4, pointing to the next one, up until the full buffer length of the memory map has been reached.

`#include <mb_info.h>`
Collaboration diagram for l4util_mb_addr_range_t:



Data Fields

- l4_uint32_t **struct_size**

  Size of structure.
- l4_uint64_t **addr**

  Start address.
- l4_uint64_t **size**

  Size of memory range.
- l4_uint32_t **type**

  type of memory range

15.370.1 Detailed Description

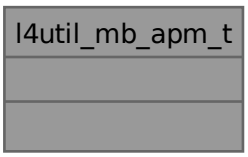
INT-15, AX=E820 style "AddressRangeDescriptor" ...with a "size" parameter on the front which is the structure size - 4, pointing to the next one, up until the full buffer length of the memory map has been reached.
Definition at line 48 of file mb_info.h.
The documentation for this struct was generated from the following file:

- l4/util/mb_info.h

15.371 l4util_mb_apm_t Struct Reference

APM BIOS info.
`#include <mb_info.h>`

Collaboration diagram for l4util_mb_apm_t:



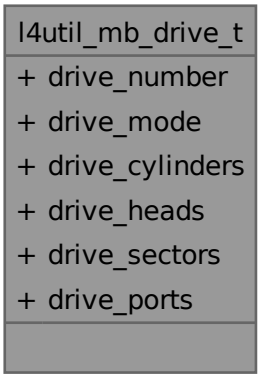
15.371.1 Detailed Description

APM BIOS info.
Definition at line 90 of file mb_info.h.
The documentation for this struct was generated from the following file:

- l4/util/mb_info.h

15.372 l4util_mb_drive_t Struct Reference

Drive Info structure.
`#include <mb_info.h>`
Collaboration diagram for l4util_mb_drive_t:



Data Fields

- l4_uint8_t **drive_number**

  < The size of this structure.
- l4_uint8_t **drive_mode**

  < The BIOS drive number.
- l4_uint16_t **drive_cylinders**

  < The access mode (see below).

- l4_uint8_t **drive_heads**

  <number of cylinders
- l4_uint8_t **drive_sectors**

  <number of heads
- l4_uint16_t **drive_ports** [0]

  <number of sectors per track

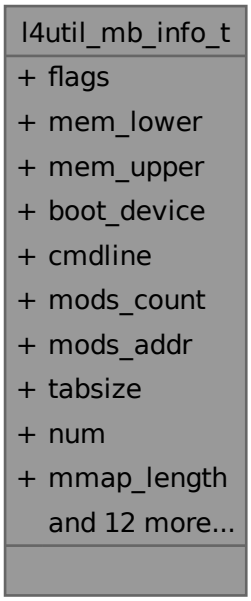
15.372.1 Detailed Description

Drive Info structure.
Definition at line 73 of file mb_info.h.
The documentation for this struct was generated from the following file:

- l4/util/mb_info.h

15.373 l4util_mb_info_t Struct Reference

MultiBoot Info description.
`#include <mb_info.h>`
Collaboration diagram for l4util_mb_info_t:



Data Fields

- l4_uint32_t **flags**

  MultiBoot info version number.
- l4_uint32_t **mem_lower**

  available memory below 1MB
- l4_uint32_t **mem_upper**

  available memory starting from 1MB [KB]

- l4_uint32_t **boot_device**

  "root" partition
- l4_uint32_t **cmdline**

  Kernel command line.
- l4_uint32_t **mods_count**

  number of modules
- l4_uint32_t **mods_addr**

  module list
- l4_uint32_t **mmap_length**

  size of memory mapping buffer
- l4_uint32_t **mmap_addr**

  address of memory mapping buffer
- l4_uint32_t **drives_length**

  size of drive info buffer
- l4_uint32_t **drives_addr**

  address of driver info buffer
- l4_uint32_t **config_table**

  ROM configuration table.
- l4_uint32_t **boot_loader_name**

  Boot Loader Name.
- l4_uint32_t **apm_table**

  APM table.
- l4_uint32_t **vbe_ctrl_info**

  VESA video contoller info.
- l4_uint32_t **vbe_mode_info**

  VESA video mode info.
- l4_uint16_t **vbe_mode**

  VESA video mode number.
- l4_uint16_t **vbe_interface_seg**

  VESA segment of prot BIOS interface.
- l4_uint16_t **vbe_interface_off**

  VESA offset of prot BIOS interface.
- l4_uint16_t **vbe_interface_len**

  VESA lenght of prot BIOS interface.

15.373.1 Detailed Description

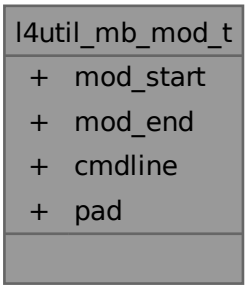
MultiBoot Info description.
This is the struct passed to the boot image. This is done by placing its address in the EAX register.
Definition at line 247 of file mb_info.h.
The documentation for this struct was generated from the following file:

- l4/util/mb_info.h

15.374 l4util_mb_mod_t Struct Reference

The structure type "mod_list" is used by the multiboot_info structure.
`#include <mb_info.h>`

Collaboration diagram for l4util_mb_mod_t:



Data Fields

- l4_uint32_t **mod_start**

  Starting address of module in memory.
- l4_uint32_t **mod_end**

  End address of module in memory.
- l4_uint32_t **cmdline**

  Module command line.
- l4_uint32_t **pad**

  padding to take it to 16 bytes

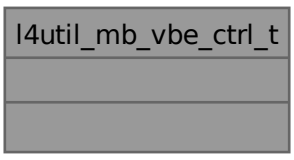
15.374.1 Detailed Description

The structure type "mod_list" is used by the multiboot_info structure.
Definition at line 33 of file mb_info.h.
The documentation for this struct was generated from the following file:

- l4/util/mb_info.h

15.375 l4util_mb_vbe_ctrl_t Struct Reference

VBE controller information.
`#include <mb_info.h>`
Collaboration diagram for l4util_mb_vbe_ctrl_t:



15.375.1 Detailed Description

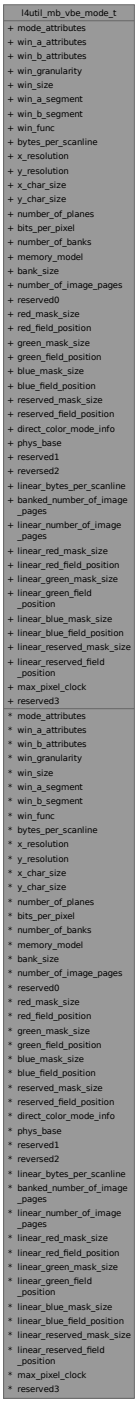
VBE controller information.
Definition at line 106 of file mb_info.h.
The documentation for this struct was generated from the following file:

- l4/util/mb_info.h

15.376 l4util_mb_vbe_mode_t Struct Reference

VBE mode information.
`#include <mb_info.h>`

Collaboration diagram for l4util_mb_vbe_mode_t:



Data Fields

all VESA versions

- l4_uint16_t **mode_attributes**
  Mode attributes.
- l4_uint8_t **win_a_attributes**
  Window A attributes.
- l4_uint8_t **win_b_attributes**

Window B attributes.

- l4_uint16_t **win_granularity**
  Window granularity.
- l4_uint16_t **win_size**
  Window size.
- l4_uint16_t **win_a_segment**
  Window A start segment.
- l4_uint16_t **win_b_segment**
  Window B start segment.
- l4_uint32_t **win_func**
  Real mode pointer to window function.
- l4_uint16_t **bytes_per_scanline**
  Bytes per scan line.

>= VESA version 1.2

- l4_uint16_t **x_resolution**
  Horizontal resolution in pixels or characters.
- l4_uint16_t **y_resolution**
  Vertical resolution in pixels or characters.
- l4_uint8_t **x_char_size**
  Character cell width in pixels.
- l4_uint8_t **y_char_size**
  Character cell height in pixels.
- l4_uint8_t **number_of_planes**
  Number of memory planes.
- l4_uint8_t **bits_per_pixel**
  Bits per pixel.
- l4_uint8_t **number_of_banks**
  Number of banks.
- l4_uint8_t **memory_model**
  Memory model type.
- l4_uint8_t **bank_size**
  Bank size in KiB.
- l4_uint8_t **number_of_image_pages**
  Number of images.
- l4_uint8_t **reserved0**
  Reserved for page function.

direct color

- l4_uint8_t **red_mask_size**
  Size of direct color red mask in bits.
- l4_uint8_t **red_field_position**
  Bit position of LSB of red mask.
- l4_uint8_t **green_mask_size**
  Size of direct color green mask in bits.
- l4_uint8_t **green_field_position**
  Bit position of LSB of green mask.
- l4_uint8_t **blue_mask_size**
  Size of direct color blue mask in bits.
- l4_uint8_t **blue_field_position**
  Bit position of LSB of blue mask.
- l4_uint8_t **reserved_mask_size**
  Size of direct color reserved mask in bits.
- l4_uint8_t **reserved_field_position**
  Bit position of LSB of reserved mask.
- l4_uint8_t **direct_color_mode_info**
  Direct color mode attributes.

>= VESA version 2.0

- l4_uint32_t **phys_base**
  Physical address for flat memory memory frame buffer.
- l4_uint32_t **reserved1**
  Reserved – always set to 0.
- l4_uint16_t **reversed2**
  Reserved – always set to 0.

>= VESA version 3.0

- l4_uint16_t **linear_bytes_per_scanline**
  Bytes per scan line for linear modes.
- l4_uint8_t **banked_number_of_image_pages**
  Number of images for banked modes.
- l4_uint8_t **linear_number_of_image_pages**
  Number of images for linear modes.
- l4_uint8_t **linear_red_mask_size**
  Size of direct color red mask (linear modes).
- l4_uint8_t **linear_red_field_position**
  Bit position of LSB of red mask (linear modes).
- l4_uint8_t **linear_green_mask_size**
  Size of direct color green mask (linear modes).
- l4_uint8_t **linear_green_field_position**
  Bit position of LSB of green mask (linear modes).
- l4_uint8_t **linear_blue_mask_size**
  Size of direct color blue mask (linear modes).
- l4_uint8_t **linear_blue_field_position**
  Bit position of LSB of blue mask (linear modes).
- l4_uint8_t **linear_reserved_mask_size**
  Size of direct color reserved mask (linear modes).
- l4_uint8_t **linear_reserved_field_position**
  Bit position of LSB of reserved mask (linear modes).
- l4_uint32_t **max_pixel_clock**
  Maximum pixel clock (in Hz) for graphics mode.
- l4_uint8_t **reserved3** [190]
  Reserved (padding).

15.376.1 Detailed Description

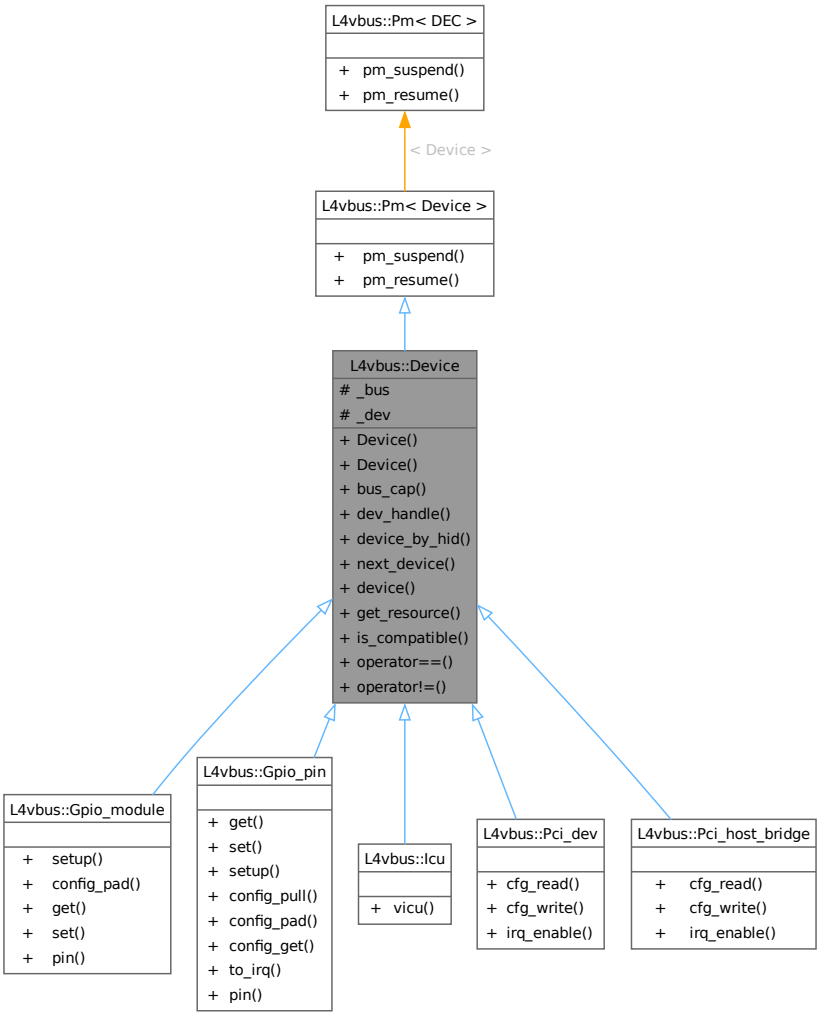
VBE mode information.
Definition at line 125 of file mb_info.h.
The documentation for this struct was generated from the following file:

- l4/util/mb_info.h

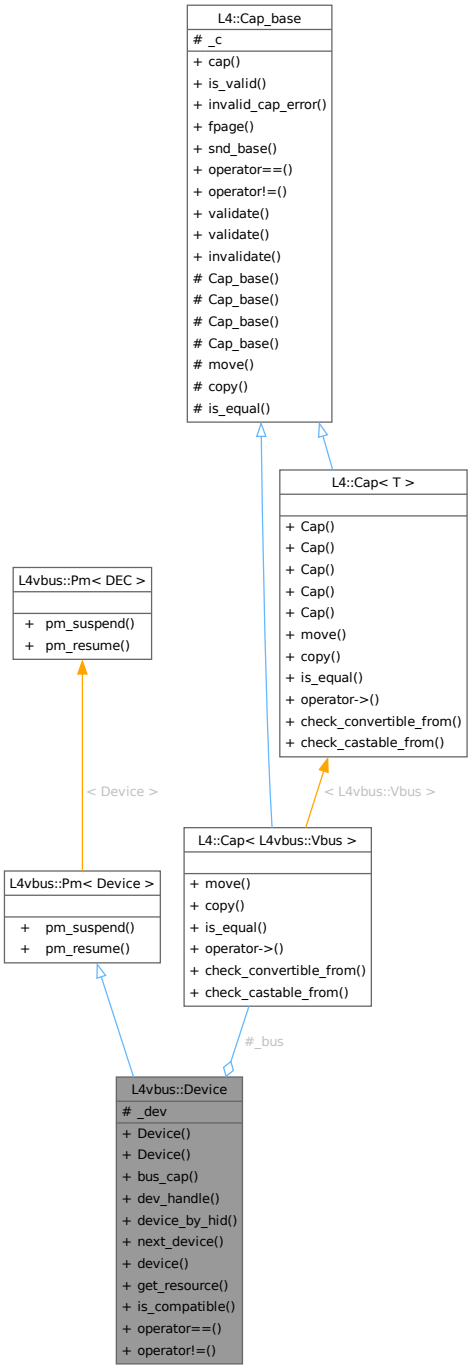
15.377 L4vbus::Device Class Reference

Device on a L4vbus::Vbus.
`#include <vbus>`

Inheritance diagram for L4vbus::Device:



Collaboration diagram for L4vbus::Device:



Public Member Functions

- **Device** ()

  Construct a new vbus device using the NULL device L4VBUS_NULL.

- Device (L4::Cap< Vbus > bus, l4vbus_device_handle_t dev)

  Construct a new vbus device using a device handle.

- L4::Cap< Vbus > bus_cap () const

  Access the Vbus capability of the underlying virtual bus.

- l4vbus_device_handle_t dev_handle () const

  Access the device handle of this device.
- int device_by_hid (Device *child, char const *hid, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find a device by the hardware interface identifier (HID).
- int next_device (Device *child, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find next child following `child`.
- int device (l4vbus_device_t *devinfo) const

  Obtain detailed information about a Vbus device.
- int get_resource (unsigned res_idx, l4vbus_resource_t *res) const

  Obtain the resource description of an individual device resource.
- int is_compatible (char const *cid) const

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- bool operator== (Device const &o) const

  Test if two devices are the same Vbus device.
- bool operator!= (Device const &o) const

  Test if two Vbus devices are not the same.

Public Member Functions inherited from L4vbus::Pm< Device >

- int pm_suspend () const

  Suspend the device.
- int pm_resume () const

  Resume the device.

Protected Attributes

- L4::Cap< Vbus > **_bus**

  The Vbus capability where this device is located on.
- l4vbus_device_handle_t **_dev**

  The device handle for this device.

15.377.1 Detailed Description

Device on a L4vbus::Vbus.
Definition at line 83 of file vbus.

15.377.2 Constructor & Destructor Documentation

15.377.2.1 Device()

```
L4vbus::Device::Device (
            L4::Cap< Vbus > bus,
            l4vbus_device_handle_t dev)  [inline]
```

Construct a new vbus device using a device handle.
Specifying the special root bus device handle L4VBUS_ROOT_BUS forms the root device of the corresponding vbus, see Vbus::root.

Parameters

bus	The vbus capability where this device is assigned.
dev	The device handle of the device.

Definition at line 100 of file vbus.
References _bus, and _dev.

15.377.3 Member Function Documentation

15.377.3.1 bus_cap()

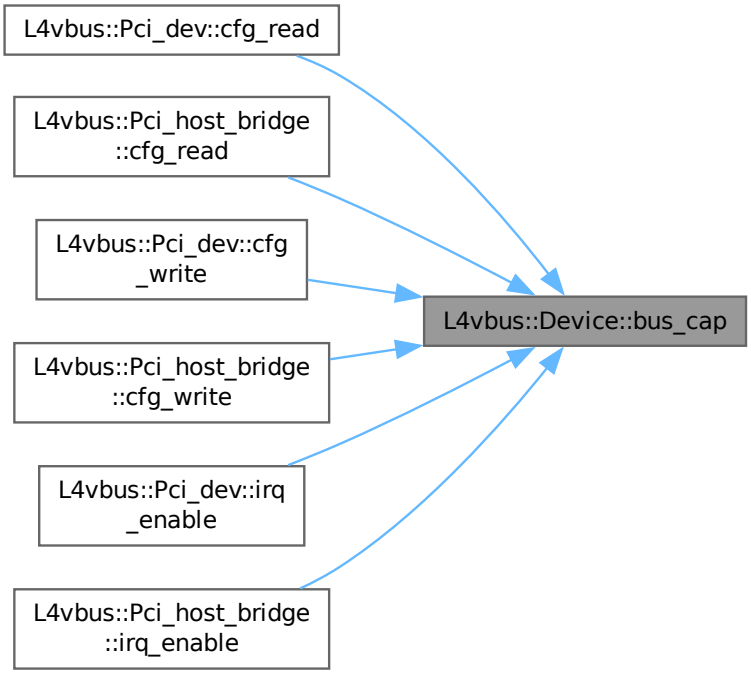
```
L4::Cap< Vbus > L4vbus::Device::bus_cap () const  [inline]
```

Access the Vbus capability of the underlying virtual bus.

Returns

the capability to the underlying Vbus.

Definition at line 107 of file vbus.
References _bus.
Referenced by L4vbus::Pci_dev::cfg_read(), L4vbus::Pci_host_bridge::cfg_read(), L4vbus::Pci_dev::cfg_write(), L4vbus::Pci_host_bridge::cfg_write(), L4vbus::Pci_dev::irq_enable(), and L4vbus::Pci_host_bridge::irq_enable().
Here is the caller graph for this function:



15.377.3.2 dev_handle()

```
l4vbus_device_handle_t L4vbus::Device::dev_handle () const  [inline]
```

Access the device handle of this device.

Returns

the device handle for this device.

The device handle is used to directly address the device on its virtual bus.
Definition at line 116 of file vbus.
References _dev.

15.377.3.3 device()

```
int L4vbus::Device::device (
            l4vbus_device_t * devinfo) const  [inline]
```

Obtain detailed information about a Vbus device.

Parameters

out	*devinfo*	Information structure which contains details about the device. The pointer might be NULL.

Return values

0	Success.
-L4_ENODEV	No device with the given device handle dev could be found.

Definition at line 189 of file vbus.
References _bus, _dev, and l4vbus_get_device().
Here is the call graph for this function:



15.377.3.4 device_by_hid()

```
int L4vbus::Device::device_by_hid (
            Device * child,
            char const * hid,
            int depth = L4VBUS_MAX_DEPTH,
            l4vbus_device_t * devinfo = 0) const  [inline]
```

Find a device by the hardware interface identifier (HID).
This function searches the vbus for a device with the given HID and returns a handle to the first matching device. The HID usually conforms to an ACPI HID or a Linux device tree compatible identifier.
It is possible to have multiple devices with the same HID on a vbus. In order to find all matching devices this function has to be called repeatedly with child pointing to the device found in the previous iteration. The iteration starts at child that might be any device node in the tree.

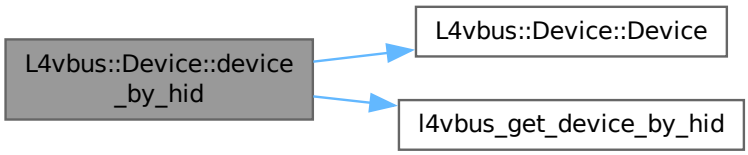
Parameters

in, out	*child*	Handle of the device from where in the device tree the search should start. To start searching from the beginning child must be initialized using the default (L4VBUS_NULL). If a matching device is found, its handle is returned through this parameter.
	hid	HID of the device
	depth	Maximum depth for the recursive lookup
out	*devinfo*	Device information structure (might be NULL)

Return values

>=0	A device with the given HID was found.
-L4_ENOENT	No device with the given HID could be found on the vbus.
-L4_EINVAL	Invalid or no HID provided.
-L4_ENODEV	Function called on a non-existing device.

Definition at line 148 of file vbus.
References _bus, _dev, Device(), and l4vbus_get_device_by_hid().
Here is the call graph for this function:



15.377.3.5 get_resource()

```
int L4vbus::Device::get_resource (
            unsigned res_idx,
            l4vbus_resource_t * res) const  [inline]
```

Obtain the resource description of an individual device resource.

Parameters

	res_idx	Index of the resource for which the resource description should be returned. The total number of resources for a device is available in the l4vbus_device_t structure that is returned by L4vbus::Device::device_by_hid() and L4vbus::Device::next_device().
out	*res*	Descriptor of the resource.

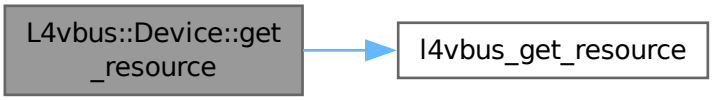
This function returns the resource descriptor of an individual device resource selected by the `res_idx` parameter.

Return values

0	Success.
-L4_ENOENT	Invalid resource index `res_idx`.

Definition at line 209 of file vbus.
References _bus, _dev, and l4vbus_get_resource().

Here is the call graph for this function:



15.377.3.6 is_compatible()

```
int L4vbus::Device::is_compatible (
            char const * cid) const  [inline]
```

Check if the given device has a compatibility ID (CID) or HID that matches *cid*.

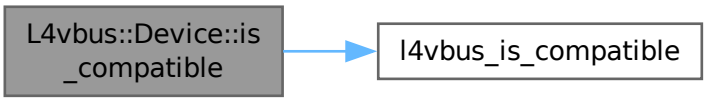
Parameters

cid	the compatibility ID to test

Returns

1 when the given ID (*cid*) matches this device, 0 when the given ID does not match, <0 on error.

Definition at line 223 of file vbus.
References _bus, _dev, and l4vbus_is_compatible().
Here is the call graph for this function:



15.377.3.7 next_device()

```
int L4vbus::Device::next_device (
            Device * child,
            int depth = L4VBUS_MAX_DEPTH,
            l4vbus_device_t * devinfo = 0) const  [inline]
```

Find next child following `child`.

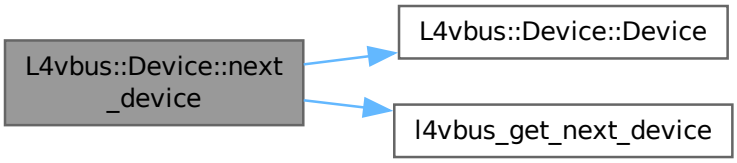
Parameters

in,out	*child*	Handle of the device that precedes the device that shall be returned. To start from the beginning, child must be initialized with L4VBUS_NULL (Device::Device). If a device is found, its handle is returned through this parameter.
	depth	Depth to look for
out	*devinfo*	Device information (might be NULL)

Returns

0 on success, else failure

Definition at line 171 of file vbus.
References _bus, _dev, Device(), and l4vbus_get_next_device().
Here is the call graph for this function:



15.377.3.8 operator"!=()

```
bool L4vbus::Device::operator!= (
            Device const & o) const  [inline]
```

Test if two Vbus devices are not the same.

Returns

true if the two devices are different, false else.

Definition at line 239 of file vbus.
References _bus, _dev, and Device().
Here is the call graph for this function:



15.377.3.9 operator==()

```
bool L4vbus::Device::operator== (
            Device const & o) const  [inline]
```

Test if two devices are the same Vbus device.

Returns

true if the two devices are the same, false else.

Definition at line 230 of file vbus.
References _bus, _dev, and Device().
Here is the call graph for this function:



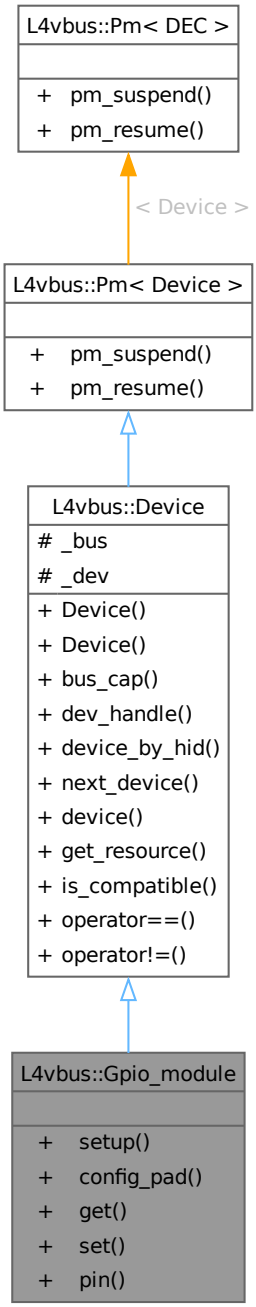
The documentation for this class was generated from the following file:

- l4/vbus/vbus

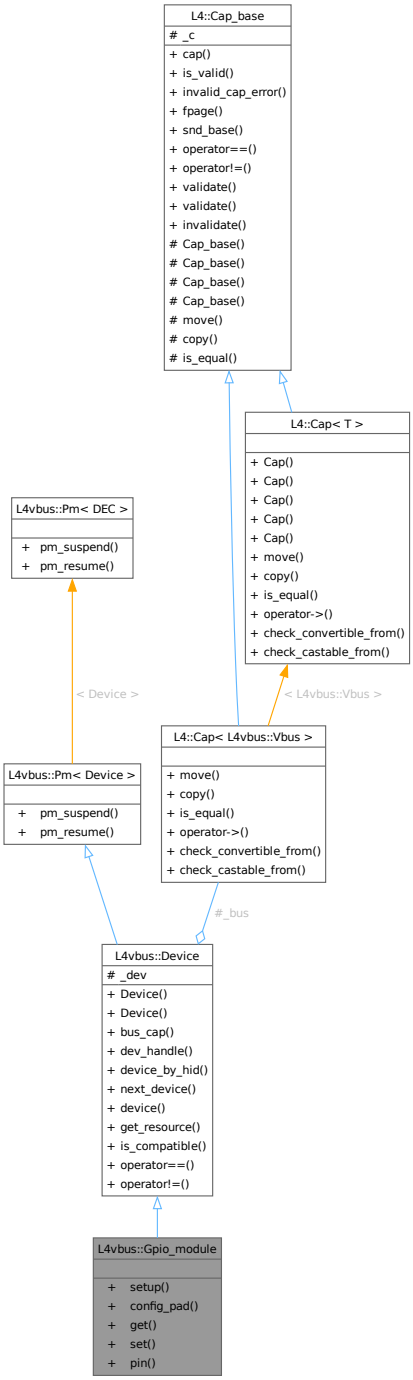
15.378 L4vbus::Gpio_module Class Reference

A Gpio_module groups multiple GPIO pins together.
`#include <vbus_gpio>`

Inheritance diagram for L4vbus::Gpio_module:



Collaboration diagram for L4vbus::Gpio_module:



Data Structures

- struct Pin_slice

  A slice of the pins provided by this module.

Public Member Functions

- int setup (Pin_slice const &mask, unsigned mode, unsigned value) const

Configure function of multiple GPIO pins at once.

- int config_pad (Pin_slice const &mask, unsigned func, unsigned value) const

  Hardware specific configuration function for multiple GPIO pins.
- int get (unsigned offset, unsigned *data) const

  Read values of multiple GPIO pins at once.
- int set (Pin_slice const &mask, unsigned data)

  Set multiple GPIO output pins at once.
- Gpio_pin pin (unsigned pin) const

  Get Gpio_pin for a specific pin of this Gpio_module.

Public Member Functions inherited from L4vbus::Device

- **Device** ()

  Construct a new vbus device using the NULL device L4VBUS_NULL.
- Device (L4::Cap< Vbus > bus, l4vbus_device_handle_t dev)

  Construct a new vbus device using a device handle.
- L4::Cap< Vbus > bus_cap () const

  Access the Vbus capability of the underlying virtual bus.
- l4vbus_device_handle_t dev_handle () const

  Access the device handle of this device.
- int device_by_hid (Device *child, char const *hid, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find a device by the hardware interface identifier (HID).
- int next_device (Device *child, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find next child following `child`.
- int device (l4vbus_device_t *devinfo) const

  Obtain detailed information about a Vbus device.
- int get_resource (unsigned res_idx, l4vbus_resource_t *res) const

  Obtain the resource description of an individual device resource.
- int is_compatible (char const *cid) const

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- bool operator== (Device const &o) const

  Test if two devices are the same Vbus device.
- bool operator!= (Device const &o) const

  Test if two Vbus devices are not the same.

Public Member Functions inherited from L4vbus::Pm< Device >

- int pm_suspend () const

  Suspend the device.
- int pm_resume () const

  Resume the device.

Additional Inherited Members

Protected Attributes inherited from L4vbus::Device

- L4::Cap< Vbus > **_bus**

  The Vbus capability where this device is located on.
- l4vbus_device_handle_t **_dev**

  The device handle for this device.

15.378.1 Detailed Description

A Gpio_module groups multiple GPIO pins together.
Definition at line 133 of file vbus_gpio.

15.378.2 Member Function Documentation

15.378.2.1 config_pad()

```
int L4vbus::Gpio_module::config_pad (
            Pin_slice const & mask,
            unsigned func,
            unsigned value) const  [inline]
```

Hardware specific configuration function for multiple GPIO pins.

Parameters

mask	Mask of GPIO pins to configure. A bit set to 1 configures this pin. A maximum of 32 pins can be configured at once. The real number depends on the hardware and the driver implementation.
func	Hardware specific configuration register, usually offset to the GPIO chip's base address.
value	Value which is written into the hardware specific configuration register for the specified pins

Returns

0 if OK, error code otherwise

Definition at line 185 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_multi_config_pad().
Here is the call graph for this function:



15.378.2.2 get()

```
int L4vbus::Gpio_module::get (
            unsigned offset,
            unsigned * data) const  [inline]
```

Read values of multiple GPIO pins at once.

Parameters

	offset	Pin corresponding to the LSB in *data*. Note: allowed may be hardware specific.
out	*data*	Each bit returns the value (0 or 1) for the corresponding GPIO pin. The value of pins that are not accessible is undefined.

Returns

0 if OK, error code otherwise

Definition at line 201 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_multi_get().
Here is the call graph for this function:



15.378.2.3 pin()

```
Gpio_pin L4vbus::Gpio_module::pin (
            unsigned pin) const  [inline]
```

Get Gpio_pin for a specific pin of this Gpio_module.

Parameters

pin	GPIO pin number to get Gpio_pin for.

Returns

Gpio_pin

Definition at line 229 of file vbus_gpio.
References pin().
Referenced by pin().
Here is the call graph for this function:



Here is the caller graph for this function:



15.378.2.4 set()

```
int L4vbus::Gpio_module::set (
            Pin_slice const & mask,
            unsigned data)  [inline]
```

Set multiple GPIO output pins at once.

Parameters

mask	Mask of GPIO pins to set. A bit set to 1 selects this pin. A maximum of 32 pins can be set at once. The real number depends on the hardware and the driver implementation.
data	Each bit corresponds to the GPIO pin in *mask*. The value of each bit is written to the GPIO pin if its bit in *mask* is set.

Returns

0 if OK, error code otherwise

Definition at line 217 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_multi_set().
Here is the call graph for this function:



15.378.2.5 setup()

```
int L4vbus::Gpio_module::setup (
            Pin_slice const & mask,
            unsigned mode,
            unsigned value) const  [inline]
```

Configure function of multiple GPIO pins at once.

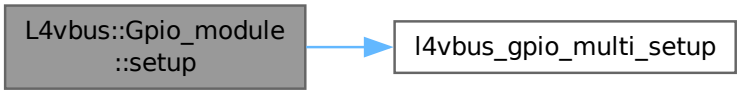
Parameters

mask	Mask of GPIO pins to configure. A bit set to 1 configures this pin. A maximum of 32 pins can be configured at once. The real number depends on the hardware and the driver implementation.
mode	GPIO function, see L4vbus_gpio_generic_func for generic functions. Hardware specific functions must be provided in the lower 8 bits.
value	Optional value to set the GPIO pins to if they are configured as output pins

Returns

0 if OK, error code otherwise

Definition at line 166 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_multi_setup().
Here is the call graph for this function:

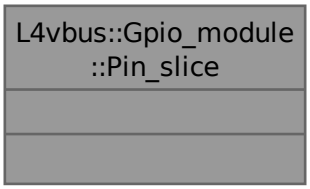


The documentation for this class was generated from the following file:

- l4/vbus/vbus_gpio

15.379 L4vbus::Gpio_module::Pin_slice Struct Reference

A slice of the pins provided by this module.
`#include <vbus_gpio>`
Collaboration diagram for L4vbus::Gpio_module::Pin_slice:



15.379.1 Detailed Description

A slice of the pins provided by this module.
Data type to specify a selection of pins for the 'multi' methods.
Definition at line 146 of file vbus_gpio.
The documentation for this struct was generated from the following file:

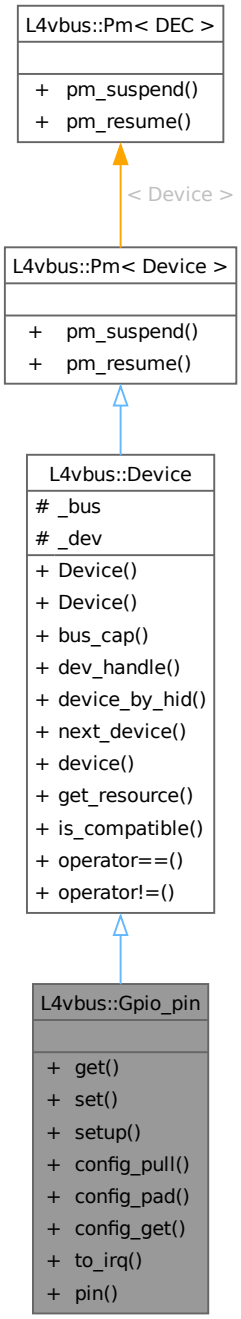
- l4/vbus/vbus_gpio

15.380 L4vbus::Gpio_pin Class Reference

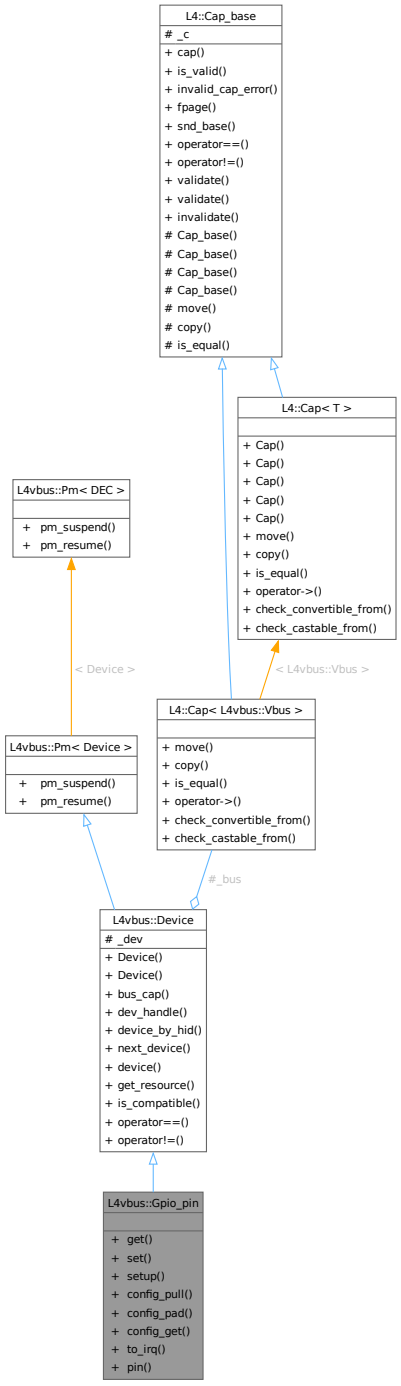
A GPIO pin.

`#include <vbus_gpio>`

Inheritance diagram for L4vbus::Gpio_pin:



Collaboration diagram for L4vbus::Gpio_pin:



Public Member Functions

- int get () const

  Read value of GPIO input pin.
- int set (int value) const

  Set GPIO output pin.
- int setup (unsigned mode, unsigned value) const

  Configure the function of a GPIO pin.

- int config_pull (unsigned mode) const

  Generic function to set pull up/down mode.
- int config_pad (unsigned func, unsigned value) const

  Hardware specific configuration function.
- int config_get (unsigned func, unsigned *value) const

  Read hardware specific configuration.
- int to_irq () const

  Create IRQ for GPIO pin.
- unsigned pin () const

  Get pin number.

Public Member Functions inherited from L4vbus::Device

- **Device** ()

  Construct a new vbus device using the NULL device L4VBUS_NULL.
- Device (L4::Cap< Vbus > bus, l4vbus_device_handle_t dev)

  Construct a new vbus device using a device handle.
- L4::Cap< Vbus > bus_cap () const

  Access the Vbus capability of the underlying virtual bus.
- l4vbus_device_handle_t dev_handle () const

  Access the device handle of this device.
- int device_by_hid (Device *child, char const *hid, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find a device by the hardware interface identifier (HID).
- int next_device (Device *child, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find next child following `child`.
- int device (l4vbus_device_t *devinfo) const

  Obtain detailed information about a Vbus device.
- int get_resource (unsigned res_idx, l4vbus_resource_t *res) const

  Obtain the resource description of an individual device resource.
- int is_compatible (char const *cid) const

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- bool operator== (Device const &o) const

  Test if two devices are the same Vbus device.
- bool operator!= (Device const &o) const

  Test if two Vbus devices are not the same.

Public Member Functions inherited from L4vbus::Pm< Device >

- int pm_suspend () const

  Suspend the device.
- int pm_resume () const

  Resume the device.

Additional Inherited Members

Protected Attributes inherited from L4vbus::Device

- L4::Cap< Vbus > **_bus**

  The Vbus capability where this device is located on.
- l4vbus_device_handle_t **_dev**

  The device handle for this device.

15.380.1 Detailed Description

A GPIO pin.
Definition at line 26 of file vbus_gpio.

15.380.2 Member Function Documentation

15.380.2.1 config_get()

```
int L4vbus::Gpio_pin::config_get (
            unsigned func,
            unsigned * value) const  [inline]
```

Read hardware specific configuration.

Parameters

	func	Hardware specific configuration register to read from. Usually this is an offset to the GPIO chip's base address.
out	*value*	The configuration value.

Returns

0 if OK, error code otherwise

Definition at line 102 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_config_get().
Here is the call graph for this function:



15.380.2.2 config_pad()

```
int L4vbus::Gpio_pin::config_pad (
            unsigned func,
            unsigned value) const  [inline]
```

Hardware specific configuration function.

Parameters

func	Hardware specific configuration register, usually offset to the GPIO chip's base address
value	Value which is written into the hardware specific configuration register for the specified pin

Returns

0 if OK, error code otherwise

Definition at line 89 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_config_pad().

Here is the call graph for this function:



15.380.2.3 config_pull()

```
int L4vbus::Gpio_pin::config_pull (
            unsigned mode) const  [inline]
```

Generic function to set pull up/down mode.

Parameters

mode	mode for pull up/down resistors, see L4vbus_gpio_pull_modes

Returns

0 if OK, error code otherwise

Definition at line 75 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_config_pull().
Here is the call graph for this function:



15.380.2.4 get()

```
int L4vbus::Gpio_pin::get () const  [inline]
```

Read value of GPIO input pin.

Returns

Value of GPIO pin (usually 0 or 1), negative error code otherwise.

Definition at line 38 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_get().
Here is the call graph for this function:



15.380.2.5 pin()

```
unsigned L4vbus::Gpio_pin::pin () const  [inline]
```

Get pin number.

Returns

GPIO pin number

Definition at line 122 of file vbus_gpio.

15.380.2.6 set()

```
int L4vbus::Gpio_pin::set (
            int value) const  [inline]
```

Set GPIO output pin.

Parameters

value	Value to write to the GPIO pin (usually 0 or 1)

Returns

0 if OK, error code otherwise

Definition at line 49 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_set().
Here is the call graph for this function:



15.380.2.7 setup()

```
int L4vbus::Gpio_pin::setup (
            unsigned mode,
            unsigned value) const  [inline]
```

Configure the function of a GPIO pin.

Parameters

mode	GPIO function, see L4vbus_gpio_generic_func for generic functions. Hardware specific functions must be provided in the lower 8 bits.
value	Optional value to set the GPIO pin to if it is configured as an output pin

Returns

0 if OK, error code otherwise

Definition at line 64 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_setup().
Here is the call graph for this function:



15.380.2.8 to_irq()

```
int L4vbus::Gpio_pin::to_irq () const  [inline]
```

Create IRQ for GPIO pin.

Returns

IRQ number if OK, negative error code otherwise

Definition at line 112 of file vbus_gpio.
References L4vbus::Device::_bus, L4vbus::Device::_dev, and l4vbus_gpio_to_irq().
Here is the call graph for this function:



The documentation for this class was generated from the following file:

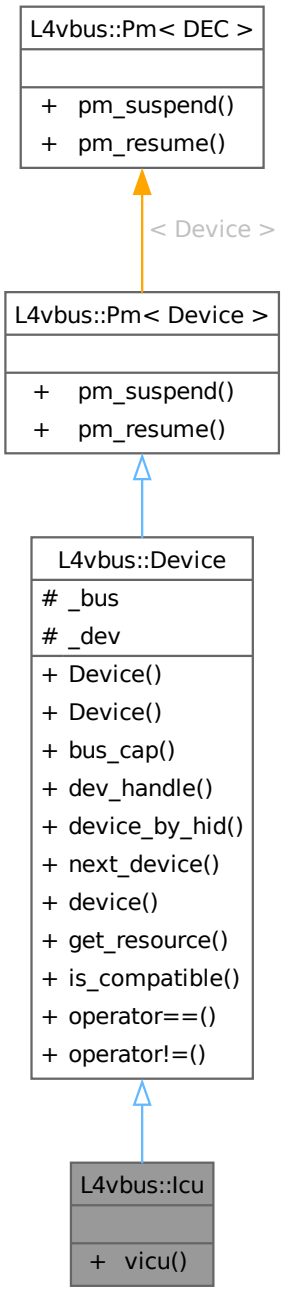
- l4/vbus/vbus_gpio

15.381 L4vbus::Icu Class Reference

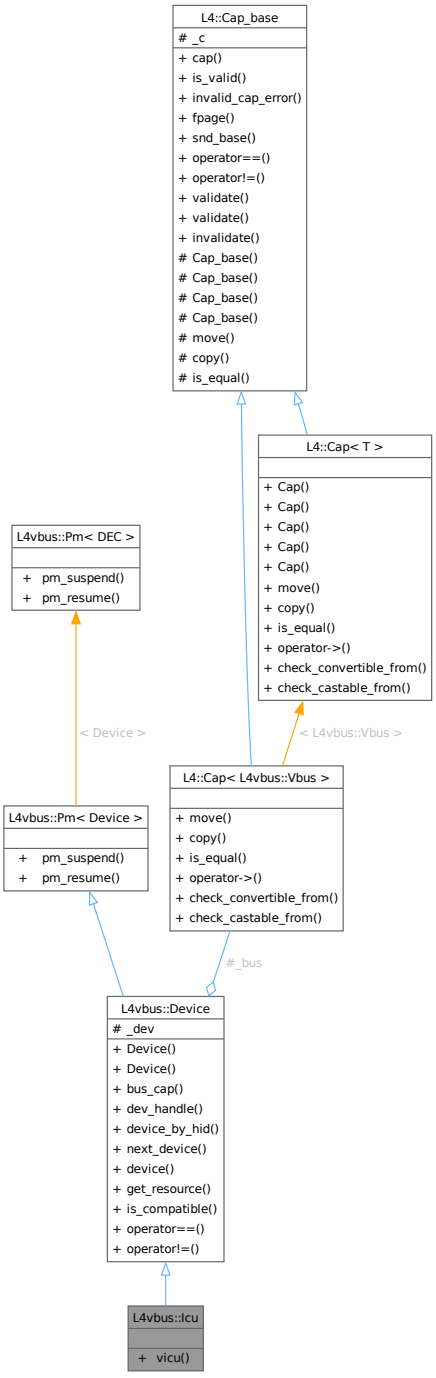
Vbus Interrupt controller API.

`#include <vbus>`

Inheritance diagram for L4vbus::Icu:



Collaboration diagram for L4vbus::Icu:



Public Types

- enum Src_types { Src_dev_handle = L4VBUS_ICU_SRC_DEV_HANDLE }

  Flags that can be used with the ICU on a vbus device.

Public Member Functions

- int vicu (L4::Cap< L4::Icu > icu) const

Request an L4::Icu capability for this Vbus's virtual ICU.

Public Member Functions inherited from L4vbus::Device

- **Device** ()

  Construct a new vbus device using the NULL device L4VBUS_NULL.
- Device (L4::Cap< Vbus > bus, l4vbus_device_handle_t dev)

  Construct a new vbus device using a device handle.
- L4::Cap< Vbus > bus_cap () const

  Access the Vbus capability of the underlying virtual bus.
- l4vbus_device_handle_t dev_handle () const

  Access the device handle of this device.
- int device_by_hid (Device *child, char const *hid, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find a device by the hardware interface identifier (HID).
- int next_device (Device *child, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find next child following `child`.
- int device (l4vbus_device_t *devinfo) const

  Obtain detailed information about a Vbus device.
- int get_resource (unsigned res_idx, l4vbus_resource_t *res) const

  Obtain the resource description of an individual device resource.
- int is_compatible (char const *cid) const

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- bool operator== (Device const &o) const

  Test if two devices are the same Vbus device.
- bool operator!= (Device const &o) const

  Test if two Vbus devices are not the same.

Public Member Functions inherited from L4vbus::Pm< Device >

- int pm_suspend () const

  Suspend the device.
- int pm_resume () const

  Resume the device.

Additional Inherited Members

Protected Attributes inherited from L4vbus::Device

- L4::Cap< Vbus > **_bus**

  The Vbus capability where this device is located on.
- l4vbus_device_handle_t **_dev**

  The device handle for this device.

15.381.1 Detailed Description

Vbus Interrupt controller API.
Every Vbus contains a virtual interrupt control unit that manages the IRQs of the devices on the bus. This class provides access to a capability to an L4::Icu object which can then be used to interface with the IRQs.

See also

L4::Icu

Definition at line 260 of file vbus.

15.381.2 Member Enumeration Documentation

15.381.2.1 Src_types

`enum L4vbus::Icu::Src_types`

Flags that can be used with the ICU on a vbus device.

Enumerator

Src_dev_handle	Flag to denote that the value should be interpreted as a device handle. This flag may be used in the `source` parameter in L4::Icu::msi_info() to denote that the ICU should interpret the source ID as a device handle.

Definition at line 264 of file vbus.

15.381.3 Member Function Documentation

15.381.3.1 vicu()

```
int L4vbus::Icu::vicu (
            L4::Cap< L4::Icu > icu) const  [inline]
```

Request an L4::Icu capability for this Vbus's virtual ICU.

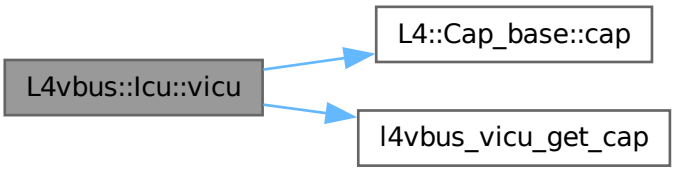
Parameters

`out`	*icu*	Capability slot where the L4::Icu capability shall be stored.

Return values

0	Success.
otherwise	IPC error.

Definition at line 285 of file vbus.
References L4vbus::Device::_bus, L4vbus::Device::_dev, L4::Cap_base::cap(), and l4vbus_vicu_get_cap().
Here is the call graph for this function:



The documentation for this class was generated from the following file:

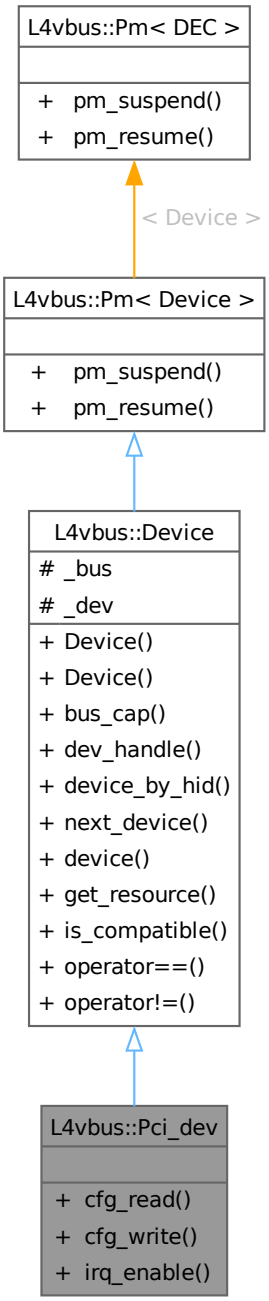
- l4/vbus/vbus

15.382 L4vbus::Pci_dev Class Reference

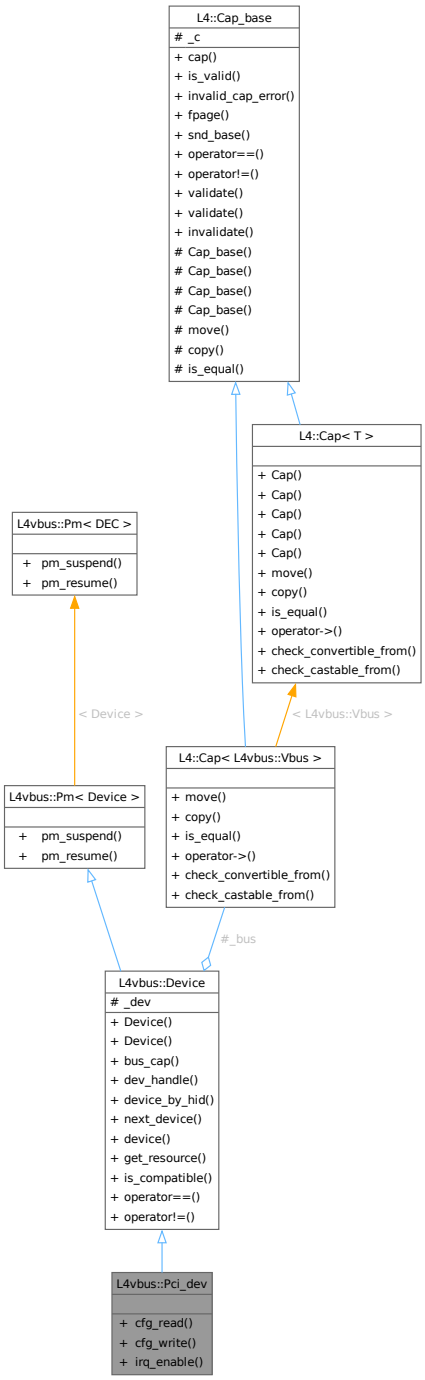
A PCI device.

`#include <vbus_pci>`

Inheritance diagram for L4vbus::Pci_dev:



Collaboration diagram for L4vbus::Pci_dev:



Public Member Functions

- int cfg_read (l4_uint32_t reg, l4_uint32_t *value, l4_uint32_t width) const

  Read from the device's vPCI configuration space.
- int cfg_write (l4_uint32_t reg, l4_uint32_t value, l4_uint32_t width) const

  Write to the device's vPCI configuration space.
- int irq_enable (unsigned char *trigger, unsigned char *polarity) const

  Enable the device's PCI interrupt.

Public Member Functions inherited from L4vbus::Device

- **Device** ()

  Construct a new vbus device using the NULL device L4VBUS_NULL.
- Device (L4::Cap< Vbus > bus, l4vbus_device_handle_t dev)

  Construct a new vbus device using a device handle.
- L4::Cap< Vbus > bus_cap () const

  Access the Vbus capability of the underlying virtual bus.
- l4vbus_device_handle_t dev_handle () const

  Access the device handle of this device.
- int device_by_hid (Device *child, char const *hid, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find a device by the hardware interface identifier (HID).
- int next_device (Device *child, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find next child following `child`.
- int device (l4vbus_device_t *devinfo) const

  Obtain detailed information about a Vbus device.
- int get_resource (unsigned res_idx, l4vbus_resource_t *res) const

  Obtain the resource description of an individual device resource.
- int is_compatible (char const *cid) const

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- bool operator== (Device const &o) const

  Test if two devices are the same Vbus device.
- bool operator!= (Device const &o) const

  Test if two Vbus devices are not the same.

Public Member Functions inherited from L4vbus::Pm< Device >

- int pm_suspend () const

  Suspend the device.
- int pm_resume () const

  Resume the device.

Additional Inherited Members

Protected Attributes inherited from L4vbus::Device

- L4::Cap< Vbus > **_bus**

  The Vbus capability where this device is located on.
- l4vbus_device_handle_t **_dev**

  The device handle for this device.

15.382.1 Detailed Description

A PCI device.
Definition at line 93 of file vbus_pci.

15.382.2 Member Function Documentation

15.382.2.1 cfg_read()

```
int L4vbus::Pci_dev::cfg_read (
            l4_uint32_t reg,
            l4_uint32_t * value,
            l4_uint32_t width) const  [inline]
```

Read from the device's vPCI configuration space.

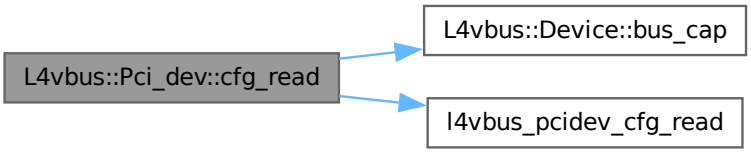
Parameters

	reg	Register in configuration space to read
out	*value*	Value that has been read
	width	Width to read in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

Definition at line 105 of file vbus_pci.
References L4vbus::Device::_dev, L4vbus::Device::bus_cap(), and l4vbus_pcidev_cfg_read().
Here is the call graph for this function:



15.382.2.2 cfg_write()

```
int L4vbus::Pci_dev::cfg_write (
            l4_uint32_t reg,
            l4_uint32_t value,
            l4_uint32_t width) const  [inline]
```

Write to the device's vPCI configuration space.

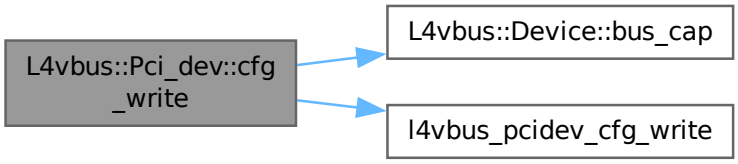
Parameters

reg	Register in configuration space to write
value	Value to write
width	Width to write in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

Definition at line 121 of file vbus_pci.
References L4vbus::Device::_dev, L4vbus::Device::bus_cap(), and l4vbus_pcidev_cfg_write().
Here is the call graph for this function:



15.382.2.3 irq_enable()

```
int L4vbus::Pci_dev::irq_enable (
            unsigned char * trigger,
            unsigned char * polarity) const  [inline]
```

Enable the device's PCI interrupt.

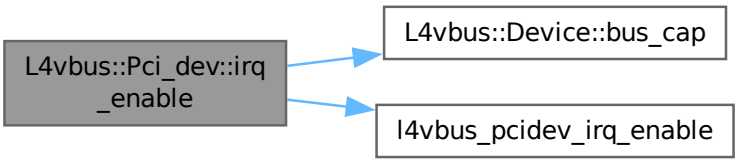
Parameters

out	*trigger*	False if interrupt is level-triggered
out	*polarity*	True if interrupt is of low polarity

Returns

On success: Interrupt line to be used, else failure

Definition at line 137 of file vbus_pci.
References L4vbus::Device::_dev, L4vbus::Device::bus_cap(), and l4vbus_pcidev_irq_enable().
Here is the call graph for this function:



The documentation for this class was generated from the following file:

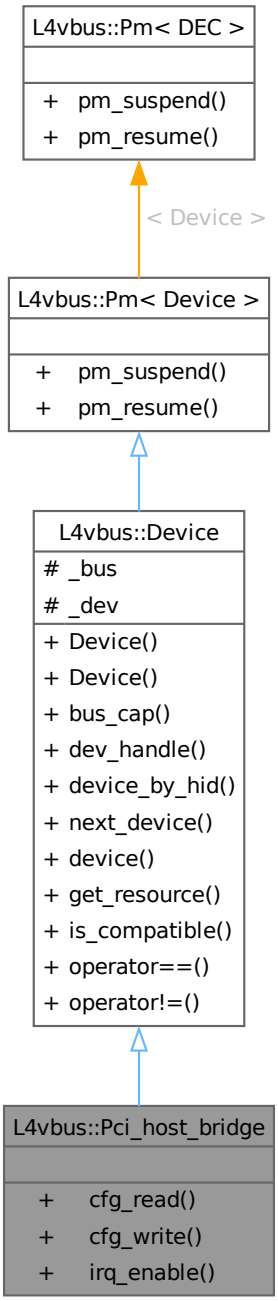
- l4/vbus/vbus_pci

15.383 L4vbus::Pci_host_bridge Class Reference

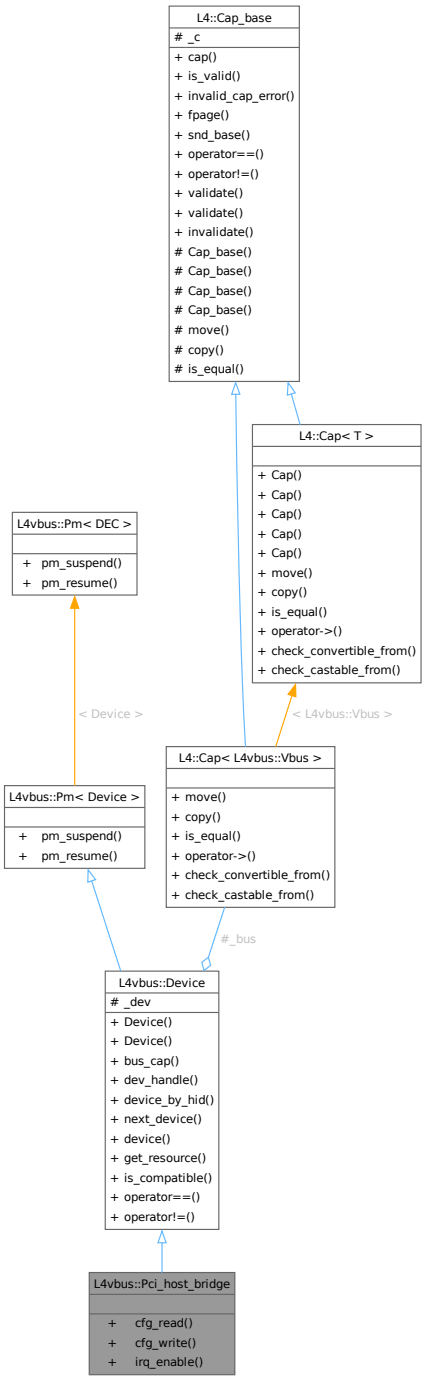
A Pci host bridge.

`#include <vbus_pci>`

Inheritance diagram for L4vbus::Pci_host_bridge:



Collaboration diagram for L4vbus::Pci_host_bridge:



Public Member Functions

- int cfg_read (l4_uint32_t bus, l4_uint32_t devfn, l4_uint32_t reg, l4_uint32_t *value, l4_uint32_t width) const

  Read from the vPCI configuration space using the PCI root bridge.
- int cfg_write (l4_uint32_t bus, l4_uint32_t devfn, l4_uint32_t reg, l4_uint32_t value, l4_uint32_t width) const

  Write to the vPCI configuration space using the PCI root bridge.
- int irq_enable (l4_uint32_t bus, l4_uint32_t devfn, int pin, unsigned char *trigger, unsigned char *polarity) const

Enable PCI interrupt for a specific device using the PCI root bridge.

Public Member Functions inherited from L4vbus::Device

- **Device** ()

  Construct a new vbus device using the NULL device L4VBUS_NULL.
- Device (L4::Cap< Vbus > bus, l4vbus_device_handle_t dev)

  Construct a new vbus device using a device handle.
- L4::Cap< Vbus > bus_cap () const

  Access the Vbus capability of the underlying virtual bus.
- l4vbus_device_handle_t dev_handle () const

  Access the device handle of this device.
- int device_by_hid (Device *child, char const *hid, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find a device by the hardware interface identifier (HID).
- int next_device (Device *child, int depth=L4VBUS_MAX_DEPTH, l4vbus_device_t *devinfo=0) const

  Find next child following `child`.
- int device (l4vbus_device_t *devinfo) const

  Obtain detailed information about a Vbus device.
- int get_resource (unsigned res_idx, l4vbus_resource_t *res) const

  Obtain the resource description of an individual device resource.
- int is_compatible (char const *cid) const

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- bool operator== (Device const &o) const

  Test if two devices are the same Vbus device.
- bool operator!= (Device const &o) const

  Test if two Vbus devices are not the same.

Public Member Functions inherited from L4vbus::Pm< Device >

- int pm_suspend () const

  Suspend the device.
- int pm_resume () const

  Resume the device.

Additional Inherited Members

Protected Attributes inherited from L4vbus::Device

- L4::Cap< Vbus > **_bus**

  The Vbus capability where this device is located on.
- l4vbus_device_handle_t **_dev**

  The device handle for this device.

15.383.1 Detailed Description

A Pci host bridge.
Definition at line 25 of file vbus_pci.

15.383.2 Member Function Documentation

15.383.2.1 cfg_read()

```
int L4vbus::Pci_host_bridge::cfg_read (
            l4_uint32_t bus,
            l4_uint32_t devfn,
            l4_uint32_t reg,
            l4_uint32_t * value,
            l4_uint32_t width) const  [inline]
```

Read from the vPCI configuration space using the PCI root bridge.

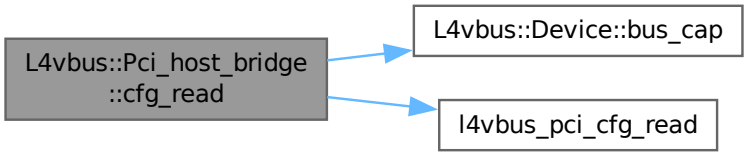
Parameters

	bus	Bus number
	devfn	Device id (upper 16bit) and function (lower 16bit)
	reg	Register in configuration space to read
out	*value*	Value that has been read
	width	Width to read in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

Definition at line 39 of file vbus_pci.
References L4vbus::Device::_dev, L4vbus::Device::bus_cap(), and l4vbus_pci_cfg_read().
Here is the call graph for this function:



15.383.2.2 cfg_write()

```
int L4vbus::Pci_host_bridge::cfg_write (
            l4_uint32_t bus,
            l4_uint32_t devfn,
            l4_uint32_t reg,
            l4_uint32_t value,
            l4_uint32_t width) const  [inline]
```

Write to the vPCI configuration space using the PCI root bridge.

Parameters

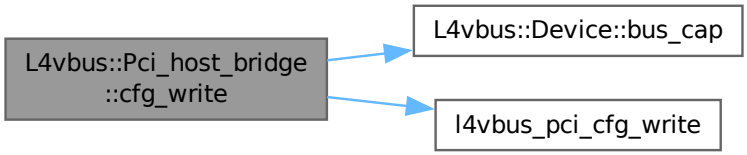
bus	Bus number
devfn	Device id (upper 16bit) and function (lower 16bit)

reg	Register in configuration space to write
value	Value to write
width	Width to write in bits (e.g. 8, 16, 32)

Returns

0 on success, else failure

Definition at line 58 of file vbus_pci.
References L4vbus::Device::_dev, L4vbus::Device::bus_cap(), and l4vbus_pci_cfg_write().
Here is the call graph for this function:



15.383.2.3 irq_enable()

```
int L4vbus::Pci_host_bridge::irq_enable (
              l4_uint32_t bus,
              l4_uint32_t devfn,
              int pin,
              unsigned char * trigger,
              unsigned char * polarity) const  [inline]
```

Enable PCI interrupt for a specific device using the PCI root bridge.

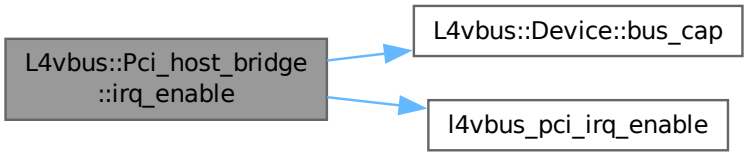
Parameters

	bus	Bus number
	devfn	Device id (upper 16bit) and function (lower 16bit)
	pin	Interrupt pin (normally as reported in configuration register INTR)
out	*trigger*	False if interrupt is level-triggered
out	*polarity*	True if interrupt is of low polarity

Returns

On success: Interrupt line to be used, else failure

Definition at line 79 of file vbus_pci.
References L4vbus::Device::_dev, L4vbus::Device::bus_cap(), and l4vbus_pci_irq_enable().
Here is the call graph for this function:



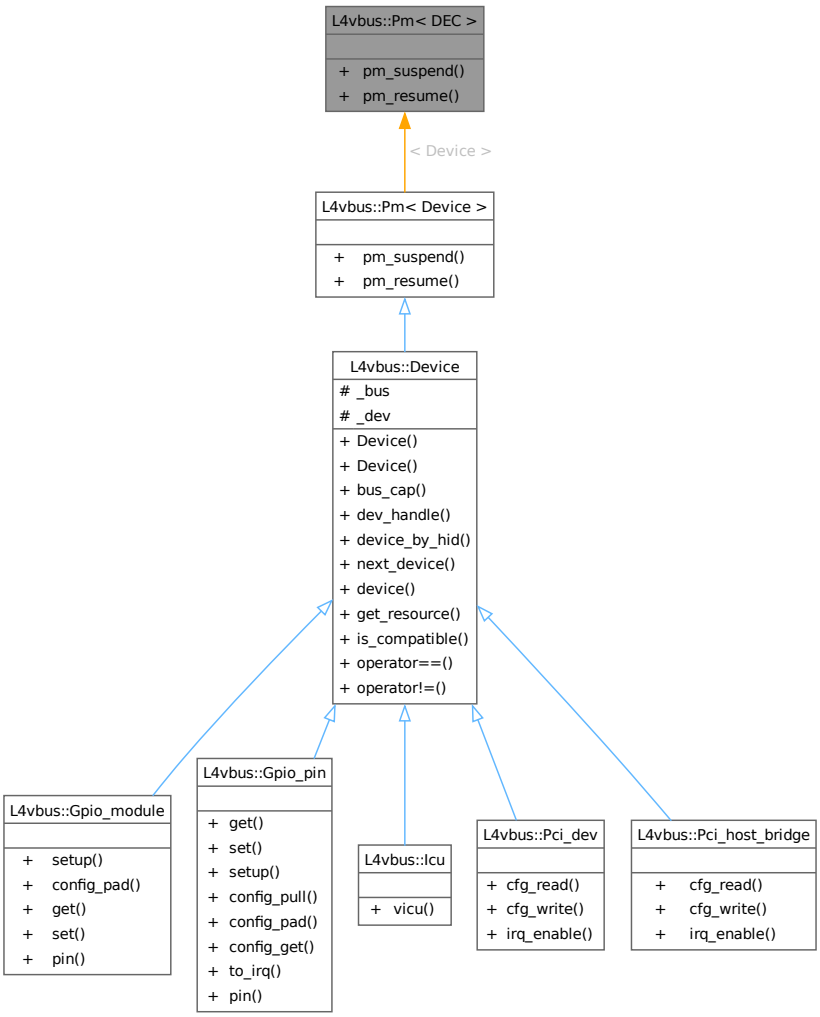
The documentation for this class was generated from the following file:

- l4/vbus/vbus_pci

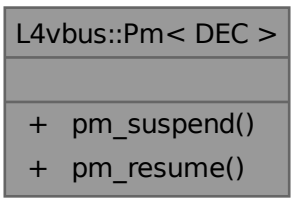
15.384 L4vbus::Pm< DEC > Class Template Reference

Power-management API mixin.
`#include <vbus>`

Inheritance diagram for L4vbus::Pm< DEC >:



Collaboration diagram for L4vbus::Pm< DEC >:



Public Member Functions

- int pm_suspend () const

Suspend the device.

- int pm_resume () const

  Resume the device.

15.384.1 Detailed Description

template<typename DEC>
class L4vbus::Pm< DEC >

Power-management API mixin.
Devices that inherit from this mixin provide an API to be suspended and resumed.
Definition at line 50 of file vbus.

15.384.2 Member Function Documentation

15.384.2.1 pm_resume()

```
template<typename DEC>
int L4vbus::Pm< DEC >::pm_resume () const  [inline]
```

Resume the device.
Switches the device from low-power mode to normal operation and restores the saved state.

Return values

0	Success.

Definition at line 74 of file vbus.
References l4vbus_pm_resume().
Here is the call graph for this function:



15.384.2.2 pm_suspend()

```
template<typename DEC>
int L4vbus::Pm< DEC >::pm_suspend () const  [inline]
```

Suspend the device.
Saves the state of the device and puts it into a low-power mode.

Return values

0	Success.

Definition at line 63 of file vbus.
References l4vbus_pm_suspend().

Here is the call graph for this function:



The documentation for this class was generated from the following file:

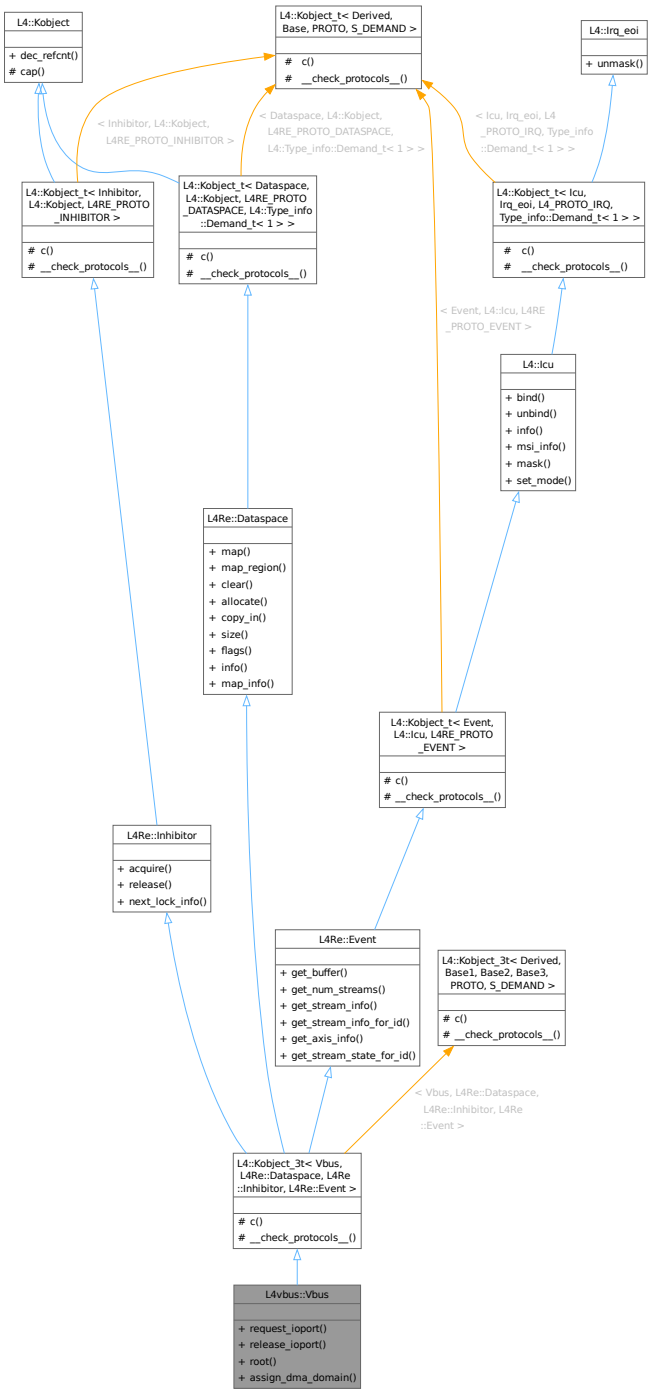
- l4/vbus/vbus

15.385 L4vbus::Vbus Class Reference

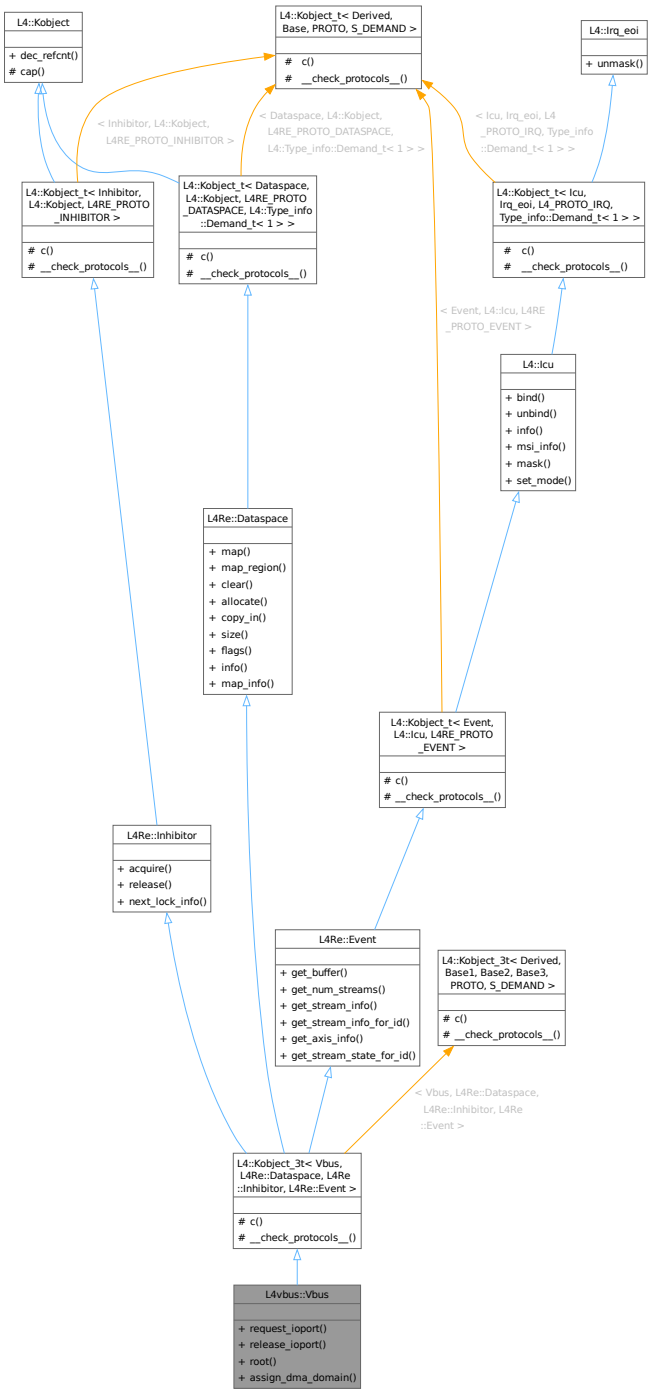
The virtual bus (Vbus) interface.

`#include <vbus>`

Inheritance diagram for L4vbus::Vbus:



Collaboration diagram for L4vbus::Vbus:



Public Member Functions

- int request_ioport (l4vbus_resource_t *res) const

  Request the given IO port resource from the bus.
- int release_ioport (l4vbus_resource_t *res) const

  Release the given IO port resource from the bus.
- Device root () const

  Get the root device of the device tree of this bus.

- int assign_dma_domain (unsigned domain_id, unsigned flags, L4::Cap< L4Re::Dma_space > dma_space) const

  Bind or unbind an L4Re::Dma_space to a DMA domain.

Public Member Functions inherited from L4Re::Dataspace

- l4_ret_t map (Offset offset, Flags flags, Map_addr local_addr, Map_addr min_addr, Map_addr max_addr, L4::Cap< L4::Task > dst=L4::Cap< L4::Task >::Invalid) const noexcept

  Request a flexpage mapping from the dataspace.
- l4_ret_t map_region (Offset offset, Flags flags, Map_addr min_addr, Map_addr max_addr, L4::Cap< L4::Task > dst=L4::Cap< L4::Task >::Invalid) const noexcept

  Map a part of a dataspace into a local memory area.
- l4_ret_t clear (Offset offset, Size size)

  Clear parts of a dataspace.
- l4_ret_t allocate (Offset offset, Size size)

  Allocate a range in the dataspace.
- l4_ret_t copy_in (Offset dst_offs, L4::Ipc::Cap< Dataspace > src, Offset src_offs, Size size)

  Copy contents from another dataspace.
- Size size () const noexcept

  Get size of a dataspace.
- Flags flags () const noexcept

  Get flags of the dataspace.
- l4_ret_t info (Stats *stats)

  Get information on the dataspace.
- long map_info (l4_addr_t *start_addr, l4_addr_t *end_addr)

  Get mapping range of dataspace.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Public Member Functions inherited from L4Re::Inhibitor

- l4_ret_t acquire (l4_umword_t id, L4::Ipc::String<> reason)

  Acquire a specific inhibitor lock.
- l4_ret_t release (l4_umword_t id)

  Release a specific inhibitor lock.
- l4_ret_t next_lock_info (char *name, unsigned len, l4_mword_t current_id=-1, l4_utcb_t *utcb=l4_utcb())

  Get information for the next available inhibitor lock.

Public Member Functions inherited from L4Re::Event

- l4_ret_t get_buffer (L4::Ipc::Out< L4::Cap< Dataspace > > ds)

  Get event signal buffer.
- l4_ret_t get_num_streams ()

  Get number of event streams.
- l4_ret_t get_stream_info (int idx, Event_stream_info *info)

  Get event stream infos.
- l4_ret_t get_stream_info_for_id (l4_umword_t stream_id, Event_stream_info *info)

  Get event stream infos.
- l4_ret_t get_axis_info (l4_umword_t stream_id, unsigned naxes, unsigned const *axis, Event_absinfo *info) const noexcept

Get event stream axis infos.

- l4_ret_t get_stream_state_for_id (l4_umword_t stream_id, Event_stream_state *state)

  Get event stream state.

Public Member Functions inherited from L4::Icu

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)

  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Public Types inherited from L4Re::Inhibitor

- enum { Name_max = 20 }

Protected Types inherited from L4::Kobject_3t< Vbus, L4Re::Dataspace, L4Re::Inhibitor, L4Re::Event >

- typedef Vbus Class

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO_ANY, Vbus > __Iface

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, Typeid::Merge_list< typename L4Re::↩ Dataspace::__Iface_list, Typeid::Merge_list< typename L4Re::Inhibitor::__Iface_list, typename L4Re::↩ Event::__Iface_list > > > __Iface_list

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Dataspace, L4::Kobject, L4RE_PROTO_DATASPACE, L4::Type_info::Demand_t< 1 > >

- typedef Dataspace **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Dataspace > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR >

- typedef Inhibitor **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Inhibitor > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Event, L4::Icu, L4RE_PROTO_EVENT >

- typedef Event **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Event > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Icu::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_3t< Vbus, L4Re::Dataspace, L4Re::Inhibitor, L4Re::Event >

- L4::Cap< Class > c () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Dataspace, L4::Kobject, L4RE_PROTO_DATASPACE, L4::Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Protected Member Functions inherited from L4::Kobject_t< Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Event, L4::Icu, L4RE_PROTO_EVENT >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_3t< Vbus, L4Re::Dataspace, L4Re::Inhibitor, L4Re::Event >

- static void __check_protocols__ () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Dataspace, L4::Kobject, L4RE_PROTO_DATASPACE, L4::Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Event, L4::Icu, L4RE_PROTO_EVENT >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.385.1 Detailed Description

The virtual bus (Vbus) interface.

See also

L4Re Vbus API

Definition at line 298 of file vbus.

15.385.2 Member Function Documentation

15.385.2.1 assign_dma_domain()

```
int L4vbus::Vbus::assign_dma_domain (
            unsigned domain_id,
            unsigned flags,
            L4::Cap< L4Re::Dma_space > dma_space) const  [inline]
```

Bind or unbind an L4Re::Dma_space to a DMA domain.

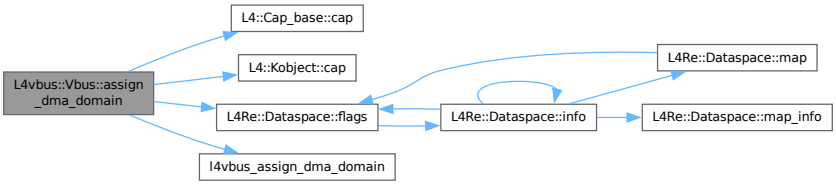
Parameters

domain_id	DMA domain ID (resource address of DMA domain found on the vBUS). If the value is ~0U the DMA space of the whole vBUS is used.
flags	A combination of L4vbus_dma_domain_assign_flags.
dma_space	The DMA space capability to bind. For unbind, the `dma_space` is ignored and should be passed an invalid capability.

Return values

0	Operation completed successfully.
-L4_ENOENT	The vbus does not support a global DMA domain or no DMA domain could be found.
-L4_EINVAL	Invalid argument used.
-L4_EBUSY	DMA domain is already active, this means another DMA space is already assigned.

Definition at line 358 of file vbus.
References L4::Cap_base::cap(), L4::Kobject::cap(), L4Re::Dataspace::flags(), and l4vbus_assign_dma_domain().
Here is the call graph for this function:



15.385.2.2 release_ioport()

```
int L4vbus::Vbus::release_ioport (
            l4vbus_resource_t * res) const  [inline]
```

Release the given IO port resource from the bus.

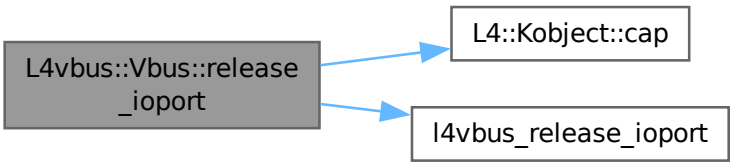
Parameters

in	*res*	The IO port resource to be released from the bus.

Returns

>=0 on success, <0 on error.

Definition at line 323 of file vbus.
References L4::Kobject::cap(), and l4vbus_release_ioport().
Here is the call graph for this function:



15.385.2.3 request_ioport()

```
int L4vbus::Vbus::request_ioport (
            l4vbus_resource_t * res) const  [inline]
```

Request the given IO port resource from the bus.

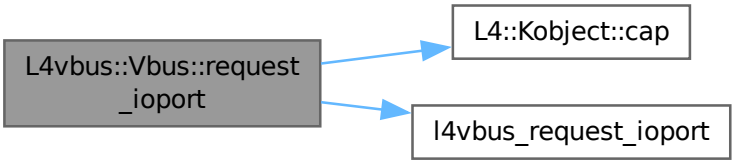
Parameters

in	*res*	The IO port resource to be requested from the bus.

Return values

0	Success.
-L4_EINVAL	Resource is not an IO port resource.
-L4_ENOENT	No matching IO port resource found.

Definition at line 311 of file vbus.
References L4::Kobject::cap(), and l4vbus_request_ioport().
Here is the call graph for this function:



15.385.2.4 root()

```
Device L4vbus::Vbus::root () const  [inline]
```

Get the root device of the device tree of this bus.
The root device is usually the starting point for iterating the bus, see Device::next_device.

Returns

A Vbus device representing the root of the device tree.

Definition at line 336 of file vbus.
References L4::Kobject::cap(), and L4VBUS_ROOT_BUS.
Here is the call graph for this function:

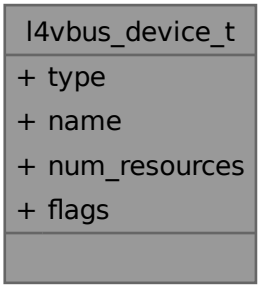


The documentation for this class was generated from the following file:

- l4/vbus/vbus

15.386 l4vbus_device_t Struct Reference

Detailed information about a vbus device.
`#include <vbus_types.h>`
Collaboration diagram for l4vbus_device_t:



Data Fields

- l4_uint32_t **type**

  Bitfield of supported sub-interfaces, see l4vbus_iface_type_t.
- char **name** [L4VBUS_DEV_NAME_LEN]

  Name.
- unsigned **num_resources**

Number of resources for this device.

- unsigned **flags**

  Flags, see l4vbus_device_flags_t.

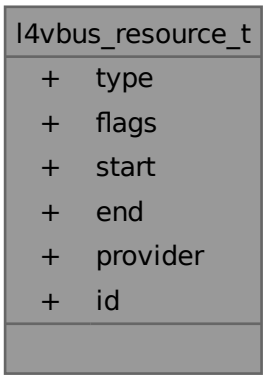
15.386.1 Detailed Description

Detailed information about a vbus device.
Definition at line 81 of file vbus_types.h.
The documentation for this struct was generated from the following file:

- l4/vbus/vbus_types.h

15.387 l4vbus_resource_t Struct Reference

Description of a single vbus resource.
`#include <vbus_types.h>`
Collaboration diagram for l4vbus_resource_t:



Data Fields

- l4_uint16_t **type**

  Resource type, see l4vbus_resource_type_t.

- l4_uint16_t **flags**

  Flags.

- l4vbus_paddr_t **start**

  Start of resource range.

- l4vbus_paddr_t **end**

  End of resource range (inclusive).

- l4vbus_device_handle_t **provider**

  Device handle of the provider of the resource.

- l4_uint32_t **id**

  Resource ID (4 bytes), usually a 4 letter ASCII name is used.

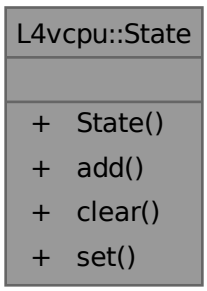
15.387.1 Detailed Description

Description of a single vbus resource.
Definition at line 23 of file vbus_types.h.
The documentation for this struct was generated from the following file:

- l4/vbus/vbus_types.h

15.388 L4vcpu::State Class Reference

C++ implementation of state word in the vCPU area.
`#include <vcpu>`
Collaboration diagram for L4vcpu::State:



Public Member Functions

- State (unsigned v)
  Initialize state.
- void add (unsigned bits) throw ()
  Add flags.
- void clear (unsigned bits) throw ()
  Clear flags.
- void set (unsigned v) throw ()
  Set flags.

15.388.1 Detailed Description

C++ implementation of state word in the vCPU area.
Definition at line 24 of file vcpu.

15.388.2 Constructor & Destructor Documentation

15.388.2.1 State()

```
L4vcpu::State::State (
            unsigned v)  [inline], [explicit]
```

Initialize state.

Parameters

v	Initial state.

Definition at line 34 of file vcpu.

15.388.3 Member Function Documentation

15.388.3.1 add()

```
void L4vcpu::State::add (
            unsigned bits) throw ( )   [inline]
```

Add flags.

Parameters

bits	Bits to add to the word.

Definition at line 41 of file vcpu.

15.388.3.2 clear()

```
void L4vcpu::State::clear (
            unsigned bits) throw ( )   [inline]
```

Clear flags.

Parameters

bits	Bits to clear in the word.

Definition at line 48 of file vcpu.

15.388.3.3 set()

```
void L4vcpu::State::set (
            unsigned v) throw ( )   [inline]
```

Set flags.

Parameters

v	Set the word to the value of v.

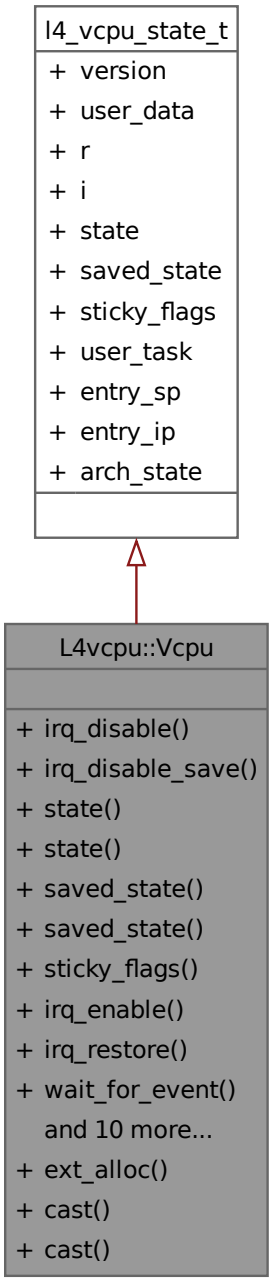
Definition at line 55 of file vcpu.
The documentation for this class was generated from the following file:

- l4/vcpu/vcpu

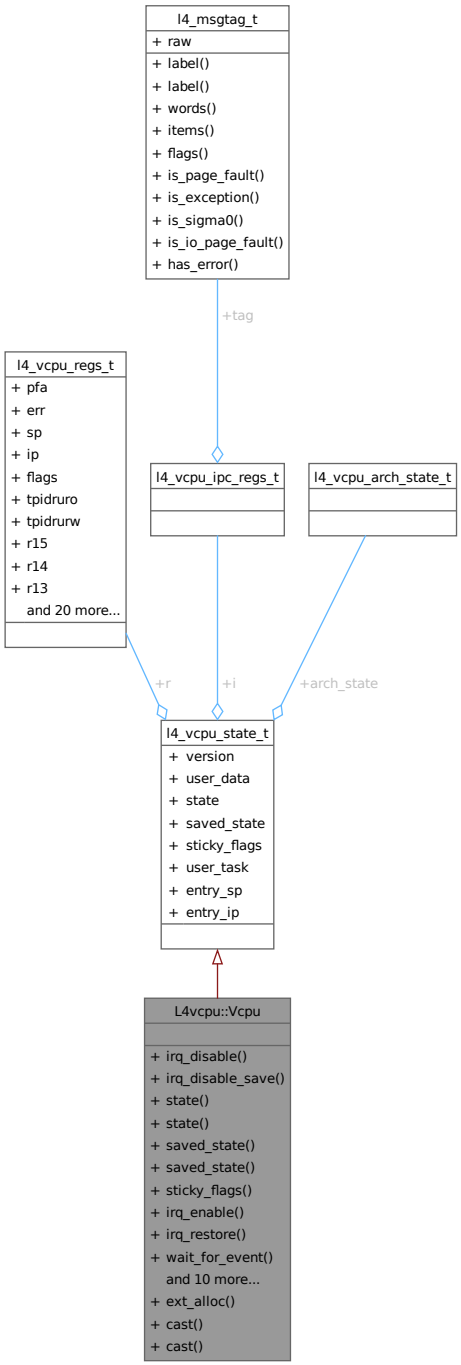
15.389 L4vcpu::Vcpu Class Reference

C++ implementation of the vCPU save state area.
`#include <vcpu>`

Inheritance diagram for L4vcpu::Vcpu:



Collaboration diagram for L4vcpu::Vcpu:



Public Member Functions

- void **irq_disable** () throw ()

  Disable the vCPU for event delivery.
- unsigned irq_disable_save () throw ()

  Disable the vCPU for event delivery and return previous state.
- State * state () throw ()

  Get state word.

- State state () const throw ()

  Get state word.
- State * saved_state () throw ()

  Get saved_state word.
- State saved_state () const throw ()

  Get saved_state word.
- l4_uint16_t **sticky_flags** () const throw ()

  Get sticky flags.
- void irq_enable (l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb, l4vcpu_setup_ipc_t setup_ipc) throw ()

  Enable the vCPU for event delivery.
- void irq_restore (unsigned s, l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb, l4vcpu_setup_ipc_t setup_ipc) throw ()

  Restore a previously saved IRQ/event state.
- void wait_for_event (l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb, l4vcpu_setup_ipc_t setup_ipc) throw ()

  Wait for event.
- void task (L4::Cap< L4::Task > const task=L4::Cap< L4::Task >::Invalid) throw ()

  Set the task of the vCPU.
- int is_page_fault_entry () const

  Return whether the entry reason was a page fault.
- int is_irq_entry () const

  Return whether the entry reason was an IRQ/IPC message.
- l4_vcpu_regs_t * r () throw ()

  Return pointer to register state.
- l4_vcpu_regs_t const * r () const throw ()

  Return pointer to register state.
- l4_vcpu_ipc_regs_t * i () throw ()

  Return pointer to IPC state.
- l4_vcpu_ipc_regs_t const * i () const throw ()

  Return pointer to IPC state.
- void entry_sp (l4_umword_t sp)

  Set vCPU entry stack pointer.
- void entry_ip (l4_umword_t ip)

  Set vCPU entry instruction pointer.
- void **print_state** (const char *prefix="") const throw ()

  Print the state of the vCPU.

Static Public Member Functions

- static int ext_alloc (Vcpu **vcpu, l4_addr_t *ext_state, L4::Cap< L4::Task > task=L4Re::Env::env() ->task(), L4::Cap< L4Re::Rm > rm=L4Re::Env::env() ->rm()) throw ()

  Allocate state area for an extended vCPU.
- static Vcpu * cast (void *x) throw ()

  Cast a void pointer to a class pointer.
- static Vcpu * cast (l4_addr_t x) throw ()

  Cast an address to a class pointer.

15.389.1 Detailed Description

C++ implementation of the vCPU save state area.
Definition at line 65 of file vcpu.

15.389.2 Member Function Documentation

15.389.2.1 cast() [1/2]

```
Vcpu * L4vcpu::Vcpu::cast (
            l4_addr_t x) throw ( )   [inline], [static]
```

Cast an address to a class pointer.

Parameters

x	Pointer.

Returns

Pointer to Vcpu class.

Definition at line 269 of file vcpu.

15.389.2.2 cast() [2/2]

```
Vcpu * L4vcpu::Vcpu::cast (
            void * x) throw ( )   [inline], [static]
```

Cast a void pointer to a class pointer.

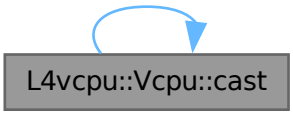
Parameters

x	Pointer.

Returns

Pointer to Vcpu class.

Definition at line 259 of file vcpu.
References cast().
Referenced by cast().
Here is the call graph for this function:



Here is the caller graph for this function:



15.389.2.3 entry_ip()

```
void L4vcpu::Vcpu::entry_ip (
            l4_umword_t ip)  [inline]
```

Set vCPU entry instruction pointer.

Parameters

ip	Instruction pointer address to set.

Definition at line 232 of file vcpu.
References l4_vcpu_state_t::entry_ip.

15.389.2.4 entry_sp()

```
void L4vcpu::Vcpu::entry_sp (
            l4_umword_t sp)  [inline]
```

Set vCPU entry stack pointer.

Parameters

sp	Stack pointer address to set.

Note

The value is only used when entering from a user-task.

Definition at line 225 of file vcpu.
References l4_vcpu_state_t::entry_sp.

15.389.2.5 ext_alloc()

```
int L4vcpu::Vcpu::ext_alloc (
            Vcpu ** vcpu,
            l4_addr_t * ext_state,
            L4::Cap< L4::Task > task = L4Re::Env::env() ->task(),
            L4::Cap< L4Re::Rm > rm = L4Re::Env::env() ->rm()) throw ( )   [static]
```

Allocate state area for an extended vCPU.

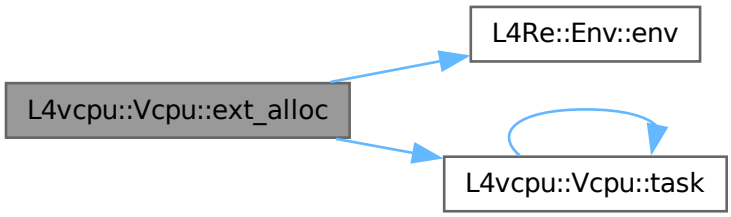
Parameters

out	*vcpu*	Allocated vcpu-state area.
out	*ext_state*	Allocated extended vcpu-state area.
	task	Task to use for allocation, defaults to own task.
	rm	Region manager to use for allocation defaults to standard region manager.

Returns

0 for success, error code otherwise

References L4Re::Env::env(), and task().
Here is the call graph for this function:



15.389.2.6 i() [1/2]

```
l4_vcpu_ipc_regs_t * L4vcpu::Vcpu::i () throw ( )   [inline]
```

Return pointer to IPC state.

Returns

Pointer to IPC state.

Definition at line 209 of file vcpu.
References l4_vcpu_state_t::i.

15.389.2.7 i() [2/2]

```
l4_vcpu_ipc_regs_t const * L4vcpu::Vcpu::i () const throw ( )   [inline]
```

Return pointer to IPC state.

Returns

Pointer to IPC state.

Definition at line 216 of file vcpu.
References l4_vcpu_state_t::i.

15.389.2.8 irq_disable_save()

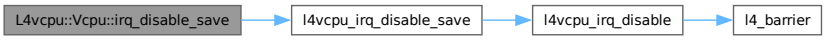
```
unsigned L4vcpu::Vcpu::irq_disable_save () throw ( )   [inline]
```

Disable the vCPU for event delivery and return previous state.

Returns

IRQ state before disabling IRQs.

Definition at line 78 of file vcpu.
References l4vcpu_irq_disable_save().
Here is the call graph for this function:



15.389.2.9 irq_enable()

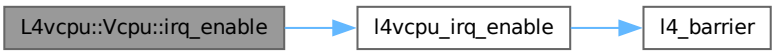
```
void L4vcpu::Vcpu::irq_enable (
            l4_utcb_t * utcb,
            l4vcpu_event_hndl_t do_event_work_cb,
            l4vcpu_setup_ipc_t setup_ipc) throw ( )   [inline]
```

Enable the vCPU for event delivery.

Parameters

utcb	The UTCB to use.
do_event_work_cb	Call-back function that is called in case an event (such as an interrupt) is pending.
setup_ipc	Call-back function that is called before an IPC operation is called, and before event delivery is enabled.

Definition at line 135 of file vcpu.
References l4vcpu_irq_enable().
Here is the call graph for this function:



15.389.2.10 irq_restore()

```
void L4vcpu::Vcpu::irq_restore (
            unsigned s,
            l4_utcb_t * utcb,
            l4vcpu_event_hndl_t do_event_work_cb,
            l4vcpu_setup_ipc_t setup_ipc) throw ( )   [inline]
```

Restore a previously saved IRQ/event state.

Parameters

s	IRQ state to be restored.
utcb	The UTCB to use.

do_event_work_cb	Call-back function that is called in case an event (such as an interrupt) is pending.
setup_ipc	Call-back function that is called before an IPC operation is called, and before event delivery is enabled.

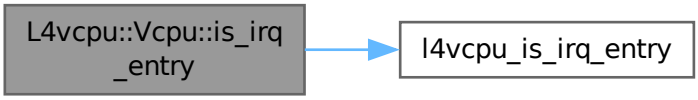
Definition at line 150 of file vcpu.
References l4vcpu_irq_restore().
Here is the call graph for this function:



15.389.2.11 is_irq_entry()

```
int L4vcpu::Vcpu::is_irq_entry () const  [inline]
```

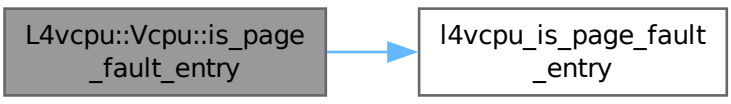
Return whether the entry reason was an IRQ/IPC message.
return 0 if not, !=0 otherwise.
Definition at line 188 of file vcpu.
References l4vcpu_is_irq_entry().
Here is the call graph for this function:



15.389.2.12 is_page_fault_entry()

```
int L4vcpu::Vcpu::is_page_fault_entry () const  [inline]
```

Return whether the entry reason was a page fault.
return 0 if not, !=0 otherwise.
Definition at line 181 of file vcpu.
References l4vcpu_is_page_fault_entry().
Here is the call graph for this function:



15.389.2.13 r() [1/2]

```
l4_vcpu_regs_t * L4vcpu::Vcpu::r () throw ( )   [inline]
```

Return pointer to register state.

Returns

Pointer to register state.

Definition at line 195 of file vcpu.
References l4_vcpu_state_t::r.

15.389.2.14 r() [2/2]

```
l4_vcpu_regs_t const * L4vcpu::Vcpu::r () const throw ( )   [inline]
```

Return pointer to register state.

Returns

Pointer to register state.

Definition at line 202 of file vcpu.
References l4_vcpu_state_t::r.

15.389.2.15 saved_state() [1/2]

```
State * L4vcpu::Vcpu::saved_state () throw ( )   [inline]
```

Get saved_state word.

Returns

Pointer to saved_state word in the vCPU

Definition at line 106 of file vcpu.
References l4_vcpu_state_t::saved_state.

15.389.2.16 saved_state() [2/2]

```
State L4vcpu::Vcpu::saved_state () const throw ( )   [inline]
```

Get saved_state word.

Returns

Pointer to saved_state word in the vCPU

Definition at line 116 of file vcpu.
References l4_vcpu_state_t::saved_state.

15.389.2.17 state() [1/2]

```
State * L4vcpu::Vcpu::state () throw ( )   [inline]
```

Get state word.

Returns

Pointer to state word in the vCPU

Definition at line 88 of file vcpu.
References l4_vcpu_state_t::state.

15.389.2.18 state() [2/2]

```
State L4vcpu::Vcpu::state () const throw ( )   [inline]
```

Get state word.

Returns

Pointer to state word in the vCPU

Definition at line 99 of file vcpu.
References l4_vcpu_state_t::state.

15.389.2.19 task()

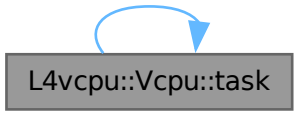
```
void L4vcpu::Vcpu::task (
            L4::Cap< L4::Task > const task = L4::Cap<L4::Task>::Invalid) throw ( )   [inline]
```

Set the task of the vCPU.

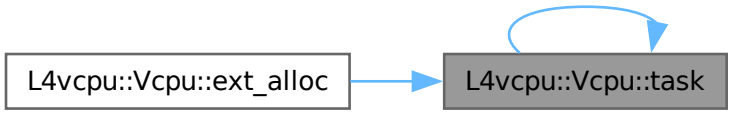
Parameters

task	Task to set, defaults to invalid task.

Definition at line 174 of file vcpu.
References L4::Cap_base::Invalid, task(), and l4_vcpu_state_t::user_task.
Referenced by ext_alloc(), and task().
Here is the call graph for this function:



Here is the caller graph for this function:



15.389.2.20 wait_for_event()

```
void L4vcpu::Vcpu::wait_for_event (
            l4_utcb_t * utcb,
            l4vcpu_event_hndl_t do_event_work_cb,
            l4vcpu_setup_ipc_t setup_ipc) throw ( )   [inline]
```

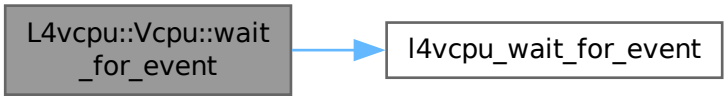
Wait for event.

Parameters

utcb	The UTCB to use.
do_event_work_cb	Call-back function that is called in case an event (such as an interrupt) is pending.
setup_ipc	Call-back function that is called before an IPC operation is called.

Note that event delivery remains disabled after this function returns.

Definition at line 166 of file vcpu.
References l4vcpu_wait_for_event().
Here is the call graph for this function:



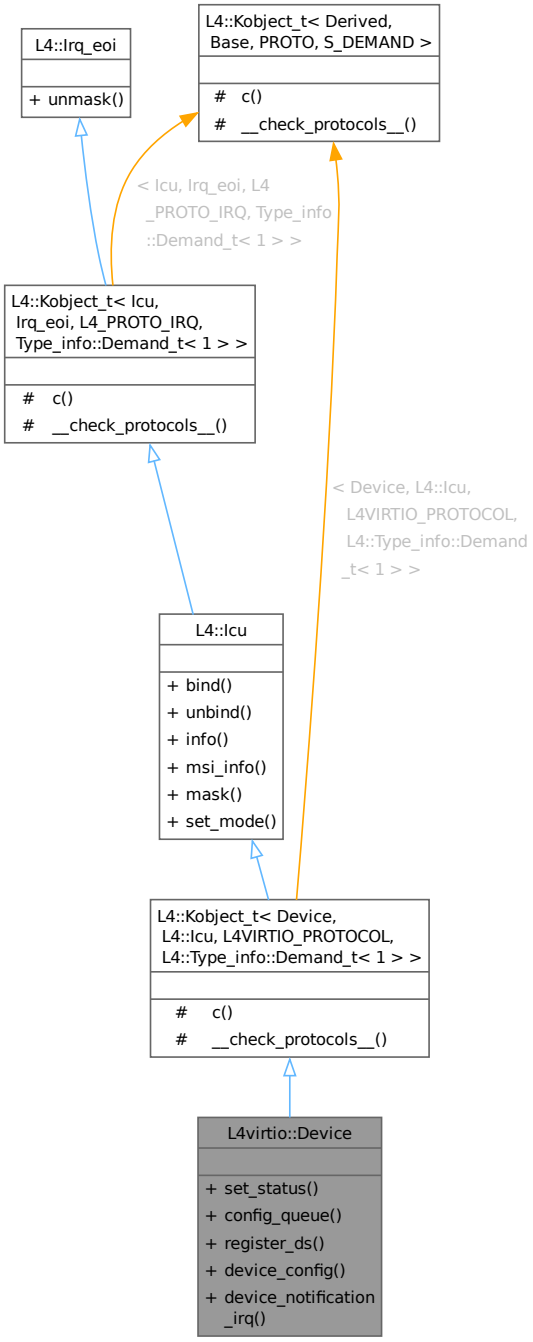
The documentation for this class was generated from the following file:

- l4/vcpu/vcpu

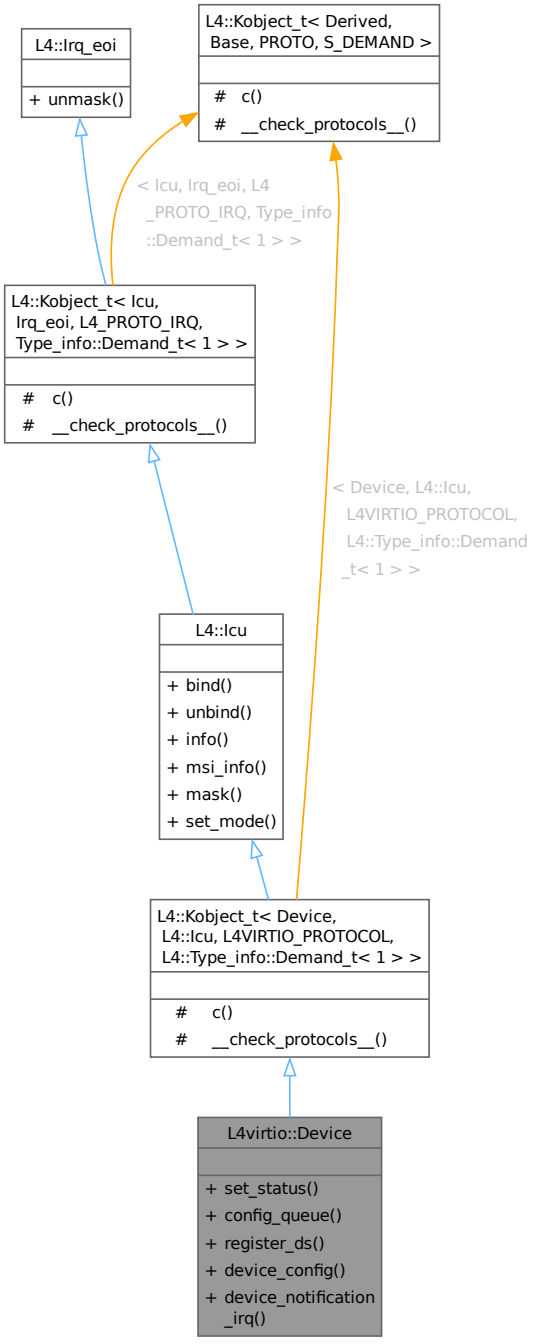
15.390 L4virtio::Device Class Reference

IPC interface for virtio over L4 IPC.
`#include <l4virtio>`

Inheritance diagram for L4virtio::Device:



Collaboration diagram for L4virtio::Device:



Public Member Functions

- long set_status (unsigned status)

  Write the VIRTIO status register.
- long config_queue (unsigned queue)

  Trigger queue configuration of the given queue.
- long register_ds (L4::Ipc::Cap< L4Re::Dataspace > ds_cap, l4_uint64_t base, l4_umword_t offset, l4_umword_t size)

Register a shared data space with VIRTIO host.

- long device_config (L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > config_ds, l4_addr_t *ds_offset)

  Get the dataspace with the L4virtio configuration page.
- long device_notification_irq (unsigned index, L4::Ipc::Out< L4::Cap< L4::Triggerable > > irq)

  Get the notification interrupt corresponding to the given index.

Public Member Functions inherited from L4::Icu

- l4_msgtag_t bind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Bind an interrupt line of an interrupt controller to an interrupt object.
- l4_msgtag_t unbind (unsigned irqnum, L4::Cap< Triggerable > irq, l4_utcb_t *utcb=l4_utcb()) noexcept

  Remove binding of an interrupt line from the interrupt controller object.
- l4_msgtag_t info (l4_icu_info_t *info, l4_utcb_t *utcb=l4_utcb()) noexcept

  Get information about the ICU features.
- l4_msgtag_t msi_info (l4_umword_t irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info)

  Get MSI info about IRQ.
- l4_msgtag_t mask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Mask an IRQ line.
- l4_msgtag_t set_mode (unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb=l4_utcb()) noexcept

  Set interrupt mode.

Public Member Functions inherited from L4::Irq_eoi

- l4_msgtag_t unmask (unsigned irqnum, l4_umword_t *label=0, l4_timeout_t to=L4_IPC_NEVER, l4_utcb_t *utcb=l4_utcb()) noexcept

  Unmask the given interrupt line.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Device, L4::Icu, L4VIRTIO_PROTOCOL, L4::Type_info::Demand_t< 1 > >

- typedef Device **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Device > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Icu::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- typedef Icu **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Icu > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Irq_eoi::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Device, L4::Icu, L4VIRTIO_PROTOCOL, L4::Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Device, L4::Icu, L4VIRTIO_PROTOCOL, L4::Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Icu, Irq_eoi, L4_PROTO_IRQ, Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.390.1 Detailed Description

IPC interface for virtio over L4 IPC.
The L4virtio protocol is an adaption of the mmio virtio transport 1.0(4). This interface allows to exchange the necessary resources: device configuration page, notification interrupts and dataspaces for payload.
Notification interrupts can be configured independently for changes to the configuration space and each queue through special L4virtio-specific notify_index fields in the config page and queue configuration. The interface distinguishes between device-to-driver and driver-to-device notification interrupts.
Device-to-driver interrupts are configured via the ICU interface. The device announces the maximum number of supported interrupts via Icu::info(). The driver can then bind interrupts using Icu::bind().
Driver-to-device interrupts must be requested from the device through device_notification_irq().
Definition at line 39 of file l4virtio.

15.390.2 Member Function Documentation

15.390.2.1 config_queue()

```
long L4virtio::Device::config_queue (
            unsigned queue)
```

Trigger queue configuration of the given queue.
Usually all queues are configured when the status is written to running. However, in some cases queues shall be disabled or enabled dynamically, in this case this function triggers a reconfiguration from the shared memory register of the queue config.

Parameters

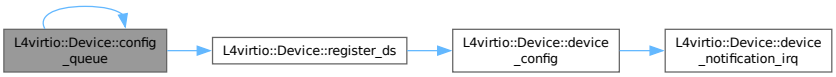
queue	Queue index for the queue to be configured.

Return values

0	on success.
-L4_EIO	The queue's status is invalid.
-L4_ERANGE	The queue index exceeds the number of queues.
-L4_EINVAL	Otherwise.

References config_queue(), L4VIRTIO_OP_REGISTER_DS, and register_ds().

Referenced by config_queue().
Here is the call graph for this function:



Here is the caller graph for this function:



15.390.2.2 device_config()

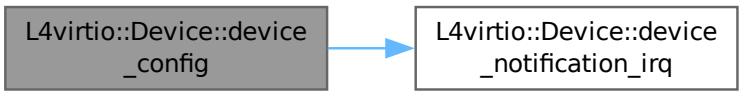
```
long L4virtio::Device::device_config (
            L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > config_ds,
            l4_addr_t * ds_offset)
```

Get the dataspace with the L4virtio configuration page.

Parameters

config_ds	Capability for receiving the dataspace capability for the shared L4-VIRTIO config data space.
ds_offset	Offset into the dataspace where the device configuration structure starts.

References device_notification_irq(), and L4VIRTIO_OP_GET_DEVICE_IRQ.
Referenced by register_ds().
Here is the call graph for this function:



Here is the caller graph for this function:



15.390.2.3 device_notification_irq()

```
long L4virtio::Device::device_notification_irq (
            unsigned index,
            L4::Ipc::Out< L4::Cap< L4::Triggerable > > irq)
```

Get the notification interrupt corresponding to the given index.

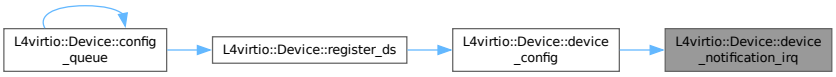
Parameters

	index	Index of the interrupt.
out	*irq*	Triggerable for the given index.

Return values

L4_EOK	Success.
L4_ENOSYS	IRQ notification not supported by device.
<0	Other error.

An index is only guaranteed to return an IRQ object when the index is set in one of the device notify index fields. The device must return the same interrupt for a given index as long as the index is in use. If an index disappears as a result of a configuration change and then is reused later, the interrupt is not guaranteed to be the same.
Interrupts must always be rerequested after a device reset.
Referenced by device_config().
Here is the caller graph for this function:



15.390.2.4 register_ds()

```
long L4virtio::Device::register_ds (
            L4::Ipc::Cap< L4Re::Dataspace > ds_cap,
            l4_uint64_t base,
            l4_umword_t offset,
            l4_umword_t size)
```

Register a shared data space with VIRTIO host.

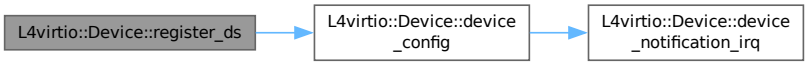
Parameters

ds_cap	Dataspace capability to register. The lower 8 bits determine the rights mask with which the guest's rights are masked during the registration of the dataspace at the VIRTIO host.
base	VIRTIO guest physical start address of shared memory region
offset	Offset within the data space that is attached to the given `base` in the guest physical memory.
size	Size of the memory region in the guest

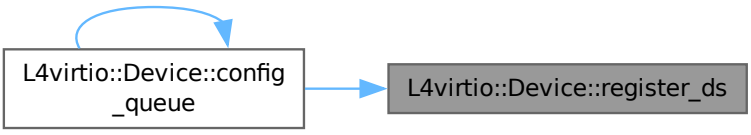
Return values

L4_EOK	Operation successful.
-L4_EINVAL	The `ds_cap` capability is invalid, does not refer to a valid dataspace, is not a trusted dataspace if trusted dataspace validation is enabled, or `size` and `offset` specify an invalid region.
-L4_ENOMEM	The limit of dataspaces that can be registered has been reached or no capability slot could be allocated.
-L4_ERANGE	`offset` is lager than the size of the dataspace.
<0	Any error returned by the dataspace when queried for information during setup or any error returned by the region manager from attaching the dataspace.

References device_config(), and L4VIRTIO_OP_DEVICE_CONFIG.
Referenced by config_queue().
Here is the call graph for this function:



Here is the caller graph for this function:



15.390.2.5 set_status()

```
long L4virtio::Device::set_status (
            unsigned status)
```

Write the VIRTIO status register.

Parameters

status	Status word to write to the VIRTIO status.

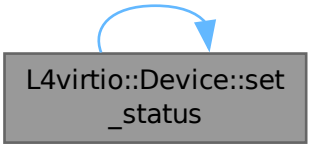
Return values

0	on success.

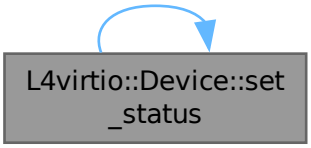
Note

All other registers are accessed via shared memory.

References L4VIRTIO_OP_CONFIG_QUEUE, and set_status().
Referenced by set_status().
Here is the call graph for this function:



Here is the caller graph for this function:



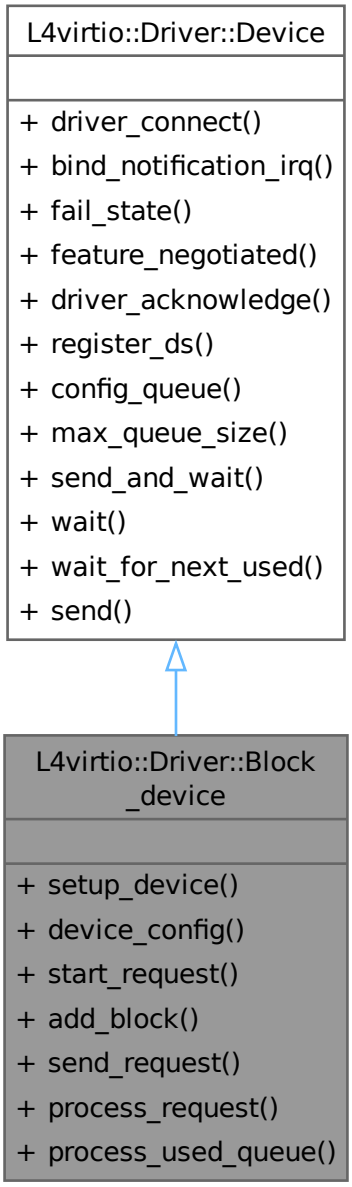
The documentation for this class was generated from the following file:

- l4/l4virtio/l4virtio

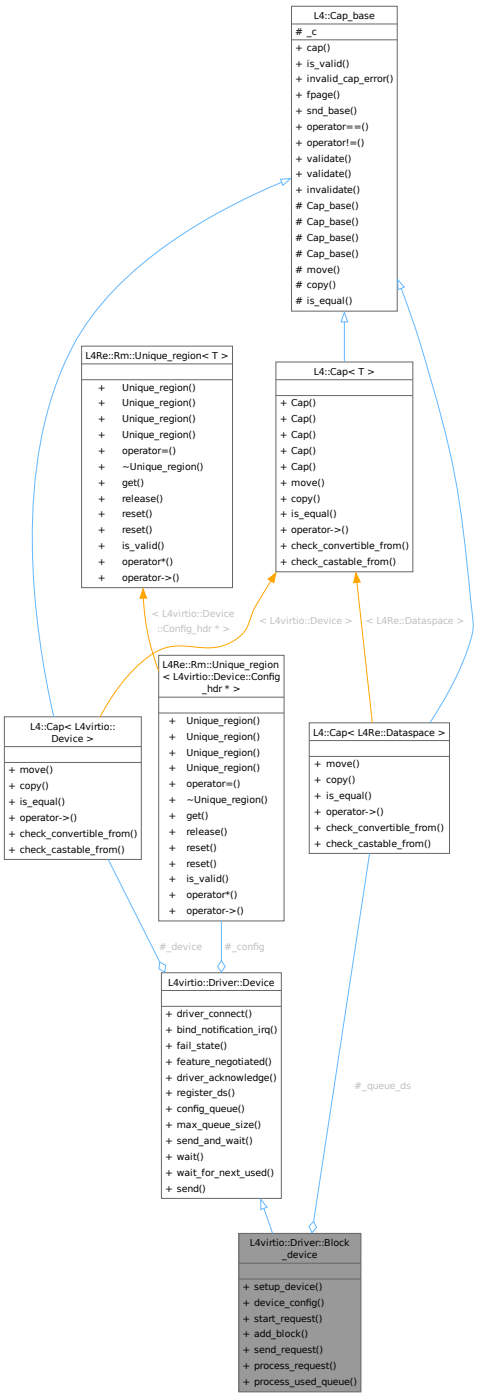
15.391 L4virtio::Driver::Block_device Class Reference

Simple class for accessing a virtio block device synchronously.
`#include <virtio-block>`

Inheritance diagram for L4virtio::Driver::Block_device:



Collaboration diagram for L4virtio::Driver::Block_device:



Data Structures

- class Handle

  Handle to an ongoing request.

Public Member Functions

- void setup_device (L4::Cap< L4virtio::Device > srvcap, l4_size_t usermem, void **userdata, Ptr< void > &user_devaddr, L4::Cap< L4Re::Dataspace > qds=L4::Cap< L4Re::Dataspace >(), l4_uint32_t fmask0=-

1U, l4_uint32_t fmask1=-1U, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

Establish a connection to the device and set up shared memory.

- l4virtio_block_config_t const & **device_config** () const

  Return a reference to the device configuration.
- Handle start_request (l4_uint64_t sector, l4_uint32_t type, Callback callback)

  Start the setup of a new request.
- int add_block (Handle handle, Ptr< void > addr, l4_uint32_t size)

  Add a data block to a request that has already been set up.
- int send_request (Handle handle)

  Process request asynchronously.
- int process_request (Handle handle)

  Process request synchronously.
- void process_used_queue ()

  Process and free all items in the used queue.

Public Member Functions inherited from L4virtio::Driver::Device

- void driver_connect (L4::Cap< L4virtio::Device > srvcap, bool manage_notify=true)

  Contacts the device and starts the initial handshake.
- int bind_notification_irq (unsigned index, L4::Cap< L4::Triggerable > irq) const

  Register a triggerable to receive notifications from the device.
- bool **fail_state** () const

  Return true if the device is in a fail state.
- bool feature_negotiated (unsigned int feat) const

  Check if a particular feature bit was negotiated with the device.
- int driver_acknowledge ()

  Finalize handshake with the device.
- int register_ds (L4::Cap< L4Re::Dataspace > ds, l4_umword_t offset, l4_umword_t size, l4_uint64_t *devaddr)

  Share a dataspace with the device.
- int config_queue (int num, unsigned size, l4_uint64_t desc_addr, l4_uint64_t avail_addr, l4_uint64_t used_addr)

  Send the virtqueue configuration to the device.
- int max_queue_size (int num) const

  Maximum queue size allowed by the device.
- int send_and_wait (Virtqueue &queue, l4_uint16_t descno)

  Send a request to the device and wait for it to be processed.
- int wait (int index) const

  Wait for a notification from the device.
- int wait_for_next_used (Virtqueue &queue, l4_uint32_t *len=nullptr) const

  Wait for the next item to arrive in the used queue and return it.
- void send (Virtqueue &queue, l4_uint16_t descno)

  Send a request to the device.

15.391.1 Detailed Description

Simple class for accessing a virtio block device synchronously.
Definition at line 36 of file virtio-block.

15.391.2 Member Function Documentation

15.391.2.1 add_block()

```
int L4virtio::Driver::Block_device::add_block (
            Handle handle,
            Ptr< void > addr,
            l4_uint32_t size)  [inline]
```

Add a data block to a request that has already been set up.

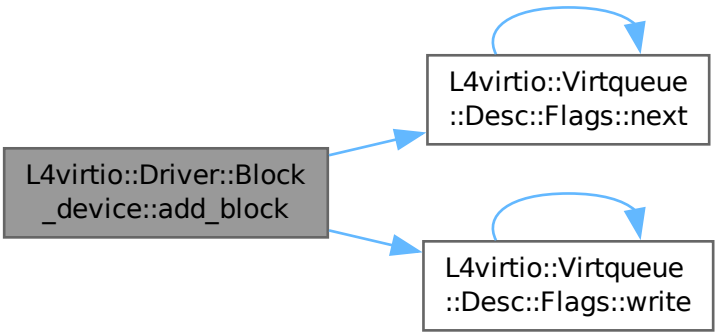
Parameters

handle	Handle to request previously set up with start_request().
addr	Address of data block in device address space.
size	Size of data block.

Return values

L4_OK	Block was successfully added.
-L4_EAGAIN	No descriptors available. Try again later.

Definition at line 232 of file virtio-block.
References L4virtio::Virtqueue::Desc::addr, L4virtio::Virtqueue::Desc::flags, L4_EAGAIN, L4_EOK, L4VIRTIO_BLOCK_T_GET_ID, L4VIRTIO_BLOCK_T_IN, L4virtio::Virtqueue::Desc::len, L4virtio::Virtqueue::Desc::Flags::next(), L4virtio::Virtqueue::Desc::next, L4virtio::Virtqueue::Desc::Flags::raw, and L4virtio::Virtqueue::Desc::Flags::write().
Here is the call graph for this function:



15.391.2.2 process_request()

```
int L4virtio::Driver::Block_device::process_request (
            Handle handle)  [inline]
```

Process request synchronously.

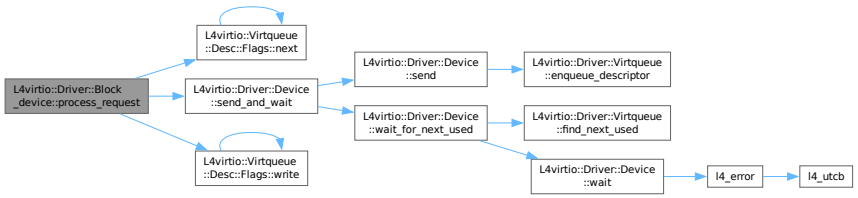
Parameters

handle	Handle to request to process.

Return values

L4_EOK	Request processed successfully.
-L4_EAGAIN	No descriptors available. Try again later.
-L4_EIO	IO error during request processing.
-L4_ENOSYS	Unsupported request.
<0	Another unspecified error occurred.

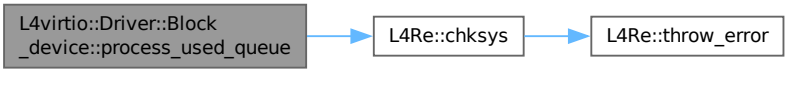
Sends a request to the driver that was previously set up with start_request() and add_block() and wait for it to be executed.
Definition at line 315 of file virtio-block.
References L4virtio::Virtqueue::Desc::addr, L4virtio::Virtqueue::Desc::flags, L4_EAGAIN, L4_EINVAL, L4_EIO, L4_ENOSYS, L4_EOK, L4VIRTIO_BLOCK_S_IOERR, L4VIRTIO_BLOCK_S_OK, L4VIRTIO_BLOCK_S_UNSUPP, L4virtio::Virtqueue::Desc::len, L4virtio::Virtqueue::Desc::Flags::next(), L4virtio::Virtqueue::Desc::next, L4virtio::Virtqueue::Desc::Flags L4virtio::Driver::Device::send_and_wait(), and L4virtio::Virtqueue::Desc::Flags::write().
Here is the call graph for this function:



15.391.2.3 process_used_queue()

```
void L4virtio::Driver::Block_device::process_used_queue ()  [inline]
```

Process and free all items in the used queue.
If the request has a callback registered it is called after the item has been removed from the queue.
Definition at line 366 of file virtio-block.
References L4Re::chksys(), and L4_ENOSYS.
Here is the call graph for this function:



15.391.2.4 send_request()

```
int L4virtio::Driver::Block_device::send_request (
            Handle handle)  [inline]
```

Process request asynchronously.

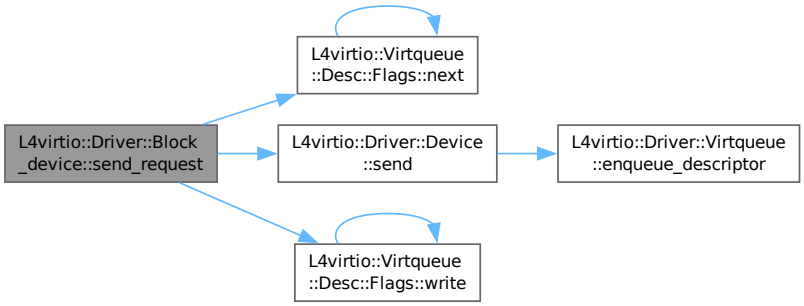
Parameters

handle	Handle to request to send to the device

Return values

L4_OK	Request was successfully scheduled.
-L4_EAGAIN	No descriptors available. Try again later.

Sends a request to the driver that was previously set up with start_request() and add_block() and wait for it to be executed.
Definition at line 274 of file virtio-block.
References L4virtio::Virtqueue::Desc::addr, L4virtio::Virtqueue::Desc::flags, L4_EAGAIN, L4_EOK, L4virtio::Virtqueue::Desc::len, L4virtio::Virtqueue::Desc::Flags::next(), L4virtio::Virtqueue::Desc::next, L4virtio::Virtqueue::Desc::Flags::raw, L4virtio::Driver::Device::send(), and L4virtio::Virtqueue::Desc::Flags::write().
Here is the call graph for this function:



15.391.2.5 setup_device()

```
void L4virtio::Driver::Block_device::setup_device (
            L4::Cap< L4virtio::Device > srvcap,
            l4_size_t usermem,
            void ** userdata,
            Ptr< void > & user_devaddr,
            L4::Cap< L4Re::Dataspace > qds = L4::Cap<L4Re::Dataspace>(),
            l4_uint32_t fmask0 = ~1U,
            l4_uint32_t fmask1 = ~1U,
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

Establish a connection to the device and set up shared memory.

Parameters

	srvcap	IPC capability of the channel to the server.
	usermem	Size of additional memory to share with device.
out	*userdata*	Pointer to the region of user-usable memory.
out	*user_devaddr*	Address of user-usable memory in device address space.

	qds	External queue dataspace. If this capability is invalid, the function will attempt to allocate a dataspace on its own. Note that the external queue dataspace must be large enough.
	fmask0	Feature bits 0..31 that the driver supports.
	fmask1	Feature bits 32..63 that the driver supports.
	msg_dev	Debug channel for developer-related information. Verbosity of L4Re::Util::Dbg(2) by default.

This function starts a handshake with the device and sets up the virtqueues for communication and the additional data structures for the block device. It will also allocate and share additional memory that the caller then can use freely, i.e. normally this memory would be used as a reception buffer. The caller may also decide to not make use of this convenience function and request 0 bytes in usermem. Then it has to allocate the block buffers for sending/receiving payload manually and share them using register_ds().
Definition at line 94 of file virtio-block.

15.391.2.6 start_request()

```
Handle L4virtio::Driver::Block_device::start_request (
            l4_uint64_t sector,
            l4_uint32_t type,
            Callback callback)  [inline]
```

Start the setup of a new request.

Parameters

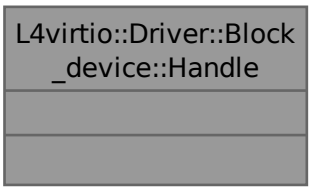
sector	First sector to write to/read from.
type	Request type.
callback	Function to call, when the request is finished. May be 0 for synchronous requests.

Definition at line 194 of file virtio-block.
References L4virtio::Virtqueue::Desc::addr, L4virtio::Virtqueue::Desc::flags, l4virtio_block_header_t::ioprio, L4virtio::Virtqueue::Desc::len, L4virtio::Virtqueue::Desc::Flags::raw, l4virtio_block_header_t::sector, and l4virtio_block_header_t::type
The documentation for this class was generated from the following file:

- l4/l4virtio/client/virtio-block

15.392 L4virtio::Driver::Block_device::Handle Class Reference

Handle to an ongoing request.
`#include <virtio-block>`
Collaboration diagram for L4virtio::Driver::Block_device::Handle:



15.392.1 Detailed Description

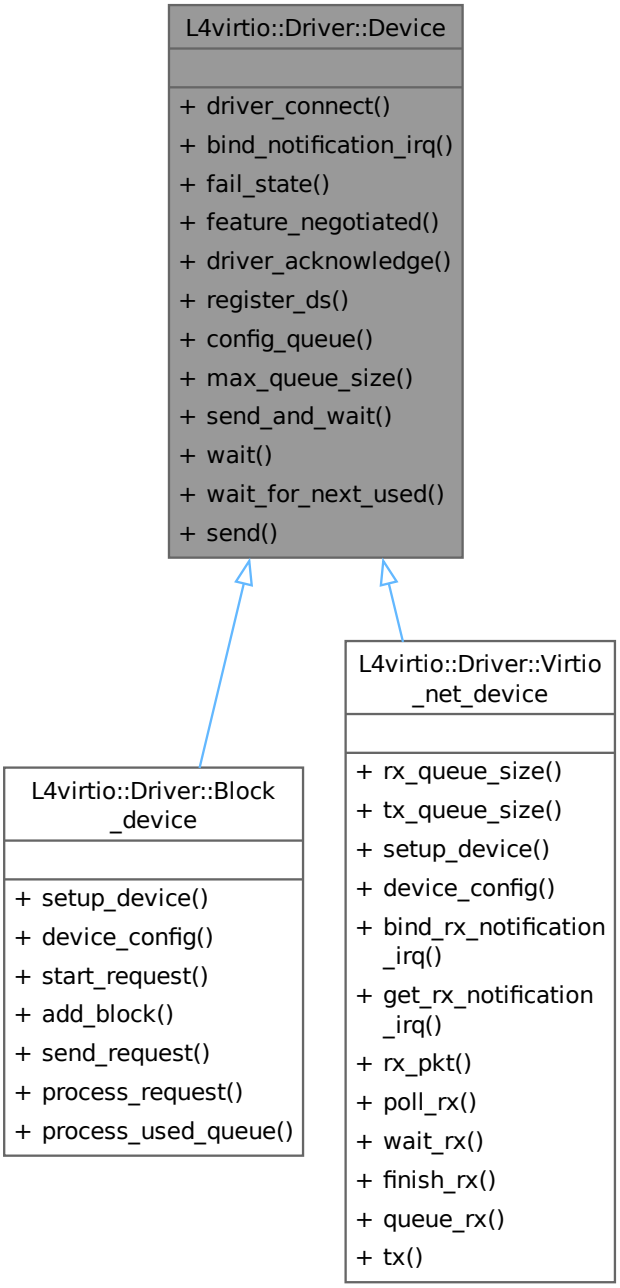
Handle to an ongoing request.
Definition at line 56 of file virtio-block.
The documentation for this class was generated from the following file:

- l4/l4virtio/client/virtio-block

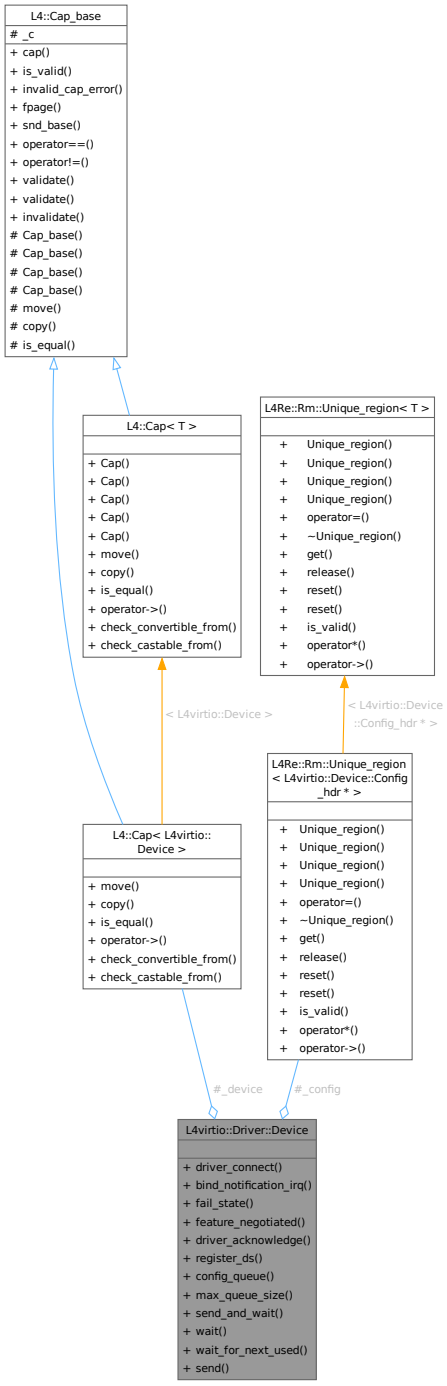
15.393 L4virtio::Driver::Device Class Reference

Client-side implementation for a general virtio device.
`#include <l4virtio>`

Inheritance diagram for L4virtio::Driver::Device:



Collaboration diagram for L4virtio::Driver::Device:



Public Member Functions

- void driver_connect (L4::Cap< L4virtio::Device > srvcap, bool manage_notify=true)

  Contacts the device and starts the initial handshake.
- int bind_notification_irq (unsigned index, L4::Cap< L4::Triggerable > irq) const

  Register a triggerable to receive notifications from the device.
- bool **fail_state** () const

  Return true if the device is in a fail state.

- bool feature_negotiated (unsigned int feat) const

  Check if a particular feature bit was negotiated with the device.
- int driver_acknowledge ()

  Finalize handshake with the device.
- int register_ds (L4::Cap< L4Re::Dataspace > ds, l4_umword_t offset, l4_umword_t size, l4_uint64_t *devaddr)

  Share a dataspace with the device.
- int config_queue (int num, unsigned size, l4_uint64_t desc_addr, l4_uint64_t avail_addr, l4_uint64_t used_addr)

  Send the virtqueue configuration to the device.
- int max_queue_size (int num) const

  Maximum queue size allowed by the device.
- int send_and_wait (Virtqueue &queue, l4_uint16_t descno)

  Send a request to the device and wait for it to be processed.
- int wait (int index) const

  Wait for a notification from the device.
- int wait_for_next_used (Virtqueue &queue, l4_uint32_t *len=nullptr) const

  Wait for the next item to arrive in the used queue and return it.
- void send (Virtqueue &queue, l4_uint16_t descno)

  Send a request to the device.

15.393.1 Detailed Description

Client-side implementation for a general virtio device.
Definition at line 31 of file l4virtio.

15.393.2 Member Function Documentation

15.393.2.1 bind_notification_irq()

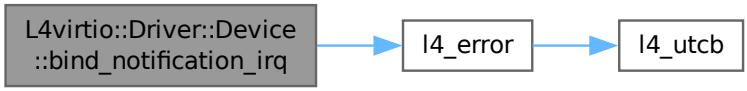
```
int L4virtio::Driver::Device::bind_notification_irq (
            unsigned index,
            L4::Cap< L4::Triggerable > irq) const  [inline]
```

Register a triggerable to receive notifications from the device.

Parameters

	index	Index of the interrupt.
out	*irq*	Triggerable to register for notifications.

Definition at line 129 of file l4virtio.
References l4_error().
Here is the call graph for this function:



15.393.2.2 config_queue()

```
int L4virtio::Driver::Device::config_queue (
            int num,
            unsigned size,
            l4_uint64_t desc_addr,
            l4_uint64_t avail_addr,
            l4_uint64_t used_addr)  [inline]
```

Send the virtqueue configuration to the device.

Parameters

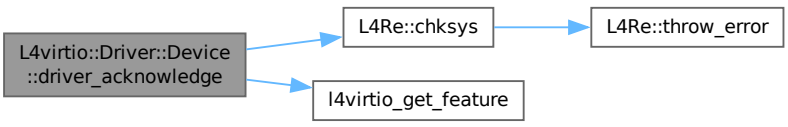
num	Number of queue to configure.
size	Size of rings in the queue, must be a power of 2)
desc_addr	Address of descriptor table (device address)
avail_addr	Address of available ring (device address)
used_addr	Address of used ring (device address)

Definition at line 212 of file l4virtio.

15.393.2.3 driver_acknowledge()

```
int L4virtio::Driver::Device::driver_acknowledge ()  [inline]
```

Finalize handshake with the device.
Must be called after all queues have been set up and before the first request is sent. It is still possible to add more shared dataspaces after the handshake has been finished.
Definition at line 156 of file l4virtio.
References L4Re::chksys(), L4_EINVAL, L4_EIO, L4_ENODEV, L4_EOK, L4VIRTIO_FEATURE_VERSION_1, l4virtio_get_feature(), L4VIRTIO_STATUS_DRIVER_OK, and L4VIRTIO_STATUS_FEATURES_OK.
Here is the call graph for this function:



15.393.2.4 driver_connect()

```
void L4virtio::Driver::Device::driver_connect (
            L4::Cap< L4virtio::Device > srvcap,
            bool manage_notify = true)  [inline]
```

Contacts the device and starts the initial handshake.

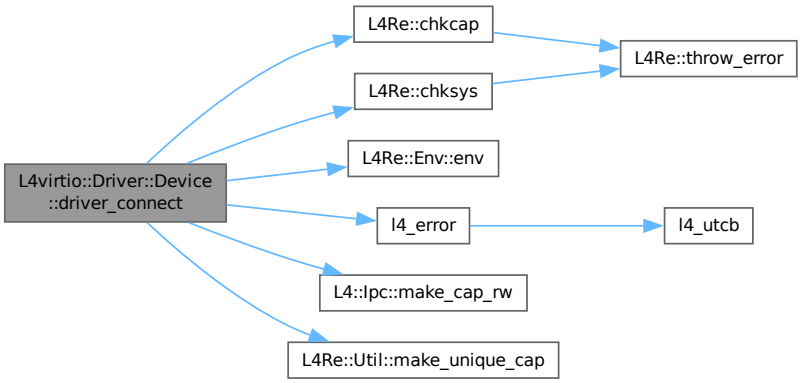
Parameters

srvcap	Capability for device communication.
manage_notify	Set up a semaphore for notifications from the device. See below.

Exceptions

L4::Runtime_error	if the initialisation fails

This function contacts the server, sets up the notification channels and the configuration dataspace. After this is done, the caller can set up any dataspaces it needs. The initialisation then needs to be finished by calling driver_acknowledge().
Per default this function creates and registers a semaphore for receiving notification from the device. This semaphore is used in the blocking functions send_and_wait(), wait() and next_used().
When `manage_notify` is false, then the caller may manually register and handle notification interrupts from the device. This is for example useful, when the client runs in an application with a server loop.
Definition at line 56 of file l4virtio.
References L4Re::chkcap(), L4Re::chksys(), L4Re::Env::env(), L4_EINVAL, L4_EIO, L4_ENODEV, l4_error(), L4_PAGEMASK, L4_PAGESHIFT, L4_PAGESIZE, L4_SUPERPAGESIZE, L4VIRTIO_STATUS_ACKNOWLEDGE, L4VIRTIO_STATUS_DRIVER, L4::Ipc::make_cap_rw(), L4Re::Util::make_unique_cap(), L4Re::Rm::F::RW, and L4Re::Rm::F::Search_addr.
Here is the call graph for this function:



15.393.2.5 feature_negotiated()

```
bool L4virtio::Driver::Device::feature_negotiated (
            unsigned int feat) const  [inline]
```

Check if a particular feature bit was negotiated with the device.
The result is only valid after driver_acknowledge() was called (when the handshake with the device was completed).

Parameters

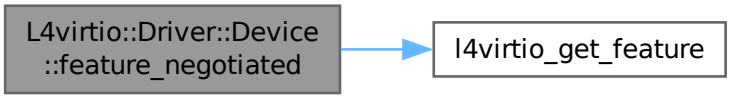
feat	The feature bit.

Return values

true	The feature is supported by both driver and device.
false	The feature is not supported by the driver and/or device.

Definition at line 145 of file l4virtio.
References l4virtio_get_feature().

Here is the call graph for this function:



15.393.2.6 max_queue_size()

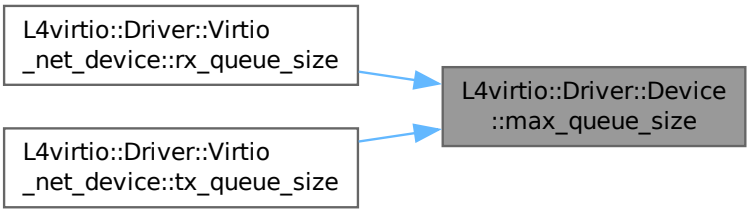
```
int L4virtio::Driver::Device::max_queue_size (
            int num) const  [inline]
```

Maximum queue size allowed by the device.

Parameters

num	Number of queue for which to determine the maximum size.

Definition at line 230 of file l4virtio.
Referenced by L4virtio::Driver::Virtio_net_device::rx_queue_size(), and L4virtio::Driver::Virtio_net_device::tx_queue_size().
Here is the caller graph for this function:



15.393.2.7 register_ds()

```
int L4virtio::Driver::Device::register_ds (
            L4::Cap< L4Re::Dataspace > ds,
            l4_umword_t offset,
            l4_umword_t size,
            l4_uint64_t * devaddr)  [inline]
```

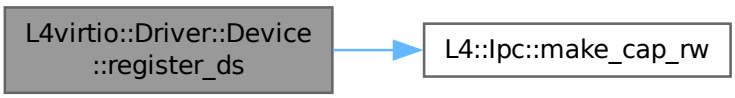
Share a dataspace with the device.

Parameters

ds	Dataspace to share with the device.
offset	Offset in dataspace where the shared part starts.

size	Total size in bytes of the shared space.
devaddr	Start of shared space in the device address space.

Although this function allows to share only a part of the given dataspace for convenience, the granularity of sharing is always the dataspace level. Thus, the remainder of the dataspace is not protected from the device.
When communicating with the device, addresses must be given with respect to the device address space. This is not the same as the virtual address space of the client in order to not leak information about the address space layout.
Definition at line 196 of file l4virtio.
References L4::Ipc::make_cap_rw().
Here is the call graph for this function:



15.393.2.8 send()

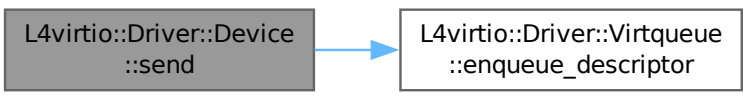
```
void L4virtio::Driver::Device::send (
            Virtqueue & queue,
            l4_uint16_t descno)  [inline]
```

Send a request to the device.

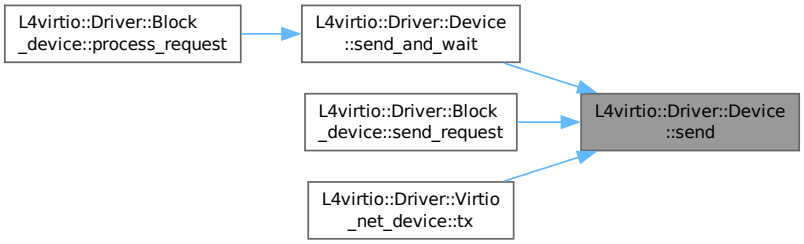
Parameters

queue	Queue that contains the request in its descriptor table
descno	Index of first entry in descriptor table where

Definition at line 312 of file l4virtio.
References L4virtio::Driver::Virtqueue::enqueue_descriptor().
Referenced by send_and_wait(), L4virtio::Driver::Block_device::send_request(), and L4virtio::Driver::Virtio_net_device::tx().
Here is the call graph for this function:



Here is the caller graph for this function:



15.393.2.9 send_and_wait()

```
int L4virtio::Driver::Device::send_and_wait (
            Virtqueue & queue,
            l4_uint16_t descno)  [inline]
```

Send a request to the device and wait for it to be processed.

Parameters

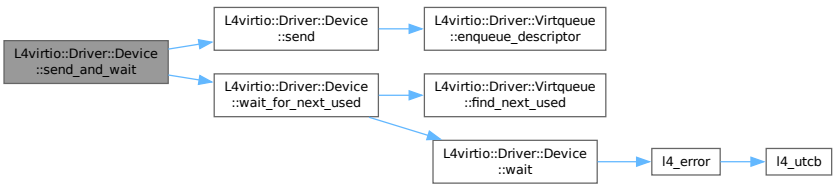
queue	Queue that contains the request in its descriptor table
descno	Index of first entry in descriptor table where

This function provides a simple mechanism to send requests synchronously. It must not be used with other requests at the same time as it directly waits for a notification on the device irq cap.

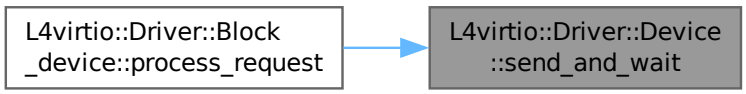
Precondition

driver_connect() was called with manage_notify.

Definition at line 247 of file l4virtio.
References L4_EINVAL, L4_EOK, send(), and wait_for_next_used().
Referenced by L4virtio::Driver::Block_device::process_request().
Here is the call graph for this function:



Here is the caller graph for this function:



15.393.2.10 wait()

```
int L4virtio::Driver::Device::wait (
            int index) const  [inline]
```

Wait for a notification from the device.

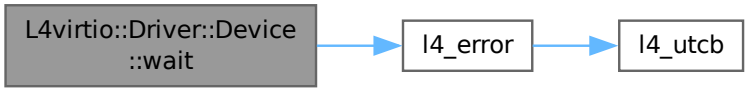
Parameters

index	Notification slot to wait for.

Precondition

driver_connect() was called with manage_notify.

Definition at line 268 of file l4virtio.
References L4_EEXIST, and l4_error().
Referenced by wait_for_next_used().
Here is the call graph for this function:



Here is the caller graph for this function:



15.393.2.11 wait_for_next_used()

```
int L4virtio::Driver::Device::wait_for_next_used (
            Virtqueue & queue,
            l4_uint32_t * len = nullptr) const  [inline]
```

Wait for the next item to arrive in the used queue and return it.

Parameters

	queue	A queue.
out	*len*	(optional) Size of valid data in finished block. Note that this is the value reported by the device, which may set it to a value that is larger than the original buffer size.

Return values

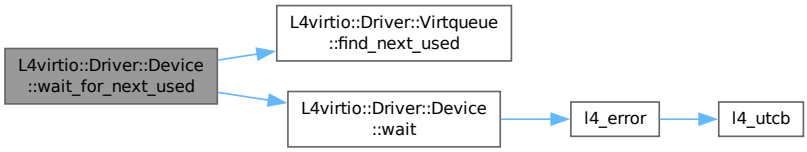
>=0	Descriptor number of item removed from used queue.
<0	IPC error while waiting for notification.

The call blocks until the next item is available in the used queue.

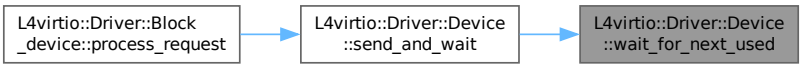
Precondition

driver_connect() was called with manage_notify.

Definition at line 291 of file l4virtio.
References L4virtio::Driver::Virtqueue::find_next_used(), and wait().
Referenced by send_and_wait().
Here is the call graph for this function:



Here is the caller graph for this function:



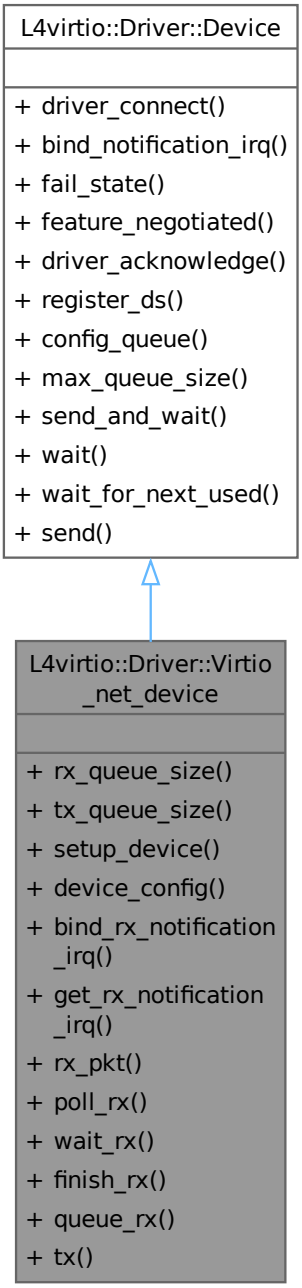
The documentation for this class was generated from the following file:

- l4/l4virtio/client/l4virtio

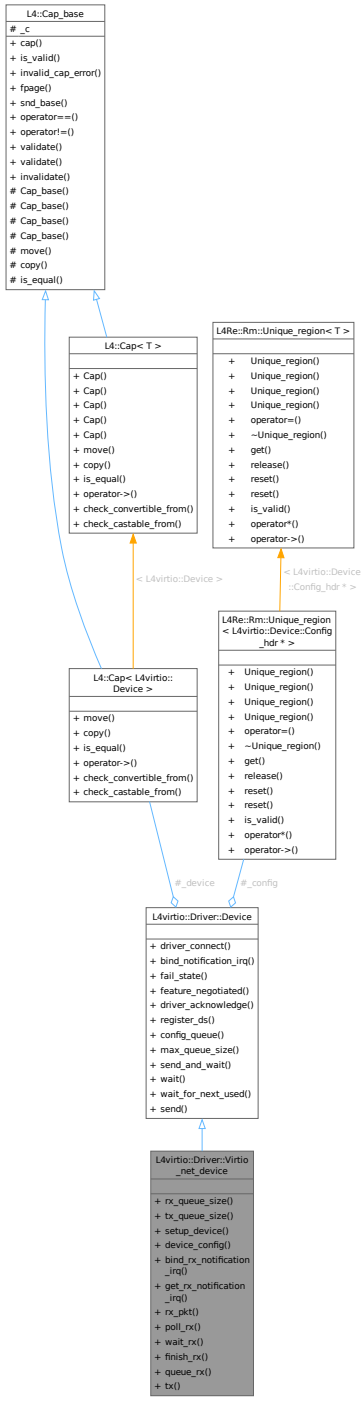
15.394 L4virtio::Driver::Virtio_net_device Class Reference

Simple class for accessing a virtio net device.
`#include <virtio-net>`

Inheritance diagram for L4virtio::Driver::Virtio_net_device:



Collaboration diagram for L4virtio::Driver::Virtio_net_device:



Data Structures

- struct Packet

  Structure for a network packet (header including data) with maximum size, assuming that no extra features have been negotiated.

Public Member Functions

- int rx_queue_size () const

Return the maximum receive queue size allowed by the device.

- int tx_queue_size () const

  Return the maximum transmit queue size allowed by the device.

- void setup_device (L4::Cap< L4virtio::Device > srvcap, L4::Cap< L4Re::Dataspace > queue_ds=L4::Cap< L4Re::Dataspace >::Invalid, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Establish a connection to the device and set up shared memory.

- l4virtio_net_config_t const & **device_config** () const

  Return a reference to the device configuration.

- int bind_rx_notification_irq (L4::Cap< L4::Thread > thread, l4_umword_t label)

  Bind the rx notification IRQ to the specified thread.

- L4::Cap< L4::Irq > **get_rx_notification_irq** () const

  Get notification IRQ.

- Packet & rx_pkt (l4_uint16_t descno)

  Return a reference to the RX packet buffer of the specified descriptor, e.g.

- l4_uint16_t poll_rx (l4_uint32_t *len=nullptr)

  Poll if a network packet has been received from the device and return the descriptor number, if any.

- l4_uint16_t wait_rx (l4_uint32_t *len=nullptr)

  Block until a network packet has been received from the device and return the descriptor number.

- void finish_rx (l4_uint16_t descno)

  Free an RX descriptor number to make it available for the RX queue again.

- void **queue_rx** ()

  Queue new available descriptors in the RX queue.

- bool tx (std::function< l4_uint32_t(Packet &)> prepare)

  Attempt to allocate a descriptor in the TX queue and transmit the packet, after calling the prepare callback.

Public Member Functions inherited from L4virtio::Driver::Device

- void driver_connect (L4::Cap< L4virtio::Device > srvcap, bool manage_notify=true)

  Contacts the device and starts the initial handshake.

- int bind_notification_irq (unsigned index, L4::Cap< L4::Triggerable > irq) const

  Register a triggerable to receive notifications from the device.

- bool **fail_state** () const

  Return true if the device is in a fail state.

- bool feature_negotiated (unsigned int feat) const

  Check if a particular feature bit was negotiated with the device.

- int driver_acknowledge ()

  Finalize handshake with the device.

- int register_ds (L4::Cap< L4Re::Dataspace > ds, l4_umword_t offset, l4_umword_t size, l4_uint64_t *devaddr)

  Share a dataspace with the device.

- int config_queue (int num, unsigned size, l4_uint64_t desc_addr, l4_uint64_t avail_addr, l4_uint64_t used_↩ addr)

  Send the virtqueue configuration to the device.

- int max_queue_size (int num) const

  Maximum queue size allowed by the device.

- int send_and_wait (Virtqueue &queue, l4_uint16_t descno)

  Send a request to the device and wait for it to be processed.

- int wait (int index) const

  Wait for a notification from the device.

- int wait_for_next_used (Virtqueue &queue, l4_uint32_t *len=nullptr) const

  Wait for the next item to arrive in the used queue and return it.

- void send (Virtqueue &queue, l4_uint16_t descno)

  Send a request to the device.

15.394.1 Detailed Description

Simple class for accessing a virtio net device.
Definition at line 30 of file virtio-net.

15.394.2 Member Function Documentation

15.394.2.1 bind_rx_notification_irq()

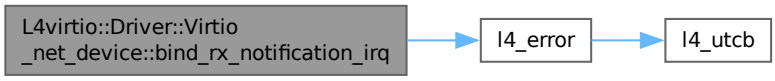
```
int L4virtio::Driver::Virtio_net_device::bind_rx_notification_irq (
            L4::Cap< L4::Thread > thread,
            l4_umword_t label)  [inline]
```

Bind the rx notification IRQ to the specified thread.

Parameters

thread	Thread to bind the notification IRQ to.
label	Label to assign to the IRQ.

Definition at line 185 of file virtio-net.
References l4_error().
Here is the call graph for this function:



15.394.2.2 finish_rx()

```
void L4virtio::Driver::Virtio_net_device::finish_rx (
            l4_uint16_t descno)  [inline]
```

Free an RX descriptor number to make it available for the RX queue again.

Parameters

descno	Descriptor number in the virtio queue.

Usually queue_rx() should be called afterwards to queue the freed descriptor(s).
Definition at line 271 of file virtio-net.

15.394.2.3 poll_rx()

```
l4_uint16_t L4virtio::Driver::Virtio_net_device::poll_rx (
            l4_uint32_t * len = nullptr)  [inline]
```

Poll if a network packet has been received from the device and return the descriptor number, if any.

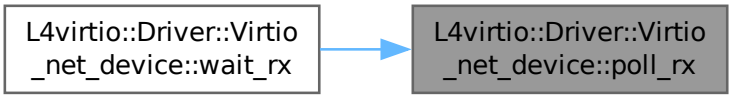
Parameters

out	*len*	(optional) Length of valid data in RX packet.

Return values

!=Virtqueue::Eoq	Descriptor number of received packet
==Virtqueue::Eoq	No descriptor is available.

The packet data can be obtained with rx_pkt(). finish_rx() should be called after the packet buffer can be returned to the RX queue.
Definition at line 221 of file virtio-net.
Referenced by wait_rx().
Here is the caller graph for this function:



15.394.2.4 rx_pkt()

```
Packet & L4virtio::Driver::Virtio_net_device::rx_pkt (
            l4_uint16_t descno)  [inline]
```

Return a reference to the RX packet buffer of the specified descriptor, e.g. from wait_rx().

Parameters

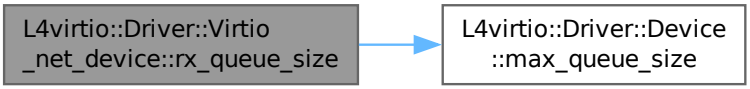
descno	Descriptor number in the virtio queue.

Definition at line 202 of file virtio-net.

15.394.2.5 rx_queue_size()

```
int L4virtio::Driver::Virtio_net_device::rx_queue_size () const  [inline]
```

Return the maximum receive queue size allowed by the device.
wait_rx() will return a descriptor number that is smaller than this size.
Definition at line 47 of file virtio-net.
References L4virtio::Driver::Device::max_queue_size().
Here is the call graph for this function:



15.394.2.6 setup_device()

```
void L4virtio::Driver::Virtio_net_device::setup_device (
            L4::Cap< L4virtio::Device > srvcap,
            L4::Cap< L4Re::Dataspace > queue_ds = L4::Cap<L4Re::Dataspace>::Invalid,
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

Establish a connection to the device and set up shared memory.

Parameters

srvcap	IPC capability of the channel to the server.
queue_ds	(optional) External queue dataspace. If this capability is invalid, the function will attempt to allocate a dataspace on its own. Note that the external queue dataspace must be large enough.
msg_dev	Debug channel for developer-related information. Verbosity of L4Re::Util::Dbg(2) by default.

This function starts a handshake with the device and sets up the virtqueues for communication and the additional data structures for the network device.
Definition at line 72 of file virtio-net.
References L4::Cap_base::Invalid.

15.394.2.7 tx()

```
bool L4virtio::Driver::Virtio_net_device::tx (
            std::function< l4_uint32_t(Packet &)> prepare)  [inline]
```

Attempt to allocate a descriptor in the TX queue and transmit the packet, after calling the prepare callback.

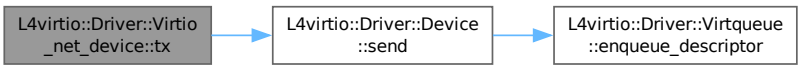
Parameters

prepare	Function that fills the packet with data, should return the length of the data copied to the packet.

Return values

true	The packet was queued.
false	TX queue is full.

The prepare callback should fill the packet with data and return the length of the packet data (without the size of the virtio-net packet header).
Definition at line 301 of file virtio-net.
References L4virtio::Driver::Device::send().
Here is the call graph for this function:

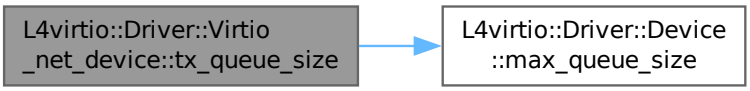


15.394.2.8 tx_queue_size()

```
int L4virtio::Driver::Virtio_net_device::tx_queue_size () const  [inline]
```

Return the maximum transmit queue size allowed by the device.

tx() will fail if the amount of queued packets exceeds this size.
Definition at line 54 of file virtio-net.
References L4virtio::Driver::Device::max_queue_size().
Here is the call graph for this function:



15.394.2.9 wait_rx()

```
l4_uint16_t L4virtio::Driver::Virtio_net_device::wait_rx (
            l4_uint32_t * len = nullptr)  [inline]
```

Block until a network packet has been received from the device and return the descriptor number.

Precondition

The calling thread must be bound to the rx notification IRQ via `bind_rx_notification_irq()`.

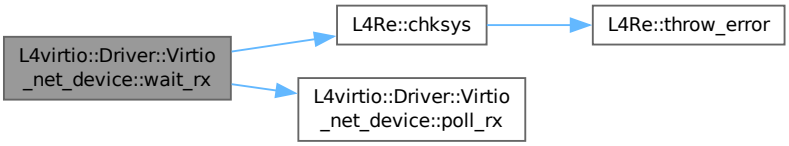
Parameters

out	*len*	(optional) Length of valid data in RX packet.

Returns

Descriptor number of received packet.

The packet data can be obtained with rx_pkt(). finish_rx() should be called after the packet buffer can be returned to the RX queue.
Definition at line 247 of file virtio-net.
References L4Re::chksys(), and poll_rx().
Here is the call graph for this function:



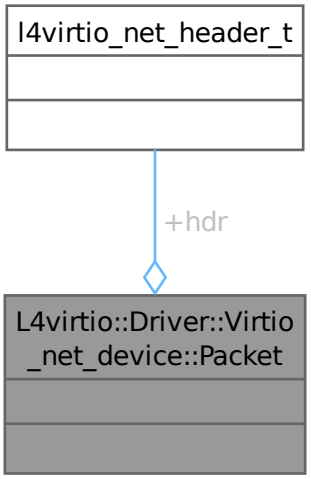
The documentation for this class was generated from the following file:

- l4/l4virtio/client/virtio-net

15.395 L4virtio::Driver::Virtio_net_device::Packet Struct Reference

Structure for a network packet (header including data) with maximum size, assuming that no extra features have been negotiated.

`#include <virtio-net>`
Collaboration diagram for L4virtio::Driver::Virtio_net_device::Packet:



15.395.1 Detailed Description

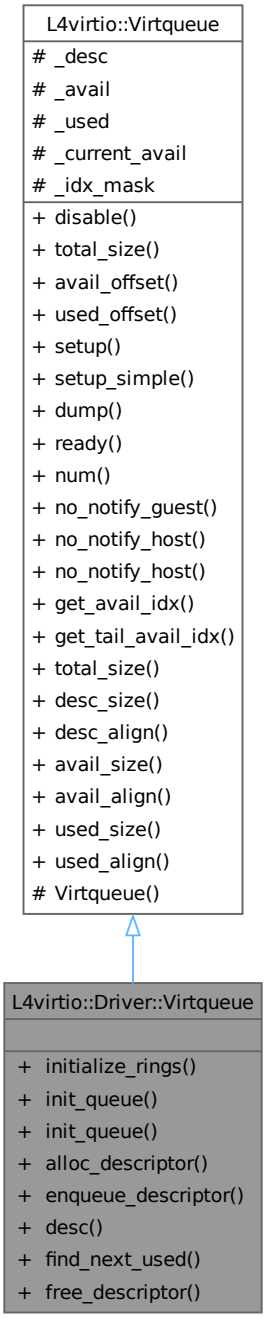
Structure for a network packet (header including data) with maximum size, assuming that no extra features have been negotiated.
Definition at line 37 of file virtio-net.
The documentation for this struct was generated from the following file:

- l4/l4virtio/client/virtio-net

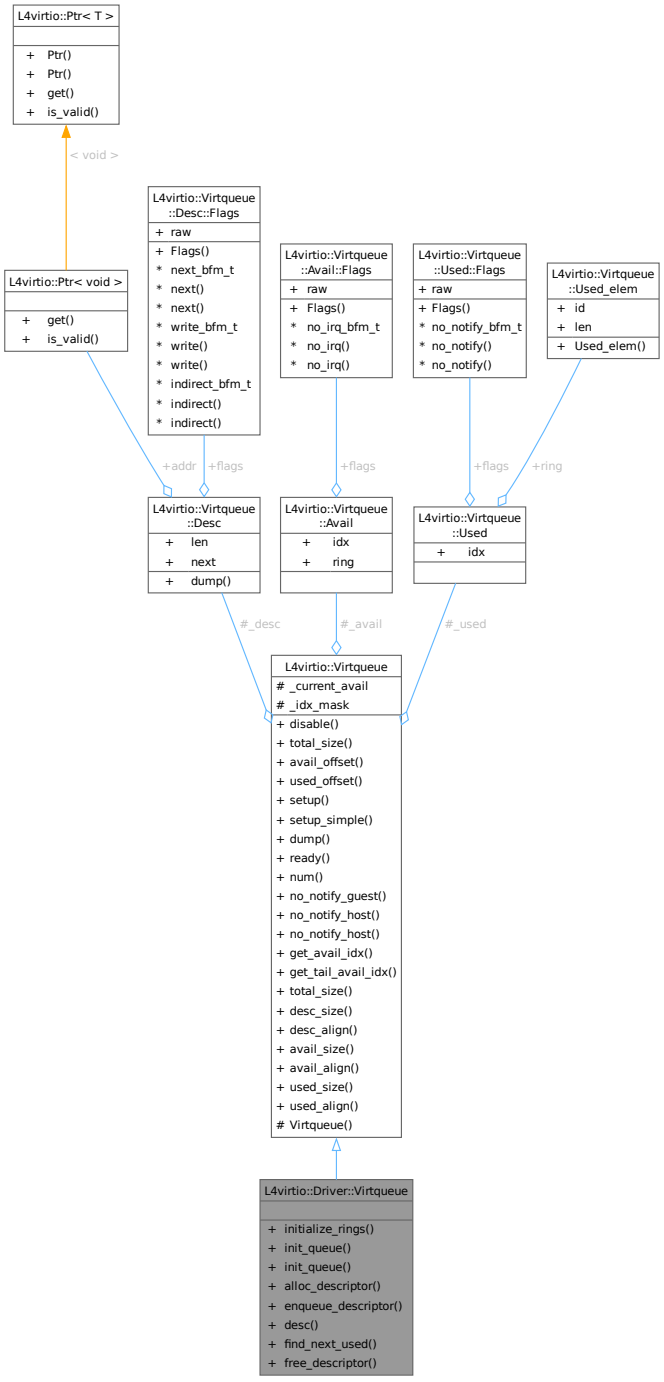
15.396 L4virtio::Driver::Virtqueue Class Reference

Driver-side implementation of a Virtqueue.
`#include <virtqueue>`

Inheritance diagram for L4virtio::Driver::Virtqueue:



Collaboration diagram for L4virtio::Driver::Virtqueue:



Public Member Functions

- void initialize_rings (unsigned num)

  Initialize the descriptor table and the index structures of this queue.

- void init_queue (unsigned num, void ∗desc, void ∗avail, void ∗used, L4Re::Util::Dbg msg_dev=L4Re::Util::↩ Dbg{2})

  Initialize this virtqueue.

- void init_queue (unsigned num, void ∗base, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

Initialize this virtqueue.

- l4_uint16_t alloc_descriptor ()

  Allocate and return an unused descriptor from the descriptor table.

- void enqueue_descriptor (l4_uint16_t descno)

  Enqueue a descriptor in the available ring.

- Desc & desc (l4_uint16_t descno)

  Return a reference to a descriptor in the descriptor table.

- l4_uint16_t find_next_used (l4_uint32_t *len=nullptr)

  Return the next finished block.

- void free_descriptor (l4_uint16_t head, l4_uint16_t tail)

  Free a chained list of descriptors in the descriptor queue.

Public Member Functions inherited from L4virtio::Virtqueue

- void disable ()

  Completely disable the queue.

- unsigned long total_size () const

  Calculate the total size of this virtqueue.

- unsigned long **avail_offset** () const

  Get the offset of the available ring from the descriptor table.

- unsigned long **used_offset** () const

  Get the offset of the used ring from the descriptor table.

- void setup (unsigned num, void *desc, void *avail, void *used, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Enable this queue.

- void setup_simple (unsigned num, void *ring, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Enable this queue.

- void dump (Desc const *d, L4Re::Util::Dbg dbg=L4Re::Util::Dbg{}) const

  Dump a descriptor for this queue.

- bool ready () const

  Test if this queue is in working state.

- unsigned num () const
- bool no_notify_guest () const

  Get the no IRQ flag of this queue.

- bool no_notify_host () const

  Get the no notify flag of this queue.

- void no_notify_host (bool value)

  Set the no-notify flag for this queue.

- l4_uint16_t get_avail_idx () const

  Get available index from available ring (for debugging).

- l4_uint16_t get_tail_avail_idx () const

  Get tail-available index stored in local state (for debugging).

Additional Inherited Members

Public Types inherited from L4virtio::Virtqueue

- enum

  Fixed alignment values for different parts of a virtqueue.

Static Public Member Functions inherited from L4virtio::Virtqueue

- static unsigned long total_size (unsigned num)

  Calculate the total size for a virtqueue of the given dimensions.
- static unsigned long desc_size (unsigned num)

  Calculate the size of the descriptor table for `num` entries.
- static unsigned long desc_align ()

  Get the alignment in zero LSBs needed for the descriptor table.
- static unsigned long avail_size (unsigned num)

  Calculate the size of the available ring for `num` entries.
- static unsigned long avail_align ()

  Get the alignment in zero LSBs needed for the available ring.
- static unsigned long used_size (unsigned num)

  Calculate the size of the used ring for `num` entries.
- static unsigned long used_align ()

  Get the alignment in zero LSBs needed for the used ring.

Protected Member Functions inherited from L4virtio::Virtqueue

- **Virtqueue** ()=default

  Create a disabled virtqueue.

Protected Attributes inherited from L4virtio::Virtqueue

- Desc * **_desc** = nullptr

  pointer to descriptor table, NULL if queue is off.
- Avail * **_avail** = nullptr

  pointer to available ring.
- Used * **_used** = nullptr

  pointer to used ring.
- l4_uint16_t **_current_avail** = 0

  The life counter for the queue.
- l4_uint16_t **_idx_mask** = 0

  mask used for indexing into the descriptor table and the rings.

15.396.1 Detailed Description

Driver-side implementation of a Virtqueue.
Adds function for managing the descriptor list, enqueueing new and dequeueing finished requests.

Note

The Virtqueue implementation is not thread-safe.

Definition at line 491 of file virtqueue.

15.396.2 Member Function Documentation

15.396.2.1 alloc_descriptor()

```
l4_uint16_t L4virtio::Driver::Virtqueue::alloc_descriptor ()  [inline]
```

Allocate and return an unused descriptor from the descriptor table.
The descriptor will be removed from the free list, the content should be considered undefined. After use, it needs to be freed using free_descriptor().

Returns

The index of the reserved descriptor or Virtqueue::Eoq if no free descriptor is available.

Note: the implementation uses (2^16 - 1) as the end of queue marker. That means that the final entry in the queue can not be allocated iff the queue size is 2^16.
Definition at line 585 of file virtqueue.
References L4virtio::Virtqueue::_desc.

15.396.2.2 desc()

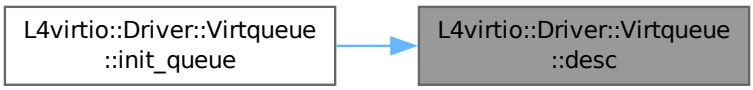
```
Desc & L4virtio::Driver::Virtqueue::desc (
            l4_uint16_t descno)  [inline]
```

Return a reference to a descriptor in the descriptor table.

Parameters

descno	Index of the descriptor, expected to be in correct range.

Definition at line 620 of file virtqueue.
References L4virtio::Virtqueue::_desc, and L4virtio::Virtqueue::_idx_mask.
Referenced by init_queue().
Here is the caller graph for this function:



15.396.2.3 enqueue_descriptor()

```
void L4virtio::Driver::Virtqueue::enqueue_descriptor (
            l4_uint16_t descno)  [inline]
```

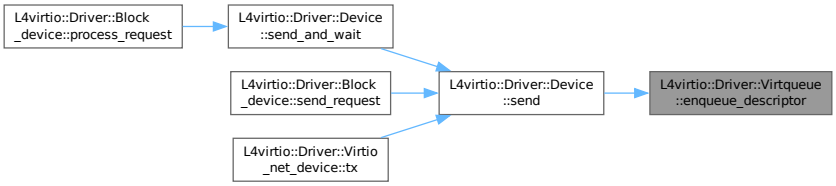
Enqueue a descriptor in the available ring.

Parameters

descno	Index of the head descriptor to enqueue.

Definition at line 601 of file virtqueue.
References L4virtio::Virtqueue::_avail, and L4virtio::Virtqueue::_idx_mask.
Referenced by L4virtio::Driver::Device::send().

Here is the caller graph for this function:



15.396.2.4 find_next_used()

```
l4_uint16_t L4virtio::Driver::Virtqueue::find_next_used (
            l4_uint32_t * len = nullptr)  [inline]
```

Return the next finished block.

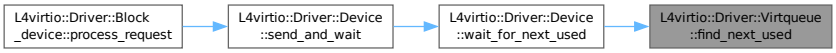
Parameters

out	*len*	(optional) Size of valid data in finished block. Note that this is the value reported by the device, which may set it to a value that is larger than the original buffer size.

Returns

Index of the head or Virtqueue::Eoq if no used element is currently available.

Definition at line 639 of file virtqueue.
References L4virtio::Virtqueue::_current_avail, L4virtio::Virtqueue::_idx_mask, and L4virtio::Virtqueue::_used.
Referenced by L4virtio::Driver::Device::wait_for_next_used().
Here is the caller graph for this function:



15.396.2.5 free_descriptor()

```
void L4virtio::Driver::Virtqueue::free_descriptor (
            l4_uint16_t head,
            l4_uint16_t tail)  [inline]
```

Free a chained list of descriptors in the descriptor queue.

Parameters

head	Index of the first element in the descriptor chain.
tail	Index of the last element in the descriptor chain.

Simply takes the descriptor chain and prepends it to the beginning of the free list. Assumes that the list has been correctly chained.
Definition at line 667 of file virtqueue.
References L4virtio::Virtqueue::_desc, and L4virtio::Virtqueue::_idx_mask.

15.396.2.6 init_queue() [1/2]

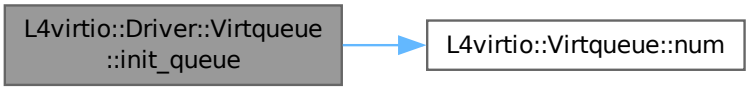
```
void L4virtio::Driver::Virtqueue::init_queue (
            unsigned num,
            void * base,
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

Initialize this virtqueue.

Parameters

num	The number of entries in the descriptor table, the available ring, and the used ring (must be a power of 2).
base	The base address for the queue data structure.
msg_dev	Debug channel for developer-related information. Verbosity of L4Re::Util::Dbg(2) by default.

This function sets up the memory and initializes the freelist.
Definition at line 563 of file virtqueue.
References L4virtio::Virtqueue::num().
Here is the call graph for this function:



15.396.2.7 init_queue() [2/2]

```
void L4virtio::Driver::Virtqueue::init_queue (
            unsigned num,
            void * desc,
            void * avail,
            void * used,
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

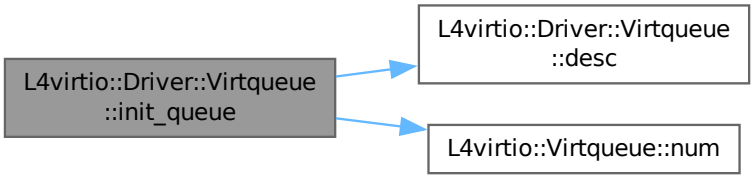
Initialize this virtqueue.

Parameters

num	The number of entries in the descriptor table, the available ring, and the used ring (must be a power of 2).
desc	The address of the descriptor table. (Must be Desc_align aligned and at least `desc_size(num)` bytes in size.)
avail	The address of the available ring. (Must be Avail_align aligned and at least `avail_size(num)` bytes in size.)
used	The address of the used ring. (Must be Used_align aligned and at least `used_size(num)` bytes in size.)
msg_dev	Debug channel for developer-related information. Verbosity of L4Re::Util::Dbg(2) by default.

This function sets up the memory and initializes the freelist.
Definition at line 545 of file virtqueue.

References desc(), and L4virtio::Virtqueue::num().
Here is the call graph for this function:



15.396.2.8 initialize_rings()

```
void L4virtio::Driver::Virtqueue::initialize_rings (
            unsigned num)  [inline]
```

Initialize the descriptor table and the index structures of this queue.

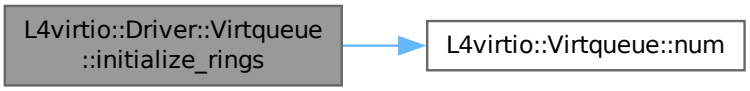
Parameters

num	The number of entries in the descriptor table, the available ring, and the used ring (must be a power of 2).

Precondition

The queue must be set up correctly with setup() or setup_simple().

Definition at line 515 of file virtqueue.
References L4virtio::Virtqueue::_avail, L4virtio::Virtqueue::_desc, L4virtio::Virtqueue::_used, and L4virtio::Virtqueue::num().
Here is the call graph for this function:



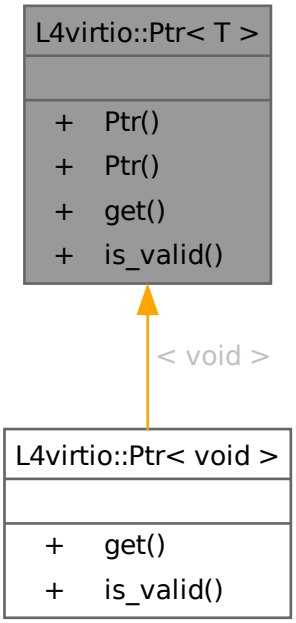
The documentation for this class was generated from the following file:

- l4/l4virtio/virtqueue

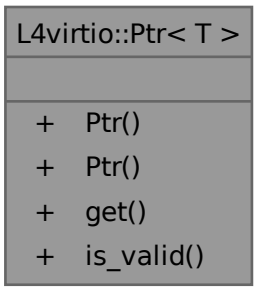
15.397 L4virtio::Ptr< T > Class Template Reference

Pointer used in virtio descriptors.
`#include <virtqueue>`

Inheritance diagram for L4virtio::Ptr< T >:



Collaboration diagram for L4virtio::Ptr< T >:



Public Types

- enum Invalid_type { Invalid }

  Type for making an invalid (NULL) Ptr.

Public Member Functions

- **Ptr** (Invalid_type)

  Make and invalid Ptr.

- **Ptr** (l4_uint64_t vm_addr)

  Make a Ptr from a raw 64bit address.
- l4_uint64_t get () const
- bool is_valid () const

15.397.1 Detailed Description

template<typename T>
class L4virtio::Ptr< T >

Pointer used in virtio descriptors.
As the descriptor contain guest addresses these pointers cannot be dereferenced directly.
Definition at line 53 of file virtqueue.

15.397.2 Member Enumeration Documentation

15.397.2.1 Invalid_type

```
template<typename T>
enum L4virtio::Ptr::Invalid_type
```

Type for making an invalid (NULL) Ptr.

Enumerator

Invalid	Use to set a Ptr to invalid (NULL).

Definition at line 57 of file virtqueue.

15.397.3 Member Function Documentation

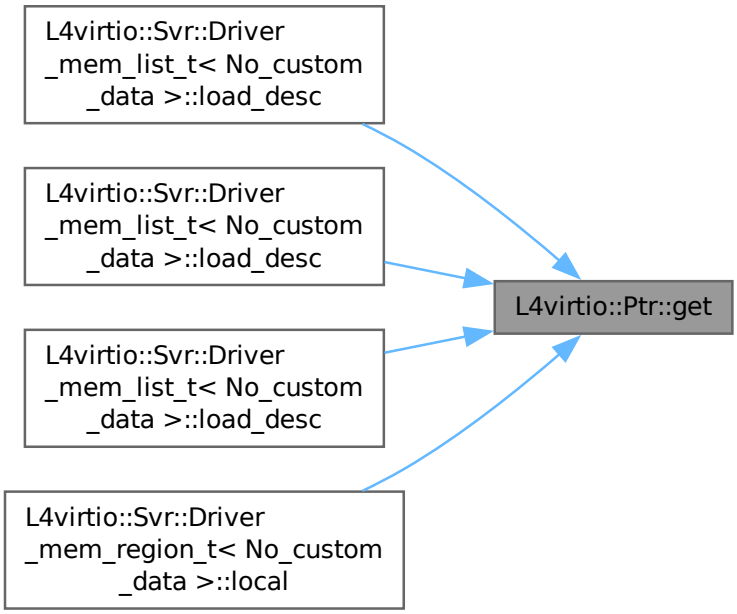
15.397.3.1 get()

```
template<typename T>
l4_uint64_t L4virtio::Ptr< T >::get () const  [inline]
```

Returns

The raw 64bit address of the stored pointer.

Definition at line 68 of file virtqueue.
Referenced by L4virtio::Svr::Driver_mem_list_t< No_custom_data >::load_desc(), L4virtio::Svr::Driver_mem_list_t< No_custom_da
L4virtio::Svr::Driver_mem_list_t< No_custom_data >::load_desc(), and L4virtio::Svr::Driver_mem_region_t< No_custom_data >::lo
Here is the caller graph for this function:



15.397.3.2 is_valid()

```
template<typename T>
bool L4virtio::Ptr< T >::is_valid () const  [inline]
```

Returns

true if the stored pointer is valid (not NULL).

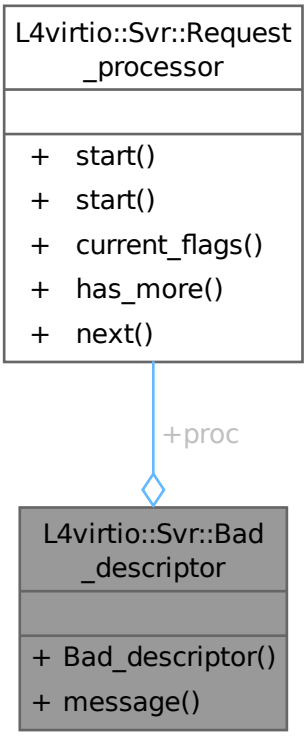
Definition at line 71 of file virtqueue.
The documentation for this class was generated from the following file:

- l4/l4virtio/virtqueue

15.398 L4virtio::Svr::Bad_descriptor Struct Reference

Exception used by Queue to indicate descriptor errors.
`#include <virtio>`

Collaboration diagram for L4virtio::Svr::Bad_descriptor:



Public Types

- enum Error {
  Bad_address , Bad_rights , Bad_flags , Bad_next ,
  Bad_size }

  The error code.

Public Member Functions

- Bad_descriptor (Request_processor const ∗proc, Error e)

  Make a bad descriptor exception.
- char const ∗ message () const

  Get a human readable description of the error code.

Data Fields

- Request_processor const ∗ **proc**

  The processor that triggered the exception.

15.398.1 Detailed Description

Exception used by Queue to indicate descriptor errors.
Definition at line 397 of file virtio.

15.398.2 Member Enumeration Documentation

15.398.2.1 Error

```
enum L4virtio::Svr::Bad_descriptor::Error
```
The error code.

Enumerator

Bad_address	Address cannot be translated.
Bad_rights	Missing access rights on memory.
Bad_flags	Invalid combination of descriptor flags.
Bad_next	Invalid next index.
Bad_size	Invalid size of memory block.

Definition at line 400 of file virtio.

15.398.3 Constructor & Destructor Documentation

15.398.3.1 Bad_descriptor()

```
L4virtio::Svr::Bad_descriptor::Bad_descriptor (
            Request_processor const * proc,
            Error e)  [inline]
```
Make a bad descriptor exception.

Parameters

proc	The request processor causing the exception
e	The error code.

Definition at line 421 of file virtio.
References proc.

15.398.4 Member Function Documentation

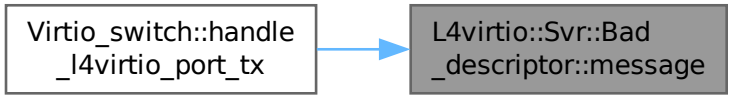
15.398.4.1 message()

```
char const * L4virtio::Svr::Bad_descriptor::message () const  [inline]
```
Get a human readable description of the error code.

Returns

Message describing the error.

Definition at line 430 of file virtio.
References Bad_address, Bad_flags, Bad_next, Bad_rights, and Bad_size.
Referenced by Virtio_switch::handle_l4virtio_port_tx().
Here is the caller graph for this function:



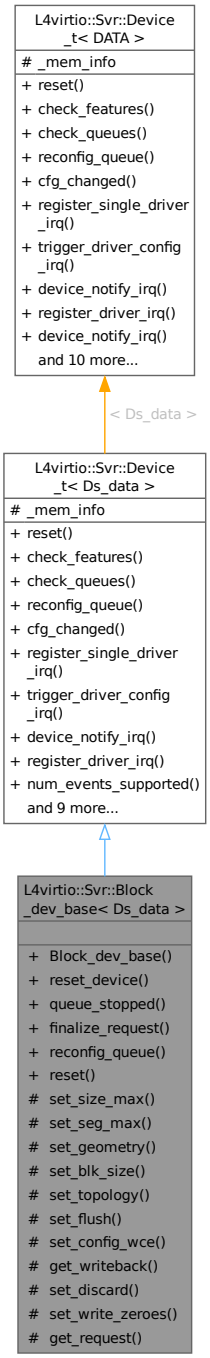
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio

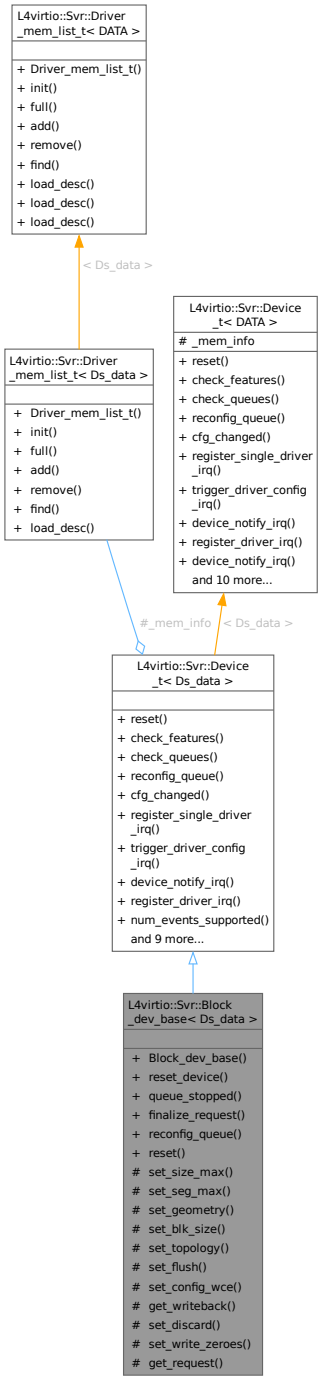
15.399 L4virtio::Svr::Block_dev_base< Ds_data > Class Template Reference

Base class for virtio block devices.
`#include <virtio-block>`

Inheritance diagram for L4virtio::Svr::Block_dev_base< Ds_data >:



Collaboration diagram for L4virtio::Svr::Block_dev_base< Ds_data >:



Public Member Functions

- Block_dev_base (l4_uint32_t vendor, unsigned queue_size, l4_uint64_t capacity, bool read_only, L4Re::↩ Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Create a new virtio block device.
- virtual void **reset_device** ()=0

  Reset the actual hardware device.
- virtual bool **queue_stopped** ()=0

Return true, if the queues should not be processed further.

- void finalize_request (cxx::unique_ptr< Request > req, unsigned sz, l4_uint8_t status=L4VIRTIO_BLOCK_S_OK)

  Releases resources related to a request and notifies the client.
- int **reconfig_queue** (unsigned idx) override

  callback for client queue-config request
- void **reset** () override

  reset callback, called for doing a device reset

Public Member Functions inherited from L4virtio::Svr::Device_t< Ds_data >

- virtual bool **check_features** ()

  callback for checking the subset of accepted features
- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual L4::Cap< L4::Irq > **device_notify_irq** () const

  callback to gather the device notification IRQ (old-style)
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Protected Member Functions

- void set_size_max (l4_uint32_t sz)

  Sets the maximum size of any single segment reported to client.
- void **set_seg_max** (l4_uint32_t sz)

  Sets the maximum number of segments in a request that is reported to client.
- void **set_geometry** (l4_uint16_t cylinders, l4_uint8_t heads, l4_uint8_t sectors)

  Set disk geometry that is reported to the client.
- void set_blk_size (l4_uint32_t sz)

  Sets block disk size to be reported to the client.

- void set_topology (l4_uint8_t physical_block_exp, l4_uint8_t alignment_offset, l4_uint16_t min_io_size, l4_uint32_t opt_io_size)

  Sets the I/O alignment information reported back to the client.
- void **set_flush** ()

  Enables the flush command.
- void set_config_wce (l4_uint8_t writeback)

  Sets cache mode and enables the writeback toggle.
- l4_uint8_t get_writeback ()

  Get the writeback field from the configuration space.
- void set_discard (l4_uint32_t max_discard_sectors, l4_uint32_t max_discard_seg, l4_uint32_t discard_↩ sector_alignment)

  Sets constraints for and enables the discard command.
- void set_write_zeroes (l4_uint32_t max_write_zeroes_sectors, l4_uint32_t max_write_zeroes_seg, l4_uint8_t write_zeroes_may_unmap)

  Sets constraints for and enables the write zeroes command.
- cxx::unique_ptr< Request > **get_request** ()

  Return one request if available.

Additional Inherited Members

Protected Attributes inherited from L4virtio::Svr::Device_t< Ds_data >

- Mem_list **_mem_info**

  Memory region list.

15.399.1 Detailed Description

template<typename Ds_data>
class L4virtio::Svr::Block_dev_base< Ds_data >

Base class for virtio block devices.
Use this class as a base to implement your own specific block device.
Definition at line 268 of file virtio-block.

15.399.2 Constructor & Destructor Documentation

15.399.2.1 Block_dev_base()

```
template<typename Ds_data>
L4virtio::Svr::Block_dev_base< Ds_data >::Block_dev_base (
            l4_uint32_t vendor,
            unsigned queue_size,
            l4_uint64_t capacity,
            bool read_only,
            L4Re::Util::Dbg msg_user = L4Re::Util::Dbg{},
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

Create a new virtio block device.

Parameters

vendor	Vendor ID
queue_size	Number of entries to provide in avail and used queue.
capacity	Size of the device in 512-byte sectors.
read_only	True, if the device should not be writable.

msg_user	Debug channel for informational messages relevant for the user. Verbosity of L4Re::Util::Dbg() by default.
msg_dev	Debug channel for debugging messages relevant for the developer. Verbosity of L4Re::Util::Dbg(2) by default.

Definition at line 457 of file virtio-block.

15.399.3 Member Function Documentation

15.399.3.1 finalize_request()

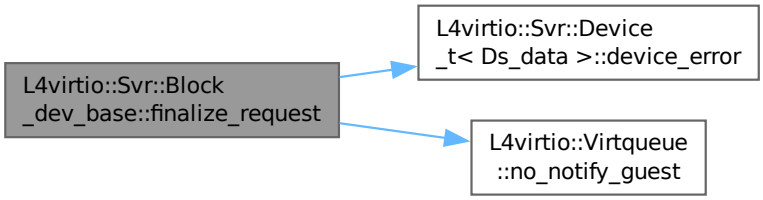
```
template<typename Ds_data>
void L4virtio::Svr::Block_dev_base< Ds_data >::finalize_request (
             cxx::unique_ptr< Request > req,
             unsigned sz,
             l4_uint8_t status = L4VIRTIO_BLOCK_S_OK)  [inline]
```

Releases resources related to a request and notifies the client.

Parameters

req	Pointer to request that has finished.
sz	Number of bytes consumed.
status	Status of request (see L4virtio_block_status).

This function must be called when an asynchronous request finishes, either successfully or with an error. The status byte in the request must have been set prior to calling it.
Definition at line 497 of file virtio-block.
References L4virtio::Svr::Device_t< Ds_data >::device_error(), L4VIRTIO_BLOCK_S_OK, L4VIRTIO_IRQ_STATUS_VRING, and L4virtio::Virtqueue::no_notify_guest().
Here is the call graph for this function:



15.399.3.2 get_writeback()

```
template<typename Ds_data>
l4_uint8_t L4virtio::Svr::Block_dev_base< Ds_data >::get_writeback ()  [inline], [protected]
```

Get the writeback field from the configuration space.

Returns

Value of the writeback field.

Definition at line 397 of file virtio-block.

15.399.3.3 set_blk_size()

```
template<typename Ds_data>
void L4virtio::Svr::Block_dev_base< Ds_data >::set_blk_size (
            l4_uint32_t sz)  [inline], [protected]
```

Sets block disk size to be reported to the client.
Setting this does not change the logical sector size used for addressing the device.
Definition at line 341 of file virtio-block.

15.399.3.4 set_config_wce()

```
template<typename Ds_data>
void L4virtio::Svr::Block_dev_base< Ds_data >::set_config_wce (
            l4_uint8_t writeback)  [inline], [protected]
```

Sets cache mode and enables the writeback toggle.

Parameters

writeback	Mode of the cache (0 for writethrough, 1 for writeback).

Definition at line 384 of file virtio-block.

15.399.3.5 set_discard()

```
template<typename Ds_data>
void L4virtio::Svr::Block_dev_base< Ds_data >::set_discard (
            l4_uint32_t max_discard_sectors,
            l4_uint32_t max_discard_seg,
            l4_uint32_t discard_sector_alignment)  [inline], [protected]
```

Sets constraints for and enables the discard command.

Parameters

max_discard_sectors	Maximum discard sectors size.
max_discard_seg	Maximum discard segment number.
discard_sector_alignment	Can be used by the driver when splitting a request based on alignment.

Definition at line 411 of file virtio-block.

15.399.3.6 set_size_max()

```
template<typename Ds_data>
void L4virtio::Svr::Block_dev_base< Ds_data >::set_size_max (
            l4_uint32_t sz)  [inline], [protected]
```

Sets the maximum size of any single segment reported to client.
The limit is also applied to any incoming requests. Requests with larger segments result in an IO error being reported to the client. That means that process_request() can safely make the assumption that all segments in the received request are smaller.
Definition at line 299 of file virtio-block.

15.399.3.7 set_topology()

```
template<typename Ds_data>
void L4virtio::Svr::Block_dev_base< Ds_data >::set_topology (
            l4_uint8_t physical_block_exp,
            l4_uint8_t alignment_offset,
```

```
            l4_uint16_t min_io_size,
            l4_uint32_t opt_io_size)  [inline], [protected]
```

Sets the I/O alignment information reported back to the client.

Parameters

physical_block_exp	Number of logical blocks per physical block(log2)
alignment_offset	Offset of the first aligned logical block
min_io_size	Suggested minimum I/O size in blocks
opt_io_size	Optimal I/O size in blocks

Definition at line 357 of file virtio-block.

15.399.3.8 set_write_zeroes()

```
template<typename Ds_data>
void L4virtio::Svr::Block_dev_base< Ds_data >::set_write_zeroes (
            l4_uint32_t max_write_zeroes_sectors,
            l4_uint32_t max_write_zeroes_seg,
            l4_uint8_t write_zeroes_may_unmap)  [inline], [protected]
```

Sets constraints for and enables the write zeroes command.

Parameters

max_write_zeroes_sectors	Maximum write zeroes sectors size.
max_write_zeroes_seg	maximum write zeroes segment number.
write_zeroes_may_unmap	Set if a write zeroes request can result in deallocating one or more sectors.

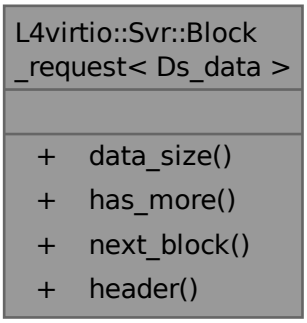
Definition at line 431 of file virtio-block.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-block

15.400 L4virtio::Svr::Block_request< Ds_data > Class Template Reference

A request to read or write data.
`#include <virtio-block>`

Collaboration diagram for L4virtio::Svr::Block_request< Ds_data >:



Public Member Functions

- unsigned data_size () const

  Compute the total size of the data in the request.
- bool **has_more** ()

  Check if the request contains more data blocks.
- Data_block next_block ()

  Return next block in scatter-gather list.
- l4virtio_block_header_t const & **header** () const

  Return the block request header.

15.400.1 Detailed Description

template<typename Ds_data>
class L4virtio::Svr::Block_request< Ds_data >

A request to read or write data.
Definition at line 28 of file virtio-block.

15.400.2 Member Function Documentation

15.400.2.1 data_size()

```
template<typename Ds_data>
unsigned L4virtio::Svr::Block_request< Ds_data >::data_size () const  [inline]
```

Compute the total size of the data in the request.

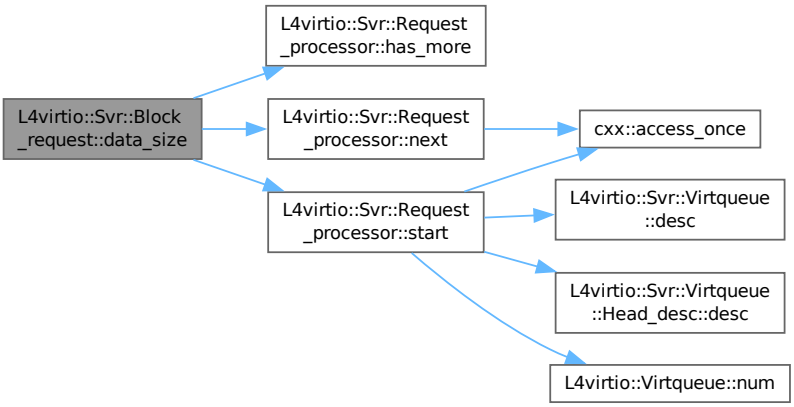
Return values

Size	in bytes or 0 if there was an error.

Exceptions

L4::Runtime_error(-L4_EIO)	Request has a bad format.

Note that this operation is relatively expensive as it has to iterate over the complete list of blocks.
Definition at line 63 of file virtio-block.
References L4virtio::Svr::Request_processor::has_more(), L4_EIO, L4virtio::Svr::Request_processor::next(), and L4virtio::Svr::Request_processor::start().
Here is the call graph for this function:



15.400.2.2 next_block()

```
template<typename Ds_data>
Data_block L4virtio::Svr::Block_request< Ds_data >::next_block ()  [inline]
```

Return next block in scatter-gather list.

Returns

Information about the next data block.

Exceptions

L4::Runtime_error	No more data block is available.
Bad_descriptor	Virtio request is corrupted.

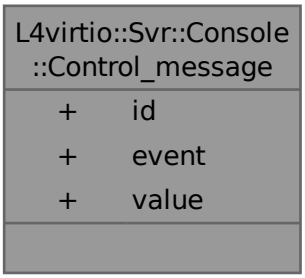
Definition at line 114 of file virtio-block.
References L4virtio::Svr::Bad_descriptor::Bad_size, and L4_EEXIST.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-block

15.401 L4virtio::Svr::Console::Control_message Struct Reference

Virtio console control message.
`#include <virtio-console>`

Collaboration diagram for L4virtio::Svr::Console::Control_message:



Public Types

- enum Events {
  Device_ready = 0 , Device_add = 1 , Device_remove = 2 , Port_ready = 3 ,
  Console_port = 4 , Resize = 5 , Port_open = 6 , Port_name = 7 }

  Possible control events.

Data Fields

- l4_uint32_t **id**

  Port number.
- l4_uint16_t **event**

  Control event, see `Events`.
- l4_uint16_t **value**

  Extra information.

15.401.1 Detailed Description

Virtio console control message.
Definition at line 31 of file virtio-console.

15.401.2 Member Enumeration Documentation

15.401.2.1 Events

`enum L4virtio::Svr::Console::Control_message::Events`
Possible control events.

Enumerator

Device_ready	Sent by driver at initialization.
Device_add	Sent by device to create new ports.
Device_remove	Sent by device to remove added ports.
Port_ready	Sent by driver as response to `Device_add`.
Console_port	Sent by device to nominate port as console port.
Resize	Sent by device to indicate a console size change.

Port_open	Sent by device and driver to indicate whether a port is open.
Port_name	Sent by device to tag a port.

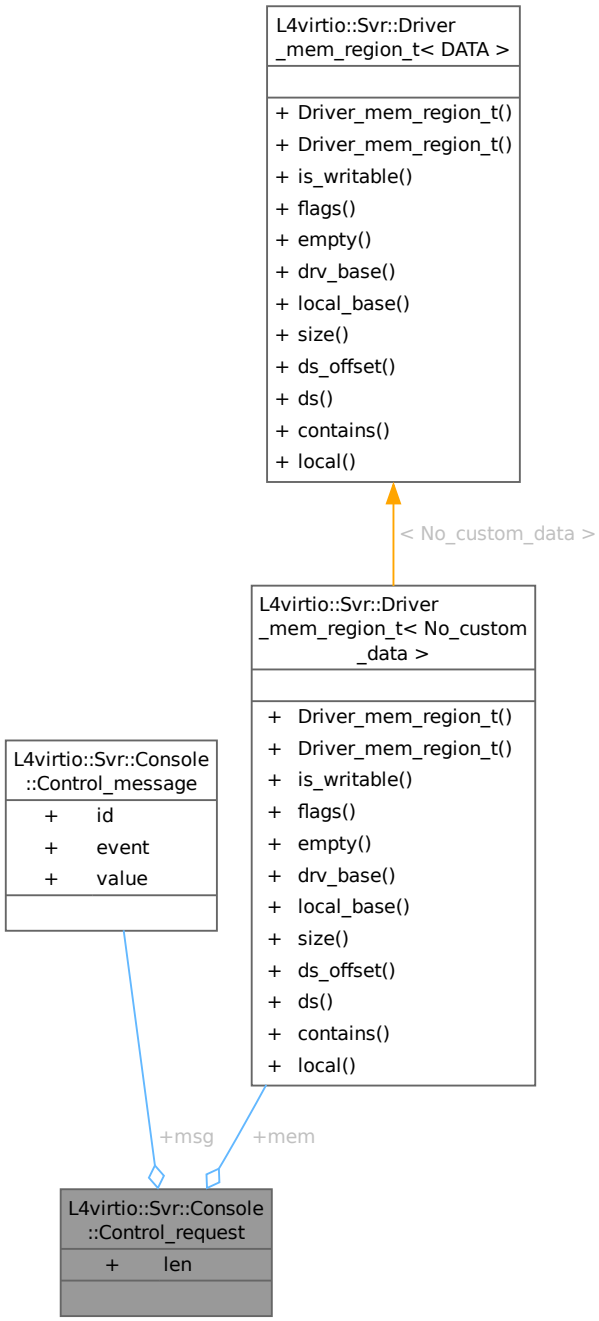
Definition at line 34 of file virtio-console.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-console

15.402 L4virtio::Svr::Console::Control_request Struct Reference

Specialised `Virtqueue::Request` providing access to control message payload.
`#include <virtio-console>`

Collaboration diagram for L4virtio::Svr::Console::Control_request:



Data Fields

- Control_message * **msg**

  Virtual address of the data block (in device space).

- l4_uint32_t **len**

  Length of datablock in bytes.

- Driver_mem_region * **mem**

  Pointer to driver memory region.

15.402.1 Detailed Description

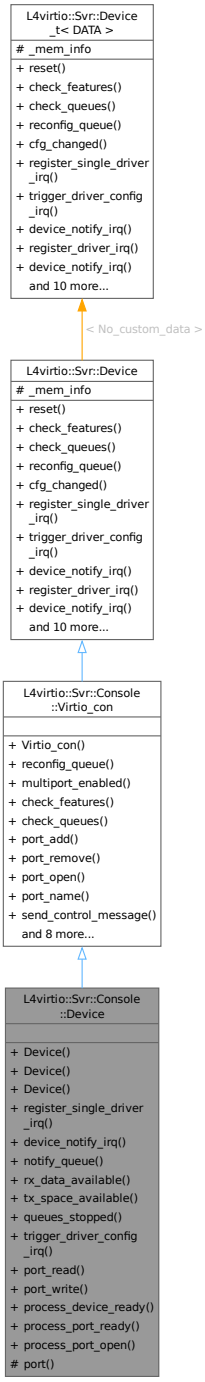
Specialised `Virtqueue::Request` providing access to control message payload.
Definition at line 65 of file virtio-console.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-console

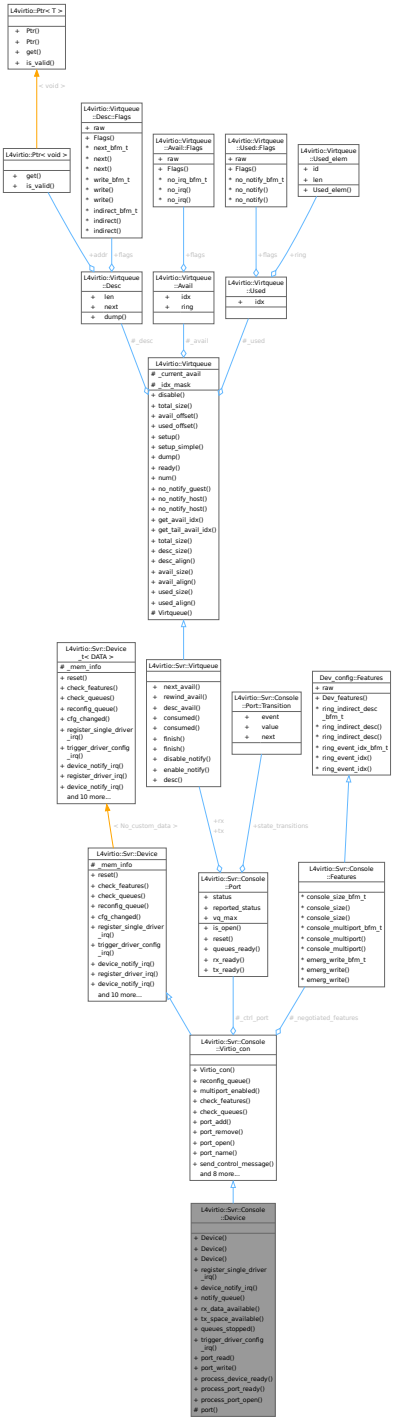
15.403 L4virtio::Svr::Console::Device Class Reference

Base class implementing a virtio console device with L4Re-based notification handling.
`#include <virtio-console-device>`

Inheritance diagram for L4virtio::Svr::Console::Device:



Collaboration diagram for L4virtio::Svr::Console::Device:



Public Member Functions

- Device (unsigned vq_max)

  Create a new console device.
- Device (unsigned vq_max, unsigned ports)

  Create a new console device.
- Device (cxx::static_vector< unsigned > const &vq_max_nums)

  Create a new console Device.

- void **register_single_driver_irq** () override

  callback for registering a single guest IRQ for all queues (old-style)
- L4::Cap< L4::Irq > **device_notify_irq** () const override

  callback to gather the device notification IRQ (old-style)
- void notify_queue (Virtqueue *queue) override

  Notify queue of available data.
- virtual void **rx_data_available** (unsigned port)=0

  Callback to notify that new data is available to be read from port.
- virtual void **tx_space_available** (unsigned port)=0

  Callback to notify that data can be written to port.
- virtual bool **queues_stopped** ()

  Return true, if the queues should not be processed further.
- void **trigger_driver_config_irq** () override

  callback for triggering configuration change notification IRQ
- unsigned port_read (char *buf, unsigned len, unsigned port=0)

  Read data from port.
- unsigned port_write (char const *buf, unsigned len, unsigned port=0)

  Write data to port.
- void process_device_ready (l4_uint16_t value) override

  Callback called on DEVICE_READY event.
- void process_port_ready (l4_uint32_t id, l4_uint16_t value) override

  Callback called on PORT_READY event.
- void process_port_open (l4_uint32_t id, l4_uint16_t value) override

  Callback called on PORT_OPEN event.

Public Member Functions inherited from L4virtio::Svr::Console::Virtio_con

- Virtio_con (unsigned max_ports, bool enable_multiport)

  Create a new multiport console device.
- int **reconfig_queue** (unsigned index) override

  callback for client queue-config request
- bool **multiport_enabled** () const

  Return true if the multiport feature is enabled and control queues are available.
- bool **check_features** (void) override

  callback for checking the subset of accepted features
- bool **check_queues** () override

  callback for checking if the queues at DRIVER_OK transition
- int port_add (unsigned idx)

  Send a DEVICE_ADD message and update the internal state.
- int port_remove (unsigned idx)

  Send a DEVICE_REMOVE message and update the internal state.
- int port_open (unsigned idx, bool open)

  Send a PORT_OPEN message and update the internal state.
- int port_name (unsigned idx, char const *name)

  Send a PORT_NAME message to announce the port name.
- int send_control_message (l4_uint32_t idx, l4_uint16_t event, l4_uint16_t value=0, const char *name=0)

  Send control message to driver.
- int handle_control_message ()

  Handle control message received from the driver.
- void **reset** () override

  reset callback, called for doing a device reset
- virtual void reset_device ()

  Reset the state of the actual console device.

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_↩ dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_↩ notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Protected Member Functions

- Port * port (unsigned idx) override

  Return the specified port.

Additional Inherited Members

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.403.1 Detailed Description

Base class implementing a virtio console device with L4Re-based notification handling.
This console device is derived from Virtio_con and already includes functionality to handle interrupts and notify drivers. If an interrupt is received, all the necessary interaction with the virtqueues is performed and only the actual data processing has to be done by the derived class. By default all available ports are added and an "open"-request of a port by the driver is automatically acknowledged. The derived class can optionally change this behaviour by overriding `process_device_ready()`, `process_port_ready()` and `process_port_open()`.
This class provides a stream-based interface to access the port data with edge-triggered notification callbacks. If a port receives data from the driver the derived class is notified with the `rx_data_available()` callback. The actual data can be retrieved by `port_read()`. If there was not enough data to be read, the call will return the available partial data. Only then will the `rx_data_available()` callback be triggered again.

Data on a port may be transmitted by `port_write()`. If there were not enough buffers available, only a part of the data will be transmitted. Once there are new buffers available, the `tx_space_available()` callback will be invoked. This callback will be called again only after a previous `port_write()` was not able to send all requested data.
Use this class as a base to provide your own high-level console device. You must derive from this class as well as L4::Epiface_t<..., L4virtio::Device>. For a working device the irq_iface() must be registered too. A typical implementation might look like the following:

```
class My_console
: public L4virtio::Svr::Console::Device,
  public L4::Epiface_t<My_console, L4virtio::Device>
{
public:
  My_console(L4Re::Util::Object_registry *r)
  : L4virtio::Svr::Console::Device(0x100)
  {
    init_mem_info(4);
    L4Re::chkcap(r->register_irq_obj(irq_iface()), "virtio notification IRQ");
  }

  void rx_data_available(unsigned port) override
  {
    // call port_read() to fetch available data
  }

  void tx_space_available(unsigned port) override
  {
    // can call port_write() to send (pending) data
  }
};

My_console console(registry);
registry->register_obj(&console, ...);
```

The maximum number of memory regions (init_mem_info()) should correlate with the number of supported ports.
Definition at line 118 of file virtio-console-device.

15.403.2 Constructor & Destructor Documentation

15.403.2.1 Device() [1/3]

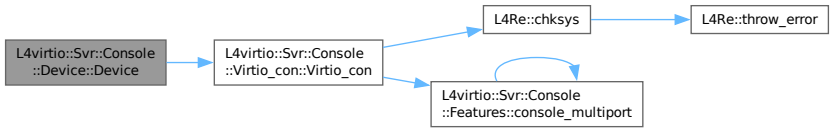
```
L4virtio::Svr::Console::Device::Device (
            unsigned vq_max)  [inline], [explicit]
```

Create a new console device.

Parameters

vq_max	Maximum number of buffers in data queues.

Create a console device with no multiport support, i.e. control queues are disabled.
Definition at line 145 of file virtio-console-device.
References L4virtio::Svr::Console::Virtio_con::Virtio_con().
Here is the call graph for this function:



15.403.2.2 Device() [2/3]

```
L4virtio::Svr::Console::Device::Device (
            unsigned vq_max,
```

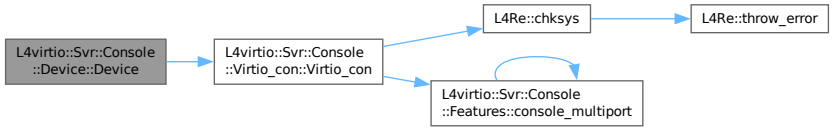
```
            unsigned ports)  [inline], [explicit]
```

Create a new console device.

Parameters

vq_max	Maximum number of buffers in data queues.
ports	Number of ports (maximum 32).

Create a console device with multiport support, i.e. control queues are enabled.
Definition at line 163 of file virtio-console-device.
References L4virtio::Svr::Console::Virtio_con::Virtio_con().
Here is the call graph for this function:



15.403.2.3 Device() [3/3]

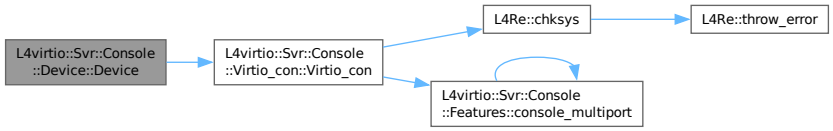
```
L4virtio::Svr::Console::Device::Device (
            cxx::static_vector< unsigned > const & vq_max_nums)  [inline], [explicit]
```

Create a new console Device.

Parameters

vq_max_nums	Maximum number of buffers in data queues, given as a cxx::static_vector with one entry per port.

Create a console device with multiport support, i.e. control queues are enabled.
Definition at line 182 of file virtio-console-device.
References L4virtio::Svr::Console::Virtio_con::Virtio_con().
Here is the call graph for this function:



15.403.3 Member Function Documentation

15.403.3.1 notify_queue()

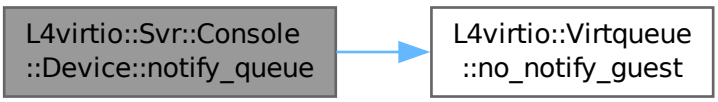
```
void L4virtio::Svr::Console::Device::notify_queue (
            Virtqueue * queue)  [inline], [override], [virtual]
```

Notify queue of available data.

Parameters

queue	Virtqueue to notify.

This callback is called whenever data is sent to `queue`. It is the responsibility of the derived class to perform all necessary notification actions, e.g. triggering guest interrupts.
Implements L4virtio::Svr::Console::Virtio_con.
Definition at line 202 of file virtio-console-device.
References L4VIRTIO_IRQ_STATUS_VRING, and L4virtio::Virtqueue::no_notify_guest().
Here is the call graph for this function:



15.403.3.2 port()

```
Port * L4virtio::Svr::Console::Device::port (
            unsigned port)  [inline], [override], [protected], [virtual]
```

Return the specified port.

Parameters

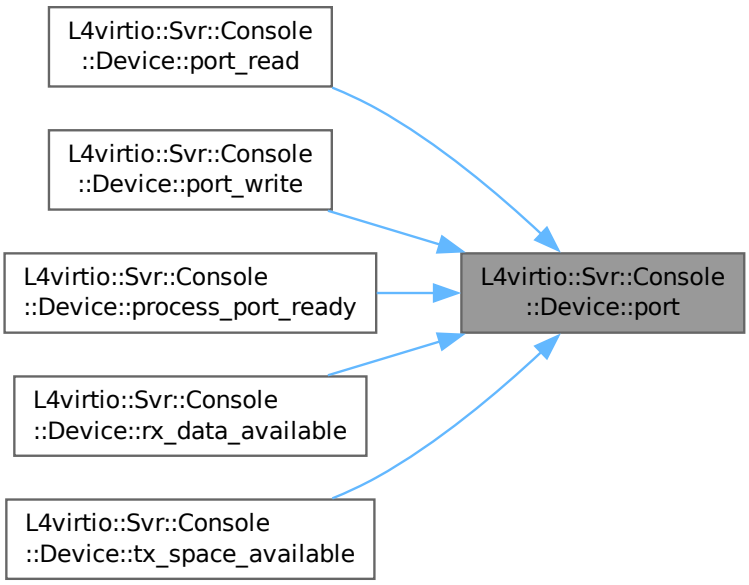
port	Port number.

Precondition

Port number must be lower than the configured maximum number of ports.

Implements L4virtio::Svr::Console::Virtio_con.
Definition at line 457 of file virtio-console-device.
Referenced by port_read(), port_write(), process_port_ready(), rx_data_available(), and tx_space_available().

Here is the caller graph for this function:



15.403.3.3 port_read()

```
unsigned L4virtio::Svr::Console::Device::port_read (
            char * buf,
            unsigned len,
            unsigned port = 0)  [inline]
```

Read data from port.

Will read up to *len* bytes from *port* into *buf*. Returns the number of bytes read, which may be less if not enough data was available. If all data was read, the rx_data_available() callback will be invoked the next time the driver queues new data for the port. The callback won't be called again until all data was consumed again.

Parameters

buf	The destination buffer
len	Size of the buffer
port	Port index to read data from

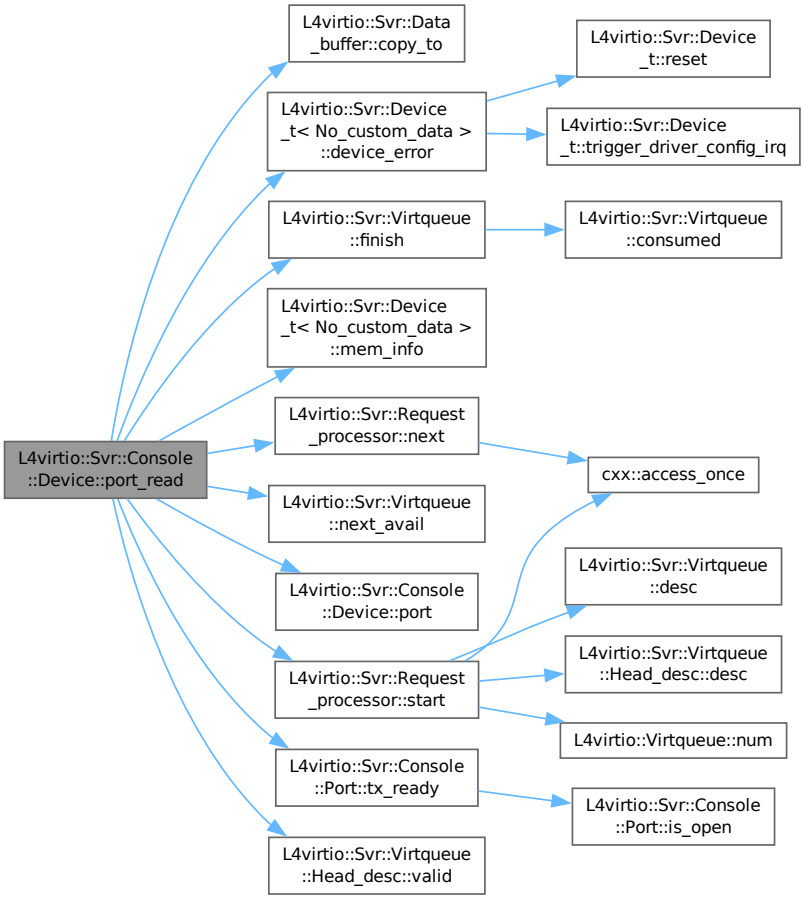
Returns

Number of bytes read

Definition at line 272 of file virtio-console-device.

References L4virtio::Svr::Data_buffer::copy_to(), L4virtio::Svr::Device_t< No_custom_data >::device_error(), L4virtio::Svr::Virtqueue::finish(), L4virtio::Svr::Data_buffer::left, L4virtio::Svr::Device_t< No_custom_data >::mem_info(), L4virtio::Svr::Request_processor::next(), L4virtio::Svr::Virtqueue::next_avail(), port(), L4virtio::Svr::Data_buffer::pos, L4virtio::Svr::Console::Device_port::request, L4virtio::Svr::Console::Device_port::rp, L4virtio::Svr::Console::Device_port::src, L4virtio::Svr::Request_processor::start(), L4virtio::Svr::Console::Port::tx, L4virtio::Svr::Console::Port::tx_ready(), and L4virtio::Svr::Virtqueue::Head_desc::valid().

Here is the call graph for this function:



15.403.3.4 port_write()

```
unsigned L4virtio::Svr::Console::Device::port_write (
            char const * buf,
            unsigned len,
            unsigned port = 0)  [inline]
```

Write data to port.

Will write up to *len* bytes to *port* from *buf*. Returns the number of bytes written, which may be less if not enough virtio buffers were available. If not all data could be written, the tx_space_available() callback will be invoked the next time the driver queues new receive buffers for the port. The callback won't be called again until all receive buffers were filled again.

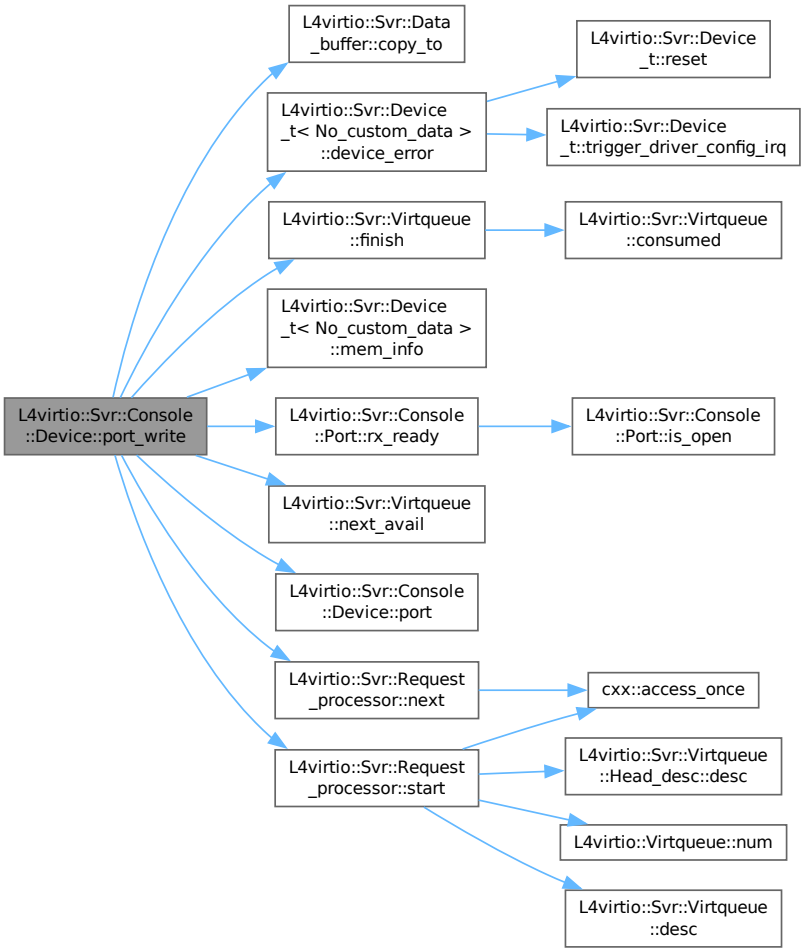
Parameters

buf	The souce buffer
len	Size of the buffer
port	Port index to write data to

Returns

Number of bytes written

Definition at line 341 of file virtio-console-device.
References L4virtio::Svr::Data_buffer::copy_to(), L4virtio::Svr::Device_t< No_custom_data >::device_error(), L4virtio::Svr::Virtqueue::finish(), L4virtio::Svr::Data_buffer::left, L4virtio::Svr::Device_t< No_custom_data >::mem_info(), L4virtio::Svr::Request_processor::next(), L4virtio::Svr::Virtqueue::next_avail(), port(), L4virtio::Svr::Data_buffer::pos, L4virtio::Svr::Console::Port::rx, L4virtio::Svr::Console::Port::rx_ready(), and L4virtio::Svr::Request_processor::start().
Here is the call graph for this function:



15.403.3.5 process_device_ready()

```
void L4virtio::Svr::Console::Device::process_device_ready (
            l4_uint16_t value)  [inline], [override], [virtual]
```

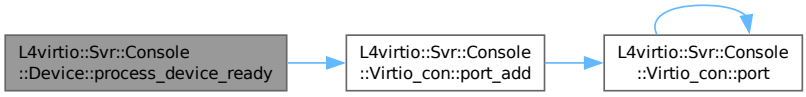
Callback called on DEVICE_READY event.

Parameters

value	The value field of the control message, indicating if the initialization was successful.

By default, this function adds all ports if the driver indicates successful initialization. Override this function to perform

custom actions for a DEVICE_READY event. It is then your responsibility to inform the driver about usable ports, see `port_add()`.
Implements L4virtio::Svr::Console::Virtio_con.
Definition at line 406 of file virtio-console-device.
References L4virtio::Svr::Console::Virtio_con::port_add().
Here is the call graph for this function:



15.403.3.6 process_port_open()

```
void L4virtio::Svr::Console::Device::process_port_open (
            l4_uint32_t id,
            l4_uint16_t value)  [inline], [override], [virtual]
```

Callback called on PORT_OPEN event.

Parameters

id	The id field of the control message, i.e. the port number.
value	The value field of the control message, indicating if the port was opened or closed.

The default implementation does nothing. Override it to implement some custom logic to respond to open/close events of the driver.
Implements L4virtio::Svr::Console::Virtio_con.
Definition at line 450 of file virtio-console-device.

15.403.3.7 process_port_ready()

```
void L4virtio::Svr::Console::Device::process_port_ready (
            l4_uint32_t id,
            l4_uint16_t value)  [inline], [override], [virtual]
```

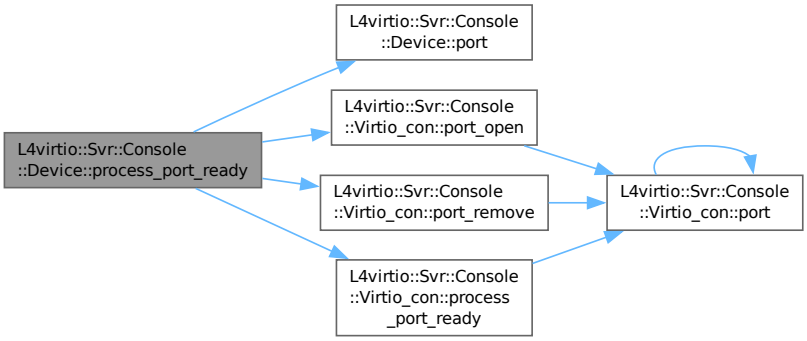
Callback called on PORT_READY event.

Parameters

id	The id field of the control message, i.e. the port number.
value	The value field of the control message, indicating if the initialization was successful.

By default, this function opens the port if the driver is ready. Otherwise, the port is removed if the driver failed to set it up correctly. Override this function to perform custom actions for a PORT_READY event, *after* the generic management of the base class. It is then your responsibility to inform the driver about connected or unusable ports. See `port_open()` and `port_remove()`.
Reimplemented from L4virtio::Svr::Console::Virtio_con.
Definition at line 429 of file virtio-console-device.
References port(), L4virtio::Svr::Console::Port::Port_failed, L4virtio::Svr::Console::Virtio_con::port_open(), L4virtio::Svr::Console::Port::Port_ready, L4virtio::Svr::Console::Virtio_con::port_remove(), L4virtio::Svr::Console::Virtio_con::process_
and L4virtio::Svr::Console::Port::status.

Here is the call graph for this function:



The documentation for this class was generated from the following file:

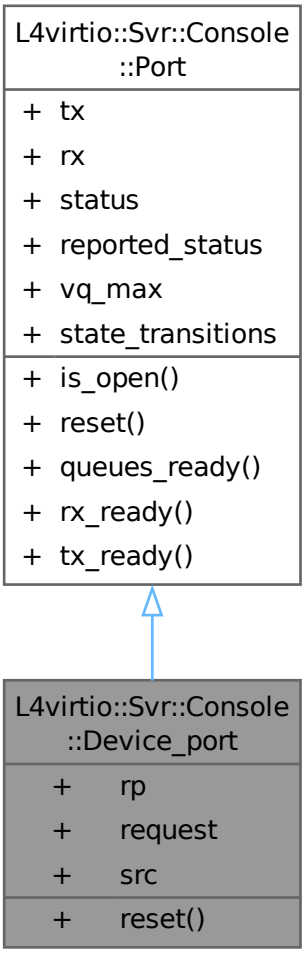
- l4/l4virtio/server/virtio-console-device

15.404 L4virtio::Svr::Console::Device_port Struct Reference

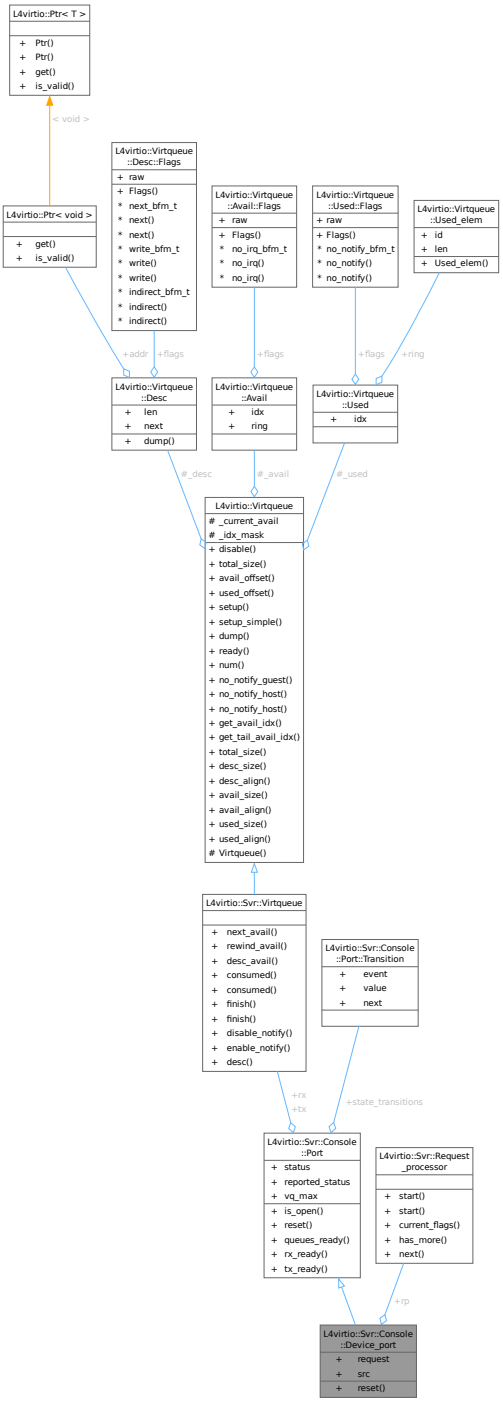
A console port with associated read/write state.

`#include <virtio-console-device>`

Inheritance diagram for L4virtio::Svr::Console::Device_port:



Collaboration diagram for L4virtio::Svr::Console::Device_port:



Public Member Functions

- void **reset** () override

  Reset the port to the initial state and disable its virtqueues.

Public Member Functions inherited from L4virtio::Svr::Console::Port

- bool **is_open** () const

Check that the port is open.

- bool **queues_ready** () const

  Check that both virtqueues are set up correctly.

- bool **rx_ready** () const

  Check that device implementation may write to receive queues.

- bool **tx_ready** () const

  Check that device implementation may read from transmit queues.

Data Fields

- Request_processor **rp**

  Request processor associated with current request.

- Virtqueue::Request **request**

  Current virtio tx queue request.

- Buffer **src**

  Source data block to process.

Data Fields inherited from L4virtio::Svr::Console::Port

- Virtqueue **tx**

  Receiveq of the port.

- Virtqueue **rx**

  Transmitq of the port.

- Port_status **status**

  State the port is in.

- Port_status **reported_status**

  State the port was last reported.

- unsigned **vq_max**

  Maximum queue sizes for this port.

Additional Inherited Members

Public Types inherited from L4virtio::Svr::Console::Port

- enum Port_status {
  Port_disabled = 0 , Port_added , Port_ready , Port_open ,
  Port_failed , Port_num_states }

  Possible states of a virtio console port.

- enum

  Size of control queues, also used as default size.

Static Public Attributes inherited from L4virtio::Svr::Console::Port

- static constexpr Transition state_transitions [Port_num_states][Port_num_states]

  State transition table from last report state to current state.

15.404.1 Detailed Description

A console port with associated read/write state.
Tracks the notification of the device implementation and holds the state when receiving data from the driver.
Definition at line 26 of file virtio-console-device.
The documentation for this struct was generated from the following file:

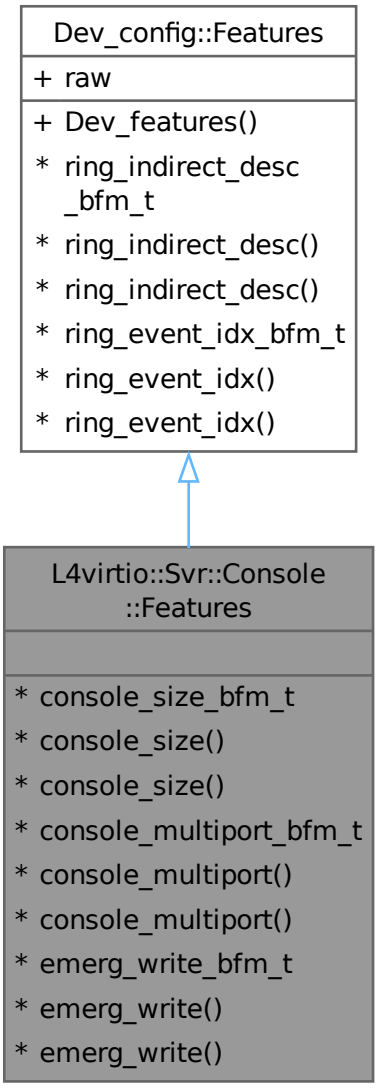
- l4/l4virtio/server/virtio-console-device

15.405 L4virtio::Svr::Console::Features Struct Reference

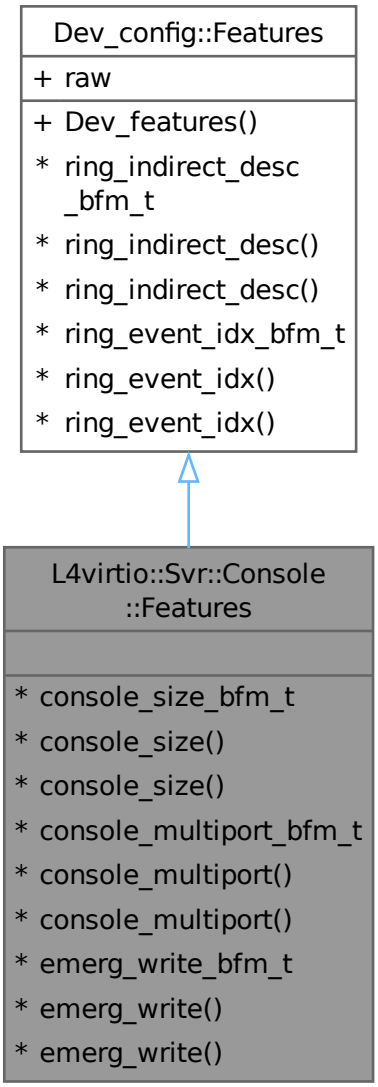
Virtio console specific feature bits.

`#include <virtio-console>`

Inheritance diagram for L4virtio::Svr::Console::Features:



Collaboration diagram for L4virtio::Svr::Console::Features:



- typedef cxx::Bitfield< decltype(raw), 0, 0 > console_size_bfm_t

  Configuration `cols` and `rows` are valid.
- constexpr console_size_bfm_t::Val **console_size** () const

  Get the `console_size` bits (0 to 0) of `raw`.
- constexpr console_size_bfm_t::Ref **console_size** ()

  Get a reference to the `console_size` bits (0 to 0) of `raw`.
- typedef cxx::Bitfield< decltype(raw), 1, 1 > console_multiport_bfm_t

  Device has support for multiple ports.
- constexpr console_multiport_bfm_t::Val **console_multiport** () const

  Get the `console_multiport` bits (1 to 1) of `raw`.
- constexpr console_multiport_bfm_t::Ref **console_multiport** ()

  Get a reference to the `console_multiport` bits (1 to 1) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 2, 2 > emerg_write_bfm_t

  Device has support for emergency write.
- constexpr emerg_write_bfm_t::Val **emerg_write** () const

  Get the `emerg_write` bits (2 to 2) of `raw`.
- constexpr emerg_write_bfm_t::Ref **emerg_write** ()

  Get a reference to the `emerg_write` bits (2 to 2) of `raw`.

Additional Inherited Members

- typedef cxx::Bitfield< decltype(raw), 28, 28 > **ring_indirect_desc_bfm_t**

  Type to access the `ring_indirect_desc` bits (28 to 28) of `raw`.
- typedef cxx::Bitfield< decltype(raw), 29, 29 > **ring_event_idx_bfm_t**

  Type to access the `ring_event_idx` bits (29 to 29) of `raw`.

Public Member Functions inherited from L4virtio::Svr::Dev_features

- **Dev_features** (l4_uint32_t v)

  Make Features from a raw bitmap.
- constexpr ring_indirect_desc_bfm_t::Val **ring_indirect_desc** () const

  Get the `ring_indirect_desc` bits (28 to 28) of `raw`.
- constexpr ring_indirect_desc_bfm_t::Ref **ring_indirect_desc** ()

  Get a reference to the `ring_indirect_desc` bits (28 to 28) of `raw`.
- constexpr ring_event_idx_bfm_t::Val **ring_event_idx** () const

  Get the `ring_event_idx` bits (29 to 29) of `raw`.
- constexpr ring_event_idx_bfm_t::Ref **ring_event_idx** ()

  Get a reference to the `ring_event_idx` bits (29 to 29) of `raw`.

Data Fields inherited from L4virtio::Svr::Dev_features

- l4_uint32_t **raw**

  The raw value of the features bitmap.

15.405.1 Detailed Description

Virtio console specific feature bits.
Definition at line 18 of file virtio-console.

15.405.2 Member Typedef Documentation

15.405.2.1 console_multiport_bfm_t

`typedef cxx::Bitfield<decltype(raw), 1, 1> L4virtio::Svr::Console::Features::console_multiport_bfm_t`
Device has support for multiple ports.
Type to access the `console_multiport` bits (1 to 1) of `raw`.
Definition at line 25 of file virtio-console.

15.405.2.2 console_size_bfm_t

`typedef cxx::Bitfield<decltype(raw), 0, 0> L4virtio::Svr::Console::Features::console_size_bfm_t`
Configuration `cols` and `rows` are valid.
Type to access the `console_size` bits (0 to 0) of `raw`.
Definition at line 23 of file virtio-console.

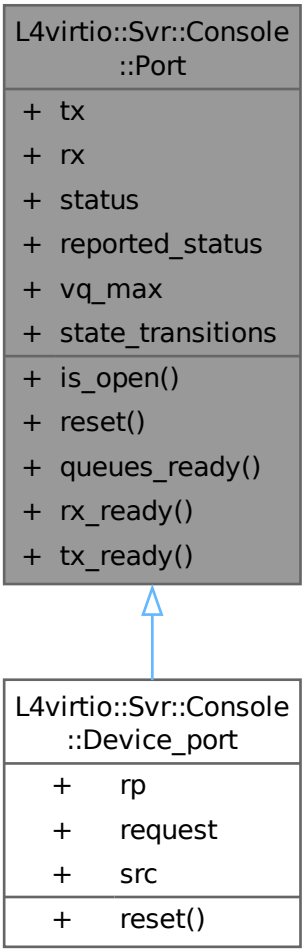
15.405.2.3 emerg_write_bfm_t

`typedef cxx::Bitfield<decltype(raw), 2, 2> L4virtio::Svr::Console::Features::emerg_write_bfm_t`
Device has support for emergency write.
Type to access the `emerg_write` bits (2 to 2) of `raw`.
Definition at line 27 of file virtio-console.
The documentation for this struct was generated from the following file:

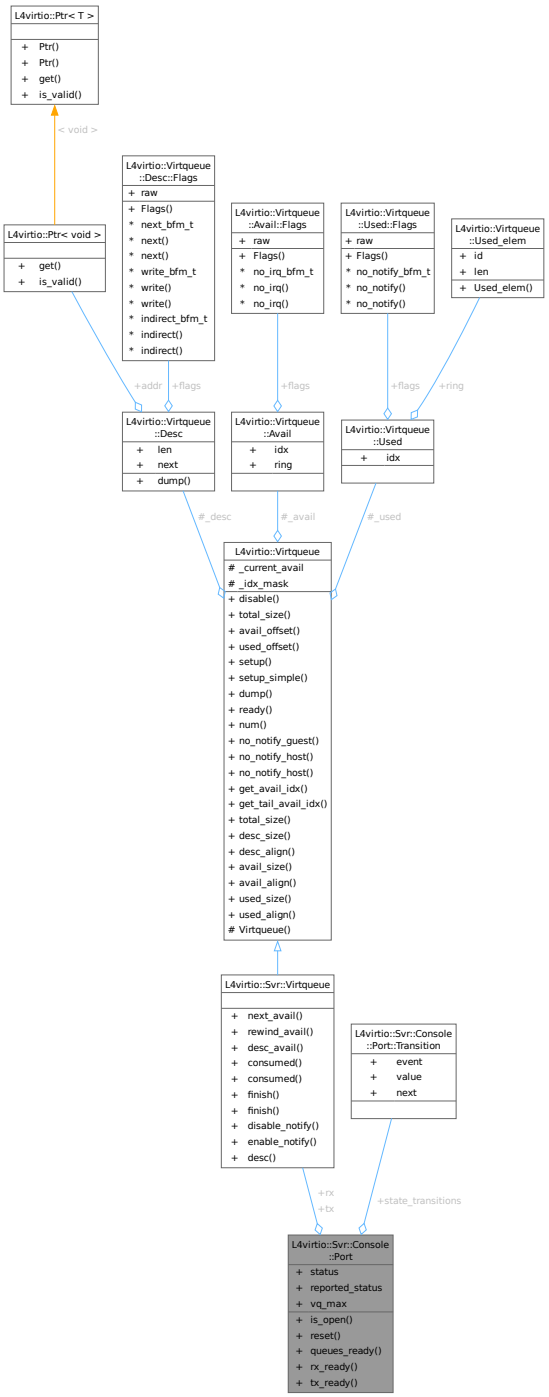
- l4/l4virtio/server/virtio-console

15.406 L4virtio::Svr::Console::Port Struct Reference

Representation of a Virtio console port.
`#include <virtio-console>`
Inheritance diagram for L4virtio::Svr::Console::Port:



Collaboration diagram for L4virtio::Svr::Console::Port:



Data Structures

- struct Transition

  State transition from last report state to current state.

Public Types

- enum Port_status {
  Port_disabled = 0 , Port_added , Port_ready , Port_open ,

Port_failed , Port_num_states }

Possible states of a virtio console port.

- enum

  Size of control queues, also used as default size.

Public Member Functions

- bool **is_open** () const

  Check that the port is open.
- virtual void **reset** ()

  Reset the port to the initial state and disable its virtqueues.
- bool **queues_ready** () const

  Check that both virtqueues are set up correctly.
- bool **rx_ready** () const

  Check that device implementation may write to receive queues.
- bool **tx_ready** () const

  Check that device implementation may read from transmit queues.

Data Fields

- Virtqueue **tx**

  Receiveq of the port.
- Virtqueue **rx**

  Transmitq of the port.
- Port_status **status**

  State the port is in.
- Port_status **reported_status**

  State the port was last reported.
- unsigned **vq_max**

  Maximum queue sizes for this port.

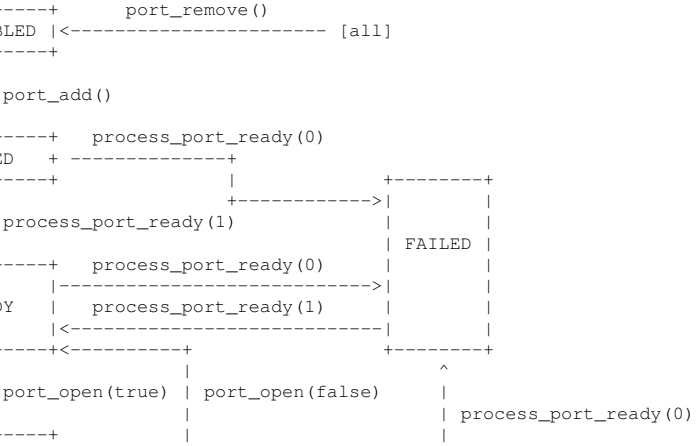
Static Public Attributes

- static constexpr Transition state_transitions [Port_num_states][Port_num_states]

  State transition table from last report state to current state.

15.406.1 Detailed Description

Representation of a Virtio console port.
Each port consists of a pair of queues for sending and receiving.
A port may be added and removed at runtime when the multi-port feature is enabled. The states are as follows:



```
|   OPEN   |-----------+                      |
+----------+----------------------------------+
```

Definition at line 109 of file virtio-console.

15.406.2 Member Enumeration Documentation

15.406.2.1 Port_status

enum L4virtio::Svr::Console::Port::Port_status
Possible states of a virtio console port.

Enumerator

Port_disabled	Reset state, waiting for port to be added.
Port_added	Port has been added by device, waiting for ready message.
Port_ready	Port is ready but still closed.
Port_open	Port is in a working state.
Port_failed	Device failure, port unusable.
Port_num_states	Number of port states. Must be last.

Definition at line 114 of file virtio-console.

15.406.3 Field Documentation

15.406.3.1 state_transitions

Transition L4virtio::Svr::Console::Port::state_transitions[Port_num_states][Port_num_states] [static], [constexpr]
State transition table from last report state to current state.
Not all transitions can be made directly. For example, if the last reported state was Port_disabled and the current state is Port_open, the device has to send two messages: Control_message::Device_add and Control_message::Port_open. This is expressed by going through an intermediate state (Port_ready) on the reporting side.
For the purpose of the driver there are only three coarse states:

1. The port does not exist (Port_disabled).
2. The port exists but is closed on the device side (Port_added, Port_ready, Port_failed).
3. The port exists and is open on the device side (Port_open).

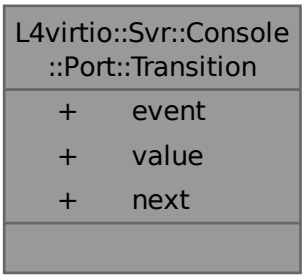
The state transition table with Port_added, Port_ready and Port_failed as current state are thus identical.
Definition at line 197 of file virtio-console.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-console

15.407 L4virtio::Svr::Console::Port::Transition Struct Reference

State transition from last report state to current state.
#include <virtio-console>

Collaboration diagram for L4virtio::Svr::Console::Port::Transition:



Data Fields

- l4_int16_t **event**

  Control_message::Events or <0 if no event is sent.
- l4_uint16_t **value**

  Extra information.
- Port_status **next**

  Next Port_status state.

15.407.1 Detailed Description

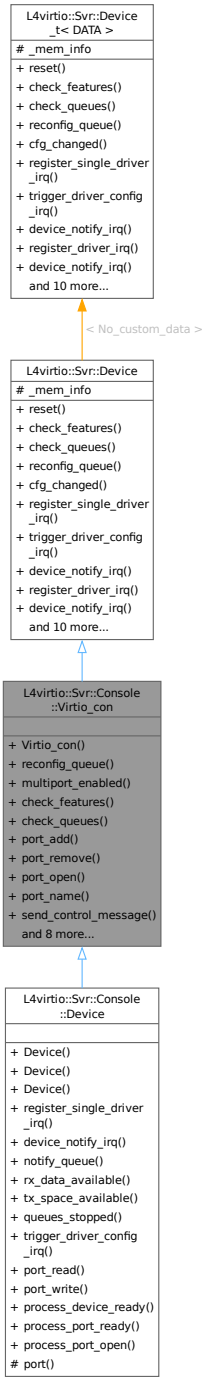
State transition from last report state to current state.
Definition at line 171 of file virtio-console.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-console

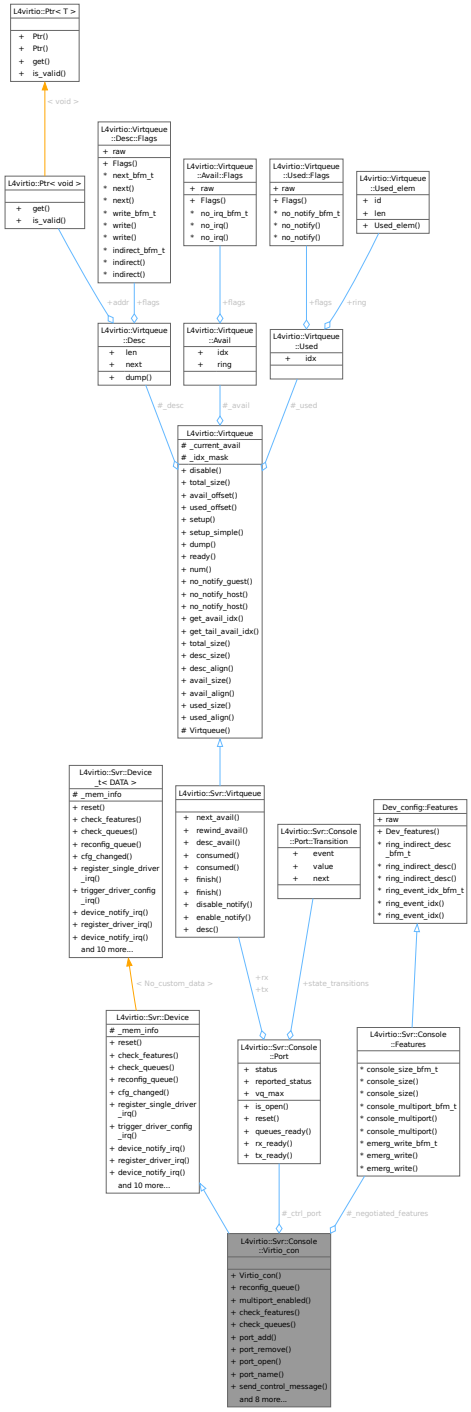
15.408 L4virtio::Svr::Console::Virtio_con Class Reference

Base class implementing a virtio console functionality.
`#include <virtio-console>`

Inheritance diagram for L4virtio::Svr::Console::Virtio_con:



Collaboration diagram for L4virtio::Svr::Console::Virtio_con:



Public Member Functions

- Virtio_con (unsigned max_ports, bool enable_multiport)

  Create a new multiport console device.
- int **reconfig_queue** (unsigned index) override

  callback for client queue-config request
- bool **multiport_enabled** () const

  Return true if the multiport feature is enabled and control queues are available.

- bool **check_features** (void) override

  callback for checking the subset of accepted features
- bool **check_queues** () override

  callback for checking if the queues at DRIVER_OK transition
- int port_add (unsigned idx)

  Send a DEVICE_ADD message and update the internal state.
- int port_remove (unsigned idx)

  Send a DEVICE_REMOVE message and update the internal state.
- int port_open (unsigned idx, bool open)

  Send a PORT_OPEN message and update the internal state.
- int port_name (unsigned idx, char const *name)

  Send a PORT_NAME message to announce the port name.
- int send_control_message (l4_uint32_t idx, l4_uint16_t event, l4_uint16_t value=0, const char *name=0)

  Send control message to driver.
- int handle_control_message ()

  Handle control message received from the driver.
- void **reset** () override

  reset callback, called for doing a device reset
- virtual void reset_device ()

  Reset the state of the actual console device.
- virtual void notify_queue (Virtqueue *queue)=0

  Notify queue of available data.
- virtual Port * port (unsigned port)=0

  Return the specified port.
- virtual void process_device_ready (l4_uint16_t value)=0

  Callback called on DEVICE_READY event.
- virtual void process_port_ready (l4_uint32_t id, l4_uint16_t value)

  Callback called on PORT_READY event.
- virtual void process_port_open (l4_uint32_t id, l4_uint16_t value)=0

  Callback called on PORT_OPEN event.

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void **register_single_driver_irq** ()

  callback for registering a single guest IRQ for all queues (old-style)
- virtual void **trigger_driver_config_irq** ()=0

  callback for triggering configuration change notification IRQ
- virtual L4::Cap< L4::Irq > **device_notify_irq** () const

  callback to gather the device notification IRQ (old-style)
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_↩ dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

Get the memory region list used for this device.

- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_↩ notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Additional Inherited Members

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.408.1 Detailed Description

Base class implementing a virtio console functionality.
It is possible to activate the MULTIPORT feature, in which case incoming control messages need to be dispatched by calling `handle_control_message()`. The derived class must additionally override `process_device_ready()`, `process_port_ready()` and `process_port_open()` to implement the actual behaviour. The derived class has the following responsibilities:

- inform the driver about usable ports once the device is ready as signaled in process_device_ready(), see the wrapper `port_add()`.
- inform the driver about unusable ports, see the wrapper `port_remove()`.
- react to open/close events, see the wrapper `port_open()`.

This implementation provides no means to handle interrupts or notify guests, therefore derived classes have to provide this functionality, see `notify_queue()` and `handle_control_message()`. Similarly, all interaction with data queues has to be implemented. Memory for port structures must be managed by the implementor as well. Use this class as a base to implement your own specific console device.
Definition at line 269 of file virtio-console.

15.408.2 Constructor & Destructor Documentation

15.408.2.1 Virtio_con()

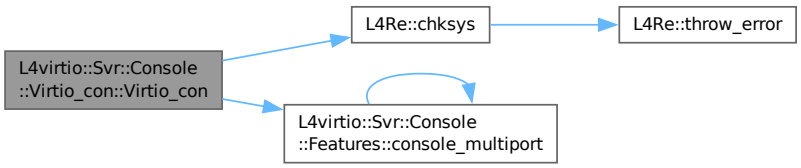
```
L4virtio::Svr::Console::Virtio_con::Virtio_con (
            unsigned max_ports,
            bool enable_multiport)  [inline], [explicit]
```

Create a new multiport console device.

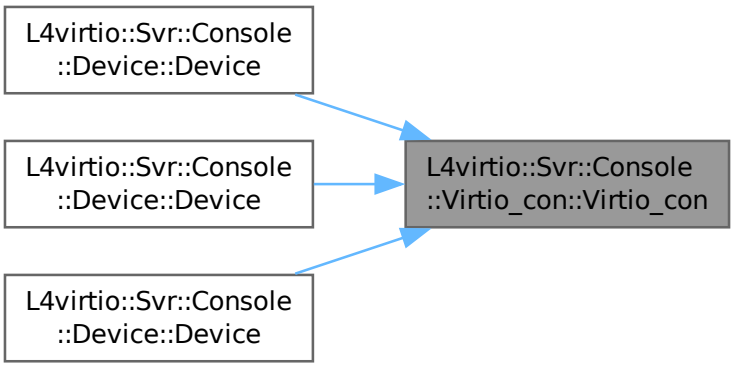
Parameters

max_ports	Maximum number of ports the device should be able to handle (ignored when `enable_multiport` is false).
enable_multiport	Enable the control queue for dynamic handling of ports.

Definition at line 295 of file virtio-console.
References L4Re::chksys(), L4virtio::Svr::Console::Features::console_multiport(), L4_EINVAL, L4VIRTIO_ID_CONSOLE, and L4virtio::Svr::Dev_features::raw.
Referenced by L4virtio::Svr::Console::Device::Device(), L4virtio::Svr::Console::Device::Device(), and L4virtio::Svr::Console::Device::D
Here is the call graph for this function:



Here is the caller graph for this function:



15.408.3 Member Function Documentation

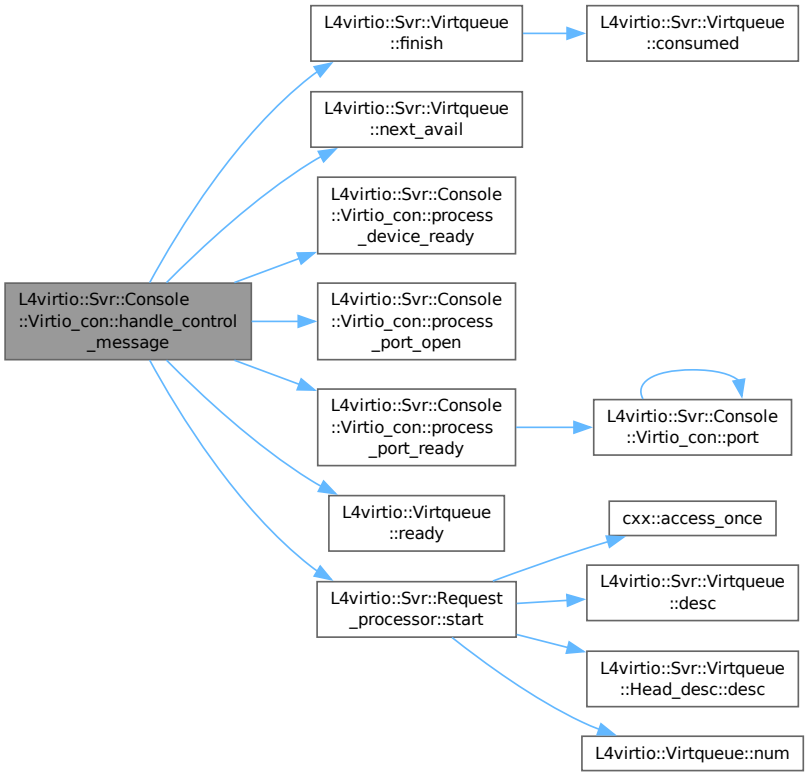
15.408.3.1 handle_control_message()

`int L4virtio::Svr::Console::Virtio_con::handle_control_message () [inline]`
Handle control message received from the driver.

Return values

L4_EOK	Message has been handled.
-L4_ENODEV	Control queue is not ready.
-L4_EINVAL	Received an unexpected control event.

This function performs the basic handling of control messages from the driver. It does all necessary work with the control queues and performs some sanity checks. All other work is deferred to the derived class, see `process_device_ready()`, `process_port_ready()` and `process_port_open()`.
Definition at line 538 of file virtio-console.
References L4virtio::Svr::Console::Control_message::Device_ready, L4virtio::Svr::Console::Control_message::event, L4virtio::Svr::Virtqueue::finish(), L4virtio::Svr::Console::Control_message::id, L4_EINVAL, L4_EIO, L4_ENODEV, L4_EOK, L4virtio::Svr::Console::Control_request::len, L4virtio::Svr::Console::Control_request::msg, L4virtio::Svr::Virtqueue::next_ava L4virtio::Svr::Console::Port::Port_disabled, L4virtio::Svr::Console::Control_message::Port_open, L4virtio::Svr::Console::Port::Port_op L4virtio::Svr::Console::Control_message::Port_ready, process_device_ready(), process_port_open(), process_port_ready(), L4virtio::Virtqueue::ready(), L4virtio::Svr::Request_processor::start(), and L4virtio::Svr::Console::Control_message::value.
Here is the call graph for this function:



15.408.3.2 notify_queue()

```
virtual void L4virtio::Svr::Console::Virtio_con::notify_queue (
            Virtqueue * queue)  [pure virtual]
```

Notify queue of available data.

Parameters

queue	Virtqueue to notify.

This callback is called whenever data is sent to `queue`. It is the responsibility of the derived class to perform all necessary notification actions, e.g. triggering guest interrupts.
Implemented in L4virtio::Svr::Console::Device.

15.408.3.3 port()

```
virtual Port * L4virtio::Svr::Console::Virtio_con::port (
            unsigned port)  [pure virtual]
```

Return the specified port.

Parameters

port	Port number.

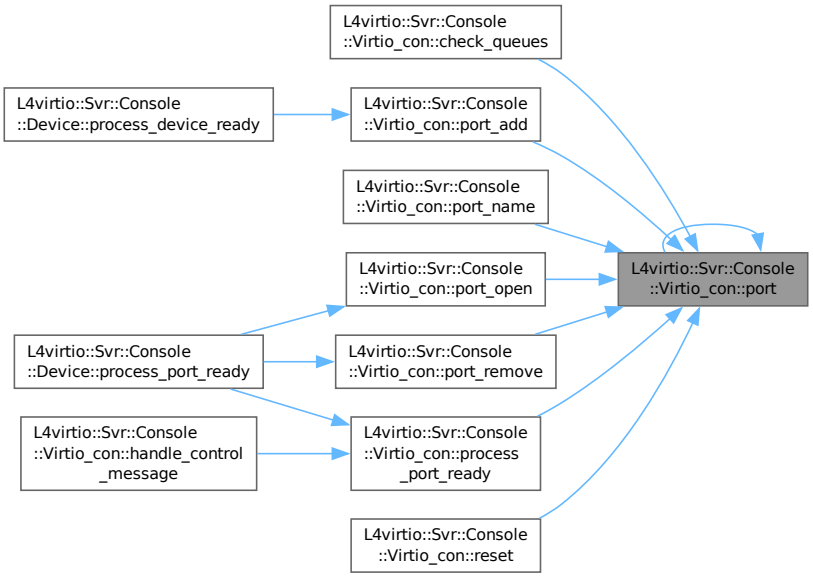
Precondition

Port number must be lower than the configured maximum number of ports.

Implemented in L4virtio::Svr::Console::Device.
References port().
Referenced by check_queues(), port(), port_add(), port_name(), port_open(), port_remove(), process_port_ready(), and reset().
Here is the call graph for this function:



Here is the caller graph for this function:



15.408.3.4 port_add()

```
int L4virtio::Svr::Console::Virtio_con::port_add (
            unsigned idx)  [inline]
```

Send a DEVICE_ADD message and update the internal state.

Parameters

idx	Port that should be added.

Return values

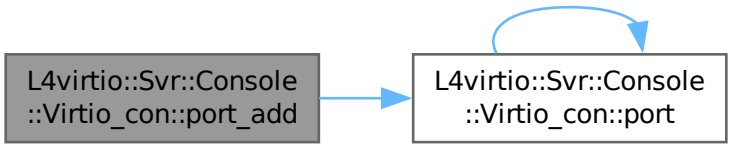
L4_EOK	Message has been sent.
-L4_EPERM	Invalid state transition.

Precondition

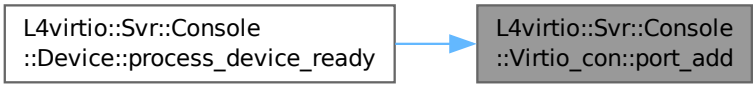
`idx` must be smaller than the configured number of ports.

Port must not already exist.

Definition at line 381 of file virtio-console.
References L4_EOK, L4_EPERM, port(), L4virtio::Svr::Console::Port::Port_added, L4virtio::Svr::Console::Port::Port_disabled, and L4virtio::Svr::Console::Port::status.
Referenced by L4virtio::Svr::Console::Device::process_device_ready().
Here is the call graph for this function:



Here is the caller graph for this function:



15.408.3.5 port_name()

```
int L4virtio::Svr::Console::Virtio_con::port_name (
```

```
unsigned idx,
char const * name)  [inline]
```

Send a PORT_NAME message to announce the port name.

Parameters

idx	Port that should be opened or closed.
name	The port name

Return values

L4_EOK	Message has been sent.
-L4_EPERM	Control message is not allowed in the current state.

Returns

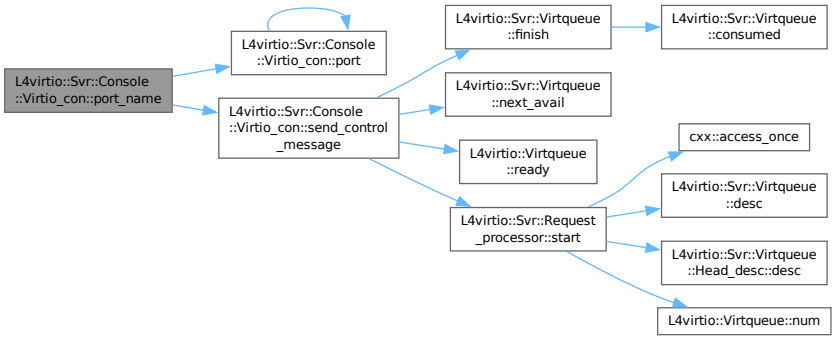
Errors from send_control_message()

Precondition

`idx` must be smaller than the configured number of ports.

Port must already exist.

Definition at line 457 of file virtio-console.
References L4_EPERM, port(), L4virtio::Svr::Console::Port::Port_disabled, L4virtio::Svr::Console::Control_message::Port_name, send_control_message(), and L4virtio::Svr::Console::Port::status.
Here is the call graph for this function:



15.408.3.6 port_open()

```
int L4virtio::Svr::Console::Virtio_con::port_open (
unsigned idx,
bool open)  [inline]
```

Send a PORT_OPEN message and update the internal state.

Parameters

idx	Port that should be opened or closed.
open	Open or close port.

Return values

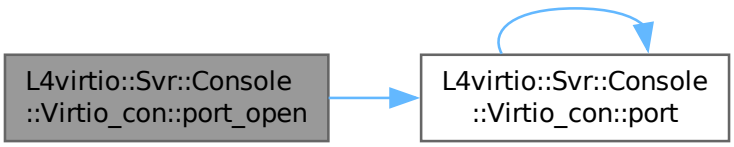
L4_EOK	Message has been sent.
-L4_EPERM	Invalid state transition.

Precondition

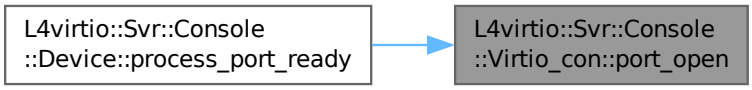
`idx` must be smaller than the configured number of ports.

Port must be ready when opening or open when closing.

Definition at line 430 of file virtio-console.
References L4_EOK, L4_EPERM, port(), L4virtio::Svr::Console::Port::Port_open, L4virtio::Svr::Console::Port::Port_ready, and L4virtio::Svr::Console::Port::status.
Referenced by L4virtio::Svr::Console::Device::process_port_ready().
Here is the call graph for this function:



Here is the caller graph for this function:



15.408.3.7 port_remove()

```
int L4virtio::Svr::Console::Virtio_con::port_remove (
            unsigned idx)  [inline]
```

Send a DEVICE_REMOVE message and update the internal state.

Parameters

idx	Port that should be removed.

Return values

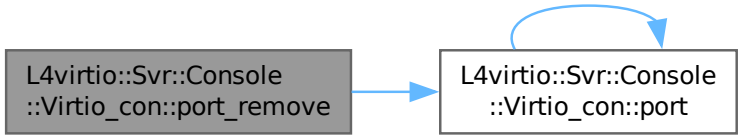
L4_EOK	Message has been sent.
-L4_EPERM	Invalid state transition.

Precondition

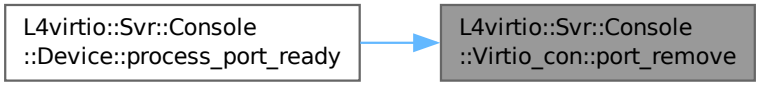
`idx` must be smaller than the configured number of ports.

Port must already exist.

Definition at line 405 of file virtio-console.
References L4_EOK, L4_EPERM, port(), L4virtio::Svr::Console::Port::Port_disabled, and L4virtio::Svr::Console::Port::status.
Referenced by L4virtio::Svr::Console::Device::process_port_ready().
Here is the call graph for this function:



Here is the caller graph for this function:



15.408.3.8 process_device_ready()

```
virtual void L4virtio::Svr::Console::Virtio_con::process_device_ready (
            l4_uint16_t value)  [pure virtual]
```

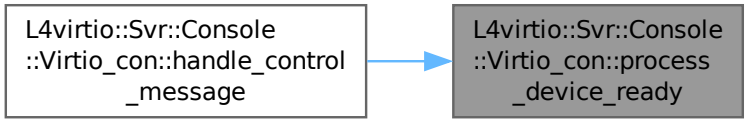
Callback called on DEVICE_READY event.

Parameters

value	The value field of the control message, indicating if the initialization was successful.

Needs to be overridden by the derived class if the MULTIPORT feature is enabled. Control messages may be sent only after the driver has successfully initialized the device.

Implemented in L4virtio::Svr::Console::Device.
Referenced by handle_control_message().
Here is the caller graph for this function:



15.408.3.9 process_port_open()

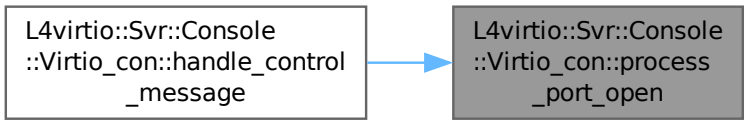
```
virtual void L4virtio::Svr::Console::Virtio_con::process_port_open (
            l4_uint32_t id,
            l4_uint16_t value)  [pure virtual]
```

Callback called on PORT_OPEN event.

Parameters

id	The id field of the control message, i.e. the port number.
value	The value field of the control message, indicating if the port was opened or closed.

Signal that an application has opened the port. Can to be overridden by the derived class if the MULTIPORT feature is enabled.
Implemented in L4virtio::Svr::Console::Device.
Referenced by handle_control_message().
Here is the caller graph for this function:



15.408.3.10 process_port_ready()

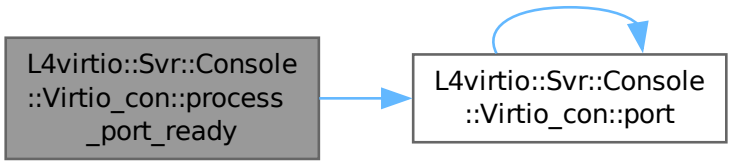
```
virtual void L4virtio::Svr::Console::Virtio_con::process_port_ready (
            l4_uint32_t id,
            l4_uint16_t value)  [inline], [virtual]
```

Callback called on PORT_READY event.

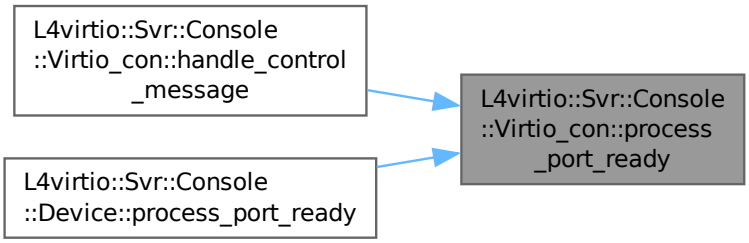
Parameters

id	The id field of the control message, i.e. the port number.
value	The value field of the control message, indicating if the initialization was successful.

May be overridden by the derived class if the MULTIPORT feature is enabled. This default implementation just sets the status of the port according to the driver message.
Reimplemented in L4virtio::Svr::Console::Device.
Definition at line 702 of file virtio-console.
References port(), L4virtio::Svr::Console::Port::Port_added, L4virtio::Svr::Console::Port::Port_failed, L4virtio::Svr::Console::Port::Port_
L4virtio::Svr::Console::Port::Port_ready, and L4virtio::Svr::Console::Port::status.
Referenced by handle_control_message(), and L4virtio::Svr::Console::Device::process_port_ready().
Here is the call graph for this function:



Here is the caller graph for this function:

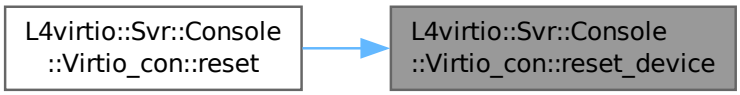


15.408.3.11 reset_device()

```
virtual void L4virtio::Svr::Console::Virtio_con::reset_device ()  [inline], [virtual]
```

Reset the state of the actual console device.
This callback is called at the end of `reset()`, allowing the derived class to reset internal state.
Definition at line 656 of file virtio-console.
Referenced by reset().

Here is the caller graph for this function:



15.408.3.12 send_control_message()

```
int L4virtio::Svr::Console::Virtio_con::send_control_message (
              l4_uint32_t idx,
              l4_uint16_t event,
              l4_uint16_t value = 0,
              const char * name = 0)  [inline]
```

Send control message to driver.

Parameters

idx	Port number.
event	Kind of control event.
value	Extra information for the event.
name	Name to be used for Port_name message

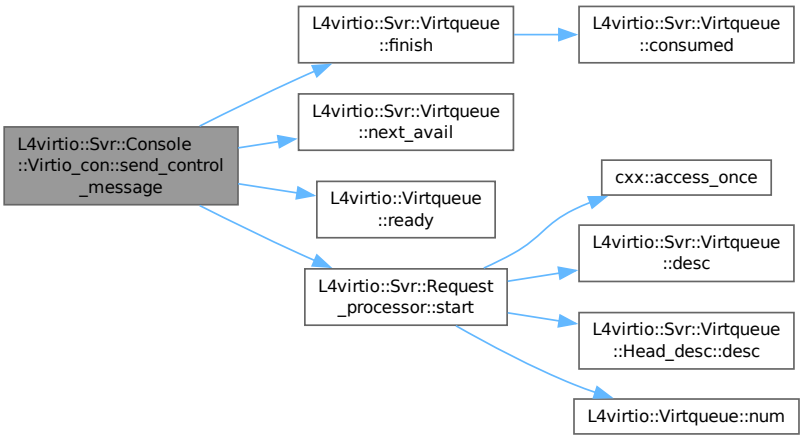
Return values

L4_EOK	Message has been sent.
-L4_ENODEV	Control queue is not ready.
-L4_EBUSY	Currently no descriptor available in the control queue.
-L4_ENOMEM	Client-issued descriptor too small. Device will be set to failed state.

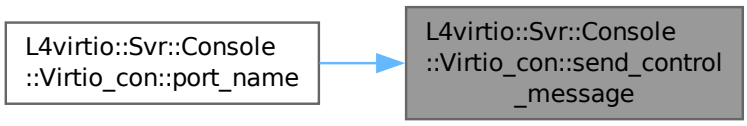
Precondition

`port` must be smaller than the configured number of ports.

The convenience functions `port_add()`, `port_remove()` and `port_open()` should cover the most use cases and are the preferred way of communication with the driver. If you use this function directly, it is your responsibility to guarantee no invalid control messages are sent to the driver.
Definition at line 489 of file virtio-console.
References L4virtio::Svr::Virtqueue::finish(), L4_EBUSY, L4_ENODEV, L4_ENOMEM, L4_EOK, L4virtio::Svr::Console::Control_reque
L4virtio::Svr::Console::Control_request::msg, L4virtio::Svr::Virtqueue::next_avail(), L4virtio::Svr::Console::Control_message::Port_na
L4virtio::Virtqueue::ready(), and L4virtio::Svr::Request_processor::start().
Referenced by port_name().
Here is the call graph for this function:



Here is the caller graph for this function:



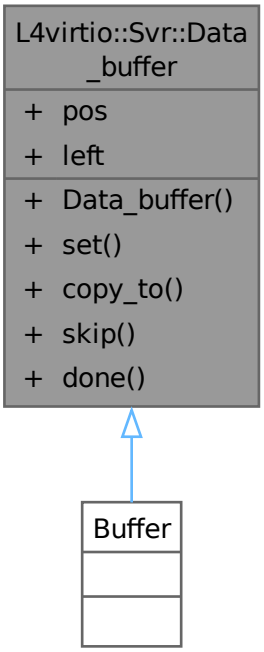
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-console

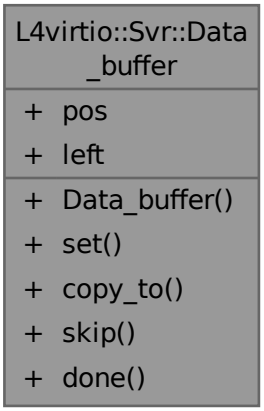
15.409 L4virtio::Svr::Data_buffer Struct Reference

Abstract data buffer.
`#include <virtio>`

Inheritance diagram for L4virtio::Svr::Data_buffer:



Collaboration diagram for L4virtio::Svr::Data_buffer:



Public Member Functions

- template<typename T>
  Data_buffer (T *p)

Create buffer for object p.

- template<typename T>
  void set (T *p)

  Set buffer for object p.
- l4_uint32_t copy_to (Data_buffer *dst, l4_uint32_t max=UINT_MAX)

  Copy contents from this buffer to the destination buffer.
- l4_uint32_t skip (l4_uint32_t bytes)

  Skip given number of bytes in this buffer.
- bool done () const

  Check if there are no more bytes left in the buffer.

Data Fields

- char * **pos**

  Current buffer position.
- l4_uint32_t **left**

  Bytes left in buffer.

15.409.1 Detailed Description

Abstract data buffer.
Definition at line 306 of file virtio.

15.409.2 Constructor & Destructor Documentation

15.409.2.1 Data_buffer()

```
template<typename T>
L4virtio::Svr::Data_buffer::Data_buffer (
            T * p)  [inline], [explicit]
```

Create buffer for object p.

Template Parameters

T	Type of object (implicit)

Parameters

p	Pointer to object.

The buffer shall point to the start of the object p and the size left is sizeof(T).
Definition at line 323 of file virtio.
References left, and pos.

15.409.3 Member Function Documentation

15.409.3.1 copy_to()

```
l4_uint32_t L4virtio::Svr::Data_buffer::copy_to (
            Data_buffer * dst,
            l4_uint32_t max = UINT_MAX)  [inline]
```

Copy contents from this buffer to the destination buffer.

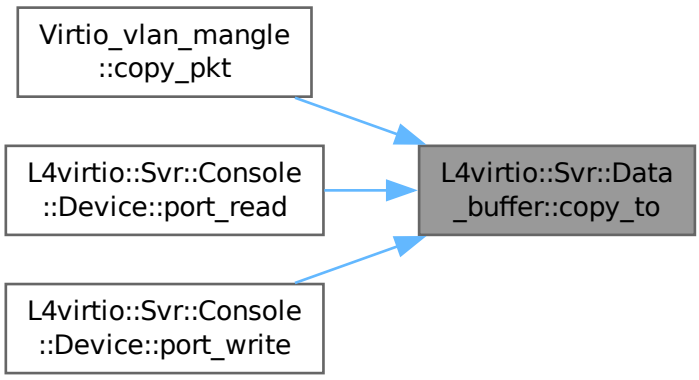
Parameters

dst	Destination buffer.
max	(optional) Maximum number of bytes to copy.

Returns

the number of bytes copied.

This function copies at most `max` bytes from this to `dst`. If `max` is omitted, copies the maximum number of bytes available that fit `dst`.
Definition at line 354 of file virtio.
References left, and pos.
Referenced by Virtio_vlan_mangle::copy_pkt(), L4virtio::Svr::Console::Device::port_read(), and L4virtio::Svr::Console::Device::port_w
Here is the caller graph for this function:



15.409.3.2 done()

```
bool L4virtio::Svr::Data_buffer::done () const  [inline]
```

Check if there are no more bytes left in the buffer.

Returns

true if there are no more bytes left in the buffer.

Definition at line 388 of file virtio.
References left.

15.409.3.3 set()

```
template<typename T>
void L4virtio::Svr::Data_buffer::set (
            T * p)  [inline]
```

Set buffer for object `p`.

Template Parameters

T	Type of object (implicit)

Parameters

p	Pointer to object.

The buffer shall point to the start of the object `p` and the size left is sizeof(T).
Definition at line 337 of file virtio.
References left, and pos.

15.409.3.4 skip()

```
l4_uint32_t L4virtio::Svr::Data_buffer::skip (
            l4_uint32_t bytes)  [inline]
```

Skip given number of bytes in this buffer.

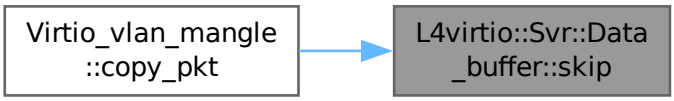
Parameters

bytes	Number of bytes that shall be skipped.

Returns

The number of bytes skipped.

Try to skip the given number of bytes in this buffer, if there are less bytes left in the buffer that given then at most left bytes are skipped and the amount is returned.
Definition at line 375 of file virtio.
References left, and pos.
Referenced by Virtio_vlan_mangle::copy_pkt().
Here is the caller graph for this function:



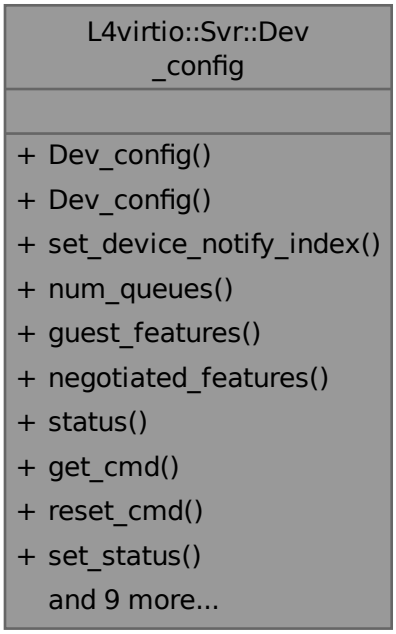
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio

15.410 L4virtio::Svr::Dev_config Class Reference

Abstraction for L4-Virtio device config memory.
`#include <l4virtio>`

Collaboration diagram for L4virtio::Svr::Dev_config:



Public Member Functions

- Dev_config (l4_uint32_t vendor, l4_uint32_t device, unsigned cfg_size, l4_uint32_t num_queues=0)

  Create a L4-Virtio config data space.
- Dev_config (Cfg_cap const &cfg, l4_addr_t cfg_offset, l4_uint32_t vendor, l4_uint32_t device, unsigned cfg↩ _size, l4_uint32_t num_queues=0)

  Setup an L4-Virtio config space in an existing data space.
- void set_device_notify_index (unsigned idx)

  Set index of interrupt that driver should trigger for config notifications.
- l4_uint32_t **num_queues** () const

  Return the number of queues currently usable.
- l4_uint32_t guest_features (unsigned idx) const

  Return a specific set of guest features.
- l4_uint32_t negotiated_features (unsigned idx) const

  Compute a specific set of negotiated features.
- Status status () const

  Get current device status (trusted).
- l4_uint32_t get_cmd () const

  Get the value from the `cmd` register.
- void reset_cmd ()

  Reset the `cmd` register after execution of a command.
- void set_status (Status status)

  Set device status register.
- void add_irq_status (l4_uint32_t status)

  Adds irq status bit.

- void set_device_needs_reset ()

  Set DEVICE_NEEDS_RESET bit in device status register.
- bool change_queue_config (l4_uint32_t num_queues)

  Setup new queue configuration.
- l4virtio_config_queue_t volatile const * qconfig (unsigned index) const

  Get queue read-only config data for queue with the given index.
- void **reset_hdr** (bool inc_generation=false) const

  Reset the config header to the initial contents.
- bool reset_queue (unsigned index, unsigned num_max, bool inc_generation=false, unsigned device_notify_index=0) const

  Reset queue config for the given queue.
- l4virtio_config_hdr_t const volatile * hdr () const

  Get a read-only pointer to the config header.
- L4::Cap< L4Re::Dataspace > ds () const

  Get data-space capability for the shared config data space.
- l4_addr_t **ds_offset** () const

  Return the offset into the config dataspace where the device configuration starts.

15.410.1 Detailed Description

Abstraction for L4-Virtio device config memory.
Virtio defines a device configuration mechanism, L4-Virtio implements this mechanism based on shared memory a set_status() and a config_queue() call. This class provides an abstraction for L4-Virtio host implementations to establish such a shared memory data space and providing the necessary contents and access functions.
Definition at line 52 of file l4virtio.

15.410.2 Constructor & Destructor Documentation

15.410.2.1 Dev_config() [1/2]

```
L4virtio::Svr::Dev_config::Dev_config (
            l4_uint32_t vendor,
            l4_uint32_t device,
            unsigned cfg_size,
            l4_uint32_t num_queues = 0)  [inline]
```

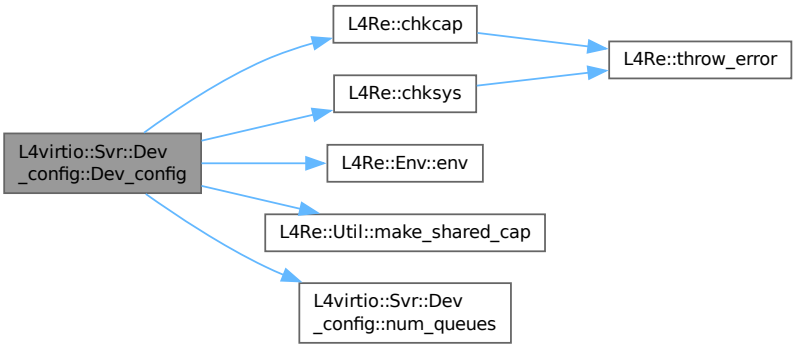
Create a L4-Virtio config data space.

Parameters

vendor	The vendor ID to store in config header.
device	The device ID to store in config header.
cfg_size	The size of the device-specific config data in bytes.
num_queues	The number of queues provided by the device.

This constructor allocates a data space used for L4-virtio config attaches the data space to the local address space and writes the initial contents to the config header.
Definition at line 119 of file l4virtio.
References L4Re::chkcap(), L4Re::chksys(), L4Re::Env::env(), L4_PAGESIZE, L4Re::Util::make_shared_cap(), and num_queues().

Here is the call graph for this function:



15.410.2.2 Dev_config() [2/2]

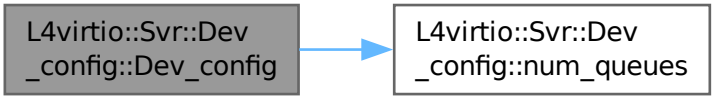
```
L4virtio::Svr::Dev_config::Dev_config (
            Cfg_cap const & cfg,
            l4_addr_t cfg_offset,
            l4_uint32_t vendor,
            l4_uint32_t device,
            unsigned cfg_size,
            l4_uint32_t num_queues = 0)  [inline]
```

Setup an L4-Virtio config space in an existing data space.

Parameters

cfg	Dataspace that should hold the L4-Virtio configuration.
cfg_offset	Offset into the dataspace where the configuration starts.
vendor	The vendor ID to store in config header.
device	The device ID to store in config header.
cfg_size	The size of the device-specific config data in bytes.
num_queues	The number of queues provided by the device.

Definition at line 155 of file l4virtio.
References L4_PAGESIZE, and num_queues().
Here is the call graph for this function:



15.410.3 Member Function Documentation

15.410.3.1 add_irq_status()

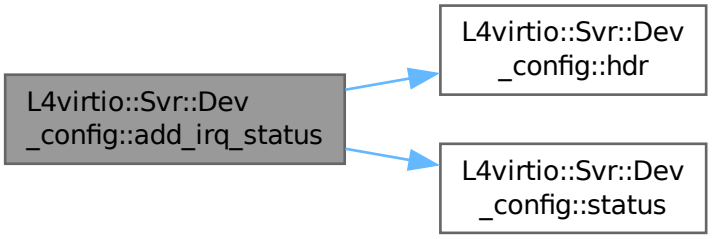
```
void L4virtio::Svr::Dev_config::add_irq_status (
            l4_uint32_t status)  [inline]
```

Adds irq status bit.

Parameters

status	The value to add to the irq status register.

This function adds the status bit to the irq status register.
Definition at line 285 of file l4virtio.
References hdr(), and status().
Here is the call graph for this function:



15.410.3.2 change_queue_config()

```
bool L4virtio::Svr::Dev_config::change_queue_config (
            l4_uint32_t num_queues)  [inline]
```

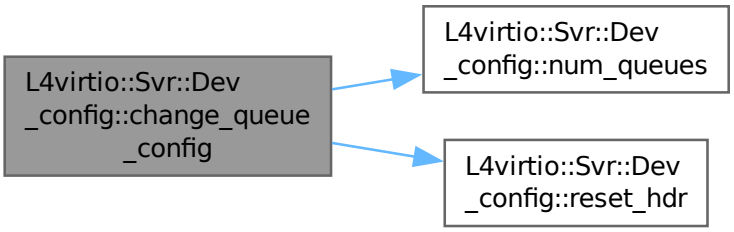
Setup new queue configuration.

Parameters

num_queues	The number of queues provided by the device.

Definition at line 306 of file l4virtio.
References L4_PAGESIZE, num_queues(), and reset_hdr().

Here is the call graph for this function:



15.410.3.3 ds()

`L4::Cap< L4Re::Dataspace > L4virtio::Svr::Dev_config::ds () const [inline]`
Get data-space capability for the shared config data space.

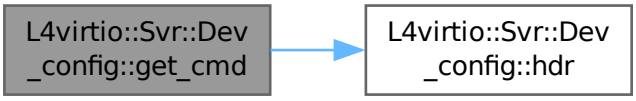
Returns

Capability for the shared config data space.

Definition at line 399 of file l4virtio.

15.410.3.4 get_cmd()

`l4_uint32_t L4virtio::Svr::Dev_config::get_cmd () const [inline]`
Get the value from the `cmd` register.
Note, the most significant eight bits are the command (0 is nothing to do). The upper eight bit are reset to zero after the command was handled.
Definition at line 250 of file l4virtio.
References hdr().
Here is the call graph for this function:



15.410.3.5 guest_features()

```
l4_uint32_t L4virtio::Svr::Dev_config::guest_features (
            unsigned idx) const [inline]
```
Return a specific set of guest features.

Parameters

idx	Index into the guest features array.

Return values

The	selected set of guest features.

This function returns a specific 32bit set of features enabled by the guest/driver. `idx` is the index in the guest features array, resp. the 32 bit set to return.
Definition at line 218 of file l4virtio.

15.410.3.6 hdr()

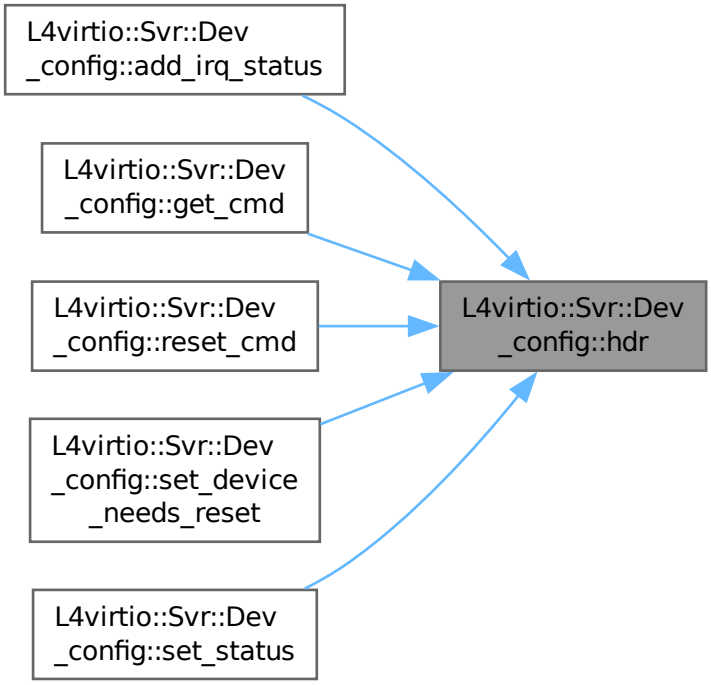
```
l4virtio_config_hdr_t const volatile * L4virtio::Svr::Dev_config::hdr () const  [inline]
```

Get a read-only pointer to the config header.

Returns

Read-only pointer to the shared config header.

Definition at line 392 of file l4virtio.
Referenced by add_irq_status(), get_cmd(), reset_cmd(), set_device_needs_reset(), and set_status().
Here is the caller graph for this function:



15.410.3.7 negotiated_features()

```
l4_uint32_t L4virtio::Svr::Dev_config::negotiated_features (
            unsigned idx) const  [inline]
```

Compute a specific set of negotiated features.

Parameters

idx	Index into the guest/host features array.

Return values

The	selected set of negotiated features.

This function returns a specific 32-bit set of features negotiated by the guest/driver and host/device. `idx` is the index in the guest/host features array, resp. the 32-bit set to return.
Definition at line 232 of file l4virtio.

15.410.3.8 qconfig()

```
l4virtio_config_queue_t volatile const * L4virtio::Svr::Dev_config::qconfig (
            unsigned index) const  [inline]
```

Get queue read-only config data for queue with the given *index*.

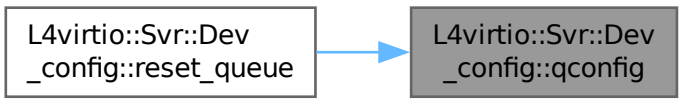
Parameters

index	The index of the queue.

Returns

Read-only pointer to the config of the queue with the given *index*, or NULL if *index* is out of range.

Definition at line 323 of file l4virtio.
References L4_UNLIKELY.
Referenced by reset_queue().
Here is the caller graph for this function:

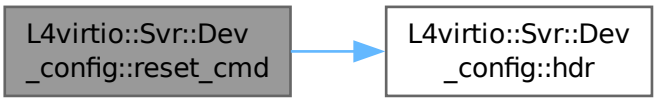


15.410.3.9 reset_cmd()

```
void L4virtio::Svr::Dev_config::reset_cmd ()  [inline]
```

Reset the `cmd` register after execution of a command.
This function resets the `cmd` register in order for the client to detect that the command was executed by the device.
Definition at line 261 of file l4virtio.

References hdr().
Here is the call graph for this function:



15.410.3.10 reset_queue()

```
bool L4virtio::Svr::Dev_config::reset_queue (
            unsigned index,
            unsigned num_max,
            bool inc_generation = false,
            unsigned device_notify_index = 0) const  [inline]
```

Reset queue config for the given queue.

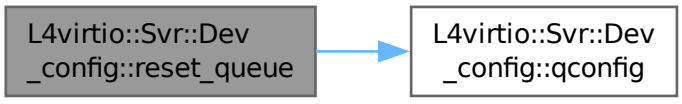
Parameters

index	The index of the queue to reset.
num_max	The maximum number of descriptors supported by this queue.
inc_generation	The config generation will be incremented when this is true.
device_notify_index	Device notification Irq index for this queue. See Device_t::device_notify_irq(unsigned).

Returns

true on success, or false when *index* is out of range.

Definition at line 367 of file l4virtio.
References l4virtio_config_queue_t::device_notify_index, L4_UNLIKELY, l4virtio_config_queue_t::num, l4virtio_config_queue_t::num
qconfig(), and l4virtio_config_queue_t::ready.
Here is the call graph for this function:

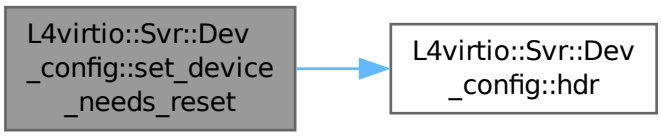


15.410.3.11 set_device_needs_reset()

```
void L4virtio::Svr::Dev_config::set_device_needs_reset ()  [inline]
```

Set DEVICE_NEEDS_RESET bit in device status register.

This function sets the internal status register and also the status register in the shared memory to DEVICE_↩ NEEDS_RESET.
Definition at line 296 of file l4virtio.
References hdr().
Here is the call graph for this function:



15.410.3.12 set_device_notify_index()

```
void L4virtio::Svr::Dev_config::set_device_notify_index (
            unsigned idx)  [inline]
```

Set index of interrupt that driver should trigger for config notifications.
See Device_t::device_notify_irq(unsigned).
Definition at line 198 of file l4virtio.

15.410.3.13 set_status()

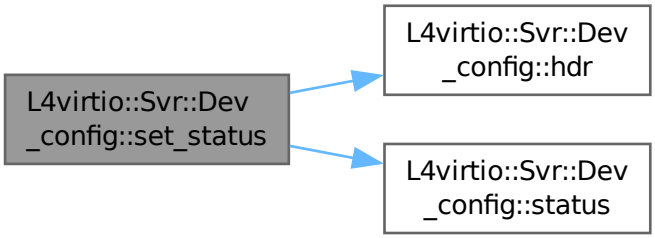
```
void L4virtio::Svr::Dev_config::set_status (
            Status status)  [inline]
```

Set device status register.

Parameters

status	The new value for the device status register.

This function sets the internal status register and also the status register in the shared memory to *status*.
Definition at line 273 of file l4virtio.
References hdr(), and status().
Here is the call graph for this function:



15.410.3.14 status()

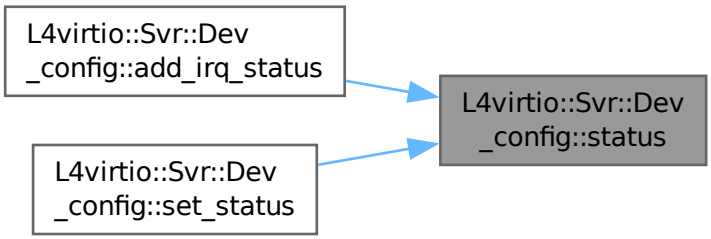
```
Status L4virtio::Svr::Dev_config::status () const  [inline]
```

Get current device status (trusted).

Returns

Current device status register (trusted).

The status returned by this function is value stored internally and cannot be written by the guest (i.e., the value can be taken as trusted.)
Definition at line 242 of file l4virtio.
Referenced by add_irq_status(), and set_status().
Here is the caller graph for this function:



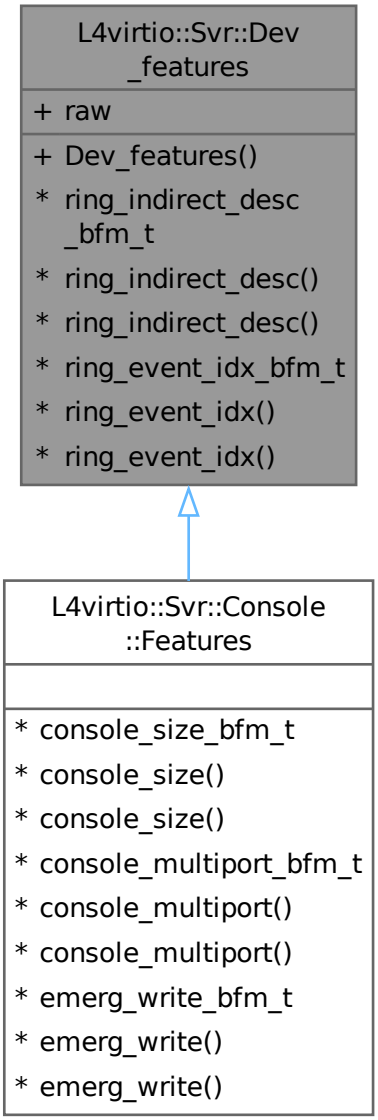
The documentation for this class was generated from the following file:

- l4/l4virtio/server/l4virtio

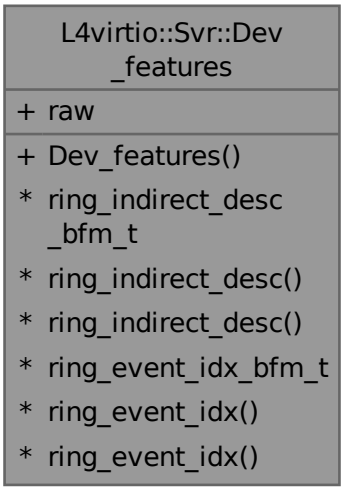
15.411 L4virtio::Svr::Dev_features Struct Reference

Type for device feature bitmap.
`#include <virtio>`

Inheritance diagram for L4virtio::Svr::Dev_features:



Collaboration diagram for L4virtio::Svr::Dev_features:



Public Member Functions

- **Dev_features** (l4_uint32_t v)

  Make Features from a raw bitmap.

Data Fields

- l4_uint32_t **raw**

  The raw value of the features bitmap.

- typedef cxx::Bitfield< decltype(raw), 28, 28 > **ring_indirect_desc_bfm_t**

  Type to access the `ring_indirect_desc` bits (28 to 28) of `raw`.
- constexpr ring_indirect_desc_bfm_t::Val **ring_indirect_desc** () const

  Get the `ring_indirect_desc` bits (28 to 28) of `raw`.
- constexpr ring_indirect_desc_bfm_t::Ref **ring_indirect_desc** ()

  Get a reference to the `ring_indirect_desc` bits (28 to 28) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 29, 29 > **ring_event_idx_bfm_t**

  Type to access the `ring_event_idx` bits (29 to 29) of `raw`.
- constexpr ring_event_idx_bfm_t::Val **ring_event_idx** () const

  Get the `ring_event_idx` bits (29 to 29) of `raw`.
- constexpr ring_event_idx_bfm_t::Ref **ring_event_idx** ()

  Get a reference to the `ring_event_idx` bits (29 to 29) of `raw`.

15.411.1 Detailed Description

Type for device feature bitmap.
Definition at line 66 of file virtio.
The documentation for this struct was generated from the following file:

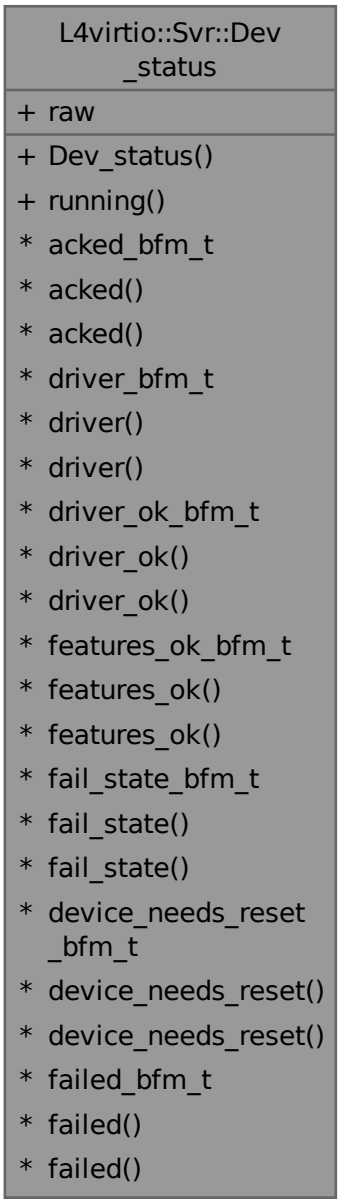
- l4/l4virtio/server/virtio

15.412 L4virtio::Svr::Dev_status Struct Reference

Type of the device status register.

`#include <virtio>`

Collaboration diagram for L4virtio::Svr::Dev_status:



Public Member Functions

- **Dev_status** (l4_uint32_t v)

  Make Status from raw value.

- bool running () const

  Check if the device is in running state.

Data Fields

- unsigned char **raw**

  Raw value of the VIRTIO device status register.

- typedef cxx::Bitfield< decltype(raw), 0, 0 > **acked_bfm_t**

  Type to access the `acked` bits (0 to 0) of `raw`.
- constexpr acked_bfm_t::Val **acked** () const

  Get the `acked` bits (0 to 0) of `raw`.
- constexpr acked_bfm_t::Ref **acked** ()

  Get a reference to the `acked` bits (0 to 0) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 1, 1 > **driver_bfm_t**

  Type to access the `driver` bits (1 to 1) of `raw`.
- constexpr driver_bfm_t::Val **driver** () const

  Get the `driver` bits (1 to 1) of `raw`.
- constexpr driver_bfm_t::Ref **driver** ()

  Get a reference to the `driver` bits (1 to 1) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 2, 2 > **driver_ok_bfm_t**

  Type to access the `driver_ok` bits (2 to 2) of `raw`.
- constexpr driver_ok_bfm_t::Val **driver_ok** () const

  Get the `driver_ok` bits (2 to 2) of `raw`.
- constexpr driver_ok_bfm_t::Ref **driver_ok** ()

  Get a reference to the `driver_ok` bits (2 to 2) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 3, 3 > **features_ok_bfm_t**

  Type to access the `features_ok` bits (3 to 3) of `raw`.
- constexpr features_ok_bfm_t::Val **features_ok** () const

  Get the `features_ok` bits (3 to 3) of `raw`.
- constexpr features_ok_bfm_t::Ref **features_ok** ()

  Get a reference to the `features_ok` bits (3 to 3) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 6, 7 > **fail_state_bfm_t**

  Type to access the `fail_state` bits (6 to 7) of `raw`.
- constexpr fail_state_bfm_t::Val **fail_state** () const

  Get the `fail_state` bits (6 to 7) of `raw`.
- constexpr fail_state_bfm_t::Ref **fail_state** ()

  Get a reference to the `fail_state` bits (6 to 7) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 6, 6 > **device_needs_reset_bfm_t**

  Type to access the `device_needs_reset` bits (6 to 6) of `raw`.
- constexpr device_needs_reset_bfm_t::Val **device_needs_reset** () const

  Get the `device_needs_reset` bits (6 to 6) of `raw`.
- constexpr device_needs_reset_bfm_t::Ref **device_needs_reset** ()

  Get a reference to the `device_needs_reset` bits (6 to 6) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 7, 7 > **failed_bfm_t**

  Type to access the `failed` bits (7 to 7) of `raw`.
- constexpr failed_bfm_t::Val **failed** () const

  Get the `failed` bits (7 to 7) of `raw`.
- constexpr failed_bfm_t::Ref **failed** ()

  Get a reference to the `failed` bits (7 to 7) of `raw`.

15.412.1 Detailed Description

Type of the device status register.
Definition at line 32 of file virtio.

15.412.2 Member Function Documentation

15.412.2.1 running()

```
bool L4virtio::Svr::Dev_status::running () const  [inline]
```

Check if the device is in running state.

Returns

true if the device is in running state.

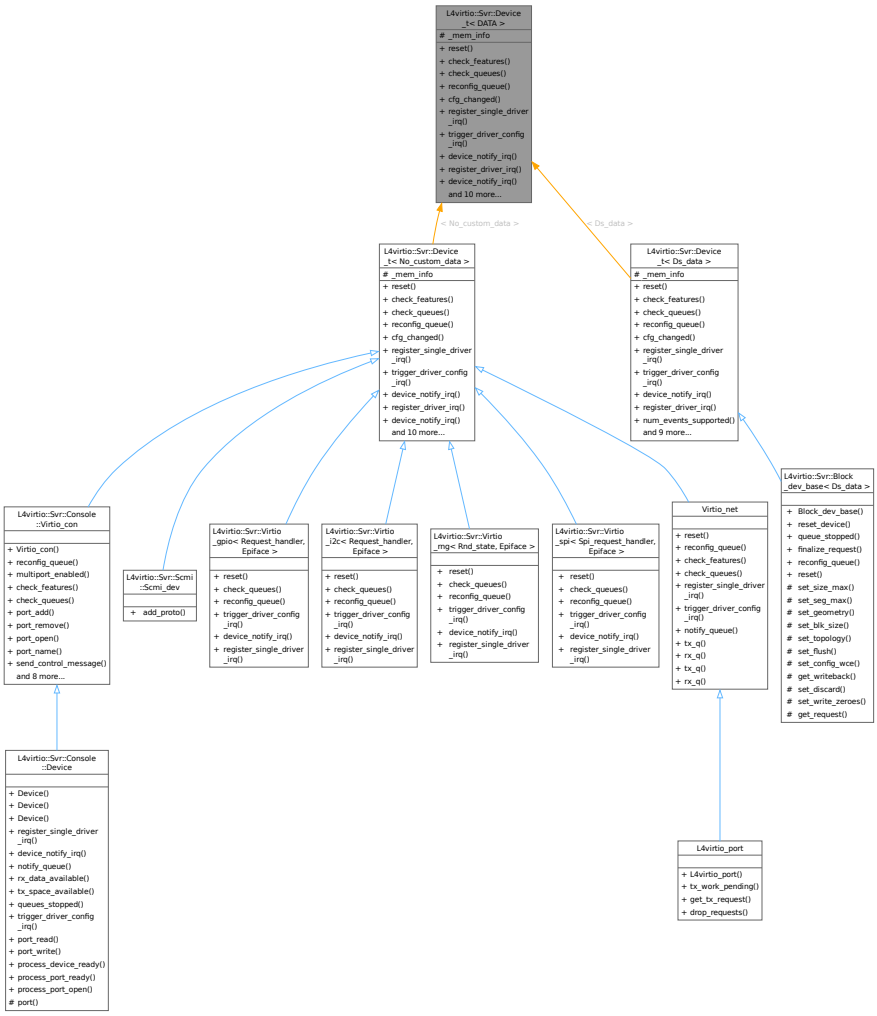
The device is in running state when acked(), driver(), features_ok(), and driver_ok() return true, and device_needs_reset() and failed() return false.
Definition at line 57 of file virtio.
References raw.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio

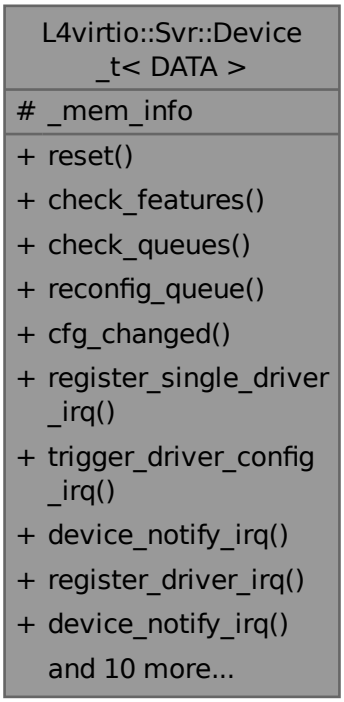
15.413 L4virtio::Svr::Device_t< DATA > Class Template Reference

Server-side L4-VIRTIO device stub.
`#include <l4virtio>`

Inheritance diagram for L4virtio::Svr::Device_t< DATA >:



Collaboration diagram for L4virtio::Svr::Device_t< DATA >:



Public Member Functions

- virtual void **reset** ()=0

  reset callback, called for doing a device reset
- virtual bool **check_features** ()

  callback for checking the subset of accepted features
- virtual bool **check_queues** ()=0

  callback for checking if the queues at DRIVER_OK transition
- virtual int **reconfig_queue** (unsigned idx)=0

  callback for client queue-config request
- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void **register_single_driver_irq** ()

  callback for registering a single guest IRQ for all queues (old-style)
- virtual void **trigger_driver_config_irq** ()=0

  callback for triggering configuration change notification IRQ
- virtual L4::Cap< L4::Irq > **device_notify_irq** () const

  callback to gather the device notification IRQ (old-style)
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

Return the highest notification index supported.

- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Make a device for the given config.

- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.

- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_notify_index=0)

  Trigger reset for the configuration space for queue idx.

- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.

- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.

- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.

- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.

- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.

- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Protected Attributes

- Mem_list **_mem_info**

  Memory region list.

15.413.1 Detailed Description

template<typename DATA>
class L4virtio::Svr::Device_t< DATA >

Server-side L4-VIRTIO device stub.
This stub supports new-style multi-event registration (using get_device_config(), bind() and get_device_notification_irq()).
Definition at line 825 of file l4virtio.

15.413.2 Constructor & Destructor Documentation

15.413.2.1 Device_t()

```
template<typename DATA>
L4virtio::Svr::Device_t< DATA >::Device_t (
            Dev_config * dev_config,
            L4Re::Util::Dbg msg_user = L4Re::Util::Dbg{},
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

Make a device for the given config.

Parameters

dev_config	The given configuration.
msg_user	Debug channel for informational messages relevant for the user. Verbosity of L4Re::Util::Dbg() by default.

msg_dev	Debug channel for debugging messages relevant for the developer. Verbosity of L4Re::Util::Dbg(2) by default.

Definition at line 930 of file l4virtio.

15.413.3 Member Function Documentation

15.413.3.1 add_trusted_dataspaces()

```
template<typename DATA>
void L4virtio::Svr::Device_t< DATA >::add_trusted_dataspaces (
            std::shared_ptr< Ds_vector const > ds)  [inline]
```

Provide a list of trusted dataspaces that can be used for validation.

Parameters

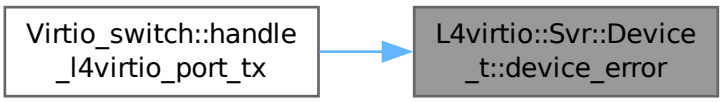
ds	list of trusted dataspaces.

Definition at line 1245 of file l4virtio.

15.413.3.2 device_error()

```
template<typename DATA>
void L4virtio::Svr::Device_t< DATA >::device_error ()  [inline]
```

Transition device into DEVICE_NEEDS_RESET state.
This function does a full reset, sets the DEVICE_NEEDS_RESET bit in the device status register, triggering a guest config IRQ if necessary. The driver still needs to perform its own reset and initialization sequence.
Definition at line 1068 of file l4virtio.
Referenced by Virtio_switch::handle_l4virtio_port_tx().
Here is the caller graph for this function:



15.413.3.3 device_notify_irq()

```
template<typename DATA>
virtual L4::Cap< L4::Irq > L4virtio::Svr::Device_t< DATA >::device_notify_irq (
            unsigned idx)  [inline], [virtual]
```

Callback to gather the device notification IRQ (multi IRQ).
The default implementation maps to the implementation for single IRQ notification points.
Definition at line 904 of file l4virtio.

15.413.3.4 handle_mem_cmd_write()

```
template<typename DATA>
bool L4virtio::Svr::Device_t< DATA >::handle_mem_cmd_write ()  [inline]
```

Check for a value in the cmd register and handle a write.

This function checks for a value in the cmd register and executes the command if there is any, or returns false if there was no command.
Execution of the command is signaled by a zero in the cmd register.
Definition at line 1201 of file l4virtio.

15.413.3.5 init_mem_info()

```
template<typename DATA>
void L4virtio::Svr::Device_t< DATA >::init_mem_info (
            unsigned num)  [inline]
```

Initialize the memory region list to the given maximum.

Parameters

num	Maximum number of memory regions that can be managed.

Definition at line 1056 of file l4virtio.

15.413.3.6 register_driver_irq()

```
template<typename DATA>
virtual void L4virtio::Svr::Device_t< DATA >::register_driver_irq (
            unsigned idx)  [inline], [virtual]
```

Callback for registering an notification IRQ (multi IRQ).
The default implementation maps to the implementation for single IRQ notification points.
Definition at line 890 of file l4virtio.

15.413.3.7 reset_queue_config()

```
template<typename DATA>
void L4virtio::Svr::Device_t< DATA >::reset_queue_config (
            unsigned idx,
            unsigned num_max,
            bool inc_generation = false,
            unsigned device_notify_index = 0)  [inline]
```

Trigger reset for the configuration space for queue *idx*.

Parameters

idx	The queue index to reset.
num_max	Maximum number of entries in this queue.
inc_generation	The config generation will be incremented when this is true.
device_notify_index	Device notification Irq index for this queue. See device_notify_irq(unsigned).

This function resets the driver-readable configuration space for the queue with the given index. The queue configuration is reset to all 0, and the maximum number of entries in the queue is set to *num_max*.
Definition at line 1044 of file l4virtio.

15.413.3.8 setup_queue()

```
template<typename DATA>
bool L4virtio::Svr::Device_t< DATA >::setup_queue (
            Virtqueue * q,
            unsigned qn,
            unsigned num_max)  [inline]
```

Enable/disable the specified queue.

Parameters

q	Pointer to the ring that represents the virtqueue internally.
qn	Index of the queue.
num_max	Maximum number of supported entries in this queue.

Returns

true for success.

- This function calculates the parameters of the virtqueue from the clients configuration space values, checks the accessibility of the queue data structures and initializes *q* to ready state when all checks succeeded.

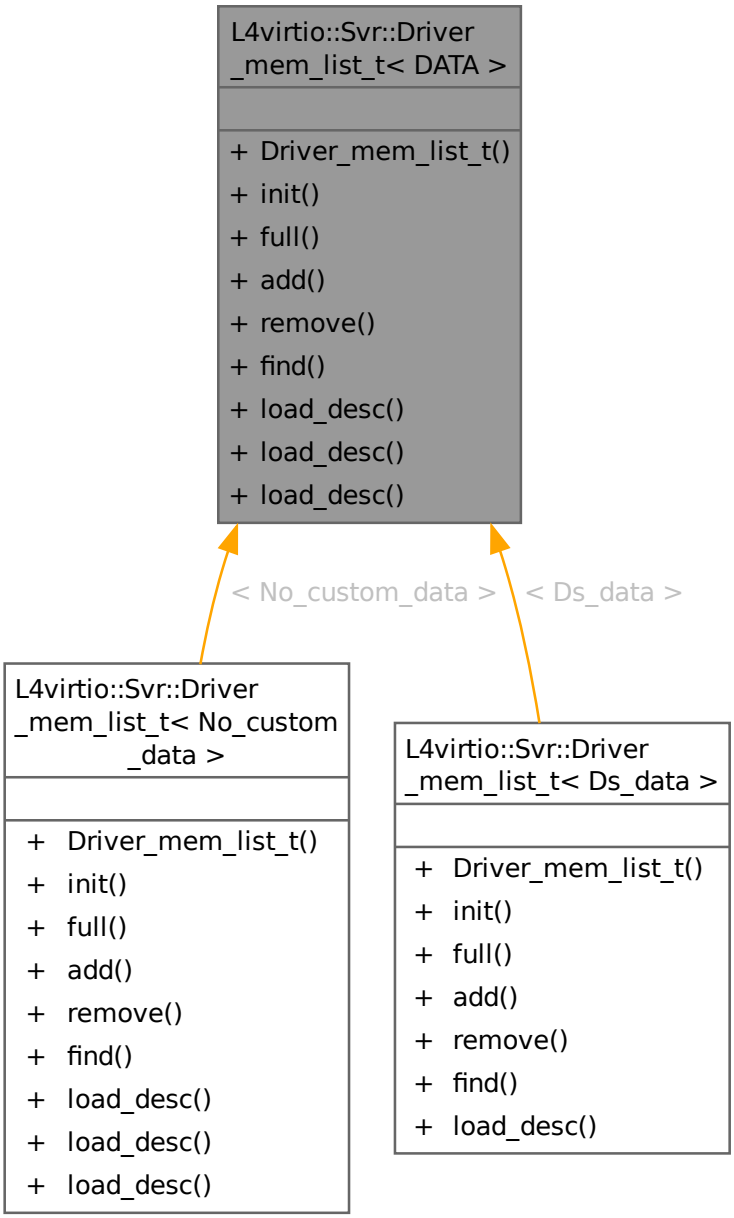
Definition at line 1091 of file l4virtio.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/l4virtio

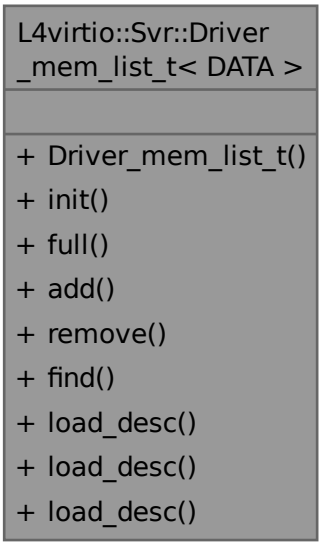
15.414 L4virtio::Svr::Driver_mem_list_t< DATA > Class Template Reference

List of driver memory regions assigned to a single L4-VIRTIO transport instance.
`#include <l4virtio>`

Inheritance diagram for L4virtio::Svr::Driver_mem_list_t< DATA >:



Collaboration diagram for L4virtio::Svr::Driver_mem_list_t< DATA >:



Public Types

- typedef L4Re::Util::Unique_cap< L4Re::Dataspace > **Ds_cap**

  type for storing a data-space capability internally

Public Member Functions

- **Driver_mem_list_t** ()

  Make an empty, zero capacity list.
- void init (unsigned max)

  Make a fresh list with capacity max.
- bool full () const
- Mem_region const * add (l4_uint64_t drv_base, l4_umword_t size, l4_addr_t offset, Ds_cap &&ds)

  Add a new region to the list.
- void remove (Mem_region const *r)

  Remove the given region from the list.
- Mem_region * find (l4_uint64_t base, l4_umword_t size) const

  Find memory region containing the given driver address region.
- void load_desc (Virtqueue::Desc const &desc, Request_processor const *p, Virtqueue::Desc const **table) const

  Default implementation for loading an indirect descriptor.
- void load_desc (Virtqueue::Desc const &desc, Request_processor const *p, Mem_region const **data) const

  Default implementation returning the Driver_mem_region.
- template<typename ARG>
  void load_desc (Virtqueue::Desc const &desc, Request_processor const *p, ARG *data) const

  Default implementation returning generic information.

15.414.1 Detailed Description

template<typename DATA>
class L4virtio::Svr::Driver_mem_list_t< DATA >

List of driver memory regions assigned to a single L4-VIRTIO transport instance.

Note

The regions added to this list *must* never overlap.

Definition at line 653 of file l4virtio.

15.414.2 Member Function Documentation

15.414.2.1 add()

```
template<typename DATA>
Mem_region const * L4virtio::Svr::Driver_mem_list_t< DATA >::add (
              l4_uint64_t drv_base,
              l4_umword_t size,
              l4_addr_t offset,
              Ds_cap && ds)  [inline]
```

Add a new region to the list.

Parameters

drv_base	Driver base address of the region.
size	Size of the region in bytes.
offset	Offset within the data space attached to drv_base.
ds	Data space backing the driver memory.

Returns

A pointer to the new region.

Definition at line 693 of file l4virtio.

15.414.2.2 find()

```
template<typename DATA>
Mem_region * L4virtio::Svr::Driver_mem_list_t< DATA >::find (
              l4_uint64_t base,
              l4_umword_t size) const  [inline]
```

Find memory region containing the given driver address region.

Parameters

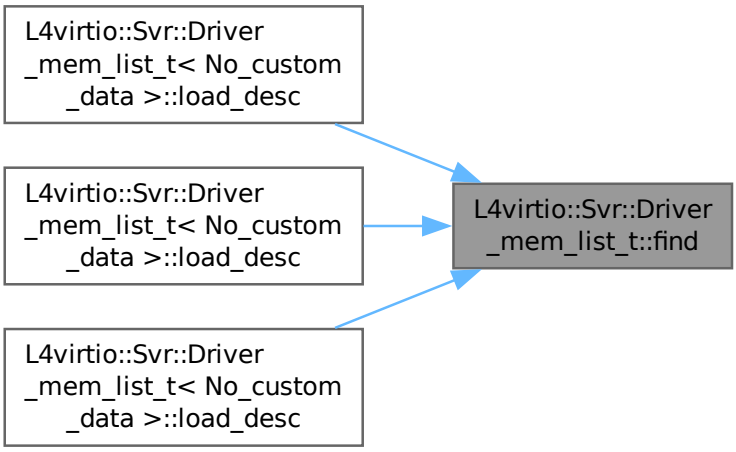
base	Driver base address.
size	Size of the region.

Returns

Pointer to the region containing the given region, NULL if none is found.

Definition at line 727 of file l4virtio.
Referenced by L4virtio::Svr::Driver_mem_list_t< No_custom_data >::load_desc(), L4virtio::Svr::Driver_mem_list_t< No_custom_da
and L4virtio::Svr::Driver_mem_list_t< No_custom_data >::load_desc().

Here is the caller graph for this function:



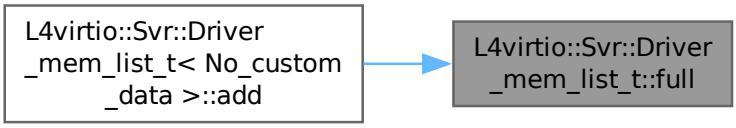
15.414.2.3 full()

```
template<typename DATA>
bool L4virtio::Svr::Driver_mem_list_t< DATA >::full () const  [inline]
```

Returns

True if the remaining capacity is 0.

Definition at line 682 of file l4virtio.
Referenced by L4virtio::Svr::Driver_mem_list_t< No_custom_data >::add().
Here is the caller graph for this function:



15.414.2.4 init()

```
template<typename DATA>
void L4virtio::Svr::Driver_mem_list_t< DATA >::init (
            unsigned max)  [inline]
```

Make a fresh list with capacity *max*.

Parameters

max	The capacity of this vector.

Definition at line 674 of file l4virtio.

15.414.2.5 load_desc() [1/3]

```
template<typename DATA>
template<typename ARG>
void L4virtio::Svr::Driver_mem_list_t< DATA >::load_desc (
            Virtqueue::Desc const & desc,
            Request_processor const * p,
            ARG * data) const  [inline]
```

Default implementation returning generic information.

Template Parameters

ARG	Abstract argument type used with Request_processor::start() and Request_processor::next() to deliver the result of loading a descriptor. This type must provide a constructor taking three arguments: (1) pointer to a Driver_mem_region, (2) the Virtqueue::Desc descriptor, and (3) a pointer to the calling Request_processor.

Parameters

	desc	The descriptor to load
	p	The request processor calling us
out	*data*	Shall be assigned to ARG(mem, desc, p)

Exceptions

Bad_descriptor	The descriptor address could not be translated.

Definition at line 788 of file l4virtio.

15.414.2.6 load_desc() [2/3]

```
template<typename DATA>
void L4virtio::Svr::Driver_mem_list_t< DATA >::load_desc (
            Virtqueue::Desc const & desc,
            Request_processor const * p,
            Mem_region const ** data) const  [inline]
```

Default implementation returning the Driver_mem_region.

Parameters

	desc	The descriptor to load
	p	The request processor calling us
out	*data*	Shall be set to a pointer to the Driver_mem_region that covers the descriptor.

Exceptions

Bad_descriptor	The descriptor address could not be translated.

Definition at line 761 of file l4virtio.

15.414.2.7 load_desc() [3/3]

```
template<typename DATA>
void L4virtio::Svr::Driver_mem_list_t< DATA >::load_desc (
            Virtqueue::Desc const & desc,
            Request_processor const * p,
            Virtqueue::Desc const ** table) const  [inline]
```

Default implementation for loading an indirect descriptor.

Parameters

	desc	The descriptor to load
	p	The request processor calling us
out	*table*	Shall be set to the loaded descriptor table

Exceptions

Bad_descriptor	The descriptor address could not be translated.

Definition at line 741 of file l4virtio.

15.414.2.8 remove()

```
template<typename DATA>
void L4virtio::Svr::Driver_mem_list_t< DATA >::remove (
            Mem_region const * r)  [inline]
```

Remove the given region from the list.

Parameters

r	The region to remove (result from add(), or find()).

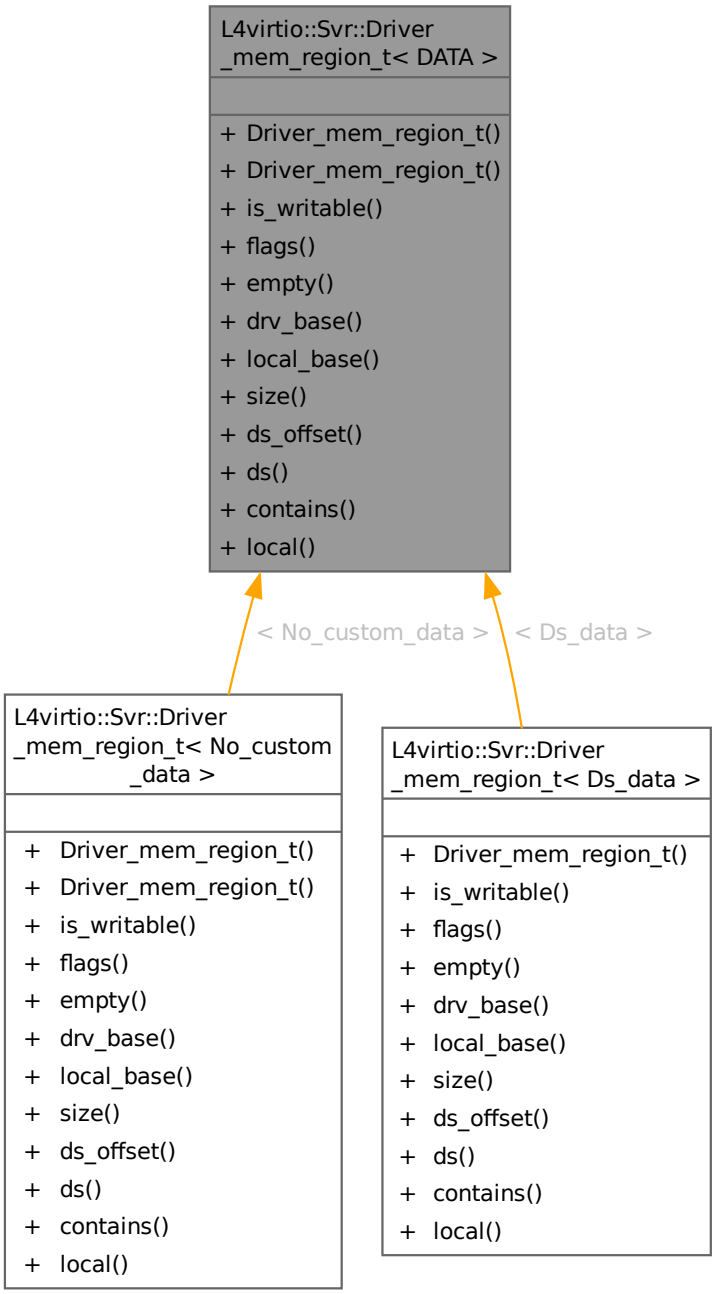
Definition at line 707 of file l4virtio.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/l4virtio

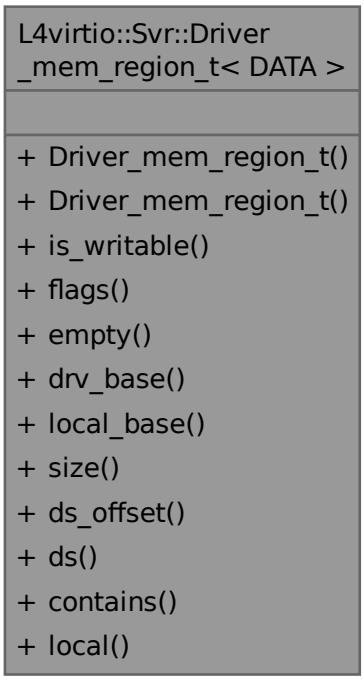
15.415 L4virtio::Svr::Driver_mem_region_t< DATA > Class Template Reference

Region of driver memory, that shall be managed locally.
`#include <l4virtio>`

Inheritance diagram for L4virtio::Svr::Driver_mem_region_t< DATA >:



Collaboration diagram for L4virtio::Svr::Driver_mem_region_t< DATA >:



Public Member Functions

- **Driver_mem_region_t** ()

  Make default empty memory region.
- Driver_mem_region_t (l4_uint64_t drv_base, l4_umword_t size, l4_addr_t offset, Ds_cap &&ds)

  Make a local memory region for the given driver values.
- bool is_writable () const
- Flags flags () const
- bool empty () const
- l4_uint64_t drv_base () const
- l4_addr_t local_base () const
- l4_umword_t size () const
- l4_addr_t ds_offset () const
- L4::Cap< L4Re::Dataspace > ds () const
- bool contains (l4_uint64_t base, l4_umword_t size) const

  Test if the given driver address range is within this region.
- template<typename T>
  T * local (Ptr< T > p) const

  Get the local address for driver address p.

15.415.1 Detailed Description

template<typename DATA>
class L4virtio::Svr::Driver_mem_region_t< DATA >

Region of driver memory, that shall be managed locally.

Template Parameters

DATA	Class defining additional information

Definition at line 474 of file l4virtio.

15.415.2 Constructor & Destructor Documentation

15.415.2.1 Driver_mem_region_t()

```
template<typename DATA>
L4virtio::Svr::Driver_mem_region_t< DATA >::Driver_mem_region_t (
            l4_uint64_t drv_base,
            l4_umword_t size,
            l4_addr_t offset,
            Ds_cap && ds)  [inline]
```

Make a local memory region for the given driver values.

Parameters

drv_base	Base address of the memory region used by the driver.
size	Size of the memory region.
offset	Offset within the data space that is mapped to *drv_base* within the driver.
ds	Data space capability backing the memory.

This constructor attaches the region of given data space to the local address space and stores the corresponding data for later reference.
Definition at line 522 of file l4virtio.

15.415.3 Member Function Documentation

15.415.3.1 contains()

```
template<typename DATA>
bool L4virtio::Svr::Driver_mem_region_t< DATA >::contains (
            l4_uint64_t base,
            l4_umword_t size) const  [inline]
```

Test if the given driver address range is within this region.

Parameters

base	The driver base address.
size	The size of the region to lookup.

Returns

true if the given driver address region is contained in this region, false else.

Definition at line 616 of file l4virtio.

15.415.3.2 drv_base()

```
template<typename DATA>
l4_uint64_t L4virtio::Svr::Driver_mem_region_t< DATA >::drv_base () const  [inline]
```

Returns

The base address used by the driver.

Definition at line 595 of file l4virtio.

15.415.3.3 ds()

```
template<typename DATA>
L4::Cap< L4Re::Dataspace > L4virtio::Svr::Driver_mem_region_t< DATA >::ds () const  [inline]
```

Returns

The data space capability for this region.

Definition at line 607 of file l4virtio.

15.415.3.4 ds_offset()

```
template<typename DATA>
l4_addr_t L4virtio::Svr::Driver_mem_region_t< DATA >::ds_offset () const  [inline]
```

Returns

The offset within the data space.

Definition at line 604 of file l4virtio.

15.415.3.5 empty()

```
template<typename DATA>
bool L4virtio::Svr::Driver_mem_region_t< DATA >::empty () const  [inline]
```

Returns

True if the region is empty (size == 0), false otherwise.

Definition at line 591 of file l4virtio.

15.415.3.6 flags()

```
template<typename DATA>
Flags L4virtio::Svr::Driver_mem_region_t< DATA >::flags () const  [inline]
```

Returns

The flags for this region.

Definition at line 588 of file l4virtio.

15.415.3.7 is_writable()

```
template<typename DATA>
bool L4virtio::Svr::Driver_mem_region_t< DATA >::is_writable () const  [inline]
```

Returns

True if the region is writable, false otherwise.

Definition at line 585 of file l4virtio.

15.415.3.8 local()

```
template<typename DATA>
template<typename T>
T * L4virtio::Svr::Driver_mem_region_t< DATA >::local (
            Ptr< T > p) const  [inline]
```

Get the local address for driver address *p*.

Parameters

p	Driver address to translate.

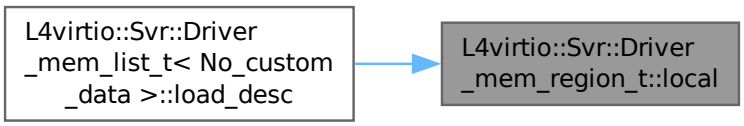
Precondition

p must be contained in this region.

Returns

Local address for the given driver address *p*.

Definition at line 640 of file l4virtio.
Referenced by L4virtio::Svr::Driver_mem_list_t< No_custom_data >::load_desc().
Here is the caller graph for this function:



15.415.3.9 local_base()

```
template<typename DATA>
l4_addr_t L4virtio::Svr::Driver_mem_region_t< DATA >::local_base () const  [inline]
```

Returns

The local base address.

Definition at line 598 of file l4virtio.

15.415.3.10 size()

```
template<typename DATA>
l4_umword_t L4virtio::Svr::Driver_mem_region_t< DATA >::size () const  [inline]
```

Returns

The size of the region in bytes.

Definition at line 601 of file l4virtio.
The documentation for this class was generated from the following file:

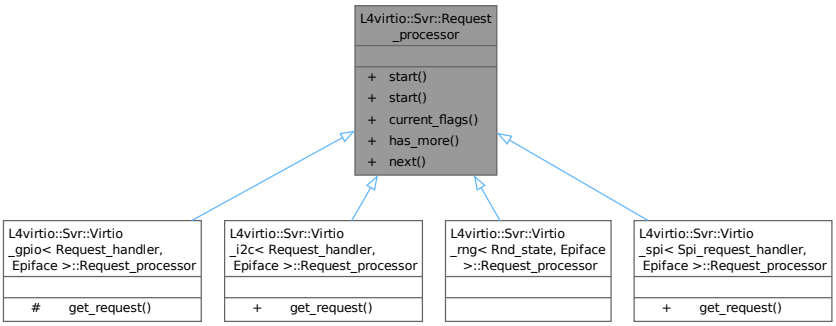
- l4/l4virtio/server/l4virtio

15.416 L4virtio::Svr::Request_processor Class Reference

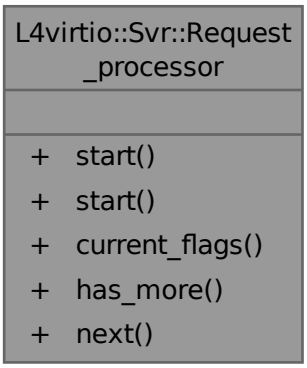
Encapsulate the state for processing a VIRTIO request.

`#include <virtio>`

Inheritance diagram for L4virtio::Svr::Request_processor:



Collaboration diagram for L4virtio::Svr::Request_processor:



Public Member Functions

- template<typename DESC_MAN, typename ... ARGS>
  void start (DESC_MAN *dm, Virtqueue *ring, Virtqueue::Head_desc const &request, ARGS... args)

  Start processing a new request.
- template<typename DESC_MAN, typename ... ARGS>
  Virtqueue::Request const & start (DESC_MAN *dm, Virtqueue::Request const &request, ARGS... args)

  Start processing a new request.
- Virtqueue::Desc::Flags current_flags () const

  Get the flags of the currently processed descriptor.
- bool has_more () const

  Are there more chained descriptors?
- template<typename DESC_MAN, typename ... ARGS>
  bool next (DESC_MAN *dm, ARGS... args)

  Switch to the next descriptor in a descriptor chain.

15.416.1 Detailed Description

Encapsulate the state for processing a VIRTIO request.
A VIRTIO request is a possibly chained list of descriptors retrieved from the available ring of a virtqueue, using Virtqueue::next_avail().
The descriptor processing depends on helper (DESC_MAN) for interpreting the descriptors in the context of the device implementation.
DESC_MAN has to provide the functionality to safely dereference a descriptor from a descriptor list.
The following methods must be provided by DESC_MAN:

- `DESC_MAN::load_desc(Virtqueue::Desc const &desc, Request_processor const *proc, Virtqueue::Desc const **table)`

  This function is used to dereference `desc` as an indirect descriptor table, and must return a pointer to an indirect descriptor table.

- `DESC_MAN::load_desc(Virtqueue::Desc const &desc, Request_processor const *proc, ...)`

  This function is used to dereference a descriptor as a normal data buffer, and '...' are the arguments that are passed to start() and next().

Definition at line 472 of file virtio.

15.416.2 Member Function Documentation

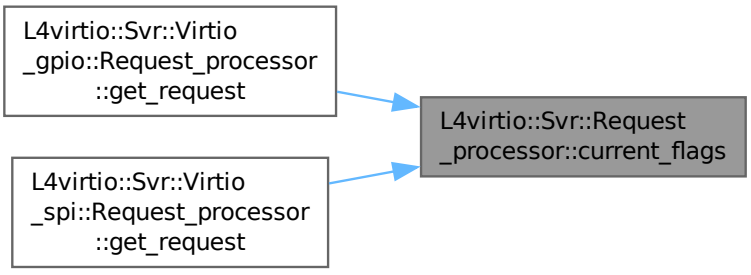
15.416.2.1 current_flags()

`Virtqueue::Desc::Flags L4virtio::Svr::Request_processor::current_flags () const [inline]`
Get the flags of the currently processed descriptor.

Returns

The flags of the currently processed descriptor.

Definition at line 549 of file virtio.
Referenced by L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Request_processor::get_request(), and L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Request_processor::get_request().
Here is the caller graph for this function:



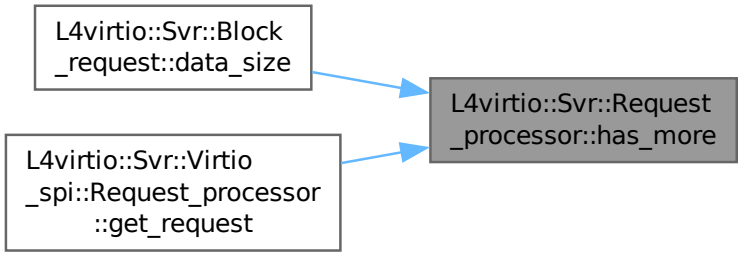
15.416.2.2 has_more()

`bool L4virtio::Svr::Request_processor::has_more () const [inline]`
Are there more chained descriptors?

Returns

true if there are more chained descriptors in the current request.

Definition at line 557 of file virtio.
Referenced by L4virtio::Svr::Block_request< Ds_data >::data_size(), and L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::
Here is the caller graph for this function:



15.416.2.3 next()

```
template<typename DESC_MAN, typename ... ARGS>
bool L4virtio::Svr::Request_processor::next (
            DESC_MAN * dm,
            ARGS... args) [inline]
```

Switch to the next descriptor in a descriptor chain.

Template Parameters

DESC_MAN	Type of descriptor manager (implicit).

Parameters

dm	Descriptor manager that is used to translate VIRTIO descriptor addresses.
args	Extra arguments passed to dm->load_desc()

Return values

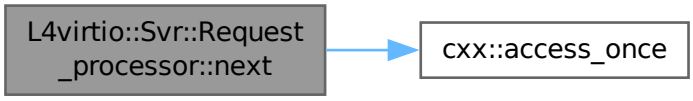
true	A next descriptor is available.
false	No descriptor available.

Exceptions

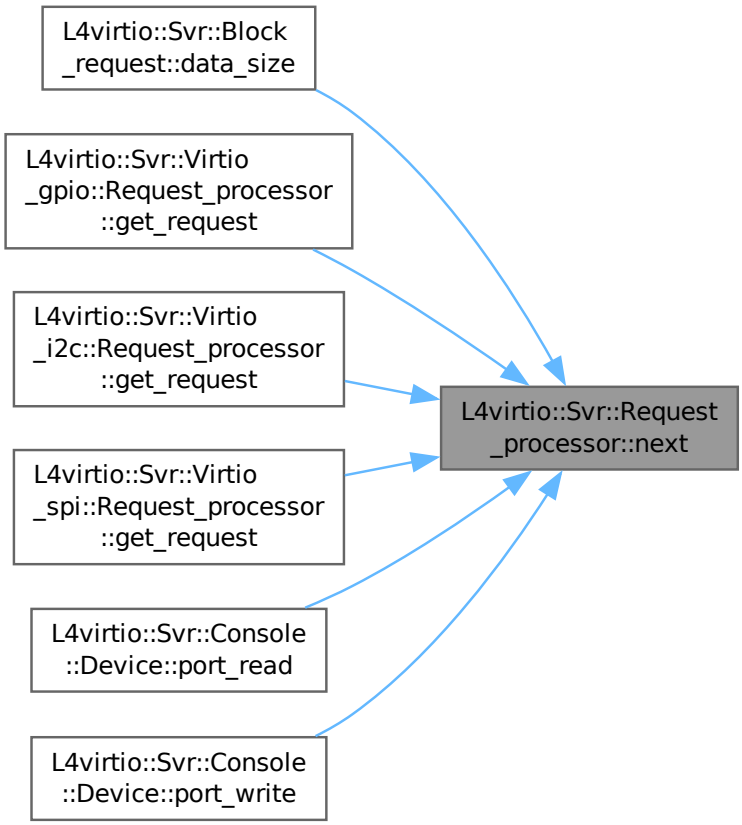
Bad_descriptor	The `next` index of this descriptor is invalid or the chain is longer than the descriptor table.

Definition at line 575 of file virtio.

References cxx::access_once(), L4virtio::Svr::Bad_descriptor::Bad_flags, L4virtio::Svr::Bad_descriptor::Bad_next, and L4_UNLIKELY.
Referenced by L4virtio::Svr::Block_request< Ds_data >::data_size(), L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Reque L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Request_processor::get_request(), L4virtio::Svr::Virtio_spi< Spi_request_har L4virtio::Svr::Console::Device::port_read(), and L4virtio::Svr::Console::Device::port_write().
Here is the call graph for this function:



Here is the caller graph for this function:



15.416.2.4 start() [1/2]

```
template<typename DESC_MAN, typename ... ARGS>
void L4virtio::Svr::Request_processor::start (
```

```
DESC_MAN * dm,
Virtqueue * ring,
Virtqueue::Head_desc const & request,
ARGS... args) [inline]
```

Start processing a new request.

Template Parameters

DESC_MAN	Type of descriptor manager (implicit).

Parameters

dm	Descriptor manager that is used to translate VIRTIO descriptor addresses.
ring	VIRTIO ring of the request.
request	VIRTIO request from Virtqueue::next_avail()
args	Extra arguments passed to dm->load_desc()

Precondition

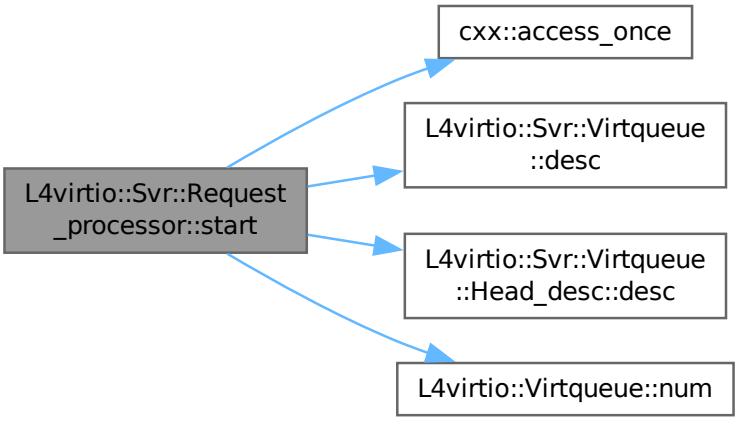
The given request must be valid.

Exceptions

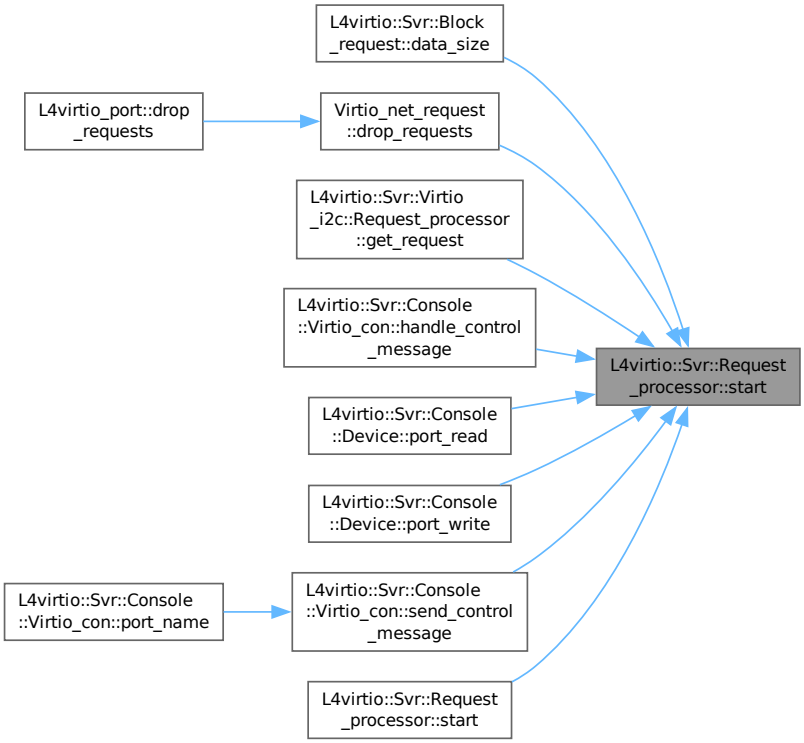
Bad_descriptor	The descriptor has an invalid size or load_desc() has thrown an exception by itself.

Definition at line 503 of file virtio.
References cxx::access_once(), L4virtio::Svr::Bad_descriptor::Bad_size, L4virtio::Svr::Virtqueue::desc(), L4virtio::Svr::Virtqueue::Hea
L4_UNLIKELY, and L4virtio::Virtqueue::num().
Referenced by L4virtio::Svr::Block_request< Ds_data >::data_size(), Virtio_net_request::drop_requests(),
L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Request_processor::get_request(), L4virtio::Svr::Console::Virtio_con::handle_
L4virtio::Svr::Console::Device::port_read(), L4virtio::Svr::Console::Device::port_write(), L4virtio::Svr::Console::Virtio_con::send_contr
and start().

Here is the call graph for this function:



Here is the caller graph for this function:



15.416.2.5 start() [2/2]

```
template<typename DESC_MAN, typename ...  ARGS>
Virtqueue::Request const & L4virtio::Svr::Request_processor::start (
```

```
DESC_MAN * dm,
Virtqueue::Request const & request,
ARGS... args) [inline]
```

Start processing a new request.

Template Parameters

DESC_MAN	Type of descriptor manager (implicit).

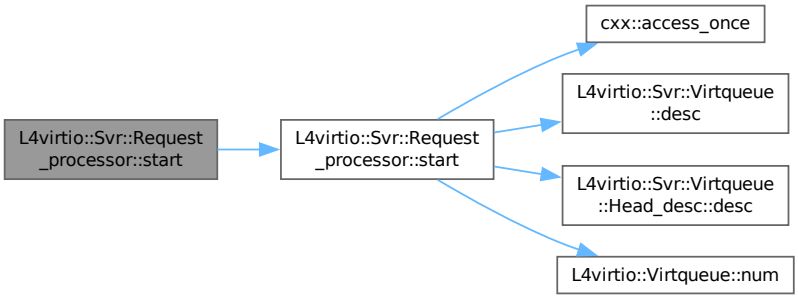
Parameters

dm	Descriptor manager that is used to translate VIRTIO descriptor addresses.
request	VIRTIO request from Virtqueue::next_avail()
args	Extra arguments passed to dm->load_desc()

Precondition

The given request must be valid.

Definition at line 538 of file virtio.
References start().
Here is the call graph for this function:



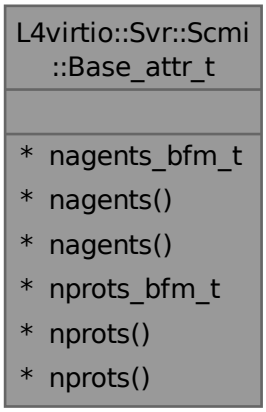
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio

15.417 L4virtio::Svr::Scmi::Base_attr_t Struct Reference

SCMI base protocol attributes.
`#include <virtio-scmi-device>`

Collaboration diagram for L4virtio::Svr::Scmi::Base_attr_t:



- typedef cxx::Bitfield< decltype(attr_raw), 8, 15 > **nagents_bfm_t**

  Type to access the `nagents` bits (8 to 15) of `attr_raw`.
- constexpr nagents_bfm_t::Val **nagents** () const

  Get the `nagents` bits (8 to 15) of `attr_raw`.
- constexpr nagents_bfm_t::Ref **nagents** ()

  Get a reference to the `nagents` bits (8 to 15) of `attr_raw`.
- typedef cxx::Bitfield< decltype(attr_raw), 0, 7 > **nprots_bfm_t**

  Type to access the `nprots` bits (0 to 7) of `attr_raw`.
- constexpr nprots_bfm_t::Val **nprots** () const

  Get the `nprots` bits (0 to 7) of `attr_raw`.
- constexpr nprots_bfm_t::Ref **nprots** ()

  Get a reference to the `nprots` bits (0 to 7) of `attr_raw`.

15.417.1 Detailed Description

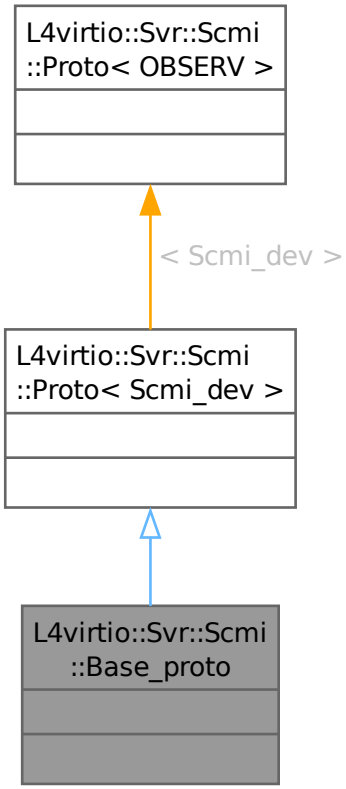
SCMI base protocol attributes.
Definition at line 90 of file virtio-scmi-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

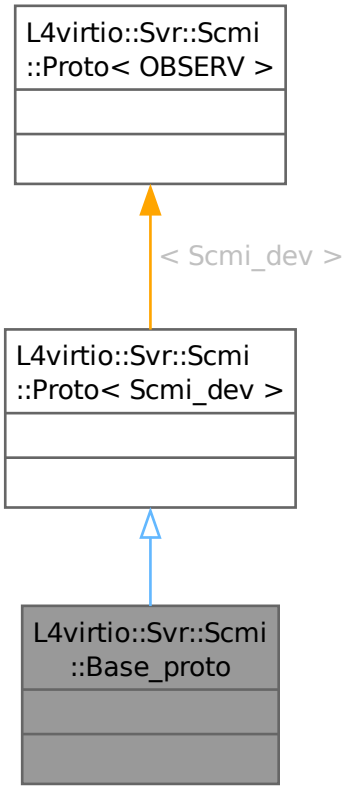
15.418 L4virtio::Svr::Scmi::Base_proto Class Reference

Base class for the SCMI base protocol.
`#include <virtio-scmi-device>`

Inheritance diagram for L4virtio::Svr::Scmi::Base_proto:



Collaboration diagram for L4virtio::Svr::Scmi::Base_proto:



15.418.1 Detailed Description

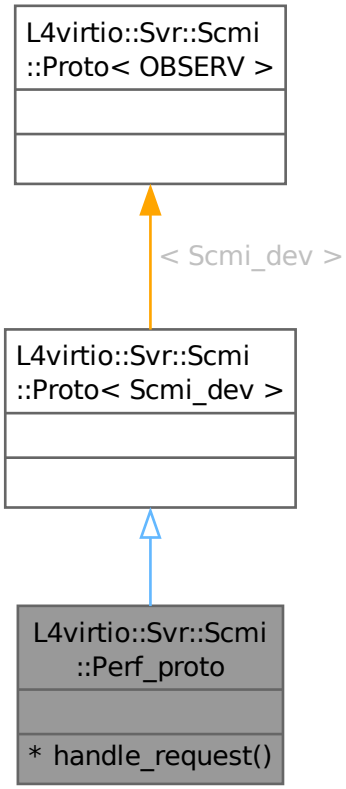
Base class for the SCMI base protocol.
Use this class as a base to implement the base protocol.
Definition at line 468 of file virtio-scmi-device.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

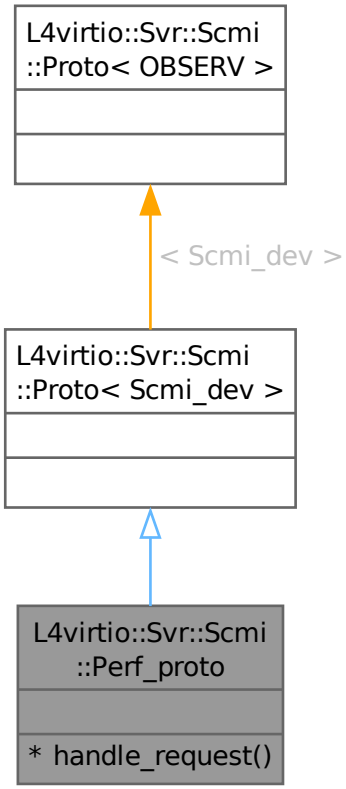
15.419 L4virtio::Svr::Scmi::Perf_proto Class Reference

Base class for the SCMI performance protocol.
`#include <virtio-scmi-device>`

Inheritance diagram for L4virtio::Svr::Scmi::Perf_proto:



Collaboration diagram for L4virtio::Svr::Scmi::Perf_proto:



15.419.1 Detailed Description

Base class for the SCMI performance protocol.
Use this class as a base to implement the performance protocol.
If you want to use this from a Uvmm Linux guest, the device tree needs to look something like this:

```
firmware {
  scmi {
    compatible = "arm,scmi-virtio";

    #address-cells = <1>;
    #size-cells = <0>;

    cpufreq: protocol@13 {
      reg = <0x13>;
      #clock-cells = <1>;
    };
  };
};
....

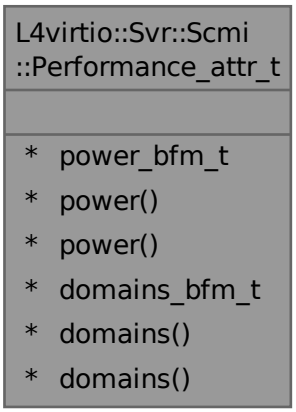
cpu@0 {
  device_type = "cpu";
  reg = <0x0>;
  clocks = <&cpufreq 0>; // domain_id
};
```

Definition at line 672 of file virtio-scmi-device.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

15.420 L4virtio::Svr::Scmi::Performance_attr_t Struct Reference

SCMI performance protocol attributes.
`#include <virtio-scmi-device>`
Collaboration diagram for L4virtio::Svr::Scmi::Performance_attr_t:



- typedef cxx::Bitfield< decltype(attr_raw), 16, 16 > **power_bfm_t**

  Type to access the `power` bits (16 to 16) of `attr_raw`.
- constexpr power_bfm_t::Val **power** () const

  Get the `power` bits (16 to 16) of `attr_raw`.
- constexpr power_bfm_t::Ref **power** ()

  Get a reference to the `power` bits (16 to 16) of `attr_raw`.

- typedef cxx::Bitfield< decltype(attr_raw), 0, 15 > **domains_bfm_t**

  Type to access the `domains` bits (0 to 15) of `attr_raw`.
- constexpr domains_bfm_t::Val **domains** () const

  Get the `domains` bits (0 to 15) of `attr_raw`.
- constexpr domains_bfm_t::Ref **domains** ()

  Get a reference to the `domains` bits (0 to 15) of `attr_raw`.

15.420.1 Detailed Description

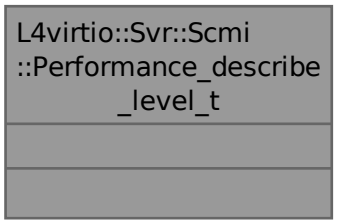
SCMI performance protocol attributes.
Definition at line 112 of file virtio-scmi-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

15.421 L4virtio::Svr::Scmi::Performance_describe_level_t Struct Reference

SCMI performance describe level.
`#include <virtio-scmi-device>`

Collaboration diagram for L4virtio::Svr::Scmi::Performance_describe_level_t:



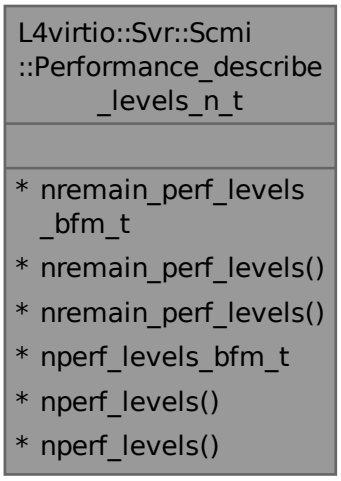
15.421.1 Detailed Description

SCMI performance describe level.
Definition at line 150 of file virtio-scmi-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

15.422 L4virtio::Svr::Scmi::Performance_describe_levels_n_t Struct Reference

SCMI performance describe levels numbers.
`#include <virtio-scmi-device>`
Collaboration diagram for L4virtio::Svr::Scmi::Performance_describe_levels_n_t:



- typedef cxx::Bitfield< decltype(num_levels_raw), 16, 31 > **nremain_perf_levels_bfm_t**

  Type to access the `nremain_perf_levels` bits (16 to 31) of `num_levels_raw`.

- constexpr nremain_perf_levels_bfm_t::Val **nremain_perf_levels** () const

  Get the `nremain_perf_levels` bits (16 to 31) of `num_levels_raw`.
- constexpr nremain_perf_levels_bfm_t::Ref **nremain_perf_levels** ()

  Get a reference to the `nremain_perf_levels` bits (16 to 31) of `num_levels_raw`.

- typedef cxx::Bitfield< decltype(num_levels_raw), 0, 11 > **nperf_levels_bfm_t**

  Type to access the `nperf_levels` bits (0 to 11) of `num_levels_raw`.
- constexpr nperf_levels_bfm_t::Val **nperf_levels** () const

  Get the `nperf_levels` bits (0 to 11) of `num_levels_raw`.
- constexpr nperf_levels_bfm_t::Ref **nperf_levels** ()

  Get a reference to the `nperf_levels` bits (0 to 11) of `num_levels_raw`.

15.422.1 Detailed Description

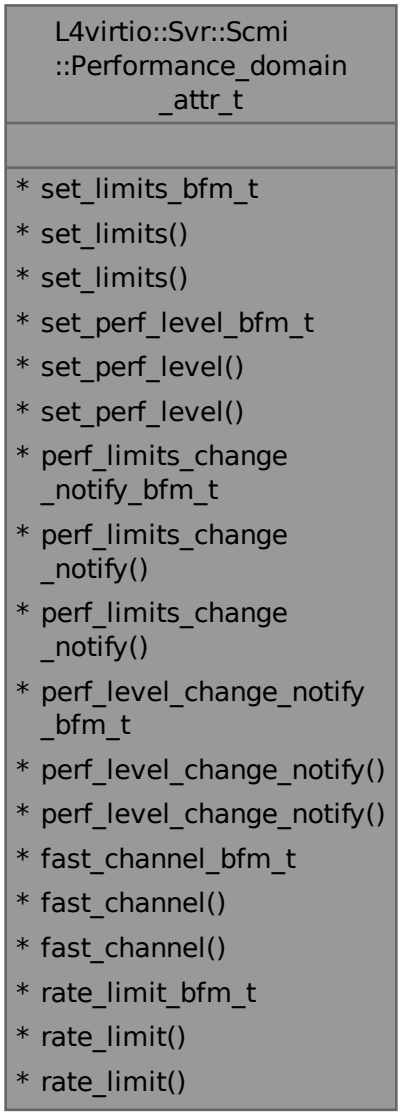
SCMI performance describe levels numbers.
Definition at line 142 of file virtio-scmi-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

15.423 L4virtio::Svr::Scmi::Performance_domain_attr_t Struct Reference

SCMI performance domain protocol attributes.
`#include <virtio-scmi-device>`

Collaboration diagram for L4virtio::Svr::Scmi::Performance_domain_attr_t:



- typedef cxx::Bitfield< decltype(attr_raw), 31, 31 > **set_limits_bfm_t**

  Type to access the `set_limits` bits (31 to 31) of `attr_raw`.
- constexpr set_limits_bfm_t::Val **set_limits** () const

  Get the `set_limits` bits (31 to 31) of `attr_raw`.
- constexpr set_limits_bfm_t::Ref **set_limits** ()

  Get a reference to the `set_limits` bits (31 to 31) of `attr_raw`.

- typedef cxx::Bitfield< decltype(attr_raw), 30, 30 > **set_perf_level_bfm_t**

  Type to access the `set_perf_level` bits (30 to 30) of `attr_raw`.
- constexpr set_perf_level_bfm_t::Val **set_perf_level** () const

  Get the `set_perf_level` bits (30 to 30) of `attr_raw`.
- constexpr set_perf_level_bfm_t::Ref **set_perf_level** ()

Get a reference to the `set_perf_level` bits (30 to 30) of `attr_raw`.

- typedef cxx::Bitfield< decltype(attr_raw), 29, 29 > **perf_limits_change_notify_bfm_t**

  Type to access the `perf_limits_change_notify` bits (29 to 29) of `attr_raw`.
- constexpr perf_limits_change_notify_bfm_t::Val **perf_limits_change_notify** () const

  Get the `perf_limits_change_notify` bits (29 to 29) of `attr_raw`.
- constexpr perf_limits_change_notify_bfm_t::Ref **perf_limits_change_notify** ()

  Get a reference to the `perf_limits_change_notify` bits (29 to 29) of `attr_raw`.

- typedef cxx::Bitfield< decltype(attr_raw), 28, 28 > **perf_level_change_notify_bfm_t**

  Type to access the `perf_level_change_notify` bits (28 to 28) of `attr_raw`.
- constexpr perf_level_change_notify_bfm_t::Val **perf_level_change_notify** () const

  Get the `perf_level_change_notify` bits (28 to 28) of `attr_raw`.
- constexpr perf_level_change_notify_bfm_t::Ref **perf_level_change_notify** ()

  Get a reference to the `perf_level_change_notify` bits (28 to 28) of `attr_raw`.

- typedef cxx::Bitfield< decltype(attr_raw), 27, 27 > **fast_channel_bfm_t**

  Type to access the `fast_channel` bits (27 to 27) of `attr_raw`.
- constexpr fast_channel_bfm_t::Val **fast_channel** () const

  Get the `fast_channel` bits (27 to 27) of `attr_raw`.
- constexpr fast_channel_bfm_t::Ref **fast_channel** ()

  Get a reference to the `fast_channel` bits (27 to 27) of `attr_raw`.

- typedef cxx::Bitfield< decltype(rate_limit_raw), 0, 19 > **rate_limit_bfm_t**

  Type to access the `rate_limit` bits (0 to 19) of `rate_limit_raw`.
- constexpr rate_limit_bfm_t::Val **rate_limit** () const

  Get the `rate_limit` bits (0 to 19) of `rate_limit_raw`.
- constexpr rate_limit_bfm_t::Ref **rate_limit** ()

  Get a reference to the `rate_limit` bits (0 to 19) of `rate_limit_raw`.

15.423.1 Detailed Description

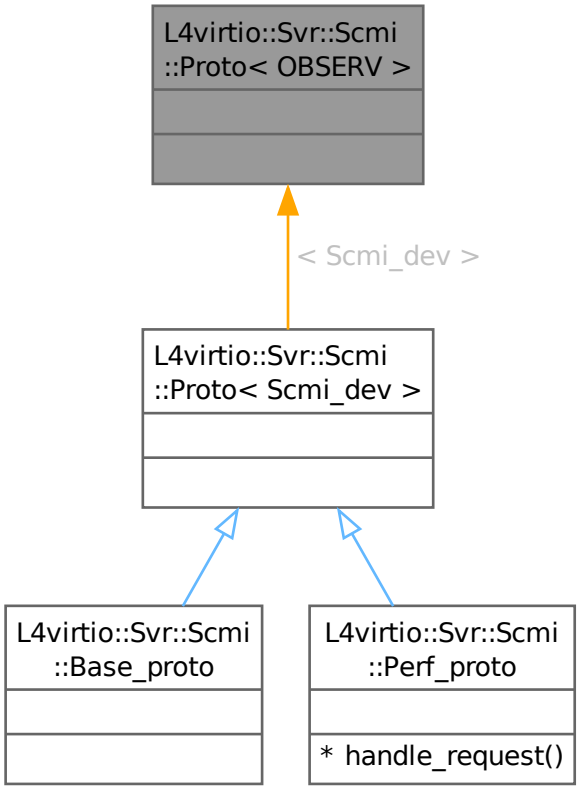
SCMI performance domain protocol attributes.
Definition at line 124 of file virtio-scmi-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

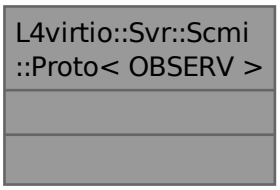
15.424 L4virtio::Svr::Scmi::Proto< OBSERV > Struct Template Reference

Base class for all protocols.
`#include <virtio-scmi-device>`

Inheritance diagram for L4virtio::Svr::Scmi::Proto< OBSERV >:



Collaboration diagram for L4virtio::Svr::Scmi::Proto< OBSERV >:



15.424.1 Detailed Description

template<typename OBSERV>
struct L4virtio::Svr::Scmi::Proto< OBSERV >

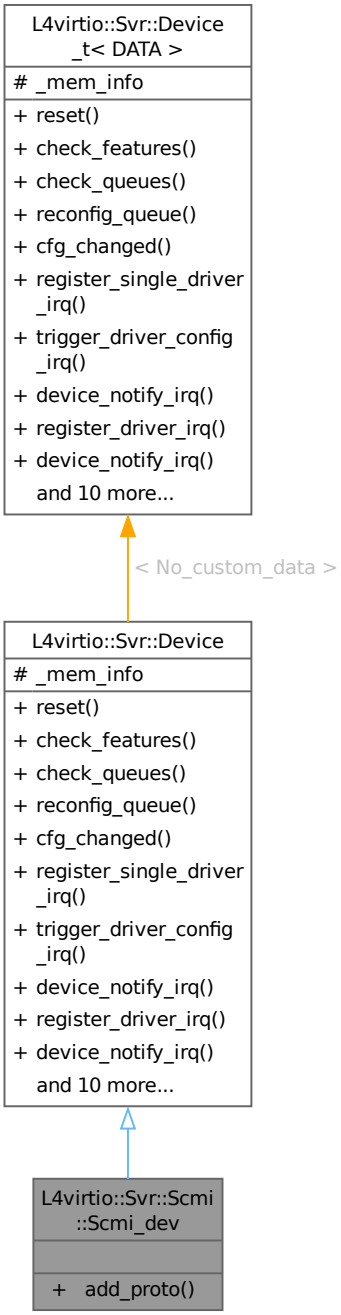
Base class for all protocols.
Defines an interface for processing the virtio buffers for the implemented protocol.

Definition at line 302 of file virtio-scmi-device.
The documentation for this struct was generated from the following file:

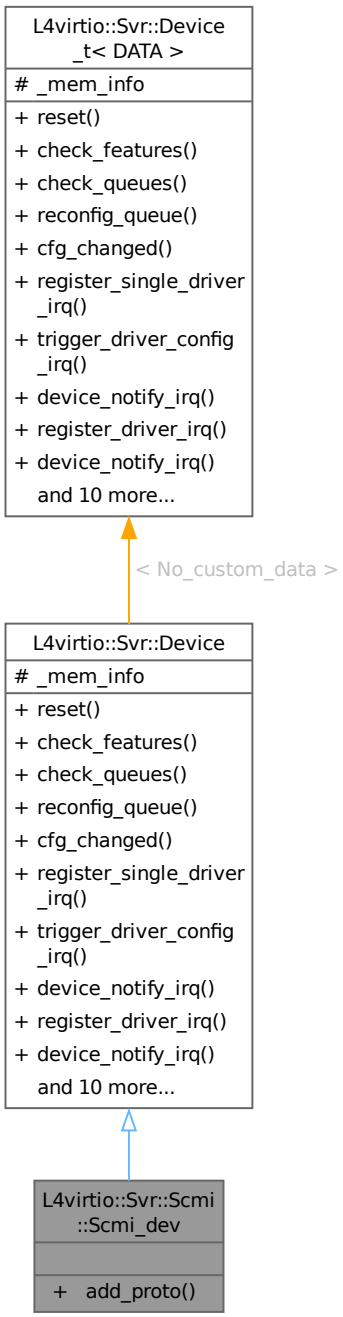
- l4/l4virtio/server/virtio-scmi-device

15.425 L4virtio::Svr::Scmi::Scmi_dev Class Reference

A server implementation of the virtio-scmi protocol.
`#include <virtio-scmi-device>`
Inheritance diagram for L4virtio::Svr::Scmi::Scmi_dev:



Collaboration diagram for L4virtio::Svr::Scmi::Scmi_dev:



Public Member Functions

- void **add_proto** (l4_uint32_t id, Proto< Scmi_dev > *proto)

  Add an actual protocol implementation with the given id to the server.

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual bool **check_features** ()

callback for checking the subset of accepted features

- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_↩ dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_↩ notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Additional Inherited Members

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.425.1 Detailed Description

A server implementation of the virtio-scmi protocol.
Use this class as a base to implement your own specific SCMI device.
SCMI defines multiple protocols which can be optionally handled. This server implementation is flexible enough to handle any combination of them. The user of this server has to deviate from the provided Proto classes (for the protocols he want to handle) and needs to implement the required callbacks.
Right now, support for the base and the performance protocol is provided.
The base protocol is mandatory.
If you want to use this from a Uvmm Linux guest, the device tree needs to look something like this:

```
firmware {
  scmi {
    compatible = "arm,scmi-virtio";

    #address-cells = <1>;
    #size-cells = <0>;

    // ... supported protocols ...
  };
};
```

Definition at line 339 of file virtio-scmi-device.
The documentation for this class was generated from the following file:

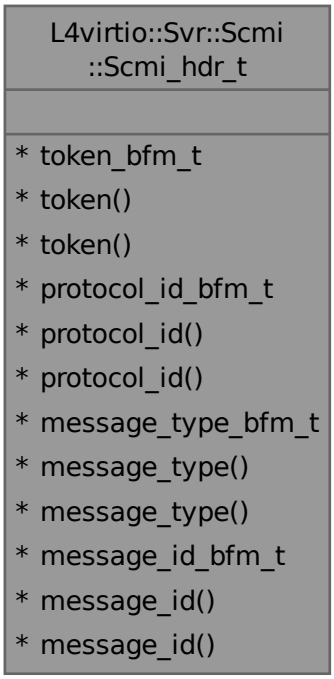
- l4/l4virtio/server/virtio-scmi-device

15.426 L4virtio::Svr::Scmi::Scmi_hdr_t Struct Reference

SCMI header.

`#include <virtio-scmi-device>`

Collaboration diagram for L4virtio::Svr::Scmi::Scmi_hdr_t:



- typedef cxx::Bitfield< decltype(hdr_raw), 18, 27 > **token_bfm_t**

  Type to access the `token` bits (18 to 27) of `hdr_raw`.
- constexpr token_bfm_t::Val **token** () const

  Get the `token` bits (18 to 27) of `hdr_raw`.
- constexpr token_bfm_t::Ref **token** ()

  Get a reference to the `token` bits (18 to 27) of `hdr_raw`.

- typedef cxx::Bitfield< decltype(hdr_raw), 10, 17 > **protocol_id_bfm_t**

  Type to access the `protocol_id` bits (10 to 17) of `hdr_raw`.
- constexpr protocol_id_bfm_t::Val **protocol_id** () const

  Get the `protocol_id` bits (10 to 17) of `hdr_raw`.
- constexpr protocol_id_bfm_t::Ref **protocol_id** ()

  Get a reference to the `protocol_id` bits (10 to 17) of `hdr_raw`.

- typedef cxx::Bitfield< decltype(hdr_raw), 8, 9 > **message_type_bfm_t**

  Type to access the `message_type` bits (8 to 9) of `hdr_raw`.
- constexpr message_type_bfm_t::Val **message_type** () const

  Get the `message_type` bits (8 to 9) of `hdr_raw`.

- constexpr message_type_bfm_t::Ref **message_type** ()

  Get a reference to the `message_type` *bits (8 to 9) of* `hdr_raw`*.*

- typedef cxx::Bitfield< decltype(hdr_raw), 0, 7 > **message_id_bfm_t**

  Type to access the `message_id` *bits (0 to 7) of* `hdr_raw`*.*

- constexpr message_id_bfm_t::Val **message_id** () const

  Get the `message_id` *bits (0 to 7) of* `hdr_raw`*.*

- constexpr message_id_bfm_t::Ref **message_id** ()

  Get a reference to the `message_id` *bits (0 to 7) of* `hdr_raw`*.*

15.426.1 Detailed Description

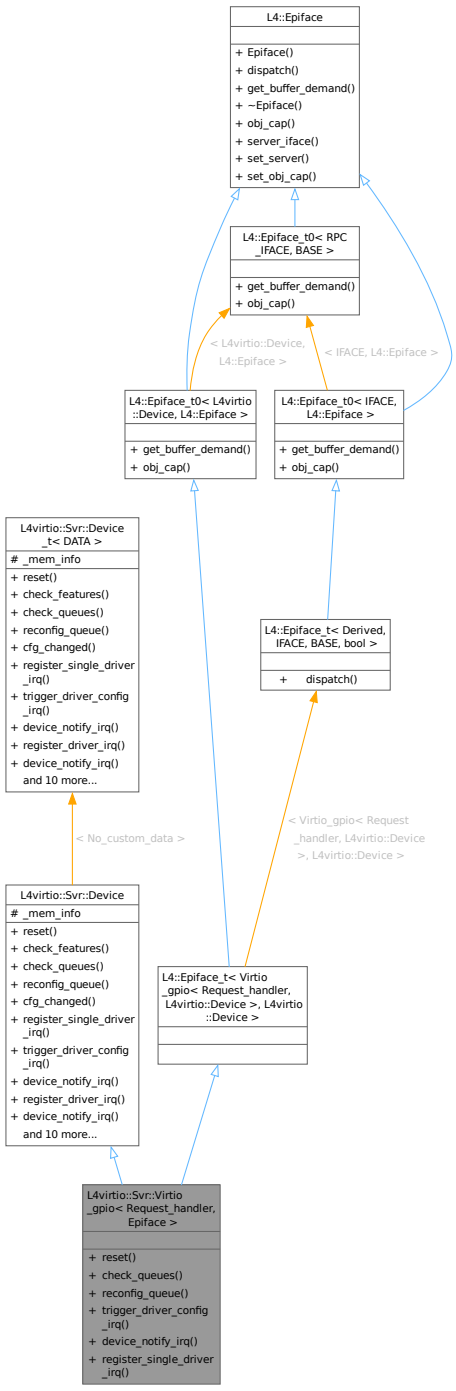
SCMI header.
Definition at line 45 of file virtio-scmi-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-scmi-device

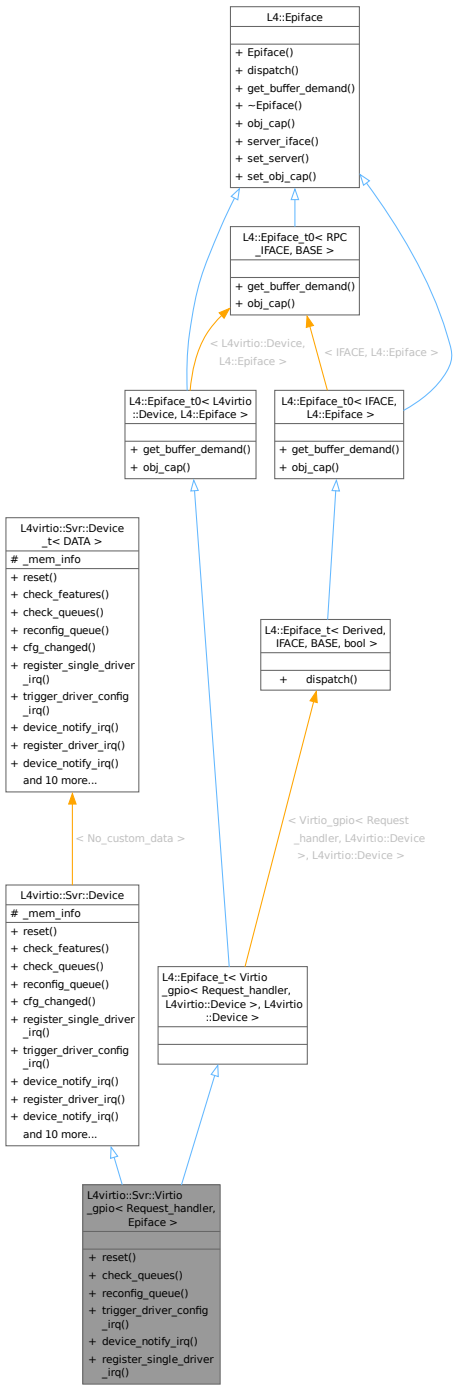
15.427 L4virtio::Svr::Virtio_gpio< Request_handler, Epiface > Class Template Reference

A server implementation of the virtio-gpio protocol.
`#include <virtio-gpio-device>`

Inheritance diagram for L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >:



Collaboration diagram for L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >:



Data Structures

- struct Irq_handler

  Handler for an gpio pin irq.
- struct Host_irq

  Handler for the host irq.
- struct Request_processor

  Generic handler for the Virtio requests.

Public Member Functions

- void **reset** () override

  reset callback, called for doing a device reset
- bool **check_queues** () override

  callback for checking if the queues at DRIVER_OK transition
- int **reconfig_queue** (unsigned idx) override

  callback for client queue-config request
- void **trigger_driver_config_irq** () override

  callback for triggering configuration change notification IRQ
- L4::Cap< L4::Irq > **device_notify_irq** () const override

  callback to gather the device notification IRQ (old-style)
- void **register_single_driver_irq** () override

  callback for registering a single guest IRQ for all queues (old-style)

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual bool **check_features** ()

  callback for checking the subset of accepted features
- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Public Member Functions inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< L4virtio::Device > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.427.1 Detailed Description

template<typename Request_handler, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >

A server implementation of the virtio-gpio protocol.

Template Parameters

Request_handler	The type that is used to handle incomming requests. Needs to have: • bool get_direction(l4_uint16_t gpio, l4_uint8_t *dir) • bool set_direction(l4_uint16_t gpio, l4_uint8_t dir) • bool get_value(l4_uint16_t gpio, l4_uint8_t *val) • bool set_value(l4_uint16_t gpio, l4_uint8_t val) • bool set_irq_type(l4_uint16_t gpio, l4_uint8_t mode) • bool enable_irq(l4_uint16_t gpio, std::shared_ptr<Virtio_gpio::Irq_handler> const &hdl) functions.

Epiface	The Epiface to derive from. Defaults to `L4virtio::Device`.

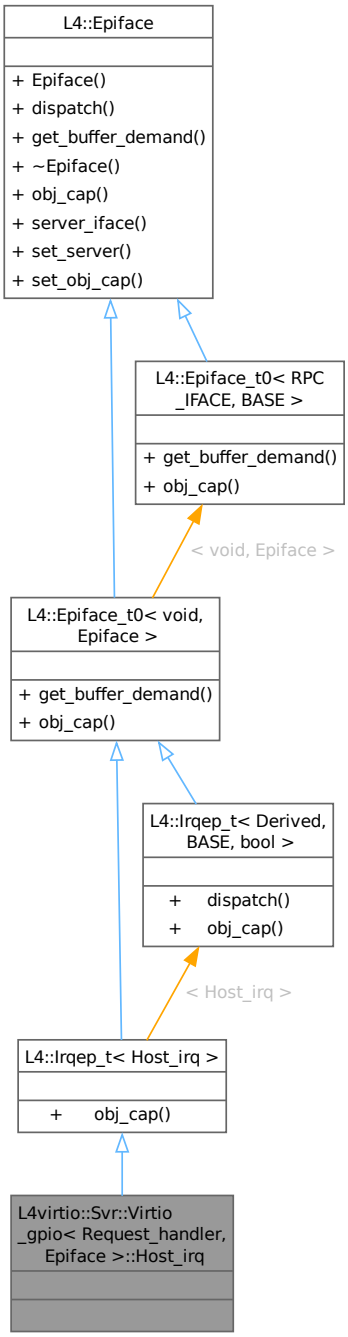
Definition at line 142 of file virtio-gpio-device.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-gpio-device

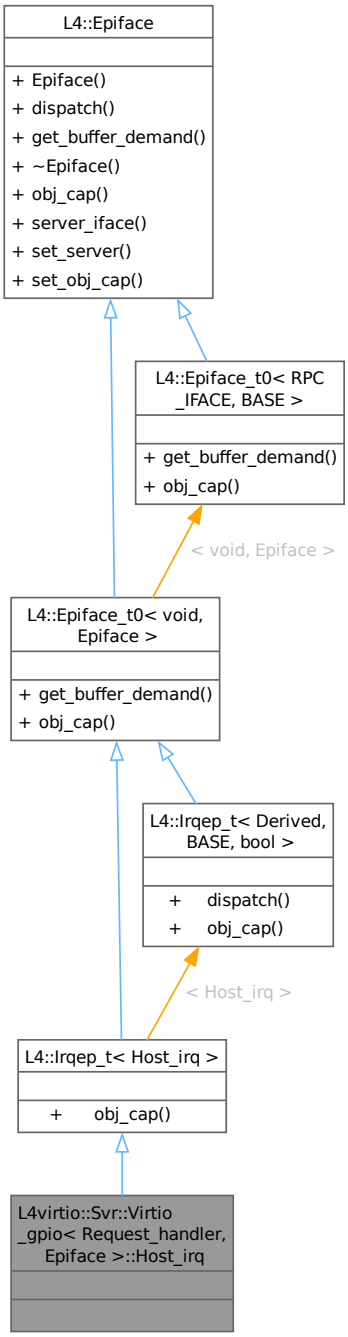
15.428 L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Host_irq Struct Reference

Handler for the host irq.
`#include <virtio-gpio-device>`

Inheritance diagram for L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Host_irq:



Collaboration diagram for L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Host_irq:



Additional Inherited Members

Public Types inherited from L4::Epiface_t0< void, Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions inherited from L4::Irqep_t< Host_irq >

- Cap< L4::Irq > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface_t0< void, Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< void > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

15.428.1 Detailed Description

template<typename Request_handler, typename Epiface = L4virtio::Device>
struct L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Host_irq

Handler for the host irq.
An `L4::Irqep_t` to handle irqs send to the server.
Definition at line 198 of file virtio-gpio-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-gpio-device

15.429 L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Irq_handler Struct Reference

Handler for an gpio pin irq.
`#include <virtio-gpio-device>`

Collaboration diagram for L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Irq_handler:



15.429.1 Detailed Description

template<typename Request_handler, typename Epiface = L4virtio::Device>
struct L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Irq_handler

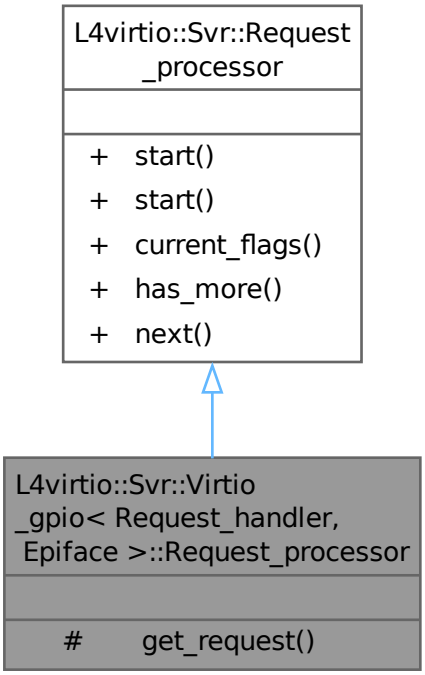
Handler for an gpio pin irq.
This notifies the virtio client that an gpio pin irq happened or the operation was canceled.
This needs to be called by any server implementation of the Virtio_gpio class, after an irq was enabled with the enable method of the Gpio_request_handler.
Definition at line 166 of file virtio-gpio-device.
The documentation for this struct was generated from the following file:

- l4/l4virtio/server/virtio-gpio-device

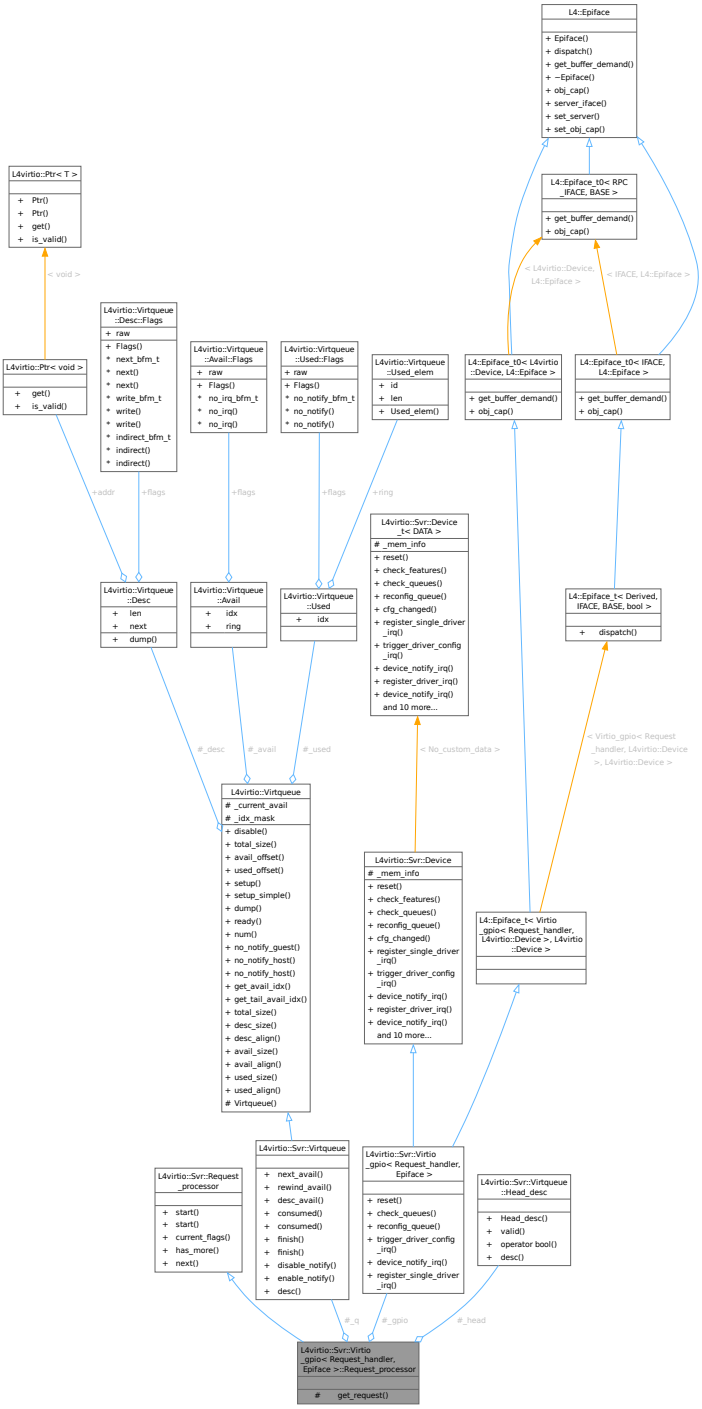
15.430 L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Request_processor Struct Reference

Generic handler for the Virtio requests.
`#include <virtio-gpio-device>`

Inheritance diagram for L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Request_processor:



Collaboration diagram for L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Request_processor:



Protected Member Functions

- template<typename T>
  T get_request ()

  The driver prepares the GPIO request in two data parts: 1st: in_hdr 2rd: out_hdr.

Additional Inherited Members

Public Member Functions inherited from L4virtio::Svr::Request_processor

- template<typename DESC_MAN, typename ... ARGS>
  void start (DESC_MAN *dm, Virtqueue *ring, Virtqueue::Head_desc const &request, ARGS... args)

  Start processing a new request.
- template<typename DESC_MAN, typename ... ARGS>
  Virtqueue::Request const & start (DESC_MAN *dm, Virtqueue::Request const &request, ARGS... args)

  Start processing a new request.
- Virtqueue::Desc::Flags current_flags () const

  Get the flags of the currently processed descriptor.
- bool has_more () const

  Are there more chained descriptors?
- template<typename DESC_MAN, typename ... ARGS>
  bool next (DESC_MAN *dm, ARGS... args)

  Switch to the next descriptor in a descriptor chain.

15.430.1 Detailed Description

template<typename Request_handler, typename Epiface = L4virtio::Device>
struct L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Request_processor

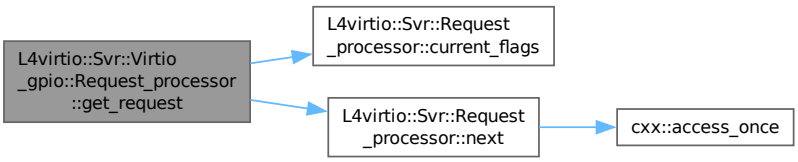
Generic handler for the Virtio requests.
Definition at line 213 of file virtio-gpio-device.

15.430.2 Member Function Documentation

15.430.2.1 get_request()

```
template<typename Request_handler, typename Epiface = L4virtio::Device>
template<typename T>
T L4virtio::Svr::Virtio_gpio< Request_handler, Epiface >::Request_processor::get_request ()
[inline], [protected]
```

The driver prepares the GPIO request in two data parts: 1st: in_hdr 2rd: out_hdr.
This parses the two Data_buffers and create the Gpio_* structure.
Definition at line 241 of file virtio-gpio-device.
References L4virtio::Svr::Request_processor::current_flags(), and L4virtio::Svr::Request_processor::next().
Here is the call graph for this function:



The documentation for this struct was generated from the following file:

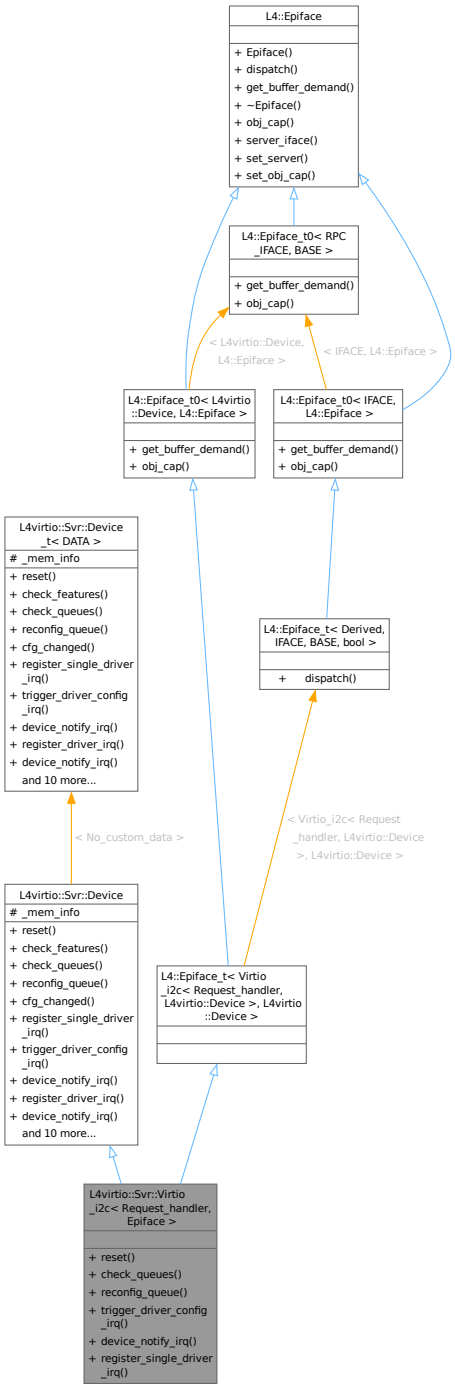
- l4/l4virtio/server/virtio-gpio-device

15.431 L4virtio::Svr::Virtio_i2c< Request_handler, Epiface > Class Template Reference

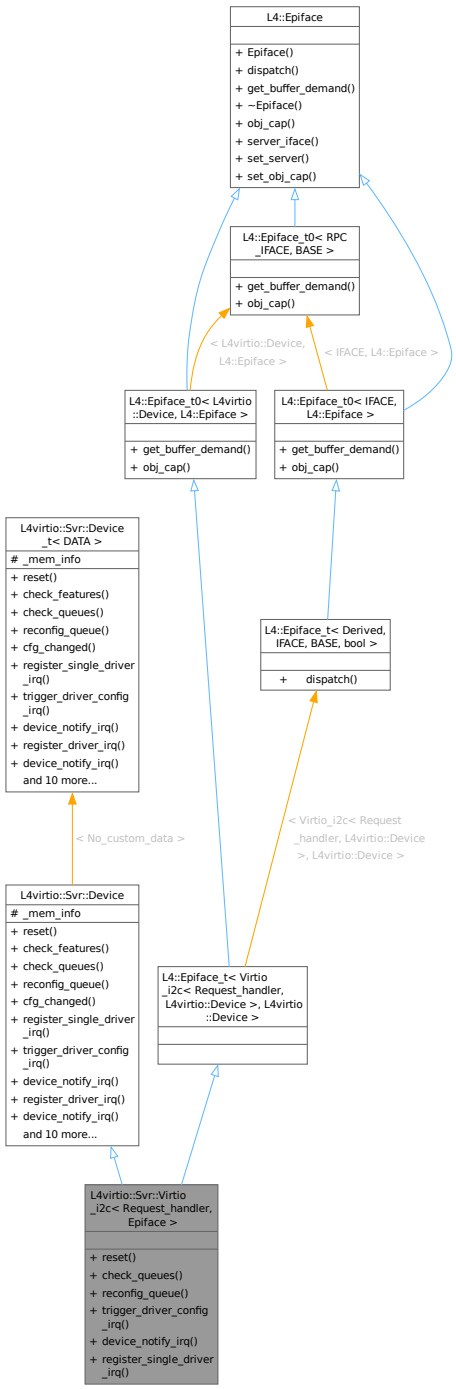
A server implementation of the virtio-i2c protocol.

`#include <virtio-i2c-device>`

Inheritance diagram for L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >:



Collaboration diagram for L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >:



Data Structures

- class Host_irq

  Handler for the host irq.
- class Request_processor

  Handler for the Virtio requests.

Public Member Functions

- void **reset** () override

  reset callback, called for doing a device reset
- bool **check_queues** () override

  callback for checking if the queues at DRIVER_OK transition
- int **reconfig_queue** (unsigned idx) override

  callback for client queue-config request
- void **trigger_driver_config_irq** () override

  callback for triggering configuration change notification IRQ
- L4::Cap< L4::Irq > **device_notify_irq** () const override

  callback to gather the device notification IRQ (old-style)
- void **register_single_driver_irq** () override

  callback for registering a single guest IRQ for all queues (old-style)

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual bool **check_features** ()

  callback for checking the subset of accepted features
- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Public Member Functions inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< L4virtio::Device > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.431.1 Detailed Description

template<typename Request_handler, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >

A server implementation of the virtio-i2c protocol.

Template Parameters

Request_handler	The type that is used to handle incomming requests. Needs to have `T handle_read(l4_uint8_t *, unsigned)` and `T handle_write(l4_uint8_t const *, unsigned)` functions, with T assignable to `std::optional<bool>`.
Epiface	The Epiface to derive from. Defaults to `L4virtio::Device`.

Definition at line 89 of file virtio-i2c-device.
The documentation for this class was generated from the following file:

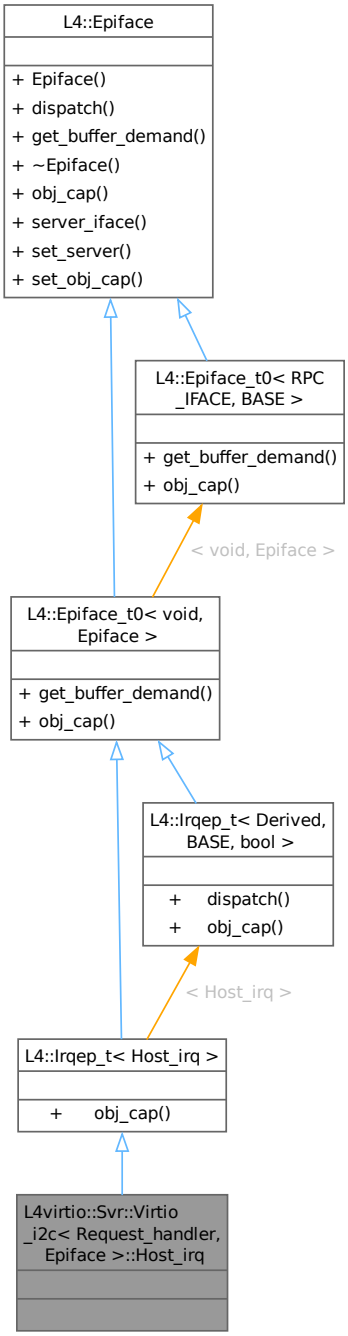
- l4/l4virtio/server/virtio-i2c-device

15.432 L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Host_irq Class Reference

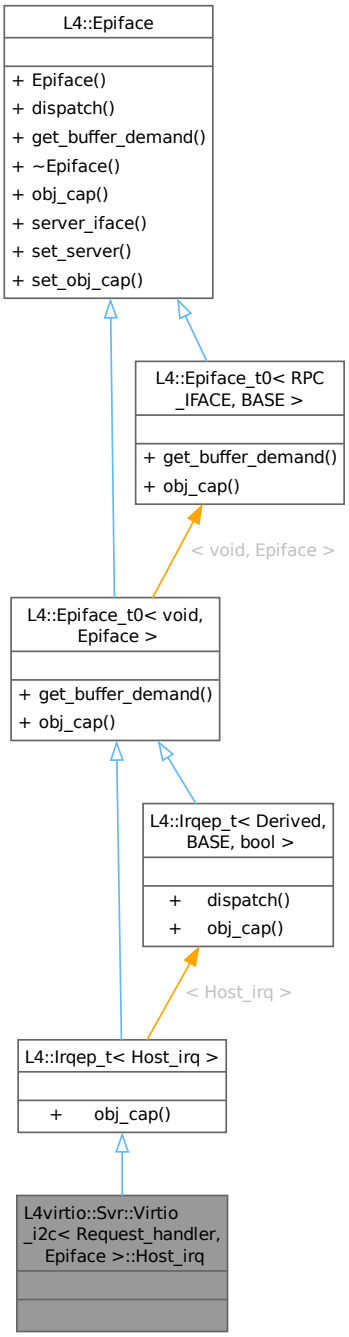
Handler for the host irq.

`#include <virtio-i2c-device>`

Inheritance diagram for L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Host_irq:



Collaboration diagram for L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Host_irq:



Additional Inherited Members

Public Types inherited from L4::Epiface_t0< void, Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions inherited from L4::Irqep_t< Host_irq >

- Cap< L4::Irq > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface_t0< void, Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< void > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

15.432.1 Detailed Description

template<typename Request_handler, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Host_irq

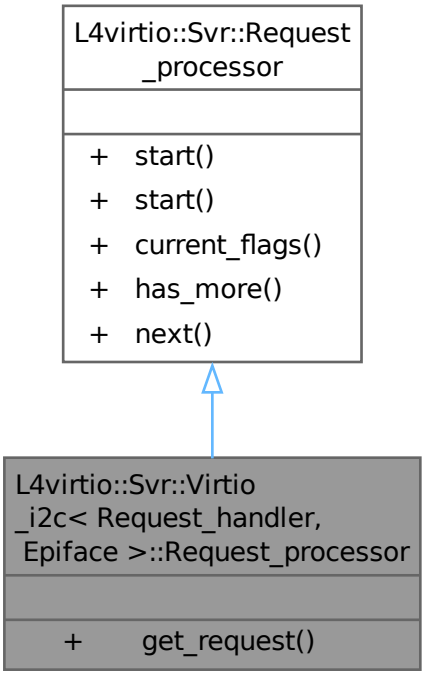
Handler for the host irq.
An `L4::Irqep_t` to handle irqs send to the server.
Definition at line 109 of file virtio-i2c-device.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-i2c-device

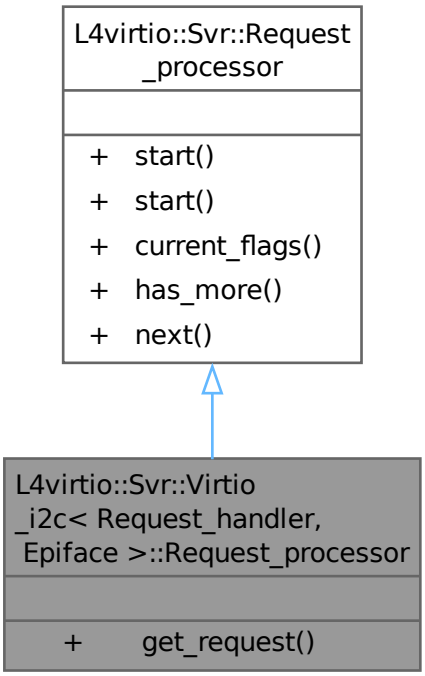
15.433 L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Request_processor Class Reference

Handler for the Virtio requests.
`#include <virtio-i2c-device>`

Inheritance diagram for L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Request_processor:



Collaboration diagram for L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Request_processor:



Public Member Functions

- l2c_req get_request ()
  Linux prepares the I2C request in three data parts: 1st: out_hdr 2nd: buffer (optional) 3rd: in_hdr.

Public Member Functions inherited from L4virtio::Svr::Request_processor

- template<typename DESC_MAN, typename ... ARGS>
  void start (DESC_MAN *dm, Virtqueue *ring, Virtqueue::Head_desc const &request, ARGS... args)
  Start processing a new request.
- template<typename DESC_MAN, typename ... ARGS>
  Virtqueue::Request const & start (DESC_MAN *dm, Virtqueue::Request const &request, ARGS... args)
  Start processing a new request.
- Virtqueue::Desc::Flags current_flags () const
  Get the flags of the currently processed descriptor.
- bool has_more () const
  Are there more chained descriptors?
- template<typename DESC_MAN, typename ... ARGS>
  bool next (DESC_MAN *dm, ARGS... args)
  Switch to the next descriptor in a descriptor chain.

15.433.1 Detailed Description

template<typename Request_handler, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Request_processor

Handler for the Virtio requests.

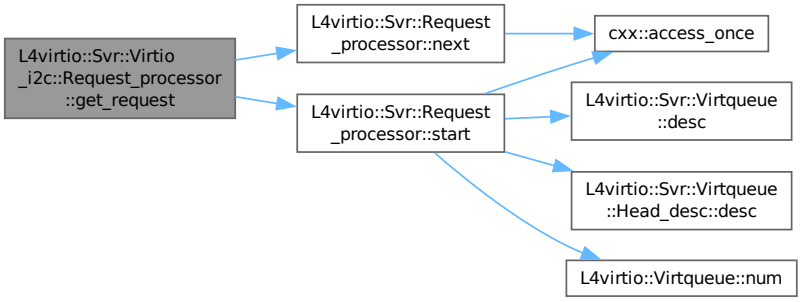
Definition at line 126 of file virtio-i2c-device.

15.433.2 Member Function Documentation

15.433.2.1 get_request()

```
template<typename Request_handler, typename Epiface = L4virtio::Device>
I2c_req L4virtio::Svr::Virtio_i2c< Request_handler, Epiface >::Request_processor::get_request
() [inline]
```

Linux prepares the I2C request in three data parts: 1st: out_hdr 2nd: buffer (optional) 3rd: in_hdr.
This parses the three Data_buffers and recreate the virtio_i2c_req structure.
Definition at line 162 of file virtio-i2c-device.
References L4_UNLIKELY, L4virtio::Svr::Data_buffer::left, L4virtio::Svr::Request_processor::next(), L4virtio::Svr::Data_buffer::pos, and L4virtio::Svr::Request_processor::start().
Here is the call graph for this function:



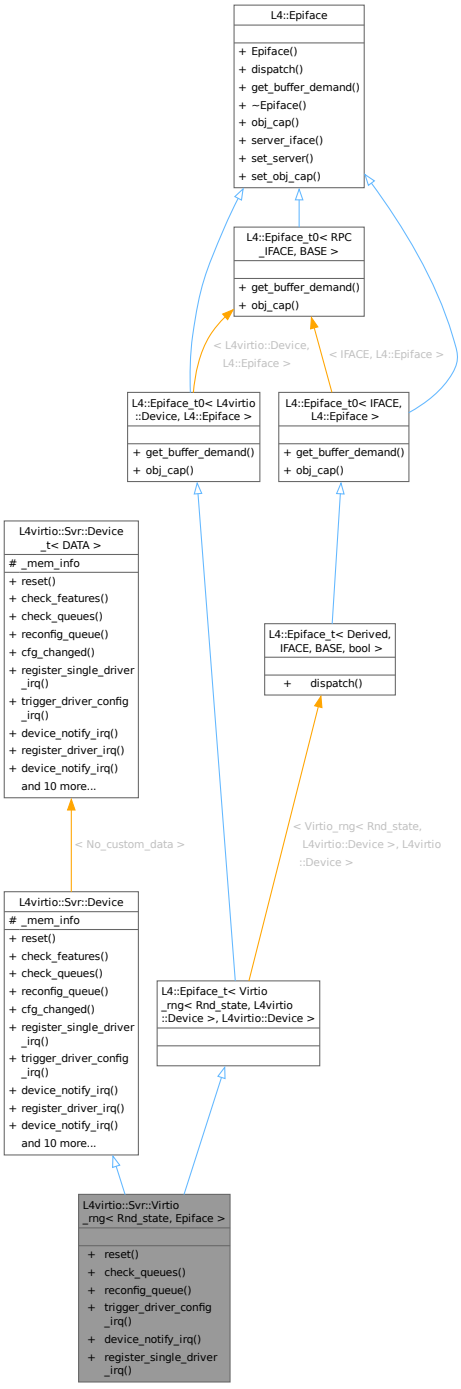
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-i2c-device

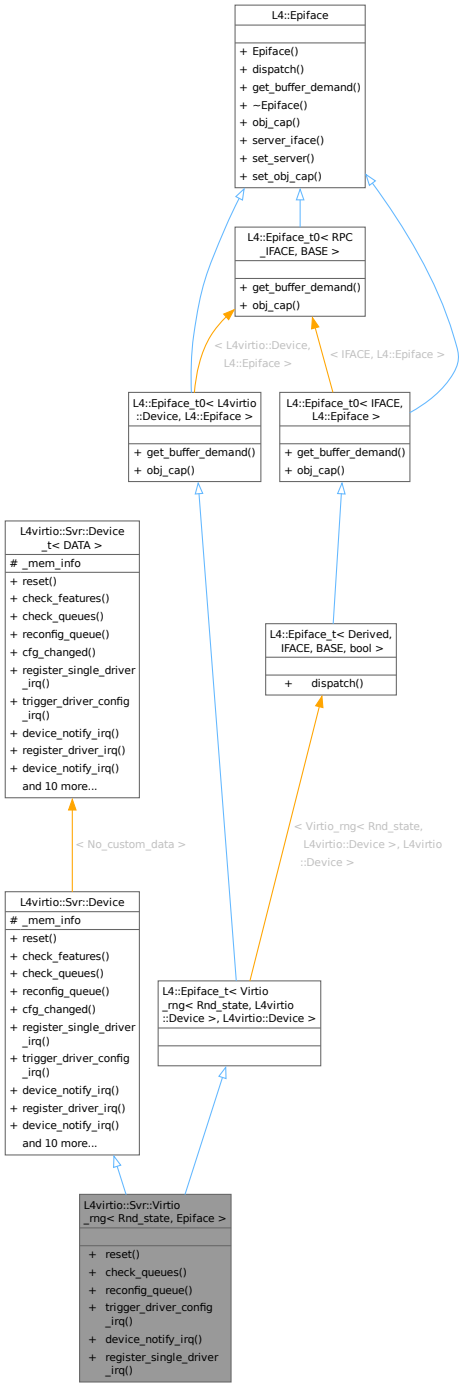
15.434 L4virtio::Svr::Virtio_rng< Rnd_state, Epiface > Class Template Reference

A server implementation of the virtio-rng protocol.
`#include <virtio-rng-device>`

Inheritance diagram for L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >:



Collaboration diagram for L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >:



Data Structures

- class Host_irq

  Handler for the host irq.
- class Request_processor

  Handler for the Virtio requests.

Public Member Functions

- void **reset** () override

  reset callback, called for doing a device reset
- bool **check_queues** () override

  callback for checking if the queues at DRIVER_OK transition
- int **reconfig_queue** (unsigned idx) override

  callback for client queue-config request
- void **trigger_driver_config_irq** () override

  callback for triggering configuration change notification IRQ
- L4::Cap< L4::Irq > **device_notify_irq** () const override

  callback to gather the device notification IRQ (old-style)
- void **register_single_driver_irq** () override

  callback for registering a single guest IRQ for all queues (old-style)

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual bool **check_features** ()

  callback for checking the subset of accepted features
- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Public Member Functions inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< L4virtio::Device > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.434.1 Detailed Description

template<typename Rnd_state, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >

A server implementation of the virtio-rng protocol.

Template Parameters

Rnd_state	The type that implements the random data generation. `Rnd_state::get_random(int len, unsigned char *buf)` is called to get len random bytes written into buf TODO: virtio-rng supports providing less random bytes then requested. This API currently does not support that, as I do not have a test case.
Epiface	The Epiface to derive from. Defaults to `L4virtio::Device`.

Definition at line 33 of file virtio-rng-device.
The documentation for this class was generated from the following file:

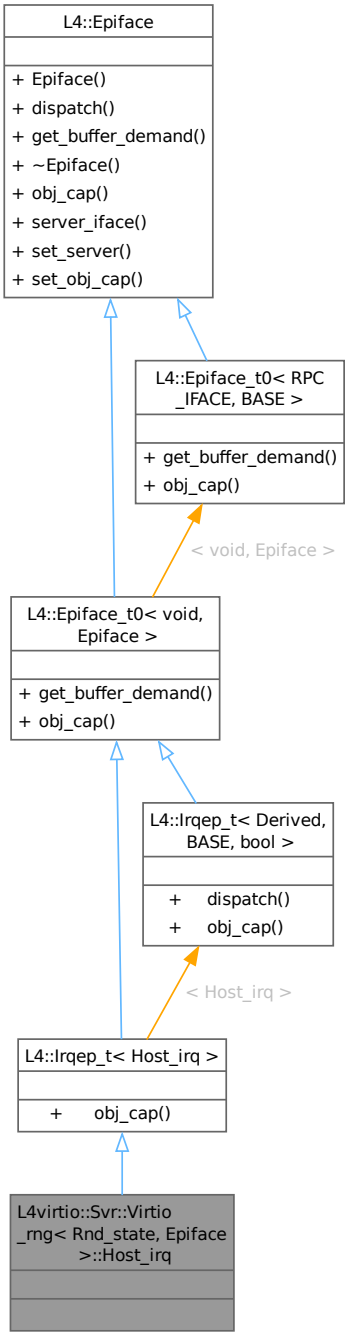
- l4/l4virtio/server/virtio-rng-device

15.435 L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Host_irq Class Reference

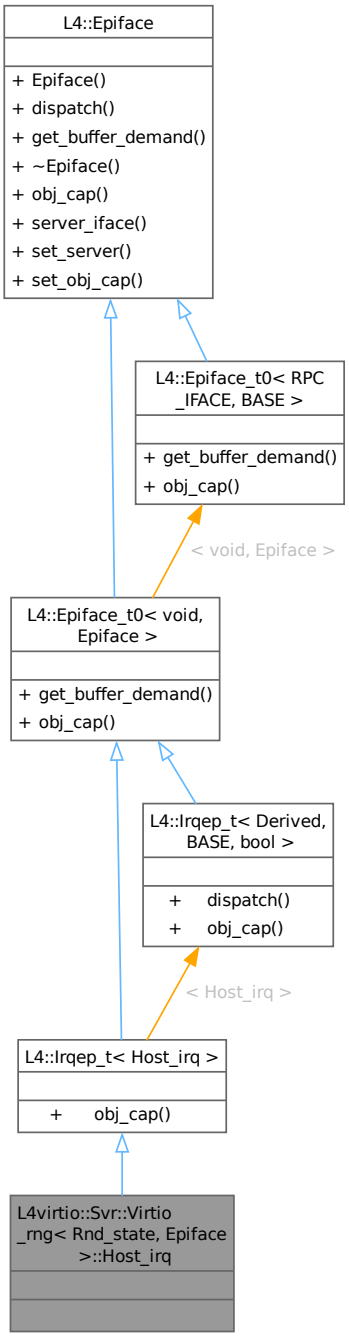
Handler for the host irq.

`#include <virtio-rng-device>`

Inheritance diagram for L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Host_irq:



Collaboration diagram for L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Host_irq:



Additional Inherited Members

Public Types inherited from L4::Epiface_t0< void, Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions inherited from L4::Irqep_t< Host_irq >

- Cap< L4::Irq > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface_t0< void, Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< void > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

15.435.1 Detailed Description

template<typename Rnd_state, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Host_irq

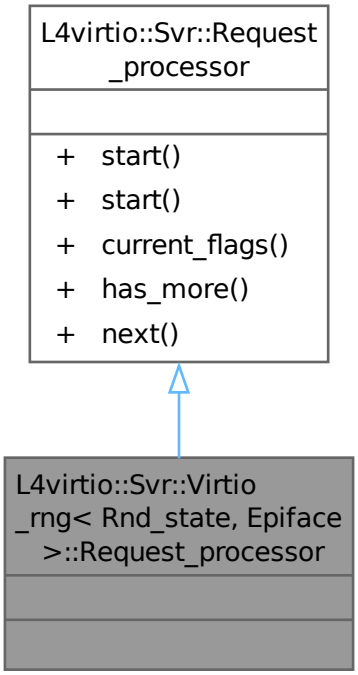
Handler for the host irq.
An `L4::Irqep_t` to handle irqs send to the server.
Definition at line 51 of file virtio-rng-device.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-rng-device

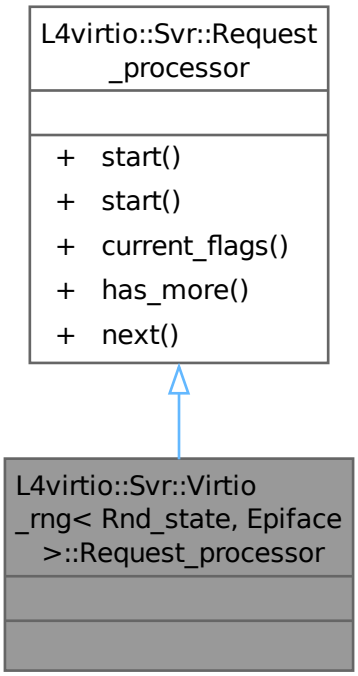
15.436 L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Request_processor Class Reference

Handler for the Virtio requests.
`#include <virtio-rng-device>`

Inheritance diagram for L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Request_processor:



Collaboration diagram for L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Request_processor:



Additional Inherited Members

Public Member Functions inherited from L4virtio::Svr::Request_processor

- template<typename DESC_MAN, typename ... ARGS>
  void start (DESC_MAN *dm, Virtqueue *ring, Virtqueue::Head_desc const &request, ARGS... args)
  Start processing a new request.
- template<typename DESC_MAN, typename ... ARGS>
  Virtqueue::Request const & start (DESC_MAN *dm, Virtqueue::Request const &request, ARGS... args)
  Start processing a new request.
- Virtqueue::Desc::Flags current_flags () const
  Get the flags of the currently processed descriptor.
- bool has_more () const
  Are there more chained descriptors?
- template<typename DESC_MAN, typename ... ARGS>
  bool next (DESC_MAN *dm, ARGS... args)
  Switch to the next descriptor in a descriptor chain.

15.436.1 Detailed Description

template<typename Rnd_state, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_rng< Rnd_state, Epiface >::Request_processor

Handler for the Virtio requests.
Definition at line 68 of file virtio-rng-device.
The documentation for this class was generated from the following file:

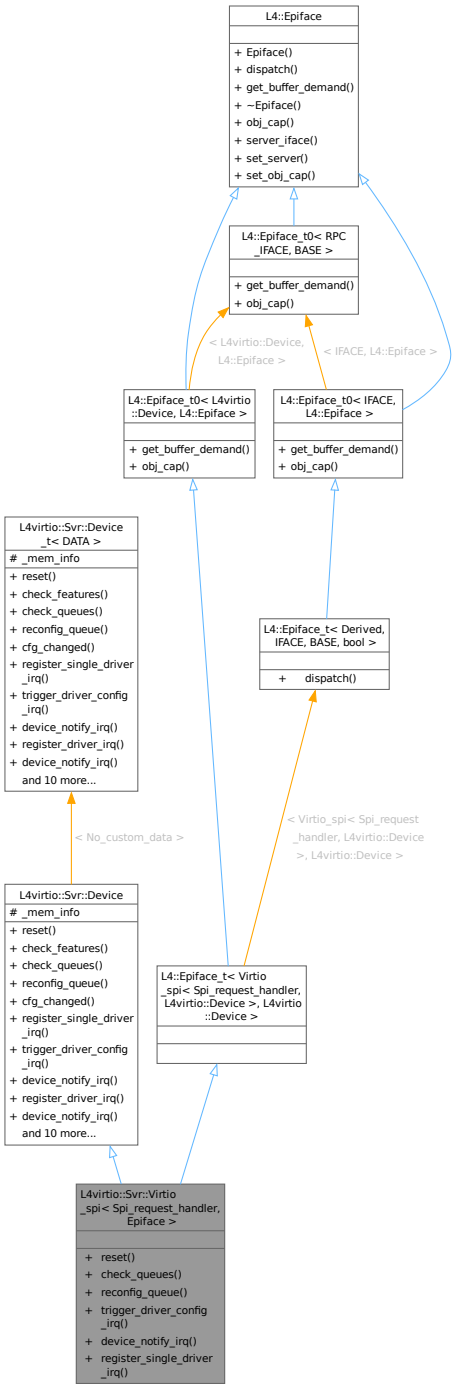
- l4/l4virtio/server/virtio-rng-device

15.437 L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface > Class Template Reference

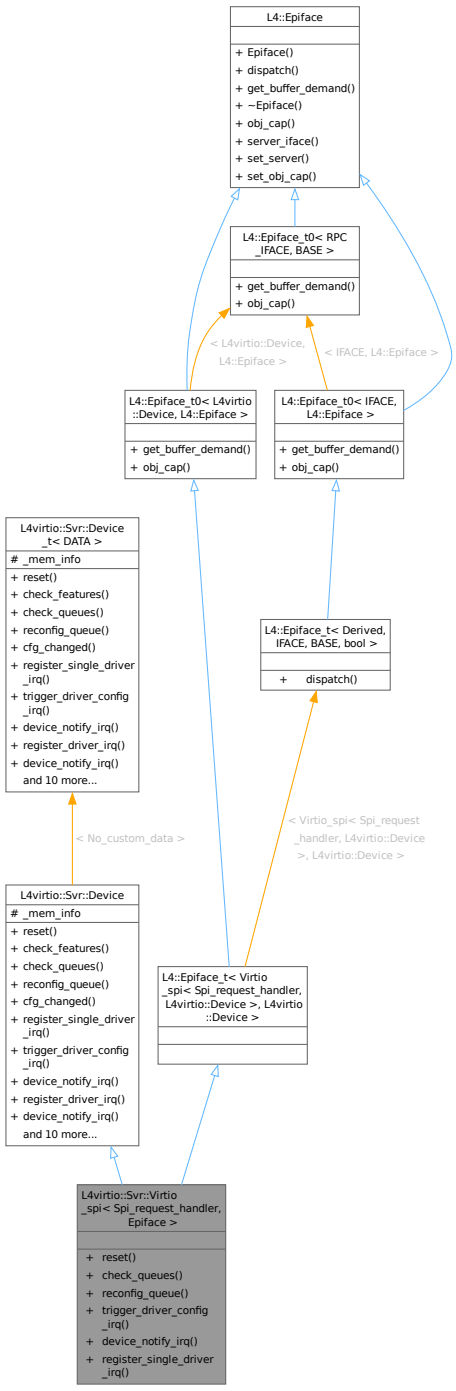
A server implementation of the virtio-spi protocol.

`#include <virtio-spi-device>`

Inheritance diagram for L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >:



Collaboration diagram for L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >:



Data Structures

- class Host_irq

  Handler for the host IRQ.

- class Request_processor

  Handler for the Virtio requests.

Public Member Functions

- void **reset** () override

  reset callback, called for doing a device reset
- bool **check_queues** () override

  callback for checking if the queues at DRIVER_OK transition
- int **reconfig_queue** (unsigned idx) override

  callback for client queue-config request
- void **trigger_driver_config_irq** () override

  callback for triggering configuration change notification IRQ
- L4::Cap< L4::Irq > **device_notify_irq** () const override

  callback to gather the device notification IRQ (old-style)
- void **register_single_driver_irq** () override

  callback for registering a single guest IRQ for all queues (old-style)

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual bool **check_features** ()

  callback for checking the subset of accepted features
- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Public Member Functions inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< L4virtio::Device > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.437.1 Detailed Description

template<typename Spi_request_handler, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >

A server implementation of the virtio-spi protocol.

Template Parameters

Spi_request_handler	The type that is used to handle incomming requests. Needs to have: • `handle_transfer(Spi_transfer_head const &, l4_uint8_t const *, l4_uint8_t *, unsigned)` function.
Epiface	The Epiface to derive from. Defaults to `L4virtio::Device`.

Definition at line 101 of file virtio-spi-device.
The documentation for this class was generated from the following file:

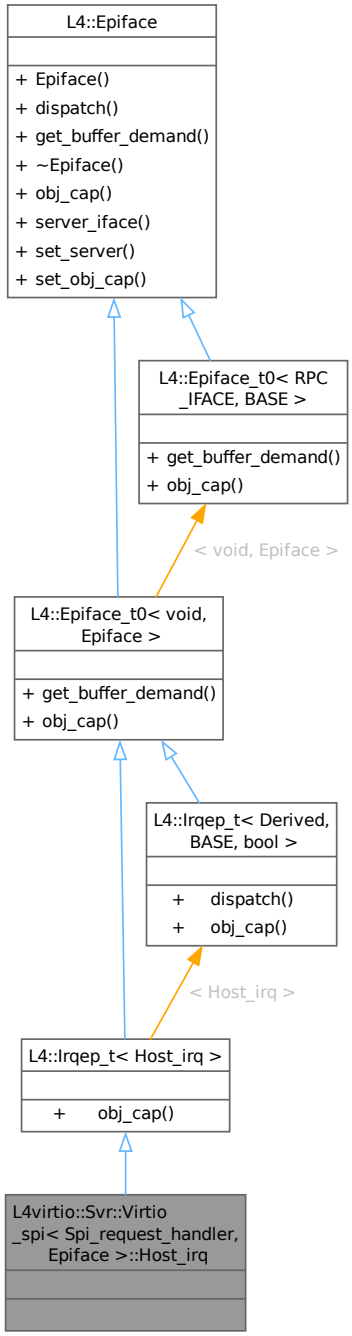
- l4/l4virtio/server/virtio-spi-device

15.438 L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Host_irq Class Reference

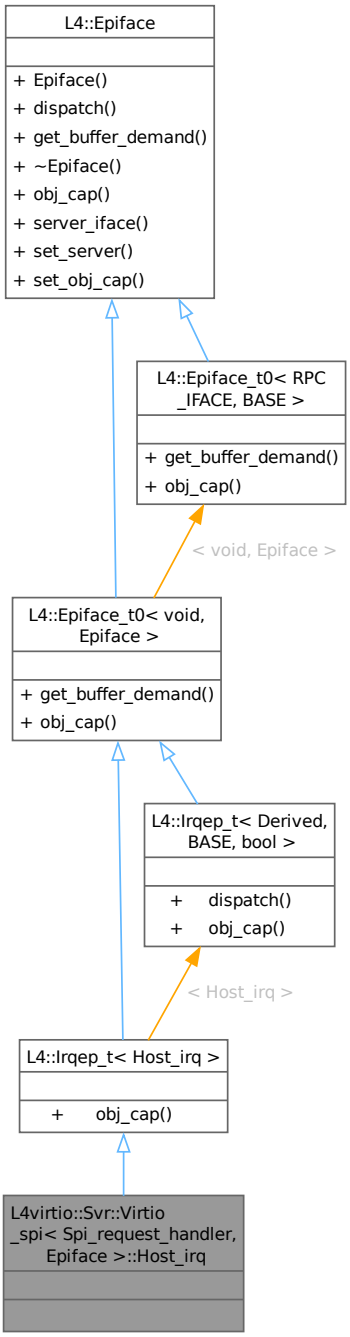
Handler for the host IRQ.

`#include <virtio-spi-device>`

Inheritance diagram for L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Host_irq:



Collaboration diagram for L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Host_irq:



Additional Inherited Members

Public Types inherited from L4::Epiface_t0< void, Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Public Member Functions inherited from L4::Irqep_t< Host_irq >

- Cap< L4::Irq > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface_t0< void, Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< void > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

15.438.1 Detailed Description

template<typename Spi_request_handler, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Host_irq

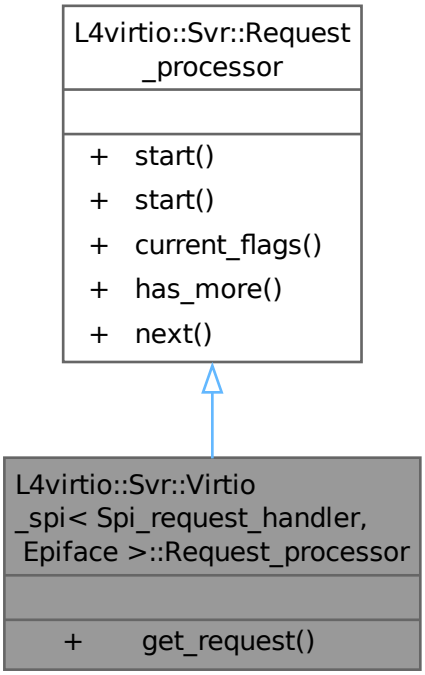
Handler for the host IRQ.
An `L4::Irqep_t` to handle irqs send to the server.
Definition at line 118 of file virtio-spi-device.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-spi-device

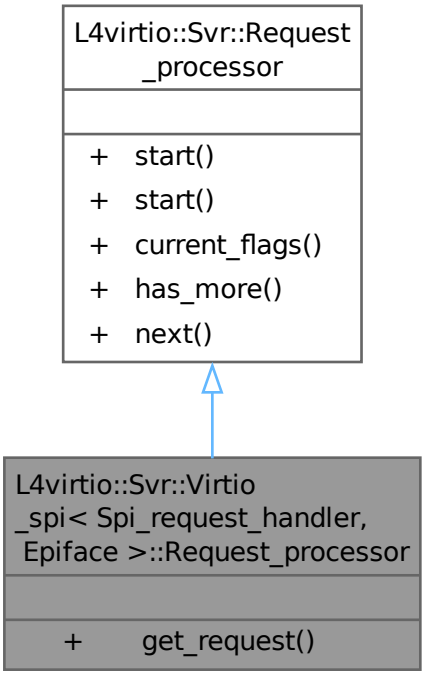
15.439 L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Request_processor Class Reference

Handler for the Virtio requests.
`#include <virtio-spi-device>`

Inheritance diagram for L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Request_processor:



Collaboration diagram for L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Request_processor:



Public Member Functions

- Spi_transfer_req get_request ()

  Linux prepares the SPI request in three or four data parts: 1st: transfer_head 2nd: TX buffer (not present for RX half-duplex transfers) 3rd: RX buffer (not present for TX half-duplex transfers) 4th: transfer result.

Public Member Functions inherited from L4virtio::Svr::Request_processor

- template<typename DESC_MAN, typename ... ARGS>
  void start (DESC_MAN *dm, Virtqueue *ring, Virtqueue::Head_desc const &request, ARGS... args)

  Start processing a new request.
- template<typename DESC_MAN, typename ... ARGS>
  Virtqueue::Request const & start (DESC_MAN *dm, Virtqueue::Request const &request, ARGS... args)

  Start processing a new request.
- Virtqueue::Desc::Flags current_flags () const

  Get the flags of the currently processed descriptor.
- bool has_more () const

  Are there more chained descriptors?
- template<typename DESC_MAN, typename ... ARGS>
  bool next (DESC_MAN *dm, ARGS... args)

  Switch to the next descriptor in a descriptor chain.

15.439.1 Detailed Description

template<typename Spi_request_handler, typename Epiface = L4virtio::Device>
class L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Request_processor

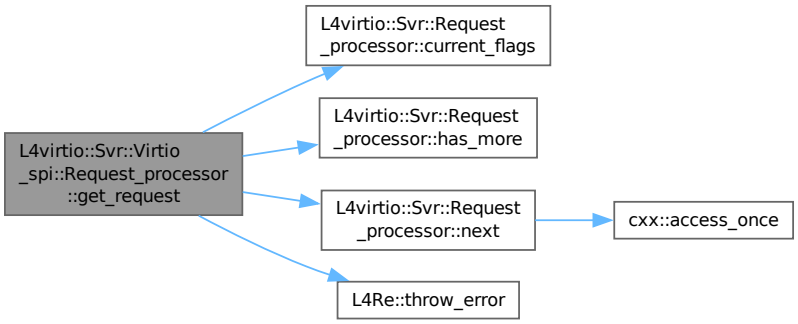
Handler for the Virtio requests.
Definition at line 135 of file virtio-spi-device.

15.439.2 Member Function Documentation

15.439.2.1 get_request()

```
template<typename Spi_request_handler, typename Epiface = L4virtio::Device>
Spi_transfer_req L4virtio::Svr::Virtio_spi< Spi_request_handler, Epiface >::Request_processor↩
::get_request () [inline]
```

Linux prepares the SPI request in three or four data parts: 1st: transfer_head 2nd: TX buffer (not present for RX half-duplex transfers) 3rd: RX buffer (not present for TX half-duplex transfers) 4th: transfer result.
This parses the three/four Data_buffers and recreates the virtio_spi_transfer_req structure.
Definition at line 185 of file virtio-spi-device.
References L4virtio::Svr::Request_processor::current_flags(), L4virtio::Svr::Request_processor::has_more(), L4_EIO, L4virtio::Svr::Request_processor::next(), and L4Re::throw_error().
Here is the call graph for this function:



The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio-spi-device

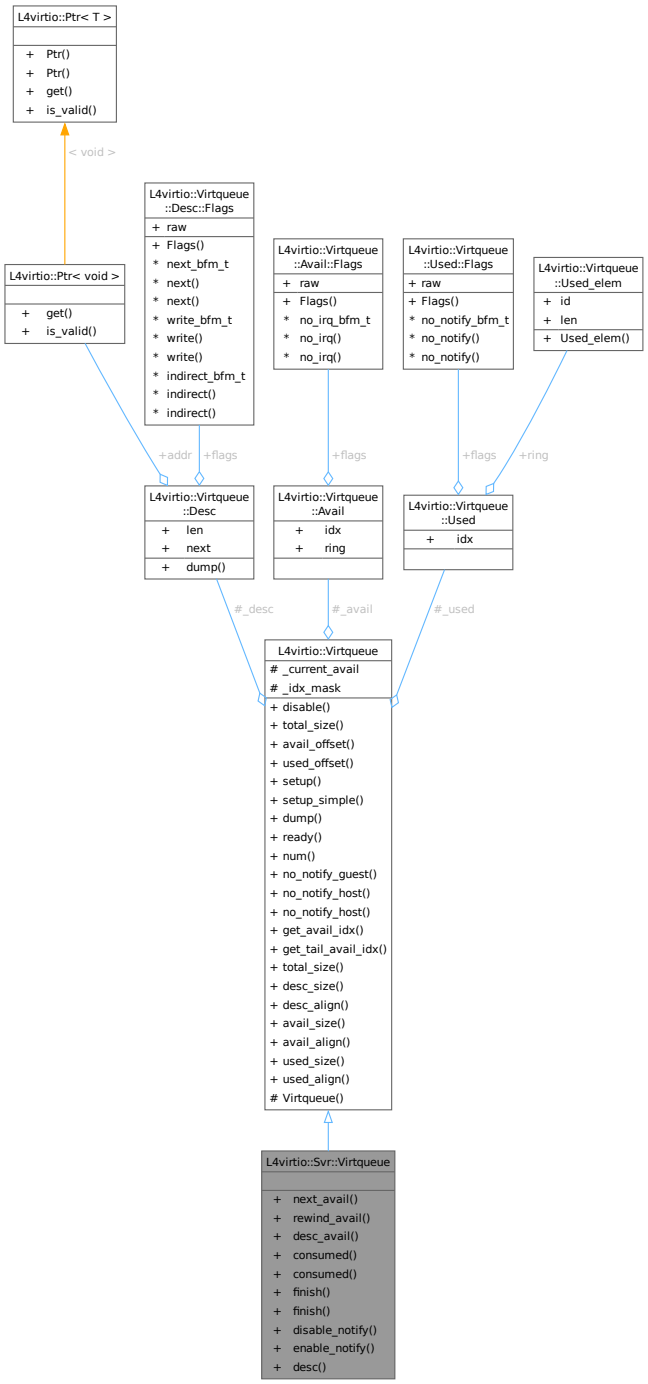
15.440 L4virtio::Svr::Virtqueue Class Reference

Virtqueue implementation for the device.
`#include <virtio>`

Inheritance diagram for L4virtio::Svr::Virtqueue:



Collaboration diagram for L4virtio::Svr::Virtqueue:



Data Structures

- class Head_desc

  VIRTIO request, essentially a descriptor from the available ring.

Public Member Functions

- Request next_avail ()

Get the next available descriptor from the available ring.

- void rewind_avail (Head_desc const &d)

  Return unfinished descriptors to the available ring, i.e.
- bool desc_avail () const

  Test for available descriptors.
- void consumed (Head_desc const &r, l4_uint32_t len=0)

  Put the given descriptor into the used ring.
- template<typename ITER>
  void consumed (ITER const &begin, ITER const &end)

  Put multiple descriptors into the used ring.
- template<typename QUEUE_OBSERVER>
  void finish (Head_desc &d, QUEUE_OBSERVER *o, l4_uint32_t len=0)

  Add a descriptor to the used ring, and notify an observer.
- template<typename ITER, typename QUEUE_OBSERVER>
  void finish (ITER const &begin, ITER const &end, QUEUE_OBSERVER *o)

  Add a range of descriptors to the used ring, and notify an observer once.
- void disable_notify ()

  Set the 'no notify' flag for this queue.
- void enable_notify ()

  Clear the 'no notify' flag for this queue.
- Desc const * desc (unsigned idx) const

  Get a descriptor from the descriptor list.

Public Member Functions inherited from L4virtio::Virtqueue

- void disable ()

  Completely disable the queue.
- unsigned long total_size () const

  Calculate the total size of this virtqueue.
- unsigned long **avail_offset** () const

  Get the offset of the available ring from the descriptor table.
- unsigned long **used_offset** () const

  Get the offset of the used ring from the descriptor table.
- void setup (unsigned num, void *desc, void *avail, void *used, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Enable this queue.
- void setup_simple (unsigned num, void *ring, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Enable this queue.
- void dump (Desc const *d, L4Re::Util::Dbg dbg=L4Re::Util::Dbg{}) const

  Dump a descriptor for this queue.
- bool ready () const

  Test if this queue is in working state.
- unsigned num () const
- bool no_notify_guest () const

  Get the no IRQ flag of this queue.
- bool no_notify_host () const

  Get the no notify flag of this queue.
- void no_notify_host (bool value)

  Set the no-notify flag for this queue.
- l4_uint16_t get_avail_idx () const

  Get available index from available ring (for debugging).
- l4_uint16_t get_tail_avail_idx () const

  Get tail-available index stored in local state (for debugging).

Additional Inherited Members

Public Types inherited from L4virtio::Virtqueue

- enum

  Fixed alignment values for different parts of a virtqueue.

Static Public Member Functions inherited from L4virtio::Virtqueue

- static unsigned long total_size (unsigned num)

  Calculate the total size for a virtqueue of the given dimensions.
- static unsigned long desc_size (unsigned num)

  Calculate the size of the descriptor table for `num` entries.
- static unsigned long desc_align ()

  Get the alignment in zero LSBs needed for the descriptor table.
- static unsigned long avail_size (unsigned num)

  Calculate the size of the available ring for `num` entries.
- static unsigned long avail_align ()

  Get the alignment in zero LSBs needed for the available ring.
- static unsigned long used_size (unsigned num)

  Calculate the size of the used ring for `num` entries.
- static unsigned long used_align ()

  Get the alignment in zero LSBs needed for the used ring.

Protected Member Functions inherited from L4virtio::Virtqueue

- **Virtqueue** ()=default

  Create a disabled virtqueue.

Protected Attributes inherited from L4virtio::Virtqueue

- Desc * **_desc** = nullptr

  pointer to descriptor table, NULL if queue is off.
- Avail * **_avail** = nullptr

  pointer to available ring.
- Used * **_used** = nullptr

  pointer to used ring.
- l4_uint16_t **_current_avail** = 0

  The life counter for the queue.
- l4_uint16_t **_idx_mask** = 0

  mask used for indexing into the descriptor table and the rings.

15.440.1 Detailed Description

Virtqueue implementation for the device.
This class represents a single virtqueue, with a local running available index.

Note

The Virtqueue implementation is not thread-safe.

Definition at line 87 of file virtio.

15.440.2 Member Function Documentation

15.440.2.1 consumed() [1/2]

```
void L4virtio::Svr::Virtqueue::consumed (
            Head_desc const & r,
            l4_uint32_t len = 0)  [inline]
```

Put the given descriptor into the used ring.

Parameters

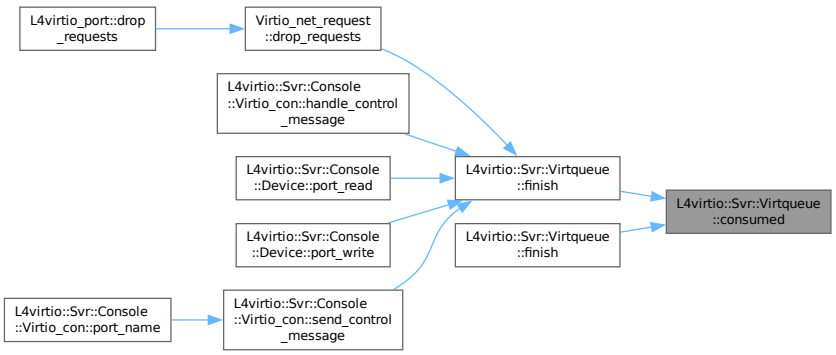
r	Request that shall be marked as finished.
len	The total number of bytes written.

Precondition

queue must be in working state.

`r` must be a valid request from this queue.

Definition at line 190 of file virtio.
References L4virtio::Virtqueue::_desc, L4virtio::Virtqueue::_idx_mask, and L4virtio::Virtqueue::_used.
Referenced by finish(), and finish().
Here is the caller graph for this function:



15.440.2.2 consumed() [2/2]

```
template<typename ITER>
void L4virtio::Svr::Virtqueue::consumed (
            ITER const & begin,
            ITER const & end)  [inline]
```

Put multiple descriptors into the used ring.
A range of descriptors, specified by `begin` and `end` iterators is added. Each iterator points to a struct that has a `first` member that is a `Head_desc` and a `second` member that is the corresponding number of bytes written.

Template Parameters

ITER	The type of the iterator (inferred).

Parameters

begin	Iterator pointing to first new descriptor.
end	Iterator pointing to one past last entry.

Precondition

queue must be in working state.

Definition at line 213 of file virtio.
References L4virtio::Virtqueue::_desc, L4virtio::Virtqueue::_idx_mask, and L4virtio::Virtqueue::_used.

15.440.2.3 desc()

```
Desc const * L4virtio::Svr::Virtqueue::desc (
            unsigned idx) const  [inline]
```

Get a descriptor from the descriptor list.

Parameters

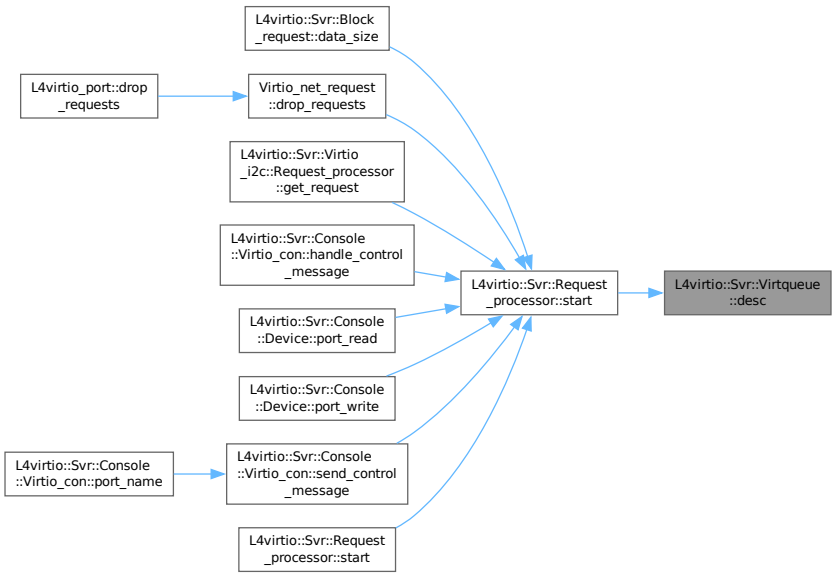
idx	The index of the descriptor.

Precondition

`idx` < `num`

queue must be in working state

Definition at line 298 of file virtio.
References L4virtio::Virtqueue::_desc.
Referenced by L4virtio::Svr::Request_processor::start().
Here is the caller graph for this function:



15.440.2.4 desc_avail()

```
bool L4virtio::Svr::Virtqueue::desc_avail () const  [inline]
```

Test for available descriptors.

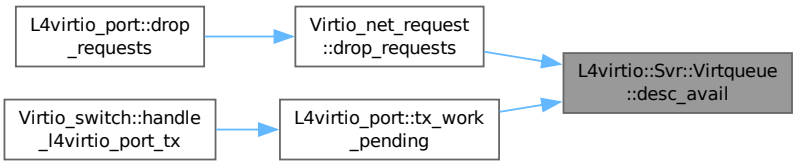
Returns

true if there are descriptors available, false if not.

Precondition

The queue must be in working state.

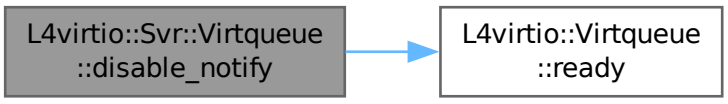
Definition at line 175 of file virtio.
References L4virtio::Virtqueue::_avail, and L4virtio::Virtqueue::_current_avail.
Referenced by Virtio_net_request::drop_requests(), and L4virtio_port::tx_work_pending().
Here is the caller graph for this function:



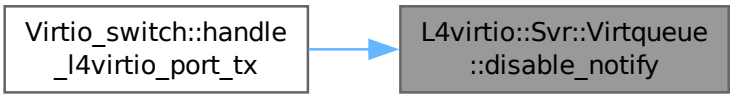
15.440.2.5 disable_notify()

```
void L4virtio::Svr::Virtqueue::disable_notify ()  [inline]
```

Set the 'no notify' flag for this queue.
This function may be called on a disabled queue.
Definition at line 273 of file virtio.
References L4virtio::Virtqueue::_used, L4_LIKELY, and L4virtio::Virtqueue::ready().
Referenced by Virtio_switch::handle_l4virtio_port_tx().
Here is the call graph for this function:



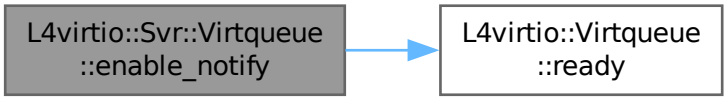
Here is the caller graph for this function:



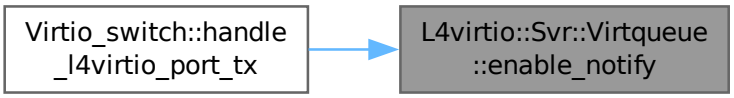
15.440.2.6 enable_notify()

```
void L4virtio::Svr::Virtqueue::enable_notify ()  [inline]
```

Clear the 'no notify' flag for this queue.
This function may be called on a disabled queue.
Definition at line 284 of file virtio.
References L4virtio::Virtqueue::_used, L4_LIKELY, and L4virtio::Virtqueue::ready().
Referenced by Virtio_switch::handle_l4virtio_port_tx().
Here is the call graph for this function:



Here is the caller graph for this function:



15.440.2.7 finish() [1/2]

```
template<typename QUEUE_OBSERVER>
void L4virtio::Svr::Virtqueue::finish (
            Head_desc & d,
            QUEUE_OBSERVER * o,
            l4_uint32_t len = 0)  [inline]
```

Add a descriptor to the used ring, and notify an observer.

Template Parameters

QUEUE_OBSERVER	The type of the observer (inferred).

Parameters

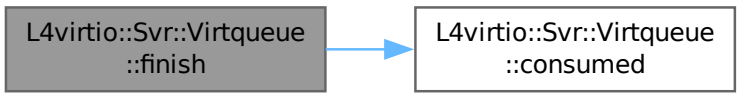
d	descriptor of the request that is to be marked as finished.
o	Pointer to the observer that is notified.
len	Number of bytes written for this request.

Precondition

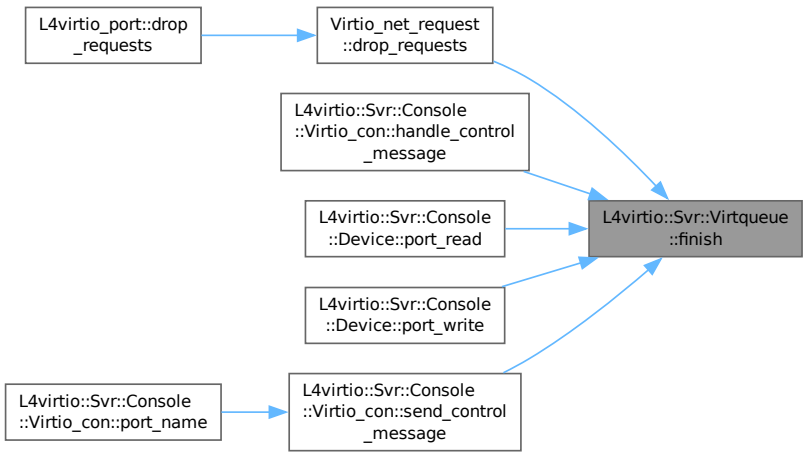
queue must be in working state.

`d` must be a valid request from this queue.

Definition at line 240 of file virtio.
References consumed().
Referenced by Virtio_net_request::drop_requests(), L4virtio::Svr::Console::Virtio_con::handle_control_message(), L4virtio::Svr::Console::Device::port_read(), L4virtio::Svr::Console::Device::port_write(), and L4virtio::Svr::Console::Virtio_con::send_c
Here is the call graph for this function:



Here is the caller graph for this function:



15.440.2.8 finish() [2/2]

```
template<typename ITER, typename QUEUE_OBSERVER>
void L4virtio::Svr::Virtqueue::finish (
             ITER const & begin,
             ITER const & end,
             QUEUE_OBSERVER * o)  [inline]
```

Add a range of descriptors to the used ring, and notify an observer once.
The iterators are passed to consumed<ITER>(ITER const &, ITER const &), and the requirements detailed there apply.

Template Parameters

ITER	type of the iterator (inferred)
QUEUE_OBSERVER	the type of the observer (inferred).

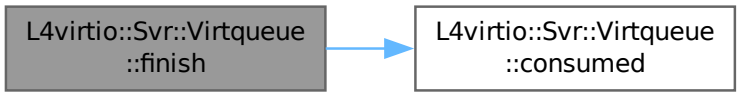
Parameters

begin	iterator pointing to first element.
end	iterator pointing to one past last element.
o	pointer to the observer that is notified.

Precondition

queue must be in working state.

Definition at line 262 of file virtio.
References consumed().
Here is the call graph for this function:



15.440.2.9 next_avail()

```
Request L4virtio::Svr::Virtqueue::next_avail ()  [inline]
```

Get the next available descriptor from the available ring.

Precondition

The queue must be in working state.

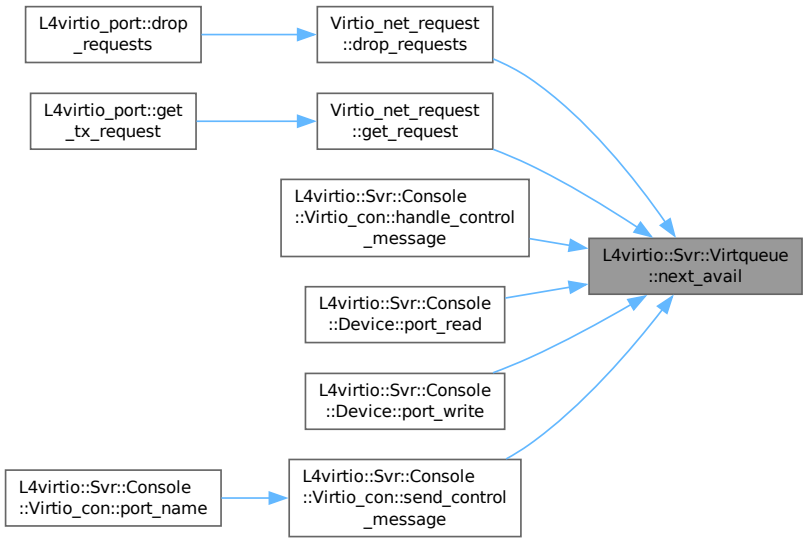
Returns

A Request for the next available descriptor, the Request is invalid if there are no descriptors in the available ring.

Note

The return value must be checked even when a previous desc_avail() returned true.

Definition at line 136 of file virtio.
References L4virtio::Virtqueue::_avail, L4virtio::Virtqueue::_current_avail, L4virtio::Virtqueue::_idx_mask, and L4_LIKELY.
Referenced by Virtio_net_request::drop_requests(), Virtio_net_request::get_request(), L4virtio::Svr::Console::Virtio_con::handle_cont
L4virtio::Svr::Console::Device::port_read(), L4virtio::Svr::Console::Device::port_write(), and L4virtio::Svr::Console::Virtio_con::send_c
Here is the caller graph for this function:



15.440.2.10 rewind_avail()

```
void L4virtio::Svr::Virtqueue::rewind_avail (
            Head_desc const & d)  [inline]
```

Return unfinished descriptors to the available ring, i.e.
reset the local next index of the available ring to the given descriptor.

Parameters

d	descriptor of the request that is to be marked as finished.

Precondition

queue must be in working state.

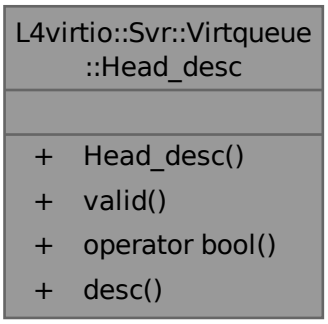
`d` must be a valid request from this queue, obtained via next_avail(), that has not yet been finished, and in addition, no descriptors following it have been finished.

Definition at line 160 of file virtio.
References L4virtio::Virtqueue::_current_avail, L4virtio::Virtqueue::_desc, and L4virtio::Virtqueue::_idx_mask.
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio

15.441 L4virtio::Svr::Virtqueue::Head_desc Class Reference

VIRTIO request, essentially a descriptor from the available ring.
`#include <virtio>`
Collaboration diagram for L4virtio::Svr::Virtqueue::Head_desc:



Public Member Functions

- **Head_desc** ()
  Make invalid (NULL) request.
- bool valid () const
- operator bool () const
- Desc const * desc () const

15.441.1 Detailed Description

VIRTIO request, essentially a descriptor from the available ring.
Definition at line 93 of file virtio.

15.441.2 Member Function Documentation

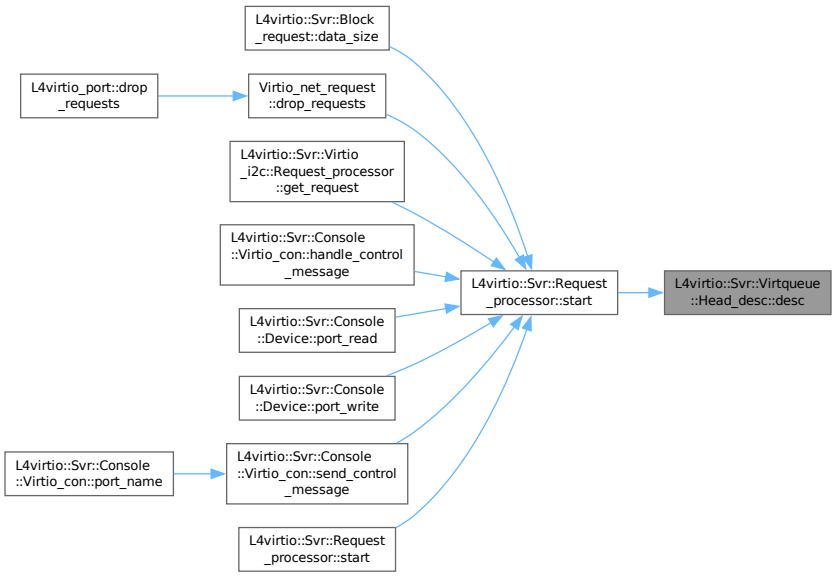
15.441.2.1 desc()

```
Desc const * L4virtio::Svr::Virtqueue::Head_desc::desc () const  [inline]
```

Returns

Pointer to the head descriptor of the request.

Definition at line 112 of file virtio.
Referenced by L4virtio::Svr::Request_processor::start().
Here is the caller graph for this function:



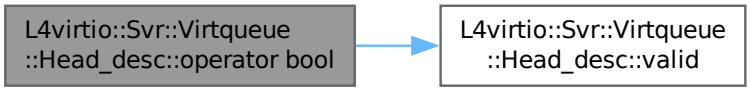
15.441.2.2 operator bool()

```
L4virtio::Svr::Virtqueue::Head_desc::operator bool () const  [inline], [explicit]
```

Returns

True if the request is valid (not NULL).

Definition at line 108 of file virtio.
References valid().
Here is the call graph for this function:



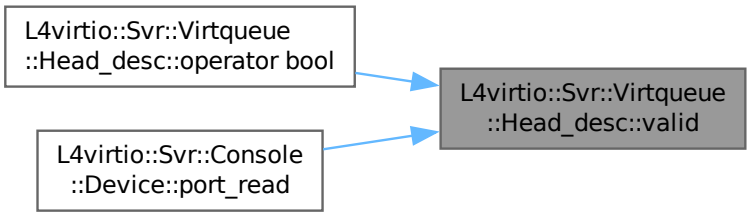
15.441.2.3 valid()

```
bool L4virtio::Svr::Virtqueue::Head_desc::valid () const  [inline]
```

Returns

True if the request is valid (not NULL).

Definition at line 105 of file virtio.
Referenced by operator bool(), and L4virtio::Svr::Console::Device::port_read().
Here is the caller graph for this function:



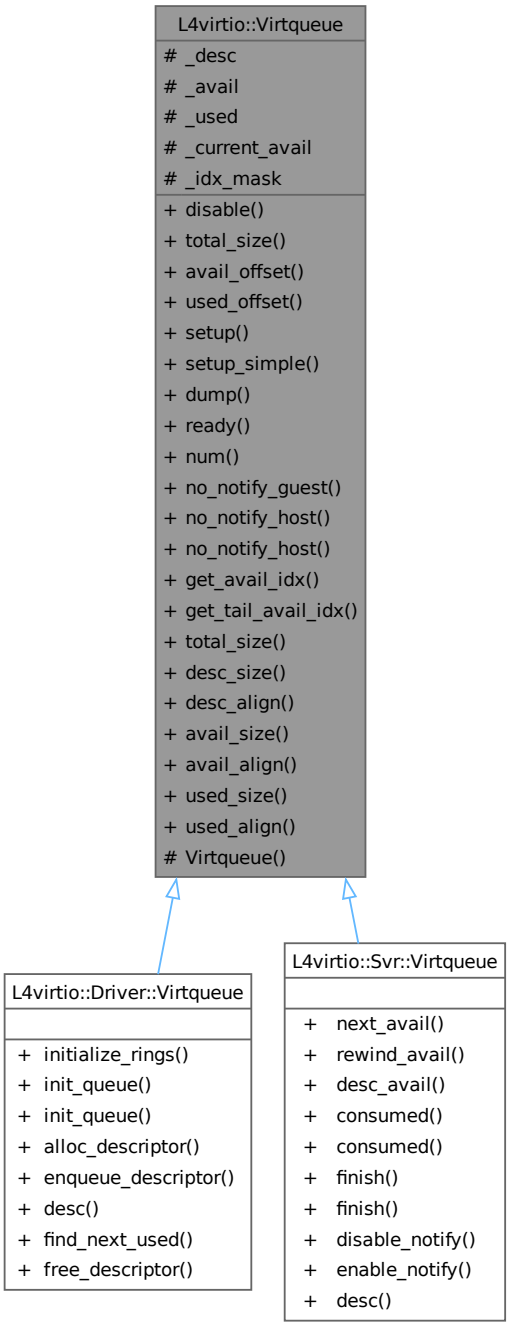
The documentation for this class was generated from the following file:

- l4/l4virtio/server/virtio

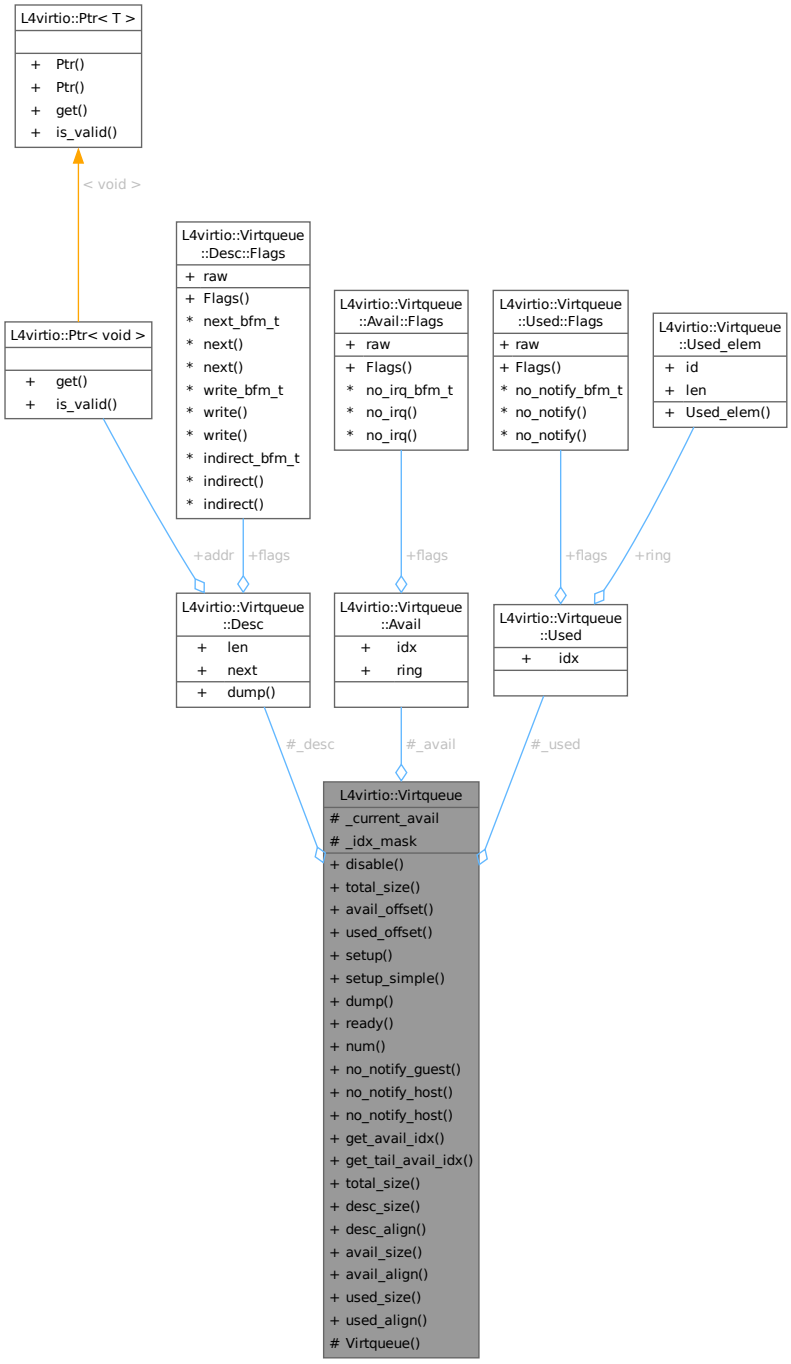
15.442 L4virtio::Virtqueue Class Reference

Low-level Virtqueue.
`#include <virtqueue>`

Inheritance diagram for L4virtio::Virtqueue:



Collaboration diagram for L4virtio::Virtqueue:



Data Structures

- class Desc

  Descriptor in the descriptor table.
- class Avail

  Type of available ring, this is read-only for the host.
- struct Used_elem

  Type of an element of the used ring.

- class Used

  Used ring.

Public Types

- enum

  Fixed alignment values for different parts of a virtqueue.

Public Member Functions

- void disable ()

  Completely disable the queue.
- unsigned long total_size () const

  Calculate the total size of this virtqueue.
- unsigned long **avail_offset** () const

  Get the offset of the available ring from the descriptor table.
- unsigned long **used_offset** () const

  Get the offset of the used ring from the descriptor table.
- void setup (unsigned num, void ∗desc, void ∗avail, void ∗used, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Enable this queue.
- void setup_simple (unsigned num, void ∗ring, L4Re::Util::Dbg msg_dev=L4Re::Util::Dbg{2})

  Enable this queue.
- void dump (Desc const ∗d, L4Re::Util::Dbg dbg=L4Re::Util::Dbg{}) const

  Dump a descriptor for this queue.
- bool ready () const

  Test if this queue is in working state.
- unsigned num () const
- bool no_notify_guest () const

  Get the no IRQ flag of this queue.
- bool no_notify_host () const

  Get the no notify flag of this queue.
- void no_notify_host (bool value)

  Set the no-notify flag for this queue.
- l4_uint16_t get_avail_idx () const

  Get available index from available ring (for debugging).
- l4_uint16_t get_tail_avail_idx () const

  Get tail-available index stored in local state (for debugging).

Static Public Member Functions

- static unsigned long total_size (unsigned num)

  Calculate the total size for a virtqueue of the given dimensions.
- static unsigned long desc_size (unsigned num)

  Calculate the size of the descriptor table for `num` *entries.*
- static unsigned long desc_align ()

  Get the alignment in zero LSBs needed for the descriptor table.
- static unsigned long avail_size (unsigned num)

  Calculate the size of the available ring for `num` *entries.*
- static unsigned long avail_align ()

  Get the alignment in zero LSBs needed for the available ring.
- static unsigned long used_size (unsigned num)

  Calculate the size of the used ring for `num` *entries.*
- static unsigned long used_align ()

  Get the alignment in zero LSBs needed for the used ring.

Protected Member Functions

- **Virtqueue** ()=default

  Create a disabled virtqueue.

Protected Attributes

- Desc * **_desc** = nullptr

  pointer to descriptor table, NULL if queue is off.
- Avail * **_avail** = nullptr

  pointer to available ring.
- Used * **_used** = nullptr

  pointer to used ring.
- l4_uint16_t **_current_avail** = 0

  The life counter for the queue.
- l4_uint16_t **_idx_mask** = 0

  mask used for indexing into the descriptor table and the rings.

15.442.1 Detailed Description

Low-level Virtqueue.
This class represents a single virtqueue, with a local running available index.

Note

The Virtqueue implementation is not thread-safe.

Definition at line 86 of file virtqueue.

15.442.2 Member Function Documentation

15.442.2.1 avail_align()

```
unsigned long L4virtio::Virtqueue::avail_align ()  [inline], [static]
```

Get the alignment in zero LSBs needed for the available ring.

Returns

The alignment in zero LSBs needed for an available ring.

Definition at line 295 of file virtqueue.

15.442.2.2 avail_size()

```
unsigned long L4virtio::Virtqueue::avail_size (
            unsigned num)  [inline], [static]
```

Calculate the size of the available ring for `num` entries.

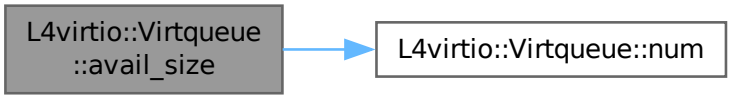
Parameters

num	The number of entries in the available ring.

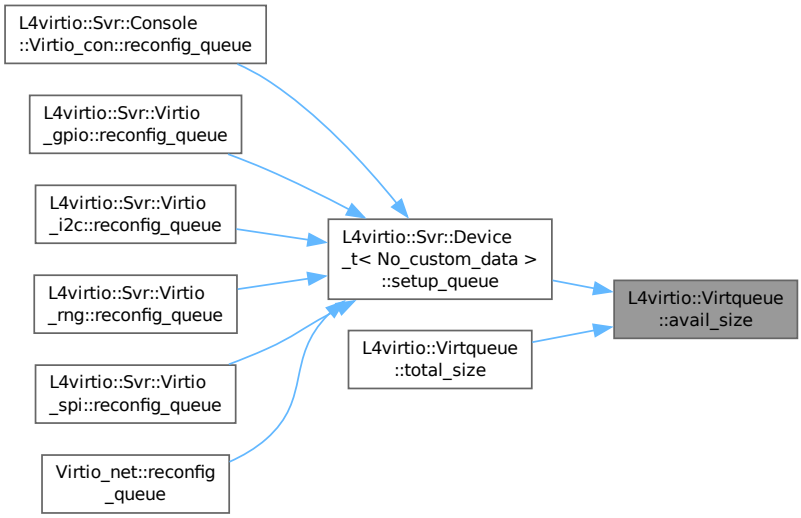
Returns

The size in bytes needed for an available ring with `num` entries.

Definition at line 287 of file virtqueue.
References num().
Referenced by L4virtio::Svr::Device_t< No_custom_data >::setup_queue(), and total_size().
Here is the call graph for this function:



Here is the caller graph for this function:



15.442.2.3 desc_align()

```
unsigned long L4virtio::Virtqueue::desc_align ()  [inline], [static]
```

Get the alignment in zero LSBs needed for the descriptor table.

Returns

The alignment in zero LSBs needed for a descriptor table.

Definition at line 277 of file virtqueue.

15.442.2.4 desc_size()

```
unsigned long L4virtio::Virtqueue::desc_size (
            unsigned num)  [inline], [static]
```

Calculate the size of the descriptor table for num entries.

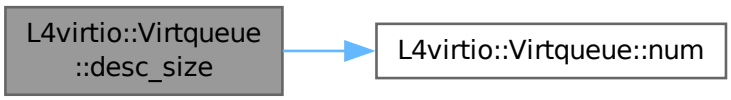
Parameters

num	The number of entries in the descriptor table.

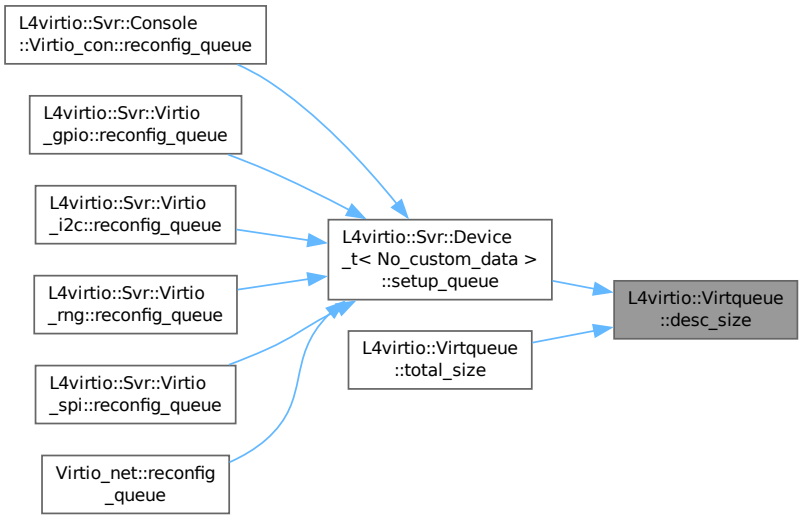
Returns

The size in bytes needed for a descriptor table with num entries.

Definition at line 269 of file virtqueue.
References num().
Referenced by L4virtio::Svr::Device_t< No_custom_data >::setup_queue(), and total_size().
Here is the call graph for this function:



Here is the caller graph for this function:

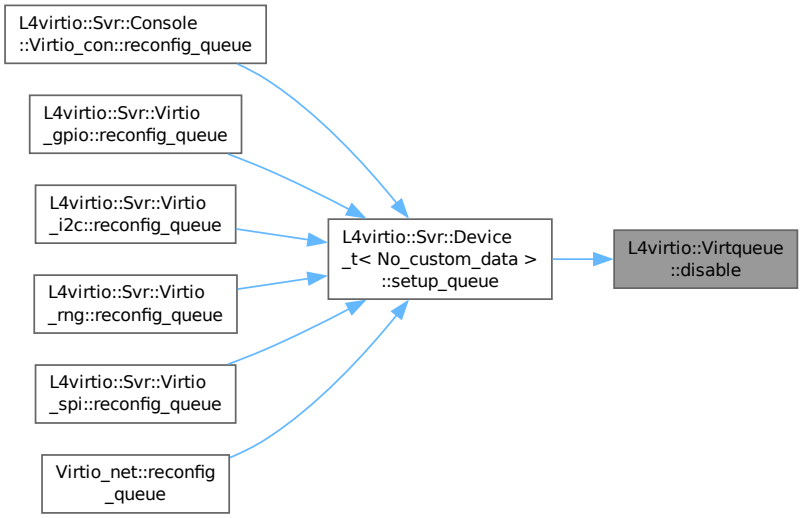


15.442.2.5 disable()

```
void L4virtio::Virtqueue::disable () [inline]
```

Completely disable the queue.
setup() must be used to enable the queue again.
Definition at line 232 of file virtqueue.
References _desc.

Referenced by L4virtio::Svr::Device_t< No_custom_data >::setup_queue().
Here is the caller graph for this function:



15.442.2.6 dump()

```
void L4virtio::Virtqueue::dump (
            Desc const * d,
            L4Re::Util::Dbg dbg = L4Re::Util::Dbg{}) const  [inline]
```

Dump a descriptor for this queue.

Parameters

d	Descriptor pointer.
dbg	Debug channel for printing the information.

Precondition

the queue must be in working state.

Definition at line 411 of file virtqueue.

15.442.2.7 get_avail_idx()

```
l4_uint16_t L4virtio::Virtqueue::get_avail_idx () const  [inline]
```

Get available index from available ring (for debugging).

Precondition

Queue must be in a working state.

Returns

current index in the available ring (shared between device model and device driver).

Definition at line 470 of file virtqueue.
References _avail.

15.442.2.8 get_tail_avail_idx()

```
l4_uint16_t L4virtio::Virtqueue::get_tail_avail_idx () const  [inline]
```

Get tail-available index stored in local state (for debugging).

Returns

current tail index for the the available ring.

Definition at line 477 of file virtqueue.
References _current_avail.

15.442.2.9 no_notify_guest()

```
bool L4virtio::Virtqueue::no_notify_guest () const  [inline]
```

Get the no IRQ flag of this queue.

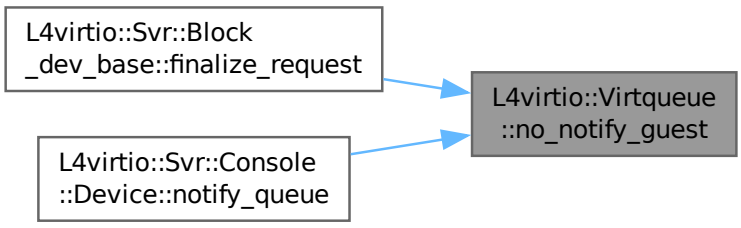
Precondition

queue must be in working state.

Returns

true if the guest does not want to get IRQs (currently).

Definition at line 433 of file virtqueue.
References _avail.
Referenced by L4virtio::Svr::Block_dev_base< Ds_data >::finalize_request(), and L4virtio::Svr::Console::Device::notify_queue().
Here is the caller graph for this function:



15.442.2.10 no_notify_host() [1/2]

```
bool L4virtio::Virtqueue::no_notify_host () const  [inline]
```

Get the no notify flag of this queue.

Precondition

queue must be in working state.

Returns

true if the host does not want to get IRQs (currently).

Definition at line 446 of file virtqueue.
References _used.

15.442.2.11 no_notify_host() [2/2]

```
void L4virtio::Virtqueue::no_notify_host (
            bool value)  [inline]
```

Set the no-notify flag for this queue.

Precondition

Queue must be in a working state.

Definition at line 457 of file virtqueue.
References _used.

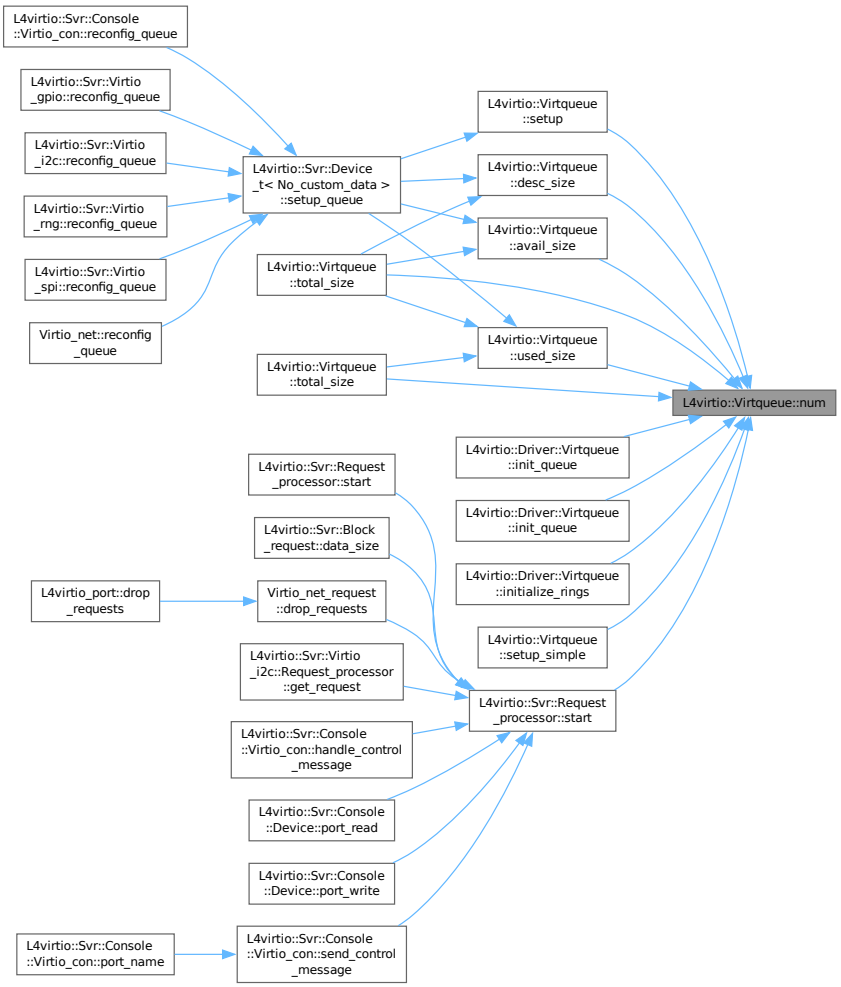
15.442.2.12 num()

```
unsigned L4virtio::Virtqueue::num () const  [inline]
```

Returns

The number of entries in the ring.

Definition at line 423 of file virtqueue.
References _idx_mask.
Referenced by avail_size(), desc_size(), L4virtio::Driver::Virtqueue::init_queue(), L4virtio::Driver::Virtqueue::init_queue(), L4virtio::Driver::Virtqueue::initialize_rings(), setup(), setup_simple(), L4virtio::Svr::Request_processor::start(), total_size(), total_size(), and used_size().
Here is the caller graph for this function:



15.442.2.13 ready()

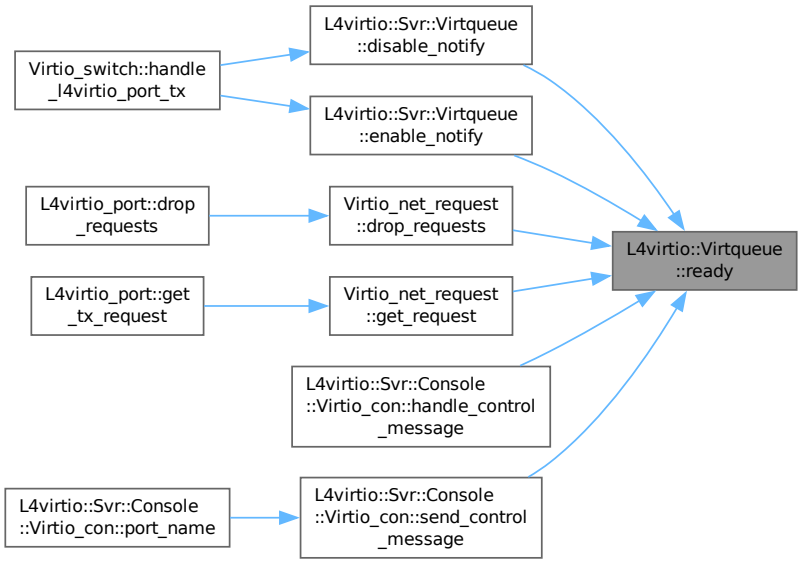
```
bool L4virtio::Virtqueue::ready () const  [inline]
```

Test if this queue is in working state.

Returns

true when the queue is in working state, false else.

Definition at line 419 of file virtqueue.
References _desc, and L4_LIKELY.
Referenced by L4virtio::Svr::Virtqueue::disable_notify(), Virtio_net_request::drop_requests(), L4virtio::Svr::Virtqueue::enable_notify(), Virtio_net_request::get_request(), L4virtio::Svr::Console::Virtio_con::handle_control_message(), and L4virtio::Svr::Console::Virtio_co
Here is the caller graph for this function:



15.442.2.14 setup()

```
void L4virtio::Virtqueue::setup (
            unsigned num,
            void * desc,
            void * avail,
            void * used,
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

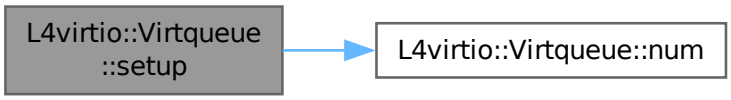
Enable this queue.

Parameters

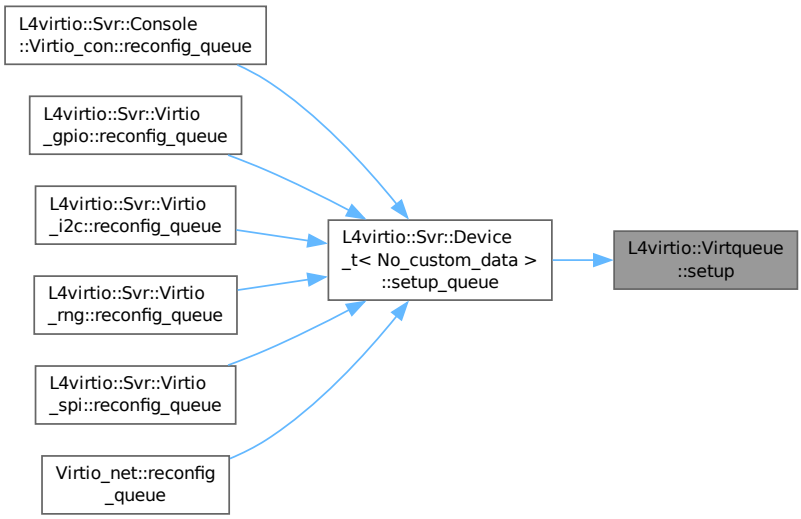
num	The number of entries in the descriptor table, the available ring, and the used ring (must be a power of 2).
desc	The address of the descriptor table. (Must be Desc_align aligned and at least `desc_size(num)` bytes in size.)
avail	The address of the available ring. (Must be Avail_align aligned and at least `avail_size(num)` bytes in size.)

used	The address of the used ring. (Must be Used_align aligned and at least `used_size(num)` bytes in size.)
msg_dev	Debug channel for developer-related information. Verbosity of L4Re::Util::Dbg(2) by default.

Due to the data type of the descriptors, the queue can have a maximum size of 2^16.
Definition at line 359 of file virtqueue.
References num().
Referenced by L4virtio::Svr::Device_t< No_custom_data >::setup_queue().
Here is the call graph for this function:



Here is the caller graph for this function:



15.442.2.15 setup_simple()

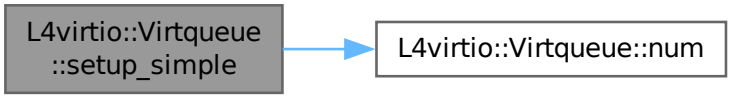
```
void L4virtio::Virtqueue::setup_simple (
            unsigned num,
            void * ring,
            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})  [inline]
```

Enable this queue.

Parameters

num	The number of entries in the descriptor table, the available ring, and the used ring (must be a power of 2).
ring	The base address for the queue data structure. The memory block at `ring` must be at least `total_size(num)` bytes in size and have an alignment of Desc_align (desc_align()) bits.
msg_dev	Debug channel for developer-related information. Verbosity of L4Re::Util::Dbg(2) by default.

Due to the data type of the descriptors, the queue can have a maximum size of 2^16.
Definition at line 393 of file virtqueue.
References num().
Here is the call graph for this function:



15.442.2.16 total_size() [1/2]

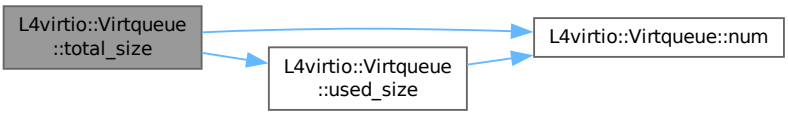
```
unsigned long L4virtio::Virtqueue::total_size () const  [inline]
```

Calculate the total size of this virtqueue.

Precondition

The queue has been set up.

Definition at line 322 of file virtqueue.
References _desc, _used, num(), and used_size().
Here is the call graph for this function:



15.442.2.17 total_size() [2/2]

```
unsigned long L4virtio::Virtqueue::total_size (
            unsigned num)  [inline], [static]
```

Calculate the total size for a virtqueue of the given dimensions.

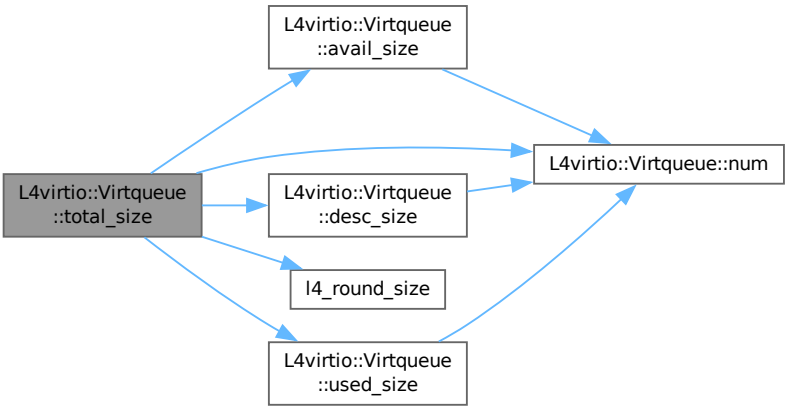
Parameters

num	The number of entries in the descriptor table, the available ring, and the used ring (must be a power of 2).

Returns

The total size in bytes of the queue data structures.

Definition at line 253 of file virtqueue.
References avail_size(), desc_size(), l4_round_size(), num(), and used_size().
Here is the call graph for this function:



15.442.2.18 used_align()

```
unsigned long L4virtio::Virtqueue::used_align ()  [inline], [static]
```

Get the alignment in zero LSBs needed for the used ring.

Returns

The alignment in zero LSBs needed for an used ring.

Definition at line 314 of file virtqueue.

15.442.2.19 used_size()

```
unsigned long L4virtio::Virtqueue::used_size (
            unsigned num)  [inline], [static]
```

Calculate the size of the used ring for num entries.

Parameters

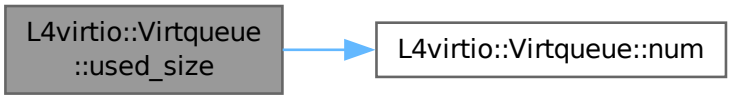
num	The number of entries in the used ring.

Returns

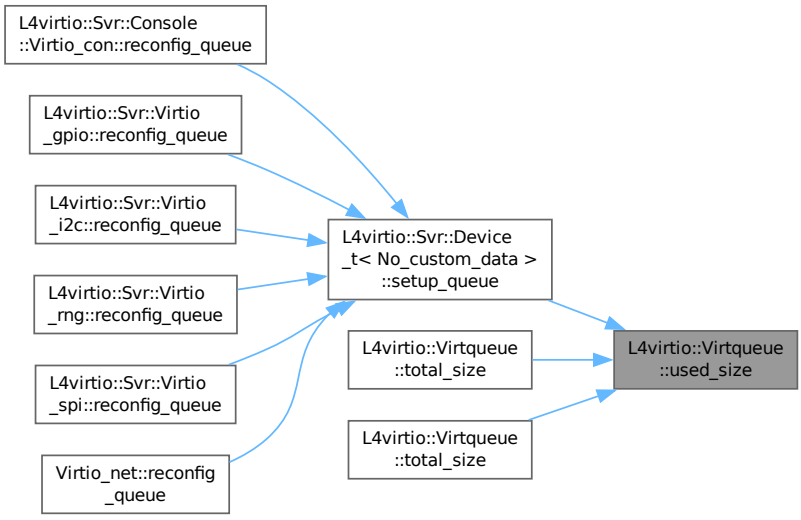
The size in bytes needed for an used ring with num entries.

Definition at line 306 of file virtqueue.
References num().
Referenced by L4virtio::Svr::Device_t< No_custom_data >::setup_queue(), total_size(), and total_size().

Here is the call graph for this function:



Here is the caller graph for this function:



The documentation for this class was generated from the following file:

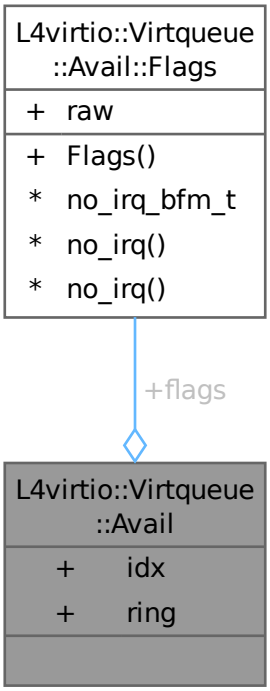
- l4/l4virtio/virtqueue

15.443 L4virtio::Virtqueue::Avail Class Reference

Type of available ring, this is read-only for the host.

`#include <virtqueue>`

Collaboration diagram for L4virtio::Virtqueue::Avail:



Data Structures

- struct Flags

  Flags of the available ring.

Data Fields

- Flags **flags**

  flags of available ring
- l4_uint16_t **idx**

  available index written by guest
- l4_uint16_t **ring** [ ]

  array of available descriptor indexes.

15.443.1 Detailed Description

Type of available ring, this is read-only for the host.
Definition at line 136 of file virtqueue.
The documentation for this class was generated from the following file:

- l4/l4virtio/virtqueue

15.444 L4virtio::Virtqueue::Avail::Flags Struct Reference

Flags of the available ring.

`#include <virtqueue>`
Collaboration diagram for L4virtio::Virtqueue::Avail::Flags:



Public Member Functions

- **Flags** (l4_uint16_t v)

  Make Flags from the raw value.

Data Fields

- l4_uint16_t **raw**

  raw 16bit flags value of the available ring.

- typedef cxx::Bitfield< decltype(raw), 0, 0 > no_irq_bfm_t

  Guest does not want to receive interrupts when requests are finished.
- constexpr no_irq_bfm_t::Val **no_irq** () const

  Get the `no_irq` bits (0 to 0) of `raw`.
- constexpr no_irq_bfm_t::Ref **no_irq** ()

  Get a reference to the `no_irq` bits (0 to 0) of `raw`.

15.444.1 Detailed Description

Flags of the available ring.
Definition at line 142 of file virtqueue.

15.444.2 Member Typedef Documentation

15.444.2.1 no_irq_bfm_t

`typedef cxx::Bitfield<decltype(raw), 0, 0> L4virtio::Virtqueue::Avail::Flags::no_irq_bfm_t`
Guest does not want to receive interrupts when requests are finished.
Type to access the `no_irq` bits (0 to 0) of `raw`.
Definition at line 151 of file virtqueue.
The documentation for this struct was generated from the following file:

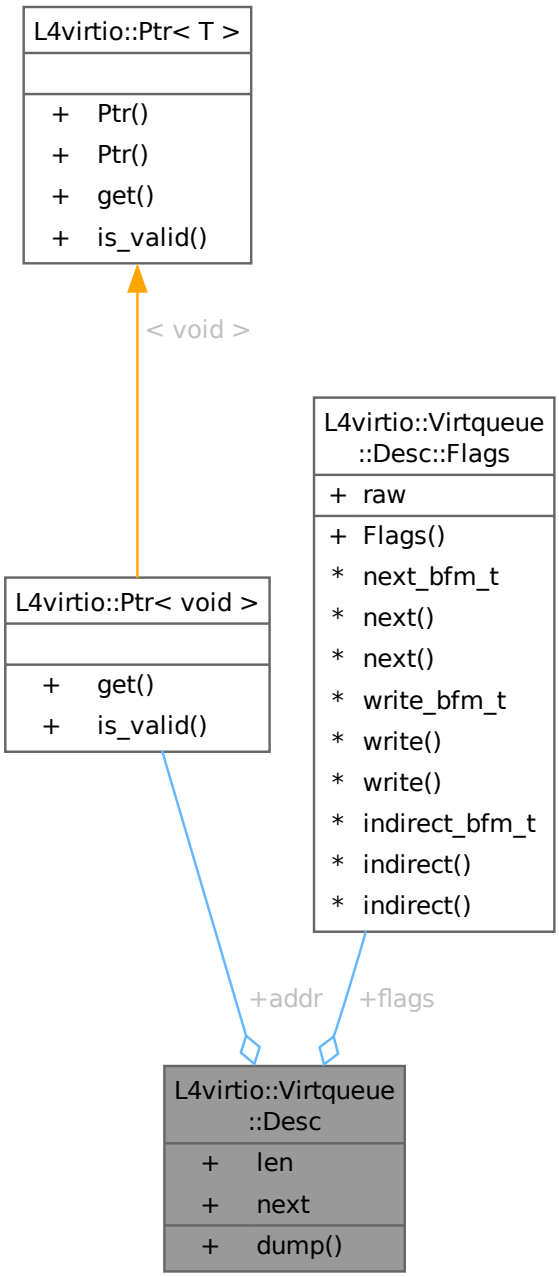
- l4/l4virtio/virtqueue

15.445 L4virtio::Virtqueue::Desc Class Reference

Descriptor in the descriptor table.

`#include <virtqueue>`

Collaboration diagram for L4virtio::Virtqueue::Desc:



Data Structures

- struct Flags

  Type for descriptor flags.

Public Member Functions

- void dump (unsigned idx, L4Re::Util::Dbg dbg=L4Re::Util::Dbg{}) const

  Dump a single descriptor.

Data Fields

- Ptr< void > **addr**

  Address stored in descriptor.
- l4_uint32_t **len**

  Length of described buffer.
- Flags **flags**

  Descriptor flags.
- l4_uint16_t **next**

  Index of the next chained descriptor.

15.445.1 Detailed Description

Descriptor in the descriptor table.
Definition at line 92 of file virtqueue.

15.445.2 Member Function Documentation

15.445.2.1 dump()

```
void L4virtio::Virtqueue::Desc::dump (
            unsigned idx,
            L4Re::Util::Dbg dbg = L4Re::Util::Dbg{}) const  [inline]
```

Dump a single descriptor.

Parameters

idx	Descriptor index.
dbg	Debug channel for printing the information. Verbosity of L4Re::Util::Dbg() by default.

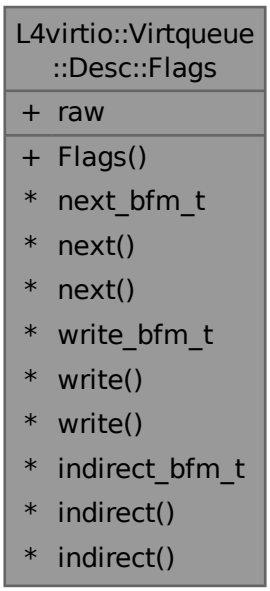
Definition at line 126 of file virtqueue.
The documentation for this class was generated from the following file:

- l4/l4virtio/virtqueue

15.446 L4virtio::Virtqueue::Desc::Flags Struct Reference

Type for descriptor flags.
`#include <virtqueue>`

Collaboration diagram for L4virtio::Virtqueue::Desc::Flags:



Public Member Functions

- **Flags** (l4_uint16_t v)

  Make Flags from raw 16bit value.

Data Fields

- l4_uint16_t **raw**

  raw flags value of a virtio descriptor.

- typedef cxx::Bitfield< decltype(raw), 0, 0 > next_bfm_t

  Part of a descriptor chain which is continued with the next field.

- constexpr next_bfm_t::Val **next** () const

  Get the `next` bits (0 to 0) of `raw`.

- constexpr next_bfm_t::Ref **next** ()

  Get a reference to the `next` bits (0 to 0) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 1, 1 > write_bfm_t

  Block described by this descriptor is writeable.

- constexpr write_bfm_t::Val **write** () const

  Get the `write` bits (1 to 1) of `raw`.

- constexpr write_bfm_t::Ref **write** ()

  Get a reference to the `write` bits (1 to 1) of `raw`.

- typedef cxx::Bitfield< decltype(raw), 2, 2 > indirect_bfm_t

  Indirect descriptor, block contains a list of descriptors.

- constexpr indirect_bfm_t::Val **indirect** () const

  Get the `indirect` bits (2 to 2) of `raw`.

- constexpr indirect_bfm_t::Ref **indirect** ()

  Get a reference to the `indirect` bits (2 to 2) of `raw`.

15.446.1 Detailed Description

Type for descriptor flags.
Definition at line 98 of file virtqueue.

15.446.2 Member Typedef Documentation

15.446.2.1 indirect_bfm_t

```
typedef cxx::Bitfield<decltype(raw), 2, 2> L4virtio::Virtqueue::Desc::Flags::indirect_bfm_t
```

Indirect descriptor, block contains a list of descriptors.
Type to access the `indirect` bits (2 to 2) of `raw`.
Definition at line 111 of file virtqueue.

15.446.2.2 next_bfm_t

```
typedef cxx::Bitfield<decltype(raw), 0, 0> L4virtio::Virtqueue::Desc::Flags::next_bfm_t
```

Part of a descriptor chain which is continued with the next field.
Type to access the `next` bits (0 to 0) of `raw`.
Definition at line 107 of file virtqueue.

15.446.2.3 write_bfm_t

```
typedef cxx::Bitfield<decltype(raw), 1, 1> L4virtio::Virtqueue::Desc::Flags::write_bfm_t
```

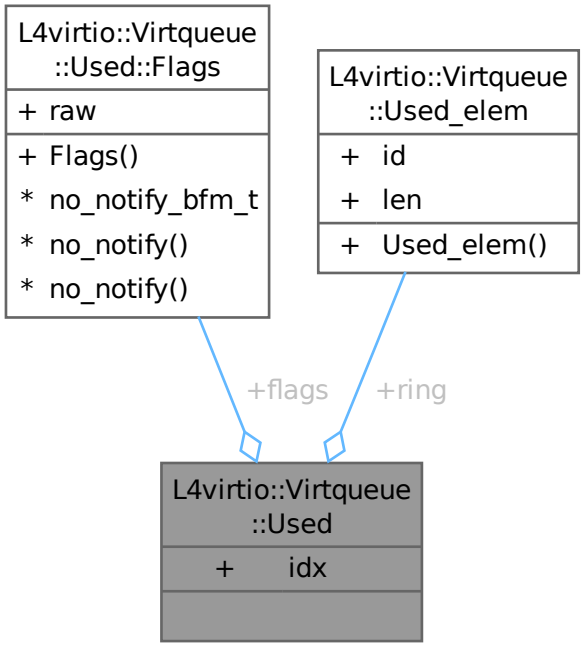
Block described by this descriptor is writeable.
Type to access the `write` bits (1 to 1) of `raw`.
Definition at line 109 of file virtqueue.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtqueue

15.447 L4virtio::Virtqueue::Used Class Reference

Used ring.
`#include <virtqueue>`

Collaboration diagram for L4virtio::Virtqueue::Used:



Data Structures

- struct Flags

  flags for the used ring.

Data Fields

- Flags **flags**

  flags of the used ring.
- l4_uint16_t **idx**

  index of the last entry in the ring.
- Used_elem **ring** [ ]

  array of used descriptors.

15.447.1 Detailed Description

Used ring.
Definition at line 181 of file virtqueue.
The documentation for this class was generated from the following file:

- l4/l4virtio/virtqueue

15.448 L4virtio::Virtqueue::Used::Flags Struct Reference

flags for the used ring.
`#include <virtqueue>`

Collaboration diagram for L4virtio::Virtqueue::Used::Flags:



Public Member Functions

- **Flags** (l4_uint16_t v)

  make Flags from raw value

Data Fields

- l4_uint16_t **raw**

  raw flags value as specified by virtio.

- typedef cxx::Bitfield< decltype(raw), 0, 0 > no_notify_bfm_t

  host does not want to be notified when new requests have been queued.
- constexpr no_notify_bfm_t::Val **no_notify** () const

  Get the `no_notify` bits (0 to 0) of `raw`.
- constexpr no_notify_bfm_t::Ref **no_notify** ()

  Get a reference to the `no_notify` bits (0 to 0) of `raw`.

15.448.1 Detailed Description

flags for the used ring.
Definition at line 187 of file virtqueue.

15.448.2 Member Typedef Documentation

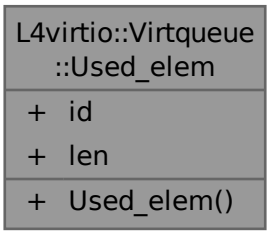
15.448.2.1 no_notify_bfm_t

`typedef cxx::Bitfield<decltype(raw), 0, 0> L4virtio::Virtqueue::Used::Flags::no_notify_bfm_t`
host does not want to be notified when new requests have been queued.
Type to access the `no_notify` bits (0 to 0) of `raw`.
Definition at line 196 of file virtqueue.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtqueue

15.449 L4virtio::Virtqueue::Used_elem Struct Reference

Type of an element of the used ring.
`#include <virtqueue>`
Collaboration diagram for L4virtio::Virtqueue::Used_elem:



Public Member Functions

- Used_elem (l4_uint16_t id, l4_uint32_t len)
  Initialize a used ring element.

Data Fields

- l4_uint32_t **id**
  descriptor index
- l4_uint32_t **len**
  length field

15.449.1 Detailed Description

Type of an element of the used ring.
Definition at line 162 of file virtqueue.

15.449.2 Constructor & Destructor Documentation

15.449.2.1 Used_elem()

```
L4virtio::Virtqueue::Used_elem::Used_elem (
            l4_uint16_t id,
            l4_uint32_t len)  [inline]
```

Initialize a used ring element.

Parameters

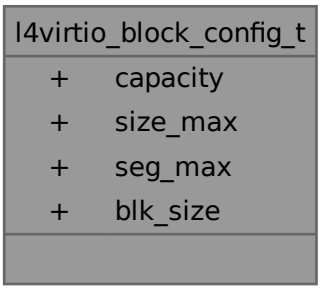
id	The index of the descriptor to be marked as used.
len	The total bytes written into the buffer of the descriptor chain.

Definition at line 173 of file virtqueue.
References id, and len.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtqueue

15.450 l4virtio_block_config_t Struct Reference

Device configuration for block devices.
`#include <virtio_block.h>`
Collaboration diagram for l4virtio_block_config_t:



Data Fields

- l4_uint64_t **capacity**

  Capacity of device in 512-byte sectors.
- l4_uint32_t **size_max**

  Maximum size of a single segment.
- l4_uint32_t **seg_max**

  Maximum number of segments per request.
- l4_uint32_t **blk_size**

  Block size of underlying disk.

15.450.1 Detailed Description

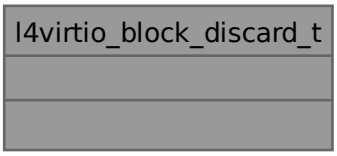
Device configuration for block devices.
Definition at line 68 of file virtio_block.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_block.h

15.451 l4virtio_block_discard_t Struct Reference

Structure used for the write zeroes and discard commands.
`#include <virtio_block.h>`

Collaboration diagram for l4virtio_block_discard_t:



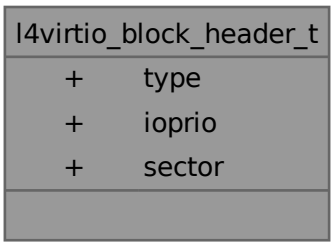
15.451.1 Detailed Description

Structure used for the write zeroes and discard commands.
Definition at line 58 of file virtio_block.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_block.h

15.452 l4virtio_block_header_t Struct Reference

Header structure of a request for a block device.
`#include <virtio_block.h>`
Collaboration diagram for l4virtio_block_header_t:



Data Fields

- l4_uint32_t **type**

  Kind of request, see L4virtio_block_operations.
- l4_uint32_t **ioprio**

  Priority (unused).
- l4_uint64_t **sector**

  First sector to read/write.

15.452.1 Detailed Description

Header structure of a request for a block device.

Definition at line 42 of file virtio_block.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_block.h

15.453 l4virtio_config_hdr_t Struct Reference

L4-VIRTIO config header, provided in shared data space.
`#include <virtio.h>`
Collaboration diagram for l4virtio_config_hdr_t:



Data Fields

- l4_uint32_t **magic**

  magic value (must be 'virt').
- l4_uint32_t **version**

  VIRTIO version.
- l4_uint32_t **device**

  device ID
- l4_uint32_t **vendor**

  vendor ID
- l4_uint32_t **dev_features**

  device features windows selected by device_feature_sel
- l4_uint32_t **num_queues**

  number of virtqueues
- l4_uint32_t **queues_offset**

  offset of virtqueue config array

15.453.1 Detailed Description

L4-VIRTIO config header, provided in shared data space.
Definition at line 141 of file virtio.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio.h

15.454 l4virtio_config_queue_t Struct Reference

Queue configuration entry.
`#include <virtio.h>`
Collaboration diagram for l4virtio_config_queue_t:



Data Fields

- l4_uint16_t **num_max**

  R: maximum number of descriptors supported by this queue.
- l4_uint16_t **num**

  RW: number of descriptors configured for this queue.
- l4_uint16_t **ready**

  RW: queue ready flag (read-write).
- l4_uint16_t **driver_notify_index**

  W: Event index to be used for device notifications (device to driver).
- l4_uint64_t **desc_addr**

  W: address of descriptor table.
- l4_uint64_t **avail_addr**

  W: address of available ring.
- l4_uint64_t **used_addr**

  W: address of used ring.
- l4_uint16_t **device_notify_index**

  R: Event index to be used by the driver (driver to device).

15.454.1 Detailed Description

Queue configuration entry.
An array of such entries is available at the l4virtio_config_hdr_t::queues_offset in the config data space.
Consistency rules for the queue config are:

- A driver might read `num_max` at any time.

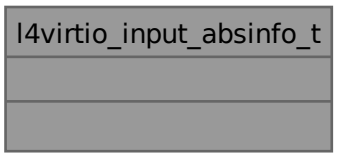
- A driver must write to num, desc_addr, avail_addr, and used_addr only when ready is zero (0). Values in these fields are validated and used by the device only after successfully setting ready to one (1), either by the IPC or by L4VIRTIO_CMD_CFG_QUEUE.
- The value of device_notify_index is valid only when ready is one.
- The driver might write to device_notify_index at any time, however the change is guaranteed to take effect after a successful L4VIRTIO_CMD_CFG_QUEUE or after a config_queue IPC. Note, the change might also have immediate effect, depending on the device implementation.

Definition at line 232 of file virtio.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio.h

15.455 l4virtio_input_absinfo_t Struct Reference

Information about the absolute axis in the underlying evdev implementation.
`#include <virtio_input.h>`
Collaboration diagram for l4virtio_input_absinfo_t:



15.455.1 Detailed Description

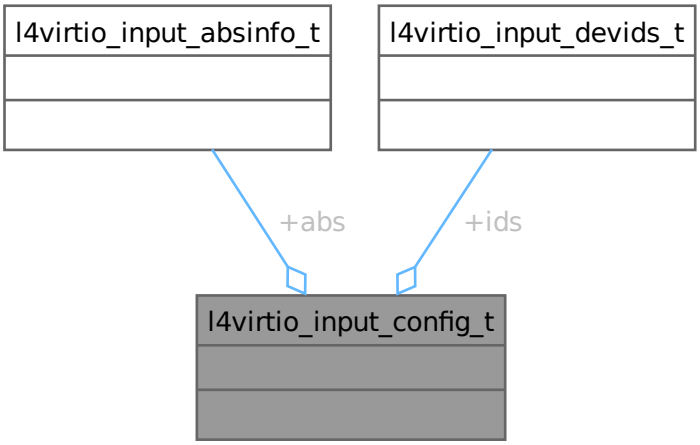
Information about the absolute axis in the underlying evdev implementation.
Definition at line 33 of file virtio_input.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_input.h

15.456 l4virtio_input_config_t Struct Reference

Device configuration for input devices.
`#include <virtio_input.h>`

Collaboration diagram for l4virtio_input_config_t:



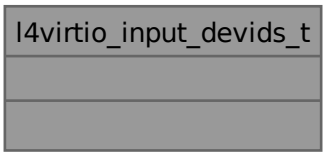
15.456.1 Detailed Description

Device configuration for input devices.
Definition at line 56 of file virtio_input.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_input.h

15.457 l4virtio_input_devids_t Struct Reference

Device ID information for the device.
`#include <virtio_input.h>`
Collaboration diagram for l4virtio_input_devids_t:



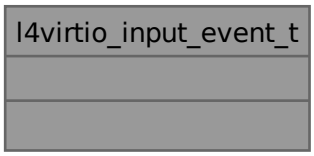
15.457.1 Detailed Description

Device ID information for the device.
Definition at line 45 of file virtio_input.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_input.h

15.458 l4virtio_input_event_t Struct Reference

Single event in event or status queue.
`#include <virtio_input.h>`
Collaboration diagram for l4virtio_input_event_t:



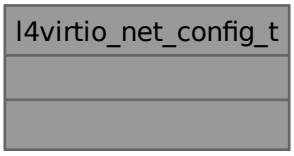
15.458.1 Detailed Description

Single event in event or status queue.
Definition at line 74 of file virtio_input.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_input.h

15.459 l4virtio_net_config_t Struct Reference

Device configuration for network devices.
`#include <virtio_net.h>`
Collaboration diagram for l4virtio_net_config_t:



15.459.1 Detailed Description

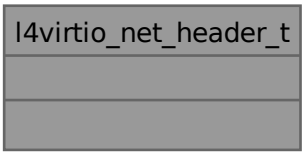
Device configuration for network devices.
Definition at line 34 of file virtio_net.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_net.h

15.460 l4virtio_net_header_t Struct Reference

Header structure of a request for a network device.

`#include <virtio_net.h>`
Collaboration diagram for l4virtio_net_header_t:



15.460.1 Detailed Description

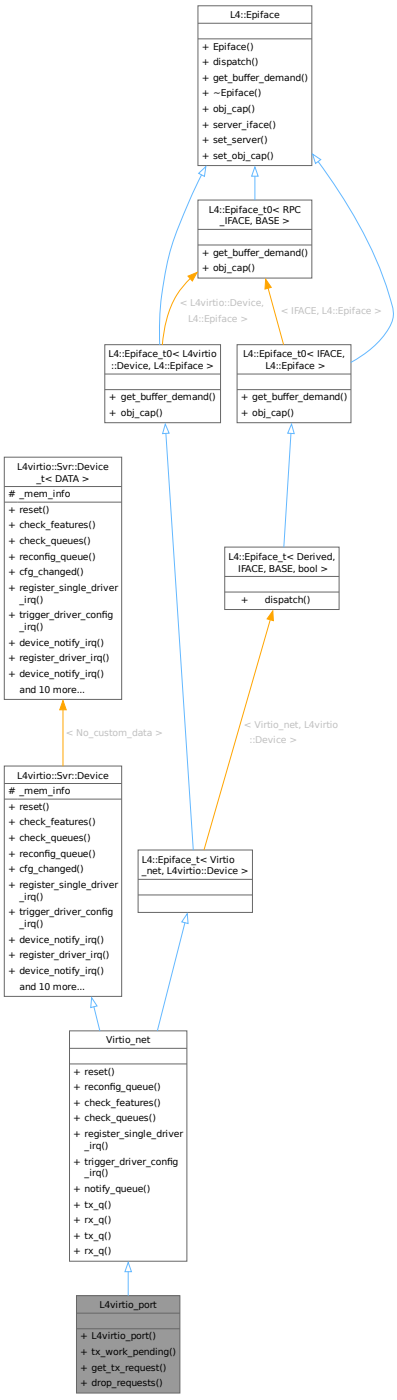
Header structure of a request for a network device.
Definition at line 20 of file virtio_net.h.
The documentation for this struct was generated from the following file:

- l4/l4virtio/virtio_net.h

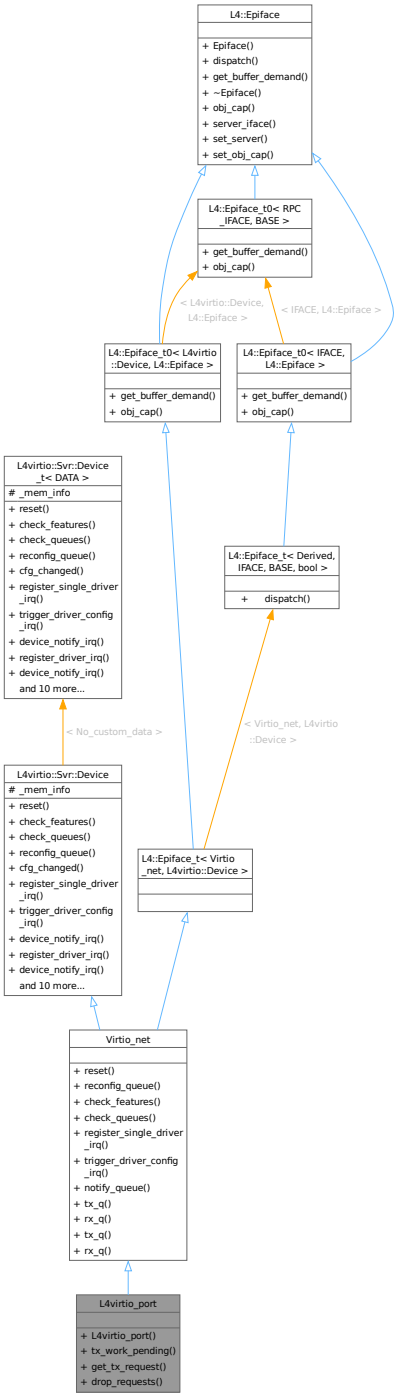
15.461 L4virtio_port Class Reference

A Port on the Virtio Net Switch.
`#include <port_l4virtio.h>`

Inheritance diagram for L4virtio_port:



Collaboration diagram for L4virtio_port:



Public Member Functions

- **L4virtio_port** (unsigned vq_max, unsigned num_ds, char const ∗name, l4_uint8_t const ∗mac)

  Create a Virtio net port object.
- bool **tx_work_pending** () const

  Check whether there is any work pending on the transmission queue.
- std::optional< Virtio_net_request > **get_tx_request** ()

  Get one request from the transmission queue.

- void drop_requests ()

  Drop all requests pending in the transmission queue.

Public Member Functions inherited from Virtio_net

- void **reset** () override

  reset callback, called for doing a device reset
- int **reconfig_queue** (unsigned index) override

  callback for client queue-config request
- bool **check_features** () override

  callback for checking the subset of accepted features
- bool **check_queues** () override

  Check whether both virtqueues are ready.
- void **register_single_driver_irq** () override

  Save the `_kick_guest_irq` that the client sent via `device_notification_irq()`.
- void **trigger_driver_config_irq** () override

  callback for triggering configuration change notification IRQ
- void notify_queue (L4virtio::Svr::Virtqueue *queue)

  Trigger the `_kick_guest_irq` IRQ.
- Virtqueue * **tx_q** ()

  Getter for the transmission queue.
- Virtqueue * **rx_q** ()

  Getter for the receive queue.
- Virtqueue const * **tx_q** () const

  Getter for the transmission queue.
- Virtqueue const * **rx_q** () const

  Getter for the receive queue.

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual L4::Cap< L4::Irq > **device_notify_irq** () const

  callback to gather the device notification IRQ (old-style)
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config *dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_↩ dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const * **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_↩ notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.

- bool setup_queue (Virtqueue *q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` *register and handle a write.*
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Public Member Functions inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< L4virtio::Device > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

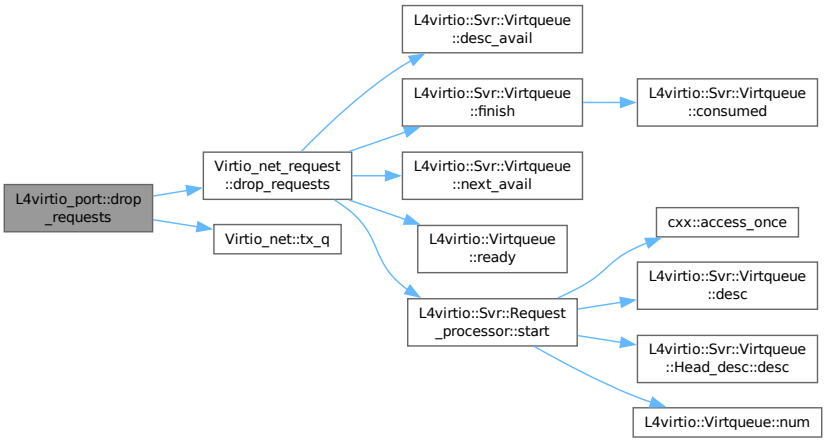
15.461.1 Detailed Description

A Port on the Virtio Net Switch.
A Port object gets created by `Virtio_factory::op_create()`. This function actually only instantiates objects of the types `Switch_port` and `Monitor_port`. The created Port registers itself at the switch's server. Usually, the IPC call for port creation comes from ned. To finalize the setup, the client has to initialize the port during the virtio initialization phase. To do this, the client registers a dataspace for queues and buffers and provides an IRQ to notify the client on incoming network requests.
Definition at line 36 of file port_l4virtio.h.

15.461.2 Member Function Documentation

15.461.2.1 drop_requests()

`void L4virtio_port::drop_requests () [inline]`
Drop all requests pending in the transmission queue.
This is used for monitor ports, which are not allowed to send packets.
Definition at line 103 of file port_l4virtio.h.
References Virtio_net_request::drop_requests(), and Virtio_net::tx_q().
Here is the call graph for this function:



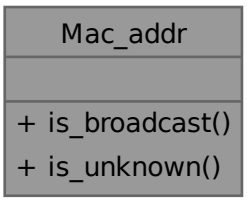
The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/server/switch/port_l4virtio.h

15.462 Mac_addr Class Reference

A wrapper class around the value of a MAC address.
`#include <mac_addr.h>`

Collaboration diagram for Mac_addr:



Public Member Functions

- bool **is_broadcast** () const

  Check if MAC address is a broadcast or multicast address.
- bool **is_unknown** () const

  Check if the MAC address is not yet known.

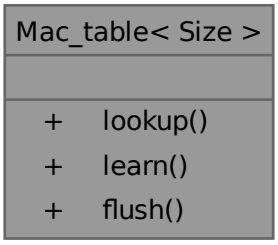
15.462.1 Detailed Description

A wrapper class around the value of a MAC address.
Definition at line 19 of file mac_addr.h.
The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/server/switch/mac_addr.h

15.463 Mac_table< Size > Class Template Reference

Mac_table manages a 1:n association between ports and MAC addresses.
`#include <mac_table.h>`
Collaboration diagram for Mac_table< Size >:



Public Member Functions

- Port_iface * lookup (Mac_addr dst, l4_uint16_t vlan_id) const

  Find the destination port for a MAC address and VLAN id.

- void learn (Mac_addr src, Port_iface *port, l4_uint16_t vlan_id)

  Learn a MAC address (add it to the MAC table).
- void flush (Port_iface *port)

  Flush all associations with a given port.

15.463.1 Detailed Description

template<std::size_t Size = 1024U>
class Mac_table< Size >

Mac_table manages a 1:n association between ports and MAC addresses.
There are different types of devices which might be attached to a port. For a normal device the switch sees exactly one MAC address per port - the MAC address of the device attached to it. But there might be other devices like software bridges attached to the port sending packets with different MAC addresses to the port. Therefore the switch has to manage a 1:n association between ports and MAC addresses. The MAC table manages this association.
When a packet comes in we need to find the destination port for the packet and therefore perform a lookup based on the MAC address.
To prevent unbounded growth of the lookup table, the number of entries is limited. Replacement is done on a round-robin basis. If the capacity was reached, the oldest entry is evicted.
Definition at line 40 of file mac_table.h.

15.463.2 Member Function Documentation

15.463.2.1 flush()

```
template<std::size_t Size = 1024U>
void Mac_table< Size >::flush (
             Port_iface * port)  [inline]
```

Flush all associations with a given port.

Parameters

port	Pointer to port that is to be flushed

This function removes all references to a given port from the MAC table. Since we manage a 1:n association between ports and MAC addresses there might be more than one entry for a given port and we have to iterate over the whole array to delete every reference to the port.
Definition at line 129 of file mac_table.h.

15.463.2.2 learn()

```
template<std::size_t Size = 1024U>
void Mac_table< Size >::learn (
             Mac_addr src,
             Port_iface * port,
             l4_uint16_t vlan_id)  [inline]
```

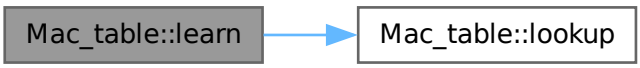
Learn a MAC address (add it to the MAC table).

Parameters

src	MAC address
port	Pointer to the port object that can be used to reach MAC address src
vlan_id	VLAN id of the packet destination.

Will evict the oldest learned address from the table if the maximum capacity was reached and if the MAC address

was not known yet. The source port of the table entry is always updated to cope with clients that move between ports.
Definition at line 78 of file mac_table.h.
References L4_UNLIKELY, and lookup().
Here is the call graph for this function:



15.463.2.3 lookup()

```
template<std::size_t Size = 1024U>
Port_iface * Mac_table< Size >::lookup (
             Mac_addr dst,
             l4_uint16_t vlan_id) const  [inline]
```

Find the destination port for a MAC address and VLAN id.

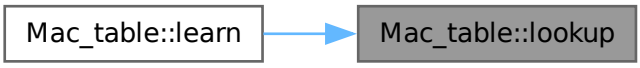
Parameters

dst	MAC address
vlan_id	VLAN id

Return values

nullptr	The MAC address is not known (yet)
other	Pointer to the destination port

Definition at line 58 of file mac_table.h.
Referenced by learn().
Here is the caller graph for this function:

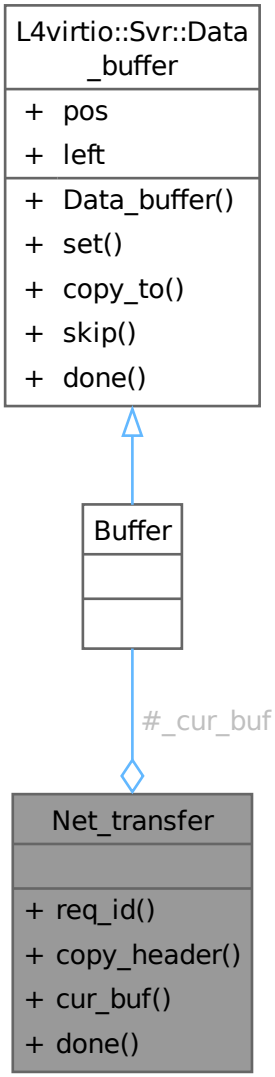


The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/server/switch/mac_table.h

15.464 Net_transfer Class Reference

A network request to only a single destination.
`#include <request.h>`
Collaboration diagram for Net_transfer:



Public Member Functions

- void const ∗ **req_id** () const

  Identifier for the underlying `Net_request`, used for logging purposes.
- virtual void **copy_header** (Virtio_net::Hdr ∗dst_header) const =0

  Populate the virtio-net header for the destination.
- Buffer & cur_buf ()

  Buffer containing (a part of) the packet data.
- virtual bool done ()=0

  Check whether the transfer has been completed, i.e.

15.464.1 Detailed Description

A network request to only a single destination.
A `Net_request` can have multiple destinations (being a broadcast request, for example). That is why it is processed by multiple `Net_transfer`s, each representing the delivery to a single destination port.
`Port_iface::handle_request` uses the `Net_transfer` to move one packet to the destination of the request.
Definition at line 33 of file request.h.

15.464.2 Member Function Documentation

15.464.2.1 cur_buf()

```
Buffer & Net_transfer::cur_buf ()  [inline]
```

Buffer containing (a part of) the packet data.
Once emptied, a call to `done()` might replenish the buffer, in case the net request consisted of multiple chained buffers.
Definition at line 54 of file request.h.

15.464.2.2 done()

```
virtual bool Net_transfer::done ()  [pure virtual]
```

Check whether the transfer has been completed, i.e.
the entire packet data has been copied.

Return values

false	There is remaining packet data that needs to be copied.
true	The entire packet data has been copied.

Exceptions

L4virtio::Svr::Bad_descriptor	Exception raised in SRC port queue.

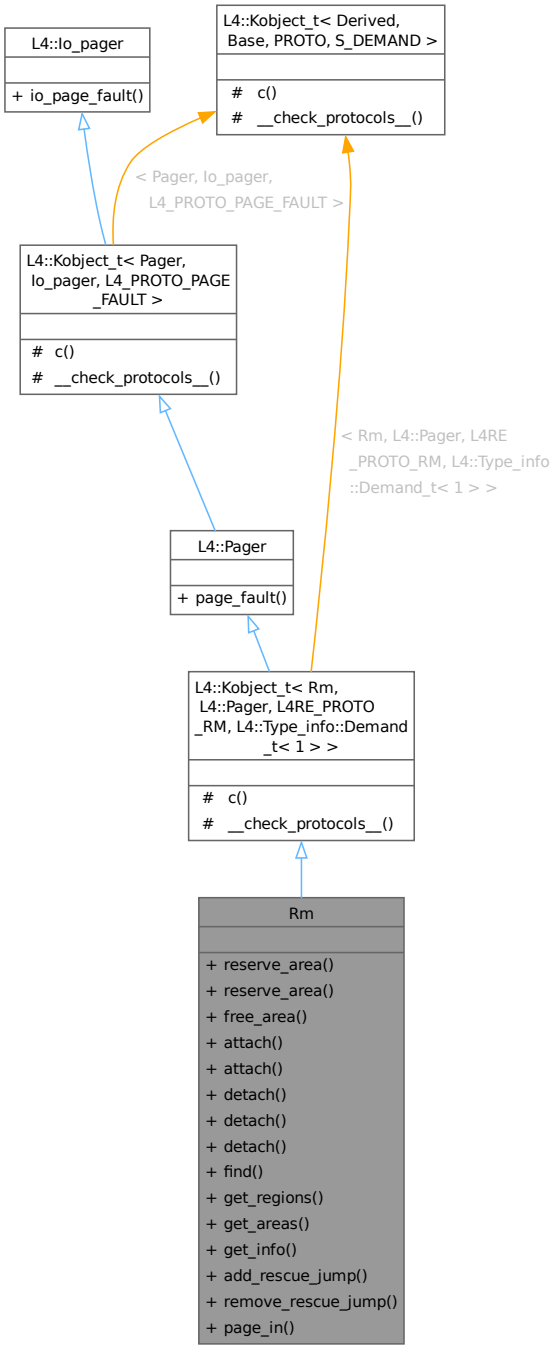
The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/server/switch/request.h

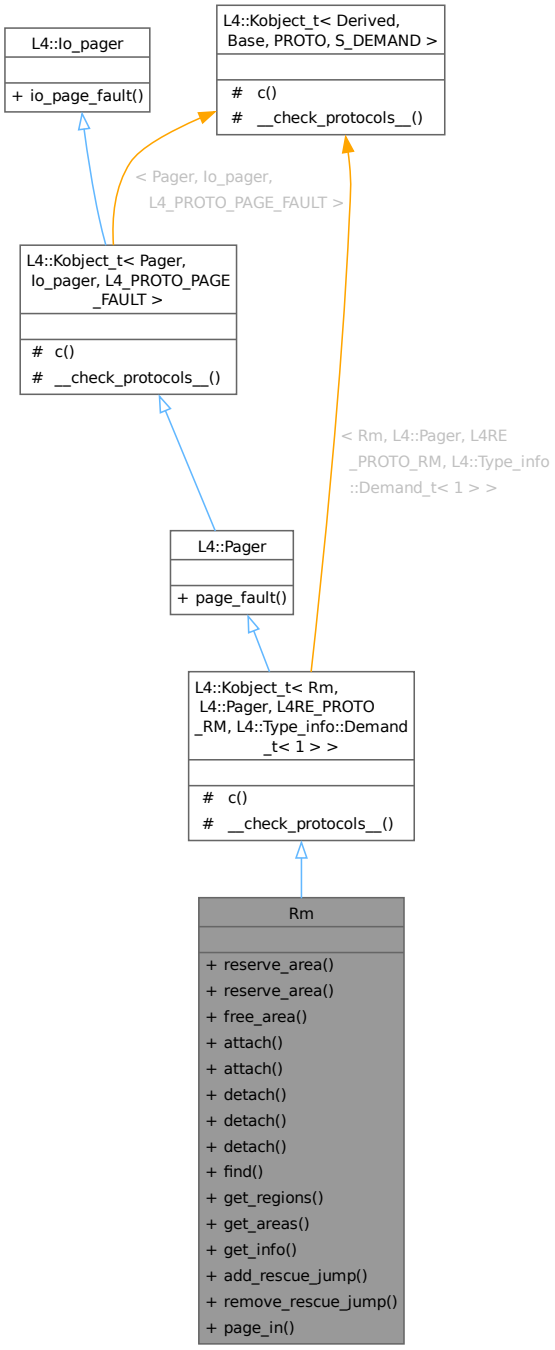
15.465 Rm Class Reference

Region map.
`#include <l4/re/rm>`

Inheritance diagram for Rm:



Collaboration diagram for Rm:



Data Structures

- struct F

  Rm flags definitions.
- class Unique_region

  Unique region.
- struct Region

  A region is a range of virtual addresses which is backed by content.

- struct Area

  An area is a range of virtual addresses which is reserved, see L4Re::Rm::reserve_area().

Public Types

- enum Detach_result {
  Detached_ds = 0 , Kept_ds = 1 , Split_ds = 2 , **Detach_result_mask** = 3 ,
  Detach_again = 4 , Unmapped_range = 8 }

  Result values for detach operation.
- enum Region_flag_shifts { Caching_shift = Dataspace::F::Caching_shift }

  Region flag shifts.
- enum Detach_flags { Detach_exact = 1 , Detach_overlap = 2 }

  Flags for detach operation.
- typedef l4_ret_t(* **page_in_fn**) (l4_addr_t min_addr, l4_addr_t max_addr, Region_flags rights)

  In-thread eager paging function.
- typedef L4::Typeid::Rpcs< attach_t, detach_t, find_t, reserve_area_t, free_area_t, get_regions_t, get_areas_t, get_info_t, add_rescue_jump_t, remove_rescue_jump_t, page_in_t > **Rpcs**

  Eager paging RPC call.

Public Member Functions

- l4_ret_t reserve_area (l4_addr_t *start, unsigned long size, Flags flags=Flags(0), unsigned char align=L4_PAGESHIFT) const noexcept

  Reserve the given area in the region map.
- template<typename T>
  l4_ret_t reserve_area (T **start, unsigned long size, Flags flags=Flags(0), unsigned char align=L4_PAGESHIFT) const noexcept

  Reserve the given area in the region map.
- l4_ret_t free_area (l4_addr_t addr)

  Free an area from the region map.
- l4_ret_t attach (l4_addr_t *start, unsigned long size, Flags flags, L4::Ipc::Cap< Dataspace > mem, Offset offs=0, unsigned char align=L4_PAGESHIFT, L4::Cap< L4::Task > const task=L4::Cap< L4::Task >::Invalid, char const *name=nullptr, Offset backing_offset=0) const noexcept

  Attach a data space to a region.
- template<typename T>
  l4_ret_t attach (T **start, unsigned long size, Flags flags, L4::Ipc::Cap< Dataspace > mem, Offset offs=0, unsigned char align=L4_PAGESHIFT, L4::Cap< L4::Task > const task=L4::Cap< L4::Task >::Invalid, char const *name=nullptr, Offset backing_offset=0) const noexcept

  Attach a data space to a region.
- l4_ret_t detach (l4_addr_t addr, L4::Cap< Dataspace > *mem, L4::Cap< L4::Task > const &task=This_task) const noexcept

  Detach and unmap a region from the address space.
- l4_ret_t detach (void *addr, L4::Cap< Dataspace > *mem, L4::Cap< L4::Task > const &task=This_task) const noexcept

  Detach and unmap a region from the address space.
- l4_ret_t detach (l4_addr_t start, unsigned long size, L4::Cap< Dataspace > *mem, L4::Cap< L4::Task > const &task=This_task) const noexcept

  Detach and unmap all parts of the regions within the specified interval.
- l4_ret_t find (l4_addr_t *addr, unsigned long *size, Offset *offset, L4Re::Rm::Flags *flags, L4::Cap< Dataspace > *m) noexcept

  Find a region given an address and size.
- l4_ret_t get_regions (l4_addr_t start, L4::Ipc::Array_ref< Region > &regions)

  Return the list of regions whose starting addresses are higher or equal to `start` in the address space managed by this region map.

- long get_areas (l4_addr_t start, L4::Ipc::Array_ref< Area > &areas)

  Return the list of areas whose starting addresses are higher or equal to `start` in the address space managed by this region map.
- l4_ret_t get_info (l4_addr_t addr, L4::Ipc::String< char > &name, Offset &backing_offset)

  Return auxiliary information of a region.
- l4_ret_t add_rescue_jump (l4_addr_t pc_begin, l4_addr_t pc_end, l4_addr_t rescue_pc)

  Register a rescue jump for a range of program counters.
- l4_ret_t remove_rescue_jump (l4_addr_t pc)

  Remove a previously registered rescue jump.
- l4_ret_t page_in (l4_addr_t start, unsigned long size, Region_flags rights, L4::Cap< L4::Task > dst=L4::Cap< L4::Task >::Invalid) const noexcept

  Allocate and map pages for the given region.

Public Member Functions inherited from L4::Pager

- l4_msgtag_t page_fault (l4_umword_t pfa, l4_umword_t pc, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  Page-fault protocol message.

Public Member Functions inherited from L4::Io_pager

- l4_msgtag_t io_page_fault (l4_fpage_t io_pfa, l4_umword_t pc, L4::Ipc::Rcv_fpage rwin, L4::Ipc::Opt< L4::Ipc::Snd_fpage & > fp)

  IO page fault protocol message.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >

- typedef Rm **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Rm > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Pager::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Types inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- typedef Pager **Class**

  The target interface type (inheriting from Kobject_t).
- typedef Typeid::Iface< PROTO, Pager > **__Iface**

  The interface description for the derived class.
- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename Io_pager::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Static Protected Member Functions inherited from L4::Kobject_t< Rm, L4::Pager, L4RE_PROTO_RM, L4::Type_info::Demand_t< 1 > >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

Static Protected Member Functions inherited from L4::Kobject_t< Pager, Io_pager, L4_PROTO_PAGE_FAULT >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.465.1 Detailed Description

Region map.

See also

Region map API .

Definition at line 81 of file rm.

15.465.2 Member Enumeration Documentation

15.465.2.1 Detach_flags

`enum L4Re::Rm::Detach_flags`

Flags for detach operation.

Enumerator

Detach_exact	Do an unmap of the exact region given.
Detach_overlap	Do an unmap of all overlapping regions.

Definition at line 223 of file rm.

15.465.2.2 Detach_result

`enum L4Re::Rm::Detach_result`

Result values for detach operation.

Enumerator

Detached_ds	Detached data space.
Kept_ds	Kept data space.
Split_ds	Split data space, and done.
Detach_again	Detached data space, more to do.
Unmapped_range	The region mananager has already unmapped the pages.

Definition at line 89 of file rm.

15.465.2.3 Region_flag_shifts

```
enum L4Re::Rm::Region_flag_shifts
```
Region flag shifts.

Enumerator

Caching_shift	Start of Rm cache bits.

Definition at line 102 of file rm.

15.465.3 Member Function Documentation

15.465.3.1 add_rescue_jump()

```
l4_ret_t L4Re::Rm::add_rescue_jump (
             l4_addr_t pc_begin,
             l4_addr_t pc_end,
             l4_addr_t rescue_pc)
```
Register a rescue jump for a range of program counters.
If a synchronous exception (e.g. a SIGSEGV with SEGV_MAPERR) is raised by an instruction whose program counter lies in the half-open range `[pc_begin, pc_end)`, execution is diverted to `rescue_pc` instead of delivering the signal to the application.
The registered rescue jumps must not overlap.

Parameters

pc_begin	Inclusive start of the instruction range.
pc_end	Exclusive end of the instruction range.
rescue_pc	Program counter to jump to on a fault in the range.

Return values

0	Success
-L4_EINVAL	Invalid arguments (e.g. `pc_begin >= pc_end`).
-L4_EEXIST	The given range overlaps with an already registered rescue jump.
-L4_ENOMEM	Out of memory.
<0	IPC errors

15.465.3.2 attach() [1/2]

```
l4_ret_t L4Re::Rm::attach (
             l4_addr_t * start,
             unsigned long size,
             Rm::Flags flags,
             L4::Ipc::Cap< Dataspace > mem,
             Rm::Offset offs = 0,
             unsigned char align = L4_PAGESHIFT,
             L4::Cap< L4::Task > const task = L4::Cap<L4::Task>::Invalid,
             char const * name = nullptr,
             Rm::Offset backing_offset = 0) const  [noexcept]
```
Attach a data space to a region.

Parameters

in,out	*start*	Virtual start address where the region manager shall attach the data space. Will be rounded down to the nearest start of a page. If L4Re::Rm::F::Search_addr is given this value is used as the start address to search for a free virtual memory region and the resulting address is returned here. If L4Re::Rm::F::In_area is given the value is used as a selector for the area (see L4Re::Rm::reserve_area) to attach the data space to.
	size	Size of the data space to attach (in bytes). Will be rounded up to the nearest multiple of the page size.
	flags	The flags control how and with which rights the dataspace is attached to the region. See L4Re::Rm::F::Attach_flags and L4Re::Rm::F::Region_flags. The caller must specify the desired rights of the attached region explicitly. The default set of rights is empty.
	mem	Data space.
	offs	Offset into the data space to use.
	align	Alignment of the virtual region, log2-size, default: a page (L4_PAGESHIFT). This is only meaningful if the L4Re::Rm::F::Search_addr flag is used.
	task	Optional destination task of mapping if `F::Eager_map` flag was passed. If invalid, the mapping is established in the current task. This parameter is only useful if the region manager is for a foreign task.
	name	Optional name of the region.
	backing_offset	Optional value describing an offset into the backing store of this region.

Return values

0	Success
-L4_ENOENT	No area could be found (see L4Re::Rm::F::In_area)
-L4_EPERM	Operation not allowed.
-L4_EINVAL	
-L4_EADDRNOTAVAIL	The given address is not available.
<0	IPC errors

Makes the whole or parts of a data space visible in the virtual memory of the corresponding task. The corresponding region in the virtual address space is backed with the contents of the dataspace.

Note

When searching for a free place in the virtual address space, the space between *start* and the end of the virtual address space is searched.

There is no region object created, instead the region is defined by a virtual address within this range (see L4Re::Rm::find).

Definition at line 38 of file rm_impl.h.

15.465.3.3 attach() [2/2]

```
template<typename T>
l4_ret_t L4Re::Rm::attach (
             T ** start,
             unsigned long size,
             Flags flags,
```

```
L4::Ipc::Cap< Dataspace > mem,
Offset offs = 0,
unsigned char align = L4_PAGESHIFT,
L4::Cap< L4::Task > const task = L4::Cap<L4::Task>::Invalid,
char const * name = nullptr,
Offset backing_offset = 0) const  [inline], [noexcept]
```

Attach a data space to a region.

Parameters

in,out	*start*	Virtual start address where the region manager shall attach the data space. Will be rounded down to the nearest start of a page. If L4Re::Rm::F::Search_addr is given this value is used as the start address to search for a free virtual memory region and the resulting address is returned here. If L4Re::Rm::F::In_area is given the value is used as a selector for the area (see L4Re::Rm::reserve_area) to attach the data space to.
	size	Size of the data space to attach (in bytes). Will be rounded up to the nearest multiple of the page size.
	flags	The flags control how and with which rights the dataspace is attached to the region. See L4Re::Rm::F::Attach_flags and L4Re::Rm::F::Region_flags. The caller must specify the desired rights of the attached region explicitly. The default set of rights is empty.
	mem	Data space.
	offs	Offset into the data space to use.
	align	Alignment of the virtual region, log2-size, default: a page (L4_PAGESHIFT). This is only meaningful if the L4Re::Rm::F::Search_addr flag is used.
	task	Optional destination task of mapping if `F::Eager_map` flag was passed. If invalid, the mapping is established in the current task. This parameter is only useful if the region manager is for a foreign task.
	name	Optional name of the region.
	backing_offset	Optional value describing an offset into the backing store of this region.

Return values

0	Success
-L4_ENOENT	No area could be found (see L4Re::Rm::F::In_area)
-L4_EPERM	Operation not allowed.
-L4_EINVAL	
-L4_EADDRNOTAVAIL	The given address is not available.
<0	IPC errors

Makes the whole or parts of a data space visible in the virtual memory of the corresponding task. The corresponding region in the virtual address space is backed with the contents of the dataspace.

Note

When searching for a free place in the virtual address space, the space between *start* and the end of the virtual address space is searched.

There is no region object created, instead the region is defined by a virtual address within this range (see L4Re::Rm::find).

Definition at line 405 of file rm.

15.465.3.4 detach() [1/3]

```
l4_ret_t L4Re::Rm::detach (
            l4_addr_t addr,
            L4::Cap< Dataspace > * mem,
            L4::Cap< L4::Task > const & task = This_task) const  [inline], [noexcept]
```

Detach and unmap a region from the address space.

Parameters

	addr	Virtual address of region, any address within the region is valid.
out	*mem*	Dataspace that is affected. Give 0 if not interested.
	task	This argument specifies the task where the pages are unmapped. Provide L4::Cap<L4::Task>::Invalid for none. The default is the current task.

Return values

L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees a region in the virtual address space given by addr (address type). The corresponding part of the address space is now available again.
Definition at line 895 of file rm.

15.465.3.5 detach() [2/3]

```
l4_ret_t L4Re::Rm::detach (
            l4_addr_t start,
            unsigned long size,
            L4::Cap< Dataspace > * mem,
            L4::Cap< L4::Task > const & task = This_task) const  [inline], [noexcept]
```

Detach and unmap all parts of the regions within the specified interval.

Parameters

	start	Start of area to detach, must be within region.
	size	Size of of area to detach (in bytes).
out	*mem*	Dataspace that is affected. Give 0 if not interested.
	task	This argument specifies the task where the pages are unmapped. Provide L4::Cap<L4::Task>::Invalid for none. The default is the current task.

Return values

L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees all regions within the interval given by start and size. If a region overlaps the start or the end of the interval this region is only detached partly. If the interval is within one region the original region is split up into two separate

regions.
Definition at line 908 of file rm.

15.465.3.6 detach() [3/3]

```
l4_ret_t L4Re::Rm::detach (
            void * addr,
            L4::Cap< Dataspace > * mem,
            L4::Cap< L4::Task > const & task = This_task) const  [inline], [noexcept]
```

Detach and unmap a region from the address space.

Parameters

	addr	Virtual address of region, any address within the region is valid.
out	*mem*	Dataspace that is affected. Give 0 if not interested.
	task	This argument specifies the task where the pages are unmapped. Provide L4::Cap<L4::Task>::Invalid for none. The default is the current task.

Return values

L4Re::Rm::Detach_result	On success.
-L4_ENOENT	No region found.
<0	IPC errors

Frees a region in the virtual address space given by addr (address type). The corresponding part of the address space is now available again.
Definition at line 900 of file rm.

15.465.3.7 find()

```
l4_ret_t L4Re::Rm::find (
            l4_addr_t * addr,
            unsigned long * size,
            Offset * offset,
            L4Re::Rm::Flags * flags,
            L4::Cap< Dataspace > * m)  [inline], [noexcept]
```

Find a region given an address and size.

Parameters

in,out	*addr*	Address to look for. Returns the start address of the found region.
in,out	*size*	Size of the area to look for (in bytes). Returns the size of the found region (in bytes).
out	*offset*	Offset at the beginning of the region within the associated dataspace.
out	*flags*	Region flags, see F::Region_flags (and F::In_area).
out	*m*	Associated dataspace or paging service. May be an invalid capability, see below.

Return values

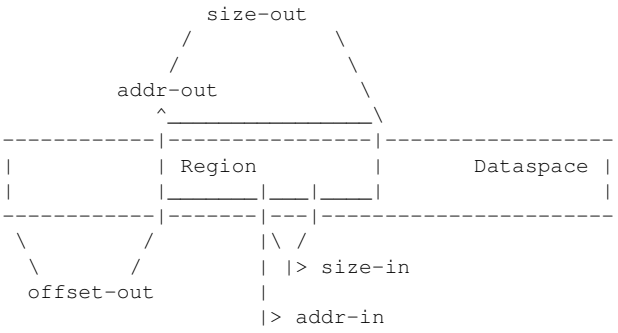
0	Success

-L4_EPERM	Operation not allowed.
-L4_ENOENT	No region found.
<0	IPC errors

This function returns the properties of the region that contains the area described by the addr and size parameter. If no such region is found but a reserved area, the area is returned and F::In_area is set in `flags`. Note, in the case of an area the `offset` and `m` return values are invalid.

Note

`m` is the dataspace that was passed when the region was attached. It is L4_INVALID_CAP whenever the region has no such dataspace, which is the case for regions attached with F::Anonymous because the memory is provided by the region manager itself. Additionally, the capability slot may have been reused by the application in the meantime. Thus, callers must be careful when using `m` of regions that have been created or manipulated by other code.



Note

The value of the size input parameter should be 1 to assure that a region can be determined unambiguously.

Definition at line 680 of file rm.

15.465.3.8 free_area()

```
l4_ret_t L4Re::Rm::free_area (
             l4_addr_t addr)
```

Free an area from the region map.

Parameters

addr	An address within the area to free.

Return values

0	Success
-L4_ENOENT	No area found.
<0	IPC errors

Note

The data spaces that are attached to that area are not detached by this operation.

See also

reserve_area() for more information about areas.

15.465.3.9 get_areas()

```
long L4Re::Rm::get_areas (
            l4_addr_t start,
            L4::Ipc::Array_ref< Area > & areas)
```

Return the list of areas whose starting addresses are higher or equal to `start` in the address space managed by this region map.

Parameters

	start	Virtual address from where to start searching.
out	*areas*	List of areas found in this region map.

Return values

>=0	Number of returned areas in the `areas` array.
<0	IPC errors

Note

The returned list of areas might not be complete and the caller shall use the function repeatedly with a start address one larger than the end address of the last area from the previous call.

15.465.3.10 get_info()

```
l4_ret_t L4Re::Rm::get_info (
            l4_addr_t addr,
            L4::Ipc::String< char > & name,
            Offset & backing_offset)
```

Return auxiliary information of a region.
This is a debugging feature and might not be available.

Parameters

	addr	Virtual address of the region.
out	*name*	Name of the region.
out	*backing_offset*	Backing offset information.

Return values

0	Success
-L4_ENOENT	Region not found.
-L4_ENOSYS	Function not available.
<0	IPC errors

15.465.3.11 get_regions()

```
l4_ret_t L4Re::Rm::get_regions (
            l4_addr_t start,
```

```
L4::Ipc::Array_ref< Region > & regions)
```

Return the list of regions whose starting addresses are higher or equal to `start` in the address space managed by this region map.

Parameters

	start	Virtual address from where to start searching.
out	*regions*	List of regions found in this region map.

Return values

>=0	Number of returned regions in the `regions` array.
<0	IPC errors

Note

The returned list of regions might not be complete and the caller shall use the function repeatedly with a start address one larger that the end address of the last region from the previous call.

15.465.3.12 page_in()

```
l4_ret_t L4Re::Rm::page_in (
            l4_addr_t start,
            unsigned long size,
            Rm::Region_flags rights,
            L4::Cap< L4::Task > dst = L4::Cap<L4::Task>::Invalid) const  [noexcept]
```

Allocate and map pages for the given region.

Establish mappings of all pages in a region so that no page faults should happen after the call returned. Note that dataspace providers may unmap pages at their own discretion. This call is therefore no guarantee that page faults cannot happen.

The whole range must be backed by attached regions. It is not possible to request more rights than with what the region was attached in the first place.

Parameters

start	Start address.
size	Size of region.
rights	Requested mapping attributes (any combination of F::R, F::W and F::X).
dst	Optional destination task of mapping. If invalid, the mapping is established in the current task. This parameter is only useful if the region manager is for a foreign task.

Return values

0	Success
-L4_EACCESS	More rights requested than attached region.
-L4_ENOENT	At least some part of the range was not covered by a region.
-L4_ENODEV	Region was not backed by a dataspace.
<0	IPC errors and other errors from dataspace provider (see L4Re::Dataspace::map).

Definition at line 116 of file rm_impl.h.

15.465.3.13 remove_rescue_jump()

```
l4_ret_t L4Re::Rm::remove_rescue_jump (
            l4_addr_t pc)
```

Remove a previously registered rescue jump.
The rescue jump whose instruction range contains `pc` is removed.

Parameters

pc	Any program counter inside the registered range.

Return values

0	Success
-L4_ENOENT	No rescue jump covers `pc`.
<0	IPC errors

15.465.3.14 reserve_area() [1/2]

```
l4_ret_t L4Re::Rm::reserve_area (
            l4_addr_t * start,
            unsigned long size,
            Flags flags = Flags(0),
            unsigned char align = L4_PAGESHIFT) const  [inline], [noexcept]
```

Reserve the given area in the region map.

Parameters

`in,out`	*start*	The virtual start address of the area to reserve. Returns the start address of the area.
	size	The size of the area to reserve (in bytes).
	flags	Flags for the reserved area (see F::Search_addr, F::Kernel and F::Reserved).
	align	Alignment of area if searched as bits (log2 value).

Return values

0	Success
-L4_EADDRNOTAVAIL	The given area cannot be reserved.
-L4_EINVAL	Invalid parameters
<0	IPC errors

This function reserves an area within the virtual address space managed by the region map. There are two kinds of areas available:

- Reserved areas (*flags* = L4Re::Rm::F::Reserved), where no data spaces can be attached
- Special purpose areas (*flags* = 0), where data spaces can be attached to the area via the L4Re::Rm::F::In_area flag and a start address within the area itself.

Note

When searching for a free place in the virtual address space (with *flags* = L4Re::Rm::F::Search_addr), the space between *start* and the end of the virtual address space is searched.

Definition at line 275 of file rm.

15.465.3.15 reserve_area() [2/2]

```
template<typename T>
l4_ret_t L4Re::Rm::reserve_area (
             T ** start,
             unsigned long size,
             Flags flags = Flags(0),
             unsigned char align = L4_PAGESHIFT) const  [inline], [noexcept]
```

Reserve the given area in the region map.

Parameters

in,out	*start*	The virtual start address of the area to reserve. Returns the start address of the area.
	size	The size of the area to reserve (in bytes).
	flags	Flags for the reserved area (see F::Search_addr, F::Kernel and F::Reserved).
	align	Alignment of area if searched as bits (log2 value).

Return values

0	Success
-L4_EADDRNOTAVAIL	The given area cannot be reserved.
-L4_EINVAL	Invalid parameters
<0	IPC errors

For more information, please refer to the analogous function

See also

L4Re::Rm::reserve_area.

Definition at line 304 of file rm.
The documentation for this class was generated from the following files:

- l4/re/rm
- l4/re/impl/rm_impl.h

15.466 Rm::Area Struct Reference

An area is a range of virtual addresses which is reserved, see L4Re::Rm::reserve_area().
`#include <rm>`

Collaboration diagram for Rm::Area:



15.466.1 Detailed Description

An area is a range of virtual addresses which is reserved, see L4Re::Rm::reserve_area().

See also

Region map API

Definition at line 713 of file rm.
The documentation for this struct was generated from the following file:

- l4/re/rm

15.467 Rm::F Struct Reference

Rm flags definitions.
`#include <rm>`
Collaboration diagram for Rm::F:



Public Types

- enum Attach_flags : l4_uint32_t {
  Search_addr = 0x20000 , In_area = 0x40000 , Eager_map = 0x80000 , No_eager_map = 0x100000 ,
  Attach_mask = 0x1f0000 }

  Flags for attach operation.
- enum Region_flags : l4_uint16_t {
  Rights_mask = 0x0f , R = Dataspace::F::R , W = Dataspace::F::W , X = Dataspace::F::X ,
  RW = Dataspace::F::RW , RX = Dataspace::F::RX , RWX = Dataspace::F::RWX , Kernel = 0x100 ,
  Pager = 0x400 , Reserved = 0x800 , Private = 0x1000 , Anonymous = 0x2000 ,
  Caching_mask = Dataspace::F::Caching_mask , Cache_normal = Dataspace::F::Normal , Cache_buffered =
  Dataspace::F::Bufferable , Cache_uncached = Dataspace::F::Uncacheable ,
  Ds_map_mask = 0xff , Region_flags_mask = 0xffff }

Region flags (permissions, cacheability, special).

15.467.1 Detailed Description

Rm flags definitions.
Definition at line 109 of file rm.

15.467.2 Member Enumeration Documentation

15.467.2.1 Attach_flags

`enum L4Re::Rm::F::Attach_flags : l4_uint32_t`
Flags for attach operation.

Enumerator

Search_addr	Search for a suitable address range.
In_area	Search only in area, or map into area.
Eager_map	Eagerly map the attached data space in.
No_eager_map	Prevent eager mapping of the attached data space.
Attach_mask	Mask of all attach flags.

Definition at line 112 of file rm.

15.467.2.2 Region_flags

`enum L4Re::Rm::F::Region_flags : l4_uint16_t`
Region flags (permissions, cacheability, special).

Enumerator

Rights_mask	Region rights.
R	Readable region.
W	Writable region.
X	Executable region.
RW	Readable and writable region.
RX	Readable and executable region.
RWX	Readable, writable and executable region.
Kernel	Kernel-provided memory (KUMEM).
Pager	Region has a pager. Page faults in this region are not handled by ITAS but rather forwarded to the external region manager / pager.
Reserved	Region is reserved (blocked).
Private	Attach the dataspace privately with copy-on-write semantics. That is, updates to the mapping are not visible in the underlying dataspace.
Anonymous	Attach anonymous memory in the region. The caller must not pass a dataspace. Instead, the region manager provides anonymous memory for the region.
Caching_mask	Mask of all Rm cache bits.
Cache_normal	Cache bits for normal cacheable memory. This is the default if no other cache-related flag was specified.
Cache_buffered	Cache bits for buffered (write combining) memory.

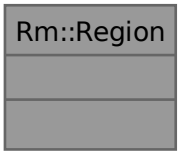
Cache_uncached	Cache bits for uncached memory.
Ds_map_mask	Mask for all bits for cache options and rights.
Region_flags_mask	Mask of all region flags.

Definition at line 130 of file rm.
The documentation for this struct was generated from the following file:

- l4/re/rm

15.468 Rm::Region Struct Reference

A region is a range of virtual addresses which is backed by content.
`#include <rm>`
Collaboration diagram for Rm::Region:



15.468.1 Detailed Description

A region is a range of virtual addresses which is backed by content.

See also

Region map API

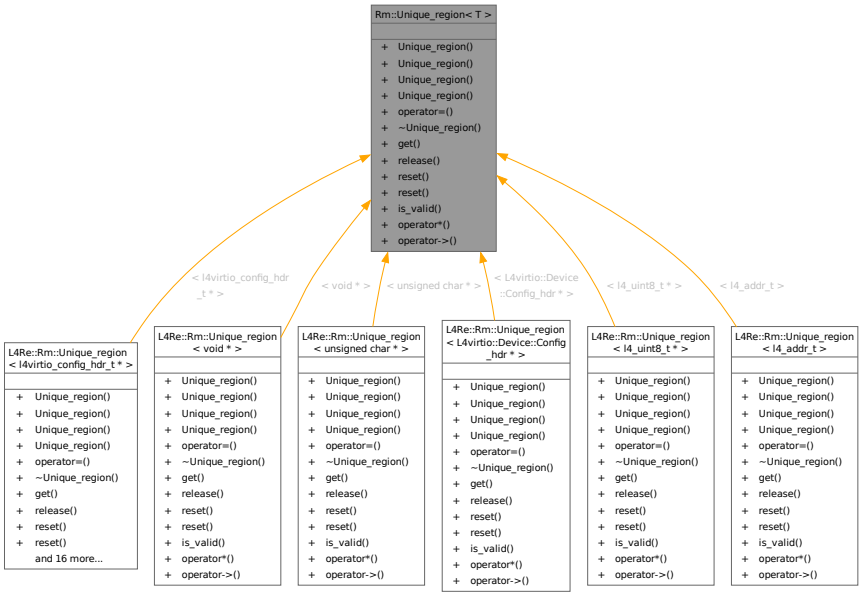
Definition at line 700 of file rm.
The documentation for this struct was generated from the following file:

- l4/re/rm

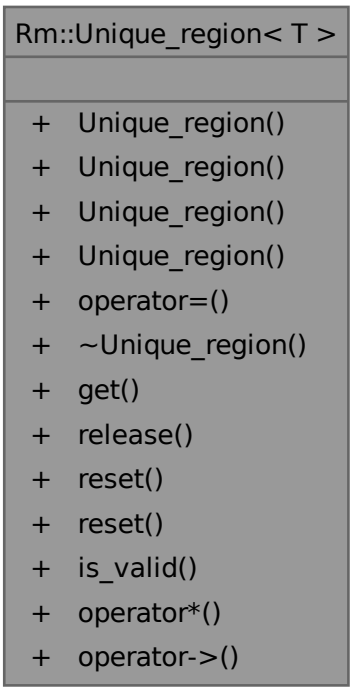
15.469 Rm::Unique_region< T > Class Template Reference

Unique region.
`#include <rm>`

Inheritance diagram for Rm::Unique_region< T >:



Collaboration diagram for Rm::Unique_region< T >:



Public Member Functions

- **Unique_region** () noexcept

  Construct an invalid `Unique_region`.
- Unique_region (T addr) noexcept

  Construct a `Unique_region` from an address.
- Unique_region (T addr, L4::Cap< Rm > const &rm) noexcept

  Construct a valid `Unique_region` from an address and a region manager.
- Unique_region (Unique_region &&o) noexcept

  Move-Construct a `Unique_region`.
- Unique_region & operator= (Unique_region &&o) noexcept

  Move-assign a `Unique_region`.
- ~Unique_region () noexcept

  Destructor.
- T get () const noexcept

  Return the address.
- T release () noexcept

  Return the address and invalidate the `Unique_region`.
- void reset (T addr, L4::Cap< Rm > const &rm) noexcept

  Set new address and region manager.
- void **reset** () noexcept

  Make the `Unique_region` invalid.
- bool is_valid () const noexcept

  Check if the `Unique_region` is valid.
- T **operator*** () const noexcept

  Dereference the address.
- T **operator->** () const noexcept

  Member access for the address.

15.469.1 Detailed Description

template<typename T>
class Rm::Unique_region< T >

Unique region.
Capture a single region with automatic detach on destruction and unique ownership. Stores the start address and the region-mapper capability internally. A unique region is valid precisely if the internal region-mapper capability is valid. The features for unique ownership and automatic detach are only active for valid unique regions.
Definition at line 431 of file rm.

15.469.2 Constructor & Destructor Documentation

15.469.2.1 Unique_region() [1/3]

```
template<typename T>
L4Re::Rm::Unique_region< T >::Unique_region (
            T addr)  [inline], [explicit], [noexcept]
```

Construct a `Unique_region` from an address.
No region manager is set.

Parameters

addr	The new address

Definition at line 452 of file rm.

15.469.2.2 Unique_region() [2/3]

```
template<typename T>
L4Re::Rm::Unique_region< T >::Unique_region (
            T addr,
            L4::Cap< Rm > const & rm)  [inline], [noexcept]
```

Construct a valid Unique_region from an address and a region manager.

Parameters

addr	The address
rm	The region manager

Definition at line 461 of file rm.

15.469.2.3 Unique_region() [3/3]

```
template<typename T>
L4Re::Rm::Unique_region< T >::Unique_region (
            Unique_region< T > && o)  [inline], [noexcept]
```

Move-Construct a Unique_region.

Parameters

o	L-value reference to other region.

Definition at line 469 of file rm.

15.469.2.4 ~Unique_region()

```
template<typename T>
L4Re::Rm::Unique_region< T >::~Unique_region ()  [inline], [noexcept]
```

Destructor.
If the region is valid, call detach.
Definition at line 494 of file rm.

15.469.3 Member Function Documentation

15.469.3.1 get()

```
template<typename T>
T L4Re::Rm::Unique_region< T >::get () const  [inline], [noexcept]
```

Return the address.

Returns

the address

Definition at line 505 of file rm.

15.469.3.2 is_valid()

```
template<typename T>
bool L4Re::Rm::Unique_region< T >::is_valid () const  [inline], [noexcept]
```

Check if the Unique_region is valid.

Returns

true iff the Unique_region is valid

Definition at line 545 of file rm.

15.469.3.3 operator=()

```
template<typename T>
Unique_region & L4Re::Rm::Unique_region< T >::operator= (
            Unique_region< T > && o)  [inline], [noexcept]
```

Move-assign a Unique_region.

Parameters

o	L-value reference to region to assign from

Definition at line 477 of file rm.

15.469.3.4 release()

```
template<typename T>
T L4Re::Rm::Unique_region< T >::release ()  [inline], [noexcept]
```

Return the address and invalidate the Unique_region.

Returns

the address

Definition at line 513 of file rm.

15.469.3.5 reset()

```
template<typename T>
void L4Re::Rm::Unique_region< T >::reset (
            T addr,
            L4::Cap< Rm > const & rm)  [inline], [noexcept]
```

Set new address and region manager.

Parameters

addr	The new address
rm	The new region manager

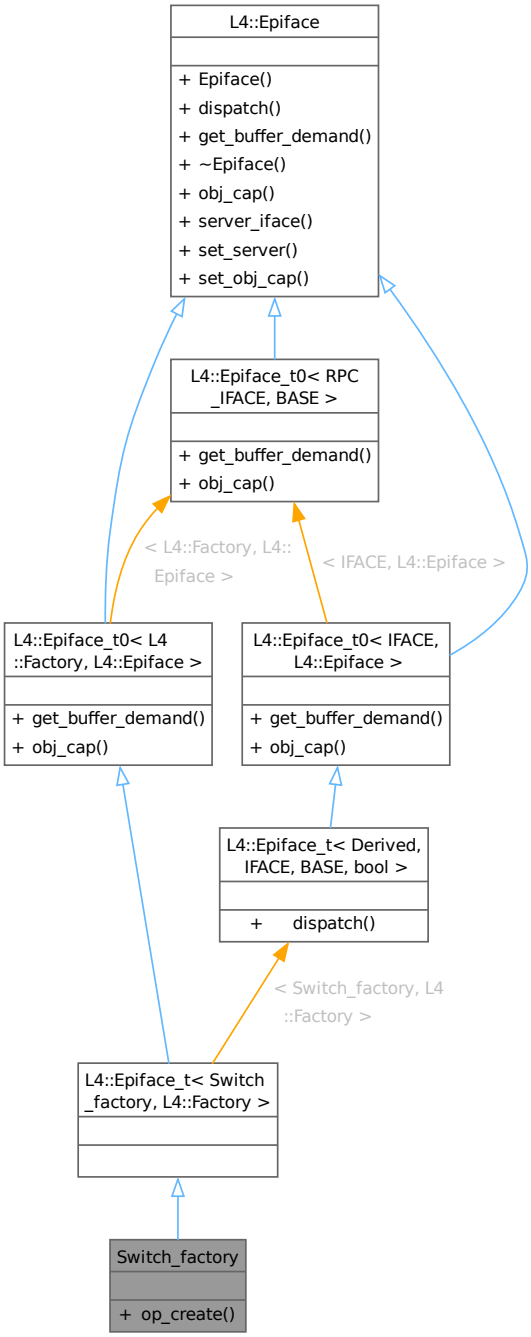
Definition at line 525 of file rm.
The documentation for this class was generated from the following file:

- l4/re/rm

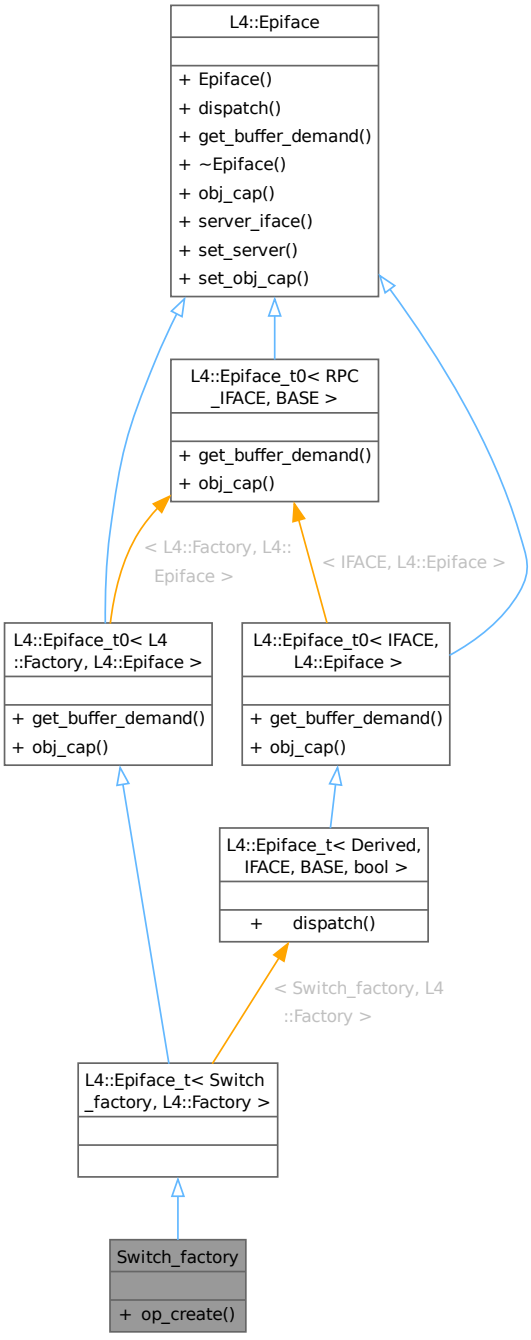
15.470 Switch_factory Class Reference

The IPC interface for creating ports.

Inheritance diagram for Switch_factory:



Collaboration diagram for Switch_factory:



Public Member Functions

- long op_create (L4::Factory::Rights, L4::Ipc::Cap< void > &res, l4_umword_t type, L4::Ipc::Varg_list_ref va)

  Handle factory protocol.

Public Member Functions inherited from L4::Epiface_t0< L4::Factory, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

Get the server-side buffer demand based in IFACE.

- Cap< L4::Factory > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.

- virtual ~**Epiface** ()=0

  Destroy the object.

- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.

- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.

- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.

- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< L4::Factory, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.

- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

15.470.1 Detailed Description

The IPC interface for creating ports.
The Switch factory provides an IPC interface to create ports. Ports are the only option for a client to communicate with the switch and, thus, with other network devices.
The `Switch_factory` gets constructed when the net switch application gets started. It thereafter gets registered on the switch's server to serve IPC `create` calls.
Definition at line 114 of file main.cc.

15.470.2 Member Function Documentation

15.470.2.1 op_create()

```
long Switch_factory::op_create (
            L4::Factory::Rights ,
            L4::Ipc::Cap< void > & res,
            l4_umword_t type,
            L4::Ipc::Varg_list_ref va)  [inline]
```

Handle factory protocol.
This function is invoked after an incoming factory::create request and creates a new port or statistics interface if possible.
Definition at line 533 of file main.cc.
References L4_EINVAL.
The documentation for this class was generated from the following file:

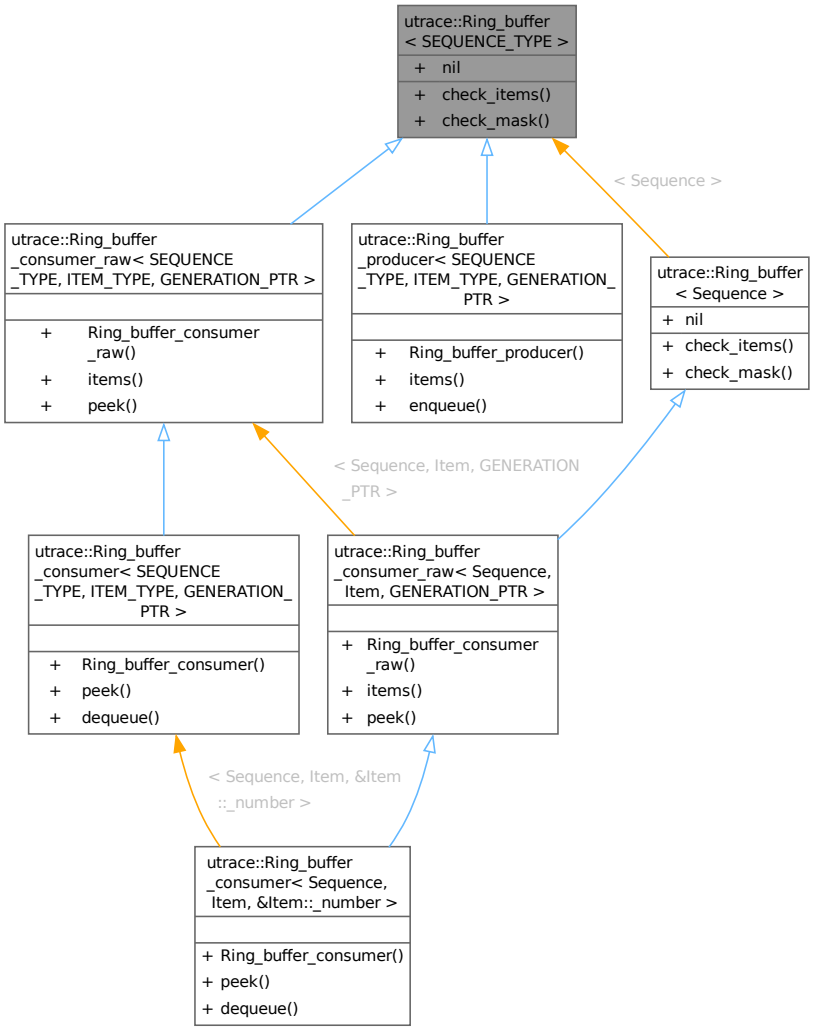
- pkg/virtio-net-switch/server/switch/main.cc

15.471 utrace::Ring_buffer< SEQUENCE_TYPE > Class Template Reference

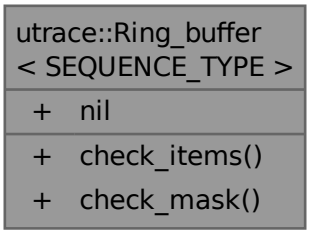
Ring buffer.

`#include <ring_buffer>`

Inheritance diagram for utrace::Ring_buffer< SEQUENCE_TYPE >:



Collaboration diagram for utrace::Ring_buffer< SEQUENCE_TYPE >:



Static Public Member Functions

- static void check_items (size_t const items)

  Check that the number of items is a power of two.
- static void check_mask (size_t const mask)

  Check that the item mask is a power of two minus one.

Static Public Attributes

- static constexpr Sequence const **nil** = 0U

  Invalid (non-committed) items set their sequence counter to 0.

15.471.1 Detailed Description

template<typename SEQUENCE_TYPE>
class utrace::Ring_buffer< SEQUENCE_TYPE >

Ring buffer.
Base class of all ring buffer objects. Not directly usable by the user.

Template Parameters

SEQUENCE_TYPE	Numerical type for storing sequence and generation counters. Must be suitable for atomic access.

Definition at line 63 of file ring_buffer.

15.471.2 Member Function Documentation

15.471.2.1 check_items()

```
template<typename SEQUENCE_TYPE>
void utrace::Ring_buffer< SEQUENCE_TYPE >::check_items (
            size_t const items)  [inline], [static]
```

Check that the number of items is a power of two.
This ring buffer implementation supports a non-zero power of two number of items.

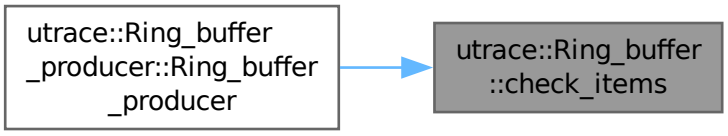
Parameters

items	Number of items.

Exceptions

std::invalid_argument	If the number of items is zero or not a power of two.

Definition at line 83 of file ring_buffer.
Referenced by utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::Ring_buffer_producer().
Here is the caller graph for this function:



15.471.2.2 check_mask()

```
template<typename SEQUENCE_TYPE>
void utrace::Ring_buffer< SEQUENCE_TYPE >::check_mask (
            size_t const mask)  [inline], [static]
```

Check that the item mask is a power of two minus one.
This ring buffer implementation uses the bitwise AND for implementing a modulo operation with the number of items.
Thus the item mask must be a power of two minus one.

Parameters

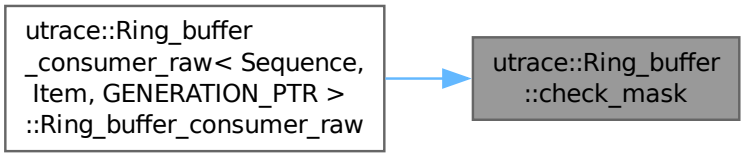
mask	Item mask.

Exceptions

td::length_error	If the item mask is not a power of two minus one.

Definition at line 103 of file ring_buffer.
Referenced by utrace::Ring_buffer_consumer_raw< Sequence, Item, GENERATION_PTR >::Ring_buffer_consumer_raw().

Here is the caller graph for this function:



The documentation for this class was generated from the following file:

- l4/utrace/ring_buffer

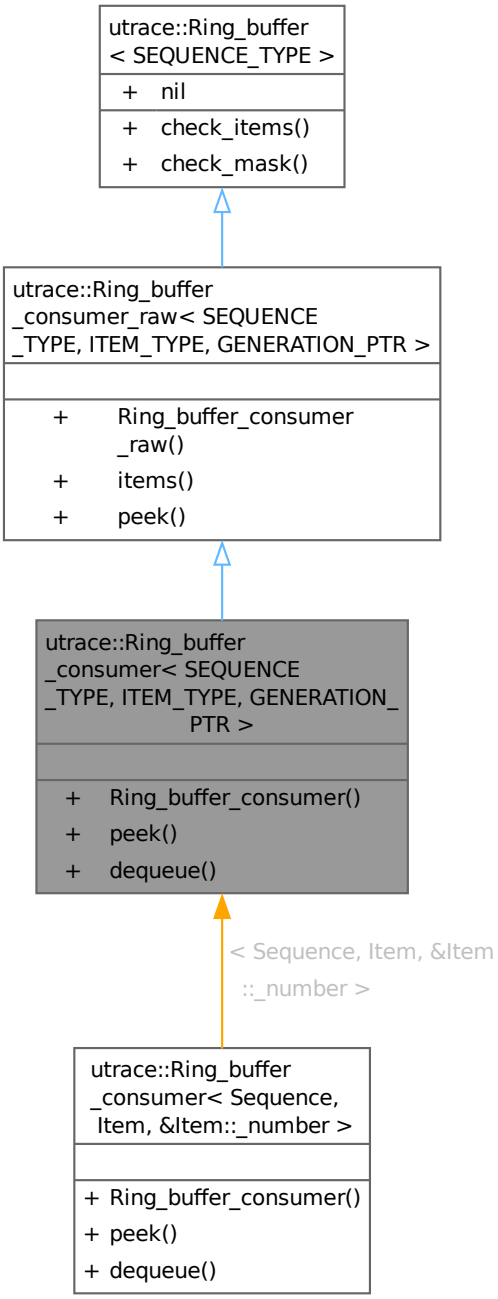
15.472 utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR > Class Template Reference

Blocking ring buffer consumer.

`#include <ring_buffer>`

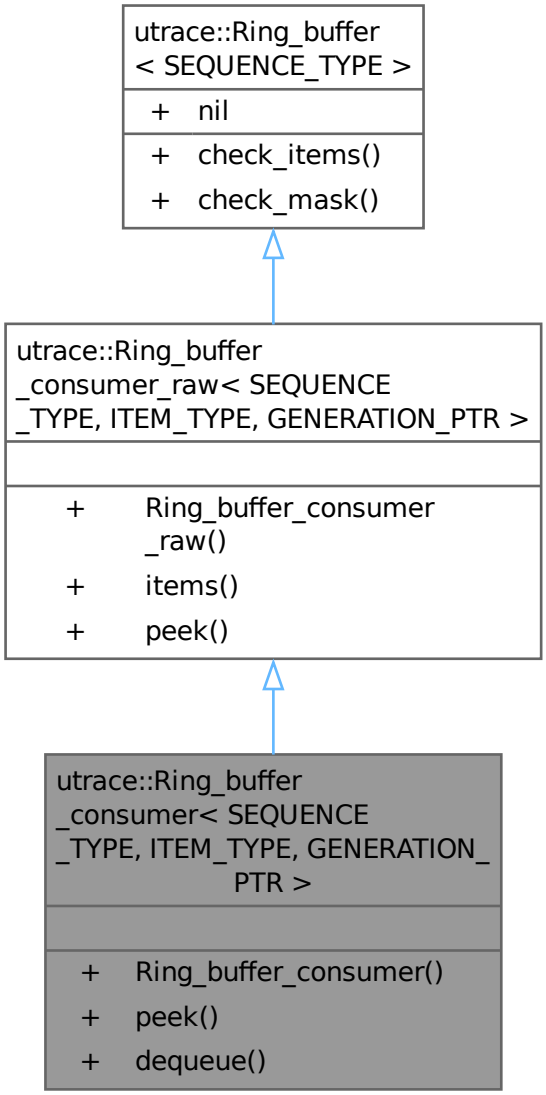
Inheritance diagram for utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR

>:



Collaboration diagram for utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR

>:



Public Member Functions

- Ring_buffer_consumer (Status const &status, Slot const ∗slots)

  Construct ring buffer consumer.
- State peek (Item &item, Drop_policy policy, Sequence ∗drops=nullptr)

  Poll and possibly dequeue an item from the ring buffer.
- size_t dequeue (Item items[ ], size_t capacity, size_t burst, Drop_policy policy, Yield const &yield, Sequence ∗drops=nullptr)

  Dequeue items from the ring buffer.

Public Member Functions inherited from utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >

- Ring_buffer_consumer_raw (Status const &status, Slot const *slots)

  Construct ring buffer consumer.
- size_t **items** () const

  Get the number of items.
- State peek (Item &item, Drop_policy policy, Sequence &current, Sequence *drops=nullptr) const

  Poll and possibly dequeue an item from the ring buffer.

Additional Inherited Members

Public Types inherited from utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >

- enum class Drop_policy { Conservative = 0 , Minimal }

  Item drop policy.
- enum class State

  Status of the dequeue operation.

Static Public Member Functions inherited from utrace::Ring_buffer< SEQUENCE_TYPE >

- static void check_items (size_t const items)

  Check that the number of items is a power of two.
- static void check_mask (size_t const mask)

  Check that the item mask is a power of two minus one.

Static Public Attributes inherited from utrace::Ring_buffer< SEQUENCE_TYPE >

- static constexpr Sequence const **nil** = 0U

  Invalid (non-committed) items set their sequence counter to 0.

15.472.1 Detailed Description

template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
class utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >

Blocking ring buffer consumer.
Both the ring buffer status area and ring buffer slots are accessed in a read-only fashion.

Template Parameters

SEQUENCE_TYPE	Numerical type for storing sequence and generation counters. Must be suitable for atomic access.
ITEM_TYPE	Actual ring buffer item type.
GENERATION_PTR	Class member pointer to the member that contains the sequence number within the item. The member needs to be suitable for an atomic reference.

Definition at line 507 of file ring_buffer.

15.472.2 Constructor & Destructor Documentation

15.472.2.1 Ring_buffer_consumer()

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::Ring_buffer_consumer
(
            Status const & status,
            Slot const * slots)  [inline]
```

Construct ring buffer consumer.

Parameters

status	Ring buffer status area.
slots	Ring buffer slots.

Exceptions

td::length_error	If the item mask (in the ring buffer status area) is not a power of two minus one.

Definition at line 532 of file ring_buffer.

15.472.3 Member Function Documentation

15.472.3.1 dequeue()

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
size_t utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::dequeue (
            Item items[],
            size_t capacity,
            size_t burst,
            Drop_policy policy,
            Yield const & yield,
            Sequence * drops = nullptr)  [inline]
```

Dequeue items from the ring buffer.

Dequeue multiple items from the ring buffer. The goal is to dequeue as many items as available from the ring buffer in a single call to avoid overhead. This operation blocks until at least *burst* items have been dequeued (but returns immediately if an item is dropped).

The implementation implicitly spins actively while waiting for items to be dequeued from the ring buffer. The *yield* function can implement passive waiting. Its argument is the number of idle spinning cycles that already happened and if the function returns true, this number is reset.

Parameters

out	*items*	Array to dequeue the next items from the ring buffer into (as copies).
	capacity	Capacity of *items* (in items).
	burst	Minimal number of items that should be collected before returning in case of waiting for items.
	policy	Item drop policy.
	yield	Yield function to implement passive waiting. Executed in every spinning cycle when no next item has been produced yet. Its argument is the current counter of the idle spinning cycles and that counter is reset when the function returns true.
out	*drops*	Pointer to store the number of items that have been dropped. Can be nullptr.

Returns

Number of items dequeued and stored into *items*.

Definition at line 592 of file ring_buffer.

15.472.3.2 peek()

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
State utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::peek (
            Item & item,
            Drop_policy policy,
            Sequence * drops = nullptr)  [inline]
```

Poll and possibly dequeue an item from the ring buffer.
This operation never blocks. However, since the expected sequence counter of the next item is managed internally with mutual exclusion, multiple concurrent calls to this method might affect the latency.

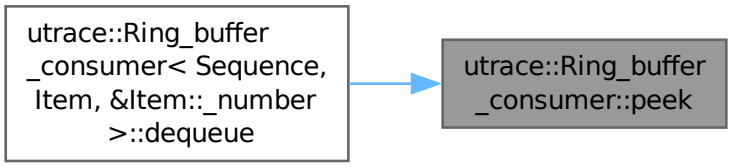
Parameters

out	*item*	Reference to dequeue the next item from the ring buffer into (as a copy).
	policy	Item drop policy.
out	*drops*	Pointer to store the number of items that have been dropped. Can be nullptr.

Return values

State::Idle	No next item has been produced yet. No item has been dequeued, no item has been dropped.
State::Ready	A next item has been dequeued from the ring buffer and stored in *item*. No item has been dropped.
State::Drop	Some items have been dropped (missed). No item has been dequeued. The number of dropped items has been stored to *drops* (if non-nullptr).

Definition at line 557 of file ring_buffer.
Referenced by utrace::Ring_buffer_consumer< Sequence, Item, &Item::_number >::dequeue().
Here is the caller graph for this function:



The documentation for this class was generated from the following file:

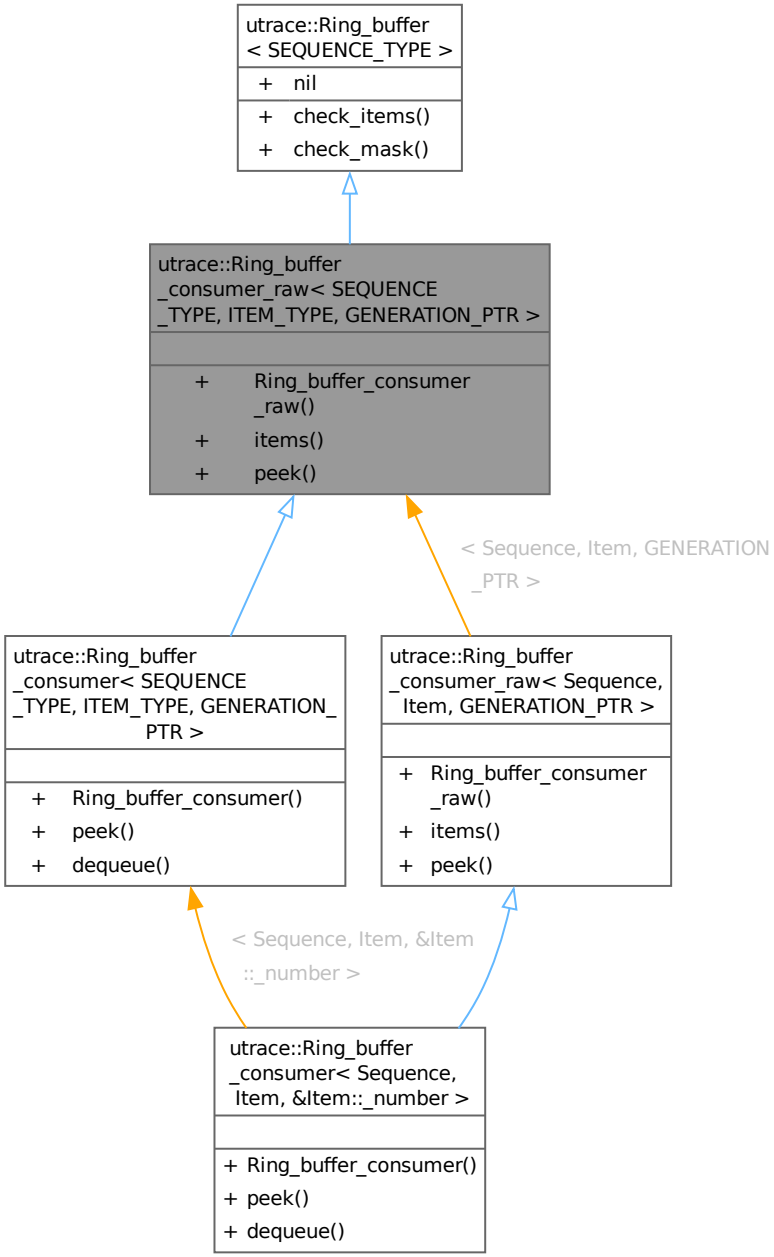
- l4/utrace/ring_buffer

15.473 utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR > Class Template Reference

Polling ring buffer consumer.

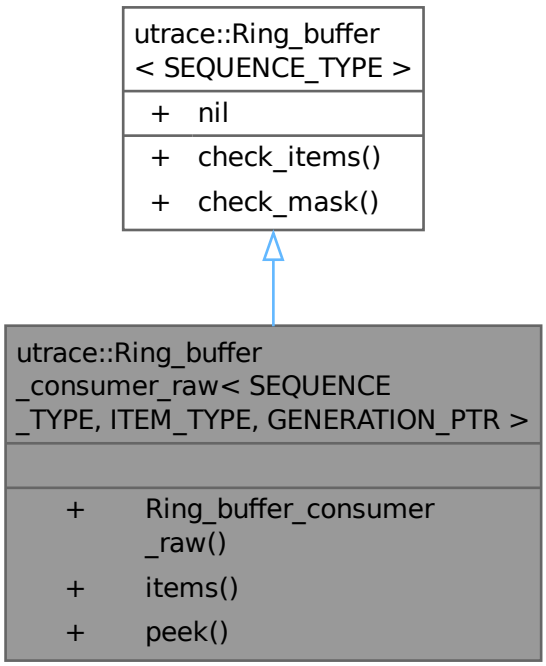
`#include <ring_buffer>`

Inheritance diagram for utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_↩ PTR >:



Collaboration diagram for utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION↩

_PTR >:



Public Types

- enum class Drop_policy { Conservative = 0 , Minimal }

  Item drop policy.
- enum class State

  Status of the dequeue operation.

Public Member Functions

- Ring_buffer_consumer_raw (Status const &status, Slot const *slots)

  Construct ring buffer consumer.
- size_t **items** () const

  Get the number of items.
- State peek (Item &item, Drop_policy policy, Sequence &current, Sequence *drops=nullptr) const

  Poll and possibly dequeue an item from the ring buffer.

Additional Inherited Members

Static Public Member Functions inherited from utrace::Ring_buffer< SEQUENCE_TYPE >

- static void check_items (size_t const items)

  Check that the number of items is a power of two.
- static void check_mask (size_t const mask)

  Check that the item mask is a power of two minus one.

Static Public Attributes inherited from utrace::Ring_buffer< SEQUENCE_TYPE >

- static constexpr Sequence const **nil** = 0U

  Invalid (non-committed) items set their sequence counter to 0.

15.473.1 Detailed Description

template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
class utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >

Polling ring buffer consumer.
Both the ring buffer status area and ring buffer slots are accessed in a read-only fashion.

Template Parameters

SEQUENCE_TYPE	Numerical type for storing sequence and generation counters. Must be suitable for atomic access.
ITEM_TYPE	Actual ring buffer item type.
GENERATION_PTR	Class member pointer to the member that contains the sequence number within the item. The member needs to be suitable for an atomic reference.

Definition at line 331 of file ring_buffer.

15.473.2 Member Enumeration Documentation

15.473.2.1 Drop_policy

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
enum class utrace::Ring_buffer_consumer_raw::Drop_policy  [strong]
```

Item drop policy.
This affects the behavior of the consumer when an item drop is detected (i.e. the consumer loses access to an item or multiple items in the ring buffer that have been overwritten by a producer in the meantime).

Enumerator

Conservative	Conservative item drop policy. Continue with the newest item in the ring buffer (i.e. proactively drop all the items except the newest one). This policy is suitable when the production of items is always faster than the consumption and it gives the consumer a chance to dequeue at least some items from the ring buffer before it falls behind again.
Minimal	Minimal item drop policy. Continue with the oldest item in the ring buffer (i.e. do not proactively drop more items than those that have been lost already). This policy is suitable when the production of items is mostly slower than the consumption and the consumer is able to catch up after an occasional drop of items.

Definition at line 350 of file ring_buffer.

15.473.3 Constructor & Destructor Documentation

15.473.3.1 Ring_buffer_consumer_raw()

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::Ring_buffer_↩
consumer_raw (
            Status const & status,
            Slot const * slots)  [inline]
```

Construct ring buffer consumer.

Parameters

status	Ring buffer status area.
slots	Ring buffer slots.

Exceptions

td::length_error	If the item mask (in the ring buffer status area) is not a power of two minus one.

Definition at line 391 of file ring_buffer.

15.473.4 Member Function Documentation

15.473.4.1 peek()

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
State utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::peek (
            Item & item,
            Drop_policy policy,
            Sequence & current,
            Sequence * drops = nullptr) const  [inline]
```

Poll and possibly dequeue an item from the ring buffer.
This operation never blocks.

Parameters

out	*item*	Reference to dequeue the next item from the ring buffer into (as a copy).
	policy	Item drop policy.
in,out	*current*	Sequence counter of the next item to be dequeued from the ring buffer. Initialize to Ring_buffer::nil to get the sequence counter of the oldest or the newest item currently available in the ring buffer (depending on the item drop policy).
out	*drops*	Pointer to store the number of items that have been dropped. Can be nullptr.

Return values

State::Idle	The next item with the expected sequence counter has not been produced yet. No item has been dequeued, no item has been dropped, the sequence counter is unchanged.
State::Ready	The next item (with the expected sequence counter) has been dequeued from the ring buffer and stored in *item*. The sequence counter *current* has been advanced to the next expected item. No item has been dropped.
State::Drop	Some items have been dropped (missed). No item has been dequeued. The number of dropped items has been stored to *drops* (if non-nullptr). The sequence counter *current* has been advanced to the oldest (if the drop policy is Minimal) or to the newest (if the drop policy is Conservative), respectively.

Definition at line 432 of file ring_buffer.
The documentation for this class was generated from the following file:

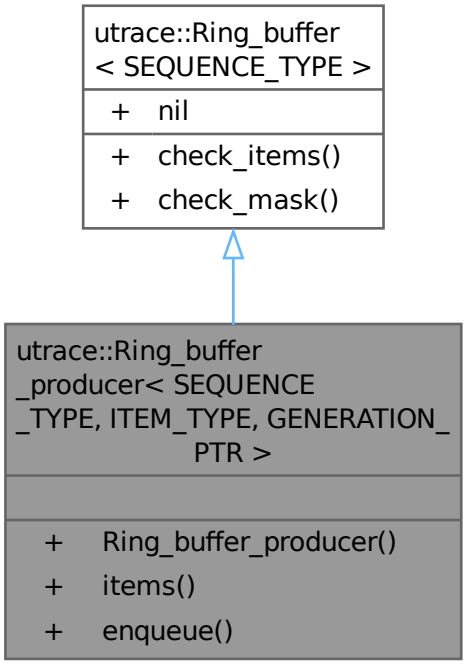
- l4/utrace/ring_buffer

15.474 utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR > Class Template Reference

Ring buffer producer.

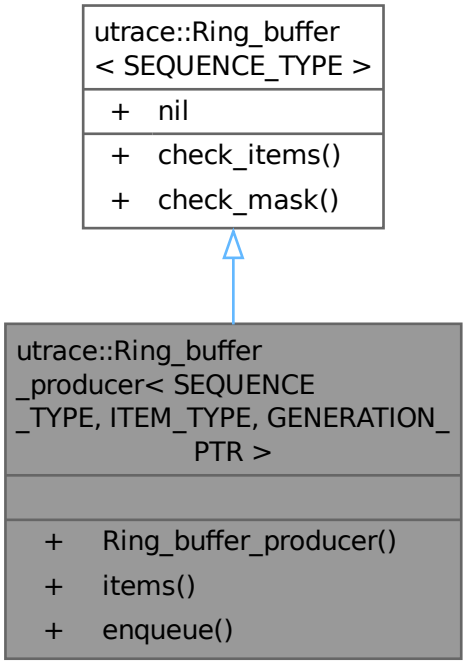
`#include <ring_buffer>`

Inheritance diagram for utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >:



Collaboration diagram for utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR

>:



Public Member Functions

- Ring_buffer_producer (Status &status, Slot &slots, unsigned const version, size_t const items)

  Construct ring buffer producer.
- size_t **items** () const

  Get the number of items.
- void enqueue (Item const &item) const

  Enqueue an item in the ring buffer.

Additional Inherited Members

Static Public Member Functions inherited from utrace::Ring_buffer< SEQUENCE_TYPE >

- static void check_items (size_t const items)

  Check that the number of items is a power of two.
- static void check_mask (size_t const mask)

  Check that the item mask is a power of two minus one.

Static Public Attributes inherited from utrace::Ring_buffer< SEQUENCE_TYPE >

- static constexpr Sequence const **nil** = 0U

  Invalid (non-committed) items set their sequence counter to 0.

15.474.1 Detailed Description

template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
class utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >

Ring buffer producer.

Template Parameters

SEQUENCE_TYPE	Numerical type for storing sequence and generation counters. Must be suitable for atomic access.
ITEM_TYPE	Actual ring buffer item type.
GENERATION_PTR	Class member pointer to the member that contains the sequence number within the item. The member needs to be suitable for an atomic reference.

Definition at line 245 of file ring_buffer.

15.474.2 Constructor & Destructor Documentation

15.474.2.1 Ring_buffer_producer()

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::Ring_buffer_producer
(
            Status & status,
            Slot & slots,
            unsigned const version,
            size_t const items)  [inline]
```

Construct ring buffer producer.
This initializes the ring buffer status area and slots.

Parameters

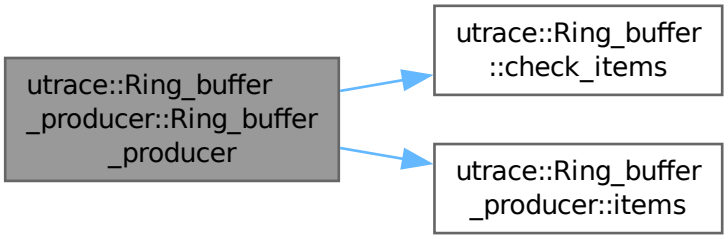
status	Ring buffer status area.
slots	Ring buffer slots.
version	Version of the ring buffer items. The semantics of the version number is defined by the user.
items	Number of items in the ring buffer slots. Must be a non-zero power of two.

Exceptions

std::invalid_argument	If the number of items is zero or not a power of two.

Definition at line 271 of file ring_buffer.
References utrace::Ring_buffer< SEQUENCE_TYPE >::check_items(), items(), and utrace::Ring_buffer< SEQUENCE_TYPE >::nil

Here is the call graph for this function:



15.474.3 Member Function Documentation

15.474.3.1 enqueue()

```
template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
void utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >::enqueue (
            Item const & item) const  [inline]
```

Enqueue an item in the ring buffer.
This operation never blocks and implements the head-drop policy (i.e. the oldest item is overwritten).

Parameters

item	Item to enqueue (as a copy).

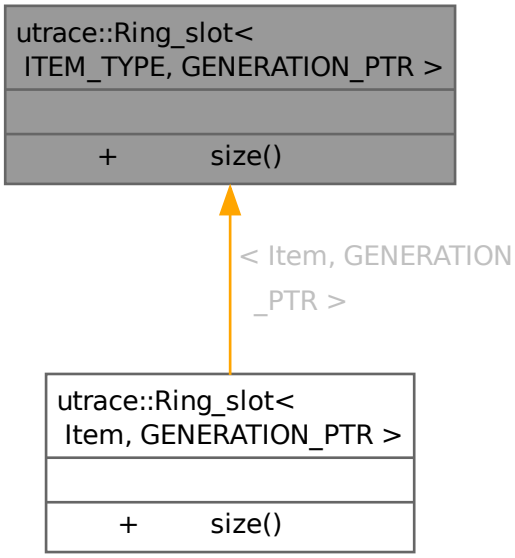
Definition at line 297 of file ring_buffer.
References utrace::Ring_buffer< SEQUENCE_TYPE >::nil.
The documentation for this class was generated from the following file:

- l4/utrace/ring_buffer

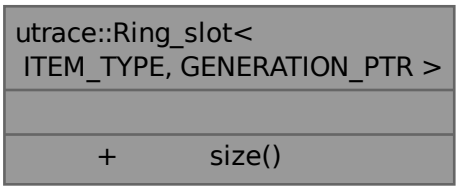
15.475 utrace::Ring_slot< ITEM_TYPE, GENERATION_PTR > Class Template Reference

Ring buffer slot.
`#include <ring_buffer>`

Inheritance diagram for utrace::Ring_slot< ITEM_TYPE, GENERATION_PTR >:



Collaboration diagram for utrace::Ring_slot< ITEM_TYPE, GENERATION_PTR >:



Static Public Member Functions

- static size_t size (size_t const items)

  Get the size (in bytes) of the given count of items.

15.475.1 Detailed Description

template<typename ITEM_TYPE, auto GENERATION_PTR>
class utrace::Ring_slot< ITEM_TYPE, GENERATION_PTR >

Ring buffer slot.
The ring buffer slot encapsulates one ring buffer item and makes sure that the item is aligned to the nearest larger power-of-two of its size.
Another purpose of this class is to abstract away the access to the sequence number of the item.

Template Parameters

ITEM_TYPE	Actual ring buffer item type.
GENERATION_PTR	Class member pointer to the member that contains the sequence number within the item. The member needs to be suitable for an atomic reference.

Definition at line 204 of file ring_buffer.

15.475.2 Member Function Documentation

15.475.2.1 size()

```
template<typename ITEM_TYPE, auto GENERATION_PTR>
size_t utrace::Ring_slot< ITEM_TYPE, GENERATION_PTR >::size (
            size_t const items)  [inline], [static]
```

Get the size (in bytes) of the given count of items.

Parameters

items	Count of items.

Returns

Size (in bytes) of the given count of items.

Definition at line 221 of file ring_buffer.

The documentation for this class was generated from the following file:

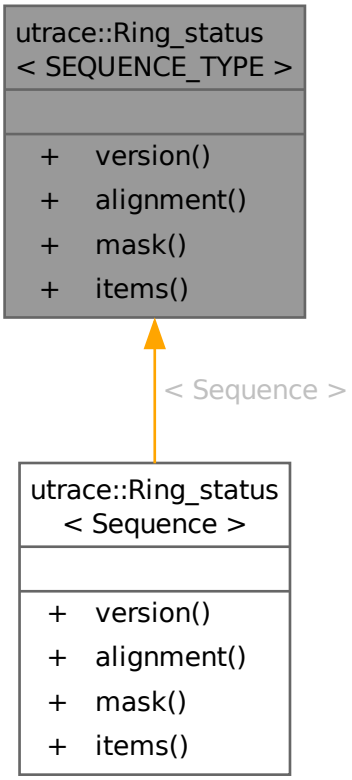
- l4/utrace/ring_buffer

15.476 utrace::Ring_status< SEQUENCE_TYPE > Class Template Reference

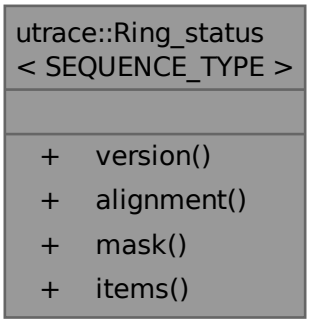
Ring buffer status area.

```
#include <ring_buffer>
```

Inheritance diagram for utrace::Ring_status< SEQUENCE_TYPE >:



Collaboration diagram for utrace::Ring_status< SEQUENCE_TYPE >:



Public Member Functions

- unsigned version () const

Get the version of the ring buffer items.

- size_t alignment () const

  Get the stable alignment of the ring buffer status members.

- size_t **mask** () const

  Get the item mask.

- size_t **items** () const

  Get the number of items.

15.476.1 Detailed Description

template<typename SEQUENCE_TYPE>
class utrace::Ring_status< SEQUENCE_TYPE >

Ring buffer status area.
The ring buffer status area contains run-time configuration information of the ring buffer, most notably the current atomic generation counter (i.e. the last sequence number allocated to an item).
This structure is only written by the producers, it is read-only for the consumers.

Template Parameters

SEQUENCE_TYPE	Numerical type for storing sequence and generation counters. Must be suitable for atomic access.

Definition at line 125 of file ring_buffer.

15.476.2 Member Function Documentation

15.476.2.1 alignment()

```
template<typename SEQUENCE_TYPE>
size_t utrace::Ring_status< SEQUENCE_TYPE >::alignment () const  [inline]
```

Get the stable alignment of the ring buffer status members.
This is relevant for the _mask and _tail members.

Returns

Stable alignment of the ring buffer status members.

Definition at line 152 of file ring_buffer.

15.476.2.2 version()

```
template<typename SEQUENCE_TYPE>
unsigned utrace::Ring_status< SEQUENCE_TYPE >::version () const  [inline]
```

Get the version of the ring buffer items.
The semantics of the version number is defined by the user.

Returns

Version of the ring buffer items.

Definition at line 142 of file ring_buffer.
The documentation for this class was generated from the following file:

- l4/utrace/ring_buffer

15.477 utrace::Tracebuffer Class Reference

Tracebuffer abstraction.

`#include <utrace>`

Collaboration diagram for utrace::Tracebuffer:



Data Structures

- struct Index_desc

  Mapping of the dynamic tracebuffer log indexes to names.

Public Member Functions

- size_t **items** () const

  Get the capacity (in items) of the tracebuffer ring buffer.
- size_t dequeue (Item *items, size_t capacity, size_t burst, Drop_policy policy, Sequence *drops=nullptr)

  Dequeue items from the tracebuffer.

Static Public Member Functions

- static void validate ()

  Check that the base debugger (JDB) capability is valid and accessible.
- static unsigned **version** ()

  Get the tracebuffer format version supported by this class.
- static std::endian **endianness** ()

  Get the endianness supported by this class.
- static std::optional< Index_desc > index (unsigned idx)

  Map a dynamic tracebuffer log index to names.
- static std::vector< Index_desc > indexes ()

  Get all mappings of dynamic tracebuffer log indexes to names.
- static Tracebuffer & **instance** ()

Get the singleton instance of this class.

- static std::optional< Id > ptr_to_id (void *const ptr)

  Convert kernel object pointer to global kernel object ID.

- static std::optional< std::string > id_to_name (Id const id)

  Convert global kernel object ID to object name.

15.477.1 Detailed Description

Tracebuffer abstraction.
Since there is only a single global tracebuffer available in the current implementation, this is a singleton class.
Definition at line 50 of file utrace.

15.477.2 Member Function Documentation

15.477.2.1 dequeue()

```
size_t utrace::Tracebuffer::dequeue (
            Item * items,
            size_t capacity,
            size_t burst,
            Drop_policy policy,
            Sequence * drops = nullptr)
```

Dequeue items from the tracebuffer.
Dequeue multiple items from the tracebuffer. The goal is to dequeue as many items as available from the tracebuffer in a single call to avoid overhead. This operation blocks until at least *burst* items have been dequeued (but returns immediately if an item is dropped).

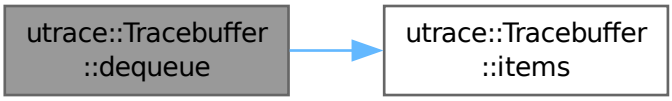
Parameters

out	*items*	Array to dequeue the next items from the tracebuffer into (as copies).
	capacity	Capacity of *items* (in items).
	burst	Minimal number of items that should be collected before returning in case of waiting for items.
	policy	Item drop policy.
out	*drops*	Pointer to store the number of items that have been dropped. Can be nullptr.

Returns

Number of items dequeued and stored into *items*.

References items().
Here is the call graph for this function:



15.477.2.2 id_to_name()

```
std::optional< std::string > utrace::Tracebuffer::id_to_name (
            Id const id)  [static]
```

Convert global kernel object ID to object name.
Some tracebuffer items contain global kernel object IDs that can be associated with human-readable object names.

Parameters

id	Global kernel object ID.

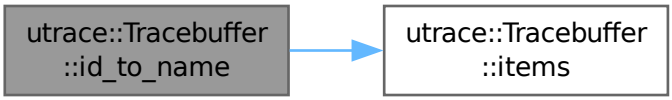
Returns

Object name.

Return values

std::nullopt	No object name was found.

References items().
Here is the call graph for this function:



15.477.2.3 index()

```
std::optional< Index_desc > utrace::Tracebuffer::index (
            unsigned idx)  [static]
```

Map a dynamic tracebuffer log index to names.

Parameters

idx	Dynamic tracebuffer log index to map.

Returns

Mapping of the dynamic tracebuffer index to names.

Return values

std::nullopt	The dynamic tracebuffer log index is not defined.

15.477.2.4 indexes()

```
std::vector< Index_desc > utrace::Tracebuffer::indexes ()  [static]
```

Get all mappings of dynamic tracebuffer log indexes to names.

Returns

Generator (if available) or a vector of all defined mappings of dynamic tracebuffer log indexes to names.

15.477.2.5 ptr_to_id()

```
std::optional< Id > utrace::Tracebuffer::ptr_to_id (
            void *const ptr)  [static]
```

Convert kernel object pointer to global kernel object ID.
Some tracebuffer items contain kernel object pointers that can be converted to global kernel object IDs.

Parameters

ptr	Kernel object pointer.

Returns

Global kernel object ID.

Return values

std::nullopt	No mapping to global kernel object ID was found.

15.477.2.6 validate()

```
void utrace::Tracebuffer::validate ()  [static]
```

Check that the base debugger (JDB) capability is valid and accessible.
The base debugger (JDB) capability is used to access the single global tracebuffer in the current implementation.

Exceptions

std::invalid_argument	If the base debugger (JDB) capability is invalid or inaccessible.

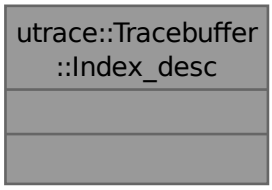
The documentation for this class was generated from the following file:

- l4/utrace/utrace

15.478 utrace::Tracebuffer::Index_desc Struct Reference

Mapping of the dynamic tracebuffer log indexes to names.
`#include <utrace>`

Collaboration diagram for utrace::Tracebuffer::Index_desc:



15.478.1 Detailed Description

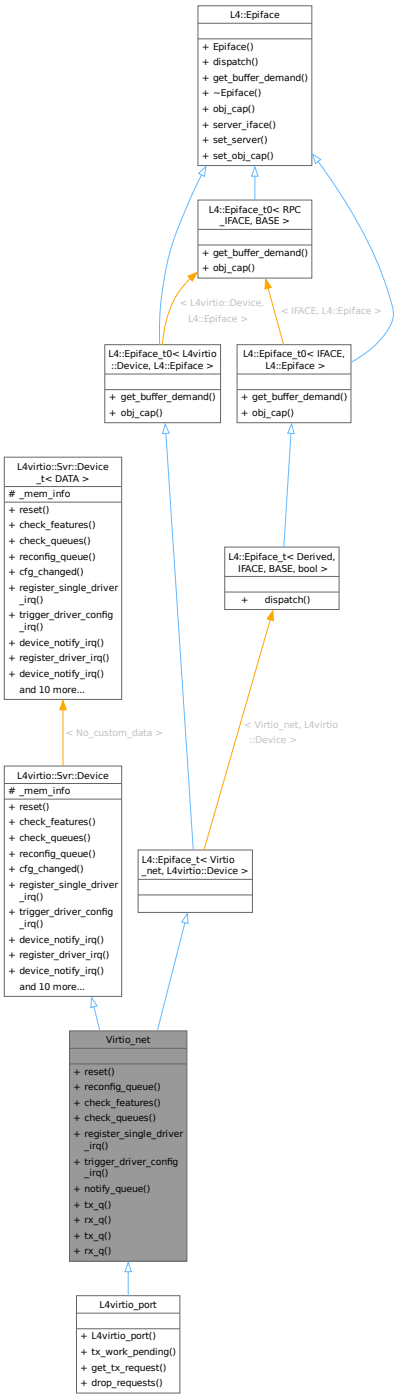
Mapping of the dynamic tracebuffer log indexes to names.
Definition at line 66 of file utrace.
The documentation for this struct was generated from the following file:

- l4/utrace/utrace

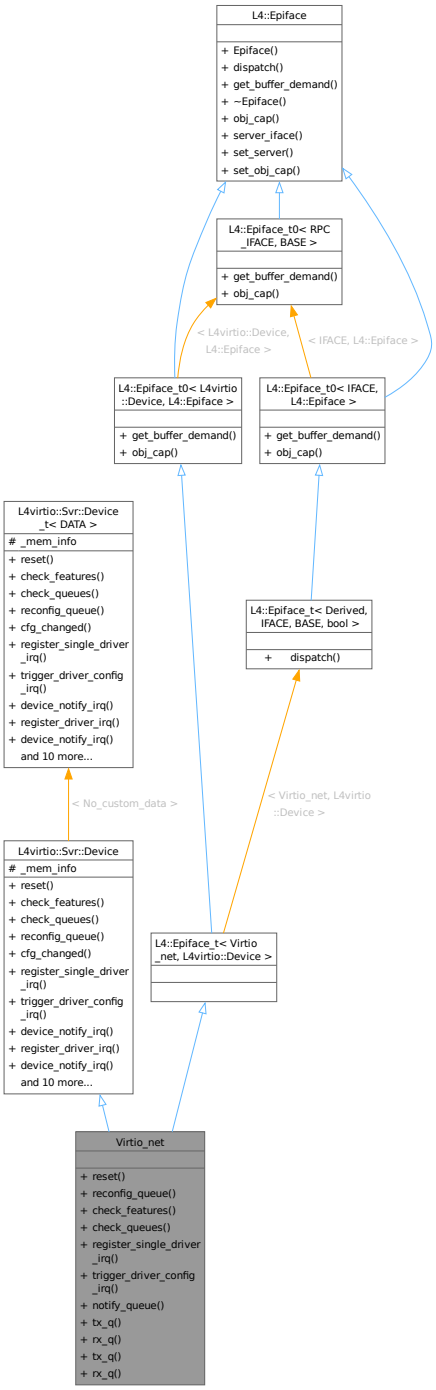
15.479 Virtio_net Class Reference

The Base class of a Port.
`#include <virtio_net.h>`

Inheritance diagram for Virtio_net:



Collaboration diagram for Virtio_net:



Public Member Functions

- void **reset** () override

  reset callback, called for doing a device reset
- int **reconfig_queue** (unsigned index) override

  callback for client queue-config request
- bool **check_features** () override

  callback for checking the subset of accepted features

- bool **check_queues** () override

  Check whether both virtqueues are ready.
- void **register_single_driver_irq** () override

  Save the `_kick_guest_irq` that the client sent via `device_notification_irq()`.
- void **trigger_driver_config_irq** () override

  callback for triggering configuration change notification IRQ
- void notify_queue (L4virtio::Svr::Virtqueue ∗queue)

  Trigger the `_kick_guest_irq` IRQ.
- Virtqueue ∗ **tx_q** ()

  Getter for the transmission queue.
- Virtqueue ∗ **rx_q** ()

  Getter for the receive queue.
- Virtqueue const ∗ **tx_q** () const

  Getter for the transmission queue.
- Virtqueue const ∗ **rx_q** () const

  Getter for the receive queue.

Public Member Functions inherited from L4virtio::Svr::Device_t< No_custom_data >

- virtual void **cfg_changed** (unsigned)

  callback for client device configuration changes
- virtual L4::Cap< L4::Irq > **device_notify_irq** () const

  callback to gather the device notification IRQ (old-style)
- virtual void register_driver_irq (unsigned idx)

  Callback for registering an notification IRQ (multi IRQ).
- virtual L4::Cap< L4::Irq > device_notify_irq (unsigned idx)

  Callback to gather the device notification IRQ (multi IRQ).
- virtual unsigned **num_events_supported** () const

  Return the highest notification index supported.
- Device_t (Dev_config ∗dev_config, L4Re::Util::Dbg msg_user=L4Re::Util::Dbg{}, L4Re::Util::Dbg msg_↩ dev=L4Re::Util::Dbg{2})

  Make a device for the given config.
- Mem_list const ∗ **mem_info** () const

  Get the memory region list used for this device.
- void reset_queue_config (unsigned idx, unsigned num_max, bool inc_generation=false, unsigned device_↩ notify_index=0)

  Trigger reset for the configuration space for queue idx.
- void init_mem_info (unsigned num)

  Initialize the memory region list to the given maximum.
- void device_error ()

  Transition device into DEVICE_NEEDS_RESET state.
- bool setup_queue (Virtqueue ∗q, unsigned qn, unsigned num_max)

  Enable/disable the specified queue.
- bool handle_mem_cmd_write ()

  Check for a value in the `cmd` register and handle a write.
- void **enable_trusted_ds_validation** ()

  Enable trusted dataspace validation.
- void add_trusted_dataspaces (std::shared_ptr< Ds_vector const > ds)

  Provide a list of trusted dataspaces that can be used for validation.

Public Member Functions inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- Type_info::Demand **get_buffer_demand** () const

  Get the server-side buffer demand based in IFACE.
- Cap< L4virtio::Device > obj_cap () const

  Get the (typed) capability to this object.

Public Member Functions inherited from L4::Epiface

- **Epiface** ()

  Make a server object.
- virtual ~**Epiface** ()=0

  Destroy the object.
- Stored_cap obj_cap () const

  Get the capability to the kernel object belonging to this object.
- Server_iface * server_iface () const

  Get pointer to server interface at which the object is currently registered.
- int set_server (Server_iface *srv, Cap< void > cap, bool managed=false)

  Set server registration info for the object.
- void **set_obj_cap** (Cap< void > const &cap)

  Deprecated server registration function.

Additional Inherited Members

Public Types inherited from L4::Epiface_t0< L4virtio::Device, L4::Epiface >

- using **Interface**

  Data type of the IPC interface definition.

Public Types inherited from L4::Epiface

- using **Server_iface** = Ipc_svr::Server_iface

  Type for abstract server interface.
- using **Demand** = Ipc_svr::Server_iface::Demand

  Type for server-side receive buffer demand.

Protected Attributes inherited from L4virtio::Svr::Device_t< No_custom_data >

- Mem_list **_mem_info**

  Memory region list.

15.479.1 Detailed Description

The Base class of a Port.
This class provides the Virtio network protocol specific implementation aspects of a port.
`Virtio_net` comprises the virtqueues for both, the incoming and the outgoing network requests:

- The transmission queue, containing requests to be transmitted to other ports. The transmission queue is filled by the client, this port relates to.
- The receive queue, containing requests that have been transmitted from other ports. The receive queue is filled by the switch.

Definition at line 71 of file virtio_net.h.

15.479.2 Member Function Documentation

15.479.2.1 notify_queue()

```
void Virtio_net::notify_queue (
            L4virtio::Svr::Virtqueue * queue)  [inline]
```

Trigger the `_kick_guest_irq` IRQ.
This function gets called on the receiving port, when a request was successfully transmitted by the switch.
Definition at line 271 of file virtio_net.h.
References L4VIRTIO_IRQ_STATUS_VRING.
The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/server/switch/virtio_net.h

15.480 Virtio_net_request Class Reference

Abstraction for a network request.
`#include <request_l4virtio.h>`
Collaboration diagram for Virtio_net_request:



Public Member Functions

- Mac_addr **dst_mac** () const

  Get the Mac address of the destination port.
- Mac_addr **src_mac** () const

  Get the Mac address of the source port.

Static Public Member Functions

- static void drop_requests (Virtio_net ∗dev, L4virtio::Svr::Virtqueue ∗queue)

  Drop all requests of a specific queue.
- static std::optional< Virtio_net_request > get_request (Virtio_net ∗dev, L4virtio::Svr::Virtqueue ∗queue)

  Construct a request from the next entry of a provided queue.

15.480.1 Detailed Description

Abstraction for a network request.
A `Virtio_net_request` is constructed by the source port, using the static function `get_request()` as part of `Port_iface::get_tx_request()`.
On destruction, `finish()` will be called, which, will trigger the client IRQ of the source client.
Definition at line 35 of file request_l4virtio.h.

15.480.2 Member Function Documentation

15.480.2.1 drop_requests()

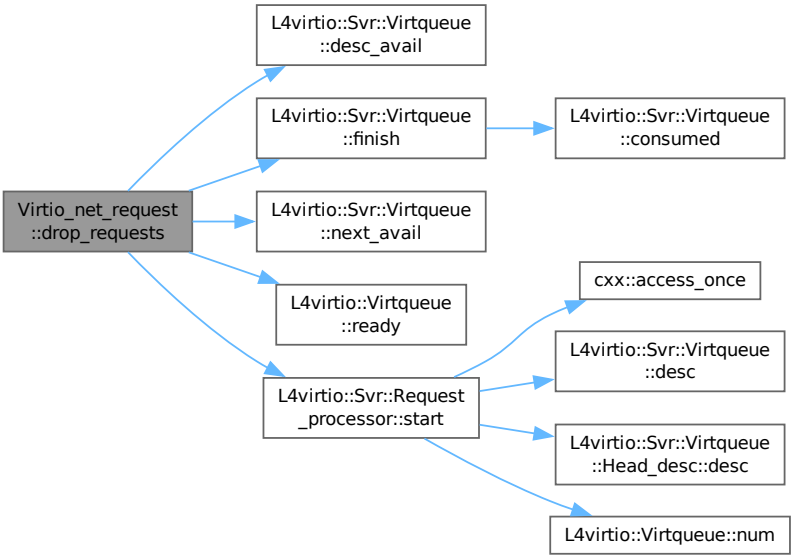
```
void Virtio_net_request::drop_requests (
            Virtio_net * dev,
            L4virtio::Svr::Virtqueue * queue)  [inline], [static]
```

Drop all requests of a specific queue.
This function is used for example to drop all requests in the transmission queue of a monitor port, since monitor ports are not allowed to transmit data.

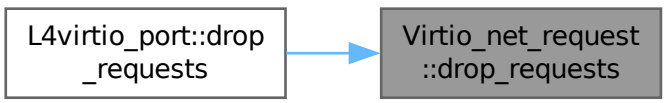
Parameters

dev	Port of the provided virtqueue.
queue	Virtqueue to drop all requests of.

Definition at line 172 of file request_l4virtio.h.
References L4virtio::Svr::Virtqueue::desc_avail(), L4virtio::Svr::Virtqueue::finish(), L4_UNLIKELY, L4virtio::Svr::Virtqueue::next_avail(), L4virtio::Virtqueue::ready(), and L4virtio::Svr::Request_processor::start().
Referenced by L4virtio_port::drop_requests().
Here is the call graph for this function:



Here is the caller graph for this function:



15.480.2.2 get_request()

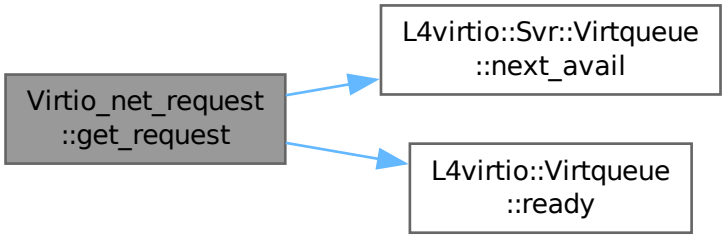
```
std::optional< Virtio_net_request > Virtio_net_request::get_request (
            Virtio_net * dev,
            L4virtio::Svr::Virtqueue * queue)  [inline], [static]
```

Construct a request from the next entry of a provided queue.

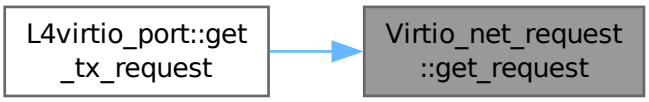
Parameters

dev	Port of the provided virtqueue.
queue	Virtqueue to extract next entry from.

Definition at line 199 of file request_l4virtio.h.
References L4_UNLIKELY, L4virtio::Svr::Virtqueue::next_avail(), and L4virtio::Virtqueue::ready().
Referenced by L4virtio_port::get_tx_request().
Here is the call graph for this function:



Here is the caller graph for this function:



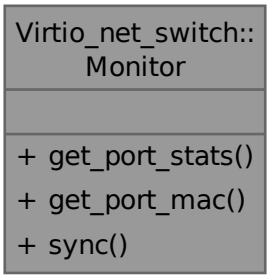
The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/server/switch/request_l4virtio.h

15.481 Virtio_net_switch::Monitor Class Reference

Statistics client interface.
`#include <stats.h>`

Collaboration diagram for Virtio_net_switch::Monitor:



Public Member Functions

- Port_statistics * get_port_stats (char const *name) const

  Retrieve pointer to Port_statistics structure.
- bool get_port_mac (char const *name, unsigned char *mac) const

  Retrieve the MAC address of a port.
- void **sync** () const

  Instruct the network switch to update the statistics information.

15.481.1 Detailed Description

Statistics client interface.
A client can retrieve per port statistics information, such as the number of sent and received packets. The information is shared with a L4Re::Dataspace. The information contained in the L4Re::Dataspace is updated by the switch only on Monitor::sync().
Definition at line 91 of file stats.h.

15.481.2 Member Function Documentation

15.481.2.1 get_port_mac()

```
bool Virtio_net_switch::Monitor::get_port_mac (
            char const * name,
            unsigned char * mac) const  [inline]
```

Retrieve the MAC address of a port.

Parameters

	name	The name of the port.
out	*mac*	A 6 byte buffer allocated by the caller. To be filled with the MAC address of the port.

Definition at line 139 of file stats.h.

15.481.2.2 get_port_stats()

```
Port_statistics * Virtio_net_switch::Monitor::get_port_stats (
            char const * name) const  [inline]
```

Retrieve pointer to Port_statistics structure.

Parameters

name	The name of the port.

Returns

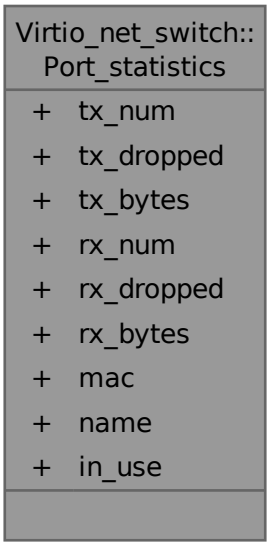
Pointer to the Port_statistics structure or `nullptr` if no port of that name was found.

Definition at line 120 of file stats.h.
The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/lib/include/stats.h

15.482 Virtio_net_switch::Port_statistics Struct Reference

Statistics for one port.
`#include <stats.h>`
Collaboration diagram for Virtio_net_switch::Port_statistics:



Data Fields

- l4_uint64_t **tx_num**
  number of successful send requests
- l4_uint64_t **tx_dropped**
  number of dropped send request
- l4_uint64_t **tx_bytes**
  bytes successfully sent
- l4_uint64_t **rx_num**
  number of successful receive requests
- l4_uint64_t **rx_dropped**
  number of dropped receive requests

- l4_uint64_t **rx_bytes**

  bytes successfully received
- unsigned char **mac** [6]

  MAC address of a port.
- char **name** [20]

  name of a port
- unsigned char **in_use**

  1 iff the data structure is currently in use, 0 otherwise

15.482.1 Detailed Description

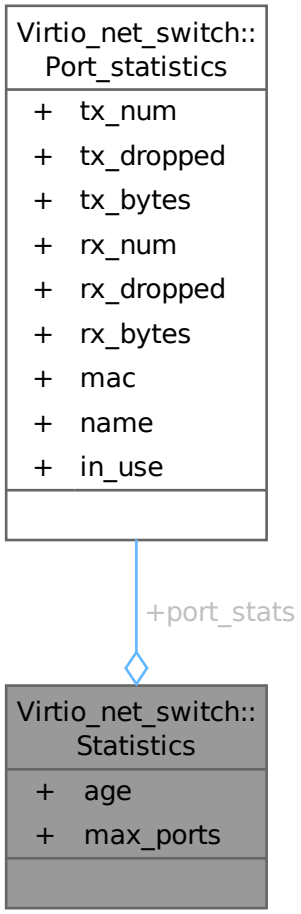
Statistics for one port.
Definition at line 27 of file stats.h.
The documentation for this struct was generated from the following file:

- pkg/virtio-net-switch/lib/include/stats.h

15.483 Virtio_net_switch::Statistics Struct Reference

Base statistics data structure, resides at the beginning of shared memory.
`#include <stats.h>`

Collaboration diagram for Virtio_net_switch::Statistics:



Data Fields

- l4_uint64_t age

  This value increases on any change in the data structure.
- l4_uint64_t **max_ports**

  The maximum number of ports that the switch supports.
- struct Port_statistics **port_stats** [ ]

  Array of Port_statistics.

15.483.1 Detailed Description

Base statistics data structure, resides at the beginning of shared memory.
Definition at line 42 of file stats.h.

15.483.2 Field Documentation

15.483.2.1 age

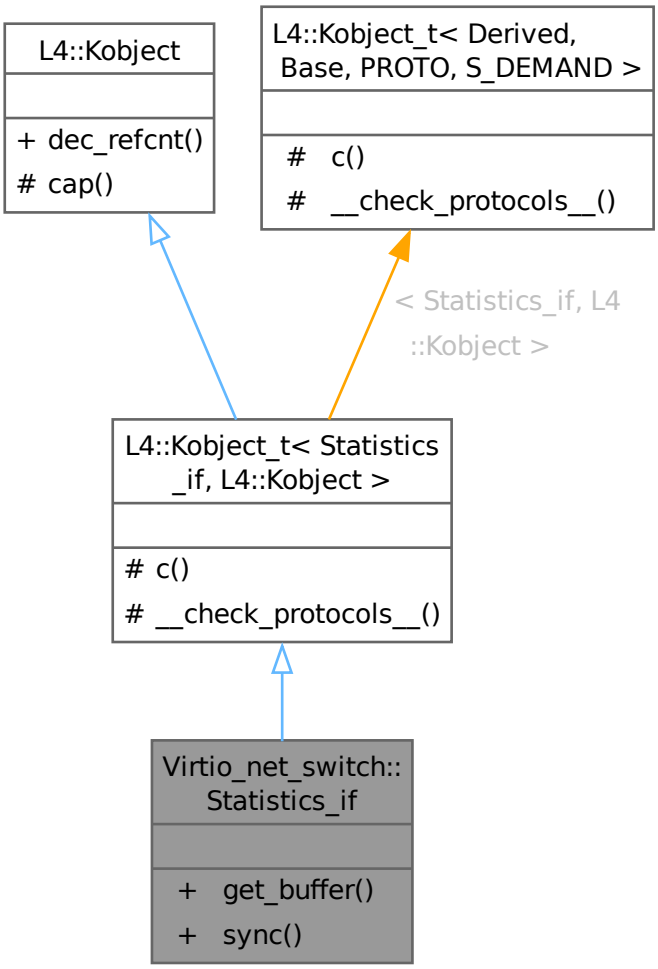
```
l4_uint64_t Virtio_net_switch::Statistics::age
```

This value increases on any change in the data structure.
E.g. when a port on the switch is created or discarded.
Definition at line 44 of file stats.h.
The documentation for this struct was generated from the following file:

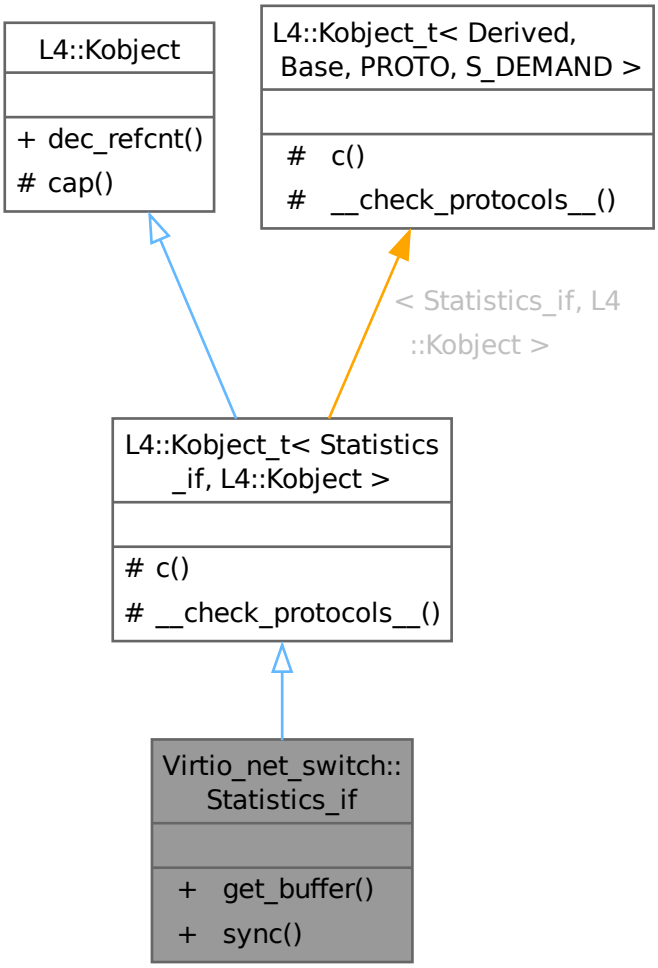
- pkg/virtio-net-switch/lib/include/stats.h

15.484 Virtio_net_switch::Statistics_if Class Reference

IPC interface for the statistics interface.
`#include <stats.h>`
Inheritance diagram for Virtio_net_switch::Statistics_if:



Collaboration diagram for Virtio_net_switch::Statistics_if:



Public Member Functions

- long get_buffer (L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > ds)

  Get shared memory buffer containing port statistics.
- long sync ()

  Instruct the switch to update the statistics information in the shared memory buffer.

Public Member Functions inherited from L4::Kobject

- l4_msgtag_t dec_refcnt (l4_mword_t diff, l4_utcb_t *utcb=l4_utcb())

  Decrement the in kernel reference counter for the object.

Additional Inherited Members

Protected Types inherited from L4::Kobject_t< Statistics_if, L4::Kobject >

- typedef Statistics_if **Class**

The target interface type (inheriting from Kobject_t).

- typedef Typeid::Iface< PROTO_ANY, Statistics_if > **__Iface**

  The interface description for the derived class.

- typedef Typeid::Merge_list< Typeid::Iface_list< __Iface >, typename L4::Kobject::__Iface_list > **__Iface_list**

  The list of all RPC interfaces provided directly or through inheritance.

Protected Member Functions inherited from L4::Kobject_t< Statistics_if, L4::Kobject >

- L4::Cap< Class > **c** () const noexcept

  Get the capability to ourselves.

Protected Member Functions inherited from L4::Kobject

- l4_cap_idx_t cap () const noexcept

  Return capability selector.

Static Protected Member Functions inherited from L4::Kobject_t< Statistics_if, L4::Kobject >

- static void **__check_protocols__** () noexcept

  Helper to check for protocol conflicts.

15.484.1 Detailed Description

IPC interface for the statistics interface.
This interface is plumbing used by the Monitor interface. Clients usually do not invoke this directly.
Definition at line 58 of file stats.h.

15.484.2 Member Function Documentation

15.484.2.1 get_buffer()

```
long Virtio_net_switch::Statistics_if::get_buffer (
            L4::Ipc::Out< L4::Cap< L4Re::Dataspace > > ds)
```

Get shared memory buffer containing port statistics.

Parameters

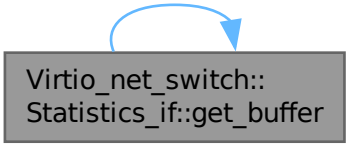
out	*ds*	Capability of the dataspace containing port statistics.

Return values

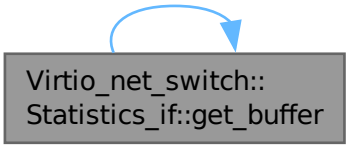
0	Success
<0	Error

References get_buffer().
Referenced by get_buffer().

Here is the call graph for this function:



Here is the caller graph for this function:



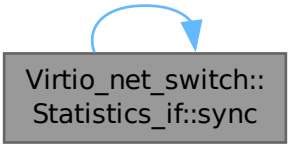
15.484.2.2 sync()

`long Virtio_net_switch::Statistics_if::sync ()`
Instruct the switch to update the statistics information in the shared memory buffer.

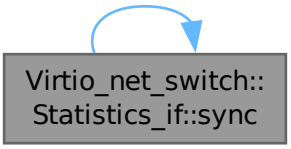
Return values

0	Success
<0	Error

References sync().
Referenced by sync().
Here is the call graph for this function:



Here is the caller graph for this function:

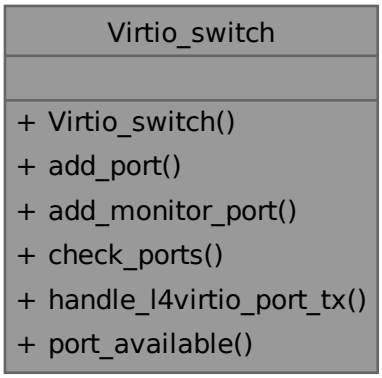


The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/lib/include/stats.h

15.485 Virtio_switch Class Reference

The Virtio switch contains all ports and processes network requests.
`#include <switch.h>`
Collaboration diagram for Virtio_switch:



Public Member Functions

- Virtio_switch (unsigned max_ports)
  Create a switch with n ports.
- bool add_port (Port_iface *port)
  Add a port to the switch.
- bool add_monitor_port (Port_iface *port)
  Add a monitor port to the switch.
- void check_ports ()
  Check validity of ports.
- bool handle_l4virtio_port_tx (L4virtio_port *port)
  Handle TX queue of the given port.

- bool port_available (bool monitor)

  Is there still a free port on this switch available?

15.485.1 Detailed Description

The Virtio switch contains all ports and processes network requests.
A Port on its own is not capable to process an incoming network request because it has no knowledge about other ports. The processing of an incoming request therefore gets delegated to the switch.
The `Virtio_switch` is constructed at the start of the Virtio Net Switch application. The factory saves a reference to it to pass it to the `Kick_irq` on port creation.
Definition at line 35 of file switch.h.

15.485.2 Constructor & Destructor Documentation

15.485.2.1 Virtio_switch()

```
Virtio_switch::Virtio_switch (
             unsigned max_ports)  [explicit]
```

Create a switch with n ports.

Parameters

max_ports	maximal number of provided ports

Definition at line 12 of file switch.cc.

15.485.3 Member Function Documentation

15.485.3.1 add_monitor_port()

```
bool Virtio_switch::add_monitor_port (
             Port_iface * port)
```

Add a monitor port to the switch.

Parameters

port	A pointer to an already constructed Port_iface object.

Return values

true	Port was added successfully.
false	Switch was not able to add the port.

Definition at line 41 of file switch.cc.

15.485.3.2 add_port()

```
bool Virtio_switch::add_port (
             Port_iface * port)
```

Add a port to the switch.

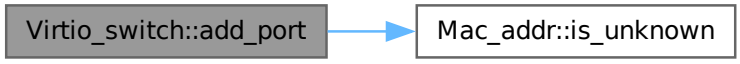
Parameters

port	A pointer to an already constructed Port_iface object.

Return values

true	Port was added successfully.
false	Switch was not able to add the port.

Definition at line 17 of file switch.cc.
References Mac_addr::is_unknown().
Here is the call graph for this function:



15.485.3.3 check_ports()

```
void Virtio_switch::check_ports ()
```

Check validity of ports.
Check whether all ports are still used and remove any unused (unreferenced) ports. Shall be invoked after an incoming cap deletion irq to remove ports without clients.
Definition at line 56 of file switch.cc.

15.485.3.4 handle_l4virtio_port_tx()

```
bool Virtio_switch::handle_l4virtio_port_tx (
            L4virtio_port * port)
```

Handle TX queue of the given port.

Parameters

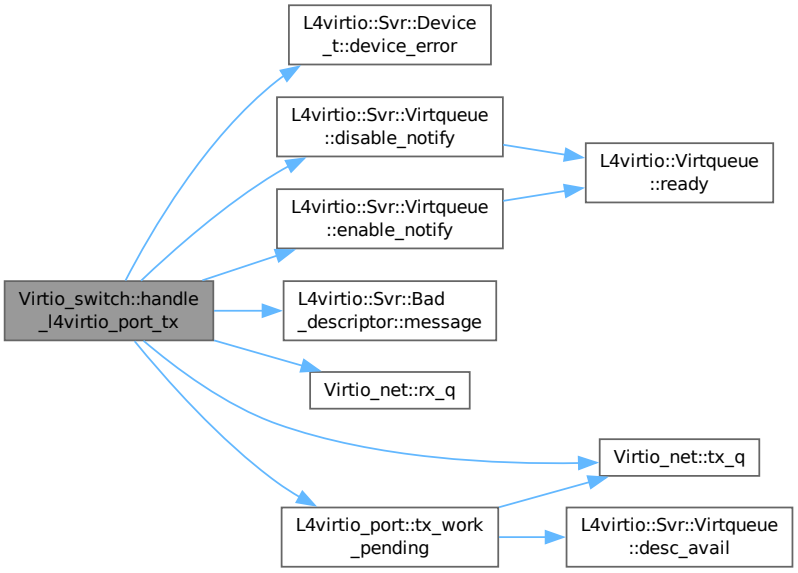
port	L4virtio_port to handle pending TX work for.

Return values

false	Port hit its TX burst limit, and thus a TX pending reschedule notification was queued.
true	Port's entire TX queue was processed.

Definition at line 180 of file switch.cc.
References L4virtio::Svr::Device_t< DATA >::device_error(), L4virtio::Svr::Virtqueue::disable_notify(), L4virtio::Svr::Virtqueue::enable
L4virtio::Svr::Bad_descriptor::message(), Virtio_net::rx_q(), Virtio_net::tx_q(), and L4virtio_port::tx_work_pending().

Here is the call graph for this function:



15.485.3.5 port_available()

```
bool Virtio_switch::port_available (
            bool monitor)  [inline]
```

Is there still a free port on this switch available?

Parameters

monitor	True if we look for a monitor slot.

Return values

true	Port is available.
false	No port available.

Definition at line 146 of file switch.h.
The documentation for this class was generated from the following files:

- pkg/virtio-net-switch/server/switch/switch.h
- pkg/virtio-net-switch/server/switch/switch.cc

15.486 Virtio_vlan_mangle Class Reference

Class for VLAN packet rewriting.
`#include <vlan.h>`

Collaboration diagram for Virtio_vlan_mangle:



Public Member Functions

- Virtio_vlan_mangle ()
  Default constructor.
- l4_uint32_t copy_pkt (Buffer &dst, Buffer &src)
  Copy packet from src to dst.
- void rewrite_hdr (Virtio_net::Hdr *hdr)
  Rewrite the virtio network header.

Static Public Member Functions

- static constexpr Virtio_vlan_mangle add (l4_uint16_t tci)
  Construct an object that adds a VLAN tag.
- static constexpr Virtio_vlan_mangle remove ()
  Construct an object that removes the VLAN tag.

15.486.1 Detailed Description

Class for VLAN packet rewriting.
Definition at line 36 of file vlan.h.

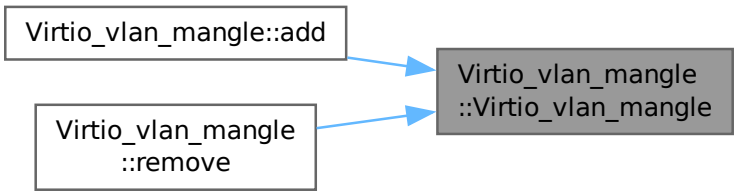
15.486.2 Constructor & Destructor Documentation

15.486.2.1 Virtio_vlan_mangle()

```
Virtio_vlan_mangle::Virtio_vlan_mangle () [inline]
```

Default constructor.
The packet is not touched in any way.
Definition at line 52 of file vlan.h.
Referenced by add(), and remove().

Here is the caller graph for this function:



15.486.3 Member Function Documentation

15.486.3.1 add()

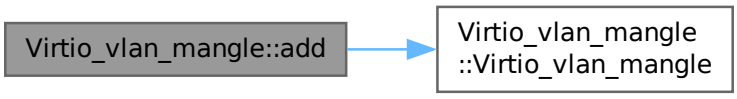
```
constexpr Virtio_vlan_mangle Virtio_vlan_mangle::add (
            l4_uint16_t tci)  [inline], [static], [constexpr]
```

Construct an object that adds a VLAN tag.

Parameters

tci	The TCI field of the VLAN tag to add.

It is the callers responsibility to ensure that the packet is not already tagged.
Definition at line 64 of file vlan.h.
References Virtio_vlan_mangle().
Here is the call graph for this function:



15.486.3.2 copy_pkt()

```
l4_uint32_t Virtio_vlan_mangle::copy_pkt (
            Buffer & dst,
            Buffer & src)  [inline]
```

Copy packet from *src* to *dst*.

Parameters

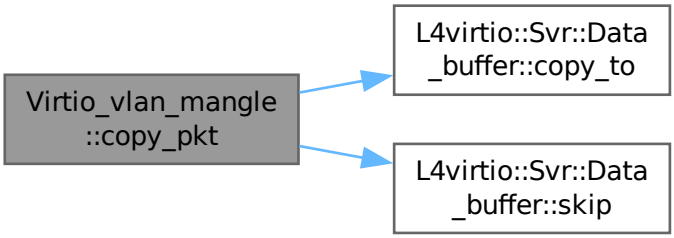
src	Source packet buffer

dst	Destination packet buffer

Returns

The number of bytes copied

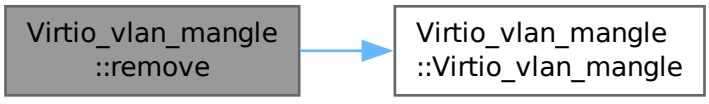
Copy the data from *src* to *dst*, possibly rewriting parts of the packet. The method is expected to be called repeatedly until the source packet is finished. Partial copies are allowed (including reading nothing from the source buffer) as long as progress is made, i.e. repeatedly calling this function eventually consumes the source buffer.
Definition at line 93 of file vlan.h.
References L4virtio::Svr::Data_buffer::copy_to(), L4_LIKELY, L4virtio::Svr::Data_buffer::left, L4virtio::Svr::Data_buffer::pos, and L4virtio::Svr::Data_buffer::skip().
Here is the call graph for this function:



15.486.3.3 remove()

```
constexpr Virtio_vlan_mangle Virtio_vlan_mangle::remove ()  [inline], [static], [constexpr]
```

Construct an object that removes the VLAN tag.
This object assumes that the Ethernet packet has a VLAN tag and will slavishly remove the necessary bytes from the packet.
Definition at line 75 of file vlan.h.
References Virtio_vlan_mangle().
Here is the call graph for this function:



15.486.3.4 rewrite_hdr()

```
void Virtio_vlan_mangle::rewrite_hdr (
            Virtio_net::Hdr * hdr)  [inline]
```

Rewrite the virtio network header.

Parameters

hdr	The virtio header of the packet

This method is called exactly once for every virtio network packet. Any necessary changes to the header are done in-place.
Definition at line 142 of file vlan.h.
References L4_UNLIKELY.
The documentation for this class was generated from the following file:

- pkg/virtio-net-switch/server/switch/vlan.h

Chapter 16

File Documentation

16.1 asm_access.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Jakub Jermar <jakub.jermar@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/sys/l4int.h>
00011
00012 namespace Asm_access {
00013
00014 inline
00015 l4_uint8_t
00016 read(l4_uint8_t const *mem)
00017 {
00018   l4_uint8_t val;
00019
00020   asm volatile ("movb %[mem], %[val]" : [val] "=q" (val) : [mem] "m" (*mem));
00021
00022   return val;
00023 }
00024
00025 inline
00026 l4_uint16_t
00027 read(l4_uint16_t const *mem)
00028 {
00029   l4_uint16_t val;
00030
00031   asm volatile ("movw %[mem], %[val]" : [val] "=r" (val) : [mem] "m" (*mem));
00032
00033   return val;
00034 }
00035
00036 inline
00037 l4_uint32_t
00038 read(l4_uint32_t const *mem)
00039 {
00040   l4_uint32_t val;
00041
00042   asm volatile ("movl %[mem], %[val]" : [val] "=r" (val) : [mem] "m" (*mem));
00043
00044   return val;
00045 }
00046
00047 inline
00048 l4_uint64_t
00049 read(l4_uint64_t const *mem)
00050 {
00051   l4_uint64_t val;
00052
00053   asm volatile ("movq %[mem], %[val]" : [val] "=r" (val) : [mem] "m" (*mem));
00054
00055   return val;
00056 }
00057
00058 inline
00059 void
00060 write(l4_uint8_t val, l4_uint8_t *mem)
00061 {
```

```
00062   asm volatile ("movb %[val], %[mem]" :[mem]  "=m" (*mem) : [val] "qi" (val));
00063 }
00064
00065 inline
00066 void
00067 write(l4_uint16_t val, l4_uint16_t *mem)
00068 {
00069   asm volatile ("movw %[val], %[mem]" : [mem] "=m" (*mem) : [val] "ri" (val));
00070 }
00071
00072 inline
00073 void
00074 write(l4_uint32_t val, l4_uint32_t *mem)
00075 {
00076   asm volatile ("movl %[val], %[mem]" : [mem] "=m" (*mem) : [val] "ri" (val));
00077 }
00078
00079 inline
00080 void
00081 write(l4_uint64_t val, l4_uint64_t *mem)
00082 {
00083   asm volatile ("movq %[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00084 }
00085
00086 }
```

16.2 asm_access.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Jakub Jermar <jakub.jermar@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/sys/l4int.h>
00011
00012 namespace Asm_access {
00013
00014 inline
00015 l4_uint8_t
00016 read(l4_uint8_t const *mem)
00017 {
00018   l4_uint8_t val;
00019
00020   asm volatile ("ldrb %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00021
00022   return val;
00023 }
00024
00025 inline
00026 l4_uint16_t
00027 read(l4_uint16_t const *mem)
00028 {
00029   l4_uint16_t val;
00030
00031   asm volatile ("ldrh %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00032
00033   return val;
00034 }
00035
00036 inline
00037 l4_uint32_t
00038 read(l4_uint32_t const *mem)
00039 {
00040   l4_uint32_t val;
00041
00042   asm volatile ("ldr %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00043
00044   return val;
00045 }
00046
00047 inline
00048 void
00049 write(l4_uint8_t val, l4_uint8_t *mem)
00050 {
00051   asm volatile ("strb %[val], %[mem]" :[mem]  "=m" (*mem) : [val] "r" (val));
00052 }
00053
00054 inline
00055 void
00056 write(l4_uint16_t val, l4_uint16_t *mem)
```

```
00057 {
00058   asm volatile ("strh %[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00059 }
00060
00061 inline
00062 void
00063 write(l4_uint32_t val, l4_uint32_t *mem)
00064 {
00065   asm volatile ("str %[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00066 }
00067
00068 }
```

16.3 asm_access.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Jakub Jermar <jakub.jermar@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/sys/l4int.h>
00011
00012 namespace Asm_access {
00013
00014 inline
00015 l4_uint8_t
00016 read(l4_uint8_t const *mem)
00017 {
00018   l4_uint8_t val;
00019
00020   asm volatile ("ldrb %w[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00021
00022   return val;
00023 }
00024
00025 inline
00026 l4_uint16_t
00027 read(l4_uint16_t const *mem)
00028 {
00029   l4_uint16_t val;
00030
00031   asm volatile ("ldrh %w[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00032
00033   return val;
00034 }
00035
00036 inline
00037 l4_uint32_t
00038 read(l4_uint32_t const *mem)
00039 {
00040   l4_uint32_t val;
00041
00042   asm volatile ("ldr %w[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00043
00044   return val;
00045 }
00046
00047 inline
00048 l4_uint64_t
00049 read(l4_uint64_t const *mem)
00050 {
00051   l4_uint64_t val;
00052
00053   asm volatile ("ldr %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00054
00055   return val;
00056 }
00057
00058 inline
00059 void
00060 write(l4_uint8_t val, l4_uint8_t *mem)
00061 {
00062   asm volatile ("strb %w[val], %[mem]" :[mem]  "=m" (*mem) : [val] "r" (val));
00063 }
00064
00065 inline
00066 void
00067 write(l4_uint16_t val, l4_uint16_t *mem)
00068 {
00069   asm volatile ("strh %w[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
```

```
00070 }
00071
00072 inline
00073 void
00074 write(l4_uint32_t val, l4_uint32_t *mem)
00075 {
00076   asm volatile ("str %w[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00077 }
00078
00079 inline
00080 void
00081 write(l4_uint64_t val, l4_uint64_t *mem)
00082 {
00083   asm volatile ("str %[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00084 }
00085
00086 }
```

16.4 asm_access.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Jakub Jermar <jakub.jermar@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/drivers/asm_access_gen.h>
```

16.5 asm_access.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/sys/l4int.h>
00011
00012 namespace Asm_access {
00013
00014 inline
00015 l4_uint8_t
00016 read(l4_uint8_t const *mem)
00017 {
00018   l4_uint8_t val;
00019
00020   asm volatile ("lb %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00021
00022   return val;
00023 }
00024
00025 inline
00026 l4_uint16_t
00027 read(l4_uint16_t const *mem)
00028 {
00029   l4_uint16_t val;
00030
00031   asm volatile ("lh %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00032
00033   return val;
00034 }
00035
00036 inline
00037 l4_uint32_t
00038 read(l4_uint32_t const *mem)
00039 {
00040   l4_uint32_t val;
00041
00042   asm volatile ("lw %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00043
00044   return val;
00045 }
00046
00047 inline
00048 void
```

```
00049 write(l4_uint8_t val, l4_uint8_t *mem)
00050 {
00051   asm volatile ("sb %[val], %[mem]" :[mem]  "=m" (*mem) : [val] "r" (val));
00052 }
00053
00054 inline
00055 void
00056 write(l4_uint16_t val, l4_uint16_t *mem)
00057 {
00058   asm volatile ("sh %[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00059 }
00060
00061 inline
00062 void
00063 write(l4_uint32_t val, l4_uint32_t *mem)
00064 {
00065   asm volatile ("sw %[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00066 }
00067
00068 #if __riscv_xlen == 64
00069
00070 inline
00071 l4_uint64_t
00072 read(l4_uint64_t const *mem)
00073 {
00074   l4_uint64_t val;
00075
00076   asm volatile ("ld %[val], %[mem]" : [val] "=r" (val) : [mem] "m" (*mem));
00077
00078   return val;
00079 }
00080
00081 inline
00082 void
00083 write(l4_uint64_t val, l4_uint64_t *mem)
00084 {
00085   asm volatile ("sd %[val], %[mem]" : [mem] "=m" (*mem) : [val] "r" (val));
00086 }
00087
00088 #endif
00089
00090 }
```

16.6 asm_access.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Jakub Jermar <jakub.jermar@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/sys/l4int.h>
00011
00012 namespace Asm_access {
00013
00014 inline
00015 l4_uint8_t
00016 read(l4_uint8_t const *mem)
00017 {
00018   l4_uint8_t val;
00019
00020   asm volatile ("movb %[mem], %[val]" : [val] "=q" (val) : [mem] "m" (*mem));
00021
00022   return val;
00023 }
00024
00025 inline
00026 l4_uint16_t
00027 read(l4_uint16_t const *mem)
00028 {
00029   l4_uint16_t val;
00030
00031   asm volatile ("movw %[mem], %[val]" : [val] "=r" (val) : [mem] "m" (*mem));
00032
00033   return val;
00034 }
00035
00036 inline
00037 l4_uint32_t
00038 read(l4_uint32_t const *mem)
00039 {
```

```
00040   l4_uint32_t val;
00041
00042   asm volatile ("movl %[mem], %[val]" : [val] "=r" (val) : [mem] "m" (*mem));
00043
00044   return val;
00045 }
00046
00047 inline
00048 void
00049 write(l4_uint8_t val, l4_uint8_t *mem)
00050 {
00051   asm volatile ("movb %[val], %[mem]" :[mem]  "=m" (*mem) : [val] "qi" (val));
00052 }
00053
00054 inline
00055 void
00056 write(l4_uint16_t val, l4_uint16_t *mem)
00057 {
00058   asm volatile ("movw %[val], %[mem]" : [mem] "=m" (*mem) : [val] "ri" (val));
00059 }
00060
00061 inline
00062 void
00063 write(l4_uint32_t val, l4_uint32_t *mem)
00064 {
00065   asm volatile ("movl %[val], %[mem]" : [mem] "=m" (*mem) : [val] "ri" (val));
00066 }
00067
00068 }
```

16.7 asm_access_gen.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Jakub Jermar <jakub.jermar@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/l4int.h>
00010 #include <l4/cxx/type_traits>
00011
00012 namespace Asm_access {
00013
00014 template <typename T>
00015 struct is_supported_type
00016 {
00017   static const bool value = cxx::is_same<T, l4_uint8_t>::value
00018                             || cxx::is_same<T, l4_uint16_t>::value
00019                             || cxx::is_same<T, l4_uint32_t>::value
00020                             || cxx::is_same<T, l4_uint64_t>::value;
00021 };
00022
00023 template <typename T>
00024 inline
00025 typename cxx::enable_if<is_supported_type<T>::value, T>::type
00026 read(T const *mem)
00027 {
00028   return *reinterpret_cast<volatile T const *>(mem);
00029 }
00030
00031 template <typename T>
00032 inline
00033 typename cxx::enable_if<is_supported_type<T>::value, void>::type
00034 write(T val, T *mem)
00035 {
00036   *reinterpret_cast<volatile T *>(mem) = val;
00037 }
00038
00039 }
```

16.8 hw_mmio_register_block

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2014-2021, 2023-2024 Kernkonzept GmbH.
00004  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00005  *            Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
```

```
00008  */
00009 #pragma once
00010
00011 #include <l4/drivers/hw_register_block>
00012 #include <l4/drivers/asm_access.h>
00013
00014 namespace L4drivers {
00015
00016 class Mmio_register_block_base
00017 {
00018 protected:
00019   l4_addr_t _base;
00020   l4_addr_t _shift;
00021
00022 public:
00023   explicit Mmio_register_block_base(l4_addr_t base = 0, l4_addr_t shift = 0)
00024   : _base(base), _shift(shift) {}
00025
00026   template< typename T >
00027   T read(l4_addr_t reg) const
00028   { return Asm_access::read(reinterpret_cast<T const *>(_base + (reg << _shift))); }
00029
00030   template< typename T >
00031   void write(T value, l4_addr_t reg) const
00032   { Asm_access::write(value, reinterpret_cast<T *>(_base + (reg << _shift))); }
00033
00034   void set_base(l4_addr_t base) { _base = base; }
00035   void set_shift(l4_addr_t shift) { _shift = shift; }
00036
00037   l4_addr_t get_base() const { return _base; }
00038 };
00039
00044 template< unsigned MAX_BITS = 32 >
00045 struct Mmio_register_block
00046 : Register_block_impl<Mmio_register_block<MAX_BITS>, MAX_BITS>,
00047   Mmio_register_block_base
00048 {
00049   explicit Mmio_register_block(l4_addr_t base = 0, l4_addr_t shift = 0)
00050   : Mmio_register_block_base(base, shift) {}
00051 };
00052
00053 }
```

16.9 hw_register_block

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2014-2021, 2023-2024 Kernkonzept GmbH.
00004  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/sys/types.h>
00011 #include <l4/cxx/type_traits>
00012
00013 namespace L4drivers {
00014
00015
00062
00063
00071 template< unsigned MAX_BITS = 32 >
00072 struct Register_block_base;
00073
00074 template<>
00075 struct Register_block_base<8>
00076 {
00077   virtual l4_uint8_t do_read_8(l4_addr_t reg) const = 0;
00078   virtual void do_write_8(l4_uint8_t value, l4_addr_t reg) = 0;
00079   virtual ~Register_block_base() = 0;
00080 };
00081
00082 inline Register_block_base<8>::~Register_block_base() {}
00083
00084 template<>
00085 struct Register_block_base<16> : Register_block_base<8>
00086 {
00087   virtual l4_uint16_t do_read_16(l4_addr_t reg) const = 0;
00088   virtual void do_write_16(l4_uint16_t value, l4_addr_t reg) = 0;
00089 };
00090
00091 template<>
00092 struct Register_block_base<32> : Register_block_base<16>
```

```
00093 {
00094   virtual l4_uint32_t do_read_32(l4_addr_t reg) const = 0;
00095   virtual void do_write_32(l4_uint32_t value, l4_addr_t reg) = 0;
00096 };
00097
00098 template<>
00099 struct Register_block_base<64> : Register_block_base<32>
00100 {
00101   virtual l4_uint64_t do_read_64(l4_addr_t reg) const = 0;
00102   virtual void do_write_64(l4_uint64_t value, l4_addr_t reg) = 0;
00103 };
00104 #undef REGBLK_READ_TEMPLATE
00105 #undef REGBLK_WRITE_TEMPLATE
00106
00107 template<typename CHILD>
00108 struct Register_block_modify_mixin
00109 {
00110   template< typename T >
00111   T modify(T clear_bits, T set_bits, l4_addr_t reg) const
00112   {
00113     CHILD const *c = static_cast<CHILD const *>(this);
00114     T r = (c->template read<T>(reg) & ~clear_bits) | set_bits;
00115     c->template write<T>(r, reg);
00116     return r;
00117   }
00118
00119   template< typename T >
00120   T set(T set_bits, l4_addr_t reg) const
00121   { return this->template modify<T>(T(0), set_bits, reg); }
00122
00123   template< typename T >
00124   T clear(T clear_bits, l4_addr_t reg) const
00125   { return this->template modify<T>(clear_bits, T(0), reg); }
00126 };
00127
00128
00129 #define REGBLK_READ_TEMPLATE(sz) \
00130   template< typename T >          \
00131   typename cxx::enable_if<sizeof(T) == (sz / 8), T>::type read(l4_addr_t reg) const \
00132   { \
00133     union X { T t; l4_uint##sz##_t v; } m; \
00134     m.v = _b->do_read_##sz (reg); \
00135     return m.t; \
00136   }
00137
00138 #define REGBLK_WRITE_TEMPLATE(sz) \
00139   template< typename T >          \
00140   void write(T value, l4_addr_t reg, typename cxx::enable_if<sizeof(T) == (sz / 8), T>::type = T())
      const \
00141   { \
00142     union X { T t; l4_uint##sz##_t v; } m; \
00143     m.t = value; \
00144     _b->do_write_##sz(m.v, reg); \
00145   }
00146
00155 template< typename BLOCK >
00156 class Register_block_tmpl
00157 : public Register_block_modify_mixin<Register_block_tmpl<BLOCK> >
00158 {
00159 private:
00160   BLOCK *_b;
00161
00162 public:
00163   Register_block_tmpl(BLOCK *blk) : _b(blk) {}
00164   Register_block_tmpl() = default;
00165
00166   operator BLOCK * () const { return _b; }
00167
00168   REGBLK_READ_TEMPLATE(8)
00169   REGBLK_WRITE_TEMPLATE(8)
00170   REGBLK_READ_TEMPLATE(16)
00171   REGBLK_WRITE_TEMPLATE(16)
00172   REGBLK_READ_TEMPLATE(32)
00173   REGBLK_WRITE_TEMPLATE(32)
00174   REGBLK_READ_TEMPLATE(64)
00175   REGBLK_WRITE_TEMPLATE(64)
00176 };
00177
00178
00179 #undef REGBLK_READ_TEMPLATE
00180 #undef REGBLK_WRITE_TEMPLATE
00181
00182 namespace __Type_helper {
00183   template<unsigned> struct Unsigned;
00184   template<> struct Unsigned<8> { typedef l4_uint8_t type; };
00185   template<> struct Unsigned<16> { typedef l4_uint16_t type; };
00186   template<> struct Unsigned<32> { typedef l4_uint32_t type; };
```

```
00187   template<> struct Unsigned<64> { typedef l4_uint64_t type; };
00188 };
00189
00190
00200 template< unsigned BITS, typename BLOCK >
00201 class Ro_register_tmpl
00202 {
00203 protected:
00204   BLOCK _b;
00205   unsigned _o;
00206
00207 public:
00208   typedef typename __Type_helper::Unsigned<BITS>::type value_type;
00209
00210   Ro_register_tmpl(BLOCK const &blk, unsigned offset) : _b(blk), _o(offset) {}
00211   Ro_register_tmpl() = default;
00212
00217   operator value_type () const
00218   { return _b.template read<value_type>(_o); }
00219
00224   value_type read() const
00225   { return _b.template read<value_type>(_o); }
00226 };
00227
00228
00236 template< unsigned BITS, typename BLOCK >
00237 class Register_tmpl : public Ro_register_tmpl<BITS, BLOCK>
00238 {
00239 public:
00240   typedef typename Ro_register_tmpl<BITS, BLOCK>::value_type value_type;
00241
00242   Register_tmpl(BLOCK const &blk, unsigned offset)
00243   : Ro_register_tmpl<BITS, BLOCK>(blk, offset)
00244   {}
00245
00246   Register_tmpl() = default;
00247
00252   Register_tmpl &operator = (value_type val)
00253   { this->_b.template write<value_type>(val, this->_o); return *this; }
00254
00259   void write(value_type val)
00260   { this->_b.template write<value_type>(val, this->_o); }
00261
00274   value_type set(value_type set_bits)
00275   { return this->_b.template set<value_type>(set_bits, this->_o); }
00276
00290   value_type clear(value_type clear_bits)
00291   { return this->_b.template clear<value_type>(clear_bits, this->_o); }
00292
00308   value_type modify(value_type clear_bits, value_type set_bits)
00309   { return this->_b.template modify<value_type>(clear_bits, set_bits, this->_o); }
00310 };
00311
00312
00324 template<
00325   unsigned MAX_BITS,
00326   typename BLOCK = Register_block_tmpl<
00327                      Register_block_base<MAX_BITS>
00328                    >
00329 >
00330 class Register_block
00331 {
00332 private:
00333   template< unsigned B, typename BLK > friend class Register_block;
00334   template< unsigned B, typename BLK > friend class Ro_register_block;
00335   typedef  BLOCK Block;
00336   Block _b;
00337
00338 public:
00339   Register_block() = default;
00340   Register_block(Block const &blk) : _b(blk) {}
00341   Register_block &operator = (Block const &blk)
00342   { _b = blk; return *this; }
00343
00344   template< unsigned BITS >
00345   Register_block(Register_block<BITS> blk) : _b(blk._b) {}
00346
00347   typedef Register_tmpl<MAX_BITS, Block> Register;
00348   typedef Ro_register_tmpl<MAX_BITS, Block> Ro_register;
00349
00356   template< unsigned BITS >
00357   Ro_register_tmpl<BITS, Block> r(unsigned offset) const
00358   { return Ro_register_tmpl<BITS, Block>(this->_b, offset); }
00359
00365   Ro_register operator [] (unsigned offset) const
00366   { return this->r<MAX_BITS>(offset); }
00367
```

```
00368
00375   template< unsigned BITS >
00376   Register_tmpl<BITS, Block> r(unsigned offset)
00377   { return Register_tmpl<BITS, Block>(this->_b, offset); }
00378
00385   Register operator [] (unsigned offset)
00386   { return this->r<MAX_BITS>(offset); }
00387 };
00388
00398 template<
00399   unsigned MAX_BITS,
00400   typename BLOCK = Register_block_tmpl<
00401                      Register_block_base<MAX_BITS> const
00402                    >
00403 >
00404 class Ro_register_block
00405 {
00406 private:
00407   template< unsigned B, typename BLK > friend class Ro_register_block;
00408   typedef  BLOCK Block;
00409   Block _b;
00410
00411 public:
00412   Ro_register_block() = default;
00413   Ro_register_block(BLOCK const &blk) : _b(blk) {}
00414
00415   template< unsigned BITS >
00416   Ro_register_block(Register_block<BITS> const &blk) : _b(blk._b) {}
00417
00418   typedef Ro_register_tmpl<MAX_BITS, Block> Ro_register;
00419   typedef Ro_register Register;
00420
00426   Ro_register operator [] (unsigned offset) const
00427   { return Ro_register(this->_b, offset); }
00428
00435   template< unsigned BITS >
00436   Ro_register_tmpl<BITS, Block> r(unsigned offset) const
00437   { return Ro_register_tmpl<BITS, Block>(this->_b, offset); }
00438 };
00439
00440
00454 template< typename BASE, unsigned MAX_BITS = 32 >
00455 struct Register_block_impl;
00456
00457 #define REGBLK_IMPL_RW_TEMPLATE(sz, ...) \
00458   l4_uint##sz##_t do_read_##sz(l4_addr_t reg) const override \
00459   { return static_cast<BASE const *>(this)->template read<l4_uint##sz##_t>(reg); } \
00460   \
00461   void do_write_##sz(l4_uint##sz##_t value, l4_addr_t reg) override \
00462   { static_cast<BASE*>(this)->template write<l4_uint##sz##_t>(value, reg); }
00463
00464
00465 template< typename BASE >
00466 struct Register_block_impl<BASE, 8> : public Register_block_base<8>
00467 {
00468   REGBLK_IMPL_RW_TEMPLATE(8);
00469 };
00470
00471 template< typename BASE >
00472 struct Register_block_impl<BASE, 16> : public Register_block_base<16>
00473 {
00474   REGBLK_IMPL_RW_TEMPLATE(8);
00475   REGBLK_IMPL_RW_TEMPLATE(16);
00476 };
00477
00478 template< typename BASE >
00479 struct Register_block_impl<BASE, 32> : public Register_block_base<32>
00480 {
00481   REGBLK_IMPL_RW_TEMPLATE(8);
00482   REGBLK_IMPL_RW_TEMPLATE(16);
00483   REGBLK_IMPL_RW_TEMPLATE(32);
00484 };
00485
00486 template< typename BASE >
00487 struct Register_block_impl<BASE, 64> : public Register_block_base<64>
00488 {
00489   REGBLK_IMPL_RW_TEMPLATE(8);
00490   REGBLK_IMPL_RW_TEMPLATE(16);
00491   REGBLK_IMPL_RW_TEMPLATE(32);
00492   REGBLK_IMPL_RW_TEMPLATE(64);
00493 };
00494
00495 #undef REGBLK_IMPL_RW_TEMPLATE
00496
00497 }
```

16.10 io_regblock.h

```
00001 /*
00002  * Copyright (C) 2012 Technische Universität Dresden.
00003  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 namespace L4
00010 {
00011   class Io_register_block
00012   {
00013   public:
00017     virtual unsigned char  read8(unsigned long reg) const = 0;
00018
00022     virtual unsigned short read16(unsigned long reg) const = 0;
00023
00027     virtual unsigned int   read32(unsigned long reg) const = 0;
00028
00029     /*
00030      * \brief Read register with an 8 byte access.
00031      */
00032     //virtual unsigned long long read64(unsigned long reg) const = 0;
00033
00037     virtual void write8(unsigned long reg, unsigned char value) const = 0;
00038
00042     virtual void write16(unsigned long reg, unsigned short value) const = 0;
00043
00047     virtual void write32(unsigned long reg, unsigned int value) const = 0;
00048
00049     /*
00050      * \brief Write register with an 8 byte access.
00051      */
00052     //virtual void write64(unsigned long reg, unsigned long long value) const = 0;
00053
00057     virtual unsigned long addr(unsigned long reg) const = 0;
00058
00064     virtual void delay() const = 0;
00065
00066     virtual ~Io_register_block() = 0;
00067
00075     template< typename R >
00076     R read(unsigned long reg) const
00077     {
00078       static_assert(sizeof(R) == 1 || sizeof(R) == 2 || sizeof(R) == 4,
00079                     "Invalid size");
00080
00081       switch (sizeof(R))
00082         {
00083         case 1: return read8(reg);
00084         case 2: return read16(reg);
00085         case 4: return read32(reg);
00086         };
00087     }
00088
00096     template< typename R >
00097     void write(unsigned long reg, R value) const
00098     {
00099       static_assert(sizeof(R) == 1 || sizeof(R) == 2 || sizeof(R) == 4,
00100                     "Invalid size");
00101
00102       switch (sizeof(R))
00103         {
00104         case 1: write8(reg, value); return;
00105         case 2: write16(reg, value); return;
00106         case 4: write32(reg, value); return;
00107         };
00108     }
00109
00120     template< typename R >
00121     R modify(unsigned long reg, R clear_bits, R set_bits) const
00122     {
00123       R r = (read<R>(reg) & ~clear_bits) | set_bits;
00124       write(reg, r);
00125       return r;
00126     }
00127
00134     template< typename R >
00135     R set(unsigned long reg, R set_bits) const
00136     {
00137       return modify<R>(reg, 0, set_bits);
00138     }
00139
00146     template< typename R >
```

```
00147     R clear(unsigned long reg, R clear_bits) const
00148     {
00149       return modify<R>(reg, clear_bits, 0);
00150     }
00151
00152   };
00153
00154   inline Io_register_block::~Io_register_block() {}
00155
00156
00157   class Io_register_block_mmio : public Io_register_block
00158   {
00159   private:
00160     template< typename R >
00161     R _read(unsigned long reg) const
00162     { return *reinterpret_cast<volatile R *>(_base + (reg << _shift)); }
00163
00164     template< typename R >
00165     void _write(unsigned long reg, R val) const
00166     { *reinterpret_cast<volatile R *>(_base + (reg << _shift)) = val; }
00167
00168   public:
00169     Io_register_block_mmio(unsigned long base, unsigned char shift = 0)
00170     : _base(base), _shift(shift)
00171     {}
00172
00173     unsigned long addr(unsigned long reg) const override
00174     { return _base + (reg << _shift); }
00175
00176     unsigned char  read8(unsigned long reg) const override
00177     { return _read<unsigned char>(reg); }
00178     unsigned short read16(unsigned long reg) const override
00179     { return _read<unsigned short>(reg); }
00180     unsigned int   read32(unsigned long reg) const override
00181     { return _read<unsigned int>(reg); }
00182
00183     void write8(unsigned long reg, unsigned char val) const override
00184     { _write(reg, val); }
00185     void write16(unsigned long reg, unsigned short val) const override
00186     { _write(reg, val); }
00187     void write32(unsigned long reg, unsigned int val) const override
00188     { _write(reg, val); }
00189
00190     void delay() const override
00191     {}
00192
00193     void set_base(unsigned long base) { _base = base; }
00194     void set_shift(unsigned char shift) { _shift = shift; }
00195
00196     unsigned long get_base() const { return _base; }
00197
00198   private:
00199     unsigned long _base;
00200     unsigned char _shift;
00201   };
00202
00203   template<typename ACCESS_TYPE>
00204   class Io_register_block_mmio_fixed_width : public Io_register_block
00205   {
00206   private:
00207     template< typename R >
00208     R _read(unsigned long reg) const
00209     { return *reinterpret_cast<volatile ACCESS_TYPE *>(_base + (reg << _shift)); }
00210
00211     template< typename R >
00212     void _write(unsigned long reg, R val) const
00213     { *reinterpret_cast<volatile ACCESS_TYPE *>(_base + (reg << _shift)) = val; }
00214
00215   public:
00216     Io_register_block_mmio_fixed_width(unsigned long base, unsigned char shift = 0)
00217     : _base(base), _shift(shift)
00218     {}
00219
00220     unsigned long addr(unsigned long reg) const
00221     { return _base + (reg << _shift); }
00222
00223     unsigned char  read8(unsigned long reg) const override
00224     { return _read<unsigned char>(reg); }
00225     unsigned short read16(unsigned long reg) const override
00226     { return _read<unsigned short>(reg); }
00227     unsigned int   read32(unsigned long reg) const override
00228     { return _read<unsigned int>(reg); }
00229
00230     void write8(unsigned long reg, unsigned char val) const override
00231     { _write(reg, val); }
00232     void write16(unsigned long reg, unsigned short val) const override
00233     { _write(reg, val); }
```

```
00234     void write32(unsigned long reg, unsigned int val) const override
00235     { _write(reg, val); }
00236
00237     void delay() const override
00238     {}
00239
00240   private:
00241     unsigned long _base;
00242     unsigned char _shift;
00243   };
00244 }
```

16.11 io_regblock_port.h

```
00001 /*
00002  * Copyright (C) 2012 Technische Universität Dresden.
00003  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "io_regblock.h"
00010
00011 namespace L4
00012 {
00013   class Io_register_block_port : public Io_register_block
00014   {
00015   public:
00016     Io_register_block_port(unsigned long base)
00017     : _base(base)
00018     {}
00019
00020     unsigned long addr(unsigned long reg) const override { return _base + reg; }
00021
00022     unsigned char  read8(unsigned long reg) const override
00023     {
00024       unsigned char val;
00025       asm volatile("inb %w1, %b0" : "=a" (val) : "Nd" (_base + reg));
00026       return val;
00027     }
00028
00029     unsigned short read16(unsigned long reg) const override
00030     {
00031       unsigned short val;
00032       asm volatile("inw %w1, %w0" : "=a" (val) : "Nd" (_base + reg));
00033       return val;
00034     }
00035
00036     unsigned int   read32(unsigned long reg) const override
00037     {
00038       unsigned int val;
00039       asm volatile("in %w1, %0" : "=a" (val) : "Nd" (_base + reg));
00040       return val;
00041     }
00042
00043     void write8(unsigned long reg, unsigned char val) const override
00044     { asm volatile("outb %b0, %w1" : : "a" (val), "Nd" (_base + reg)); }
00045
00046     void write16(unsigned long reg, unsigned short val) const override
00047     { asm volatile("outw %w0, %w1" : : "a" (val), "Nd" (_base + reg)); }
00048
00049     void write32(unsigned long reg, unsigned int val) const override
00050     { asm volatile("out %0, %w1" : : "a" (val), "Nd" (_base + reg)); }
00051
00052     void delay() const override
00053     { asm volatile ("outb %al,$0x80"); }
00054
00055   private:
00056     unsigned long _base;
00057   };
00058 }
```

16.12 poll_timeout_counter.h

```
00001 /*
00002  * Copyright (C) 2012 Technische Universität Dresden.
00003  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
```

```
00007 #pragma once
00008
00009 namespace L4 {
00010
00034 class Poll_timeout_counter
00035 {
00036 public:
00042   Poll_timeout_counter(unsigned counter_val)
00043   {
00044     set(counter_val);
00045   }
00046
00053   void set(unsigned counter_val)
00054   {
00055     _c = counter_val;
00056   }
00057
00061   bool test(bool expression = true)
00062   {
00063     if (!expression)
00064       return false;
00065
00066     if (_c)
00067       {
00068         --_c;
00069         return true;
00070       }
00071
00072     return false;
00073   }
00074
00081   bool timed_out() const { return _c == 0; }
00082
00083 private:
00084   unsigned _c;
00085 };
00086
00087 }
```

16.13 device.h

```
00001 #pragma once
00002
00003 #include <stdint.h>
00004
00005 struct l4re_device_spec_dt_ids
00006 {
00007   const char *compatible;
00008 };
00009
00010 struct l4re_device_spec_pcidev_pciids
00011 {
00012   uint16_t vendor;
00013   uint16_t function;
00014 };
00015
00016 struct l4re_device_spec_pcidev_ids
00017 {
00018   struct l4re_device_spec_pcidev_pciids *pcidevs;
00019 };
00020
00021 struct l4re_device_ids
00022 {
00023   struct l4re_device_spec_dt_ids         const *dt = nullptr;
00024   struct l4re_device_spec_pcidev_ids const *pcidev = nullptr;
00025 };
00026
00027 // ---- Internal device
00028 namespace L4 {
00029
00030   class Dev_obj
00031   {
00032   };
00033
00034 }
00035
00036 struct l4re_device_type_base
00037 {
00038   virtual L4::Dev_obj *create(void *obj_mem, unsigned arg1) = 0;
00039   virtual unsigned obj_size() = 0;
00040   virtual const l4re_device_ids *ids() = 0;
00041 };
00042
00043 #include <stdio.h>
```

```
00044 #include <string.h>
00045
00046 static inline
00047 L4::Dev_obj *
00048 l4re_dev_create_by_dt_compatible(const char *dt_compatible,
00049                                  void *obj_store, unsigned obj_store_size,
00050                                  unsigned arg1)
00051 {
00052   l4re_device_type_base *device = nullptr;
00053
00054   extern l4re_device_type_base *__L4RE_DEVICE_BEGIN[];
00055   extern l4re_device_type_base *__L4RE_DEVICE_END[];
00056
00057   for (auto const *d = __L4RE_DEVICE_BEGIN;
00058        device == nullptr && d < __L4RE_DEVICE_END; ++d)
00059     {
00060       const l4re_device_ids *ids = (*d)->ids();
00061       if (ids->dt)
00062         for (l4re_device_spec_dt_ids const *dt_id = ids->dt; dt_id->compatible; ++dt_id)
00063           if (!strcmp(dt_compatible, dt_id->compatible))
00064             {
00065               device = *d;
00066               break;
00067             }
00068     }
00069
00070   if (!device)
00071     return nullptr;
00072
00073   if (device->obj_size() > obj_store_size)
00074     return nullptr;
00075
00076   return device->create(reinterpret_cast<void *>(obj_store), arg1);
00077 }
00078
00079 #define l4re_register_device(Device_class_base, Device_class, \
00080                              instance_name, __ids) \
00081   struct l4re_device_type_##instance_name \
00082   : public l4re_device_type_base \
00083   { \
00084     Device_class_base *create(void *obj_mem, unsigned arg1) override \
00085     { return new (obj_mem) Device_class(arg1); } \
00086     \
00087     unsigned obj_size() override { return sizeof(Device_class); } \
00088     const l4re_device_ids *ids() override { return &__ids; } \
00089   }; \
00090   static const l4re_device_type_##instance_name \
00091     l4re_device_inst_##instance_name; \
00092   static const l4re_device_type_base * const \
00093     __attribute__((section(".data.l4redevice"),used)) \
00094     l4re_device_inst_p_##instance_name \
00095     = &l4re_device_inst_##instance_name
```

16.14 uart_16550.h

```
00001 /*
00002  * Copyright (C) 2008-2021 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *            Alexander Warg <alexander.warg@os.inf.tu-dresden.de>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include "uart_base.h"
00012
00013 namespace L4 {
00014
00015 class Uart_16550 : public Uart
00016 {
00017 protected:
00018   enum Registers
00019   {
00020     TRB      = 0x00, // Transmit/Receive Buffer  (read/write)
00021     BRD_LOW  = 0x00, // Baud Rate Divisor LSB if bit 7 of LCR is set  (read/write)
00022     IER      = 0x01, // Interrupt Enable Register  (read/write)
00023     BRD_HIGH = 0x01, // Baud Rate Divisor MSB if bit 7 of LCR is set  (read/write)
00024     IIR      = 0x02, // Interrupt Identification Register  (read only)
00025     FCR      = 0x02, // 16550 FIFO Control Register  (write only)
00026     LCR      = 0x03, // Line Control Register  (read/write)
00027     MCR      = 0x04, // Modem Control Register  (read/write)
00028     LSR      = 0x05, // Line Status Register  (read only)
00029     MSR      = 0x06, // Modem Status Register  (read only)
```

```
00030     SPR      = 0x07, // Scratch Pad Register  (read/write)
00031   };
00032
00033   enum Register_value_iir
00034   {
00035     IIR_BUSY = 7,
00036   };
00037
00038   enum Register_value_lsr
00039   {
00040     LSR_DR   = 0x01,    // Receiver data ready
00041     LSR_THRE = 0x20,    // Transmit hold register empty
00042     LSR_TSRE = 0x40,    // Transmitter empty
00043   };
00044
00045   enum Init_values
00046   {
00047 #ifdef UART_16550_INIT_MCR
00048     Init_mcr = UART_16550_INIT_MCR,
00049 #else
00050     Init_mcr = 0,
00051 #endif
00052 #ifdef UART_16550_INIT_IER
00053     Init_ier = UART_16550_INIT_IER,
00054 #else
00055     Init_ier = 0,
00056 #endif
00057 #ifdef UART_16550_INIT_FCR
00058     Init_fcr = UART_16550_INIT_FCR,
00059 #else
00060     Init_fcr = 0,
00061 #endif
00062   };
00063
00064 public:
00065   enum
00066   {
00067     PAR_NONE = 0x00,
00068     PAR_EVEN = 0x18,
00069     PAR_ODD  = 0x08,
00070     DAT_5    = 0x00,
00071     DAT_6    = 0x01,
00072     DAT_7    = 0x02,
00073     DAT_8    = 0x03,
00074     STOP_1   = 0x00,
00075     STOP_2   = 0x04,
00076
00077     MODE_8N1 = PAR_NONE | DAT_8 | STOP_1,
00078     MODE_7E1 = PAR_EVEN | DAT_7 | STOP_1,
00079
00080     // these two values are to leave either mode
00081     // or baud rate unchanged on a call to change_mode
00082     MODE_NC  = 0x1000000,
00083     BAUD_NC  = 0x1000000,
00084
00085     Base_rate_x86 = 115200,
00086     Base_rate_pxa = 921600,
00087   };
00088
00089   explicit Uart_16550(unsigned long base_rate, unsigned char init_flags = 0,
00090                       unsigned char ier_bits = Init_ier,
00091                       unsigned char mcr_bits = Init_mcr,
00092                       unsigned char fcr_bits = Init_fcr)
00093   : _base_rate(base_rate), _init_flags(init_flags), _mcr_bits(mcr_bits),
00094     _ier_bits(ier_bits), _fcr_bits(fcr_bits)
00095   {}
00096
00097   bool startup(Io_register_block const *regs) override;
00098   void shutdown() override;
00099   bool change_mode(Transfer_mode m, Baud_rate r) override;
00100   bool tx_avail() const;
00101   void wait_tx_done() const;
00102   inline void out_char(char c) const;
00103   int write(char const *s, unsigned long count,
00104             bool blocking = true) const override;
00105
00106 #ifndef UART_WITHOUT_INPUT
00107   bool enable_rx_irq(bool enable = true) override;
00108   int char_avail() const override;
00109   int get_char(bool blocking = true) const override;
00110 #endif
00111
00112 private:
00113   unsigned long _base_rate;
00114   unsigned char _init_flags;
00115   unsigned char _mcr_bits;
00116   unsigned char _ier_bits;
```

```
00117   unsigned char _fcr_bits;
00118 };
00119
00120 } // namespace L4
```

16.15 uart_16550_dw.h

```
00001 /*
00002  * Copyright (C) 2015 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@l4re.org>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_16550.h"
00011
00012 namespace L4 {
00013
00014 class Uart_16550_dw : public Uart_16550
00015 {
00016 public:
00017   explicit Uart_16550_dw(unsigned long base_rate)
00018   : Uart_16550(base_rate)
00019   {}
00020
00021 #ifndef UART_WITHOUT_INPUT
00022   void irq_ack() override;
00023 #endif
00024 };
00025
00026 } // namespace L4
```

16.16 uart_apb.h

```
00001 /*
00002  * Copyright (C) 2017, 2019, 2023-2025 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "uart_base.h"
00010
00011 namespace L4 {
00012
00017 class Uart_apb : public Uart
00018 {
00019 public:
00021   Uart_apb(unsigned freq) : _freq(freq) {}
00022   bool startup(Io_register_block const *) override;
00023   void shutdown() override;
00024   bool change_mode(Transfer_mode m, Baud_rate r) override;
00025   bool tx_avail() const;
00026   void wait_tx_done() const;
00027   inline void out_char(char c) const;
00028   int write(char const *s, unsigned long count,
00029             bool blocking = true) const override;
00030
00031 #ifndef UART_WITHOUT_INPUT
00032   bool enable_rx_irq(bool enable) override;
00033   int char_avail() const override;
00034   int get_char(bool blocking = true) const override;
00035 #endif
00036
00037 private:
00038   void set_rate(Baud_rate r);
00039   unsigned _freq;
00040 };
00041
00042 } // namespace L4
```

16.17 uart_base.h

```
00001 /*
00002  * Copyright (C) 2009-2012 Technische Universität Dresden.
```

```
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <stddef.h>
00011 #include <l4/drivers/io_regblock.h>
00012 #include <l4/sys/types.h>
00013
00014 #include <l4/drivers/device.h>
00015 #include "poll_timeout_counter.h"
00016
00017 namespace L4 {
00018
00022 class Uart : public Dev_obj
00023 {
00024 protected:
00025   unsigned _mode;
00026   unsigned _rate;
00027   Io_register_block const *_regs;
00028
00029 public:
00030   void *operator new (size_t, void *p) { return p; }
00031
00032 public:
00033   typedef unsigned Transfer_mode;
00034   typedef unsigned Baud_rate;
00035
00036   Uart()
00037   : _mode(~0U), _rate(~0U)
00038   {}
00039
00047   virtual bool reg_shift(unsigned char *shift __attribute__((unused))) const
00048   { return false; }
00049
00057   virtual bool startup(Io_register_block const *regs) = 0;
00058
00059   virtual ~Uart() {}
00060
00064   virtual void shutdown() = 0;
00065
00077   virtual bool change_mode(Transfer_mode m, Baud_rate r) = 0;
00078
00089   virtual int write(char const *s, unsigned long count,
00090                     bool blocking = true) const = 0;
00091
00097   Transfer_mode mode() const { return _mode; }
00098
00104   Baud_rate rate() const { return _rate; }
00105
00106 #ifndef UART_WITHOUT_INPUT
00107
00115   virtual bool enable_rx_irq(bool = true) { return false; }
00116
00120   virtual void irq_ack() {}
00121
00128   virtual int char_avail() const = 0;
00129
00138   virtual int get_char(bool blocking = true) const = 0;
00139
00140 #endif // !UART_WITHOUT_INPUT
00141
00142 protected:
00154   template <typename Uart_driver, bool Timeout_guard = true>
00155   int generic_write(char const *s, unsigned long count,
00156                     bool blocking = true) const
00157   {
00158     auto *self = static_cast<Uart_driver const*>(this);
00159
00160     unsigned long c;
00161     for (c = 0; c < count; ++c)
00162       {
00163         if (!blocking && !self->tx_avail())
00164           break;
00165
00166         if constexpr (Timeout_guard)
00167           {
00168             Poll_timeout_counter i(3000000);
00169             while (i.test(!self->tx_avail()))
00170               ;
00171           }
00172         else
00173           {
00174             while (!self->tx_avail())
00175               ;
```

```
00176           }
00177
00178         self->out_char(*s++);
00179       }
00180
00181     if (blocking)
00182       self->wait_tx_done();
00183
00184     return c;
00185   }
00186 };
00187
00188 } // namespace L4
00189
00190 /*
00191  * Instantiate a UART, given the memory.
00192  */
00193 static inline
00194 L4::Uart *
00195 l4re_dev_uart_create_by_dt_compatible(const char *dt_compatible,
00196                                       void *obj_buf, unsigned obj_buf_size,
00197                                       unsigned freq)
00198 {
00199   L4::Dev_obj *dev = l4re_dev_create_by_dt_compatible(dt_compatible,
00200                                                       obj_buf, obj_buf_size,
00201                                                       freq);
00202   return static_cast<L4::Uart *>(dev);
00203 }
00204
00205 /*
00206  * Instantiate a UART a single time, use an internal static buffer.
00207  */
00208 static inline
00209 L4::Uart *
00210 l4re_dev_uart_create_by_dt_compatible_once(const char *dt_compatible, unsigned freq)
00211 {
00212   static bool once_done = false;
00213
00214   if (once_done)
00215     return nullptr;
00216
00217   static char __attribute__((aligned(sizeof(long) * 2))) obj_buf[64];
00218   L4::Uart *uart
00219     = l4re_dev_uart_create_by_dt_compatible(dt_compatible,
00220                                             obj_buf, sizeof(obj_buf),
00221                                             freq);
00222   if (uart)
00223     once_done = true;
00224
00225   return uart;
00226 }
00227
00228 #define l4re_register_device_uart(Device_class, instance_name, \
00229                                   device_dt_ids, pci_ids) \
00230   static const struct l4re_device_ids __dev_spec_##instance_name \
00231     = { .dt = device_dt_ids, .pcidev = pci_ids }; \
00232   l4re_register_device(L4::Uart, Device_class, instance_name, \
00233                        __dev_spec_##instance_name)
00234
00235 #define l4re_register_device_uart_dt(Device_class, instance_name, dt_ids) \
00236   l4re_register_device_uart(Device_class, instance_name, dt_ids, nullptr)
00237
00238 #define l4re_register_device_uart_pci(Device_class, instance_name, pci_ids) \
00239   l4re_register_device_uart(Device_class, instance_name, nullptr, pci_ids)
00240
```

16.18 uart_bcm2835.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jakub Jermar <jakub.jermar@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include "uart_16550.h"
00011
00012 namespace L4 {
00013
00014 /*
00015  * According to the BCM2835 ARM Peripherals document, the mini UART is not
00016  * compatible with the 16550 UART, but has a 16550-like register layout.
```

```
00017  * The document is known to have many errors, including the mini UART part, as
00018  * described in this errata:
00019  *
00020  *   https://elinux.org/BCM2835_datasheet_errata#p12
00021  *
00022  * Even from the errata the meaning of some bits in the IER is not very clear.
00023  */
00024 class Uart_bcm2835 : public Uart_16550
00025 {
00026 public:
00027   explicit Uart_bcm2835(unsigned long base_rate)
00028   : Uart_16550(base_rate, 0, 8)
00029   {}
00030
00031   bool reg_shift(unsigned char *shift) const override
00032   {
00033     *shift = 2;
00034     return true;
00035   }
00036 };
00037
00038 } // namespace L4
```

16.19 uart_cadence.h

```
00001 /*
00002  * Copyright (C) 2013 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_cadence : public Uart
00015 {
00016 public:
00017   explicit Uart_cadence(unsigned base_rate) : _base_rate(base_rate) {}
00018   bool startup(Io_register_block const *) override;
00019   void shutdown() override;
00020   bool change_mode(Transfer_mode m, Baud_rate r) override;
00021   bool tx_avail() const;
00022   void wait_tx_done() const {}
00023   inline void out_char(char c) const;
00024   int write(char const *s, unsigned long count,
00025             bool blocking = true) const override;
00026
00027 #ifndef UART_WITHOUT_INPUT
00028   bool enable_rx_irq(bool) override;
00029   void irq_ack() override;
00030   int char_avail() const override;
00031   int get_char(bool blocking = true) const override;
00032 #endif
00033
00034 private:
00035   unsigned _base_rate;
00036 };
00037
00038 } // namespace L4
```

16.20 uart_dcc-v6.h

```
00001 /*
00002  * Copyright (C) 2009 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_dcc_v6 : public Uart
00015 {
```

```
00016 public:
00017   explicit Uart_dcc_v6() {}
00018   explicit Uart_dcc_v6(unsigned /*base_rate*/) {}
00019   bool startup(Io_register_block const *) override;
00020   void shutdown() override;
00021   bool change_mode(Transfer_mode m, Baud_rate r) override;
00022   bool tx_avail() const;
00023   void wait_tx_done() const;
00024   inline void out_char(char c) const;
00025   int write(char const *s, unsigned long count,
00026             bool blocking = true) const override;
00027
00028 #ifndef UART_WITHOUT_INPUT
00029   int char_avail() const override;
00030   int get_char(bool blocking = true) const override;
00031 #endif
00032
00033 private:
00034   unsigned get_status() const;
00035 };
00036
00037 } // namespace l4
```

16.21 uart_dm.h

```
00001 /*
00002  * Copyright (C) 2021-2022 Stephan Gerhold <stephan@gerhold.net>
00003  * Copyright (C) 2022-2025 Kernkonzept GmbH.
00004  * Author(s): Stephan Gerhold <stephan@gerhold.net>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_dm : public Uart
00015 {
00016 public:
00017   explicit Uart_dm(unsigned /*base_rate*/) {}
00018   bool startup(Io_register_block const *) override;
00019   void shutdown() override;
00020   bool change_mode(Transfer_mode m, Baud_rate r) override;
00021   bool tx_avail() const;
00022   void wait_tx_done() const;
00023   inline void out_char(char c) const;
00024   int write(char const *s, unsigned long count,
00025             bool blocking = true) const override;
00026
00027 #ifndef UART_WITHOUT_INPUT
00028   bool enable_rx_irq(bool enable = true) override;
00029   int char_avail() const override;
00030   int get_char(bool blocking = true) const override;
00031 #endif
00032 };
00033
00034 } // namespace L4
```

16.22 uart_dummy.h

```
00001 /*
00002  * Copyright 2009 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_dummy : public Uart
00015 {
00016 public:
00017   explicit Uart_dummy() {}
00018   explicit Uart_dummy(unsigned /*base_rate*/) {}
00019   bool startup(Io_register_block const *) override { return true; }
```

```
00020   void shutdown() override {}
00021   bool change_mode(Transfer_mode, Baud_rate) override { return true; }
00022   inline void out_char(char /*ch*/) const {}
00023   int write(char const * /*str*/, unsigned long /*count*/,
00024             bool /*blocking*/ = true) const override
00025   { return 0; }
00026
00027 #ifndef UART_WITHOUT_INPUT
00028   int char_avail() const override { return false; }
00029   int get_char(bool /*blocking*/ = true) const override { return 0; }
00030 #endif
00031 };
00032
00033 } // namespace L4
```

16.23 uart_geni.h

```
00001 /*
00002  * Copyright (C) 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Stephan Gerhold <stephan.gerhold@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "uart_base.h"
00010
00011 namespace L4 {
00012
00013 class Uart_geni : public Uart
00014 {
00015 public:
00016   explicit Uart_geni(unsigned /*base_rate*/) {}
00017   bool startup(Io_register_block const *) override;
00018   void shutdown() override;
00019   bool change_mode(Transfer_mode m, Baud_rate r) override;
00020   bool tx_avail() const;
00021   void wait_tx_done() const;
00022   void out_char(char c) const;
00023   int write(char const *s, unsigned long count,
00024             bool blocking = true) const override;
00025
00026 #ifndef UART_WITHOUT_INPUT
00027   bool enable_rx_irq(bool enable = true) override;
00028   void irq_ack() override;
00029   int char_avail() const override;
00030   int get_char(bool blocking = true) const override;
00031 #endif
00032 };
00033
00034 } // namespace L4
```

16.24 uart_imx.h

```
00001 /*
00002  * Copyright (C) 2008-2009 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_imx : public Uart
00015 {
00016 public:
00017   enum platform_type
00018   {
00019     Type_imx21,
00020     Type_imx35,
00021     Type_imx51,
00022     Type_imx6,
00023     Type_imx7,
00024     Type_imx8,
00025   };
00026   explicit Uart_imx(enum platform_type type) : _type(type) {}
00027   explicit Uart_imx(enum platform_type type, unsigned /*base_rate*/)
```

```
00028     : _type(type) {}
00029   bool startup(Io_register_block const *) override;
00030   void shutdown() override;
00031   bool change_mode(Transfer_mode m, Baud_rate r) override;
00032   bool tx_avail() const;
00033   void wait_tx_done() const;
00034   inline void out_char(char c) const;
00035   int write(char const *s, unsigned long count,
00036             bool blocking = true) const override;
00037
00038 #ifndef UART_WITHOUT_INPUT
00039   bool enable_rx_irq(bool enable = true) override;
00040   int char_avail() const override;
00041   int get_char(bool blocking = true) const override;
00042 #endif
00043
00044 private:
00045   enum platform_type _type;
00046 };
00047
00048 class Uart_imx21 : public Uart_imx
00049 {
00050 public:
00051   Uart_imx21() : Uart_imx(Type_imx21) {}
00052   explicit Uart_imx21(unsigned base_rate) : Uart_imx(Type_imx21, base_rate) {}
00053 };
00054
00055 class Uart_imx35 : public Uart_imx
00056 {
00057 public:
00058   Uart_imx35() : Uart_imx(Type_imx35) {}
00059   explicit Uart_imx35(unsigned base_rate) : Uart_imx(Type_imx35, base_rate) {}
00060 };
00061
00062 class Uart_imx51 : public Uart_imx
00063 {
00064 public:
00065   Uart_imx51() : Uart_imx(Type_imx51) {}
00066   explicit Uart_imx51(unsigned base_rate) : Uart_imx(Type_imx51, base_rate) {}
00067 };
00068
00069 class Uart_imx6 : public Uart_imx
00070 {
00071 public:
00072   Uart_imx6() : Uart_imx(Type_imx6) {}
00073   explicit Uart_imx6(unsigned base_rate) : Uart_imx(Type_imx6, base_rate) {}
00074
00075 #ifndef UART_WITHOUT_INPUT
00076   void irq_ack() override;
00077 #endif
00078 };
00079
00080 class Uart_imx7 : public Uart_imx
00081 {
00082 public:
00083   Uart_imx7() : Uart_imx(Type_imx7) {}
00084   explicit Uart_imx7(unsigned base_rate) : Uart_imx(Type_imx7, base_rate) {}
00085 };
00086
00087 class Uart_imx8 : public Uart_imx
00088 {
00089 public:
00090   Uart_imx8() : Uart_imx(Type_imx8) {}
00091   explicit Uart_imx8(unsigned base_rate) : Uart_imx(Type_imx8, base_rate) {}
00092 };
00093
00094 } // namespace L4
```

16.25 uart_leon3.h

```
00001 /*
00002  * Copyright (C) 2011 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *            Björn Döbel <doebel@os.inf.tu-dresden.de>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include "uart_base.h"
00012
00013 namespace L4 {
00014
```

```
00015 class Uart_leon3 : public Uart
00016 {
00017 public:
00018   explicit Uart_leon3() {}
00019   explicit Uart_leon3(unsigned /*base_rate*/) {}
00020   bool startup(Io_register_block const *) override;
00021   void shutdown() override;
00022   bool change_mode(Transfer_mode m, Baud_rate r) override;
00023   bool tx_avail() const;
00024   void wait_tx_done() const;
00025   inline void out_char(char c) const;
00026   int write(char const *s, unsigned long count,
00027             bool blocking = true) const override;
00028
00029 #ifndef UART_WITHOUT_INPUT
00030   bool enable_rx_irq(bool = true) override;
00031   int char_avail() const override;
00032   int get_char(bool blocking = true) const override;
00033 #endif
00034 };
00035
00036 } // namespace L4
```

16.26 uart_linflex.h

```
00001 /*
00002  * Copyright (C) 2018 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@l4re.org>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_linflex : public Uart
00015 {
00016 public:
00017   explicit Uart_linflex(unsigned) {}
00018   bool startup(Io_register_block const *) override;
00019   void shutdown() override;
00020   bool change_mode(Transfer_mode m, Baud_rate r) override;
00021   bool tx_avail() const;
00022   void wait_tx_done() const;
00023   inline void out_char(char c) const;
00024   int write(char const *s, unsigned long count,
00025             bool blocking = true) const override;
00026
00027 #ifndef UART_WITHOUT_INPUT
00028   bool enable_rx_irq(bool enable = true) override;
00029   int char_avail() const override;
00030   int get_char(bool blocking = true) const override;
00031 #endif
00032
00033 private:
00034   void set_uartcr(bool fifo);
00035   bool is_tx_fifo_enabled() const;
00036   bool is_rx_fifo_enabled() const;
00037 };
00038
00039 } // namespace L4
```

16.27 uart_lpuart.h

```
00001 /*
00002  * Copyright (C) 2019, 2023-2025 Kernkonzept GmbH.
00003  * Author(s): Adam Lackorzynski <adam@l4re.org>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "uart_base.h"
00010
00011 namespace L4 {
00012
00013 class Uart_lpuart : public Uart
00014 {
```

```
00015 public:
00017   Uart_lpuart(unsigned freq = 0) : _freq(freq) {}
00018   bool startup(Io_register_block const *) override;
00019   void shutdown() override;
00020   bool change_mode(Transfer_mode m, Baud_rate r) override;
00021   bool tx_avail() const;
00022   void wait_tx_done() const {}
00023   inline void out_char(char c) const;
00024   int write(char const *s, unsigned long count,
00025             bool blocking = true) const override;
00026
00027 #ifndef UART_WITHOUT_INPUT
00028   bool enable_rx_irq(bool enable = true) override;
00029   int char_avail() const override;
00030   int get_char(bool blocking = true) const override;
00031 #endif
00032
00033 private:
00034   unsigned _freq;
00035 };
00036
00037 } // namespace L4
```

16.28 uart_mvebu.h

```
00001 /*
00002  * Copyright (C) 2017, 2023-2025 Kernkonzept GmbH.
00003  * Author(s) Adam Lackorzynski <adam@l4re.org>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "uart_base.h"
00010
00011 namespace L4 {
00012
00013 class Uart_mvebu : public Uart
00014 {
00015 public:
00016   explicit Uart_mvebu(unsigned baserate) : _baserate(baserate) {}
00017   bool startup(Io_register_block const *) override;
00018   void shutdown() override;
00019   bool change_mode(Transfer_mode m, Baud_rate r) override;
00020   bool tx_avail() const;
00021   void wait_tx_done() const {}
00022   inline void out_char(char c) const;
00023   int write(char const *s, unsigned long count,
00024             bool blocking = true) const override;
00025
00026 #ifndef UART_WITHOUT_INPUT
00027   bool enable_rx_irq(bool enable = true) override;
00028   int char_avail() const override;
00029   int get_char(bool blocking = true) const override;
00030 #endif
00031
00032 private:
00033   unsigned _baserate;
00034 };
00035
00036 } // namespace L4
```

16.29 uart_of.h

```
00001 /*
00002  * Copyright (C) 2009 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011 #include <stdarg.h>
00012 #include <string.h>
00013 #include <l4/drivers/of.h>
00014
00015 namespace L4 {
00016
00017 class Uart_of : public Uart, public L4_drivers::Of
```

```
00018 {
00019 private:
00020   ihandle_t  _serial;
00021
00022 public:
00023   Uart_of() : Of(), _serial(0) {}
00024   explicit Uart_of(unsigned /*base_rate*/) : Of(), _serial(0) {}
00025   bool startup(Io_register_block const *) override;
00026   void shutdown() override;
00027   bool change_mode(Transfer_mode m, Baud_rate r) override;
00028   bool tx_avail() const;
00029   void out_char(char c) const;
00030   int write(char const *s, unsigned long count,
00031             bool blocking = true) const override;
00032
00033 #ifndef UART_WITHOUT_INPUT
00034   int char_avail() const override;
00035   int get_char(bool blocking = true) const override;
00036 #endif
00037 };
00038
00039 } // namespace L4
```

16.30 uart_omap35x.h

```
00001 /*
00002  * Copyright (C) 2009 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s) Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_omap35x : public Uart
00015 {
00016 public:
00017   explicit Uart_omap35x() {}
00018   explicit Uart_omap35x(unsigned /*base_rate*/) {}
00019   bool startup(Io_register_block const *) override;
00020   void shutdown() override;
00021   bool change_mode(Transfer_mode m, Baud_rate r) override;
00022   bool tx_avail() const;
00023   void wait_tx_done() const;
00024   inline void out_char(char c) const;
00025   int write(char const *s, unsigned long count,
00026             bool blocking = true) const override;
00027
00028 #ifndef UART_WITHOUT_INPUT
00029   bool enable_rx_irq(bool) override;
00030   int char_avail() const override;
00031   int get_char(bool blocking = true) const override;
00032 #endif
00033 };
00034
00035 } // namespace L4
```

16.31 uart_pl011.h

```
00001 /*
00002  * Copyright (C) 2009 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_pl011 : public Uart
00015 {
00016 public:
00018   Uart_pl011(unsigned freq) : _freq(freq) {}
00019   bool startup(Io_register_block const *) override;
```

```
00020   void shutdown() override;
00021   bool change_mode(Transfer_mode m, Baud_rate r) override;
00022   bool tx_avail() const;
00023   void wait_tx_done() const;
00024   inline void out_char(char c) const;
00025   int write(char const *s, unsigned long count,
00026             bool blocking = true) const override;
00027
00028 #ifndef UART_WITHOUT_INPUT
00029   bool enable_rx_irq(bool enable) override;
00030   int char_avail() const override;
00031   int get_char(bool blocking = true) const override;
00032 #endif
00033
00034 private:
00035   void set_rate(Baud_rate r);
00036   unsigned _freq;
00037 };
00038
00039 } // namespace L4
```

16.32 uart_s3c2410.h

```
00001 /*
00002  * Copyright (C) 2009-2012 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_s3c : public Uart
00015 {
00016 protected:
00017   enum Uart_type
00018   {
00019     Type_24xx, Type_64xx, Type_s5pv210,
00020   };
00021
00022   Uart_type type() const { return _type; }
00023
00024 public:
00025   explicit Uart_s3c(Uart_type type) : _type(type) {}
00026   explicit Uart_s3c(Uart_type type, unsigned /*base_rate*/) : _type(type) {}
00027   bool startup(Io_register_block const *) override;
00028   void shutdown() override;
00029   bool change_mode(Transfer_mode m, Baud_rate r) override;
00030   bool tx_avail() const;
00031   void wait_tx_done() const;
00032   inline void out_char(char c) const;
00033   int write(char const *s, unsigned long count,
00034             bool blocking = true) const override;
00035   void fifo_reset();
00036
00037 #ifndef UART_WITHOUT_INPUT
00038   int char_avail() const override;
00039   int get_char(bool blocking = true) const override;
00040 #endif
00041
00042 protected:
00043   virtual void ack_rx_irq() const = 0;
00044   virtual void wait_for_empty_tx_fifo() const = 0;
00045   virtual unsigned is_rx_fifo_non_empty() const = 0;
00046   virtual bool is_tx_fifo_not_full() const = 0;
00047
00048 private:
00049   Uart_type _type;
00050 };
00051
00052 class Uart_s3c2410 : public Uart_s3c
00053 {
00054 public:
00055   Uart_s3c2410() : Uart_s3c(Type_24xx) {}
00056   explicit Uart_s3c2410(unsigned base_rate) : Uart_s3c(Type_24xx, base_rate) {}
00057
00058 protected:
00059   void ack_rx_irq() const override {}
00060   void wait_for_empty_tx_fifo() const override;
00061   unsigned is_rx_fifo_non_empty() const override;
```

```
00062   bool is_tx_fifo_not_full() const override;
00063
00064   void auto_flow_control(bool on);
00065 };
00066
00067 class Uart_s3c64xx : public Uart_s3c
00068 {
00069 public:
00070   Uart_s3c64xx() : Uart_s3c(Type_64xx) {}
00071   explicit Uart_s3c64xx(unsigned base_rate) : Uart_s3c(Type_64xx, base_rate) {}
00072
00073 protected:
00074   void ack_rx_irq() const override;
00075   void wait_for_empty_tx_fifo() const override;
00076   unsigned is_rx_fifo_non_empty() const override;
00077   bool is_tx_fifo_not_full() const override;
00078 };
00079
00080 class Uart_s5pv210 : public Uart_s3c
00081 {
00082 public:
00083   Uart_s5pv210() : Uart_s3c(Type_s5pv210) {}
00084   explicit Uart_s5pv210(unsigned base_rate) : Uart_s3c(Type_s5pv210, base_rate) {}
00085
00086 protected:
00087   void ack_rx_irq() const override;
00088   void wait_for_empty_tx_fifo() const override;
00089   unsigned is_rx_fifo_non_empty() const override;
00090   bool is_tx_fifo_not_full() const override;
00091 };
00092
00093 } // namespace L4
```

16.33 uart_sa1000.h

```
00001 /*
00002  * Copyright (C) 2008-2012 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *            Alexander Warg <alexander.warg@os.inf.tu-dresden.de>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include "uart_base.h"
00012
00013 namespace L4 {
00014
00015 class Uart_sa1000 : public Uart
00016 {
00017 public:
00018   explicit Uart_sa1000() {}
00019   explicit Uart_sa1000(unsigned /*base_rate*/) {}
00020   bool startup(Io_register_block const *) override;
00021   void shutdown() override;
00022   bool change_mode(Transfer_mode m, Baud_rate r) override;
00023   bool tx_avail() const;
00024   void wait_tx_done() const;
00025   inline void out_char(char c) const;
00026   int write(char const *s, unsigned long count,
00027             bool blocking = true) const override;
00028
00029 #ifndef UART_WITHOUT_INPUT
00030   int char_avail() const override;
00031   int get_char(bool blocking = true) const override;
00032 #endif
00033 };
00034
00035 } // namespace L4
```

16.34 uart_sbi.h

```
00001 /*
00002  * Copyright (C) 2021, 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
```

```
00009 #include "uart_base.h"
00010
00011 namespace L4 {
00012
00013 class Uart_sbi : public Uart
00014 {
00015 public:
00016   Uart_sbi();
00017   explicit Uart_sbi(unsigned /*base_rate*/) : Uart_sbi() {}
00018   bool startup(Io_register_block const *) override;
00019   void shutdown() override;
00020   bool change_mode(Transfer_mode m, Baud_rate r) override;
00021   bool tx_avail() const { return true; }
00022   void wait_tx_done() const {}
00023   inline void out_char(char c) const;
00024   int write(char const *s, unsigned long count,
00025             bool blocking = true) const override;
00026
00027 #ifndef UART_WITHOUT_INPUT
00028   int char_avail() const override;
00029   int get_char(bool blocking = true) const override;
00030 #endif
00031
00032 private:
00033   mutable int _bufchar;
00034 };
00035
00036 } // namespace L4
```

16.35 uart_sh.h

```
00001 /*
00002  * Copyright (C) 2016 Technische Universität Dresden.
00003  * Copyright (C) 2023-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@l4re.org>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "uart_base.h"
00011
00012 namespace L4 {
00013
00014 class Uart_sh : public Uart
00015 {
00016 public:
00017   explicit Uart_sh() {}
00018   explicit Uart_sh(unsigned /*base_rate*/) {}
00019   bool startup(Io_register_block const *) override;
00020   void shutdown() override;
00021   bool change_mode(Transfer_mode m, Baud_rate r) override;
00022   bool tx_avail() const;
00023   void wait_tx_done() const {}
00024   inline void out_char(char c) const;
00025   int write(char const *s, unsigned long count,
00026             bool blocking = true) const override;
00027
00028 #ifndef UART_WITHOUT_INPUT
00029   bool enable_rx_irq(bool enable = true) override;
00030   void irq_ack() override;
00031   int char_avail() const override;
00032   int get_char(bool blocking = true) const override;
00033 #endif
00034 };
00035
00036 } // namespace L4
```

16.36 uart_sifive.h

```
00001 /*
00002  * Copyright (C) 2021-2025 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "uart_base.h"
00010
00011 namespace L4 {
```

```
00012
00013 class Uart_sifive : public Uart
00014 {
00015 public:
00016   Uart_sifive(unsigned freq) : _freq(freq), _bufchar(-1) {}
00017   bool startup(Io_register_block const *) override;
00018   void shutdown() override;
00019   bool change_mode(Transfer_mode m, Baud_rate r) override;
00020   bool tx_avail() const;
00021   void wait_tx_done() const;
00022   inline void out_char(char c) const;
00023   int write(char const *s, unsigned long count,
00024             bool blocking = true) const override;
00025
00026 #ifndef UART_WITHOUT_INPUT
00027   bool enable_rx_irq(bool enable) override;
00028   int char_avail() const override;
00029   int get_char(bool blocking = true) const override;
00030 #endif
00031
00032 private:
00033   unsigned _freq;
00034   mutable int _bufchar;
00035 };
00036
00037 } // namespace L4
```

16.37 uart_stm32.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Adam Lackorzynski <adam@l4re.org>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "uart_base.h"
00010
00011 namespace L4 {
00012
00013 class Uart_stm32 : public Uart
00014 {
00015 public:
00017   Uart_stm32(unsigned freq = 0) : _freq(freq) {}
00018   bool startup(Io_register_block const *) override;
00019   void shutdown() override;
00020   bool change_mode(Transfer_mode m, Baud_rate r) override;
00021   bool tx_avail() const;
00022   void wait_tx_done() const;
00023   inline void out_char(char c) const;
00024   int write(char const *s, unsigned long count,
00025             bool blocking = true) const override;
00026
00027 #ifndef UART_WITHOUT_INPUT
00028   bool enable_rx_irq(bool enable = true) override;
00029   int char_avail() const override;
00030   int get_char(bool blocking = true) const override;
00031 #endif
00032
00033 private:
00034   unsigned _freq;
00035 };
00036
00037 } // namespace L4
```

16.38 uart_tegra-tcu.h

```
00001 /*
00002  * Copyright (C) 2025 Kernkonzept GmbH.
00003  * Author(s): Adam Lackorzynski <adam@l4re.org>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "uart_base.h"
00010
00011 namespace L4 {
00012
00013 class Uart_tegra_tcu : public Uart
```

```
00014 {
00015 public:
00016   Uart_tegra_tcu() {}
00017   Uart_tegra_tcu(unsigned long) {}
00018   bool startup(Io_register_block const *tx_mbox) override;
00019   void set_rx_mbox(Io_register_block const *rx_mbox);
00020   void shutdown() override;
00021   bool change_mode(Transfer_mode m, Baud_rate r) override;
00022   bool tx_avail() const;
00023   void wait_tx_done() const {}
00024   inline void out_char(char c) const;
00025   int write(char const *s, unsigned long count,
00026             bool blocking = true) const override;
00027
00028 #ifndef UART_WITHOUT_INPUT
00029   int char_avail() const override;
00030   int get_char(bool blocking = true) const override;
00031 #endif
00032
00033 private:
00034   mutable unsigned _current_rx_val = 0u;
00035   Io_register_block const *_rx_mbox = nullptr;
00036 };
00037
00038 } // namespace L4
```

16.39 tutorial.lua

```
00001 local _doc = [==[
00002
00003 Tutorial lua script for Ned
00004 ===========================
00005
00006 Firstly we have a set of definitions available. Some come from 'ned.lua'
00007 embedded script and others from the C++ bindings within Ned. The whole L4
00008 functionality is in the lua module "L4" (use 'local L4 = require("L4");').
00009 The L4 module classes and functions cope with L4 capabilities and
00010 their invocations, provide a set of constants and access to the L4Re environment of
00011 the running program.  Finally, of course it can also start L4 applications.
00012
00013 L4 Capabilities
00014 ===============
00015
00016 The L4 module defines a user data type for capabilities.  A capability in lua
00017 carries a typed L4 capability and is accompanied with a set of type specific
00018 methods that may be called on the object behind the capability.  There also
00019 exists a way to cast a capability to a capability to a different type of
00020 object using L4.cast(type, cap).
00021
00022 L4.cast(type, cap)
00023
00024 Returns a cap transformed to a capability of the given type, whereas type
00025 is either the fully qualified C++ name of the class encapsulating the object
00026 or the L4 protocol ID assigned to all L4Re and L4 system objects.
00027 If the type is unknown then nil is returned.
00028
00029 Generic capabilities provide the following methods:
00030
00031 is_valid()
00032
00033   Returns true if the capability is not the invalid cap (L4_INVALID_CAP), and
00034   false if it is the invalid cap.
00035
00036
00037 L4Re::Namespace object
00038 ======================
00039
00040 There is a lua type for name spaces that has the following methods:
00041
00042 query(name), or q(name)
00043
00044   Returns a closure (function) that initiates a query for the given name
00045   within the name space.  The function takes no arguments and returns
00046   a capability if successful or nil if name is not found.
00047
00048
00049 link(name), or l(name)
00050
00051   Returns a function that can create a link to the given object in the name
00052   space if put into another name space. The function takes two parameters
00053   the target name space and the name in the target name space.
00054   Loader:create_namespace and Loader.fill_namespace calls this function
00055   when things are really put into an L4Re::Namespace.
00056
```

```
00057
00058 register(name, cap), or r(name, cap)
00059
00060   Registers the given object capability under the given name. cap can
00061   be either a real capability (note query returns a function), a string, or
00062   nil.  If it is a capability it is just put into the name space.
00063   In the case cap is a string a placeholder will be put into the name space
00064   that will be replaced with a real capability later by some program.
00065   And if nil is use the name will be deleted from the name space.
00066
00067
00068 L4::Factory object
00069 ==================
00070
00071 The factory object provides an interface to the generic create method of a
00072 factory.
00073
00074 create(proto, ...)
00075
00076   This method calls the factory to create an object of the given type,
00077   via the L4 protocol number (see L4.Proto table for more) all further
00078   arguments are passed to the factory.
00079
00080
00081 Access to the L4Re Env capabilities
00082 ===================================
00083
00084 The L4 module defines a table L4.Env that contains the capabilities
00085 of the L4Re::Env::env() environment. Namely:
00086
00087 factory      The kernel factory of Ned
00088 log          The log object of Ned
00089 user_factory The factory provided to Ned, including memory
00090 parent       The parent of Ned
00091 rm           The region map of Ned
00092 scheduler    The scheduler of Ned
00093
00094
00095 Some useful constants
00096 ====================
00097
00098 L4.Proto table contains the most important protocol values for
00099 L4 and L4Re objects.
00100
00101   Namespace
00102   Goos
00103   Rm
00104   Irq
00105   Sigma0
00106   Factory
00107   Log
00108   Scheduler
00109
00110 The L4.Info table contains the following functions:
00111
00112   Kip.str()    The banner string found in the kernel info page
00113   arch()       Architecture name, such as: x86, amd64, arm, ppc32
00114   platform()   Platform name, such as: pc, ux, realview, beagleboard
00115   mword_bits() Number of native machine word bits (32, 64)
00116
00117
00118 Support for starting L4 programs
00119 ================================
00120
00121 The L4 module defines two classes that are useful for starting L4 applications.
00122 The class L4.Loader that encapsulates a fairly high level policy
00123 that is useful for starting a whole set of processes. And the class L4.App_env
00124 that encapsulates a more fine-grained policy.
00125
00126 L4.Loader
00127 ---------
00128
00129 The class L4.Loader encapsulates the policy for starting programs with the
00130 basic building blocks for the application coming from a dedicated loader,
00131 such as Moe or a Loader instance. These building blocks are a region map (Rm),
00132 a scheduler, a memory allocator, and a logging facility.
00133 A L4.Loader object is typically used to start multiple applications. There
00134 is a L4.default_loader instance of L4.Loader that uses the L4.Env.mem_alloc
00135 factory of the current Ned instance to create the objects for a new program.
00136 However you may also use a more restricted factory for applications and
00137 instantiate a loader for them.  The L4.Loader objects can already be used
00138 to start a program with L4.Loader:start(app_spec, cmd, ...). Where app_spec
00139 is a table containing parameters for the new application. cmd is the
00140 command to run and the remaining arguments are the command-line options for
00141 the application.
00142
00143 ]==]
```

```
00144
00145 L4.default_loader:start({}, "rom/hello");
00146
00147 local _doc = [==[
00148
00149 This statement does the following:
00150  1. Create a new environment for the application
00151  2. Add the rom name-space into the new environment (thus shares Ned's
00152     'rom' directory with the new program).
00153  3. Creates all the building blocks for the new process and starts the
00154     'l4re' support kernel in the new process which in turn starts 'rom/hello'
00155     in the new process.
00156
00157 Using the app_spec parameter you can modify the behavior in two ways. There are
00158 two supported options 'caps' for providing more capabilities for the
00159 application. And 'log' for modifying the logger tag and color.
00160
00161 ]==]
00162
00163 local my_caps = {
00164   fb = L4.Env.fb;
00165 };
00166
00167 L4.default_loader:start({caps = my_caps, log = {"APP", "blue"}}, "rom/hello");
00168
00169 local _doc = [==[
00170
00171 This snippet creates a caps template (my_caps) and uses it for the
00172 new process and also sets user-defined log tags.  The L4.Loader:start method,
00173 however, automatically adds the 'rom' directory to the caps environment if
00174 not already specified in the template.
00175
00176 Environment variables may be given as a table in the third argument to
00177 start. Argument to the program are given space separated after the program
00178 name within a single string.
00179
00180 ]==]
00181
00182 L4.default_loader:start({}, "rom/program arg1 " .. arg2, { LD_DEBUG = 1 });
00183
00184 local _doc = [==[
00185
00186 L4.default_loader:startv is a variant of the start function that takes the
00187 arguments of the program as a single argument each. If the last argument to
00188 startv is a table it is interpreted as environment variables for the program.
00189 The above example would translate to:
00190
00191 ]==]
00192
00193 L4.default_loader:startv({}, "rom/program", "arg1", arg2, { LD_DEBUG = 1 });
00194
00195 local _doc = [==[
00196
00197 To create a new L4.Loader instance you may use a generic factory for all
00198 building blocks or set individual factories.
00199
00200 ]==]
00201
00202 l = L4.Loader.new({
00203   mem = L4.Env.user_factory:create(L4.Proto.Factory, 512*1024):m("rs")
00204 });
00205
00206 local _doc = [==[
00207
00208 Creates a loader instance that uses the newly created 512 KB factory for
00209 all building blocks. To set individual factories use the options:
00210   'mem'       as memory allocator for the new processes and as
00211               default factory for all objects not explicitely set to a
00212               different factory
00213   'log_fab'   for creating log objects.
00214   'ns_fab'    for creating name-space objects.
00215   'rm_fab'    for creating region-map objects.
00216
00217
00218
00219 L4.App_env
00220 ----------
00221
00222 L4.App_env provides a more fine-grained control for a single process or for a
00223 limited number of processes. L4.App_env uses an L4.Loader object as basic
00224 facility. However you can override the memory allocator 'mem' for for the new
00225 process as well as the kernel factory 'factory', the log capability etc.
00226
00227 ]==]
00228
00229 local e = L4.App_env.new({
00230   loader = l,
```

```
00231   mem = L4.Env.user_factory:create(L4.Proto.Factory, 128*1024):m("rs")
00232 });
00233
00234 e:start("rom/hello");
```

16.40 cmd_control

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00003 /*
00004  * Copyright (C) 2016, 2024 Kernkonzept GmbH.
00005  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include <l4/sys/cxx/ipc_epiface>
00012 #include <l4/sys/cxx/ipc_string>
00013
00014 namespace L4Re { namespace Ned {
00015
00019 class Cmd_control : public L4::Kobject_0t<Cmd_control>
00020 {
00021   L4_INLINE_RPC_NF(long, execute, (L4::Ipc::String<> cmd,
00022                                    L4::Ipc::Array<char> &result));
00023
00024 public:
00042   long execute(L4::Ipc::String<> cmd) noexcept
00043   {
00044     L4::Ipc::Array<char> res(0, NULL);
00045     return execute_t::call(c(), cmd, res);
00046   }
00047
00064   long execute(L4::Ipc::String<> cmd,
00065                L4::Ipc::String<char> *result) noexcept
00066   {
00067     L4::Ipc::Array<char> res(result->length, result->data);
00068     long r = execute_t::call(c(), cmd, res);
00069     if (r >= 0)
00070       result->length = res.length;
00071     return r;
00072   }
00073
00074   typedef L4::Typeid::Rpcs<execute_t> Rpcs;
00075 };
00076
00077 } } // namespace
```

16.41 pkg/uvmm/configs/vmm.lua File Reference

Functions

- new_sched (prio, cpu_mask, ...)
- start_io (busses, cmdline, opts)
- set_sched (opts, prio, cpus, ...)
- start_virtio_switch (ports, prio, cpus, switch_type, ext_caps)
- start_virtio_switch_tbl (options)
- start_vm (options)

16.41.1 Function Documentation

16.41.1.1 new_sched()

```
new_sched (
              prio,
              cpu_mask,
              ...  )
```

Creates a new scheduler proxy at moe.

Parameters

prio	Base priority of the threads running in the scheduler proxy
cpu_mask	First of a list of CPU masks for the first 64 CPUs to use for the scheduler proxy
...	more CPU masks

Returns

created scheduler

16.41.1.2 set_sched()

```
set_sched (
              opts,
              prio,
              cpus,
              ...  )
```

Create scheduler proxy and add it into the `opts` table under the key `scheduler`.

Parameters

`in,out`	*opts*	option table
	prio	thread priority (or `nil`)
	cpus	cpu mask (or `nil`)
	...	more CPU masks

There are four possibilities for values of prio and cpus:

- No prio and no cpus: No scheduler proxy created.
- A prio, but no cpus: Create a scheduler proxy with only a priority limit.
- No Prio, but cpus: Create a scheduler proxy with default prio and cpus limit.
- A prio and cpus: Create a scheduler proxy with given limits.

16.41.1.3 start_io()

```
start_io (
              busses,
              cmdline,
              opts)
```

Start IO service with the given options

Parameters

`in,out`	*busses*	table of vBus names as keys. Uses io config `<name>.vbus` to fill vBus `<name>`.
	cmdline	io command line parameters
	opts	Option table for loader.start function, e.g. scheduler or ext_caps. Entries from ext_caps have precedence over default caps created by this function.

After this function returns the created vBusses are located in the table passed as `busses`.

16.41.1.4 start_virtio_switch()

```
start_virtio_switch (
              ports,
              prio,
              cpus,
              switch_type,
              ext_caps)
```

Start virtio network application.

Deprecated This function exists for backwards compatiblity reasons and calls start_virtio_switch_tbl with an appropriate `options` table

Parameters

`in,out`	*ports*	table with port names as keys
	prio	priority for started thread
	cpus	cpu mask for started thread
	switch_type	Selects application to start. Either `switch` or `p2p`
	ext_caps	Extra capabilities to pass to the started application

The switch_type `switch` can take additional arguments to create a port at the switch. To pass these arguments for a specific port, pass a table as value for a key in the ports table.

16.41.1.5 start_virtio_switch_tbl()

```
start_virtio_switch_tbl (
              options)
```

Start virtio network application.

Parameters

options	A table of parameters

The following keys are supported in the `options` table:

table key	value
`ports`	table with port names as keys
`scheduler`	scheduler (e.g. created with new_sched)
`switch_type`	selects application to start. Either `switch` or `p2p`
`ext_caps`	Extra capabilities to pass to the started application
`svr_cap`	cap slot to be used for the server interface
`port_limit`	the maximum number of dynamic ports the switch shall support

The switch_type `switch` can take additional arguments to create a port at the switch. To pass these arguments for a specific port, pass a table as value for a key in the ports table.

Note

The `svr_cap` capability requires server rights, use ":svr()".

16.41.1.6 start_vm()

```
start_vm (
              options)
```

Start UVMM

Parameters

options	A table of parameters

The following keys are supported in the `options` table:

table key	value
`bootargs`	command line for guest kernel
`cpus`	cpu mask
`ext_args`	additional arguments to pass to UVMM
`fdt`	file name of the device tree
`id`	an integer identifying the VM
`jdb`	jdb capability
`kernel`	file name of the guest kernel binary
`mem`	RAM size in MiB *or* dataspace cap for guest memory.
`mem_align`	alignment for the guest memory in bits. Ignored if mem is a cap.
`mon`	monitor application file name
`net`	a virtio cap, e.g. for network
`prio`	thread priority
`ram_base`	start of guest memory
`rd`	file name of the ramdisk
`scheduler`	a scheduler cap. If used, prio and cpus are ignored.
`vbus`	the vBus to attach to the VM

16.42 vmm.lua

Go to the documentation of this file.

```
00001 --! \file vmm.lua
00002
00003 local L4 = require "L4";
00004
00005 local l = L4.Loader.new({mem = L4.Env.user_factory});
00006 loader = l;
00007
00008 --[[!
00009   \internal
00010
00011   Utility function to merge several lua tables
00012
00013   \param ... one or more tables
00014
00015   \note Later tables are given more priority when merging
00016
00017   \return a new combined table
00018 ]]
00019 function table_override(...)
00020   local combined = {}
00021   for _, tab in ipairs({...}) do
00022     for k, v in pairs(tab) do
00023       combined[k] = v
00024     end
00025   end
00026   return combined
00027 end
```

```
00028
00029 --[[!
00030   Creates a new scheduler proxy at moe.
00031
00032   \param prio     Base priority of the threads running in the scheduler proxy
00033   \param cpu_mask First of a list of CPU masks for the first 64 CPUs to use for
00034                   the scheduler proxy
00035   \param ...      more CPU masks
00036
00037   \return created scheduler
00038 ]]
00039 function new_sched(prio, cpu_mask, ...)
00040   return  L4.Env.user_factory:create(L4.Proto.Scheduler, prio + 10, prio,
00041                                      cpu_mask, ...);
00042 end
00043
00044 --[[!
00045   Start IO service with the given options
00046
00047   \param[in,out] busses  table of vBus names as keys. Uses io config
00048                          `<name>.vbus` to fill vBus `<name>`.
00049   \param         cmdline io command line parameters
00050   \param         opts    Option table for loader.start function, e.g. scheduler
00051                          or ext_caps. Entries from ext_caps have precedence over
00052                          default caps created by this function.
00053
00054   After this function returns the created vBusses are located in the table
00055   passed as `busses`.
00056 ]]
00057 function start_io(busses, cmdline, opts)
00058   if opts == nil then opts = {} end
00059
00060   if opts.caps ~= nil then
00061     print("Warning: use opts.ext_caps to pass custom/additional capabilities.")
00062   end
00063
00064   if opts.scheduler == nil then
00065     print("IO started with base priority. Risk of priority related deadlocks! "
00066           .. "Provide an opts.scheduler entry.")
00067   end
00068
00069   local caps = {
00070     sigma0 = L4.cast(L4.Proto.Factory, L4.Env.sigma0):create(L4.Proto.Sigma0);
00071     icu    = L4.Env.icu;
00072     iommu  = L4.Env.iommu;
00073     dma_mgr = L4.Env.dma_mgr;
00074   };
00075
00076   local files = "";
00077
00078   for k, v in pairs(busses) do
00079     if caps[k] ~= nil then
00080       print("Warning: overwriting caps." .. k .. " with vbus of same name.")
00081     end
00082     local c = l:new_channel();
00083     busses[k] = c
00084     caps[k] = c:svr();
00085     files = files .. " rom/" .. k .. ".vbus";
00086   end
00087
00088   opts.caps = table_override(caps, opts.caps or {}, opts.ext_caps or {})
00089   opts.log  = opts.log or { "io", "red" }
00090
00091   return l:start(opts, "rom/io " .. cmdline .. files)
00092 end
00093
00094 --[[!
00095   Create scheduler proxy and add it into the `opts` table under
00096   the key `scheduler`.
00097
00098   \param[in,out]  opts  option table
00099   \param          prio  thread priority (or `nil`)
00100   \param          cpus  cpu mask (or `nil`)
00101   \param          ...   more CPU masks
00102
00103   There are four possibilities for values of prio and cpus:
00104
00105   \li No prio and no cpus: No scheduler proxy created.
00106   \li A prio, but no cpus: Create a scheduler proxy with only a priority limit.
00107   \li No Prio, but cpus: Create a scheduler proxy with default prio and cpus
00108       limit.
00109   \li A prio and cpus: Create a scheduler proxy with given limits.
00110 ]]
00111 function set_sched(opts, prio, cpus, ...)
00112   if cpus == nil and prio == nil then
00113     return
00114   end
```

```
00115
00116   if prio == nil then
00117     -- Default to zero to use the L4Re Default_thread_prio
00118     prio = 0
00119   end
00120
00121   local sched = new_sched(prio, cpus, ...);
00122   opts["scheduler"] = sched;
00123 end
00124
00125 --[[!
00126   Start virtio network application.
00127
00128   \deprecated This function exists for backwards compatiblity reasons and calls
00129               \ref start_virtio_switch_tbl with an appropriate `options` table
00130
00131   \param[in,out] ports       table with port names as keys
00132   \param         prio        priority for started thread
00133   \param         cpus        cpu mask for started thread
00134   \param         switch_type Selects application to start. Either `switch` or `p2p`
00135   \param         ext_caps    Extra capabilities to pass to the started application
00136
00137   The switch_type `switch` can take additional arguments to create a port at the
00138   switch. To pass these arguments for a specific port, pass a table as value for
00139   a key in the ports table.
00140
00141 ]]
00142 function start_virtio_switch(ports, prio, cpus, switch_type, ext_caps)
00143   local opts = {
00144     ports = ports,
00145     switch_type = switch_type,
00146     ext_caps = ext_caps,
00147   }
00148   set_sched(opts, prio, cpus)
00149   return start_virtio_switch_tbl(opts)
00150 end
00151
00152 --[[!
00153   Start virtio network application.
00154
00155   \param options  A table of parameters
00156
00157   The following keys are supported in the `options` table:
00158
00159   | table key    | value                                                          |
00160   | ------------ | -------------------------------------------------------------- |
00161   | `ports`      | table with port names as keys                                  |
00162   | `scheduler`  | scheduler (e.g. created with new_sched)                        |
00163   | `switch_type`| selects application to start. Either `switch` or `p2p`         |
00164   | `ext_caps`   | Extra capabilities to pass to the started application          |
00165   | `svr_cap`    | cap slot to be used for the server interface                   |
00166   | `port_limit` | the maximum number of dynamic ports the switch shall support   |
00167
00168   The switch_type `switch` can take additional arguments to create a port at the
00169   switch. To pass these arguments for a specific port, pass a table as value for
00170   a key in the ports table.
00171
00172   \note The `svr_cap` capability requires server rights, use ":svr()".
00173 ]]
00174 function start_virtio_switch_tbl(options)
00175   local ports = options.ports;
00176   local scheduler = options.scheduler;
00177   local switch_type = options.switch_type;
00178   local ext_caps = options.ext_caps;
00179   local svr_cap = options.svr_cap;
00180   local port_limit = options.port_limit;
00181
00182   if svr_cap and port_limit == nil then
00183     print("Warning: start_virtio_switch_tbl(): 'svr_cap' defined, but no "..
00184           "'port_limit' set. The svr_cap will not support dynamic port "..
00185           "creation.")
00186   end
00187
00188   if port_limit and svr_cap == nil then
00189     error("start_virtio_switch_tbl(): 'port_limit' set, but no 'svr_cap'. "..
00190           "This is not supported")
00191   end
00192
00193   local switch
00194
00195   if svr_cap then
00196     switch = svr_cap:svr()
00197   else
00198     switch = l:new_channel()
00199   end
00200
00201   local opts = {
```

```
00202     log = { "switch", "Blue" },
00203     caps = table_override({ svr = switch:svr() }, ext_caps or {});
00204   };
00205
00206   if scheduler then
00207     opts["scheduler"] = scheduler;
00208   end
00209
00210   if switch_type == "switch" then
00211     local port_count = 0;
00212     for k, v in pairs(ports) do
00213       port_count = port_count + 1;
00214     end
00215     if port_limit then
00216       port_count = port_count + port_limit
00217     end
00218
00219     svr = l:start(opts, "rom/l4vio_switch -v -p " .. port_count );
00220
00221     for k, extra_opts in pairs(ports) do
00222       if type(extra_opts) ~= "table" then
00223         extra_opts = {}
00224       end
00225
00226       ports[k] = L4.cast(L4.Proto.Factory, switch):create(
00227           0,
00228           "ds-max=4",
00229           "name=" .. k,
00230           table.unpack(extra_opts)
00231       )
00232     end
00233   else
00234     svr = l:start(opts, "rom/l4vio_net_p2p");
00235
00236     for k, v in pairs(ports) do
00237       ports[k] = L4.cast(L4.Proto.Factory, switch):create(0, "ds-max=4");
00238     end
00239   end
00240
00241   return svr;
00242 end
00243
00244 --[[!
00245   Start UVMM
00246
00247   \param options  A table of parameters
00248
00249   The following keys are supported in the `options` table:
00250
00251   | table key   | value                                                          |
00252   | ----------- | -------------------------------------------------------------- |
00253   | `bootargs`  | command line for guest kernel                                  |
00254   | `cpus`      | cpu mask                                                       |
00255   | `ext_args`  | additional arguments to pass to UVMM                           |
00256   | `fdt`       | file name of the device tree                                   |
00257   | `id`        | an integer identifying the VM                                  |
00258   | `jdb`       | jdb capability                                                 |
00259   | `kernel`    | file name of the guest kernel binary                           |
00260   | `mem`       | RAM size in MiB \e or dataspace cap for guest memory.          |
00261   | `mem_align` | alignment for the guest memory in bits. Ignored if mem is a cap. |
00262   | `mon`       | monitor application file name                                  |
00263   | `net`       | a virtio cap, e.g. for network                                 |
00264   | `prio`      | thread priority                                                |
00265   | `ram_base`  | start of guest memory                                          |
00266   | `rd`        | file name of the ramdisk                                       |
00267   | `scheduler` | a scheduler cap. If used, prio and cpus are ignored.           |
00268   | `vbus`      | the vBus to attach to the VM                                   |
00269 ]]
00270 function start_vm(options)
00271   local nr       = options.id;
00272   local size_mb = 0;
00273   local vbus     = options.vbus;
00274   local vnet     = options.net;
00275   local prio     = options.prio;
00276   local cpus     = options.cpus;
00277   local scheduler = options.scheduler;
00278   local nonidentmem = options.nonidentmem;
00279
00280   local align   = 10;
00281   if L4.Info.arch() == "arm" then
00282     align = 28;
00283   elseif L4.Info.arch() == "arm64" then
00284     align = 21;
00285   end
00286   align = options.mem_align or align;
00287
00288   local cmdline = {};
```

```
00289  if options.fdt then
00290    if type(options.fdt) ~= "table" then
00291      options.fdt = { options.fdt }
00292    end
00293    for _,v in ipairs(options.fdt) do
00294      cmdline[#cmdline+1] = "-d" .. v;
00295    end
00296  end
00297
00298  if options.bootargs then
00299    cmdline[#cmdline+1] = "-c" .. options.bootargs;
00300  end
00301
00302  if options.rd then
00303    cmdline[#cmdline+1] = "-r" .. options.rd;
00304  end
00305
00306  if options.kernel then
00307    cmdline[#cmdline+1] = "-k" .. options.kernel;
00308  end
00309
00310  if options.ram_base then
00311    cmdline[#cmdline+1] = "-b" .. options.ram_base;
00312  end
00313
00314  if L4.Info.arch() == "arm" or L4.Info.arch() == "arm64" then
00315    if not options.nonidentmem then
00316      cmdline[#cmdline+1] = "-i";
00317    end
00318  end
00319
00320  local keyb_shortcut = nil;
00321  if nr ~= nil then
00322    keyb_shortcut = "key=" .. nr;
00323  end
00324
00325  local vm_ram;
00326  if type(options.mem) == "userdata" then
00327    -- User gave us a cap. Using this as dataspace for guest RAM.
00328    vm_ram = options.mem
00329  elseif type(options.mem) == "number" then
00330    -- User gave us a number. Using this as size for a new Dataspace.
00331    size_mb = options.mem
00332  elseif type(options.mem) == "string" then
00333    print("start_vm: mem parameter '" .. options.mem .. "' is of type string, "
00334          .. "please use integer.");
00335    size_mb = tonumber(options.mem)
00336  else
00337    -- User did not give us any valid value.
00338    size_mb = 16
00339  end
00340
00341  if size_mb > 0 then
00342    local mem_flags = L4.Mem_alloc_flags.Continuous
00343                    | L4.Mem_alloc_flags.Pinned
00344                    | L4.Mem_alloc_flags.Super_pages;
00345
00346    vm_ram = L4.Env.user_factory:create(L4.Proto.Dataspace,
00347                                        size_mb * 1024 * 1024,
00348                                        mem_flags, align):m("rw");
00349  end
00350
00351  local caps = {
00352    net  = vnet;
00353    vbus = vbus;
00354    ram  = vm_ram;
00355  };
00356
00357  if options.jdb then
00358    caps["jdb"] = L4.Env.jdb
00359  end
00360
00361  if options.ext_args then
00362    for _,v in ipairs(options.ext_args) do
00363      cmdline[#cmdline+1] = v
00364    end
00365  end
00366
00367  local opts = {
00368    log  = options.log or l.log_fab:create(L4.Proto.Log, "vm" .. nr, "w",
00369                                           keyb_shortcut);
00370    caps = table_override(caps, options.ext_caps or {});
00371  };
00372
00373  if scheduler then
00374    opts["scheduler"] = scheduler;
00375  else
```

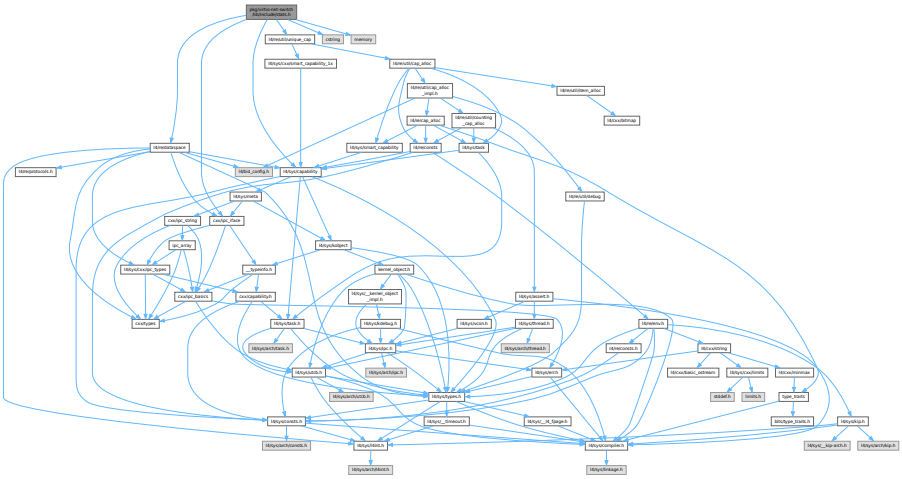
```
00376     set_sched(opts, prio, cpus);
00377   end
00378
00379   if type(options.mon) == 'string' then
00380     -- assume 'mon' is the name of a server binary which implements the uvmm
00381     -- CLI interface
00382     mon = l:new_channel()
00383
00384     l:start({
00385       scheduler = opts.scheduler;
00386       log = l.log_fab:create(L4.Proto.Log, "mon" .. nr),
00387       caps = { mon = mon:svr() }
00388     }, "rom/" .. options.mon)
00389
00390     opts.caps["mon"] = mon
00391   elseif options.mon ~= false then
00392     opts.caps["mon"] = l.log_fab:create(L4.Proto.Log, "mon" .. nr, "g");
00393   end
00394
00395   return l:startv(opts, "rom/uvmm", table.unpack(cmdline));
00396 end
00397
00398 return _ENV
```

16.43 pkg/virtio-net-switch/lib/include/stats.h File Reference

Client interface for port statistics.

```
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_iface>
#include <l4/re/dataspace>
#include <l4/re/util/unique_cap>
#include <cstring>
#include <memory>
```

Include dependency graph for stats.h:



Data Structures

- struct Virtio_net_switch::Port_statistics

  Statistics for one port.
- struct Virtio_net_switch::Statistics

  Base statistics data structure, resides at the beginning of shared memory.
- class Virtio_net_switch::Statistics_if

  IPC interface for the statistics interface.
- class Virtio_net_switch::Monitor

  Statistics client interface.

16.43.1 Detailed Description

Client interface for port statistics.
Definition in file stats.h.

16.44 stats.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2020, 2025 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * This file is distributed under the terms of the GNU General Public
00006  * License, version 2.  Please see the COPYING-GPL-2 file for details.
00007  */
00008 #pragma once
00009
00010 #include <l4/sys/capability>
00011 #include <l4/sys/cxx/ipc_iface>
00012 #include <l4/re/dataspace>
00013 #include <l4/re/util/unique_cap>
00014
00015 #include <cstring>
00016 #include <memory>
00017
00023
00024 namespace Virtio_net_switch {
00025
00027 struct Port_statistics
00028 {
00029   l4_uint64_t tx_num;
00030   l4_uint64_t tx_dropped;
00031   l4_uint64_t tx_bytes;
00032   l4_uint64_t rx_num;
00033   l4_uint64_t rx_dropped;
00034   l4_uint64_t rx_bytes;
00035   unsigned char mac[6];
00036   char          name[20];
00037   unsigned char in_use;
00039 };
00040
00042 struct Statistics
00043 {
00044   l4_uint64_t age;
00047   l4_uint64_t max_ports;
00049   struct Port_statistics port_stats[];
00050 };
00051
00058 class Statistics_if : public L4::Kobject_t<Statistics_if, L4::Kobject>
00059 {
00060 public:
00069   L4_INLINE_RPC(long, get_buffer, (L4::Ipc::Out<L4::Cap<L4Re::Dataspace> > ds));
00070
00078   L4_INLINE_RPC(long, sync, ());
00079
00080   typedef L4::Typeid::Rpcs<get_buffer_t, sync_t> Rpcs;
00081 };
00082
00091 class Monitor
00092 {
00093 public:
00094   Monitor(L4Re::Util::Unique_del_cap<Statistics_if> cap)
00095   : _cap(std::move(cap))
00096   {
00097     _ds = L4Re::Util::make_unique_cap<L4Re::Dataspace>();
00098     L4Re::chksys(_cap->get_buffer(_ds.get()),
00099                  "Could not get stats dataspace from switch.");
00100     void *addr;
00101     L4Re::chksys(L4Re::Env::env()->rm()->attach(&addr, _ds->size(),
00102                                                 L4Re::Rm::F::Search_addr | L4Re::Rm::F::R,
00103                                                 L4::Ipc::make_cap(_ds.get(), L4_CAP_FPAGE_RO)),
00104                  "Could not attach stats dataspace.");
00105     _stats = reinterpret_cast<Virtio_net_switch::Statistics *>(addr);
00106   }
00107
00108   ~Monitor()
00109   {
00110     L4Re::Env::env()->rm()->detach(reinterpret_cast<l4_addr_t>(_stats), 0);
00111   }
00112
00120   Port_statistics *get_port_stats(char const *name) const
00121   {
00122     for(size_t i = 0; i < _stats->max_ports; ++i)
```

```
00123       {
00124         if (_stats->port_stats[i].in_use
00125             && !strncmp (_stats->port_stats[i].name, name,
00126                          sizeof(_stats->port_stats[i].name)))
00127           return &_stats->port_stats[i];
00128       }
00129     return nullptr;
00130   }
00131
00139   bool get_port_mac(char const *name, unsigned char *mac) const
00140   {
00141     for (l4_uint64_t i = 0; i < _stats->max_ports; ++i)
00142       {
00143         if (_stats->port_stats[i].in_use
00144             && !strncmp (_stats->port_stats[i].name, name, 20))
00145           {
00146             std::memcpy(mac, _stats->port_stats[i].mac, 6);
00147             return true;
00148           }
00149       }
00150     return false;
00151   }
00152
00156   void sync() const
00157   {
00158     L4Re::chksys(_cap->sync(),
00159                  "Synchronizing statistics information failed.\n");
00160   }
00161
00162   l4_uint64_t age() const
00163   { return _stats->age; }
00164
00165 private:
00166   L4Re::Util::Unique_cap<L4Re::Dataspace> _ds;
00167   L4Re::Util::Unique_del_cap<Statistics_if> _cap;
00168   Statistics *_stats;
00169 };
00170
00171 class Port_monitor
00172 {
00173 private:
00174   std::shared_ptr<Monitor> _m;
00175   char _name[20];
00176   l4_uint64_t _age;
00177   Port_statistics *_stats; //only valid for the given age
00178
00179 public:
00183   Port_monitor(std::shared_ptr<Monitor> m, char const *name)
00184   : _m(m)
00185   {
00186     strncpy(_name, name, sizeof(_name) - 1);
00187     _name[sizeof(_name) - 1] = '\0';
00188     _age = _m->age();
00189     _stats = _m->get_port_stats(_name);
00190   }
00191
00198   void stats(l4_uint64_t *tx_num,
00199              l4_uint64_t *tx_dropped,
00200              l4_uint64_t *tx_bytes,
00201              l4_uint64_t *rx_num,
00202              l4_uint64_t *rx_dropped,
00203              l4_uint64_t *rx_bytes)
00204   {
00205     // ports have changed
00206     if (_age != _m->age())
00207       {
00208         _stats = _m->get_port_stats(_name);
00209         _age = _m->age();
00210       }
00211
00212     // no port found
00213     if (!_stats)
00214       {
00215         tx_num = tx_dropped = tx_bytes = rx_num = rx_dropped = rx_bytes = 0;
00216         return;
00217       }
00218
00219     *tx_num = _stats->tx_num;
00220     *tx_dropped = _stats->tx_dropped;
00221     *tx_bytes = _stats->tx_bytes;
00222     *rx_num = _stats->rx_num;
00223     *rx_dropped = _stats->rx_dropped;
00224     *rx_bytes = _stats->rx_bytes;
00225   }
00226 };
00227 }
```

16.45 stats.h

```
00001 #include <l4/re/env>
00002 #include <l4/re/dataspace>
00003 #include <l4/re/error_helper>
00004 #include <l4/re/util/cap_alloc>
00005 #include <l4/virtio-net-switch/stats.h>
00006
00007 class Switch_statistics
00008 {
00009 private:
00010   Virtio_net_switch::Statistics *_stats;
00011   bool _initialized = false;
00012
00013   Switch_statistics() {}
00014
00015   ~Switch_statistics()
00016   {
00017     if (_initialized)
00018       L4Re::Env::env()->rm()->detach(reinterpret_cast<l4_addr_t>(_stats), 0);
00019   }
00020
00021   l4_size_t _size;
00022
00023 public:
00024   Virtio_net_switch::Statistics *stats()
00025   {
00026     if (_initialized)
00027       return _stats;
00028     else
00029       throw L4::Runtime_error(-L4_EAGAIN, "Statistics not set up.");
00030   }
00031
00032   static Switch_statistics& get_instance()
00033   {
00034     static Switch_statistics instance;
00035     return instance;
00036   }
00037
00038   void initialize(l4_uint64_t num_max_ports)
00039   {
00040     _size = l4_round_page(sizeof(Virtio_net_switch::Statistics)
00041                           + sizeof(Virtio_net_switch::Port_statistics) * num_max_ports);
00042     void *addr = malloc(_size);
00043     if (!addr)
00044       throw L4::Runtime_error(-L4_ENOMEM,
00045                               "Could not allocate statistics memory.");
00046
00047     memset(addr, 0, _size);
00048     _stats = reinterpret_cast<Virtio_net_switch::Statistics *>(addr);
00049     _initialized = true;
00050     _stats->max_ports = num_max_ports;
00051   }
00052
00053   Virtio_net_switch::Port_statistics *
00054   allocate_port_statistics(char const* name)
00055   {
00056     for (unsigned i = 0; i < _stats->max_ports; ++i)
00057       {
00058         if (!_stats->port_stats[i].in_use)
00059           {
00060             memset(reinterpret_cast<void*>(&_stats->port_stats[i]), 0,
00061                    sizeof(Virtio_net_switch::Port_statistics));
00062             _stats->port_stats[i].in_use = 1;
00063             size_t len = std::min(strlen(name), sizeof(_stats->port_stats[i].name) - 1);
00064             memcpy(_stats->port_stats[i].name, name, len);
00065             _stats->port_stats[i].name[len] = '\0';
00066             _stats->age++;
00067             return &_stats->port_stats[i];
00068           }
00069       }
00070     return nullptr;
00071   }
00072
00073   inline l4_size_t size()
00074   { return _size; }
00075
00076   Switch_statistics(Switch_statistics const&) = delete;
00077   void operator=(Switch_statistics const &) = delete;
00078 };
```

16.46 debug.h

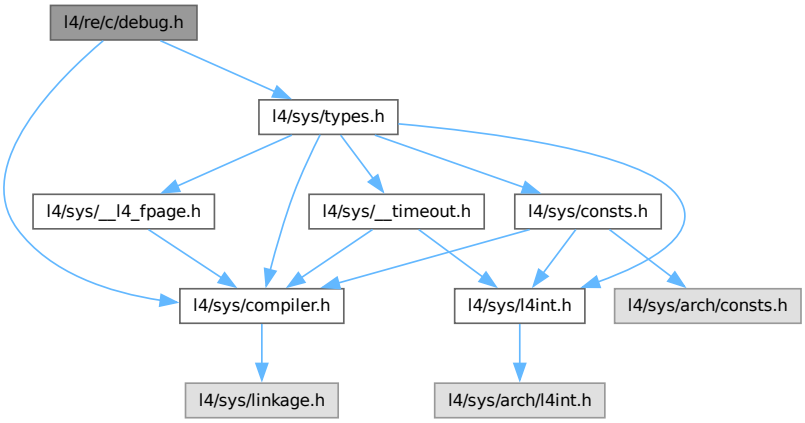
```
00001 /*
00002  * (c) 2013-2014 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/re/util/debug>
00010
00011 struct Err : L4Re::Util::Err
00012 {
00013   Err(Level l = Fatal) : L4Re::Util::Err(l, "VSwitch") {}
00014 };
00015
00016 class Dbg : public L4Re::Util::Dbg
00017 {
00019   static constexpr unsigned Verbosity_shift = 4;
00020   static constexpr unsigned long Verbosity_mask = (1UL << Verbosity_shift) - 1;
00021
00022 public:
00024   enum Verbosity : unsigned long
00025   {
00026     Quiet = 0,
00027     Warn = 1,
00028     Info = 2,
00029     Debug = 4,
00030     Trace = 8,
00031     Max_verbosity = 8
00032   };
00033
00037   enum Component
00038   {
00039     Core = 0,
00040     Virtio,
00041     Port,
00042     Request,
00043     Queue,
00044     Packet,
00045     Max_component
00046   };
00047
00048 #ifndef NDEBUG
00049
00050   static_assert(Max_component * Verbosity_shift <= sizeof(level) * 8,
00051                 "Too many components for level mask");
00052   static_assert((Max_verbosity & Verbosity_mask) == Max_verbosity,
00053                 "Verbosity_shift to small for verbosity levels");
00054
00060   static void set_verbosity(unsigned mask)
00061   {
00062     for (unsigned i = 0; i < Max_component; ++i)
00063       set_verbosity(i, mask);
00064   }
00065
00072   static void set_verbosity(unsigned c, unsigned mask)
00073   {
00074     level &= ~(Verbosity_mask << (Verbosity_shift * c));
00075     level |= (mask & Verbosity_mask) << (Verbosity_shift * c);
00076   }
00077
00087   static bool is_active(unsigned c, unsigned mask)
00088   { return level & (mask & Verbosity_mask) << (Verbosity_shift * c); }
00089
00096   using L4Re::Util::Dbg::is_active;
00097
00098   Dbg(Component c = Core, Verbosity v = Warn, char const *subsys = nullptr)
00099   : L4Re::Util::Dbg(v << (Verbosity_shift * c), "SWI", subsys)
00100   {}
00101
00102 #else
00103
00104   static void set_verbosity(unsigned) {}
00105   static void set_verbosity(unsigned, unsigned) {}
00106
00107   static bool is_active(unsigned, unsigned) { return false; }
00108   using L4Re::Util::Dbg::is_active;
00109
00110   Dbg(Component c = Core, Verbosity v = Warn, char const *subsys = nullptr)
00111   : L4Re::Util::Dbg(v << (Verbosity_shift * c), "", subsys)
00112   {}
00113
00114 #endif
00115 };
```

16.47 l4/re/c/debug.h File Reference

Debug C interface.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
```

Include dependency graph for debug.h:



Functions

- L4_BEGIN_DECLS l4_ret_t l4re_debug_obj_debug (l4_cap_idx_t srv, unsigned long function) L4_NOTHROW

  Call debug function of L4Re service.

16.47.1 Detailed Description

Debug C interface.
Definition in file debug.h.

16.48 debug.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00017
00018 #include <l4/sys/compiler.h>
00019 #include <l4/sys/types.h>
00020
00021 L4_BEGIN_DECLS
00022
00030 L4_CV l4_ret_t
00031 l4re_debug_obj_debug(l4_cap_idx_t srv, unsigned long function) L4_NOTHROW;
00032
00033 L4_END_DECLS
```

16.49 filter.cc

```
00001 /*
00002  * Copyright (C) 2016-2017, 2024 Kernkonzept GmbH.
```

```
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #include "filter.h"
00008
00009 /* This is an example filter and therefore rather verbose. A real
00010    filter would not produce any output */
00011
00012 bool
00013 filter(const uint8_t *buf, size_t size)
00014 {
00015   // Packet large enough to apply filter condition?
00016   if (size <= 13)
00017     return false;
00018
00019   uint16_t ether_type = (uint16_t)*(buf + 12) << 8
00020                       | (uint16_t)*(buf + 13);
00021   char const *protocol;
00022   switch (ether_type)
00023     {
00024     case 0x0800: protocol = "IPv4"; break;
00025     case 0x0806: protocol = "ARP"; break;
00026     case 0x8100: protocol = "Vlan"; break;
00027     case 0x86dd: protocol = "IPv6"; break;
00028     case 0x8863: protocol = "PPPoE Discovery"; break;
00029     case 0x8864: protocol = "PPPoE Session"; break;
00030     default: protocol = nullptr;
00031     }
00032   if (protocol)
00033     printf("%s\n", protocol);
00034   else
00035     printf("%04x\n", ether_type);
00036
00037   if (ether_type == 0x0806)
00038     {
00039       printf("Do not filter arp\n");
00040       return false;
00041     }
00042
00043   return true;
00044 }
```

16.50 filter.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2023-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "request.h"
00010 #include <l4/bid_config.h>
00011
00024 #ifdef CONFIG_VNS_PORT_FILTER
00025 bool filter(const uint8_t *buf, size_t size);
00026 #else
00027 inline bool filter(const uint8_t *, size_t)
00028 {
00029   // default implementation filtering out no packets, see filter.cc for
00030   // other examples
00031   return false;
00032 }
00033 #endif
00034
00043 inline bool filter_request(Net_request const &req)
00044 {
00045   size_t size;
00046   const uint8_t *buf = req.buffer(&size);
00047   return filter(buf, size);
00048 }
```

16.51 mac_addr.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2020, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
```

```
00006  */
00007 #pragma once
00008
00009 #include <cstring>
00010 #include <inttypes.h>
00015
00019 class Mac_addr
00020 {
00021 public:
00022   enum
00023   {
00024     Addr_length = 6,
00025     Addr_unknown = 0ULL
00026   };
00027
00028   explicit Mac_addr(char const *_src)
00029   {
00030     /* A mac address is 6 bytes long, it is transmitted in big endian
00031        order over the network. For our internal representation we
00032        focus on easy testability of broadcast/multicast and reorder
00033        the bytes that the most significant byte becomes the least
00034        significant one. */
00035     unsigned char const *src = reinterpret_cast<unsigned char const *>(_src);
00036     _mac =    ((uint64_t)src[0])        | (((uint64_t)src[1]) << 8)
00037             | (((uint64_t)src[2]) << 16) | (((uint64_t)src[3]) << 24)
00038             | (((uint64_t)src[4]) << 32) | (((uint64_t)src[5]) << 40);
00039   }
00040
00041    static Mac_addr from_uncached(char volatile const *src)
00042    { return Mac_addr(src); }
00043
00044   explicit Mac_addr(uint64_t mac) : _mac{mac} {}
00045
00046   Mac_addr(Mac_addr const &other) : _mac{other._mac} {}
00047
00049   bool is_broadcast() const
00050   {
00051     /* There are broadcast and multicast addresses, both are supposed
00052        to be delivered to all station and the local network (layer 2).
00053
00054        Broadcast address is FF:FF:FF:FF:FF:FF, multicast addresses have
00055        the LSB of the first octet set. Since this holds for both
00056        broadcast and multicast we test for the multicast bit here.
00057
00058        In our internal representation we store the bytes in reverse
00059        order, so we test the least significant bit of the least
00060        significant byte.
00061     */
00062     return _mac & 1;
00063   }
00064
00066   bool is_unknown() const
00067   { return _mac == Addr_unknown; }
00068
00069   bool operator == (Mac_addr const &other) const
00070   { return _mac == other._mac; }
00071
00072   bool operator != (Mac_addr const &other) const
00073   { return _mac != other._mac; }
00074
00075   bool operator < (Mac_addr const &other) const
00076   { return _mac < other._mac; }
00077
00078   Mac_addr& operator = (Mac_addr const &other)
00079   { _mac = other._mac; return *this; }
00080
00081   Mac_addr& operator = (uint64_t mac)
00082   { _mac = mac; return *this; }
00083
00084   template<typename T>
00085   void print(T &stream) const
00086   {
00087     stream.cprintf("%02x:%02x:%02x:%02x:%02x:%02x",
00088                    (int)(_mac & 0xff)        , (int)((_mac >> 8)  & 0xff),
00089                    (int)((_mac >> 16) & 0xff), (int)((_mac >> 24) & 0xff),
00090                    (int)((_mac >> 32) & 0xff), (int)((_mac >> 40) & 0xff));
00091   }
00092
00093   void to_array(unsigned char mac[6]) const
00094   {
00095     mac[0] = _mac & 0xffU;
00096     mac[1] = (_mac >> 8) & 0xffU;
00097     mac[2] = (_mac >> 16) & 0xffU;
00098     mac[3] = (_mac >> 24) & 0xffU;
00099     mac[4] = (_mac >> 32) & 0xffU;
00100     mac[5] = (_mac >> 40) & 0xffU;
00101   }
```

```
00102
00103 private:
00104    explicit Mac_addr(char volatile const *_src)
00105    {
00106     /* A mac address is 6 bytes long, it is transmitted in big endian
00107        order over the network. For our internal representation we
00108        focus on easy testability of broadcast/multicast and reorder
00109        the bytes that the most significant byte becomes the least
00110        significant one. */
00111     volatile unsigned char const *src = reinterpret_cast<volatile unsigned char const *>(_src);
00112     _mac =    ((uint64_t)src[0])       | (((uint64_t)src[1]) « 8)
00113             | (((uint64_t)src[2]) « 16) | (((uint64_t)src[3]) « 24)
00114             | (((uint64_t)src[4]) « 32) | (((uint64_t)src[5]) « 40);
00115    }
00116
00118   uint64_t _mac;
00119 };
```

16.52 mac_table.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2020, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "mac_addr.h"
00010 #include "port.h"
00011
00012 #include <array>
00013 #include <map>
00014 #include <tuple>
00015 #include <algorithm>
00020
00039 template<std::size_t Size = 1024U>
00040 class Mac_table
00041 {
00042 public:
00043   Mac_table()
00044   : _mac_table(),
00045     _entries(),
00046     _rr_index(0U)
00047   {}
00048
00058   Port_iface *lookup(Mac_addr dst, l4_uint16_t vlan_id) const
00059   {
00060     auto entry = _mac_table.find(std::tuple(dst, vlan_id));
00061     return (entry != _mac_table.end()) ? entry->second->port : nullptr;
00062   }
00063
00078   void learn(Mac_addr src, Port_iface *port, l4_uint16_t vlan_id)
00079   {
00080     Dbg info(Dbg::Port, Dbg::Info);
00081
00082     if (L4_UNLIKELY(info.is_active()))
00083       {
00084         // check whether we already know about src mac and vlan_id
00085         auto *p = lookup(src, vlan_id);
00086         if (!p || p != port)
00087           {
00088             info.printf("%s %-20s -> ", !p ? "learned " : "replaced",
00089                         port->get_name());
00090             src.print(info);
00091             info.cprintf("\n");
00092           }
00093       }
00094
00095     auto status = _mac_table.emplace(std::tuple(src, vlan_id),
00096                                      &_entries[_rr_index]);
00097     if (L4_UNLIKELY(status.second))
00098       {
00099         if (_entries[_rr_index].port)
00100           {
00101             // remove old entry
00102             _mac_table.erase(std::tuple(_entries[_rr_index].addr,
00103                                         _entries[_rr_index].vlan_id));
00104           }
00105         // Set/Replace port and mac address
00106         _entries[_rr_index].port = port;
00107         _entries[_rr_index].addr = src;
00108         _entries[_rr_index].vlan_id = vlan_id;
00109         _rr_index = (_rr_index + 1U) % Size;
```

```
00110       }
00111     else
00112       {
00113         // Update port to allow for movement of client between ports
00114         status.first->second->port = port;
00115       }
00116   }
00117
00129   void flush(Port_iface *port)
00130   {
00131     typedef std::pair<std::tuple<const Mac_addr, l4_uint16_t>, Entry*> TableEntry;
00132
00133     auto iter = _mac_table.begin();
00134     while ((iter = std::find_if(iter, _mac_table.end(),
00135                                 [port](TableEntry const &p)
00136                                 { return p.second->port == port; }))
00137            != _mac_table.end())
00138       {
00139         iter->second->port = nullptr;
00140         iter->second->addr = Mac_addr::Addr_unknown;
00141         iter->second->vlan_id = 0;
00142         iter = _mac_table.erase(iter);
00143       }
00144
00145     assert(std::find_if(_mac_table.begin(), _mac_table.end(),
00146                         [port](TableEntry const &p)
00147                         { return p.second->port == port; }) == _mac_table.end());
00148   }
00149
00150 private:
00157   struct Entry {
00158     Port_iface *port;
00159     Mac_addr addr;
00160     l4_uint16_t vlan_id;
00161
00162     Entry()
00163     : port(nullptr),
00164       addr(Mac_addr::Addr_unknown),
00165       vlan_id(0)
00166     {}
00167   };
00168
00169   std::map<std::tuple<Mac_addr, l4_uint16_t>, Entry*> _mac_table;
00170   std::array<Entry, Size> _entries;
00171   size_t _rr_index;
00172 };
```

16.53 main.cc

```
00001 /*
00002  * Copyright (C) 2016-2020, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Manuel von Oltersdorff-Kalettka <manuel.kalettka@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #include <l4/re/util/meta>
00009 #include <l4/re/util/object_registry>
00010 #include <l4/re/util/br_manager>
00011
00012 #include <l4/sys/factory>
00013 #include <l4/sys/task>
00014
00015 #include <l4/sys/cxx/ipc_epiface>
00016 #include <l4/sys/cxx/ipc_varg>
00017 #include <l4/cxx/dlist>
00018 #include <l4/cxx/string>
00019
00020 #include <stdlib.h>
00021 #include <string>
00022 #include <terminate_handler-l4>
00023 #include <vector>
00024
00025 #include "debug.h"
00026 #include "options.h"
00027 #include "switch.h"
00028 #include "vlan.h"
00029 #include <l4/virtio-net-switch/stats.h>
00030
00047
00048
00049 /*
00050  * Registry for our server, used to register
00051  * - factory capability
```

```
00052  * - irq object for capability deletion irqs
00053  * - virtio host kick irqs
00054  */
00055 static L4Re::Util::Registry_server<L4Re::Util::Br_manager_hooks> server;
00056
00057 using Ds_vector = std::vector<L4::Cap<L4Re::Dataspace»;
00058 static std::shared_ptr<Ds_vector> trusted_dataspaces;
00059
00060 static bool
00061 parse_int_param(L4::Ipc::Varg const &param, char const *prefix, int *out)
00062 {
00063   l4_size_t headlen = strlen(prefix);
00064
00065   if (param.length() < headlen)
00066     return false;
00067
00068   char const *pstr = param.value<char const *>();
00069
00070   if (strncmp(pstr, prefix, headlen) != 0)
00071     return false;
00072
00073   std::string tail(pstr + headlen, param.length() - headlen);
00074
00075   if (!parse_int_optstring(tail.c_str(), out))
00076     {
00077       Err(Err::Normal).printf("Bad parameter '%s'. Invalid number specified.\n",
00078                               prefix);
00079       throw L4::Runtime_error(-L4_EINVAL);
00080     }
00081
00082   return true;
00083 }
00084
00085 static void
00086 assign_random_mac(l4_uint8_t mac[6])
00087 {
00088   static bool initialized = false;
00089
00090   if (!initialized)
00091     {
00092       srandom(l4_kip_clock(l4re_kip()));
00093       initialized = true;
00094     }
00095
00096   for (int i = 0; i < 6; i++)
00097     mac[i] = static_cast<l4_uint8_t>(random());
00098
00099   mac[0] &= ~(1U « 0); // clear multicast bit
00100   mac[0] |= 1U « 1;    // set "locally administered" bit
00101 }
00102
00114 class Switch_factory : public L4::Epiface_t<Switch_factory, L4::Factory>
00115 {
00119   class Port : public L4virtio_port
00120   {
00121     // Irq used to notify the guest
00122     L4::Cap<L4::Irq> _device_notify_irq;
00123
00124     L4::Cap<L4::Irq> device_notify_irq() const override
00125     { return _device_notify_irq; }
00126
00127   public:
00128     Port(unsigned vq_max, unsigned num_ds, char const *name,
00129          l4_uint8_t const *mac)
00130     : L4virtio_port(vq_max, num_ds, name, mac) {}
00131
00133     void register_end_points(L4Re::Util::Object_registry* registry,
00134                              L4::Epiface *kick_irq)
00135     {
00136       // register virtio host kick irq
00137       _device_notify_irq = L4Re::chkcap(registry->register_irq_obj(kick_irq));
00138
00139       // register virtio endpoint
00140       L4Re::chkcap(registry->register_obj(this));
00141
00142       // decrement ref counter to get a notification when the last
00143       // external reference vanishes
00144       obj_cap()->dec_refcnt(1);
00145     }
00146
00147     virtual ~Port()
00148     { server.registry()->unregister_obj(this); }
00149   };
00150
00154   class Switch_port : public Port
00155   {
00166     class Kick_irq : public L4::Irqep_t<Kick_irq>
```

```
00167     {
00168       Virtio_switch *_switch;
00169       L4virtio_port *_port;
00170
00171     public:
00178       void handle_irq()
00179       { _switch->handle_l4virtio_port_tx(_port); }
00180
00181       Kick_irq(Virtio_switch *virtio_switch, L4virtio_port *port)
00182       : _switch{virtio_switch}, _port{port} {}
00183     };
00184
00185     Kick_irq _kick_irq;
00186     Kick_irq _reschedule_tx_irq;
00187
00188   public:
00189     Switch_port(L4Re::Util::Object_registry *registry,
00190                 Virtio_switch *virtio_switch, unsigned vq_max, unsigned num_ds,
00191                 char const *name, l4_uint8_t const *mac)
00192     : Port(vq_max, num_ds, name, mac),
00193       _kick_irq(virtio_switch, this),
00194       _reschedule_tx_irq(virtio_switch, this)
00195     {
00196       register_end_points(registry, &_kick_irq);
00197
00198       _pending_tx_reschedule =
00199         L4Re::chkcap(registry->register_irq_obj(&_reschedule_tx_irq),
00200                      "Register TX reschedule IRQ.");
00201       _pending_tx_reschedule->unmask();
00202     }
00203
00204     virtual ~Switch_port()
00205     {
00206       // We need to delete the IRQ object created in register_irq_obj() ourselves
00207       L4::Cap<L4::Task>(L4Re::This_task)
00208         ->unmap(_kick_irq.obj_cap().fpage(),
00209                 L4_FP_ALL_SPACES | L4_FP_DELETE_OBJ);
00210       server.registry()->unregister_obj(&_kick_irq);
00211
00212       L4::Cap<L4::Task>(L4Re::This_task)
00213         ->unmap(_pending_tx_reschedule.fpage(),
00214                 L4_FP_ALL_SPACES | L4_FP_DELETE_OBJ);
00215       server.registry()->unregister_obj(&_reschedule_tx_irq);
00216     }
00217   };
00218
00222   class Monitor_port : public Port
00223   {
00229     class Kick_irq : public L4::Irqep_t<Kick_irq>
00230     {
00231       L4virtio_port *_port;
00232
00233     public:
00241       void handle_irq()
00242       {
00243         do
00244           {
00245             _port->tx_q()->disable_notify();
00246             _port->rx_q()->disable_notify();
00247
00248             _port->drop_requests();
00249
00250             _port->tx_q()->enable_notify();
00251             _port->rx_q()->enable_notify();
00252
00253             L4virtio::wmb();
00254             L4virtio::rmb();
00255           }
00256         while (_port->tx_work_pending());
00257       }
00258
00259       Kick_irq(L4virtio_port *port) : _port{port} {}
00260     };
00261
00262     Kick_irq _kick_irq;
00263
00264   public:
00265     Monitor_port(L4Re::Util::Object_registry* registry,
00266                  unsigned vq_max, unsigned num_ds, char const *name,
00267                  l4_uint8_t const *mac)
00268     : Port(vq_max, num_ds, name, mac), _kick_irq(this)
00269     { register_end_points(registry, &_kick_irq); }
00270
00271     virtual ~Monitor_port()
00272     {
00273       // We need to delete the IRQ object created in register_irq_obj() ourselves
00274       L4::Cap<L4::Task>(L4Re::This_task)
```

```
00275         ->unmap(_kick_irq.obj_cap().fpage(),
00276                 L4_FP_ALL_SPACES | L4_FP_DELETE_OBJ);
00277       server.registry()->unregister_obj(&_kick_irq);
00278     }
00279   };
00280
00284   class Stats_reader
00285     : public cxx::D_list_item,
00286       public L4::Epiface_t<Stats_reader, Virtio_net_switch::Statistics_if>
00287   {
00288     L4Re::Util::Unique_cap<L4Re::Dataspace> _ds;
00289     l4_addr_t _addr;
00290
00291   public:
00292     Stats_reader()
00293     {
00294       l4_size_t size = Switch_statistics::get_instance().size();
00295       _ds = L4Re::Util::make_unique_cap<L4Re::Dataspace>();
00296       L4Re::chksys(L4Re::Env::env()->mem_alloc()->alloc(size, _ds.get()),
00297                    "Could not allocate shared mem ds.");
00298       L4Re::chksys(L4Re::Env::env()->rm()->attach(&_addr, _ds->size(),
00299                                                   L4Re::Rm::F::Search_addr
00300                                                   | L4Re::Rm::F::RW,
00301                                                   L4::Ipc::make_cap_rw(_ds.get())));
00302
00303       memset(reinterpret_cast<void*>(_addr), 0, _ds->size());
00304     }
00305
00306     ~Stats_reader()
00307     {
00308       L4Re::Env::env()->rm()->detach(reinterpret_cast<l4_addr_t>(_addr), 0);
00309       server.registry()->unregister_obj(this);
00310     }
00311
00312     long op_get_buffer(Virtio_net_switch::Statistics_if::Rights,
00313                        L4::Ipc::Cap<L4Re::Dataspace> &ds)
00314     {
00315       // We hand out the dataspace in a read only manner. Clients must not be
00316       // able to modify information as that would create an unwanted data
00317       // channel.
00318       ds = L4::Ipc::Cap<L4Re::Dataspace>(_ds.get(), L4_CAP_FPAGE_RO);
00319       return L4_EOK;
00320     }
00321
00322     long op_sync(Virtio_net_switch::Statistics_if::Rights)
00323     {
00324       memcpy(reinterpret_cast<void *>(_addr),
00325              reinterpret_cast<void *>(Switch_statistics::get_instance().stats()),
00326              Switch_statistics::get_instance().size());
00327       return L4_EOK;
00328     }
00329
00330     bool is_valid()
00331     { return obj_cap() && obj_cap().validate().label(); }
00332   };
00333
00334   class Stats_reader_list
00335   {
00336     cxx::D_list<Stats_reader> _readers;
00337
00338   public:
00339     void check_readers()
00340     {
00341       auto it = _readers.begin();
00342       while (it != _readers.end())
00343         {
00344           auto *reader = *it;
00345           if (!reader->is_valid())
00346             {
00347               it = _readers.erase(it);
00348               delete reader;
00349             }
00350           else
00351             ++it;
00352         }
00353     }
00354
00355     void push_back(cxx::unique_ptr<Stats_reader> reader)
00356     {
00357       _readers.push_back(reader.release());
00358     }
00359   };
00360
00361   /*
00362    * Handle vanishing caps by telling the switch that a port might have gone
00363    */
00364   struct Del_cap_irq : public L4::Irqep_t<Del_cap_irq>
```

```
00365   {
00366   public:
00367     void handle_irq()
00368     {
00369       _switch->check_ports();
00370       _stats_readers->check_readers();
00371     }
00372
00373     Del_cap_irq(Virtio_switch *virtio_switch, Stats_reader_list *stats_readers)
00374     : _switch{virtio_switch},
00375       _stats_readers{stats_readers}
00376     {}
00377
00378   private:
00379     Virtio_switch *_switch;
00380     Stats_reader_list *_stats_readers;
00381   };
00382
00383   Virtio_switch *_virtio_switch;
00384
00386   unsigned _vq_max_num;
00387   Stats_reader_list _stats_readers;
00388   Del_cap_irq _del_cap_irq;
00393   unsigned _dbg_port_num = 0;
00394
00410   bool handle_opt_arg(L4::Ipc::Varg const &opt, bool &monitor,
00411                       char *name, size_t size,
00412                       l4_uint16_t &vlan_access,
00413                       std::vector<l4_uint16_t> &vlan_trunk,
00414                       bool *vlan_trunk_all,
00415                       l4_uint8_t mac[6], bool &mac_set)
00416   {
00417     assert(opt.is_of<char const *>());
00418     unsigned len = opt.length();
00419     const char *opt_str = opt.data();
00420     Err err(Err::Normal);
00421
00422
00423     if (len > 5)
00424       {
00425         if (!strncmp("type=", opt_str, 5))
00426           {
00427             if (!strncmp("type=monitor", opt_str, len))
00428               {
00429                 monitor = true;
00430                 return true;
00431               }
00432             else if (!strncmp("type=none", opt_str, len))
00433               return true;
00434
00435             err.printf("Unknown type '%.*s'\n", opt.length() - 5, opt.data() + 5);
00436             return false;
00437           }
00438         else if (!strncmp("name=", opt_str, 5))
00439           {
00440             snprintf(name, size, "%.*s", opt.length() - 5, opt.data() + 5);
00441             return true;
00442           }
00443         else if (!strncmp("vlan=", opt_str, 5))
00444           {
00445             cxx::String str(opt_str + 5, strnlen(opt_str + 5, len - 5));
00446             cxx::String::Index idx;
00447
00448             if ((idx = str.starts_with("access=")))
00449               {
00450                 str = str.substr(idx);
00451                 l4_uint16_t vid;
00452                 int next = str.from_dec(&vid);
00453                 if (next && next == str.len() && vlan_valid_id(vid))
00454                   vlan_access = vid;
00455                 else
00456                   {
00457                     err.printf("Invalid VLAN access port id '%.*s'\n",
00458                                opt.length(), opt.data());
00459                     return false;
00460                   }
00461               }
00462             else if ((idx = str.starts_with("trunk=")))
00463               {
00464                 int next;
00465                 l4_uint16_t vid;
00466                 str = str.substr(idx);
00467                 if (str == cxx::String("all"))
00468                 {
00469                   *vlan_trunk_all = true;
00470                   return true;
00471                 }
```

```
00472                 while ((next = str.from_dec(&vid)))
00473                   {
00474                     if (!vlan_valid_id(vid))
00475                       break;
00476                     vlan_trunk.push_back(vid);
00477                     if (next < str.len() && str[next] != ',')
00478                       break;
00479                     str = str.substr(next+1);
00480                   }
00481
00482                 if (vlan_trunk.empty() || !str.empty())
00483                   {
00484                     err.printf("Invalid VLAN trunk port spec '%.*s'\n",
00485                                opt.length(), opt.data());
00486                     return false;
00487                   }
00488               }
00489             else
00490               {
00491                 err.printf("Invalid VLAN specification..\n");
00492                 return false;
00493               }
00494
00495             return true;
00496           }
00497         else if (!strncmp("mac=", opt_str, 4))
00498           {
00499             size_t const OPT_LEN = 4 /* mac= */ + 6*2 /* digits */ + 5 /* : */;
00500             // expect NUL terminated string for simplicity
00501             if (len > OPT_LEN && opt_str[OPT_LEN] == '\0' &&
00502                 sscanf(opt_str+4, "%hhx:%hhx:%hhx:%hhx:%hhx:%hhx", &mac[0],
00503                        &mac[1], &mac[2], &mac[3], &mac[4], &mac[5]) == 6)
00504               {
00505                 mac_set = true;
00506                 return true;
00507               }
00508
00509             err.printf("Invalid mac address '%.*s'\n", len - 4, opt_str + 4);
00510             return false;
00511           }
00512       }
00513
00514     err.printf("Unknown option '%.*s'\n", opt.length(), opt.data());
00515     return false;
00516   }
00517
00518 public:
00519   Switch_factory(Virtio_switch *virtio_switch, unsigned vq_max_num)
00520   : _virtio_switch{virtio_switch}, _vq_max_num{vq_max_num},
00521     _del_cap_irq{virtio_switch, &_stats_readers}
00522   {
00523     auto c = L4Re::chkcap(server.registry()->register_irq_obj(&_del_cap_irq));
00524     L4Re::chksys(L4Re::Env::env()->main_thread()->register_del_irq(c));
00525   };
00526
00533   long op_create(L4::Factory::Rights, L4::Ipc::Cap<void> &res,
00534                  l4_umword_t type, L4::Ipc::Varg_list_ref va)
00535   {
00536     switch (type)
00537       {
00538       case 0:
00539         return create_port(res, va);
00540       case 1:
00541         return create_stats(res);
00542       default:
00543         Dbg(Dbg::Core, Dbg::Warn).printf("op_create: Invalid object type\n");
00544         return -L4_EINVAL;
00545       }
00546   }
00547
00548   long create_port(L4::Ipc::Cap<void> &res, L4::Ipc::Varg_list_ref va)
00549   {
00550     Dbg warn(Dbg::Port, Dbg::Warn, "Port");
00551     Dbg info(Dbg::Port, Dbg::Info, "Port");
00552
00553     info.printf("Incoming port request\n");
00554
00555     bool monitor = false;
00556     char name[20] = "";
00557     unsigned arg_n = 2;
00558     l4_uint16_t vlan_access = 0;
00559     std::vector<l4_uint16_t> vlan_trunk;
00560     bool vlan_trunk_all = false;
00561
00562     l4_uint8_t mac[6];
00563     bool mac_set = false;
00564     int num_ds = 2;
```

```
00565
00566     for (L4::Ipc::Varg opt: va)
00567       {
00568         if (!opt.is_of<char const *>())
00569           {
00570             warn.printf("Unexpected type for argument %d\n", arg_n);
00571             return -L4_EINVAL;
00572           }
00573
00574         if (parse_int_param(opt, "ds-max=", &num_ds))
00575           {
00576             if (num_ds <= 0 || num_ds > 80)
00577               {
00578                 Err(Err::Normal).printf("warning: client requested invalid number"
00579                                         " of data spaces: 0 < %d <= 80\n", num_ds);
00580                 return -L4_EINVAL;
00581               }
00582           }
00583         else if (!handle_opt_arg(opt, monitor, name, sizeof(name), vlan_access,
00584                                  vlan_trunk, &vlan_trunk_all, mac, mac_set))
00585           return -L4_EINVAL;
00586
00587         ++arg_n;
00588       }
00589
00590     if (!_virtio_switch->port_available(monitor))
00591       {
00592         warn.printf("No port available\n");
00593         return -L4_ENOMEM;
00594       }
00595
00596     if (vlan_access && (!vlan_trunk.empty() || vlan_trunk_all))
00597       {
00598         warn.printf("VLAN port cannot be access and trunk simultaneously.\n");
00599         return -L4_EINVAL;
00600       }
00601
00602     if (!name[0])
00603       snprintf(name, sizeof(name), "%s[%u]", monitor ? "monitor": "",
00604                _dbg_port_num++);
00605
00606     info.printf("    Creating port %s%s\n", name,
00607                 monitor ? " as monitor port" : "");
00608
00609     // Assign a random MAC address if we assign one to our devices but the
00610     // user has not passed an explicit one for a port.
00611     if (!mac_set && Options::get_options()->assign_mac())
00612       assign_random_mac(mac);
00613
00614     l4_uint8_t *mac_ptr = (mac_set || Options::get_options()->assign_mac())
00615                           ? mac : nullptr;
00616
00617     // create port
00618     Port *port;
00619     if (monitor)
00620       {
00621         port = new Monitor_port(server.registry(), _vq_max_num, num_ds, name,
00622                                 mac_ptr);
00623         port->set_monitor();
00624
00625         if (vlan_access)
00626           warn.printf("vlan=access=<id> ignored on monitor ports!\n");
00627         if (!vlan_trunk.empty())
00628           warn.printf("vlan=trunk=... ignored on monitor ports!\n");
00629       }
00630     else
00631       {
00632         port = new Switch_port(server.registry(), _virtio_switch, _vq_max_num,
00633                                num_ds, name, mac_ptr);
00634
00635         if (vlan_access)
00636           port->set_vlan_access(vlan_access);
00637         else if (vlan_trunk_all)
00638           port->set_vlan_trunk_all();
00639         else if (!vlan_trunk.empty())
00640           port->set_vlan_trunk(vlan_trunk);
00641       }
00642
00643     port->add_trusted_dataspaces(trusted_dataspaces);
00644     if (!trusted_dataspaces->empty())
00645       port->enable_trusted_ds_validation();
00646
00647     // hand port over to the switch
00648     bool added = monitor ? _virtio_switch->add_monitor_port(port)
00649                          : _virtio_switch->add_port(port);
00650     if (!added)
00651       {
```

```
00652         delete port;
00653         return -L4_ENOMEM;
00654       }
00655     res = L4::Ipc::make_cap(port->obj_cap(), L4_CAP_FPAGE_RWSD);
00656
00657     info.printf("    Created port %s\n", name);
00658     return L4_EOK;
00659   }
00660
00661   long create_stats(L4::Ipc::Cap<void> &res)
00662   {
00663     // Create a stats reader and throw away our reference to get a notification
00664     // when the external reference vanishes.
00665     auto reader = cxx::make_unique<Stats_reader>();
00666     L4Re::chkcap(server.registry()->register_obj(reader.get()));
00667     reader->obj_cap()->dec_refcnt(1);
00668     res = L4::Ipc::make_cap(reader->obj_cap(),
00669                             L4_CAP_FPAGE_R | L4_CAP_FPAGE_D);
00670     _stats_readers.push_back(cxx::move(reader));
00671     return L4_EOK;
00672   }
00673 };
00674
00675 #if CONFIG_VNS_IXL
00679 class Ixl_hw_port : public Ixl_port
00680 {
00681   template<typename Derived>
00682   class Port_irq : public L4::Irqep_t<Derived>
00683   {
00684   public:
00685     Port_irq(Virtio_switch *virtio_switch, Ixl_port *port)
00686     : _switch{virtio_switch}, _port{port} {}
00687
00688   protected:
00689     Virtio_switch *_switch;
00690     Ixl_port *_port;
00691   };
00692
00693   class Receive_irq : public Port_irq<Receive_irq>
00694   {
00695   public:
00696     using Port_irq::Port_irq;
00697
00704     void handle_irq()
00705     {
00706       if (!_port->dev()->check_recv_irq(0))
00707         return;
00708
00709       if (_switch->handle_ixl_port_tx(_port))
00710         _port->dev()->ack_recv_irq(0);
00711     }
00712   };
00713
00714   class Reschedule_tx_irq : public Port_irq<Reschedule_tx_irq>
00715   {
00716   public:
00717     using Port_irq::Port_irq;
00718
00719     void handle_irq()
00720     {
00721       if (_switch->handle_ixl_port_tx(_port))
00722         // Entire TX queue handled, re-enable the recv IRQ again.
00723         _port->dev()->ack_recv_irq(0);
00724     }
00725   };
00726
00727   Receive_irq _recv_irq;
00728   Reschedule_tx_irq _reschedule_tx_irq;
00729
00730 public:
00731   Ixl_hw_port(L4Re::Util::Object_registry *registry,
00732               Virtio_switch *virtio_switch, Ixl::Ixl_device *dev)
00733   : Ixl_port(dev),
00734     _recv_irq(virtio_switch, this),
00735     _reschedule_tx_irq(virtio_switch, this)
00736   {
00737     L4::Cap<L4::Irq> recv_irq_cap = L4Re::chkcap(dev->get_recv_irq(0), "Get receive IRQ");
00738     L4Re::chkcap(registry->register_obj(&_recv_irq, recv_irq_cap),
00739                  "Register receive IRQ.");
00740     recv_irq_cap->unmask();
00741
00742     _pending_tx_reschedule =
00743       L4Re::chkcap(registry->register_irq_obj(&_reschedule_tx_irq),
00744                    "Register TX reschedule IRQ.");
00745     _pending_tx_reschedule->unmask();
00746   }
00747
```

```
00748   ~Ixl_hw_port() override
00749   {
00750     server.registry()->unregister_obj(&_recv_irq);
00751   }
00752 };
00753
00754 static void
00755 discover_ixl_devices(L4::Cap<L4vbus::Vbus> vbus, Virtio_switch *virtio_switch)
00756 {
00757   struct Ixl::Dev_cfg cfg;
00758   // Configure the device in asynchronous notify mode.
00759   cfg.irq_timeout_ms = -1;
00760
00761   // TODO: Support detecting multiple devices on a Vbus.
00762   // Setup the driver (also resets and initializes the NIC).
00763   Ixl::Ixl_device *dev = Ixl::Ixl_device::ixl_init(vbus, 0, cfg);
00764   if (!dev)
00765     // No Ixl supported device found, Ixl already printed an error message.
00766     return;
00767
00768   Ixl_hw_port *hw_port = new Ixl_hw_port(server.registry(), virtio_switch, dev);
00769   if (!virtio_switch->add_port(hw_port))
00770     {
00771       Err().printf("error adding ixl port\n");
00772       delete hw_port;
00773     }
00774 }
00775 #endif
00776
00777 int main(int argc, char *argv[])
00778 {
00779   trusted_dataspaces = std::make_shared<Ds_vector>();
00780   auto *opts = Options::parse_options(argc, argv, trusted_dataspaces);
00781   if (!opts)
00782     {
00783       Err().printf("Error during command line parsing.\n");
00784       return 1;
00785     }
00786
00787   // Show welcome message if debug level is not set to quiet
00788   if (Dbg(Dbg::Core, Dbg::Warn).is_active())
00789     printf("Hello from l4virtio switch\n");
00790
00791   Virtio_switch *virtio_switch = new Virtio_switch(opts->get_max_ports());
00792
00793 #ifdef CONFIG_VNS_STATS
00794   Switch_statistics::get_instance().initialize(opts->get_max_ports());
00795 #endif
00796
00797 #if CONFIG_VNS_IXL
00798   auto vbus = L4Re::Env::env()->get_cap<L4vbus::Vbus>("vbus");
00799   if (vbus.is_valid())
00800     discover_ixl_devices(vbus, virtio_switch);
00801 #endif
00802
00803   Switch_factory *factory = new Switch_factory(virtio_switch,
00804                                                opts->get_virtq_max_num());
00805
00806   L4::Cap<void> cap = server.registry()->register_obj(factory, "svr");
00807   if (!cap.is_valid())
00808     {
00809       Err().printf("error registering switch\n");
00810       return 2;
00811     }
00812
00813   /*
00814    * server loop will handle 4 types of events
00815    * - Switch_factory
00816    *   - factory protocol
00817    *   - capability deletion
00818    *     - delegated to  Virtio_switch::check_ports()
00819    * - Switch_factory::Switch_port
00820    *   - irqs triggered by clients
00821    *     - delegated to Virtio_switch::handle_l4virtio_port_tx()
00822    * - Virtio_net_transfer
00823    *   - timeouts for pending transfer requests added by
00824    *     Port_iface::handle_request() via registered via
00825    *     L4::Epiface::server_iface()->add_timeout()
00826    */
00827   server.loop();
00828   return 0;
00829 }
00830
```

16.54 Makefile

```
00001 PKGDIR  = ..
00002 L4DIR ?= $(PKGDIR)/../..
00003
00004 PKGNAME     = drivers
00005 PC_FILENAME = drivers-frst
00006 EXTRA_TARGET += hw_mmio_register_block hw_register_block
00007
00008 include $(L4DIR)/mk/include.mk
```

16.55 Makefile

```
00001 PKGDIR  = ../..
00002 L4DIR ?= $(PKGDIR)/../..
00003
00004 PKGNAME = drivers
00005
00006 include $(L4DIR)/mk/include.mk
```

16.56 Makefile

```
00001 PKGDIR  = ../..
00002 L4DIR  ?= $(PKGDIR)/../../..
00003
00004 EXTRA_TARGET += cmd_control
00005
00006 include $(L4DIR)/mk/include.mk
```

16.57 Makefile

```
00001 PKGDIR         ?= ../..
00002 L4DIR          ?= $(PKGDIR)/../..
00003
00004 TARGET          = l4vio_switch
00005
00006 REQUIRES_LIBS   = libstdc++ l4virtio
00007 REQUIRES_LIBS-$(CONFIG_VNS_IXL) += ixl
00008
00009 SRC_CC-$(CONFIG_VNS_PORT_FILTER) += filter.cc
00010
00011 SRC_CC = main.cc switch.cc options.cc
00012
00013 include $(L4DIR)/mk/prog.mk
```

16.58 options.cc

```
00001 /*
00002  * Copyright (C) 2016-2017, 2019, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Manuel von Oltersdorff-Kalettka <manuel.kalettka@kernkonzept.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #include <getopt.h>
00010 #include <stdlib.h>
00011 #include <cstring>
00012 #include <type_traits>
00013
00014 #include <l4/cxx/exceptions>
00015 #include <l4/re/error_helper>
00016 #include <l4/re/env>
00017
00018 #include "debug.h"
00019 #include "options.h"
00020
00021 bool
00022 parse_int_optstring(char const *optstring, int *out)
00023 {
00024   char *endp;
00025
00026   errno = 0;
00027   long num = strtol(optstring, &endp, 10);
```

```
00028
00029   // check that long can be converted to int
00030   if (errno || *endp != '\0' || num < INT_MIN || num > INT_MAX)
00031     return false;
00032
00033   *out = num;
00034
00035   return true;
00036 }
00037
00038 static int
00039 verbosity_mask_from_string(char const *str, unsigned *mask)
00040 {
00041   if (strcmp("quiet", str) == 0)
00042     {
00043       *mask = Dbg::Quiet;
00044       return 0;
00045     }
00046   if (strcmp("warn", str) == 0)
00047     {
00048       *mask = Dbg::Warn;
00049       return 0;
00050     }
00051   if (strcmp("info", str) == 0)
00052     {
00053       *mask = Dbg::Warn | Dbg::Info;
00054       return 0;
00055     }
00056   if (strcmp("debug", str) == 0)
00057     {
00058       *mask = Dbg::Warn | Dbg::Info | Dbg::Debug;
00059       return 0;
00060     }
00061   if (strcmp("trace", str) == 0)
00062     {
00063       *mask = Dbg::Warn | Dbg::Info | Dbg::Debug | Dbg::Trace;
00064       return 0;
00065     }
00066
00067   return -L4_ENOENT;
00068 }
00069
00099 static void
00100 set_verbosity(char const *str)
00101 {
00102   unsigned mask;
00103   if (verbosity_mask_from_string(str, &mask) == 0)
00104     {
00105       Dbg::set_verbosity(mask);
00106       return;
00107     }
00108
00109   static char const *const components[] =
00110     { "core", "virtio", "port", "request", "queue", "packet" };
00111
00112   static_assert(std::extent<decltype(components)>::value == Dbg::Max_component,
00113                 "Component names must match 'enum Component'.");
00114
00115   for (unsigned i = 0; i < Dbg::Max_component; ++i)
00116     {
00117       auto len = strlen(components[i]);
00118       if (strncmp(components[i], str, len) == 0 && str[len] == '='
00119           && verbosity_mask_from_string(str + len + 1, &mask) == 0)
00120         {
00121           Dbg::set_verbosity(i, mask);
00122           return;
00123         }
00124     }
00125 }
00126
00127 int
00128 Options::parse_cmd_line(int argc, char **argv,
00129                         std::shared_ptr<Ds_vector> trusted_dataspaces)
00130 {
00131   int opt, index;
00132
00133   struct option options[] =
00134     {
00135       {"size",          1, 0, 's' }, // size of in/out queue == #buffers in queue
00136       {"ports",         1, 0, 'p' }, // number of ports
00137       {"mac",           0, 0, 'm' }, // switch sets MAC address for each client
00138       {"no-random-mac", 0, 0, 'M' }, // don't assign random MAC address to ports by default
00139       {"debug",         1, 0, 'D' }, // configure debug levels
00140       {"verbose",       0, 0, 'v' },
00141       {"quiet",         0, 0, 'q' },
00142       {"register-ds",   1, 0, 'd' }, // register a trusted dataspace
00143       {0, 0, 0, 0}
```

```
00144     };
00145
00146   unsigned long verbosity = Dbg::Warn;
00147
00148   Dbg info(Dbg::Core, Dbg::Info);
00149
00150   Dbg::set_verbosity(Dbg::Core, Dbg::Info);
00151   info.printf("Arguments:\n");
00152   for (int i = 0; i < argc; ++i)
00153     info.printf("\t%s\n", argv[i]);
00154
00155   Dbg::set_verbosity(verbosity);
00156   while ( (opt = getopt_long(argc, argv, "s:p:mMqvD:d:", options, &index)) != -1)
00157     {
00158       switch (opt)
00159         {
00160         case 's':
00161
00162           // QueueNumMax must be power of 2 between 1 and 0x8000
00163           if (!parse_int_optstring(optarg, &_virtq_max_num)
00164               || _virtq_max_num < 1 || _virtq_max_num > 32768
00165               || (_virtq_max_num & (_virtq_max_num - 1)))
00166             {
00167               Err().printf("Max number of virtqueue buffers must be power of 2"
00168                            " between 1 and 32768. Invalid value %i or argument "
00169                            "%s\n",
00170                            _virtq_max_num, optarg);
00171               return -1;
00172             }
00173           info.printf("Max number of buffers in virtqueue: %i\n",
00174                       _virtq_max_num);
00175           break;
00176         case 'p':
00177           if (parse_int_optstring(optarg, &_max_ports))
00178             info.printf("Max number of ports: %u\n", _max_ports);
00179           else
00180             {
00181               Err().printf("Invalid number of ports argument: %s\n", optarg);
00182               return -1;
00183             }
00184           break;
00185         case 'q':
00186           verbosity = Dbg::Quiet;
00187           Dbg::set_verbosity(verbosity);
00188           break;
00189         case 'v':
00190           verbosity = (verbosity << 1) | 1;
00191           Dbg::set_verbosity(verbosity);
00192           break;
00193         case 'D':
00194           set_verbosity(optarg);
00195           break;
00196         case 'm':
00197           info.printf("Option -m ignored to compatibility.\n");
00198           break;
00199         case 'M':
00200           _assign_mac = false;
00201           break;
00202         case 'd':
00203           {
00204             L4::Cap<L4Re::Dataspace> ds =
00205               L4Re::chkcap(L4Re::Env::env()->get_cap<L4Re::Dataspace>(optarg),
00206                            "Find a dataspace capability.\n");
00207             trusted_dataspaces->push_back(ds);
00208             break;
00209           }
00210         default:
00211           Err().printf("Unknown command line option '%c' (%d)\n", opt, opt);
00212           return -1;
00213         }
00214     }
00215   return 0;
00216 }
00217
00218 static Options options;
00219
00220 Options const *
00221 Options::get_options()
00222 { return &options; }
00223
00224 Options const *
00225 Options::parse_options(int argc, char **argv,
00226                        std::shared_ptr<Ds_vector> trusted_dataspaces)
00227 {
00228   if (options.parse_cmd_line(argc, argv, trusted_dataspaces) < 0)
00229     return nullptr;
00230
```

```
00231   return &options;
00232 }
```

16.59 options.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2022, 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Manuel von Oltersdorff-Kalettka <manuel.kalettka@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <memory>
00011 #include <vector>
00012 #include <cerrno>
00013 #include <climits>
00014
00015 #include <l4/re/dataspace>
00016
00017 bool
00018 parse_int_optstring(char const *optstring, int *out);
00019
00020 class Options
00021 {
00022   using Ds_vector = std::vector<L4::Cap<L4Re::Dataspace»;
00023 public:
00024   int get_max_ports() const
00025   { return _max_ports; }
00026
00027   int get_virtq_max_num() const
00028   { return _virtq_max_num; }
00029
00030   int get_portq_max_num() const
00031   { return _portq_max_num; }
00032
00033   int get_request_timeout() const
00034   { return _request_timeout; }
00035
00036   int assign_mac() const
00037   { return _assign_mac; }
00038
00039   static Options const *
00040   parse_options(int argc, char **argv,
00041                 std::shared_ptr<Ds_vector> trusted_dataspaces);
00042   static Options const *get_options();
00043
00044 private:
00045   int _max_ports = 256;
00046   int _virtq_max_num = 0x100; // default value for data queues
00047   int _portq_max_num = 50;    // default value for port queues
00048   int _request_timeout = 1 * 1000 * 1000; // default packet timeout 1 second
00049   bool _assign_mac = true;
00050
00051   int parse_cmd_line(int argc, char **argv,
00052                      std::shared_ptr<Ds_vector> trusted_dataspaces);
00053 };
```

16.60 port.h

```
00001 /*
00002  * Copyright (C) 2016-2018, 2020, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "request.h"
00011 #include "mac_addr.h"
00012 #include "vlan.h"
00013 #include "stats.h"
00014
00015 #include <cassert>
00016 #include <set>
00017 #include <vector>
00018
00023
00024 class Port_iface
```

```
00025 {
00026 protected:
00027   Virtio_net_switch::Port_statistics *_stats;
00028
00029 public:
00030   Port_iface(char const *name)
00031   {
00032     strncpy(_name, name, sizeof(_name));
00033     _name[sizeof(_name) - 1] = '\0';
00034 #ifdef CONFIG_VNS_STATS
00035     _stats = Switch_statistics::get_instance().allocate_port_statistics(name);
00036     if (!_stats)
00037       throw L4::Runtime_error(-L4_ENOMEM,
00038                               "Could not allocate port statistics.\n");
00039 #endif
00040   }
00041
00042   virtual ~Port_iface()
00043   {
00044 #ifdef CONFIG_VNS_STATS
00045     _stats->in_use = false;
00046 #endif
00047   }
00048
00049   // delete copy and assignment
00050   Port_iface(Port_iface const &) = delete;
00051   Port_iface &operator = (Port_iface const &) = delete;
00052
00053   char const *get_name() const
00054   { return _name; }
00055
00056   l4_uint16_t get_vlan() const
00057   { return _vlan_id; }
00058
00059   inline bool is_trunk() const
00060   { return _vlan_id == VLAN_ID_TRUNK; }
00061
00062   inline bool is_native() const
00063   { return _vlan_id == VLAN_ID_NATIVE; }
00064
00065   inline bool is_access() const
00066   { return !is_trunk() && !is_native(); }
00067
00075   void set_vlan_access(l4_uint16_t id)
00076   {
00077     assert(vlan_valid_id(id));
00078     _vlan_id = id;
00079     _vlan_bloom_filter = 0;
00080     _vlan_ids.clear();
00081   }
00082
00092   void set_vlan_trunk(const std::vector<l4_uint16_t> &ids)
00093   {
00094     // bloom filter to quickly reject packets that do not belong to this port
00095     l4_uint32_t filter = 0;
00096
00097     _vlan_ids.clear();
00098     for (const auto id : ids)
00099       {
00100         assert(vlan_valid_id(id));
00101         filter |= vlan_bloom_hash(id);
00102         _vlan_ids.insert(id);
00103       }
00104
00105     _vlan_id = VLAN_ID_TRUNK;
00106     _vlan_bloom_filter = filter;
00107   }
00108
00112   void set_vlan_trunk_all()
00113   {
00114     _vlan_all = true;
00115     _vlan_id = VLAN_ID_TRUNK;
00116     _vlan_bloom_filter = -1;
00117   }
00118
00125   void set_monitor()
00126   {
00127     _vlan_id = VLAN_ID_TRUNK;
00128     _vlan_bloom_filter = 0;
00129   }
00130
00139   bool match_vlan(uint16_t id)
00140   {
00141     // Regular case native/access port
00142     if (id == _vlan_id)
00143       return true;
00144
```

```
00145     // This port participates in all VLANs
00146     if (_vlan_all)
00147       return true;
00148
00149     // Quick check: does port probably accept this VLAN?
00150     if ((_vlan_bloom_filter & vlan_bloom_hash(id)) == 0)
00151       return false;
00152
00153     return _vlan_ids.find(id) != _vlan_ids.end();
00154   }
00155
00162   inline Mac_addr mac() const
00163   { return _mac; }
00164
00165   Virtio_vlan_mangle create_vlan_mangle(Port_iface *src_port) const
00166   {
00167     Virtio_vlan_mangle mangle;
00168
00169     if (is_trunk())
00170       {
00171         /*
00172          * Add a VLAN tag only if the packet does not already have one (by
00173          * coming from another trunk port) or if the packet does not belong to
00174          * any VLAN (by coming from a native port). The latter case is only
00175          * relevant if this is a monitor port. Otherwise traffic from native
00176          * ports is never forwarded to trunk ports.
00177          */
00178         if (!src_port->is_trunk() && !src_port->is_native())
00179           mangle = Virtio_vlan_mangle::add(src_port->get_vlan());
00180       }
00181     else
00182       /*
00183        * Remove VLAN tag only if the packet actually has one (by coming from a
00184        * trunk port).
00185        */
00186       if (src_port->is_trunk())
00187         mangle = Virtio_vlan_mangle::remove();
00188
00189     return mangle;
00190   }
00191
00192   virtual void rx_notify_disable_and_remember() = 0;
00193   virtual void rx_notify_emit_and_enable() = 0;
00194
00195   virtual bool is_gone() const = 0;
00196
00198   // std::optional<Net_request> get_tx_request() = 0;
00199
00200   enum class Result
00201   {
00202     Delivered, Exception, Dropped,
00203   };
00204
00220   virtual Result handle_request(Port_iface *src_port,
00221                                 Net_transfer &src,
00222                                 l4_uint64_t *bytes_transferred) = 0;
00223
00224   void reschedule_pending_tx()
00225   { _pending_tx_reschedule->trigger(); }
00226
00227 protected:
00228   /*
00229    * VLAN related management information.
00230    *
00231    * A port may either be
00232    *  - a native port (_vlan_id == VLAN_ID_NATIVE), or
00233    *  - an access port (_vlan_id set accordingly), or
00234    *  - a trunk port (_vlan_id == VLAN_ID_TRUNK, _vlan_bloom_filter and
00235    *    _vlan_ids populated accordingly, or _vlan_all == true).
00236    */
00237   l4_uint16_t _vlan_id = VLAN_ID_NATIVE; // VID for native/access port
00238   l4_uint32_t _vlan_bloom_filter = 0; // Bloom filter for trunk ports
00239   std::set<l4_uint16_t> _vlan_ids;  // Authoritative list of trunk VLANs
00240   bool _vlan_all = false; // This port participates in all VLANs (ignoring _vlan_ids)
00241
00242   inline l4_uint32_t vlan_bloom_hash(l4_uint16_t vid)
00243   { return 1UL << (vid & 31U); }
00244
00248   L4::Cap<L4::Irq> _pending_tx_reschedule;
00249
00250   Mac_addr _mac = Mac_addr(Mac_addr::Addr_unknown);
00251   char _name[20];
00252
00253 public:
00254 #ifdef CONFIG_VNS_STATS
00255   inline void stat_inc_tx_num()
00256   { _stats->tx_num++; }
```

```
00257   inline void stat_inc_tx_dropped()
00258   { _stats->tx_dropped++; }
00259   inline void stat_inc_tx_bytes(l4_uint64_t bytes)
00260   { _stats->tx_bytes += bytes; }
00261   inline void stat_inc_rx_num()
00262   { _stats->rx_num++; }
00263   inline void stat_inc_rx_dropped()
00264   { _stats->rx_dropped++; }
00265   inline void stat_inc_rx_bytes(l4_uint64_t bytes)
00266   { _stats->rx_bytes += bytes; }
00267 #else
00268   inline void stat_inc_tx_num()
00269   {}
00270   inline void stat_inc_tx_dropped()
00271   {}
00272   inline void stat_inc_tx_bytes(l4_uint64_t /*bytes*/)
00273   {}
00274   inline void stat_inc_rx_num()
00275   {}
00276   inline void stat_inc_rx_dropped()
00277   {}
00278   inline void stat_inc_rx_bytes(l4_uint64_t /*bytes*/)
00279   {}
00280 #endif
00281 };
00282
```

16.61 port_ixl.h

```
00001 /*
00002  * Copyright (C) 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "port.h"
00010 #include "request_ixl.h"
00011
00012 #include <l4/ixl/device.h>
00013 #include <l4/ixl/memory.h>
00014
00015 #include <optional>
00016
00021
00022 class Ixl_port : public Port_iface
00023 {
00024 public:
00025   static constexpr unsigned Tx_batch_size = 32;
00026   static constexpr unsigned Num_bufs = 1024;
00027   static constexpr unsigned Buf_size = 2048;
00028   static constexpr l4_uint64_t Max_mem_size = 1ULL << 28;
00029
00030   Ixl_port(Ixl::Ixl_device *dev)
00031   : Port_iface(dev->get_driver_name().c_str()),
00032     _dev(dev),
00033     _mempool(*_dev, Num_bufs, Buf_size, Max_mem_size)
00034   {
00035     Ixl::mac_address mac_addr = _dev->get_mac_addr();
00036     _mac = Mac_addr(reinterpret_cast<char const *>(mac_addr.addr));
00037 #if CONFIG_VNS_STATS
00038     _mac.to_array(_stats->mac);
00039 #endif
00040   }
00041
00042   // OPTIMIZE: Could use this information for rx batching, i.e. collect while
00043   //           rx_notify is disabled, then flush the collected buffers when
00044   //           rx_notify is enabled again.
00045   void rx_notify_disable_and_remember() override {}
00046   void rx_notify_emit_and_enable() override {}
00047   bool is_gone() const override { return false; }
00048
00050   bool tx_work_pending()
00051   {
00052     fetch_tx_requests();
00053     return _tx_batch_idx < _tx_batch_len;
00054   }
00055
00057   std::optional<Ixl_net_request> get_tx_request()
00058   {
00059     fetch_tx_requests();
00060     if (_tx_batch_idx < _tx_batch_len)
00061       return std::make_optional<Ixl_net_request>(_tx_batch[_tx_batch_idx++]);
```

```
00062     else
00063       return std::nullopt;
00064   }
00065
00066   Result handle_request(Port_iface *src_port, Net_transfer &src,
00067                         l4_uint64_t *bytes_transferred) override
00068   {
00069     Virtio_vlan_mangle mangle = create_vlan_mangle(src_port);
00070
00071     Dbg trace(Dbg::Request, Dbg::Trace, "REQ-IXL");
00072     trace.printf("%s: Transfer request %p.\n", _name, src.req_id());
00073
00074     struct Ixl::pkt_buf *buf = _mempool.pkt_buf_alloc();
00075     if (!buf)
00076       {
00077         trace.printf("\tTransfer failed, out-of-memory, dropping.\n");
00078         return Result::Dropped;
00079       }
00080
00081     // NOTE: Currently, the switch does not offer checksum or segmentation
00082     //       offloading to its l4virtio clients, so it is fine to simply ignore
00083     //       the Virtio_net::Hdr of the request here.
00084
00085     // Copy the request to the pkt_buf.
00086     Buffer dst_buf(reinterpret_cast<char *>(buf->data),
00087                    Buf_size - offsetof(Ixl::pkt_buf, data));
00088     unsigned max_size = Buf_size - offsetof(Ixl::pkt_buf, data);
00089     for (;;)
00090       {
00091         try
00092           {
00093             if (src.done())
00094               // Request completely copied to destination.
00095               break;
00096           }
00097         catch (L4virtio::Svr::Bad_descriptor &e)
00098           {
00099             trace.printf("\tTransfer failed, bad descriptor exception, dropping.\n");
00100
00101             // Handle partial transfers to destination port.
00102             Ixl::pkt_buf_free(buf);
00103             throw;
00104           }
00105
00106         if (dst_buf.done())
00107           {
00108             trace.printf(
00109               "\tTransfer failed, exceeds max packet-size, dropping.\n");
00110             Ixl::pkt_buf_free(buf);
00111             return Result::Dropped;
00112           }
00113
00114         auto &src_buf = src.cur_buf();
00115         trace.printf("\tCopying %p#%p:%u (%x) -> %p#%p:%u  (%x)\n",
00116                      src_port, src_buf.pos, src_buf.left, src_buf.left,
00117                      static_cast<Port_iface *>(this),
00118                      dst_buf.pos, dst_buf.left, dst_buf.left);
00119
00120         mangle.copy_pkt(dst_buf, src_buf);
00121       }
00122     buf->size = max_size - dst_buf.left;
00123     *bytes_transferred = buf->size;
00124
00125     // Enqueue the pkt_buf at the device.
00126     if (_dev->tx_batch(0, &buf, 1) == 1)
00127       {
00128         trace.printf("\tTransfer queued at device.\n");
00129         return Result::Delivered;
00130       }
00131     else
00132       {
00133         trace.printf("\tTransfer failed, dropping.\n");
00134         Ixl::pkt_buf_free(buf);
00135         return Result::Dropped;
00136       }
00137   }
00138
00139   Ixl::Ixl_device *dev() { return _dev; }
00140
00141 private:
00142   void fetch_tx_requests()
00143   {
00144     if (_tx_batch_idx < _tx_batch_len)
00145       // Previous batch not yet fully processed.
00146       return;
00147
00148     // Batch receive, then cache in member array, to avoid frequent interactions
```

```
00149     // with the hardware.
00150     _tx_batch_len = _dev->rx_batch(0, _tx_batch, Tx_batch_size);
00151     _tx_batch_idx = 0;
00152   }
00153
00154   Ixl::Ixl_device *_dev;
00155   Ixl::Mempool _mempool;
00156   Ixl::pkt_buf *_tx_batch[Tx_batch_size];
00157   unsigned _tx_batch_idx = 0;
00158   unsigned _tx_batch_len = 0;
00159 };
00160
```

16.62 port_l4virtio.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2020, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *            Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include "port.h"
00012 #include "request_l4virtio.h"
00013 #include "virtio_net.h"
00014
00015 #include <l4/cxx/pair>
00016
00017 #include <vector>
00018
00023
00036 class L4virtio_port : public Port_iface, public Virtio_net
00037 {
00038 public:
00042   explicit L4virtio_port(unsigned vq_max, unsigned num_ds, char const *name,
00043                          l4_uint8_t const *mac)
00044   : Port_iface(name), Virtio_net(vq_max)
00045   {
00046     init_mem_info(num_ds);
00047
00048     Features hf = _dev_config.host_features(0);
00049     if (mac)
00050       {
00051         _mac = Mac_addr((char const *)mac);
00052         memcpy((void *)_dev_config.priv_config()->mac, mac,
00053                sizeof(_dev_config.priv_config()->mac));
00054
00055         hf.mac() = true;
00056         Dbg d(Dbg::Port, Dbg::Info);
00057         d.cprintf("%s: Adding Mac '", _name);
00058         _mac.print(d);
00059         d.cprintf("' to host features to %x\n", hf.raw);
00060       }
00061     _dev_config.host_features(0) = hf.raw;
00062     _dev_config.reset_hdr();
00063     Dbg(Dbg::Port, Dbg::Info)
00064       .printf("%s: Set host features to %x\n", _name,
00065               _dev_config.host_features(0));
00066 #if CONFIG_VNS_STATS
00067     _mac.to_array(_stats->mac);
00068 #endif
00069   }
00070
00071   void rx_notify_disable_and_remember() override
00072   {
00073     kick_disable_and_remember();
00074   }
00075
00076   void rx_notify_emit_and_enable() override
00077   {
00078     kick_emit_and_enable();
00079   }
00080
00081   bool is_gone() const override
00082   {
00083     return obj_cap() && !obj_cap().validate().label();
00084   }
00085
00087   bool tx_work_pending() const
00088   {
00089     return L4_LIKELY(tx_q()->ready()) && tx_q()->desc_avail();
```

```
00090   }
00091
00093   std::optional<Virtio_net_request> get_tx_request()
00094   {
00095     return Virtio_net_request::get_request(this, tx_q());
00096   }
00097
00103   void drop_requests()
00104   { Virtio_net_request::drop_requests(this, tx_q()); }
00105
00106   Result handle_request(Port_iface *src_port, Net_transfer &src,
00107                         l4_uint64_t *bytes_transferred) override
00108   {
00109     Virtio_vlan_mangle mangle = create_vlan_mangle(src_port);
00110
00111     Dbg trace(Dbg::Request, Dbg::Trace, "REQ-VIO");
00112     trace.printf("%s: Transfer request %p.\n", _name, src.req_id());
00113
00114     Buffer dst;
00115     int total = 0;
00116     l4_uint16_t num_merged = 0;
00117     l4_uint64_t total_merged = 0;
00118     typedef cxx::Pair<L4virtio::Svr::Virtqueue::Head_desc, l4_uint32_t> Consumed_entry;
00119     std::vector<Consumed_entry> consumed;
00120
00121     Virtio_net *dst_dev = this;
00122     Virtqueue *dst_queue = rx_q();
00123     L4virtio::Svr::Virtqueue::Head_desc dst_head;
00124     L4virtio::Svr::Request_processor dst_req_proc;
00125     Virtio_net::Hdr *dst_header = nullptr;
00126
00127     for (;;)
00128       {
00129         try
00130           {
00131             if (src.done())
00132               // Request completely copied to destination.
00133               break;
00134           }
00135         catch (L4virtio::Svr::Bad_descriptor &e)
00136           {
00137             trace.printf("\tTransfer failed, bad descriptor exception, dropping.\n");
00138
00139             // Handle partial transfers to destination port.
00140             if (!consumed.empty())
00141               // Partial transfer, rewind to before first descriptor of transfer.
00142               dst_queue->rewind_avail(consumed.at(0).first);
00143             else if (dst_head)
00144               // Partial transfer, still at first _dst_head.
00145               dst_queue->rewind_avail(dst_head);
00146             throw;
00147           }
00148
00149         /* The source data structures are already initialized, the header
00150            is consumed and src stands at the very first real buffer.
00151            Initialize the target data structures if necessary and fill the
00152            header. */
00153         if (!dst_head)
00154           {
00155             if (!dst_queue->ready())
00156               return Result::Dropped;
00157
00158             auto r = dst_queue->next_avail();
00159
00160             if (L4_UNLIKELY(!r))
00161               {
00162                 trace.printf("\tTransfer failed, destination queue depleted, dropping.\n");
00163                 // Abort incomplete transfer.
00164                 if (!consumed.empty())
00165                   dst_queue->rewind_avail(consumed.front().first);
00166                 return Result::Dropped;
00167               }
00168
00169             try
00170               {
00171                 dst_head = dst_req_proc.start(dst_dev->mem_info(), r, &dst);
00172               }
00173             catch (L4virtio::Svr::Bad_descriptor &e)
00174               {
00175                 Dbg(Dbg::Request, Dbg::Warn, "REQ")
00176                   .printf("%s: bad descriptor exception: %s - %i"
00177                           " -- signal device error in destination device %p.\n",
00178                           __PRETTY_FUNCTION__, e.message(), e.error, dst_dev);
00179
00180                 dst_dev->device_error();
00181                 return Result::Exception; // Must not touch the dst queues anymore.
00182               }
```

```
00183
00184             if (!dst_header)
00185               {
00186                 if (dst.left < sizeof(Virtio_net::Hdr))
00187                   throw L4::Runtime_error(-L4_EINVAL,
00188                                           "Target buffer too small for header");
00189                 dst_header = reinterpret_cast<Virtio_net::Hdr *>(dst.pos);
00190                 trace.printf("\tCopying header to %p (size: %u)\n",
00191                              dst.pos, dst.left);
00192                 /*
00193                  * Header and csum offloading/general segmentation offloading
00194                  *
00195                  * We just copy the original header from source to
00196                  * destination and have to consider three different
00197                  * cases:
00198                  * - no flags are set
00199                  *   - we got a packet that is completely checksummed
00200                  *     and correctly fragmented, there is nothing to
00201                  *     do other then copying.
00202                  * - virtio_net_hdr_f_needs_csum set
00203                  *   - the packet is partially checksummed; if we would
00204                  *     send the packet out on the wire we would have
00205                  *     to calculate checksums now. But here we rely on
00206                  *     the ability of our guest to handle partially
00207                  *     checksummed packets and simply delegate the
00208                  *     checksum calculation to them.
00209                  * - gso_type != gso_none
00210                  *   - the packet needs to be segmented; if we would
00211                  *     send it out on the wire we would have to
00212                  *     segment it now. But again we rely on the
00213                  *     ability of our guest to handle gso
00214                  *
00215                  * We currently assume that our guests negotiated
00216                  * virtio_net_f_guest_*, this needs to be checked in
00217                  * the future.
00218                  *
00219                  * We also discussed the usage of
00220                  * virtio_net_hdr_f_data_valid to remove the need to
00221                  * checksum packets at all. But since our clients send
00222                  * partially checksummed packets anyway the only
00223                  * interesting case would be a packet without
00224                  * net_hdr_f_needs_checksum set. In that case we would
00225                  * signal that we checked the checksum and the
00226                  * checksum is actually correct. Since we do not know
00227                  * the origin of the packet (it could have been send
00228                  * by an external node and could have been routed to
00229                  * u) we can not signal this without actually
00230                  * verifying the checksum. Otherwise a packet with an
00231                  * invalid checksum could be successfully delivered.
00232                  */
00233                 total = sizeof(Virtio_net::Hdr);
00234                 src.copy_header(dst_header);
00235                 mangle.rewrite_hdr(dst_header);
00236                 dst.skip(total);
00237               }
00238             ++num_merged;
00239           }
00240
00241         bool has_dst_buffer = !dst.done();
00242         if (!has_dst_buffer)
00243           try
00244             {
00245               // The current dst buffer is full, try to get next chained buffer.
00246               has_dst_buffer = dst_req_proc.next(dst_dev->mem_info(), &dst);
00247             }
00248           catch (L4virtio::Svr::Bad_descriptor &e)
00249             {
00250               Dbg(Dbg::Request, Dbg::Warn, "REQ")
00251                 .printf("%s: bad descriptor exception: %s - %i"
00252                         " -- signal device error in destination device %p.\n",
00253                         __PRETTY_FUNCTION__, e.message(), e.error, dst_dev);
00254               dst_dev->device_error();
00255               return Result::Exception; // Must not touch the dst queues anymore.
00256             }
00257
00258         if (has_dst_buffer)
00259           {
00260             auto &src_buf = src.cur_buf();
00261             trace.printf("\tCopying %p#%p:%u (%x) -> %p#%p:%u  (%x)\n",
00262                          src_port, src_buf.pos, src_buf.left, src_buf.left,
00263                          static_cast<Port_iface *>(this),
00264                          dst.pos, dst.left, dst.left);
00265
00266             total += mangle.copy_pkt(dst, src_buf);
00267           }
00268         else if (negotiated_features().mrg_rxbuf())
00269           {
```

```
00270             // save descriptor information for later
00271             trace.printf("\tSaving descriptor for later\n");
00272             consumed.push_back(Consumed_entry(dst_head, total));
00273             total_merged += total;
00274             total = 0;
00275             dst_head = L4virtio::Svr::Virtqueue::Head_desc();
00276           }
00277         else
00278           {
00279             trace.printf("\tTransfer failed, destination buffer too small, dropping.\n");
00280             // Abort incomplete transfer.
00281             dst_queue->rewind_avail(dst_head);
00282             return Result::Dropped;
00283           }
00284       }
00285
00286     /*
00287      * Finalize the Request delivery. Call `finish()' on the destination
00288      * port's receive queue, which will result in triggering the destination
00289      * client IRQ.
00290      */
00291
00292     if (!dst_header)
00293       {
00294         if (!total)
00295           trace.printf("\tTransfer - not started yet, dropping\n");
00296         return Result::Dropped;
00297       }
00298
00299     if (consumed.empty())
00300       {
00301         assert(dst_head);
00302         assert(num_merged == 1);
00303         trace.printf("\tTransfer - Invoke dst_queue->finish()\n");
00304         dst_header->num_buffers = 1;
00305         dst_queue->finish(dst_head, dst_dev, total);
00306         *bytes_transferred = total;
00307       }
00308     else
00309       {
00310         assert(dst_head);
00311         dst_header->num_buffers = num_merged;
00312         consumed.push_back(Consumed_entry(dst_head, total));
00313         trace.printf("\tTransfer - Invoke dst_queue->finish(iter)\n");
00314         *bytes_transferred = total + total_merged;
00315         dst_queue->finish(consumed.begin(), consumed.end(), dst_dev);
00316       }
00317     return Result::Delivered;
00318   }
00319 };
00320
```

16.63 request.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2020, 2022, 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "mac_addr.h"
00010 #include "virtio_net.h"
00011 #include "virtio_net_buffer.h"
00012 #include "vlan.h"
00013
00014 #include <l4/l4virtio/server/virtio>
00015
00016
00021
00033 class Net_transfer
00034 {
00035 public:
00036   virtual ~Net_transfer() = default;
00037
00041   void const *req_id() const { return _req_id; }
00042
00046   virtual void copy_header(Virtio_net::Hdr *dst_header) const = 0;
00047
00054   Buffer &cur_buf() { return _cur_buf; }
00055
00065   virtual bool done() = 0;
00066
```

```
00067 protected:
00068   Buffer _cur_buf;
00069   void const *_req_id;
00070 };
00071
00072 class Net_request
00073 {
00074 public:
00075
00076   bool has_vlan() const
00077   {
00078     if (!_pkt.pos || _pkt.left < 14)
00079       return false;
00080
00081     uint8_t *p = reinterpret_cast<uint8_t *>(_pkt.pos);
00082     return p[12] == 0x81U && p[13] == 0x00U;
00083   }
00084
00085   uint16_t vlan_id() const
00086   {
00087     if (!has_vlan() || _pkt.left < 16)
00088       return VLAN_ID_NATIVE;
00089
00090     uint8_t *p = reinterpret_cast<uint8_t *>(_pkt.pos);
00091     return (uint16_t{p[14]} << 8 | p[15]) & 0xfffU;
00092   }
00093
00105   uint8_t const *buffer(size_t *size) const
00106   {
00107     *size = _pkt.left;
00108     return reinterpret_cast<uint8_t const *>(_pkt.pos);
00109   }
00110
00111   void dump_pkt() const
00112   {
00113     Dbg pkt_debug(Dbg::Packet, Dbg::Debug, "PKT");
00114     if (pkt_debug.is_active())
00115       {
00116         //pkt_debug.cprintf("\t");
00117         //src_mac().print(pkt_debug);
00118         //pkt_debug.cprintf(" -> ");
00119         //dst_mac().print(pkt_debug);
00120         //pkt_debug.cprintf("\n");
00121
00122         Dbg pkt_trace(Dbg::Packet, Dbg::Trace, "PKT");
00123         if (pkt_trace.is_active() && _pkt.left >= 14)
00124           {
00125             uint8_t const *packet = reinterpret_cast<uint8_t const *>(_pkt.pos);
00126             pkt_trace.cprintf("\n\tEthertype: ");
00127             uint16_t ether_type = uint16_t{packet[12]} << 8 | packet[13];
00128             char const *protocol;
00129             switch (ether_type)
00130               {
00131               case 0x0800: protocol = "IPv4"; break;
00132               case 0x0806: protocol = "ARP"; break;
00133               case 0x8100: protocol = "Vlan"; break;
00134               case 0x86dd: protocol = "IPv6"; break;
00135               case 0x8863: protocol = "PPPoE Discovery"; break;
00136               case 0x8864: protocol = "PPPoE Session"; break;
00137               default: protocol = nullptr;
00138               }
00139             if (protocol)
00140               pkt_trace.cprintf("%s\n", protocol);
00141             else
00142               pkt_trace.cprintf("%04x\n", ether_type);
00143           }
00144       }
00145   }
00146
00147 protected:
00148   Buffer _pkt;
00149 };
00150
```

16.64 request_ixl.h

```
00001 /*
00002  * Copyright (C) 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
```

```
00009 #include "port.h"
00010 #include "request.h"
00011
00012 #include <l4/ixl/memory.h>
00013
00014 #include <utility>
00015
00020
00021 class Ixl_net_request final : public Net_request
00022 {
00023 public:
00024   class Ixl_net_transfer final : public Net_transfer
00025   {
00026   public:
00027     explicit Ixl_net_transfer(Ixl_net_request const &request)
00028     : _request(request)
00029     {
00030       _cur_buf = Buffer(reinterpret_cast<char *>(request.buf()->data),
00031                         request.buf()->size);
00032       _req_id = _request.buf();
00033     }
00034
00035     // delete copy constructor and copy assignment operator
00036     Ixl_net_transfer(Ixl_net_transfer const &) = delete;
00037     Ixl_net_transfer &operator = (Ixl_net_transfer const &) = delete;
00038
00039     void copy_header(Virtio_net::Hdr *dst_header) const override
00040     {
00041       dst_header->flags.data_valid() = 0;
00042       dst_header->flags.need_csum() = 0;
00043       dst_header->gso_type = 0; // GSO_NONE
00044       dst_header->hdr_len = sizeof(Virtio_net::Hdr);
00045       dst_header->gso_size = 0;
00046       dst_header->csum_start = 0;
00047       dst_header->csum_offset = 0;
00048       dst_header->num_buffers = 1;
00049     }
00050
00051     bool done() override { return _cur_buf.done(); }
00052
00053   private:
00054     Ixl_net_request const &_request;
00055   };
00056
00057   void dump_request(Port_iface *port) const
00058   {
00059     Dbg debug(Dbg::Request, Dbg::Debug, "REQ-IXL");
00060     if (debug.is_active())
00061       {
00062         debug.printf("%s: Next packet: %p - %x bytes\n",
00063                      port->get_name(), _pkt.pos, _pkt.left);
00064       }
00065     dump_pkt();
00066   }
00067
00068   explicit Ixl_net_request(Ixl::pkt_buf *buf) : _buf(buf)
00069   {
00070     _pkt = Buffer(reinterpret_cast<char *>(buf->data), buf->size);
00071   }
00072
00073   // delete copy constructor and copy assignment operator
00074   Ixl_net_request(Ixl_net_request const &) = delete;
00075   Ixl_net_request &operator=(Ixl_net_request const &) = delete;
00076
00077   // define move constructor and copy assignment operator
00078   Ixl_net_request(Ixl_net_request &&other)
00079   : _buf(other._buf)
00080   {
00081     _pkt = std::move(other._pkt);
00082
00083     // Invalidate other.
00084     other._buf = nullptr;
00085   }
00086
00087   Ixl_net_request &operator=(Ixl_net_request &&other)
00088   {
00089     // Invalidate self.
00090     if (_buf != nullptr)
00091       Ixl::pkt_buf_free(_buf);
00092
00093     _buf = other._buf;
00094     _pkt = std::move(other._pkt);
00095
00096     // Invalidate other.
00097     other._buf = nullptr;
00098
00099     return *this;
```

```
00100   }
00101
00102   ~Ixl_net_request()
00103   {
00104     if (_buf != nullptr)
00105       {
00106         Ixl::pkt_buf_free(_buf);
00107         _buf = nullptr;
00108       }
00109   }
00110
00112   Mac_addr dst_mac() const
00113   {
00114     return (_pkt.pos && _pkt.left >= Mac_addr::Addr_length)
00115       ? Mac_addr::from_uncached(_pkt.pos)
00116       : Mac_addr(Mac_addr::Addr_unknown);
00117   }
00118
00120   Mac_addr src_mac() const
00121   {
00122     return (_pkt.pos && _pkt.left >= Mac_addr::Addr_length * 2)
00123       ? Mac_addr::from_uncached(_pkt.pos + Mac_addr::Addr_length)
00124       : Mac_addr(Mac_addr::Addr_unknown);
00125   }
00126
00127   Ixl::pkt_buf *buf() const { return _buf; }
00128
00129   Ixl_net_transfer transfer_src() const
00130   { return Ixl_net_transfer(*this); }
00131
00132 private:
00133   Ixl::pkt_buf *_buf;
00134 };
00135
```

16.65 request_l4virtio.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2020, 2022, 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "debug.h"
00011 #include "port.h"
00012 #include "request.h"
00013 #include "virtio_net.h"
00014
00015 #include <l4/l4virtio/server/virtio>
00016 #include <l4/util/assert.h>
00017
00018 #include <optional>
00019 #include <utility>
00020
00025
00035 class Virtio_net_request final : public Net_request
00036 {
00037 public:
00038   class Virtio_net_transfer final : public Net_transfer
00039   {
00040   public:
00041     explicit Virtio_net_transfer(Virtio_net_request const &request)
00042     : _request(request),
00043       // We already looked at the very first buffer to find the target of the
00044       // packet. The request processor of the "parent request" contains the
00045       // current state of the transaction up to this point. Since there might be
00046       // more then one target for the request we have to keep track of our own
00047       // state and need our own request processor instance, which will be
00048       // initialized using the current state of the "parent request".
00049       _req_proc(_request.get_request_processor())
00050     {
00051       // The buffer descriptors used for this transaction and the amount of bytes
00052       // copied to the current target descriptor.
00053       _cur_buf = request.first_buffer();
00054       _req_id = _request.header();
00055     }
00056
00057     // delete copy constructor and copy assignment operator
00058     Virtio_net_transfer(Virtio_net_transfer const &) = delete;
00059     Virtio_net_transfer &operator = (Virtio_net_transfer const &) = delete;
00060
```

```
00061     void copy_header(Virtio_net::Hdr *dst_header) const override
00062     {
00063       memcpy(dst_header, _request.header(), sizeof(Virtio_net::Hdr));
00064     }
00065
00066     bool done() override
00067     {
00068       return _cur_buf.done() && !_req_proc.next(_request.dev()->mem_info(), &_cur_buf);
00069     }
00070
00071   private:
00072     Virtio_net_request const &_request;
00073     L4virtio::Svr::Request_processor _req_proc;
00074   };
00075
00076   void dump_request(Port_iface *port) const
00077   {
00078     Dbg debug(Dbg::Request, Dbg::Debug, "REQ-VIO");
00079     if (debug.is_active())
00080       {
00081         debug.printf("%s: Next packet: %p:%p - %x bytes\n",
00082                      port->get_name(), _header, _pkt.pos, _pkt.left);
00083         if (_header->flags.raw || _header->gso_type)
00084           {
00085             debug.cprintf("flags:\t%x\n\t"
00086                           "gso_type:\t%x\n\t"
00087                           "header len:\t%x\n\t"
00088                           "gso size:\t%x\n\t"
00089                           "csum start:\t%x\n\t"
00090                           "csum offset:\t%x\n"
00091                           "\tnum buffer:\t%x\n",
00092                           _header->flags.raw,
00093                           _header->gso_type, _header->hdr_len,
00094                           _header->gso_size,
00095                           _header->csum_start, _header->csum_offset,
00096                           _header->num_buffers);
00097           }
00098       }
00099     dump_pkt();
00100   }
00101
00102   // delete copy constructor and copy assignment operator
00103   Virtio_net_request(Virtio_net_request const &) = delete;
00104   Virtio_net_request &operator = (Virtio_net_request const &) = delete;
00105
00106   // define move constructor and copy assignment operator
00107   Virtio_net_request(Virtio_net_request &&other)
00108   : _dev(other._dev),
00109     _queue(other._queue),
00110     _head(std::move(other._head)),
00111     _req_proc(std::move(other._req_proc)),
00112     _header(other._header)
00113   {
00114     _pkt = std::move(other._pkt);
00115
00116     // Invalidate other.
00117     other._queue = nullptr;
00118   }
00119
00120   Virtio_net_request &operator = (Virtio_net_request &&other)
00121   {
00122     // Invalidate self.
00123     finish();
00124
00125     _dev = other._dev;
00126     _queue = other._queue;
00127     _head = std::move(other._head);
00128     _req_proc = std::move(other._req_proc);
00129     _header = other._header;
00130     _pkt = std::move(other._pkt);
00131
00132     // Invalidate other.
00133     other._queue = nullptr;
00134
00135     return *this;
00136   }
00137
00138   Virtio_net_request(Virtio_net *dev, L4virtio::Svr::Virtqueue *queue,
00139                      L4virtio::Svr::Virtqueue::Request const &req)
00140   : _dev(dev), _queue(queue)
00141   {
00142     _head = _req_proc.start(_dev->mem_info(), req, &_pkt);
00143
00144     _header = (Virtio_net::Hdr *)_pkt.pos;
00145     l4_uint32_t skipped = _pkt.skip(sizeof(Virtio_net::Hdr));
00146
00147     if (L4_UNLIKELY(   (skipped != sizeof(Virtio_net::Hdr))
```

```
00148                     || (_pkt.done() && !_next_buffer(&_pkt))))
00149       {
00150         _header = 0;
00151         Dbg(Dbg::Queue, Dbg::Warn).printf("Invalid request\n");
00152         return;
00153       }
00154   }
00155
00156   ~Virtio_net_request()
00157   { finish(); }
00158
00159   bool valid() const
00160   { return _header != 0; }
00161
00172   static void drop_requests(Virtio_net *dev,
00173                             L4virtio::Svr::Virtqueue *queue)
00174   {
00175     if (L4_UNLIKELY(!queue->ready()))
00176       return;
00177
00178     if (queue->desc_avail())
00179       Dbg(Dbg::Request, Dbg::Debug)
00180         .printf("Dropping incoming packets on monitor port\n");
00181
00182     L4virtio::Svr::Request_processor req_proc;
00183     Buffer pkt;
00184
00185     while (auto req = queue->next_avail())
00186       {
00187         auto head = req_proc.start(dev->mem_info(), req, &pkt);
00188         queue->finish(head, dev, 0);
00189       }
00190   }
00191
00198   static std::optional<Virtio_net_request>
00199   get_request(Virtio_net *dev, L4virtio::Svr::Virtqueue *queue)
00200   {
00201     if (L4_UNLIKELY(!queue->ready()))
00202       return std::nullopt;
00203
00204     if (auto r = queue->next_avail())
00205       {
00206         // Virtio_net_request keeps "a lot of internal state",
00207         // therefore we create the object before creating the
00208         // state.
00209         // We might check later on whether it is possible to
00210         // save the state when we actually have to because a
00211         // transfer is blocking on a port.
00212         auto request = Virtio_net_request(dev, queue, r);
00213         if (request.valid())
00214           return request;
00215       }
00216     return std::nullopt;
00217   }
00218
00219   Buffer const &first_buffer() const
00220   { return _pkt; }
00221
00222   Virtio_net::Hdr const *header() const
00223   { return _header; }
00224
00225   L4virtio::Svr::Request_processor const &get_request_processor() const
00226   { return _req_proc; }
00227
00228   Virtio_net const *dev() const
00229   { return _dev; }
00230
00231   Virtio_net_transfer transfer_src() const
00232   { return Virtio_net_transfer(*this); }
00233
00235   Mac_addr dst_mac() const
00236   {
00237     return (_pkt.pos && _pkt.left >= Mac_addr::Addr_length)
00238       ? Mac_addr(_pkt.pos)
00239       : Mac_addr(Mac_addr::Addr_unknown);
00240   }
00241
00243   Mac_addr src_mac() const
00244   {
00245     return (_pkt.pos && _pkt.left >= Mac_addr::Addr_length * 2)
00246       ? Mac_addr(_pkt.pos + Mac_addr::Addr_length)
00247       : Mac_addr(Mac_addr::Addr_unknown);
00248   }
00249
00250
00251 private:
00252   /* needed for Virtqueue::finish() */
```

```
00254   Virtio_net *_dev;
00256   L4virtio::Svr::Virtqueue *_queue;
00257   L4virtio::Svr::Virtqueue::Head_desc _head;
00258
00259   /* the actual request processor, encapsulates the decoding of the request */
00260   L4virtio::Svr::Request_processor _req_proc;
00261
00262   /* A request to the virtio net layer consists of one or more buffers
00263      containing the Virtio_net::Hdr and the actual packet. To make a
00264      switching decision we need to be able to look at the packet while
00265      still being able access the Virtio_net::Hdr for the actual copy
00266      operation. Therefore we keep track of two locations, the header
00267      location and the start of the packet (which might be in a
00268      different buffer) */
00269   Virtio_net::Hdr *_header;
00270
00271   bool _next_buffer(Buffer *buf)
00272   { return _req_proc.next(_dev->mem_info(), buf); }
00273
00280   void finish()
00281   {
00282     if (_queue == nullptr || !_queue->ready())
00283       return;
00284
00285     Dbg(Dbg::Virtio, Dbg::Trace).printf("%s(%p)\n", __PRETTY_FUNCTION__, this);
00286     _queue->finish(_head, _dev, 0);
00287     _queue = nullptr;
00288   }
00289 };
00290
```

16.66 switch.cc

```
00001 /*
00002  * Copyright (C) 2016-2018, 2020, 2023-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #include "debug.h"
00009 #include "switch.h"
00010 #include "filter.h"
00011
00012 Virtio_switch::Virtio_switch(unsigned max_ports)
00013 : _max_ports(max_ports)
00014 {}
00015
00016 bool
00017 Virtio_switch::add_port(Port_iface *port)
00018 {
00019   if (_ports.size() == _max_ports)
00020     {
00021       Dbg(Dbg::Port, Dbg::Warn)
00022         .printf("Port limit (%u) has been reached.\n", _max_ports);
00023       return false;
00024     }
00025
00026   if (!port->mac().is_unknown())
00027     for (auto const *p: _ports)
00028       if (p->mac() == port->mac())
00029         {
00030           Dbg(Dbg::Port, Dbg::Warn)
00031             .printf("Rejecting port '%s'. MAC address already in use.\n",
00032                     port->get_name());
00033           return false;
00034         }
00035
00036   _ports.push_back(port);
00037   return true;
00038 }
00039
00040 bool
00041 Virtio_switch::add_monitor_port(Port_iface *port)
00042 {
00043   if (!_monitor)
00044     {
00045       _monitor = port;
00046       return true;
00047     }
00048
00049   Dbg(Dbg::Port, Dbg::Warn).printf("'%s' already defined as monitor port,"
00050                                   " rejecting monitor port '%s'\n",
00051                                   _monitor->get_name(), port->get_name());
```

```
00052   return false;
00053 }
00054
00055 void
00056 Virtio_switch::check_ports()
00057 {
00058   for (std::vector<Port_iface *>::iterator it = _ports.begin();
00059        it != _ports.end();)
00060     {
00061       auto *port = *it;
00062       if (port->is_gone())
00063         {
00064           Dbg(Dbg::Port, Dbg::Info)
00065             .printf("Client on port %p has gone. Deleting...\n", port);
00066
00067           _mac_table.flush(port);
00068           it = _ports.erase(it);
00069           delete port;
00070         }
00071       else
00072         ++it;
00073     }
00074
00075   if (_monitor && _monitor->is_gone())
00076     {
00077       delete(_monitor);
00078       _monitor = nullptr;
00079     }
00080 }
00081
00082 template<typename REQ>
00083 void
00084 Virtio_switch::handle_tx_request(Port_iface *port, REQ const &request)
00085 {
00086   // Trunk ports are required to have a VLAN tag and only accept packets that
00087   // belong to a configured VLAN.
00088   if (port->is_trunk() && !port->match_vlan(request.vlan_id()))
00089     {
00090       // Drop packet.
00091       port->stat_inc_tx_dropped();
00092       return;
00093     }
00094
00095   // Access ports must not be VLAN tagged to prevent double tagging attacks.
00096   if (port->is_access() && request.has_vlan())
00097     {
00098       // Drop packet.
00099       port->stat_inc_tx_dropped();
00100       return;
00101     }
00102
00103   auto handle_request = [](Port_iface *dst_port, Port_iface *src_port,
00104                            REQ const &req)
00105     {
00106       auto transfer_src = req.transfer_src();
00107       l4_uint64_t bytes;
00108       auto res = dst_port->handle_request(src_port, transfer_src, &bytes);
00109       switch (res)
00110         {
00111         case Port_iface::Result::Delivered:
00112           dst_port->stat_inc_tx_num();
00113           dst_port->stat_inc_tx_bytes(bytes);
00114           src_port->stat_inc_rx_num();
00115           src_port->stat_inc_rx_bytes(bytes);
00116           break;
00117         case Port_iface::Result::Dropped:
00118           [[fallthrough]];
00119         case Port_iface::Result::Exception:
00120           [[fallthrough]];
00121         default:
00122           dst_port->stat_inc_tx_dropped();
00123           break;
00124         }
00125     };
00126
00127   Mac_addr src = request.src_mac();
00128
00129   auto dst = request.dst_mac();
00130   bool is_broadcast = dst.is_broadcast();
00131   uint16_t vlan = request.has_vlan() ? request.vlan_id() : port->get_vlan();
00132   _mac_table.learn(src, port, vlan);
00133   if (L4_LIKELY(!is_broadcast))
00134     {
00135       auto *target = _mac_table.lookup(dst, vlan);
00136       if (target)
00137         {
00138           // Do not send packets to the port they came in; they might
```

```
00139           // be sent to us by another switch which does not know how
00140           // to reach the target.
00141           if (target != port)
00142             {
00143               handle_request(target, port, request);
00144               if (_monitor && !filter_request(request))
00145                 handle_request(_monitor, port, request);
00146             }
00147           return;
00148         }
00149     }
00150
00151   // It is either a broadcast or an unknown destination - send to all
00152   // known ports except the source port
00153   for (auto *target: _ports)
00154     {
00155       if (target != port && target->match_vlan(vlan))
00156         handle_request(target, port, request);
00157     }
00158
00159   // Send a copy to the monitor port
00160   if (_monitor && !filter_request(request))
00161     handle_request(_monitor, port, request);
00162 }
00163
00164 template<typename PORT>
00165 void
00166 Virtio_switch::handle_tx_requests(PORT *port, unsigned &num_reqs_handled)
00167 {
00168   while (auto req = port->get_tx_request())
00169     {
00170       req->dump_request(port);
00171       handle_tx_request(port, *req);
00172
00173       if (++num_reqs_handled >= Tx_burst)
00174         // Port has hit its TX burst limit.
00175         break;
00176     }
00177 }
00178
00179 bool
00180 Virtio_switch::handle_l4virtio_port_tx(L4virtio_port *port)
00181 {
00182   /* handle IRQ on one port for the time being */
00183   if (!port->tx_work_pending())
00184     Dbg(Dbg::Port, Dbg::Debug)
00185       .printf("%s: Irq without pending work\n", port->get_name());
00186
00187   unsigned num_reqs_handled = 0;
00188   do
00189     {
00190       port->tx_q()->disable_notify();
00191       port->rx_q()->disable_notify();
00192
00193       if (num_reqs_handled >= Tx_burst)
00194         {
00195           Dbg(Dbg::Port, Dbg::Debug)
00196             .printf(
00197               "%s: Tx burst limit hit, reschedule remaining Tx work.\n",
00198               port->get_name());
00199
00200           // Port has hit its TX burst limit, so for fairness reasons, stop
00201           // processing TX work from this port, and instead reschedule the
00202           // pending work for later.
00203           port->reschedule_pending_tx();
00204           // NOTE: Notifications for this port remain disabled, until eventually
00205           // the reschedule handler calls `handle_l4virtio_port_tx' again.
00206           return false;
00207         }
00208
00209       // Within the loop, to trigger before enabling notifications again.
00210       all_rx_notify_disable_and_remember();
00211
00212       try
00213         {
00214           // throws Bad_descriptor exceptions raised on SRC port
00215           handle_tx_requests(port, num_reqs_handled);
00216         }
00217       catch (L4virtio::Svr::Bad_descriptor &e)
00218         {
00219             Dbg(Dbg::Port, Dbg::Warn, "REQ")
00220               .printf("%s: caught bad descriptor exception: %s - %i"
00221                       " -- Signal device error on device %p.\n",
00222                       __PRETTY_FUNCTION__, e.message(), e.error, port);
00223           port->device_error();
00224           all_rx_notify_emit_and_enable();
00225           return false;
```

```
00226         }
00227
00228       all_rx_notify_emit_and_enable();
00229
00230       port->tx_q()->enable_notify();
00231       port->rx_q()->enable_notify();
00232
00233       L4virtio::wmb();
00234       L4virtio::rmb();
00235     }
00236   while (port->tx_work_pending());
00237
00238   return true;
00239 }
00240
00241 #if CONFIG_VNS_IXL
00242 bool
00243 Virtio_switch::handle_ixl_port_tx(Ixl_port *port)
00244 {
00245   unsigned num_reqs_handled = 0;
00246
00247   all_rx_notify_disable_and_remember();
00248   handle_tx_requests(port, num_reqs_handled);
00249   all_rx_notify_emit_and_enable();
00250
00251   if (num_reqs_handled >= Tx_burst && port->tx_work_pending())
00252     {
00253       Dbg(Dbg::Port, Dbg::Info)
00254         .printf("%s: Tx burst limit hit, reschedule remaining Tx work.\n",
00255                 port->get_name());
00256
00257       // Port has hit its TX burst limit, so for fairness reasons, stop
00258       // processing TX work from this port, and instead reschedule the
00259       // pending work for later.
00260       port->reschedule_pending_tx();
00261       return false;
00262     }
00263
00264   return true;
00265 }
00266 #endif
00267
```

16.67 switch.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2020, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "port.h"
00011 #include "port_l4virtio.h"
00012 #include "mac_table.h"
00013
00014 #if CONFIG_VNS_IXL
00015 #include "port_ixl.h"
00016 #endif
00017
00018 #include <vector>
00019
00035 class Virtio_switch
00036 {
00037 private:
00038   std::vector<Port_iface *> _ports;
00039   Port_iface *_monitor = nullptr;
00040
00041   unsigned _max_ports;
00042   Mac_table<> _mac_table;
00043
00044   // Limits the number of consecutive TX requests a port can process before
00045   // being interrupted to ensure fairness to other ports.
00046   static constexpr unsigned Tx_burst = 128;
00047
00057   template<typename REQ>
00058   void handle_tx_request(Port_iface *port, REQ const &request);
00059
00060   template<typename PORT>
00061   void handle_tx_requests(PORT *port, unsigned &num_reqs_handled);
00062
00063
```

```
00064   void all_rx_notify_emit_and_enable()
00065   {
00066     for (auto *port : _ports)
00067       port->rx_notify_emit_and_enable();
00068   }
00069
00070   void all_rx_notify_disable_and_remember()
00071   {
00072     for (auto *port: _ports)
00073       port->rx_notify_disable_and_remember();
00074   }
00075
00076 public:
00083   explicit Virtio_switch(unsigned max_ports);
00084
00093   bool add_port(Port_iface *port);
00094
00103   bool add_monitor_port(Port_iface *port);
00104
00112   void check_ports();
00113
00123   bool handle_l4virtio_port_tx(L4virtio_port *port);
00124
00125 #if CONFIG_VNS_IXL
00135   bool handle_ixl_port_tx(Ixl_port *port);
00136 #endif
00137
00146   bool port_available(bool monitor)
00147   {
00148     if (monitor)
00149       return _monitor == 0;
00150
00151     return _ports.size() < _max_ports;
00152   }
00153 };
```

16.68 virtio_net.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2019, 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/re/dataspace>
00011 #include <l4/re/util/unique_cap>
00012
00013 #include <l4/sys/cxx/ipc_epiface>
00014
00015 #include <l4/l4virtio/server/virtio>
00016 #include <l4/l4virtio/server/l4virtio>
00017 #include <l4/l4virtio/l4virtio>
00018
00019 #include "debug.h"
00024 class Virtqueue : public L4virtio::Svr::Virtqueue
00025 {
00026 public:
00027   bool kick_queue()
00028   {
00029     if (no_notify_guest())
00030       return false;
00031
00032     if (_do_kick)
00033       return true;
00034
00035     _kick_pending = true;
00036     return false;
00037   }
00038
00039   bool kick_enable_get_pending()
00040   {
00041     _do_kick = true;
00042     return _kick_pending;
00043   }
00044
00045   void kick_disable_and_remember()
00046   {
00047     _do_kick = false;
00048     _kick_pending = false;
00049   }
00050
```

```
00051 private:
00052   bool _do_kick = true;
00053   bool _kick_pending = false;
00054 };
00055
00071 class Virtio_net :
00072   public L4virtio::Svr::Device,
00073   public L4::Epiface_t<Virtio_net, L4virtio::Device>
00074 {
00075 public:
00076   struct Hdr_flags
00077   {
00078     l4_uint8_t raw;
00079     CXX_BITFIELD_MEMBER( 0, 0, need_csum, raw);
00080     CXX_BITFIELD_MEMBER( 1, 1, data_valid, raw);
00081   };
00082
00083   struct Hdr
00084   {
00085     Hdr_flags flags;
00086     l4_uint8_t gso_type;
00087     l4_uint16_t hdr_len;
00088     l4_uint16_t gso_size;
00089     l4_uint16_t csum_start;
00090     l4_uint16_t csum_offset;
00091     l4_uint16_t num_buffers;
00092   };
00093
00094   struct Features : L4virtio::Svr::Dev_config::Features
00095   {
00096     Features() = default;
00097     Features(l4_uint32_t raw) : L4virtio::Svr::Dev_config::Features(raw) {}
00098
00099     CXX_BITFIELD_MEMBER( 0,  0, csum, raw);       // host handles partial csum
00100     CXX_BITFIELD_MEMBER( 1,  1, guest_csum, raw); // guest handles partial csum
00101     CXX_BITFIELD_MEMBER( 5,  5, mac, raw);        // host has given mac
00102     CXX_BITFIELD_MEMBER( 6,  6, gso, raw);        // host handles packets /w any GSO
00103     CXX_BITFIELD_MEMBER( 7,  7, guest_tso4, raw); // guest handles TSOv4 in
00104     CXX_BITFIELD_MEMBER( 8,  8, guest_tso6, raw); // guest handles TSOv6 in
00105     CXX_BITFIELD_MEMBER( 9,  9, guest_ecn, raw);  // guest handles TSO[6] with ECN in
00106     CXX_BITFIELD_MEMBER(10, 10, guest_ufo, raw);  // guest handles UFO in
00107     CXX_BITFIELD_MEMBER(11, 11, host_tso4, raw);  // host handles TSOv4 in
00108     CXX_BITFIELD_MEMBER(12, 12, host_tso6, raw);  // host handles TSOv6 in
00109     CXX_BITFIELD_MEMBER(13, 13, host_ecn, raw);   // host handles TSO[6] with ECN in
00110     CXX_BITFIELD_MEMBER(14, 14, host_ufo, raw);   // host handles UFO
00111     CXX_BITFIELD_MEMBER(15, 15, mrg_rxbuf, raw);  // host can merge receive buffers
00112     CXX_BITFIELD_MEMBER(16, 16, status, raw);     // virtio_net_config.status available
00113     CXX_BITFIELD_MEMBER(17, 17, ctrl_vq, raw);    // Control channel available
00114     CXX_BITFIELD_MEMBER(18, 18, ctrl_rx, raw);    // Control channel RX mode support
00115     CXX_BITFIELD_MEMBER(19, 19, ctrl_vlan, raw);  // Control channel VLAN filtering
00116     CXX_BITFIELD_MEMBER(20, 20, ctrl_rx_extra, raw); // Extra RX mode control support
00117     CXX_BITFIELD_MEMBER(21, 21, guest_announce, raw); // Guest can announce device on the network
00118     CXX_BITFIELD_MEMBER(22, 22, mq, raw);         // Device supports Receive Flow Steering
00119     CXX_BITFIELD_MEMBER(23, 23, ctrl_mac_addr, raw); // Set MAC address
00120   };
00121
00122   enum
00123   {
00124     Rx = 0,
00125     Tx = 1,
00126   };
00127
00128   struct Net_config_space
00129   {
00130     // The config defining mac address (if VIRTIO_NET_F_MAC aka Features::mac)
00131     l4_uint8_t mac[6];
00132     // currently not used ...
00133     l4_uint16_t status;
00134     l4_uint16_t max_virtqueue_pairs;
00135   };
00136
00137   L4virtio::Svr::Dev_config_t<Net_config_space> _dev_config;
00138
00139   explicit Virtio_net(unsigned vq_max)
00140   : L4virtio::Svr::Device(&_dev_config,
00141                           Dbg{Dbg::Virtio, Dbg::Warn},
00142                           Dbg{Dbg::Virtio, Dbg::Debug}),
00143     _dev_config(L4VIRTIO_VENDOR_KK, L4VIRTIO_ID_NET, 2),
00144     _vq_max(vq_max)
00145   {
00146     Features hf(0);
00147     hf.ring_indirect_desc() = true;
00148     hf.mrg_rxbuf() = true;
00149 #if 0
00150     // disable currently unsupported options, but leave them in for
00151     // documentation purposes
00152     hf.csum()       = true;
```

```
00153     hf.host_tso4() = true;
00154     hf.host_tso6() = true;
00155     hf.host_ufo()  = true;
00156     hf.host_ecn()  = true;
00157
00158     hf.guest_csum() = true;
00159     hf.guest_tso4() = true;
00160     hf.guest_tso6() = true;
00161     hf.guest_ufo()  = true;
00162     hf.guest_ecn()  = true;
00163 #endif
00164
00165     _dev_config.host_features(0) = hf.raw;
00166     _dev_config.set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00167     _dev_config.reset_hdr();
00168
00169     reset_queue_config(Rx, vq_max);
00170     reset_queue_config(Tx, vq_max);
00171   }
00172
00173   void reset() override
00174   {
00175     for (L4virtio::Svr::Virtqueue &q: _q)
00176       q.disable();
00177
00178     reset_queue_config(Rx, _vq_max);
00179     reset_queue_config(Tx, _vq_max);
00180     _dev_config.reset_hdr();
00181   }
00182
00183   template<typename T, unsigned N >
00184   static unsigned array_length(T (&)[N]) { return N; }
00185
00186   int reconfig_queue(unsigned index) override
00187   {
00188     Dbg(Dbg::Virtio, Dbg::Info, "Virtio")
00189       .printf("(%p): Reconfigure queue %d (%p): Status: %02x\n",
00190               this, index, _q + index, _dev_config.status().raw);
00191
00192     if (index >= array_length(_q))
00193       return -L4_ERANGE;
00194
00195     if (setup_queue(_q + index, index, _vq_max))
00196       return 0;
00197
00198     return -L4_EINVAL;
00199   }
00200
00201   void dump_features(Dbg const &dbg, const volatile l4_uint32_t *p)
00202   {
00203     dbg.cprintf("%08x:%08x:%08x:%08x:%08x:%08x\n",
00204                 p[0], p[1], p[2], p[3], p[4], p[5]);
00205   }
00206
00207   void dump_features()
00208   {
00209     Dbg info(Dbg::Virtio, Dbg::Info, "Virtio");
00210     if (!info.is_active())
00211       return;
00212
00213     auto *hdr = _dev_config.hdr();
00214
00215     info.printf("Device %p running (%02x)\n\thost features:  ",
00216                 this, _dev_config.status().raw);
00217     dump_features(info, hdr->dev_features_map);
00218     info.printf("\tguest features: ");
00219     dump_features(info, hdr->driver_features_map);
00220   }
00221
00222   bool check_features() override
00223   {
00224     _negotiated_features = _dev_config.negotiated_features(0);
00225     return true;
00226   }
00227
00228   bool device_needs_reset() const
00229   { return _dev_config.status().device_needs_reset(); }
00230
00232   bool check_queues() override
00233   {
00234     for (L4virtio::Svr::Virtqueue &q: _q)
00235       if (!q.ready())
00236         {
00237           reset();
00238           Err().printf("failed to start queues\n");
00239           return false;
00240         }
```

```
00241     dump_features();
00242     return true;
00243   }
00244
00245   Server_iface *server_iface() const override
00246   { return L4::Epiface::server_iface(); }
00247
00252   void register_single_driver_irq() override
00253   {
00254     _kick_guest_irq = L4Re::Util::Unique_cap<L4::Irq>(
00255         L4Re::chkcap(server_iface()->template rcv_cap<L4::Irq>(0)));
00256     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
00257   }
00258
00259   void trigger_driver_config_irq() override
00260   {
00261     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00262     _kick_guest_irq->trigger();
00263   }
00264
00271   void notify_queue(L4virtio::Svr::Virtqueue *queue)
00272   {
00273     // Downcast to Virtqueue to access kick_queue() - we know that our
00274     // queues have the type Virtqueue.
00275     Virtqueue *q = static_cast<Virtqueue*>(queue);
00276     if (q->kick_queue())
00277       {
00278         _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00279         _kick_guest_irq->trigger();
00280       }
00281   }
00282
00283   void kick_emit_and_enable()
00284   {
00285     bool kick_pending = false;
00286
00287     for (auto &q : _q)
00288       kick_pending |= q.kick_enable_get_pending();
00289
00290     if (kick_pending)
00291       {
00292         _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00293         _kick_guest_irq->trigger();
00294       }
00295   }
00296
00297   void kick_disable_and_remember()
00298   {
00299     for (auto &q : _q)
00300       q.kick_disable_and_remember();
00301   }
00302
00303   Features negotiated_features() const
00304   { return _negotiated_features; }
00305
00307   Virtqueue *tx_q() { return &_q[Tx]; }
00309   Virtqueue *rx_q() { return &_q[Rx]; }
00311   Virtqueue const *tx_q() const { return &_q[Tx]; }
00313   Virtqueue const *rx_q() const { return &_q[Rx]; }
00314
00315 private:
00316   Features _negotiated_features;
00318   unsigned _vq_max;
00320   Virtqueue _q[2];
00325   L4Re::Util::Unique_cap<L4::Irq> _kick_guest_irq;
00326 };
```

16.69 virtio_net.h

```
00001 /* SPDX-License-Identifier: MIT */
00002 /*
00003  * Copyright (C) 2022, 2024 Kernkonzept GmbH.
00004  * Author(s): Stephan Gerhold <stephan.gerhold@kernkonzept.com>
00005  */
00006
00007 #pragma once
00008
00014
00015 #include <l4/sys/types.h>
00016
00020 typedef struct l4virtio_net_header_t
00021 {
00022   l4_uint8_t flags;
00023   l4_uint8_t gso_type;
```

```
00024   l4_uint16_t hdr_len;
00025   l4_uint16_t gso_size;
00026   l4_uint16_t csum_start;
00027   l4_uint16_t csum_offset;
00028   l4_uint16_t num_buffers;
00029 } l4virtio_net_header_t;
00030
00034 typedef struct l4virtio_net_config_t
00035 {
00036   l4_uint8_t mac[6];
00037   l4_uint16_t status;
00038   l4_uint16_t max_virtqueue_pairs;
00039   l4_uint16_t mtu;
00040   l4_uint32_t speed;
00041   l4_uint8_t duplex;
00042 } l4virtio_net_config_t;
00043
00045 enum L4virtio_net_feature_bits
00046 {
00047   L4VIRTIO_NET_F_CSUM = 0,
00048   L4VIRTIO_NET_F_GUEST_CSUM = 1,
00049   L4VIRTIO_NET_F_MTU = 3,
00050   L4VIRTIO_NET_F_MAC = 5,
00051   L4VIRTIO_NET_F_GUEST_TSO4 = 7,
00052   L4VIRTIO_NET_F_GUEST_TSO6 = 8,
00053   L4VIRTIO_NET_F_GUEST_ECN = 9,
00054   L4VIRTIO_NET_F_GUEST_UFO = 10,
00055   L4VIRTIO_NET_F_HOST_TSO4 = 11,
00056   L4VIRTIO_NET_F_HOST_TSO6 = 12,
00057   L4VIRTIO_NET_F_HOST_ECN = 13,
00058   L4VIRTIO_NET_F_HOST_UFO = 14,
00059   L4VIRTIO_NET_F_MRG_RXBUF = 15,
00060   L4VIRTIO_NET_F_STATUS = 16,
00061   L4VIRTIO_NET_F_CTRL_VQ = 17,
00062   L4VIRTIO_NET_F_CTRL_RX = 18,
00063   L4VIRTIO_NET_F_CTRL_VLAN = 19,
00064   L4VIRTIO_NET_F_GUEST_ANNOUNCE = 21,
00065   L4VIRTIO_NET_F_MQ = 22,
00066   L4VIRTIO_NET_F_CTRL_MAC_ADDR = 23,
00067 };
00068
```

16.70 virtio_net_buffer.h

```
00001 /*
00002  * Copyright (C) 2016-2017, 2022, 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Jean Wolter <jean.wolter@kernkonzept.com>
00004  *            Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/l4virtio/server/l4virtio>
00015
00019 struct Buffer : L4virtio::Svr::Data_buffer
00020 {
00021   Buffer() = default;
00022   Buffer(L4virtio::Svr::Driver_mem_region const *r,
00023          L4virtio::Svr::Virtqueue::Desc const &d,
00024          L4virtio::Svr::Request_processor const *)
00025   {
00026     pos = static_cast<char *>(r->local(d.addr));
00027     left = d.len;
00028   }
00029
00030   Buffer(char *data, l4_uint32_t size)
00031   {
00032     pos = data;
00033     left = size;
00034   }
00035
00036   template<typename T>
00037   explicit Buffer(T *p) : Data_buffer(p) {};
00038 };
00039
```

16.71 vlan.h

```
00001 /*
00002  * Copyright (C) 2020, 2022-2024 Kernkonzept GmbH.
```

```
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/cxx/minmax>
00010 #include <l4/l4virtio/server/virtio>
00011 #include <l4/sys/types.h>
00012 #include <string.h>
00013
00014 #include "virtio_net.h"
00015 #include "virtio_net_buffer.h"
00016
00017 namespace {
00018
00019 const l4_uint16_t VLAN_ID_NATIVE = 0xffffU;
00020 const l4_uint16_t VLAN_ID_TRUNK = 0xfffeU;
00021
00022 inline bool vlan_valid_id(l4_uint16_t id)
00023 {
00024   return id > 0U && id < 0xfffU;
00025 }
00026
00027 }
00032
00036 class Virtio_vlan_mangle
00037 {
00038   l4_uint16_t _tci;
00039   l4_uint8_t _mac_remaining;
00040   l4_int8_t _tag_remaining;
00041
00042   constexpr Virtio_vlan_mangle(l4_uint16_t tci, l4_int8_t tag_remaining)
00043   : _tci{tci}, _mac_remaining{12}, _tag_remaining{tag_remaining}
00044   {}
00045
00046 public:
00052   Virtio_vlan_mangle()
00053   : _tci{0}, _mac_remaining{0}, _tag_remaining{0}
00054   {}
00055
00064   static constexpr Virtio_vlan_mangle add(l4_uint16_t tci)
00065   {
00066     return Virtio_vlan_mangle(tci, 4);
00067   }
00068
00075   static constexpr Virtio_vlan_mangle remove()
00076   {
00077     return Virtio_vlan_mangle(0xffffU, -4);
00078   }
00079
00093   l4_uint32_t copy_pkt(Buffer &dst, Buffer &src)
00094   {
00095     l4_uint32_t ret;
00096
00097     if (L4_LIKELY(_tci == 0))
00098       {
00099         // pass through (no tag or keep tag)
00100         ret = src.copy_to(&dst);
00101       }
00102     else if (_mac_remaining)
00103       {
00104         // copy initial MAC addresses
00105         ret = src.copy_to(&dst, _mac_remaining);
00106         _mac_remaining -= ret;
00107       }
00108     else if (_tag_remaining > 0)
00109       {
00110         // add VLAN tag
00111         l4_uint8_t tag[4] = {
00112           0x81, 0x00,
00113           static_cast<l4_uint8_t>(_tci » 8),
00114           static_cast<l4_uint8_t>(_tci & 0xffU)
00115         };
00116
00117         ret = cxx::min(static_cast<l4_uint32_t>(_tag_remaining), dst.left);
00118         memcpy(dst.pos, &tag[4 - _tag_remaining], ret);
00119         dst.skip(ret);
00120         _tag_remaining -= (int)ret;
00121       }
00122     else if (_tag_remaining < 0)
00123       {
00124         // remove VLAN tag
00125         _tag_remaining += static_cast<int>(src.skip(-_tag_remaining));
00126         ret = 0;
00127       }
00128     else
```

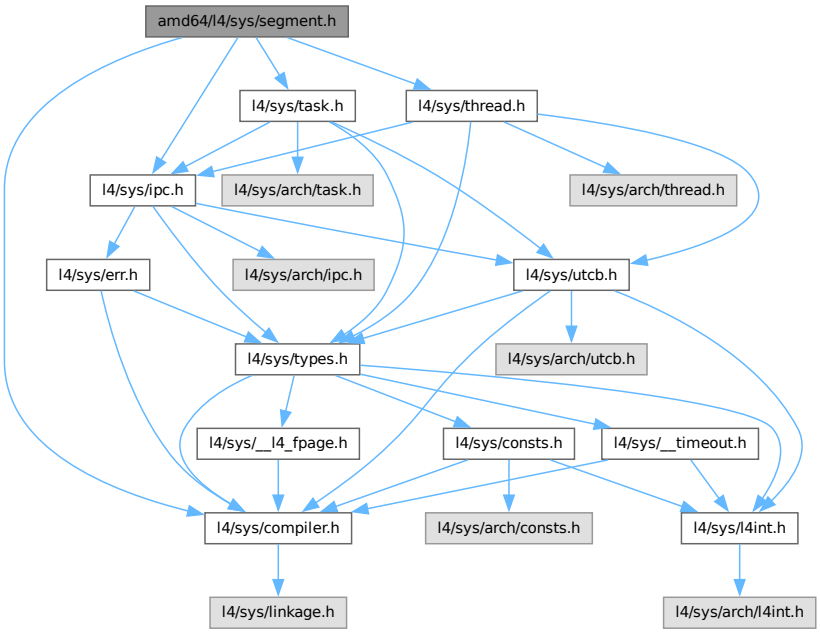
```
00129       ret = src.copy_to(&dst);
00130
00131     return ret;
00132   }
00133
00142   void rewrite_hdr(Virtio_net::Hdr *hdr)
00143   {
00144     if (L4_UNLIKELY(_tci != 0 && hdr->flags.need_csum()))
00145       {
00146         if (_tci == 0xffffU)
00147           hdr->csum_start -= 4U;
00148         else
00149           hdr->csum_start += 4U;
00150       }
00151   }
00152 };
00153
```

16.72 amd64/l4/sys/segment.h File Reference

Segment handling (AMD64).

```
#include <l4/sys/ipc.h>
#include <l4/sys/task.h>
#include <l4/sys/thread.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for segment.h:



Enumerations

- enum L4_task_ldt_x86_consts { L4_TASK_LDT_X86_ENTRY_SIZE = 8 , L4_TASK_LDT_X86_MAX_ENTRIES }

  Constants for LDT handling.

- enum L4_sys_segment { L4_AMD64_SEGMENT_FS = 0 , L4_AMD64_SEGMENT_GS = 1 }

  Constants for identifying segments.

Functions

- long fiasco_ldt_set (l4_cap_idx_t task, void *ldt, unsigned int num_desc, unsigned int entry_number_start, l4_utcb_t *utcb)

  Set LDT segments descriptors.
- long fiasco_gdt_set (l4_cap_idx_t thread, void *desc, unsigned int size, unsigned int entry_number_start, l4_utcb_t *utcb)

  Set GDT segment descriptors.
- unsigned fiasco_gdt_get_entry_offset (l4_cap_idx_t thread, l4_utcb_t *utcb)

  Return the offset of the entry in the GDT.
- long fiasco_amd64_set_fs (l4_cap_idx_t thread, l4_umword_t base, l4_utcb_t *utcb)

  Set the base address for the FS segment.
- long fiasco_amd64_set_segment_base (l4_cap_idx_t thread, enum L4_sys_segment segr, l4_umword_t base, l4_utcb_t *utcb)

  Set the base address for a segment.
- long fiasco_amd64_segment_info (l4_cap_idx_t thread, unsigned *user_ds, unsigned *user_cs, unsigned *user32_cs, l4_utcb_t *utcb)

  Get segment information.

16.72.1 Detailed Description

Segment handling (AMD64).
Definition in file segment.h.

16.72.2 Enumeration Type Documentation

16.72.2.1 L4_sys_segment

```
enum L4_sys_segment
```

Constants for identifying segments.

Enumerator

L4_AMD64_SEGMENT_FS	Constant identifying the FS segment.
L4_AMD64_SEGMENT_GS	Constant identifying the GS segment.

Definition at line 106 of file segment.h.

16.72.2.2 L4_task_ldt_x86_consts

```
enum L4_task_ldt_x86_consts
```

Constants for LDT handling.

Enumerator

L4_TASK_LDT_X86_ENTRY_SIZE	Size of an LDT entry.
L4_TASK_LDT_X86_MAX_ENTRIES	Maximum number of LDT entries that can be written with one call.

Definition at line 75 of file segment.h.

16.72.3 Function Documentation

16.72.3.1 fiasco_amd64_segment_info()

```
long fiasco_amd64_segment_info (
            l4_cap_idx_t thread,
```

```
unsigned * user_ds,
unsigned * user_cs,
unsigned * user32_cs,
l4_utcb_t * utcb)  [inline]
```

Get segment information.

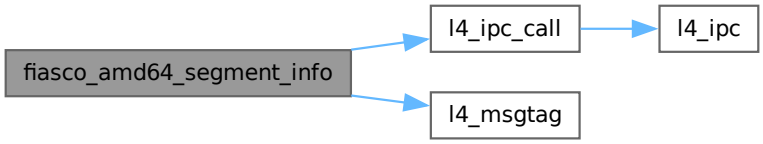
Parameters

in	*thread*	Thread to get info from.
out	*user_ds*	DS segment selector.
out	*user_cs*	64-bit CS segment selector.
out	*user32_cs*	32-bit CS segment selector.
	utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Returns

System call error

Definition at line 175 of file segment.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_PROTO_THREAD, L4_THREAD_AMD64_GET_SEGMENT_INFO_OP, and l4_msg_regs_t::mr.
Here is the call graph for this function:



16.72.3.2 fiasco_amd64_set_fs()

```
long fiasco_amd64_set_fs (
l4_cap_idx_t thread,
l4_umword_t base,
l4_utcb_t * utcb)  [inline]
```

Set the base address for the FS segment.

Parameters

thread	Thread for which the FS base address shall be modified.
base	Base address.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

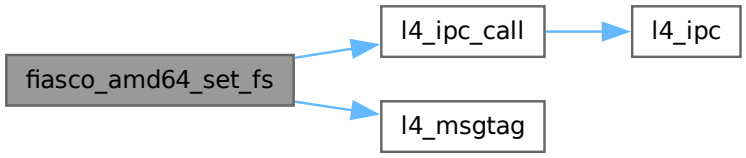
Return values

L4_EOK	Success.
-L4_EINVAL	Invalid base address (`base`).
-L4_ENOSYS	Operation not supported with current kernel configuration.

Note

Calling this function is equivalent to calling `fiasco_amd64_set_segment_base(thread, L4_↩ AMD64_SEGMENT_FS, base, utcb)`.

Definition at line 203 of file segment.h.
References L4_AMD64_SEGMENT_FS, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_PROTO_THREAD, and L4_THREAD_AMD64_SET_SEGMENT_BASE_OP.
Here is the call graph for this function:



16.72.3.3 fiasco_amd64_set_segment_base()

```
long fiasco_amd64_set_segment_base (
            l4_cap_idx_t thread,
            enum L4_sys_segment segr,
            l4_umword_t base,
            l4_utcb_t * utcb)  [inline]
```

Set the base address for a segment.

Parameters

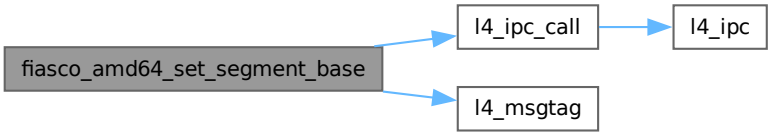
thread	Thread for which the base address of the selected segment shall be modified.
segr	Segment to modify (one of L4_sys_segment).
base	Base address.
utcb	UTCB to be used for this operation, shall be the UTCB of the calling thread. See l4_utcb.

Return values

L4_EOK	Success.
-L4_EINVAL	Invalid segment (`segr`) or base address (`base`).
-L4_ENOSYS	Operation not supported with current kernel configuration.

Definition at line 211 of file segment.h.
References l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_PROTO_THREAD, and L4_THREAD_AMD64_SET_SEGMENT_BASE_

Here is the call graph for this function:



16.73 segment.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 /*****************************************************************************/
00013 #ifndef __L4_SYS__ARCH_X86__SEGMENT_H__
00014 #define __L4_SYS__ARCH_X86__SEGMENT_H__
00015
00016 #ifndef L4API_l4f
00017 #error This header file can only be used with a L4API version!
00018 #endif
00019
00020 #include <l4/sys/ipc.h>
00021
00039 L4_INLINE long
00040 fiasco_ldt_set(l4_cap_idx_t task, void *ldt, unsigned int num_desc,
00041                unsigned int entry_number_start, l4_utcb_t *utcb);
00042
00059 L4_INLINE long
00060 fiasco_gdt_set(l4_cap_idx_t thread, void *desc, unsigned int size,
00061                unsigned int entry_number_start, l4_utcb_t *utcb);
00062
00069 L4_INLINE unsigned
00070 fiasco_gdt_get_entry_offset(l4_cap_idx_t thread, l4_utcb_t *utcb);
00071
00075 enum L4_task_ldt_x86_consts
00076 {
00078   L4_TASK_LDT_X86_ENTRY_SIZE = 8,
00080   L4_TASK_LDT_X86_MAX_ENTRIES
00081     = (L4_UTCB_GENERIC_DATA_SIZE - 2)
00082       / (L4_TASK_LDT_X86_ENTRY_SIZE / (L4_MWORD_BITS / 8)),
00083 };
00084
00100 L4_INLINE long
00101 fiasco_amd64_set_fs(l4_cap_idx_t thread, l4_umword_t base, l4_utcb_t *utcb);
00102
00106 enum L4_sys_segment
00107 {
00109   L4_AMD64_SEGMENT_FS = 0,
00111   L4_AMD64_SEGMENT_GS = 1
00112 };
00113
00127 L4_INLINE long
00128 fiasco_amd64_set_segment_base(l4_cap_idx_t thread, enum L4_sys_segment segr,
00129                               l4_umword_t base, l4_utcb_t *utcb);
00130
00140 L4_INLINE long
00141 fiasco_amd64_segment_info(l4_cap_idx_t thread, unsigned *user_ds,
00142                           unsigned *user_cs, unsigned *user32_cs,
00143                           l4_utcb_t *utcb);
00144
00145 /*****************************************************************************
00146  *** Implementation
00147  *****************************************************************************/
00148
00149 #include <l4/sys/task.h>
00150 #include <l4/sys/thread.h>
00151
00152 L4_INLINE long
```

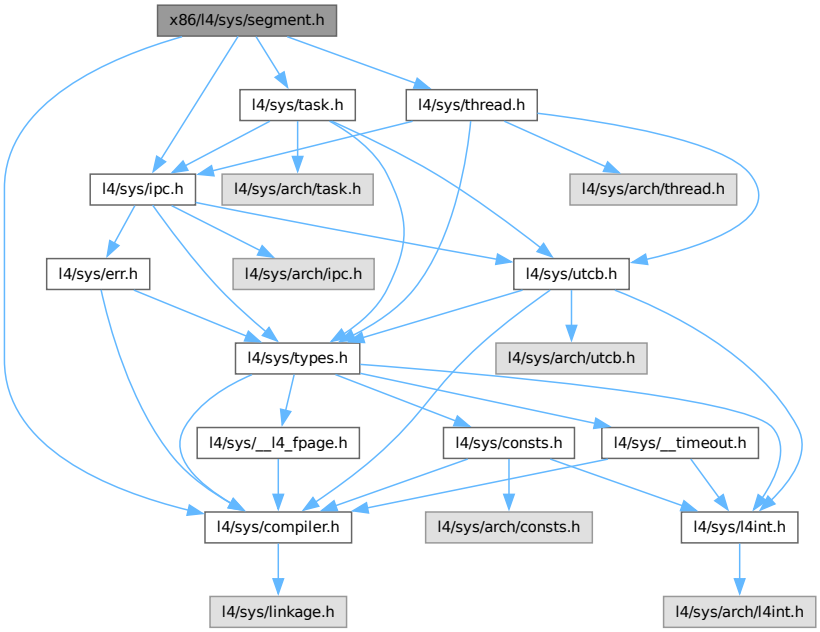
```
00153 fiasco_ldt_set(l4_cap_idx_t task, void *ldt, unsigned int num_desc,
00154                unsigned int entry_number_start, l4_utcb_t *utcb)
00155 {
00156   if (num_desc > L4_TASK_LDT_X86_MAX_ENTRIES)
00157     return -L4_EINVAL;
00158   l4_utcb_mr_u(utcb)->mr[0] = L4_TASK_LDT_SET_X86_OP;
00159   l4_utcb_mr_u(utcb)->mr[1] = entry_number_start;
00160   __builtin_memcpy(&l4_utcb_mr_u(utcb)->mr[2], ldt,
00161                    num_desc * L4_TASK_LDT_X86_ENTRY_SIZE);
00162   return l4_error_u(l4_ipc_call(task, utcb, l4_msgtag(L4_PROTO_TASK, 2 + num_desc * 2, 0, 0),
      L4_IPC_NEVER), utcb);
00163 }
00164
00165 L4_INLINE unsigned
00166 fiasco_gdt_get_entry_offset(l4_cap_idx_t thread, l4_utcb_t *utcb)
00167 {
00168   l4_utcb_mr_u(utcb)->mr[0] = L4_THREAD_X86_GDT_OP;
00169   if (l4_error_u(l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0), L4_IPC_NEVER), utcb))
00170     return -1;
00171   return l4_utcb_mr_u(utcb)->mr[0];
00172 }
00173
00174 L4_INLINE long
00175 fiasco_amd64_segment_info(l4_cap_idx_t thread, unsigned *user_ds,
00176                           unsigned *user_cs, unsigned *user32_cs,
00177                           l4_utcb_t *utcb)
00178 {
00179   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00180   int r;
00181
00182   m->mr[0] = L4_THREAD_AMD64_GET_SEGMENT_INFO_OP;
00183
00184   r = l4_error_u(l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0),
00185                              L4_IPC_NEVER), utcb);
00186   if (r < 0)
00187     return r;
00188
00189   *user_ds   = m->mr[0];
00190   *user_cs   = m->mr[1];
00191   *user32_cs = m->mr[2];
00192
00193   return 0;
00194 }
00195
00196 #include <l4/sys/compiler.h>
00197
00198 /*****************************************************************************
00199  *** Implementation
00200  *****************************************************************************/
00201
00202 L4_INLINE long
00203 fiasco_amd64_set_fs(l4_cap_idx_t thread, l4_umword_t base, l4_utcb_t *utcb)
00204 {
00205   l4_utcb_mr_u(utcb)->mr[0] = L4_THREAD_AMD64_SET_SEGMENT_BASE_OP | ((l4_umword_t)L4_AMD64_SEGMENT_FS
      << 16);
00206   l4_utcb_mr_u(utcb)->mr[1] = base;
00207   return l4_error_u(l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2, 0, 0), L4_IPC_NEVER),
      utcb);
00208 }
00209
00210 L4_INLINE long
00211 fiasco_amd64_set_segment_base(l4_cap_idx_t thread, enum L4_sys_segment segr,
00212                               l4_umword_t base, l4_utcb_t *utcb)
00213 {
00214   l4_utcb_mr_u(utcb)->mr[0] = L4_THREAD_AMD64_SET_SEGMENT_BASE_OP | ((l4_umword_t)segr << 16);
00215   l4_utcb_mr_u(utcb)->mr[1] = base;
00216   return l4_error_u(l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2, 0, 0), L4_IPC_NEVER),
      utcb);
00217 }
00218
00219 L4_INLINE long
00220 fiasco_gdt_set(l4_cap_idx_t thread, void *desc, unsigned int size,
00221                unsigned int entry_number_start, l4_utcb_t *utcb)
00222 {
00223   l4_utcb_mr_u(utcb)->mr[0] = L4_THREAD_X86_GDT_OP;
00224   l4_utcb_mr_u(utcb)->mr[1] = entry_number_start;
00225   __builtin_memcpy(&l4_utcb_mr_u(utcb)->mr[2], desc, size);
00226   return l4_error_u(l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2 + (size / 8), 0, 0),
      L4_IPC_NEVER), utcb);
00227 }
00228
00229
00230 #endif /* ! __L4_SYS__ARCH_X86__SEGMENT_H__ */
```

16.74 x86/l4/sys/segment.h File Reference

Segment handling (x86).

```
#include <l4/sys/ipc.h>
#include <l4/sys/compiler.h>
#include <l4/sys/task.h>
#include <l4/sys/thread.h>
```

Include dependency graph for segment.h:



Enumerations

- enum L4_task_ldt_x86_consts { L4_TASK_LDT_X86_ENTRY_SIZE = 8 , L4_TASK_LDT_X86_MAX_ENTRIES }

  Constants for LDT handling.

Functions

- long fiasco_ldt_set (l4_cap_idx_t task, void *ldt, unsigned int num_desc, unsigned int entry_number_start, l4_utcb_t *utcb)

  Set LDT segments descriptors.
- long fiasco_gdt_set (l4_cap_idx_t thread, void *desc, unsigned int size, unsigned int entry_number_start, l4_utcb_t *utcb)

  Set GDT segment descriptors.
- unsigned fiasco_gdt_get_entry_offset (l4_cap_idx_t thread, l4_utcb_t *utcb)

  Return the offset of the entry in the GDT.

16.74.1 Detailed Description

Segment handling (x86).
Definition in file segment.h.

16.74.2 Enumeration Type Documentation

16.74.2.1 L4_task_ldt_x86_consts

enum L4_task_ldt_x86_consts
Constants for LDT handling.

Enumerator

L4_TASK_LDT_X86_ENTRY_SIZE	Size of an LDT entry.
L4_TASK_LDT_X86_MAX_ENTRIES	Maximum number of LDT entries that can be written with one call.

Definition at line 75 of file segment.h.

16.75 segment.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 /*****************************************************************************/
00013 #ifndef __L4_SYS__ARCH_X86__SEGMENT_H__
00014 #define __L4_SYS__ARCH_X86__SEGMENT_H__
00015
00016 #ifndef L4API_l4f
00017 #error This header file can only be used with a L4API version!
00018 #endif
00019
00020 #include <l4/sys/ipc.h>
00021
00039 L4_INLINE long
00040 fiasco_ldt_set(l4_cap_idx_t task, void *ldt, unsigned int num_desc,
00041                unsigned int entry_number_start, l4_utcb_t *utcb);
00042
00059 L4_INLINE long
00060 fiasco_gdt_set(l4_cap_idx_t thread, void *desc, unsigned int size,
00061          unsigned int entry_number_start, l4_utcb_t *utcb);
00062
00069 L4_INLINE unsigned
00070 fiasco_gdt_get_entry_offset(l4_cap_idx_t thread, l4_utcb_t *utcb);
00071
00075 enum L4_task_ldt_x86_consts
00076 {
00078   L4_TASK_LDT_X86_ENTRY_SIZE = 8,
00080   L4_TASK_LDT_X86_MAX_ENTRIES
00081     = (L4_UTCB_GENERIC_DATA_SIZE - 2)
00082       / (L4_TASK_LDT_X86_ENTRY_SIZE / (L4_MWORD_BITS / 8)),
00083 };
00084
00085 /*****************************************************************************
00086  *** Implementation
00087  *****************************************************************************/
00088
00089 #include <l4/sys/compiler.h>
00090 #include <l4/sys/task.h>
00091 #include <l4/sys/thread.h>
00092
00093 L4_INLINE long
00094 fiasco_ldt_set(l4_cap_idx_t task, void *ldt, unsigned int num_desc,
00095                unsigned int entry_number_start, l4_utcb_t *utcb)
00096 {
00097   if (num_desc > L4_TASK_LDT_X86_MAX_ENTRIES)
00098     return -L4_EINVAL;
00099   l4_utcb_mr_u(utcb)->mr[0] = L4_TASK_LDT_SET_X86_OP;
00100   l4_utcb_mr_u(utcb)->mr[1] = entry_number_start;
00101   __builtin_memcpy(&l4_utcb_mr_u(utcb)->mr[2], ldt,
00102                    num_desc * L4_TASK_LDT_X86_ENTRY_SIZE);
00103   return l4_error_u(l4_ipc_call(task, utcb, l4_msgtag(L4_PROTO_TASK, 2 + num_desc * 2, 0, 0),
      L4_IPC_NEVER), utcb);
00104 }
00105
00106 L4_INLINE unsigned
00107 fiasco_gdt_get_entry_offset(l4_cap_idx_t thread, l4_utcb_t *utcb)
```

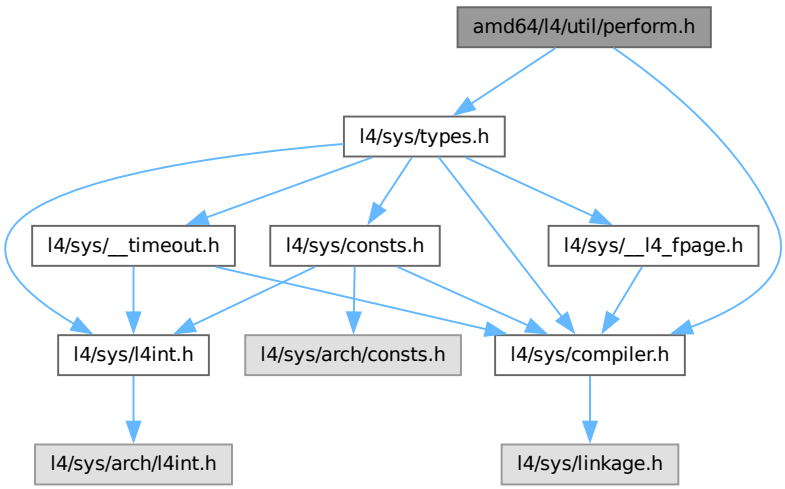
```
00108 {
00109   l4_utcb_mr_u(utcb)->mr[0] = L4_THREAD_X86_GDT_OP;
00110   if (l4_error_u(l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0), L4_IPC_NEVER), utcb))
00111     return -1;
00112   return l4_utcb_mr_u(utcb)->mr[0];
00113 }
00114
00115 L4_INLINE long
00116 fiasco_gdt_set(l4_cap_idx_t thread, void *desc, unsigned int size,
00117          unsigned int entry_number_start, l4_utcb_t *utcb)
00118 {
00119   l4_utcb_mr_u(utcb)->mr[0] = L4_THREAD_X86_GDT_OP;
00120   l4_utcb_mr_u(utcb)->mr[1] = entry_number_start;
00121   __builtin_memcpy(&l4_utcb_mr_u(utcb)->mr[2], desc, size);
00122   return l4_error_u(l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2 + (size » 2), 0, 0),
      L4_IPC_NEVER), utcb);
00123 }
00124
00125 #endif /* ! __L4_SYS__ARCH_X86__SEGMENT_H__ */
```

16.76 amd64/l4/util/perform.h File Reference

Perfomance Monitoring using P5/P6 Measurement Counters.

```
#include <l4/sys/types.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for perform.h:



16.76.1 Detailed Description

Perfomance Monitoring using P5/P6 Measurement Counters.
Define either CPU_PENTIUM or CPU_P6
Definition in file perform.h.

16.77 perform.h

Go to the documentation of this file.

```
00001
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
```

```
00013 #ifndef __L4UTIL_PERFORM_H
00014 #define __L4UTIL_PERFORM_H
00015
00016 #include <l4/sys/types.h>
00017 #include <l4/sys/compiler.h>
00018
00019 L4_BEGIN_DECLS
00020
00021 extern const char*strp6pmc_event(l4_uint32_t event);
00022
00023 #ifndef CONFIG_PERFORM_ONLY_PROTOTYPES
00024
00025 #if ! (defined CPU_PENTIUM  ^ defined CPU_P6 ^ defined CPU_K7)
00026
00027 #error You must define your target architecture.
00028 #error Define EITHER CPU_PENTIUM for Intel Pentium or CPU_P6 for Intel PPro/PII/PIII.
00029
00030 #else
00031
00032 /* P5/P6/K7 section */
00033
00034 /* Makros for access to model specific registers (MSR) */
00035
00036 /* Write the 64-Bit Model Specific Register. First argument is the register,
00037    second the 64-Bit value. This can only be called at priviledge level 0.
00038    With L4, the kernel emulates the WRMSR when calling in PL 3.
00039    */
00040 static inline void l4_i586_wrmsr(unsigned reg,unsigned long long*val){
00041   unsigned long dummyeax, dummyecx, dummyedx;
00042
00043   asm volatile(
00044         ".byte 0xf; .byte 0x30\n" /* wrmsr */
00045   : "=a" (dummyeax), "=d" (dummyedx), "=c" (dummyecx)
00046   : "2" (reg), "0" (*(unsigned *)val), "1" (*((unsigned *)val+1))
00047   );
00048 }
00049
00050 /* Read the 64-Bit Model Specific Register. First argument is the register,
00051    second the address to a 64-Bit value. This can only be called at
00052    priviledge level 0.  With L4, the kernel emulates the RDMSR when calling
00053    in PL 3.
00054    */
00055 static inline void l4_i586_rdmsr(unsigned reg,unsigned long long*val){
00056   unsigned dummy;
00057
00058   asm volatile(
00059         ".byte 0xf; .byte 0x32\n" /* rdmsr */
00060   : "=a" (*(unsigned *)val), "=d" (*((unsigned *)val+1)), "=c" (dummy)
00061   : "2" (reg)
00062   );
00063 }
00064
00065
00066 #ifdef CPU_PENTIUM
00067 /* Pentium section */
00068
00069 /* functions and events defined here are only usable at Pentium
00070    Processors. P6 architecture does NOT support this kind of measuring and
00071    these events. P6 architecture has its own counters and its own events.
00072    See P6-section for details. */
00073
00074 /* from l4linux/arch/l4-i386/include/perform.h */
00075
00076 static inline void
00077 l4_i586_reset_event_counter(void){
00078    asm volatile("xor %%rax, %%rax\n"
00079     "xor %%rdx, %%rdx\n"
00080     "mov $0x12, %%rcx\n"
00081     ".byte 0x0f, 0x30\n"
00082     "movl $0x13, %%rcx\n"
00083     ".byte 0x0f, 0x30\n"
00084     : : : "cx", "ax", "dx"
00085     );
00086 };
00087
00088 static inline void
00089 l4_i586_read_event_counter_long(long long *counter0, long long *counter1)
00090 {
00091   asm volatile(
00092         /*        "movl  $0, %%eax\n"
00093         "movl  $0x11, %%ecx\n"
00094         ".byte 0x0f, 0x30\n" *//* stop event counting */
00095         "mov  $0x12, %%rcx\n"
00096         ".byte 0x0f, 0x32\n"
00097         "mov %%rax, (%%rbx)\n"
00098         "mov %%rdx, 4(%%rbx)\n"
00099         "mov $0x13, %%ecx\n"
```

```
00100          ".byte 0x0f, 0x32\n"
00101          "mov %%rax, (%%rsi)\n"
00102          "mov %%rdx, 4(%%rsi)\n"
00103          : /* no output */
00104          : "b" (counter0), "S" (counter1)
00105          : "ax", "cx", "dx"
00106          );
00107 }
00108
00109 static inline void
00110 l4_i586_read_event_counter(int *counter0, int *counter1)
00111 {
00112   asm volatile("push %%rdx    \n"
00113          ".byte  0x0f, 0x30 \n"
00114          "mov  $0x12, %%rcx \n"
00115          ".byte 0x0f, 0x32  \n"
00116          "mov  %%rax, %%rbx \n"
00117          "movl $0x13, %%rcx \n"
00118          ".byte 0x0f, 0x32\n"
00119          "popl  %%edx\n"
00120          : "=b" (*counter0), "=a" (*counter1)
00121          : "1" (0), "c" (0x11)
00122          );
00123 }
00124
00125 static inline void
00126 l4_i586_select_event(int event0, int event1)
00127 {
00128    asm volatile(".byte 0x0f, 0x30\n"
00129     :
00130     :
00131     "a" (event0 + (event1 « 16)),
00132     "d" (0),
00133     "c" (0x11)
00134     );
00135 };
00136
00137 #define P5_RD_MISS          0x003 /* 000011B */
00138 #define P5_WR_MISS          0x008 /* 000100B */
00139 #define P5_RW_MISS          0x029 /* 101001B */
00140 #define P5_EX_MISS          0x00e /* 001110B */
00141
00142 #define P5_D_WBACK          0x006 /* 000110B */
00143
00144 #define P5_RW_TLB           0x002 /* 00010B */
00145 #define P5_EX_TLB           0x00d /* 01101B */
00146
00147 #define P5_A_STALL          0x01f /* 11111B */
00148 #define P5_W_STALL          0x019 /* 11001B */
00149 #define P5_R_STALL          0x01a /* 11010B */
00150 #define P5_X_STALL          0x01b /* 11011B */
00151
00152 #define P5_AGI_STALL        0x01f /* 11111B */
00153
00154 #define P5_PIPLINE_FLUSH    0x015 /* 10101B */
00155
00156 #define P5_NON_CACHE_RD     0x01e /* 11110B */
00157 #define P5_NCACHE_REFS      0x01e /* 11110B */
00158 #define P5_LOCKED_BUS       0x01c /* 11100B */
00159
00160 #define P5_MEM2PIPE         0x009 /* 01001B */
00161 #define P5_BANK_CONF        0x00a /* 01010B */
00162
00163
00164 #define P5_INSTRS_EX        0x016 /* 10110B */
00165 #define P5_INSTRS_EX_V      0x017 /* 10111B */
00166
00167
00168 #define P5_CNT_NOTHING      (0x00 « 6) /* 00B « 6 */
00169 #define P5_CNT_EVENT_PL0    (0x01 « 6) /* 01B « 6 */
00170 #define P5_CNT_EVENT_PL3    (0x02 « 6) /* 10B « 6 */
00171 #define P5_CNT_EVENT        (0x03 « 6) /* 11B « 6 */
00172 #define P5_CNT_CLOCKS_PL0   (0x05 « 6) /* 101B « 6 */
00173 #define P5_CNT_CLOCKS_PL3   (0x06 « 6) /* 110B « 6 */
00174 #define P5_CNT_CLOCKS       (0x07 « 6) /* 111B « 6 */
00175
00176
00177 #else
00178 #if defined CPU_P6
00179 /* PPro/PII/PIII section */
00180
00181 /*-
00182  * Copyright (c) 1997 The President and Fellows of Harvard College.
00183  * All rights reserved.
00184  * Copyright (c) 1997 Aaron B. Brown.
00185  *
00186  * Redistribution and use in source and binary forms, with or without
```

```
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00193  *    documentation and/or other materials provided with the distribution.
00194  * 3. All advertising materials mentioning features or use of this software
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00198  * 4. Neither the name of the University nor the names of its contributors
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00208  * SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS
00209  * INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN
00210  * CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE)
00211  * ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE
00212  * POSSIBILITY OF SUCH DAMAGE.
00213  */
00214
00215 /************************************************************************
00216  ** Symbolic names for counter numbers (used in select_p6counter()) **
00217  ************************************************************************
00218  *
00219  * These correspond in order to the Pentium Pro counters. Add new counters at
00220  * the end. These agree with the mneumonics in the Pentium Pro Family
00221  * Developer's Manual, vol 3.
00222  *
00223  * Those events marked with a $ require a MESI unit field; those marked with
00224  * a @ require a self/any unit field. Those marked with a 0 are only supported
00225  * in counter 0; those marked with 1 are only supported in counter 1.
00226  */
00227
00228 /* Data cache unit */
00229 #define P6_DATA_MEM_REFS  0x43  /* total memory refs */
00230 #define P6_DCU_LINES_IN   0x45  /* all lines allocated in cache unit */
00231 #define P6_DCU_M_LINES_IN 0x46  /* M lines allocated in cache unit */
00232 #define P6_DCU_M_LINES_OUT  0x47  /* M lines evicted from cache */
00233 #define P6_DCU_MISS_OUTSTANDING 0x48  /* #cycles a miss is outstanding */
00234
00235 /* Instruction fetch unit */
00236 #define P6_IFU_IFETCH   0x80  /* instruction fetches */
00237 #define P6_IFU_IFETCH_MISS  0x81  /* instruction fetch misses */
00238 #define P6_ITLB_MISS    0x85  /* ITLB misses */
00239 #define P6_IFU_MEM_STALL  0x86  /* number of cycles IFU is stalled */
00240 #define P6_ILD_STALL    0x87  /* #stalls in instr length decode */
00241
00242 /* L2 Cache */
00243 #define P6_L2_IFETCH    0x28  /* ($) l2 ifetches */
00244 #define P6_L2_LD    0x29  /* ($) l2 data loads */
00245 #define P6_L2_ST    0x2a  /* ($) l2 data stores */
00246 #define P6_L2_LINES_IN    0x24  /* lines allocated in l2 */
00247 #define P6_L2_LINES_OUT   0x26  /* lines removed from l2 */
00248 #define P6_L2_M_LINES_INM 0x25  /* modified lines allocated in L2 */
00249 #define P6_L2_M_LINES_OUTM  0x27  /* modified lines removed from L2 */
00250 #define P6_L2_RQSTS   0x2e  /* ($) number of l2 requests */
00251 #define P6_L2_ADS   0x21  /* number of l2 addr strobes */
00252 #define P6_L2_DBUS_BUSY   0x22  /* number of data bus busy cycles */
00253 #define P6_L2_DBUS_BUSY_RD  0x23  /* #bus cycles xferring l2->cpu */
00254
00255 /* External bus logic */
00256 #define P6_BUS_DRDY_CLOCKS  0x62  /* (@) #clocks DRDY is asserted */
00257 #define P6_BUS_LOCK_CLOCKS  0x63  /* (@) #clocks LOCK is asserted */
00258 #define P6_BUS_REQ_OUTSTANDING  0x60  /* #bus requests outstanding */
00259 #define P6_BUS_TRAN_BRD   0x65  /* (@) bus burst read txns */
00260 #define P6_BUS_TRAN_RFO   0x66  /* (@) bus read for ownership txns */
00261 #define P6_BUS_TRAN_WB    0x67  /* (@) bus writeback txns */
00262 #define P6_BUS_TRAN_IFETCH  0x68  /* (@) bus instr fetch txns */
00263 #define P6_BUS_TRAN_INVAL 0x69  /* (@) bus invalidate txns */
00264 #define P6_BUS_TRAN_PWR   0x6a  /* (@) bus partial write txns */
00265 #define P6_BUS_TRANS_P    0x6b  /* (@) bus partial txns */
00266 #define P6_BUS_TRANS_IO   0x6c  /* (@) bus I/O txns */
00267 #define P6_BUS_TRAN_DEF   0x6d  /* (@) bus deferred txns */
00268 #define P6_BUS_TRAN_BURST 0x6e  /* (@) bus burst txns */
00269 #define P6_BUS_TRAN_ANY   0x70  /* (@) total bus txns */
00270 #define P6_BUS_TRAN_MEM   0x6f  /* (@) total memory txns */
00271 #define P6_BUS_DATA_RCV   0x64  /* #busclocks CPU is receiving data */
00272 #define P6_BUS_BNR_DRV    0x61  /* #busclocks CPU is driving BNR pin */
00273 #define P6_BUS_HIT_DRV    0x7a  /* #busclocks CPU is driving HIT pin */
```

```
00274 #define P6_BUS_HITM_DRV   0x7b  /* #busclocks CPU is driving HITM pin*/
00275 #define P6_BUS_SNOOP_STALL  0x7e  /* #clkcycles bus is snoop-stalled */
00276
00277 /* FPU */
00278 #define P6_FLOPS          0xc1  /* (0) number of FP ops retired */
00279 #define P6_FP_COMP_OPS    0x10  /* (0) computational FPOPS exec'd */
00280 #define P6_FP_ASSIST    0x11  /* (1) FP excep's handled in ucode */
00281 #define P6_MUL      0x12  /* (1) number of FP multiplies */
00282 #define P6_DIV      0x13  /* (1) number of FP divides */
00283 #define P6_CYCLES_DIV_BUSY  0x14  /* (0) number of cycles divider busy */
00284
00285 /* Memory ordering */
00286 #define P6_LD_BLOCKS    0x03  /* number of store buffer blocks */
00287 #define P6_SB_DRAINS    0x04  /* # of store buffer drain cycles */
00288 #define P6_MISALING_MEM_REF 0x05  /* # misaligned data memory refs */
00289
00290 /* Instruction decoding and retirement */
00291 #define P6_INST_RETIRED   0xc0  /* number of instrs retired */
00292 #define P6_UOPS_RETIRED   0xc2  /* number of micro-ops retired */
00293 #define P6_INST_DECODER   0xd0  /* number of instructions decoded */
00294
00295 /* Interrupts */
00296 #define P6_HW_INT_RX    0xc8  /* number of hardware interrupts */
00297 #define P6_CYCLES_INT_MASKED  0xc6  /* number of cycles hardints masked */
00298 #define P6_CYCLES_INT_PENDING_AND_MASKED 0xc7 /* #cycles masked but pending */
00299
00300 /* Branches */
00301 #define P6_BR_INST_RETIRED  0xc4  /* number of branch instrs retired */
00302 #define P6_BR_MISS_PRED_RETIRED 0xc5  /* number of mispred'd brs retired */
00303 #define P6_BR_TAKEN_RETIRED 0xc9  /* number of taken branches retired */
00304 #define P6_BR_MISS_PRED_TAKEN_RET 0xca  /* #taken mispredictions br's retired*/
00305 #define P6_BR_INST_DECODED      0xe0  /* number of branch instrs decoded */
00306 #define P6_BTB_MISSES   0xe2  /* # of branches that missed in BTB */
00307 #define P6_BR_BOGUS   0xe4  /* number of bogus branches */
00308 #define P6_BACLEARS   0xe6  /* # times BACLEAR is asserted */
00309
00310 /* Stalls */
00311 #define P6_RESOURCE_STALLS  0xa2  /* # resource-related stall cycles */
00312 #define P6_PARTIAL_RAT_STALLS 0xd2  /* # cycles/events for partial stalls*/
00313
00314 /* Segment register loads */
00315 #define P6_SEGMENT_REG_LOADS  0x06  /* number of segment register loads */
00316
00317 /* Clocks */
00318 #define P6_CPU_CLK_UNHALTED 0x79  /* #clocks CPU is not halted */
00319
00320 /* Unit field tags */
00321 #define P6_UNIT_M   0x0800
00322 #define P6_UNIT_E   0x0400
00323 #define P6_UNIT_S   0x0200
00324 #define P6_UNIT_I   0x0100
00325 #define P6_UNIT_MESI    0x0f00
00326
00327 #define P6_UNIT_SELF    0x0000
00328 #define P6_UNIT_ANY   0x2000
00329
00330 /*********************************************************************
00331  ** Flag bit definitions (used for the 'flag' field in select_p6counter()) **
00332  *********************************************************************
00333  *
00334  * The driver accepts fully-formed counter specifications from user-level.
00335  * The following flags are mneumonics for the bits that get set in the
00336  * PerfEvtSel0 and PerfEvtSel1 MSR's
00337  *
00338  */
00339 #define P6CNT_U  0x010000 /* Monitor user-level events */
00340 #define P6CNT_K  0x020000 /* Monitor kernel-level events */
00341 #define P6CNT_E  0x040000 /* Edge detect: count state transitions */
00342 #define P6CNT_PC 0x080000 /* Pin control: ?? */
00343 #define P6CNT_IE 0x100000 /* Int enable: enable interrupt on overflow */
00344 #define P6CNT_F  0x200000 /* Freeze counter (handled in software) */
00345 #define P6CNT_EN 0x400000 /* enable counters (in PerfEvtSel0) */
00346 #define P6CNT_IV 0x800000 /* Invert counter mask comparison result */
00347
00348 /*****************************
00349  ** Miscellaneous constants **
00350  *****************************
00351  *
00352  * Number of Pentium Pro programable hardware counters.
00353  */
00354 #define NUM_P6HWC 2
00355
00356 /*********************************************************************************
00357 *
00358 * End of Copyright by Harvard College
00359 *
00360 *********************************************************************************/
```

```
00361
00362
00363 #define MSR_P6_EVNTSEL0 0x186
00364 #define MSR_P6_EVNTSEL1 0x187
00365 #define MSR_P6_PERFCTR0 0xc1
00366 #define MSR_P6_PERFCTR1 0xc2
00367
00368 /* P6-specific Makros to manipulate and read counters */
00369
00370 /* Read the 40 bit performance monitoring counter. This requires
00371    the PCE-flag in CR4 to be set. Otherwise GP0 is raised. Works only
00372    at P6.
00373    */
00374 #define l4_i686_rdpmc(cntr, res_p) \
00375   __asm __volatile(           \
00376    "mov %2, %%rcx   # put counter number in   \n\
00377    .byte 0xf; .byte 0x33  # RDPMC instruction   \n\
00378          mov %%rdx, %1    # High order 32 bits    \n\
00379          mov %%rax, %0    # Low order 32 bits"    \
00380   : "=g" (*(int *)(res_p)), "=g" (*(((int *)res_p)+1))  \
00381   : "g" (cntr)            \
00382   : "ecx", "eax", "edx")
00383
00384 static inline l4_uint32_t l4_i686_rdpmc_32(int cntr){
00385   l4_uint32_t x;
00386
00387   __asm__ __volatile__(
00388    ".byte 0xf; .byte 0x33 # RDPMC instruction"
00389   : "=a" (x)
00390   : "c" (cntr)
00391   : "rcx", "rax", "rdx");
00392   return x;
00393 }
00394
00395 static inline void l4_i686_select_perfctr_event(int counter,
00396                                                 unsigned long long val){
00397   l4_i586_wrmsr(MSR_P6_EVNTSEL0+counter, &val);
00398 }
00399
00400 static inline void l4_i686_select_perfctr0_event(long long *val){
00401   asm volatile(
00402                "mov $MSR_P6_EVNTSEL0, %%rcx\n"
00403                "mov (%%rbx), %%rax\n"
00404                "mov 4(%%rbx), %%rdx\n"
00405                //".byte 0xcc, 0xeb, 0x01, 0x21\n"
00406                ".byte 0x0f, 0x30\n" // wrmsr
00407                //".byte 0xcc, 0xeb, 0x01, 0x21\n"
00408                : /* no output */
00409                : "b" (val)
00410                : "ax", "cx", "dx", "bx"
00411                );
00412
00413 }
00414
00415 /* end of P6 section */
00416 #else
00417
00418 #define K7CNT_U  0x010000 /* Monitor user-level events */
00419 #define K7CNT_K  0x020000 /* Monitor kernel-level events */
00420 #define K7CNT_E  0x040000 /* Edge detect: count state transitions */
00421 #define K7CNT_PC 0x080000 /* Pin control: ?? */
00422 #define K7CNT_IE 0x100000 /* Int enable: enable interrupt on overflow */
00423 #define K7CNT_F  0x200000 /* Freeze counter (handled in software) */
00424 #define K7CNT_EN 0x400000 /* enable counters (in PerfEvtSel0) */
00425 #define K7CNT_IV 0x800000 /* Invert counter mask comparison result */
00426
00427 #define MSR_K7_EVNTSEL0 0xC0010000
00428 #define MSR_K7_EVNTSEL1 0xC0010001
00429 #define MSR_K7_EVNTSEL2 0xC0010002
00430 #define MSR_K7_EVNTSEL3 0xC0010003
00431 #define MSR_K7_PERFCTR0 0xC0010004
00432 #define MSR_K7_PERFCTR1 0xC0010005
00433 #define MSR_K7_PERFCTR2 0xC0010006
00434 #define MSR_K7_PERFCTR3 0xC0010007
00435
00436 #endif
00437
00438 #endif
00439
00440 /* end of P5/P6/K7 section*/
00441 #endif
00442
00443 /* end of not only lib-prototypes section */
00444 #endif
00445
00446 L4_END_DECLS
00447
```

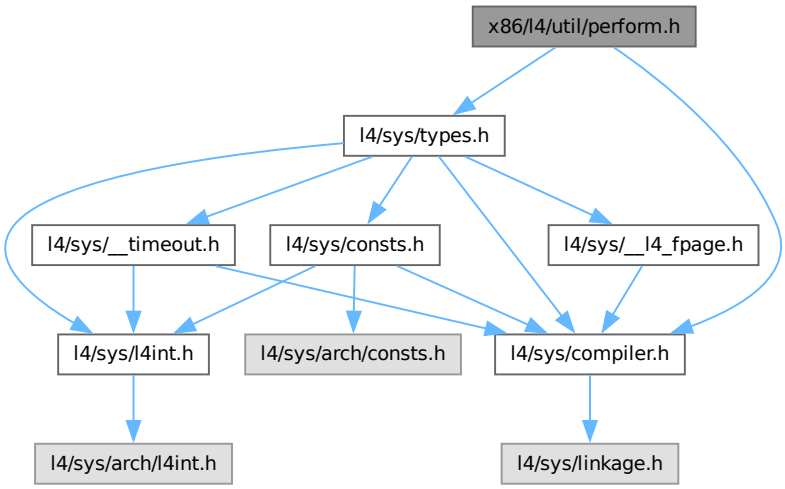
```
00448 #endif
```

16.78 x86/l4/util/perform.h File Reference

Perfomance Monitoring using P5/P6 Measurement Counters.

```
#include <l4/sys/types.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for perform.h:



16.78.1 Detailed Description

Perfomance Monitoring using P5/P6 Measurement Counters.
Define either CPU_PENTIUM or CPU_P6
Definition in file perform.h.

16.79 perform.h

Go to the documentation of this file.

```
00001
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>,
00010  *               Lars Reuther <reuther@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #ifndef __L4UTIL_PERFORM_H
00016 #define __L4UTIL_PERFORM_H
00017
00018 #include <l4/sys/types.h>
00019 #include <l4/sys/compiler.h>
00020
00021 L4_BEGIN_DECLS
00022
00023 extern const char*strp6pmc_event(l4_uint32_t event);
00024
00025 #ifndef CONFIG_PERFORM_ONLY_PROTOTYPES
00026
00027 #if ! (defined CPU_PENTIUM  ^ defined CPU_P6 ^ defined CPU_K7)
00028
00029 #error You must define your target architecture.
00030 #error Define EITHER CPU_PENTIUM for Intel Pentium or CPU_P6 for Intel PPro/PII/PIII.
```

```
00031
00032 #else
00033
00034 /* P5/P6/K7 section */
00035
00036 /* Makros for access to model specific registers (MSR) */
00037
00038 /* Write the 64-Bit Model Specific Register. First argument is the register,
00039    second the 64-Bit value. This can only be called at priviledge level 0.
00040    With L4, the kernel emulates the WRMSR when calling in PL 3.
00041    */
00042 static inline void l4_i586_wrmsr(unsigned reg,unsigned long long*val){
00043   unsigned long dummyeax, dummyecx, dummyedx;
00044
00045   asm volatile(
00046         ".byte 0xf; .byte 0x30\n" /* wrmsr */
00047   : "=a" (dummyeax), "=d" (dummyedx), "=c" (dummyecx)
00048   : "2" (reg), "0" (*(unsigned *)val), "1" (*((unsigned *)val+1))
00049   );
00050 }
00051
00052 /* Read the 64-Bit Model Specific Register. First argument is the register,
00053    second the address to a 64-Bit value. This can only be called at
00054    priviledge level 0.  With L4, the kernel emulates the RDMSR when calling
00055    in PL 3.
00056    */
00057 static inline void l4_i586_rdmsr(unsigned reg,unsigned long long*val){
00058   unsigned dummy;
00059
00060   asm volatile(
00061         ".byte 0xf; .byte 0x32\n" /* rdmsr */
00062   : "=a" (*(unsigned *)val), "=d" (*((unsigned *)val+1)), "=c" (dummy)
00063   : "2" (reg)
00064   );
00065 }
00066
00067
00068 #ifdef CPU_PENTIUM
00069 /* Pentium section */
00070
00071 /* functions and events defined here are only usable at Pentium
00072    Processors. P6 architecture does NOT support this kind of measuring and
00073    these events. P6 architecture has its own counters and its own events.
00074    See P6-section for details. */
00075
00076 /* from l4linux/arch/l4-i386/include/perform.h */
00077
00078 static inline void
00079 l4_i586_reset_event_counter(void){
00080    asm volatile("xor %%eax, %%eax\n"
00081     "xor %%edx, %%edx\n"
00082     "movl $0x12, %%ecx\n"
00083     ".byte 0x0f, 0x30\n"
00084     "movl $0x13, %%ecx\n"
00085     ".byte 0x0f, 0x30\n"
00086     : : : "cx", "ax", "dx"
00087     );
00088 };
00089
00090 static inline void
00091 l4_i586_read_event_counter_long(long long *counter0, long long *counter1)
00092 {
00093   asm volatile(
00094         /*        "movl  $0, %%eax\n"
00095         "movl  $0x11, %%ecx\n"
00096         ".byte 0x0f, 0x30\n" *//* stop event counting */
00097         "movl $0x12, %%ecx\n"
00098         ".byte 0x0f, 0x32\n"
00099         "movl %%eax, (%%ebx)\n"
00100         "movl %%edx, 4(%%ebx)\n"
00101         "movl $0x13, %%ecx\n"
00102         ".byte 0x0f, 0x32\n"
00103         "movl %%eax, (%%esi)\n"
00104         "movl %%edx, 4(%%esi)\n"
00105         : /* no output */
00106         : "b" (counter0), "S" (counter1)
00107         : "ax", "cx", "dx"
00108         );
00109 }
00110
00111 static inline void
00112 l4_i586_read_event_counter(int *counter0, int *counter1)
00113 {
00114   asm volatile("pushl %%edx\n"
00115         ".byte 0x0f, 0x30\n"
00116         "movl $0x12, %%ecx\n"
00117         ".byte 0x0f, 0x32\n"
```

```
00118          "movl %%eax, %%ebx\n"
00119          "movl $0x13, %%ecx\n"
00120          ".byte 0x0f, 0x32\n"
00121          "popl  %%edx\n"
00122          : "=b" (*counter0), "=a" (*counter1)
00123          : "1" (0), "c" (0x11)
00124          );
00125 }
00126
00127 static inline void
00128 l4_i586_select_event(int event0, int event1)
00129 {
00130    asm volatile(".byte 0x0f, 0x30\n"
00131     :
00132     :
00133     "a" (event0 + (event1 « 16)),
00134     "d" (0),
00135     "c" (0x11)
00136     );
00137 };
00138
00139 #define P5_RD_MISS          0x003 /* 000011B */
00140 #define P5_WR_MISS          0x008 /* 000100B */
00141 #define P5_RW_MISS          0x029 /* 101001B */
00142 #define P5_EX_MISS          0x00e /* 001110B */
00143
00144 #define P5_D_WBACK          0x006 /* 000110B */
00145
00146 #define P5_RW_TLB           0x002 /* 00010B */
00147 #define P5_EX_TLB           0x00d /* 01101B */
00148
00149 #define P5_A_STALL          0x01f /* 11111B */
00150 #define P5_W_STALL          0x019 /* 11001B */
00151 #define P5_R_STALL          0x01a /* 11010B */
00152 #define P5_X_STALL          0x01b /* 11011B */
00153
00154 #define P5_AGI_STALL        0x01f /* 11111B */
00155
00156 #define P5_PIPLINE_FLUSH    0x015 /* 10101B */
00157
00158 #define P5_NON_CACHE_RD     0x01e /* 11110B */
00159 #define P5_NCACHE_REFS      0x01e /* 11110B */
00160 #define P5_LOCKED_BUS       0x01c /* 11100B */
00161
00162 #define P5_MEM2PIPE         0x009 /* 01001B */
00163 #define P5_BANK_CONF        0x00a /* 01010B */
00164
00165
00166 #define P5_INSTRS_EX        0x016 /* 10110B */
00167 #define P5_INSTRS_EX_V      0x017 /* 10111B */
00168
00169
00170 #define P5_CNT_NOTHING      (0x00 « 6) /* 00B « 6 */
00171 #define P5_CNT_EVENT_PL0    (0x01 « 6) /* 01B « 6 */
00172 #define P5_CNT_EVENT_PL3    (0x02 « 6) /* 10B « 6 */
00173 #define P5_CNT_EVENT        (0x03 « 6) /* 11B « 6 */
00174 #define P5_CNT_CLOCKS_PL0   (0x05 « 6) /* 101B « 6 */
00175 #define P5_CNT_CLOCKS_PL3   (0x06 « 6) /* 110B « 6 */
00176 #define P5_CNT_CLOCKS       (0x07 « 6) /* 111B « 6 */
00177
00178
00179 #else
00180 #if defined CPU_P6
00181 /* PPro/PII/PIII section */
00182
00183 /*-
00184  * Copyright (c) 1997 The President and Fellows of Harvard College.
00185  * All rights reserved.
00186  * Copyright (c) 1997 Aaron B. Brown.
00187  *
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00190  * are met:
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00192  *    notice, this list of conditions and the following disclaimer.
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00194  *    notice, this list of conditions and the following disclaimer in the
00195  *    documentation and/or other materials provided with the distribution.
00196  * 3. All advertising materials mentioning features or use of this software
00197  *    must display the following acknowledgement:
00198  *      This product includes software developed by Harvard University
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00200  * 4. Neither the name of the University nor the names of its contributors
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00203  *
00204  * THIS SOFTWARE IS PROVIDED BY HARVARD AND CONTRIBUTORS ``AS IS'' AND
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00208  * LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR
00209  * CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF
00210  * SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS
00211  * INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN
00212  * CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE)
00213  * ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE
00214  * POSSIBILITY OF SUCH DAMAGE.
00215  */
00216
00217 /************************************************************************
00218  ** Symbolic names for counter numbers (used in select_p6counter()) **
00219  ************************************************************************
00220  *
00221  * These correspond in order to the Pentium Pro counters. Add new counters at
00222  * the end. These agree with the mneumonics in the Pentium Pro Family
00223  * Developer's Manual, vol 3.
00224  *
00225  * Those events marked with a $ require a MESI unit field; those marked with
00226  * a @ require a self/any unit field. Those marked with a 0 are only supported
00227  * in counter 0; those marked with 1 are only supported in counter 1.
00228  */
00229
00230 /* Data cache unit */
00231 #define P6_DATA_MEM_REFS  0x43  /* total memory refs */
00232 #define P6_DCU_LINES_IN   0x45  /* all lines allocated in cache unit */
00233 #define P6_DCU_M_LINES_IN 0x46  /* M lines allocated in cache unit */
00234 #define P6_DCU_M_LINES_OUT  0x47  /* M lines evicted from cache */
00235 #define P6_DCU_MISS_OUTSTANDING 0x48  /* #cycles a miss is outstanding */
00236
00237 /* Instruction fetch unit */
00238 #define P6_IFU_IFETCH   0x80  /* instruction fetches */
00239 #define P6_IFU_IFETCH_MISS  0x81  /* instruction fetch misses */
00240 #define P6_ITLB_MISS    0x85  /* ITLB misses */
00241 #define P6_IFU_MEM_STALL  0x86  /* number of cycles IFU is stalled */
00242 #define P6_ILD_STALL    0x87  /* #stalls in instr length decode */
00243
00244 /* L2 Cache */
00245 #define P6_L2_IFETCH    0x28  /* ($) l2 ifetches */
00246 #define P6_L2_LD    0x29  /* ($) l2 data loads */
00247 #define P6_L2_ST    0x2a  /* ($) l2 data stores */
00248 #define P6_L2_LINES_IN    0x24  /* lines allocated in l2 */
00249 #define P6_L2_LINES_OUT   0x26  /* lines removed from l2 */
00250 #define P6_L2_M_LINES_INM 0x25  /* modified lines allocated in L2 */
00251 #define P6_L2_M_LINES_OUTM  0x27  /* modified lines removed from L2 */
00252 #define P6_L2_RQSTS   0x2e  /* ($) number of l2 requests */
00253 #define P6_L2_ADS   0x21  /* number of l2 addr strobes */
00254 #define P6_L2_DBUS_BUSY   0x22  /* number of data bus busy cycles */
00255 #define P6_L2_DBUS_BUSY_RD  0x23  /* #bus cycles xferring l2->cpu */
00256
00257 /* External bus logic */
00258 #define P6_BUS_DRDY_CLOCKS  0x62  /* (@) #clocks DRDY is asserted */
00259 #define P6_BUS_LOCK_CLOCKS  0x63  /* (@) #clocks LOCK is asserted */
00260 #define P6_BUS_REQ_OUTSTANDING  0x60  /* #bus requests outstanding */
00261 #define P6_BUS_TRAN_BRD   0x65  /* (@) bus burst read txns */
00262 #define P6_BUS_TRAN_RFO   0x66  /* (@) bus read for ownership txns */
00263 #define P6_BUS_TRAN_WB    0x67  /* (@) bus writeback txns */
00264 #define P6_BUS_TRAN_IFETCH  0x68  /* (@) bus instr fetch txns */
00265 #define P6_BUS_TRAN_INVAL 0x69  /* (@) bus invalidate txns */
00266 #define P6_BUS_TRAN_PWR   0x6a  /* (@) bus partial write txns */
00267 #define P6_BUS_TRANS_P    0x6b  /* (@) bus partial txns */
00268 #define P6_BUS_TRANS_IO   0x6c  /* (@) bus I/O txns */
00269 #define P6_BUS_TRAN_DEF   0x6d  /* (@) bus deferred txns */
00270 #define P6_BUS_TRAN_BURST 0x6e  /* (@) bus burst txns */
00271 #define P6_BUS_TRAN_ANY   0x70  /* (@) total bus txns */
00272 #define P6_BUS_TRAN_MEM   0x6f  /* (@) total memory txns */
00273 #define P6_BUS_DATA_RCV   0x64  /* #busclocks CPU is receiving data */
00274 #define P6_BUS_BNR_DRV    0x61  /* #busclocks CPU is driving BNR pin */
00275 #define P6_BUS_HIT_DRV    0x7a  /* #busclocks CPU is driving HIT pin */
00276 #define P6_BUS_HITM_DRV   0x7b  /* #busclocks CPU is driving HITM pin*/
00277 #define P6_BUS_SNOOP_STALL  0x7e  /* #clkcycles bus is snoop-stalled */
00278
00279 /* FPU */
00280 #define P6_FLOPS          0xc1  /* (0) number of FP ops retired */
00281 #define P6_FP_COMP_OPS    0x10  /* (0) computational FPOPS exec'd */
00282 #define P6_FP_ASSIST    0x11  /* (1) FP excep's handled in ucode */
00283 #define P6_MUL      0x12  /* (1) number of FP multiplies */
00284 #define P6_DIV      0x13  /* (1) number of FP divides */
00285 #define P6_CYCLES_DIV_BUSY  0x14  /* (0) number of cycles divider busy */
00286
00287 /* Memory ordering */
00288 #define P6_LD_BLOCKS    0x03  /* number of store buffer blocks */
00289 #define P6_SB_DRAINS    0x04  /* # of store buffer drain cycles */
00290 #define P6_MISALING_MEM_REF 0x05  /* # misaligned data memory refs */
00291
```

```
00292 /* Instruction decoding and retirement */
00293 #define P6_INST_RETIRED   0xc0  /* number of instrs retired */
00294 #define P6_UOPS_RETIRED   0xc2  /* number of micro-ops retired */
00295 #define P6_INST_DECODER   0xd0  /* number of instructions decoded */
00296
00297 /* Interrupts */
00298 #define P6_HW_INT_RX    0xc8  /* number of hardware interrupts */
00299 #define P6_CYCLES_INT_MASKED  0xc6  /* number of cycles hardints masked */
00300 #define P6_CYCLES_INT_PENDING_AND_MASKED 0xc7 /* #cycles masked but pending */
00301
00302 /* Branches */
00303 #define P6_BR_INST_RETIRED  0xc4  /* number of branch instrs retired */
00304 #define P6_BR_MISS_PRED_RETIRED 0xc5  /* number of mispred'd brs retired */
00305 #define P6_BR_TAKEN_RETIRED 0xc9  /* number of taken branches retired */
00306 #define P6_BR_MISS_PRED_TAKEN_RET 0xca  /* #taken mispredictions br's retired*/
00307 #define P6_BR_INST_DECODED      0xe0  /* number of branch instrs decoded */
00308 #define P6_BTB_MISSES   0xe2  /* # of branches that missed in BTB */
00309 #define P6_BR_BOGUS   0xe4  /* number of bogus branches */
00310 #define P6_BACLEARS   0xe6  /* # times BACLEAR is asserted */
00311
00312 /* Stalls */
00313 #define P6_RESOURCE_STALLS  0xa2  /* # resource-related stall cycles */
00314 #define P6_PARTIAL_RAT_STALLS 0xd2  /* # cycles/events for partial stalls*/
00315
00316 /* Segment register loads */
00317 #define P6_SEGMENT_REG_LOADS  0x06  /* number of segment register loads */
00318
00319 /* Clocks */
00320 #define P6_CPU_CLK_UNHALTED 0x79  /* #clocks CPU is not halted */
00321
00322 /* Unit field tags */
00323 #define P6_UNIT_M   0x0800
00324 #define P6_UNIT_E   0x0400
00325 #define P6_UNIT_S   0x0200
00326 #define P6_UNIT_I   0x0100
00327 #define P6_UNIT_MESI    0x0f00
00328
00329 #define P6_UNIT_SELF    0x0000
00330 #define P6_UNIT_ANY   0x2000
00331
00332 /*********************************************************************
00333  ** Flag bit definitions (used for the 'flag' field in select_p6counter()) **
00334  *********************************************************************
00335  *
00336  * The driver accepts fully-formed counter specifications from user-level.
00337  * The following flags are mneumonics for the bits that get set in the
00338  * PerfEvtSel0 and PerfEvtSel1 MSR's
00339  *
00340  */
00341 #define P6CNT_U  0x010000 /* Monitor user-level events */
00342 #define P6CNT_K  0x020000 /* Monitor kernel-level events */
00343 #define P6CNT_E  0x040000 /* Edge detect: count state transitions */
00344 #define P6CNT_PC 0x080000 /* Pin control: ?? */
00345 #define P6CNT_IE 0x100000 /* Int enable: enable interrupt on overflow */
00346 #define P6CNT_F  0x200000 /* Freeze counter (handled in software) */
00347 #define P6CNT_EN 0x400000 /* enable counters (in PerfEvtSel0) */
00348 #define P6CNT_IV 0x800000 /* Invert counter mask comparison result */
00349
00350 /*****************************
00351  ** Miscellaneous constants **
00352  *****************************
00353  *
00354  * Number of Pentium Pro programable hardware counters.
00355  */
00356 #define NUM_P6HWC 2
00357
00358 /*********************************************************************************
00359 *
00360 * End of Copyright by Harvard College
00361 *
00362 *********************************************************************************/
00363
00364
00365 #define MSR_P6_EVNTSEL0 0x186
00366 #define MSR_P6_EVNTSEL1 0x187
00367 #define MSR_P6_PERFCTR0 0xc1
00368 #define MSR_P6_PERFCTR1 0xc2
00369
00370 /* P6-specific Makros to manipulate and read counters */
00371
00372 /* Read the 40 bit performance monitoring counter. This requires
00373    the PCE-flag in CR4 to be set. Otherwise GP0 is raised. Works only
00374    at P6.
00375    */
00376 #define l4_i686_rdpmc(cntr, res_p) \
00377   __asm __volatile(           \
00378    "movl %2, %%ecx  # put counter number in   \n\
```

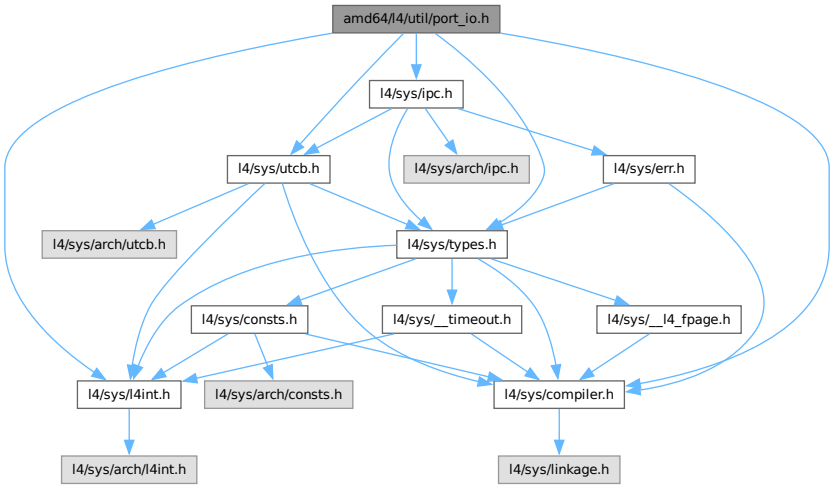
```
00379    .byte 0xf; .byte 0x33  # RDPMC instruction   \n\
00380          movl %%edx, %1   # High order 32 bits    \n\
00381          movl %%eax, %0   # Low order 32 bits"    \
00382   : "=g" (*(int *)(res_p)), "=g" (*(((int *)res_p)+1))  \
00383   : "g" (cntr)            \
00384   : "ecx", "eax", "edx")
00385
00386 static inline l4_uint32_t l4_i686_rdpmc_32(int cntr){
00387   l4_uint32_t x;
00388
00389   __asm__ __volatile__(
00390    ".byte 0xf; .byte 0x33 # RDPMC instruction"
00391   : "=a" (x)
00392   : "c" (cntr)
00393   : "ecx", "eax", "edx");
00394   return x;
00395 }
00396
00397 static inline void l4_i686_select_perfctr_event(int counter,
00398                                                 unsigned long long val){
00399   l4_i586_wrmsr(MSR_P6_EVNTSEL0+counter, &val);
00400 }
00401
00402 static inline void l4_i686_select_perfctr0_event(long long *val){
00403   asm volatile(
00404                "movl $MSR_P6_EVNTSEL0, %%ecx\n"
00405                "movl (%%ebx), %%eax\n"
00406                "movl 4(%%ebx), %%edx\n"
00407                //".byte 0xcc, 0xeb, 0x01, 0x21\n"
00408                ".byte 0x0f, 0x30\n" // wrmsr
00409                //".byte 0xcc, 0xeb, 0x01, 0x21\n"
00410                : /* no output */
00411                : "b" (val)
00412                : "ax", "cx", "dx", "bx"
00413                );
00414
00415 }
00416
00417 /* end of P6 section */
00418 #else
00419
00420 #define K7CNT_U  0x010000 /* Monitor user-level events */
00421 #define K7CNT_K  0x020000 /* Monitor kernel-level events */
00422 #define K7CNT_E  0x040000 /* Edge detect: count state transitions */
00423 #define K7CNT_PC 0x080000 /* Pin control: ?? */
00424 #define K7CNT_IE 0x100000 /* Int enable: enable interrupt on overflow */
00425 #define K7CNT_F  0x200000 /* Freeze counter (handled in software) */
00426 #define K7CNT_EN 0x400000 /* enable counters (in PerfEvtSel0) */
00427 #define K7CNT_IV 0x800000 /* Invert counter mask comparison result */
00428
00429 #define MSR_K7_EVNTSEL0 0xC0010000
00430 #define MSR_K7_EVNTSEL1 0xC0010001
00431 #define MSR_K7_EVNTSEL2 0xC0010002
00432 #define MSR_K7_EVNTSEL3 0xC0010003
00433 #define MSR_K7_PERFCTR0 0xC0010004
00434 #define MSR_K7_PERFCTR1 0xC0010005
00435 #define MSR_K7_PERFCTR2 0xC0010006
00436 #define MSR_K7_PERFCTR3 0xC0010007
00437
00438 #endif
00439
00440 #endif
00441
00442 /* end of P5/P6/K7 section*/
00443 #endif
00444
00445 /* end of not only lib-prototypes section */
00446 #endif
00447
00448 L4_END_DECLS
00449
00450 #endif
```

16.80 amd64/l4/util/port_io.h File Reference

x86 port I/O

```
#include <l4/sys/l4int.h>
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for port_io.h:



Functions

- l4_uint8_t l4util_in8 (l4_uint16_t port)

  Read byte from I/O port.
- l4_uint16_t l4util_in16 (l4_uint16_t port)

  Read 16-bit-value from I/O port.
- l4_uint32_t l4util_in32 (l4_uint16_t port)

  Read 32-bit-value from I/O port.
- void l4util_ins8 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Read a block of 8-bit-values from I/O ports.
- void l4util_ins16 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Read a block of 16-bit-values from I/O ports.
- void l4util_ins32 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Read a block of 32-bit-values from I/O ports.
- void l4util_out8 (l4_uint8_t value, l4_uint16_t port)

  Write byte to I/O port.
- void l4util_out16 (l4_uint16_t value, l4_uint16_t port)

  Write 16-bit-value to I/O port.
- void l4util_out32 (l4_uint32_t value, l4_uint16_t port)

  Write 32-bit-value to I/O port.
- void l4util_outs8 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write a block of bytes to I/O port.
- void l4util_outs16 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write a block of 16-bit-values to I/O port.
- void l4util_outs32 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write block of 32-bit-values to I/O port.
- void **l4util_iodelay** (void)

  delay I/O port access by writing to port 0x80
- int l4util_ioport_map (l4_cap_idx_t sigma0id, unsigned port_start, unsigned log2size)

  Map a range of I/O ports.

16.80.1 Detailed Description

x86 port I/O

Date

06/2003

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file port_io.h.

16.81 port_io.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00009 /*****************************************************************************/
00010
00011 /*
00012  * (c) 2003-2009 Author(s)
00013  *     economic rights: Technische Universität Dresden (Germany)
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016
00017 #ifndef _L4UTIL_PORT_IO_H
00018 #define _L4UTIL_PORT_IO_H
00019
00024
00025 /* L4 includes */
00026 #include <l4/sys/l4int.h>
00027 #include <l4/sys/compiler.h>
00028 #include <l4/sys/types.h>
00029
00030 /*****************************************************************************
00031  *** Prototypes
00032  *****************************************************************************/
00033
00034 L4_BEGIN_DECLS
00045 L4_INLINE l4_uint8_t
00046 l4util_in8(l4_uint16_t port);
00047
00054 L4_INLINE l4_uint16_t
00055 l4util_in16(l4_uint16_t port);
00056
00063 L4_INLINE l4_uint32_t
00064 l4util_in32(l4_uint16_t port);
00065
00073 L4_INLINE void
00074 l4util_ins8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00075
00083 L4_INLINE void
00084 l4util_ins16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00085
00093 L4_INLINE void
00094 l4util_ins32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00095
00102 L4_INLINE void
00103 l4util_out8(l4_uint8_t value, l4_uint16_t port);
00104
00111 L4_INLINE void
00112 l4util_out16(l4_uint16_t value, l4_uint16_t port);
00113
00120 L4_INLINE void
00121 l4util_out32(l4_uint32_t value, l4_uint16_t port);
00122
00130 L4_INLINE void
00131 l4util_outs8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00132
00140 L4_INLINE void
00141 l4util_outs16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00142
00150 L4_INLINE void
00151 l4util_outs32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00152
00156 L4_INLINE void
00157 l4util_iodelay(void);
00158
00170 L4_INLINE int
00171 l4util_ioport_map(l4_cap_idx_t sigma0id,
```

```
00172                   unsigned port_start, unsigned log2size);
00173
00175
00176 L4_END_DECLS
00177
00178
00179 /*****************************************************************************
00180  *** Implementation
00181  *****************************************************************************/
00182
00183 #include <l4/sys/utcb.h>
00184 #include <l4/sys/ipc.h>
00185
00186 L4_INLINE l4_uint8_t
00187 l4util_in8(l4_uint16_t port)
00188 {
00189   l4_uint8_t value;
00190   asm volatile ("inb %w1, %b0" : "=a" (value) : "Nd" (port));
00191   return value;
00192 }
00193
00194 L4_INLINE l4_uint16_t
00195 l4util_in16(l4_uint16_t port)
00196 {
00197   l4_uint16_t value;
00198   asm volatile ("inw %w1, %w0" : "=a" (value) : "Nd" (port));
00199   return value;
00200 }
00201
00202 L4_INLINE l4_uint32_t
00203 l4util_in32(l4_uint16_t port)
00204 {
00205   l4_uint32_t value;
00206   asm volatile ("inl %w1, %0" : "=a" (value) : "Nd" (port));
00207   return value;
00208 }
00209
00210 L4_INLINE void
00211 l4util_ins8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00212 {
00213   l4_umword_t dummy1, dummy2;
00214   asm volatile ("rep insb" : "=D"(dummy1), "=c"(dummy2)
00215         : "d" (port), "D" (addr), "c"(count)
00216         : "memory");
00217 }
00218
00219 L4_INLINE void
00220 l4util_ins16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00221 {
00222   l4_umword_t dummy1, dummy2;
00223   asm volatile ("rep insw" : "=D"(dummy1), "=c"(dummy2)
00224         : "d" (port), "D" (addr), "c"(count)
00225         : "memory");
00226 }
00227
00228 L4_INLINE void
00229 l4util_ins32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00230 {
00231   l4_umword_t dummy1, dummy2;
00232   asm volatile ("rep insl" : "=D"(dummy1), "=c"(dummy2)
00233         : "d" (port), "D" (addr), "c"(count)
00234         : "memory");
00235 }
00236
00237 L4_INLINE void
00238 l4util_out8(l4_uint8_t value, l4_uint16_t port)
00239 {
00240   asm volatile ("outb %b0, %w1" : : "a" (value), "Nd" (port));
00241 }
00242
00243 L4_INLINE void
00244 l4util_out16(l4_uint16_t value, l4_uint16_t port)
00245 {
00246   asm volatile ("outw %w0, %w1" : : "a" (value), "Nd" (port));
00247 }
00248
00249 L4_INLINE void
00250 l4util_out32(l4_uint32_t value, l4_uint16_t port)
00251 {
00252   asm volatile ("outl %0, %w1" : : "a" (value), "Nd" (port));
00253 }
00254
00255 L4_INLINE void
00256 l4util_outs8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00257 {
00258   l4_umword_t dummy1, dummy2;
00259   asm volatile ("rep outsb" : "=S"(dummy1), "=c"(dummy2)
```

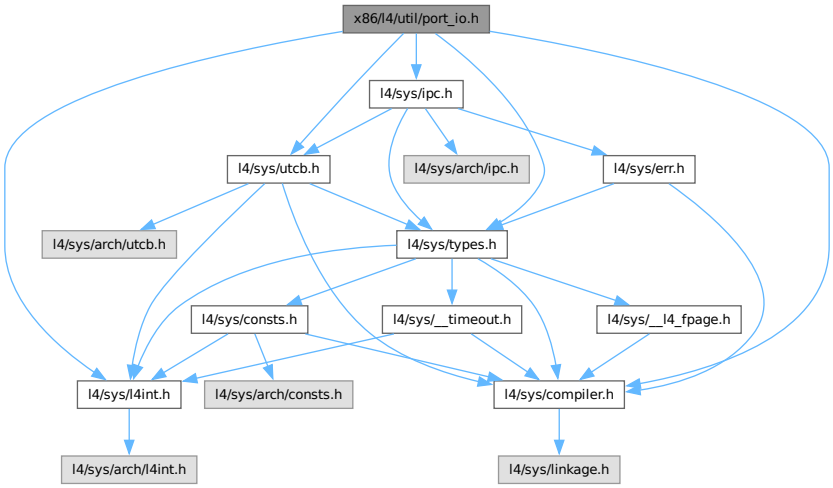
```
00260           : "d" (port), "S" (addr), "c"(count)
00261           : "memory");
00262 }
00263
00264 L4_INLINE void
00265 l4util_outs16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00266 {
00267   l4_umword_t dummy1, dummy2;
00268   asm volatile ("rep outsw" : "=S"(dummy1), "=c"(dummy2)
00269           : "d" (port), "S" (addr), "c"(count)
00270           : "memory");
00271 }
00272
00273 L4_INLINE void
00274 l4util_outs32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00275 {
00276   l4_umword_t dummy1, dummy2;
00277   asm volatile ("rep outsl" : "=S"(dummy1), "=c"(dummy2)
00278           : "d" (port), "S" (addr), "c"(count)
00279           : "memory");
00280 }
00281
00282 L4_INLINE void
00283 l4util_iodelay(void)
00284 {
00285   asm volatile ("outb %al,$0x80");
00286 }
00287
00288 L4_INLINE int
00289 l4util_ioport_map(l4_cap_idx_t sigma0id,
00290                   unsigned port_start, unsigned log2size)
00291 {
00292   l4_fpage_t iofp;
00293   l4_msgtag_t tag;
00294   long err;
00295
00296   iofp = l4_iofpage(port_start, log2size);
00297   l4_utcb_mr()->mr[0] = iofp.raw;
00298   l4_utcb_br()->bdr   = 0;
00299   l4_utcb_br()->br[0] = L4_ITEM_MAP;
00300   l4_utcb_br()->br[1] = iofp.raw;
00301   tag = l4_ipc_call(sigma0id, l4_utcb(),
00302               l4_msgtag(L4_PROTO_IO_PAGE_FAULT, 1, 0, 0),
00303                     L4_IPC_NEVER);
00304
00305   if ((err = l4_ipc_error(tag, l4_utcb())))
00306     return err;
00307
00308   return l4_msgtag_items(tag) > 0 ? 0 : -L4_ENOENT;
00309 }
00310
00311 #endif
```

16.82 x86/l4/util/port_io.h File Reference

x86 port I/O

```
#include <l4/sys/l4int.h>
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for port_io.h:



Functions

- l4_uint8_t l4util_in8 (l4_uint16_t port)

  Read byte from I/O port.
- l4_uint16_t l4util_in16 (l4_uint16_t port)

  Read 16-bit-value from I/O port.
- l4_uint32_t l4util_in32 (l4_uint16_t port)

  Read 32-bit-value from I/O port.
- void l4util_ins8 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Read a block of 8-bit-values from I/O ports.
- void l4util_ins16 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Read a block of 16-bit-values from I/O ports.
- void l4util_ins32 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Read a block of 32-bit-values from I/O ports.
- void l4util_out8 (l4_uint8_t value, l4_uint16_t port)

  Write byte to I/O port.
- void l4util_out16 (l4_uint16_t value, l4_uint16_t port)

  Write 16-bit-value to I/O port.
- void l4util_out32 (l4_uint32_t value, l4_uint16_t port)

  Write 32-bit-value to I/O port.
- void l4util_outs8 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write a block of bytes to I/O port.
- void l4util_outs16 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write a block of 16-bit-values to I/O port.
- void l4util_outs32 (l4_uint16_t port, l4_umword_t addr, l4_umword_t count)

  Write block of 32-bit-values to I/O port.
- void **l4util_iodelay** (void)

  delay I/O port access by writing to port 0x80
- int l4util_ioport_map (l4_cap_idx_t sigma0id, unsigned port_start, unsigned log2size)

  Map a range of I/O ports.

16.82.1 Detailed Description

x86 port I/O

Date

06/2003

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file port_io.h.

16.83 port_io.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00009 /*****************************************************************************/
00010
00011 /*
00012  * (c) 2003-2009 Author(s)
00013  *     economic rights: Technische Universität Dresden (Germany)
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016
00017 #ifndef _L4UTIL_PORT_IO_H
00018 #define _L4UTIL_PORT_IO_H
00019
00024
00025 /* L4 includes */
00026 #include <l4/sys/l4int.h>
00027 #include <l4/sys/compiler.h>
00028 #include <l4/sys/types.h>
00029
00030 /*****************************************************************************
00031  *** Prototypes
00032  *****************************************************************************/
00033
00034 L4_BEGIN_DECLS
00045 L4_INLINE l4_uint8_t
00046 l4util_in8(l4_uint16_t port);
00047
00054 L4_INLINE l4_uint16_t
00055 l4util_in16(l4_uint16_t port);
00056
00063 L4_INLINE l4_uint32_t
00064 l4util_in32(l4_uint16_t port);
00065
00073 L4_INLINE void
00074 l4util_ins8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00075
00083 L4_INLINE void
00084 l4util_ins16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00085
00093 L4_INLINE void
00094 l4util_ins32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00095
00102 L4_INLINE void
00103 l4util_out8(l4_uint8_t value, l4_uint16_t port);
00104
00111 L4_INLINE void
00112 l4util_out16(l4_uint16_t value, l4_uint16_t port);
00113
00120 L4_INLINE void
00121 l4util_out32(l4_uint32_t value, l4_uint16_t port);
00122
00130 L4_INLINE void
00131 l4util_outs8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00132
00140 L4_INLINE void
00141 l4util_outs16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00142
00150 L4_INLINE void
00151 l4util_outs32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count);
00152
00156 L4_INLINE void
00157 l4util_iodelay(void);
00158
00170 L4_INLINE int
00171 l4util_ioport_map(l4_cap_idx_t sigma0id,
```

```
00172                   unsigned port_start, unsigned log2size);
00173
00175
00176 L4_END_DECLS
00177
00178
00179 /*****************************************************************************
00180  *** Implementation
00181  *****************************************************************************/
00182
00183 #include <l4/sys/utcb.h>
00184 #include <l4/sys/ipc.h>
00185
00186 L4_INLINE l4_uint8_t
00187 l4util_in8(l4_uint16_t port)
00188 {
00189   l4_uint8_t value;
00190   asm volatile ("inb %w1, %b0" : "=a" (value) : "Nd" (port));
00191   return value;
00192 }
00193
00194 L4_INLINE l4_uint16_t
00195 l4util_in16(l4_uint16_t port)
00196 {
00197   l4_uint16_t value;
00198   asm volatile ("inw %w1, %w0" : "=a" (value) : "Nd" (port));
00199   return value;
00200 }
00201
00202 L4_INLINE l4_uint32_t
00203 l4util_in32(l4_uint16_t port)
00204 {
00205   l4_uint32_t value;
00206   asm volatile ("inl %w1, %0" : "=a" (value) : "Nd" (port));
00207   return value;
00208 }
00209
00210 L4_INLINE void
00211 l4util_ins8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00212 {
00213   l4_umword_t dummy1, dummy2;
00214   asm volatile ("rep insb" : "=D"(dummy1), "=c"(dummy2)
00215         : "d" (port), "D" (addr), "c"(count)
00216         : "memory");
00217 }
00218
00219 L4_INLINE void
00220 l4util_ins16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00221 {
00222   l4_umword_t dummy1, dummy2;
00223   asm volatile ("rep insw" : "=D"(dummy1), "=c"(dummy2)
00224         : "d" (port), "D" (addr), "c"(count)
00225         : "memory");
00226 }
00227
00228 L4_INLINE void
00229 l4util_ins32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00230 {
00231   l4_umword_t dummy1, dummy2;
00232   asm volatile ("rep insl" : "=D"(dummy1), "=c"(dummy2)
00233         : "d" (port), "D" (addr), "c"(count)
00234         : "memory");
00235 }
00236
00237 L4_INLINE void
00238 l4util_out8(l4_uint8_t value, l4_uint16_t port)
00239 {
00240   asm volatile ("outb %b0, %w1" : : "a" (value), "Nd" (port));
00241 }
00242
00243 L4_INLINE void
00244 l4util_out16(l4_uint16_t value, l4_uint16_t port)
00245 {
00246   asm volatile ("outw %w0, %w1" : : "a" (value), "Nd" (port));
00247 }
00248
00249 L4_INLINE void
00250 l4util_out32(l4_uint32_t value, l4_uint16_t port)
00251 {
00252   asm volatile ("outl %0, %w1" : : "a" (value), "Nd" (port));
00253 }
00254
00255 L4_INLINE void
00256 l4util_outs8(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00257 {
00258   l4_umword_t dummy1, dummy2;
00259   asm volatile ("rep outsb" : "=S"(dummy1), "=c"(dummy2)
```

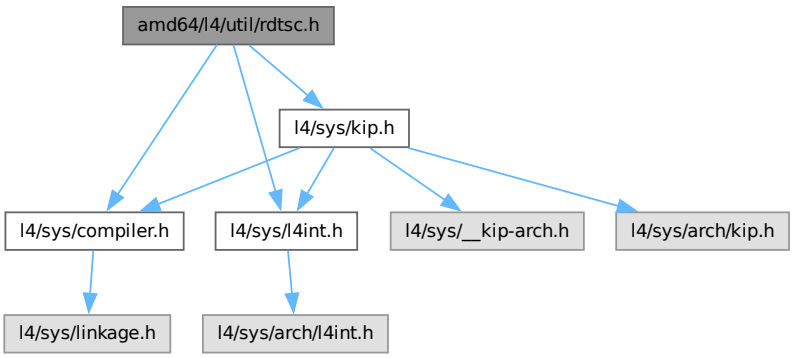
```
00260           : "d" (port), "S" (addr), "c"(count)
00261           : "memory");
00262 }
00263
00264 L4_INLINE void
00265 l4util_outs16(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00266 {
00267   l4_umword_t dummy1, dummy2;
00268   asm volatile ("rep outsw" : "=S"(dummy1), "=c"(dummy2)
00269           : "d" (port), "S" (addr), "c"(count)
00270           : "memory");
00271 }
00272
00273 L4_INLINE void
00274 l4util_outs32(l4_uint16_t port, l4_umword_t addr, l4_umword_t count)
00275 {
00276   l4_umword_t dummy1, dummy2;
00277   asm volatile ("rep outsl" : "=S"(dummy1), "=c"(dummy2)
00278           : "d" (port), "S" (addr), "c"(count)
00279           : "memory");
00280 }
00281
00282 L4_INLINE void
00283 l4util_iodelay(void)
00284 {
00285   asm volatile ("outb %al,$0x80");
00286 }
00287
00288 L4_INLINE int
00289 l4util_ioport_map(l4_cap_idx_t sigma0id,
00290                   unsigned port_start, unsigned log2size)
00291 {
00292   l4_fpage_t iofp;
00293   l4_msgtag_t tag;
00294   long err;
00295
00296   iofp = l4_iofpage(port_start, log2size);
00297   l4_utcb_mr()->mr[0] = iofp.raw;
00298   l4_utcb_br()->bdr   = 0;
00299   l4_utcb_br()->br[0] = L4_ITEM_MAP;
00300   l4_utcb_br()->br[1] = iofp.raw;
00301   tag = l4_ipc_call(sigma0id, l4_utcb(),
00302               l4_msgtag(L4_PROTO_IO_PAGE_FAULT, 1, 0, 0),
00303                     L4_IPC_NEVER);
00304
00305   if ((err = l4_ipc_error(tag, l4_utcb())))
00306     return err;
00307
00308   return l4_msgtag_items(tag) > 0 ? 0 : -L4_ENOENT;
00309 }
00310
00311 #endif
```

16.84 amd64/l4/util/rdtsc.h File Reference

Timestamp counter related functions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
#include <l4/sys/kip.h>
```

Include dependency graph for rdtsc.h:



Functions

- l4_cpu_time_t l4_rdtsc (void)
  Read current value of CPU-internal timestamp counter.
- l4_uint32_t l4_rdtsc_32 (void)
  Read the lest significant 32 bit of the TSC.
- l4_uint64_t l4_rdpmc (int ecx)
  Return current value of CPU-internal performance measurement counter.
- l4_uint32_t l4_rdpmc_32 (int ecx)
  Return the least significant 32 bit of a performance counter.
- l4_uint64_t l4_tsc_to_ns (l4_cpu_time_t tsc)
  Convert timestamp to ns value.
- l4_uint64_t l4_tsc_to_us (l4_cpu_time_t tsc)
  Convert timestamp into micro seconds value.
- void l4_tsc_to_s_and_ns (l4_cpu_time_t tsc, l4_uint32_t *s, l4_uint32_t *ns)
  Convert timestamp to s.ns value.
- l4_cpu_time_t l4_ns_to_tsc (l4_uint64_t ns)
  Convert nano seconds into CPU ticks.
- void l4_busy_wait_ns (l4_uint64_t ns)
  Wait busy for a small amount of time.
- void l4_busy_wait_us (l4_uint64_t us)
  Wait busy for a small amount of time.
- l4_uint32_t l4_calibrate_tsc (l4_kernel_info_t const *kip)
  Determine scalers for timestamp calculations.
- l4_uint32_t l4_tsc_init (l4_kernel_info_t const *kip)
  Initialize scaler for TSC calibrations from the kernel.
- l4_uint32_t l4_get_hz (void)
  Get CPU frequency in Hz.

16.84.1 Detailed Description

Timestamp counter related functions.

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file rdtsc.h.

16.85 rdtsc.h

Go to the documentation of this file.

```
00001
00008
00009 /*
00010  * (c) 2003-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00011  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00012  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00013  *     economic rights: Technische Universität Dresden (Germany)
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016
00017 #ifndef __l4_rdtsc_h
00018 #define __l4_rdtsc_h
00019
00024
00025 #include <l4/sys/compiler.h>
00026 #include <l4/sys/l4int.h>
00027 #include <l4/sys/kip.h>
00028
00029 L4_BEGIN_DECLS
00030
00031 /* interface */
00036
00037 extern l4_uint32_t l4_scaler_tsc_to_ns;
00038 extern l4_uint32_t l4_scaler_tsc_to_us;
00039 extern l4_uint32_t l4_scaler_ns_to_tsc;
00040 extern l4_uint32_t l4_scaler_tsc_linux;
00041
00046 L4_INLINE l4_cpu_time_t
00047 l4_rdtsc (void);
00048
00054 L4_INLINE
00055 l4_uint32_t l4_rdtsc_32(void);
00056
00063 L4_INLINE l4_uint64_t
00064 l4_rdpmc (int ecx);
00065
00071 L4_INLINE
00072 l4_uint32_t l4_rdpmc_32(int ecx);
00073
00078 L4_INLINE l4_uint64_t
00079 l4_tsc_to_ns (l4_cpu_time_t tsc);
00080
00085 L4_INLINE l4_uint64_t
00086 l4_tsc_to_us (l4_cpu_time_t tsc);
00087
00093 L4_INLINE void
00094 l4_tsc_to_s_and_ns (l4_cpu_time_t tsc, l4_uint32_t *s, l4_uint32_t *ns);
00095
00101 L4_INLINE l4_cpu_time_t
00102 l4_ns_to_tsc (l4_uint64_t ns);
00103
00109 L4_INLINE void
00110 l4_busy_wait_ns (l4_uint64_t ns);
00111
00117 L4_INLINE void
00118 l4_busy_wait_us (l4_uint64_t us);
00119
00126 L4_INLINE l4_uint32_t
00127 l4_calibrate_tsc(l4_kernel_info_t const *kip);
00128
00142 L4_CV l4_uint32_t
00143 l4_tsc_init(l4_kernel_info_t const *kip);
00144
00149 L4_CV l4_uint32_t
00150 l4_get_hz (void);
00151
00153
00154 L4_END_DECLS
00155
00156 /* implementation */
00157
00158 L4_INLINE l4_uint32_t
00159 l4_calibrate_tsc(l4_kernel_info_t const *kip)
00160 {
00161   return l4_tsc_init(kip);
00162 }
00163
00164 L4_INLINE l4_cpu_time_t
00165 l4_rdtsc (void)
00166 {
00167   l4_umword_t lo, hi;
00168
00169   __asm__ __volatile__ ("rdtsc" : "=a"(lo), "=d"(hi));
```

```
00170
00171   return ((l4_cpu_time_t)hi << 32) | lo;
00172 }
00173
00174 L4_INLINE l4_uint64_t
00175 l4_rdpmc (int ecx)
00176 {
00177   l4_umword_t lo, hi;
00178
00179   __asm__ __volatile__ ("rdpmc" : "=a"(lo), "=d"(hi) : "c"(ecx));
00180
00181   return ((l4_cpu_time_t)hi << 32) | lo;
00182 }
00183
00184 L4_INLINE
00185 l4_uint32_t l4_rdtsc_32(void)
00186 {
00187   l4_umword_t lo, hi;
00188
00189   __asm__ __volatile__ ("rdtsc" : "=a"(lo), "=d"(hi));
00190
00191   return lo;
00192 }
00193
00194 L4_INLINE
00195 l4_uint32_t l4_rdpmc_32(int ecx)
00196 {
00197   l4_umword_t lo, hi;
00198
00199   __asm__ __volatile__ ("rdpmc" : "=a"(lo), "=d"(hi) : "c"(ecx));
00200
00201   return lo;
00202 }
00203
00204 L4_INLINE l4_uint64_t
00205 l4_tsc_to_ns (l4_cpu_time_t tsc)
00206 {
00207     l4_uint64_t ns, dummy;
00208     __asm__
00209   ("        \n\t"
00210    "mulq  %3       \n\t"
00211          "shrd  $27, %%rdx, %%rax       \n\t"
00212   :"=a" (ns), "=d"(dummy)
00213   :"a" (tsc), "r" ((l4_uint64_t)l4_scaler_tsc_to_ns)
00214   );
00215     return ns;
00216 }
00217
00218 L4_INLINE l4_uint64_t
00219 l4_tsc_to_us (l4_cpu_time_t tsc)
00220 {
00221     l4_uint64_t ns, dummy;
00222     __asm__
00223   ("        \n\t"
00224    "mulq  %3       \n\t"
00225          "shrd  $32, %%rdx, %%rax       \n\t"
00226   :"=a" (ns), "=d" (dummy)
00227   :"a" (tsc), "r" ((l4_uint64_t)l4_scaler_tsc_to_us)
00228   );
00229     return ns;
00230 }
00231
00232 L4_INLINE void
00233 l4_tsc_to_s_and_ns (l4_cpu_time_t tsc, l4_uint32_t *s, l4_uint32_t *ns)
00234 {
00235     __asm__
00236   ("        \n\t"
00237    "mulq  %3       \n\t"
00238          "shrd  $27, %%rdx, %%rax       \n\t"
00239          "xorq  %%rdx, %%rdx            \n\t"
00240    "divq  %4       \n\t"
00241   :"=a" (*s), "=&d" (*ns)
00242   : "a" (tsc), "r" ((l4_uint64_t)l4_scaler_tsc_to_ns),
00243           "rm"(1000000000ULL)
00244   );
00245 }
00246
00247 L4_INLINE l4_cpu_time_t
00248 l4_ns_to_tsc (l4_uint64_t ns)
00249 {
00250     l4_uint64_t tsc, dummy;
00251     __asm__
00252         ("                              \n\t"
00253    "mulq  %3       \n\t"
00254          "shrd  $27, %%rdx, %%rax       \n\t"
00255   :"=a" (tsc), "=d" (dummy)
00256   :"a" (ns), "r" ((l4_uint64_t)l4_scaler_ns_to_tsc)
```

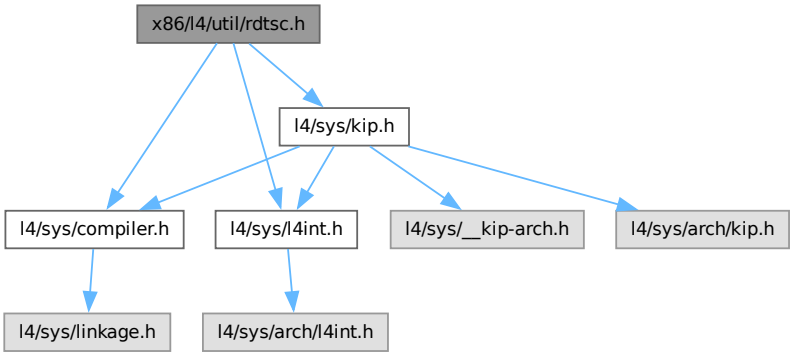
```
00257   );
00258     return tsc;
00259 }
00260
00261 L4_INLINE void
00262 l4_busy_wait_ns (l4_uint64_t ns)
00263 {
00264   l4_cpu_time_t stop = l4_rdtsc();
00265   stop += l4_ns_to_tsc(ns);
00266
00267   while (l4_rdtsc() < stop)
00268     ;
00269 }
00270
00271 L4_INLINE void
00272 l4_busy_wait_us (l4_uint64_t us)
00273 {
00274   l4_cpu_time_t stop = l4_rdtsc ();
00275   stop += l4_ns_to_tsc(us*1000ULL);
00276
00277   while (l4_rdtsc() < stop)
00278     ;
00279 }
00280
00281 #endif /* __l4_rdtsc_h */
00282
```

16.86 x86/l4/util/rdtsc.h File Reference

Timestamp counter related functions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
#include <l4/sys/kip.h>
```

Include dependency graph for rdtsc.h:



Functions

- l4_cpu_time_t l4_rdtsc (void)

  Read current value of CPU-internal timestamp counter.
- l4_uint32_t l4_rdtsc_32 (void)

  Read the lest significant 32 bit of the TSC.
- l4_uint64_t l4_rdpmc (int ecx)

  Return current value of CPU-internal performance measurement counter.
- l4_uint32_t l4_rdpmc_32 (int ecx)

  Return the least significant 32 bit of a performance counter.
- l4_uint64_t l4_tsc_to_ns (l4_cpu_time_t tsc)

  Convert timestamp to ns value.

- l4_uint64_t l4_tsc_to_us (l4_cpu_time_t tsc)

  Convert timestamp into micro seconds value.
- void l4_tsc_to_s_and_ns (l4_cpu_time_t tsc, l4_uint32_t *s, l4_uint32_t *ns)

  Convert timestamp to s.ns value.
- l4_cpu_time_t l4_ns_to_tsc (l4_uint64_t ns)

  Convert nano seconds into CPU ticks.
- void l4_busy_wait_ns (l4_uint64_t ns)

  Wait busy for a small amount of time.
- void l4_busy_wait_us (l4_uint64_t us)

  Wait busy for a small amount of time.
- l4_uint32_t l4_calibrate_tsc (l4_kernel_info_t const *kip)

  Determine scalers for timestamp calculations.
- l4_uint32_t l4_tsc_init (l4_kernel_info_t const *kip)

  Initialize scaler for TSC calibrations from the kernel.
- l4_uint32_t l4_get_hz (void)

  Get CPU frequency in Hz.

16.86.1 Detailed Description

Timestamp counter related functions.

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file rdtsc.h.

16.87 rdtsc.h

Go to the documentation of this file.

```
00001
00008
00009 /*
00010  * (c) 2003-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00011  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00012  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>,
00013  *               Jork Löser <jork@os.inf.tu-dresden.de>,
00014  *               Martin Pohlack <mp26@os.inf.tu-dresden.de>
00015  *     economic rights: Technische Universität Dresden (Germany)
00016  * License: see LICENSE.spdx (in this directory or the directories above)
00017  */
00018
00019 #ifndef __l4_rdtsc_h
00020 #define __l4_rdtsc_h
00021
00026
00027 #include <l4/sys/compiler.h>
00028 #include <l4/sys/l4int.h>
00029 #include <l4/sys/kip.h>
00030
00031 L4_BEGIN_DECLS
00032
00033 /* interface */
00038
00039 extern l4_uint32_t l4_scaler_tsc_to_ns;
00040 extern l4_uint32_t l4_scaler_tsc_to_us;
00041 extern l4_uint32_t l4_scaler_ns_to_tsc;
00042 extern l4_uint32_t l4_scaler_tsc_linux;
00043
00048 L4_INLINE l4_cpu_time_t
00049 l4_rdtsc (void);
00050
00056 L4_INLINE
00057 l4_uint32_t l4_rdtsc_32(void);
00058
00065 L4_INLINE l4_uint64_t
00066 l4_rdpmc (int ecx);
00067
00073 L4_INLINE
```

```
00074 l4_uint32_t l4_rdpmc_32(int ecx);
00075
00080 L4_INLINE l4_uint64_t
00081 l4_tsc_to_ns (l4_cpu_time_t tsc);
00082
00087 L4_INLINE l4_uint64_t
00088 l4_tsc_to_us (l4_cpu_time_t tsc);
00089
00095 L4_INLINE void
00096 l4_tsc_to_s_and_ns (l4_cpu_time_t tsc, l4_uint32_t *s, l4_uint32_t *ns);
00097
00103 L4_INLINE l4_cpu_time_t
00104 l4_ns_to_tsc (l4_uint64_t ns);
00105
00111 L4_INLINE void
00112 l4_busy_wait_ns (l4_uint64_t ns);
00113
00119 L4_INLINE void
00120 l4_busy_wait_us (l4_uint64_t us);
00121
00128 L4_INLINE l4_uint32_t
00129 l4_calibrate_tsc(l4_kernel_info_t const *kip);
00130
00144 L4_CV l4_uint32_t
00145 l4_tsc_init(l4_kernel_info_t const *kip);
00146
00151 L4_CV l4_uint32_t
00152 l4_get_hz (void);
00153
00155
00156 L4_END_DECLS
00157
00158 /* implementation */
00159
00160 L4_INLINE l4_uint32_t
00161 l4_calibrate_tsc(l4_kernel_info_t const *kip)
00162 {
00163   return l4_tsc_init(kip);
00164 }
00165
00166 L4_INLINE l4_cpu_time_t
00167 l4_rdtsc (void)
00168 {
00169     l4_cpu_time_t v;
00170
00171     __asm__ __volatile__
00172   ("        \n\t"
00173    ".byte 0x0f, 0x31    \n\t"
00174   /*"rdtsc\n\t"*/
00175   :
00176   "=A" (v)
00177   : /* no inputs */
00178   );
00179
00180     return v;
00181 }
00182
00183 /* the same, but only 32 bit. Useful for smaller differences,
00184    needs less cycles. */
00185 L4_INLINE
00186 l4_uint32_t l4_rdtsc_32(void)
00187 {
00188   l4_uint32_t x;
00189
00190   __asm__ __volatile__ (
00191        ".byte 0x0f, 0x31\n\t" // rdtsc
00192        : "=a" (x)
00193        :
00194        : "edx");
00195
00196   return x;
00197 }
00198
00199 L4_INLINE l4_uint64_t
00200 l4_rdpmc (int ecx)
00201 {
00202     l4_cpu_time_t v;
00203
00204     __asm__ __volatile__ (
00205    "rdpmc       \n\t"
00206   :
00207   "=A" (v)
00208   : "c" (ecx)
00209   );
00210
00211     return v;
00212 }
```

```
00213
00214 /* the same, but only 32 bit. Useful for smaller differences,
00215    needs less cycles. */
00216 L4_INLINE
00217 l4_uint32_t l4_rdpmc_32(int ecx)
00218 {
00219   l4_uint32_t x;
00220
00221   __asm__ __volatile__ (
00222        "rdpmc       \n\t"
00223        : "=a" (x)
00224        : "c" (ecx)
00225        : "edx");
00226
00227   return x;
00228 }
00229
00230 L4_INLINE l4_uint64_t
00231 l4_tsc_to_ns (l4_cpu_time_t tsc)
00232 {
00233     l4_uint32_t dummy;
00234     l4_uint64_t ns;
00235     __asm__
00236   ("         \n\t"
00237    "movl  %%edx, %%ecx    \n\t"
00238    "mull  %3      \n\t"
00239    "movl  %%ecx, %%eax    \n\t"
00240    "movl  %%edx, %%ecx    \n\t"
00241    "mull  %3      \n\t"
00242    "addl  %%ecx, %%eax    \n\t"
00243    "adcl  $0, %%edx   \n\t"
00244    "shld  $5, %%eax, %%edx  \n\t"
00245    "shll  $5, %%eax   \n\t"
00246   :"=A" (ns),
00247    "=&c" (dummy)
00248   :"0" (tsc),
00249    "g" (l4_scaler_tsc_to_ns)
00250   );
00251     return ns;
00252 }
00253
00254 L4_INLINE l4_uint64_t
00255 l4_tsc_to_us (l4_cpu_time_t tsc)
00256 {
00257     l4_uint32_t dummy;
00258     l4_uint64_t us;
00259     __asm__
00260   ("         \n\t"
00261    "movl  %%edx, %%ecx    \n\t"
00262    "mull  %3      \n\t"
00263    "movl  %%ecx, %%eax    \n\t"
00264    "movl  %%edx, %%ecx    \n\t"
00265    "mull  %3      \n\t"
00266    "addl  %%ecx, %%eax    \n\t"
00267    "adcl  $0, %%edx   \n\t"
00268   :"=A" (us),
00269    "=&c" (dummy)
00270   :"0" (tsc),
00271    "g" (l4_scaler_tsc_to_us)
00272   );
00273     return us;
00274 }
00275
00276 L4_INLINE void
00277 l4_tsc_to_s_and_ns (l4_cpu_time_t tsc, l4_uint32_t *s, l4_uint32_t *ns)
00278 {
00279     l4_uint32_t dummy;
00280     __asm__
00281   ("         \n\t"
00282    "movl  %%edx, %%ecx    \n\t"
00283    "mull  %4      \n\t"
00284    "movl  %%ecx, %%eax    \n\t"
00285    "movl  %%edx, %%ecx    \n\t"
00286    "mull  %4      \n\t"
00287    "addl  %%ecx, %%eax    \n\t"
00288    "adcl  $0, %%edx   \n\t"
00289    "movl  $1000000000, %%ecx  \n\t"
00290    "shld  $5, %%eax, %%edx  \n\t"
00291    "shll  $5, %%eax   \n\t"
00292    "divl  %%ecx     \n\t"
00293   :"=a" (*s), "=d" (*ns), "=&c" (dummy)
00294   : "A" (tsc), "g" (l4_scaler_tsc_to_ns)
00295   );
00296 }
00297
00298 L4_INLINE l4_cpu_time_t
00299 l4_ns_to_tsc (l4_uint64_t ns)
```

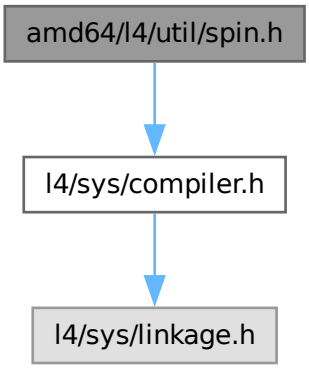
```
00300 {
00301     l4_uint32_t dummy;
00302     l4_cpu_time_t tsc;
00303     __asm__
00304   ("        \n\t"
00305    "movl  %%edx, %%ecx    \n\t"
00306    "mull  %3      \n\t"
00307    "movl  %%ecx, %%eax    \n\t"
00308    "movl  %%edx, %%ecx    \n\t"
00309    "mull  %3      \n\t"
00310    "addl  %%ecx, %%eax    \n\t"
00311    "adcl  $0, %%edx   \n\t"
00312    "shld  $5, %%eax, %%edx  \n\t"
00313    "shll  $5, %%eax   \n\t"
00314   :"=A" (tsc),
00315    "=&c" (dummy)
00316   :"0" (ns),
00317    "g" (l4_scaler_ns_to_tsc)
00318   );
00319     return tsc;
00320 }
00321
00322 L4_INLINE void
00323 l4_busy_wait_ns (l4_uint64_t ns)
00324 {
00325   l4_cpu_time_t stop = l4_rdtsc();
00326   stop += l4_ns_to_tsc(ns);
00327
00328   while (l4_rdtsc() < stop)
00329     ;
00330 }
00331
00332 L4_INLINE void
00333 l4_busy_wait_us (l4_uint64_t us)
00334 {
00335   l4_cpu_time_t stop = l4_rdtsc ();
00336   stop += l4_ns_to_tsc(us*1000ULL);
00337
00338   while (l4_rdtsc() < stop)
00339     ;
00340 }
00341
00342 #endif /* __l4_rdtsc_h */
00343
```

16.88 amd64/l4/util/spin.h File Reference

Spinning for amd64.

`#include <l4/sys/compiler.h>`

Include dependency graph for spin.h:



16.88.1 Detailed Description

Spinning for amd64.
Definition in file spin.h.

16.89 spin.h

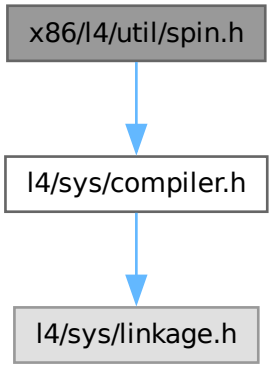
Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #ifndef __l4util_spin_h
00012 #define __l4util_spin_h
00013
00014 #include <l4/sys/compiler.h>
00015
00016 L4_BEGIN_DECLS
00017
00018 L4_CV void l4_spin(int x,int y);
00019 L4_CV void l4_spin_vga(int x,int y);
00020 L4_CV void l4_spin_n_text(int x, int y, int len, const char*s);
00021 L4_CV void l4_spin_n_text_vga(int x, int y, int len, const char*s);
00022
00023 /*****************************************************************************
00024 *                                                                           *
00025 * spin_text()     - spinning wheel at the hercules screen. The given text   *
00026 *                   must be a text constant, no variables or arrays. Its    *
00027 *                   size is determined with the sizeof operator, it's much  *
00028 *                   faster than the strlen function.                        *
00029 * spin_text_vga() - same for vga.                                           *
00030 *                                                                           *
00031 *****************************************************************************/
00032 #define l4_spin_text(x, y, text) \
00033   l4_spin_n_text((x), (y), sizeof(text)-1, "" text)
00034 #define l4_spin_text_vga(x, y, text) \
00035   l4_spin_n_text_vga((x), (y), sizeof(text)-1, "" text)
00036
00037 L4_END_DECLS
00038
00039 #endif
```

16.90 x86/l4/util/spin.h File Reference

Spinning for x86.

`#include <l4/sys/compiler.h>`
Include dependency graph for spin.h:



16.90.1 Detailed Description

Spinning for x86.
Definition in file spin.h.

16.91 spin.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #ifndef __l4util_spin_h
00012 #define __l4util_spin_h
00013
00014 #include <l4/sys/compiler.h>
00015
00016 L4_BEGIN_DECLS
00017
00018 L4_CV void l4_spin(int x,int y);
00019 L4_CV void l4_spin_vga(int x,int y);
00020 L4_CV void l4_spin_n_text(int x, int y, int len, const char*s);
00021 L4_CV void l4_spin_n_text_vga(int x, int y, int len, const char*s);
00022
00023 /*****************************************************************************
00024 *                                                                           *
00025 * spin_text()     - spinning wheel at the hercules screen. The given text   *
00026 *                   must be a text constant, no variables or arrays. Its    *
00027 *                   size is determined with the sizeof operator, it's much  *
00028 *                   faster than the strlen function.                        *
00029 * spin_text_vga() - same for vga.                                           *
00030 *                                                                           *
00031 *****************************************************************************/
00032 #define l4_spin_text(x, y, text) \
00033   l4_spin_n_text((x), (y), sizeof(text)-1, "" text)
00034 #define l4_spin_text_vga(x, y, text) \
00035   l4_spin_n_text_vga((x), (y), sizeof(text)-1, "" text)
00036
00037 L4_END_DECLS
00038
00039 #endif
```

16.92 __kip-arch.h

```
00001 /*
00002  * (c) 2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 struct l4_kip_platform_info_arch
00010 {};
```

16.93 __kip-arch.h

```
00001 /*
00002  * (c) 2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00014 struct l4_kip_platform_info_arch
00015 {
00016   struct
00017   {
00018     l4_uint32_t MIDR, CTR, TCMTR, TLBTR, MPIDR, REVIDR;
00019     l4_uint32_t ID_PFR[2], ID_DFR0, ID_AFR0, ID_MMFR[4], ID_ISAR[6];
00020   } cpuinfo;
00021 };
```

16.94 __kip-arch.h

```
00001 /*
00002  * (c) 2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00014 struct l4_kip_platform_info_arch
00015 {
00016   struct
00017   {
00018     l4_uint64_t MIDR, MPIDR, REVIDR;
00019     l4_uint64_t ID_PFR[3], ID_DFR0, ID_AFR0, ID_MMFR[4], ID_ISAR[7], ID_MVFR[3];
00020     l4_uint64_t ID_AA64DFR[2], ID_AA64ISAR[3], ID_AA64MMFR[3], ID_AA64PFR[2];
00021   } cpuinfo;
00022 };
```

16.95 __kip-arch.h

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 struct l4_kip_platform_info_arch
00010 {
00011   l4_uint32_t isa_ext[7];
00012   l4_uint32_t timebase_frequency;
00013   l4_uint32_t hart_num;
00014   l4_uint32_t hart_ids[16];
00015   l4_umword_t plic_addr;
00016   l4_uint32_t plic_nr_irqs;
00017   l4_uint32_t plic_hart_irq_targets[16];
00018 };
00019
00020 typedef enum L4_riscv_isa_ext
00021 {
00022   // IDs 0-25 are reserved for single-letter RISC-V ISA extensions.
00023   L4_riscv_isa_ext_a = ('a' - 'a'), // Atomics
```

```
00024   L4_riscv_isa_ext_b = ('b' - 'a'), // Bit Manipulation
00025   L4_riscv_isa_ext_c = ('c' - 'a'), // Quad-Precision Floating-Point
00026   L4_riscv_isa_ext_d = ('d' - 'a'), // Double-Precision Floating-Point
00027   L4_riscv_isa_ext_e = ('e' - 'a'), // Reduced Integer
00028   L4_riscv_isa_ext_f = ('f' - 'a'), // Single-Precision Floating-Point
00029   L4_riscv_isa_ext_g = ('g' - 'a'), // General
00030   L4_riscv_isa_ext_h = ('h' - 'a'), // Hypervisor
00031   L4_riscv_isa_ext_i = ('i' - 'a'), // Integer
00032   L4_riscv_isa_ext_m = ('m' - 'a'), // Integer Multiplication and Division
00033   L4_riscv_isa_ext_p = ('p' - 'a'), // Packed-SIMD Extensions
00034   L4_riscv_isa_ext_q = ('q' - 'a'), // Quad-Precision Floating-Point
00035   L4_riscv_isa_ext_v = ('v' - 'a'), // Vector
00036
00037   // IDs starting from 26 represent multi-letter extensions. The assignment does
00038   // not follow a defined order, IDs are simply assigned incrementally when new
00039   // extensions are added.
00040   L4_riscv_isa_ext_base = 26,
00041
00042   L4_riscv_isa_ext_sstc = 27, // stimecmp / vstimecmp
00043
00044   // Maximum number of extensions that can be represented, corresponds to the
00045   // size of the `l4_kip_platform_info_arch.isa_ext` bitmap.
00046   L4_riscv_isa_ext_max  = 224,
00047 } L4_riscv_isa_ext;
```

16.96 __kip-arch.h

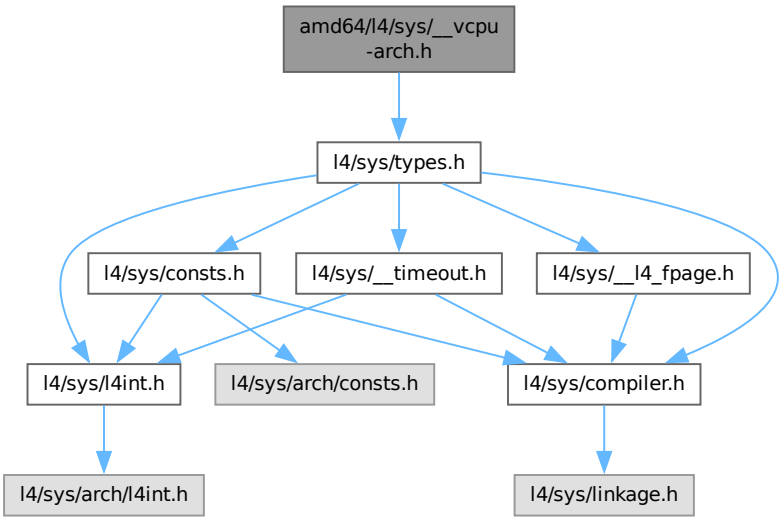
```
00001 /*
00002  * (c) 2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 struct l4_kip_platform_info_arch
00010 {};
```

16.97 amd64/l4/sys/__vcpu-arch.h File Reference

AMD64-specific vCPU interface.

`#include <l4/sys/types.h>`

Include dependency graph for __vcpu-arch.h:



Data Structures

- struct l4_vcpu_arch_state_t

  Architecture-specific vCPU state.
- struct l4_vcpu_regs_t

  vCPU registers.
- struct l4_vcpu_ipc_regs_t

  vCPU message registers.

Typedefs

- typedef struct l4_vcpu_arch_state_t **l4_vcpu_arch_state_t**

  Architecture-specific vCPU state.
- typedef struct l4_vcpu_regs_t **l4_vcpu_regs_t**

  vCPU registers.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**

  vCPU message registers.

Enumerations

- enum { L4_VCPU_STATE_VERSION = 0x26 , **L4_VCPU_STATE_SIZE** = 0x200 , **L4_VCPU_STATE_EXT_SIZE** = L4_PAGESIZE }
- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x400 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.

16.97.1 Detailed Description

AMD64-specific vCPU interface.
Definition in file __vcpu-arch.h.

16.97.2 Enumeration Type Documentation

16.97.2.1 anonymous enum

```
anonymous enum
```

Enumerator

L4_VCPU_STATE_VERSION	Architecture-specific version ID. This ID must match the version field in the l4_vcpu_state_t structure after enabling vCPU mode or extended vCPU mode for a thread.

Definition at line 16 of file __vcpu-arch.h.

16.98 __vcpu-arch.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015
```

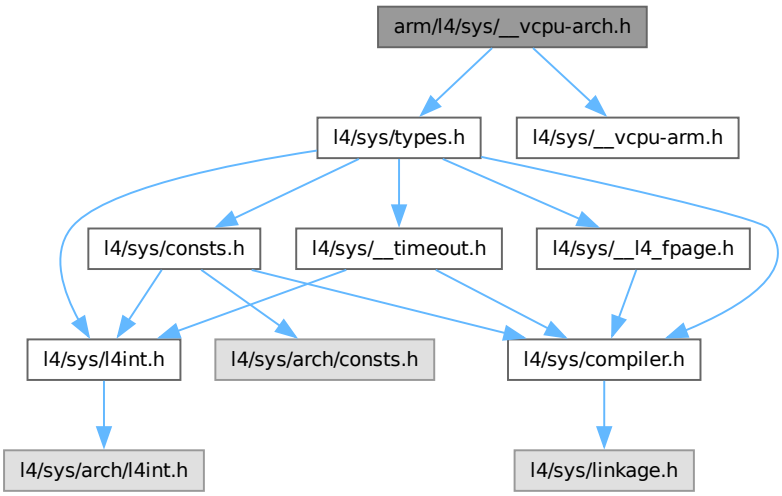
```
00016 enum
00017 {
00024   L4_VCPU_STATE_VERSION = 0x26,
00025
00026   L4_VCPU_STATE_SIZE = 0x200,
00027   L4_VCPU_STATE_EXT_SIZE = L4_PAGESIZE,
00028 };
00029
00034 enum L4_vcpu_state_offset
00035 {
00036   L4_VCPU_OFFSET_EXT_STATE = 0x400,
00037   L4_VCPU_OFFSET_EXT_INFOS = 0x200,
00038 };
00039
00043 typedef struct l4_vcpu_arch_state_t
00044 {
00045   l4_umword_t host_fs_base;
00046   l4_umword_t host_gs_base;
00047   l4_uint16_t host_ds, host_es, host_fs, host_gs;
00048
00049   l4_uint16_t const user_ds32;
00050   l4_uint16_t const user_cs64;
00051   l4_uint16_t const user_cs32;
00052 } l4_vcpu_arch_state_t;
00053
00054
00059 typedef struct l4_vcpu_regs_t
00060 {
00061   l4_umword_t r15;
00062   l4_umword_t r14;
00063   l4_umword_t r13;
00064   l4_umword_t r12;
00065   l4_umword_t r11;
00066   l4_umword_t r10;
00067   l4_umword_t r9;
00068   l4_umword_t r8;
00069
00070   l4_umword_t di;
00071   l4_umword_t si;
00072   l4_umword_t bp;
00073   l4_umword_t pfa;
00074   l4_umword_t bx;
00075   l4_umword_t dx;
00076   l4_umword_t cx;
00077   l4_umword_t ax;
00078
00079   l4_umword_t trapno;
00080   l4_umword_t err;
00081
00082   l4_umword_t ip;
00083   l4_umword_t cs;
00084   l4_umword_t flags;
00085   l4_umword_t sp;
00086   l4_umword_t ss;
00087   l4_umword_t fs_base;
00088   l4_umword_t gs_base;
00089   l4_uint16_t ds, es, fs, gs;
00090
00091 } l4_vcpu_regs_t;
00092
00097 typedef struct l4_vcpu_ipc_regs_t
00098 {
00099   l4_umword_t _res[1];
00100   l4_umword_t label;
00101   l4_umword_t _res2[5];
00102   l4_msgtag_t tag;
00103 } l4_vcpu_ipc_regs_t;
```

16.99 arm/l4/sys/__vcpu-arch.h File Reference

ARM-specific vCPU interface.

```
#include <l4/sys/types.h>
#include <l4/sys/__vcpu-arm.h>
```

Include dependency graph for __vcpu-arch.h:



Data Structures

- struct l4_vcpu_regs_t

  vCPU registers.
- struct l4_vcpu_arch_state_t

  Architecture-specific vCPU state.
- struct l4_vcpu_ipc_regs_t

  vCPU message registers.

Typedefs

- typedef struct l4_vcpu_regs_t **l4_vcpu_regs_t**

  vCPU registers.
- typedef struct l4_vcpu_arch_state_t **l4_vcpu_arch_state_t**

  Architecture-specific vCPU state.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**

  vCPU message registers.

Enumerations

- enum { L4_VCPU_STATE_VERSION = 0x38 , **L4_VCPU_STATE_SIZE** = 0x100 , **L4_VCPU_STATE_EXT_SIZE** = 0x400 }
- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x180 , L4_VCPU_OFFSET_EXT_INFOS = 0x100 }

  Offsets for vCPU state layouts.
- enum L4_vcpu_e_field_ids { }

  IDs for extended vCPU state fields.

16.99.1 Detailed Description

ARM-specific vCPU interface.
Definition in file __vcpu-arch.h.

16.99.2 Enumeration Type Documentation

16.99.2.1 anonymous enum

anonymous enum

Enumerator

L4_VCPU_STATE_VERSION	Architecture-specific version ID. This ID must match the version field in the l4_vcpu_state_t structure after enabling vCPU mode or extended vCPU mode for a thread.

Definition at line 17 of file __vcpu-arch.h.

16.99.2.2 L4_vcpu_e_field_ids

enum L4_vcpu_e_field_ids

IDs for extended vCPU state fields.
Bits 14..15: are the field size:

- 0 = 32bit field
- 1 = register width field
- 2 = 64bit field

Enumerator

L4_VCPU_E_VTMR_CFG	vtimer irq configuration

Definition at line 99 of file __vcpu-arch.h.

16.100 __vcpu-arch.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015 #include <l4/sys/__vcpu-arch.h>
00016
00017 enum
00018 {
00025   L4_VCPU_STATE_VERSION = 0x38,
00026
00027   L4_VCPU_STATE_SIZE = 0x100,
00028   L4_VCPU_STATE_EXT_SIZE = 0x400,
00029 };
00030
00035 enum L4_vcpu_state_offset
00036 {
00037   L4_VCPU_OFFSET_EXT_STATE = 0x180,
00038   L4_VCPU_OFFSET_EXT_INFOS = 0x100,
00039 };
00040
00041 L4_INLINE l4_arm_vcpu_e_info_t const *
00042 l4_vcpu_e_info(void const *vcpu) L4_NOTHROW
00043 {
00044   return (l4_arm_vcpu_e_info_t const *)((l4_addr_t)vcpu
00045                                         + L4_VCPU_OFFSET_EXT_INFOS);
00046 }
00047
00048 L4_INLINE void *l4_vcpu_e_ptr(void const *vcpu, unsigned id) L4_NOTHROW
```

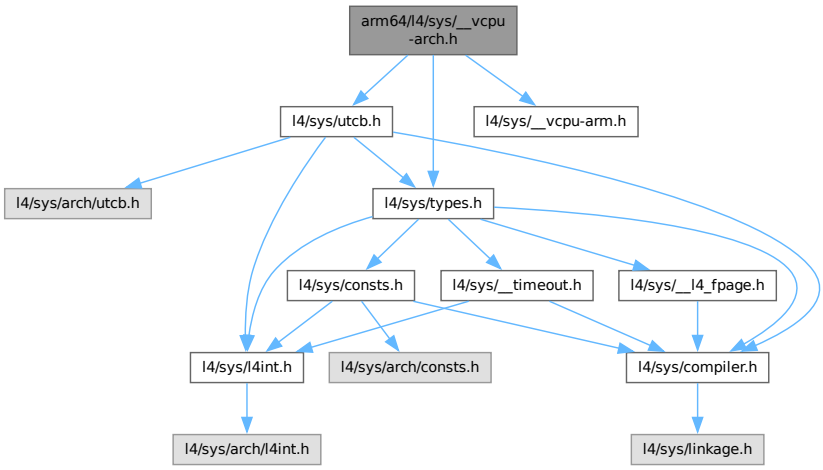
```
00049 { return (void *)((l4_addr_t)vcpu + L4_VCPU_OFFSET_EXT_STATE + (id & 0xfff)); }
00050
00055 typedef struct l4_vcpu_regs_t
00056 {
00057   l4_umword_t pfa;
00058   l4_umword_t err;
00059
00060   l4_umword_t r[13];
00061
00062   l4_umword_t sp;
00063   l4_umword_t lr;
00064   l4_umword_t _dummy;
00065   l4_umword_t ip;
00066   l4_umword_t flags;
00067   l4_umword_t tpidruro;
00068   l4_umword_t tpidrurw;
00069 } l4_vcpu_regs_t;
00070
00074 typedef struct l4_vcpu_arch_state_t
00075 {
00076   l4_umword_t host_tpidruro;
00077 } l4_vcpu_arch_state_t;
00078
00083 typedef struct l4_vcpu_ipc_regs_t
00084 {
00085   l4_msgtag_t tag;
00086   l4_umword_t _d1[3];
00087   l4_umword_t label;
00088   l4_umword_t _d2[8];
00089 } l4_vcpu_ipc_regs_t;
00090
00099 enum L4_vcpu_e_field_ids
00100 {
00101   L4_VCPU_E_HCR        = 0x8008,
00102   L4_VCPU_E_TTBR0      = 0x8010,
00103   L4_VCPU_E_TTBR1      = 0x8018,
00104   L4_VCPU_E_TTBCR      = 0x0020,
00105   L4_VCPU_E_SCTLR      = 0x0024,
00106   L4_VCPU_E_DACR       = 0x0028,
00107   L4_VCPU_E_FCSEIDR    = 0x002c,
00108
00109   L4_VCPU_E_CNTVCTL    = 0x0030,
00110   L4_VCPU_E_CNTVOFF    = 0x8038,
00111
00112   L4_VCPU_E_VMPIDR     = 0x0040,
00113   L4_VCPU_E_VPIDR      = 0x0044,
00114
00115   L4_VCPU_E_VTMR_CFG   = 0x0048,
00116
00117   L4_VCPU_E_GIC_HCR    = 0x0050,
00118   L4_VCPU_E_GIC_VTR    = 0x0054,
00119   L4_VCPU_E_GIC_VMCR   = 0x0058,
00120   L4_VCPU_E_GIC_MISR   = 0x005c,
00121   L4_VCPU_E_GIC_EISR   = 0x0060,
00122   L4_VCPU_E_GIC_ELSR   = 0x0064,
00123   L4_VCPU_E_GIC_V2_LR0 = 0x0068,
00124   L4_VCPU_E_GIC_V3_LR0 = 0x8068,
00125 };
```

16.101 arm64/l4/sys/__vcpu-arch.h File Reference

ARM64-specific vCPU interface.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/__vcpu-arm.h>
```

Include dependency graph for __vcpu-arch.h:



Data Structures

- struct l4_vcpu_arch_state_t

  Architecture-specific vCPU state.
- struct l4_vcpu_ipc_regs_t

  vCPU message registers.

Typedefs

- typedef l4_exc_regs_t **l4_vcpu_regs_t**

  vCPU registers.
- typedef struct l4_vcpu_arch_state_t **l4_vcpu_arch_state_t**

  Architecture-specific vCPU state.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**

  vCPU message registers.

Enumerations

- enum { L4_VCPU_STATE_VERSION = 0x38 , **L4_VCPU_STATE_SIZE** = 0x200 , **L4_VCPU_STATE_EXT**↩ **_SIZE** = 0x800 }
- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x280 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.
- enum L4_vcpu_e_field_ids { }

  IDs for extended vCPU state fields.

16.101.1 Detailed Description

ARM64-specific vCPU interface.
Definition in file __vcpu-arch.h.

16.101.2 Enumeration Type Documentation

16.101.2.1 anonymous enum

anonymous enum

Enumerator

L4_VCPU_STATE_VERSION	Architecture-specific version ID. This ID must match the version field in the l4_vcpu_state_t structure after enabling vCPU mode or extended vCPU mode for a thread.

Definition at line 18 of file __vcpu-arch.h.

16.101.2.2 L4_vcpu_e_field_ids

enum L4_vcpu_e_field_ids

IDs for extended vCPU state fields.
Bits 14..15: are the field size:

- 0 = 32bit field
- 1 = register width field
- 2 = 64bit field

Enumerator

L4_VCPU_E_VTMR_CFG	vtimer irq configuration

Definition at line 85 of file __vcpu-arch.h.

16.102 __vcpu-arch.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015 #include <l4/sys/utcb.h>
00016 #include <l4/sys/__vcpu-arm.h>
00017
00018 enum
00019 {
00026   L4_VCPU_STATE_VERSION = 0x38,
00027
00028   L4_VCPU_STATE_SIZE = 0x200,
00029   L4_VCPU_STATE_EXT_SIZE = 0x800,
00030 };
00031
00036 enum L4_vcpu_state_offset
00037 {
00038   L4_VCPU_OFFSET_EXT_STATE = 0x280,
00039   L4_VCPU_OFFSET_EXT_INFOS = 0x200,
00040 };
00041
00042 L4_INLINE l4_arm_vcpu_e_info_t const *
00043 l4_vcpu_e_info(void const *vcpu) L4_NOTHROW
00044 {
00045   return (l4_arm_vcpu_e_info_t const *)((l4_addr_t)vcpu
00046                                         + L4_VCPU_OFFSET_EXT_INFOS);
00047 }
00048
00049 L4_INLINE void *l4_vcpu_e_ptr(void const *vcpu, unsigned id) L4_NOTHROW
```

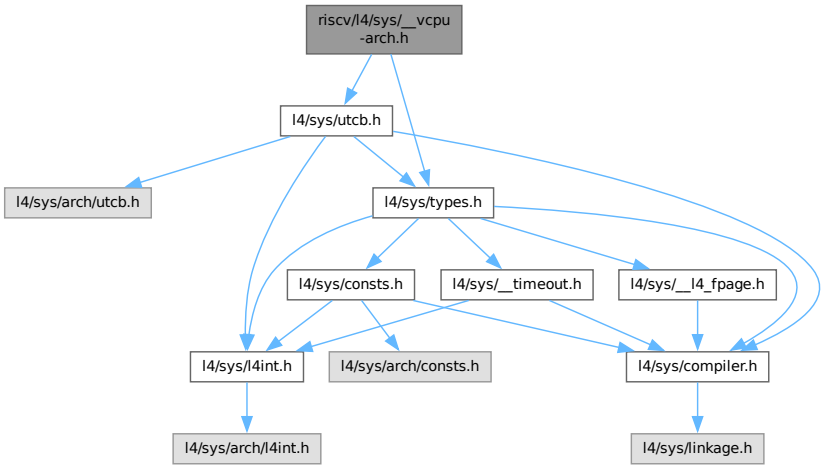
```
00050 { return (void *)((l4_addr_t)vcpu + L4_VCPU_OFFSET_EXT_STATE + (id & 0xfff)); }
00051
00056 typedef l4_exc_regs_t l4_vcpu_regs_t;
00057
00061 typedef struct l4_vcpu_arch_state_t
00062 {
00063   l4_umword_t host_tpidruro;
00064 } l4_vcpu_arch_state_t;
00065
00070 typedef struct l4_vcpu_ipc_regs_t
00071 {
00072   l4_msgtag_t tag;
00073   l4_umword_t label;
00074   l4_umword_t _d1[3];
00075 } l4_vcpu_ipc_regs_t;
00076
00085 enum L4_vcpu_e_field_ids
00086 {
00087   L4_VCPU_E_HCR        = 0x8008,
00088   L4_VCPU_E_SCTLR      = 0x0010,
00089   L4_VCPU_E_CPACR      = 0x0014,
00090
00091   L4_VCPU_E_CNTVCTL    = 0x0018,
00092   L4_VCPU_E_CNTVOFF    = 0x8020,
00093
00094   L4_VCPU_E_VMPIDR     = 0x8028,
00095   L4_VCPU_E_VPIDR      = 0x0030,
00096
00097   L4_VCPU_E_VTMR_CFG   = 0x0034,
00098   L4_VCPU_E_VTCR       = 0x8038,
00099
00100   L4_VCPU_E_GIC_HCR    = 0x0040,
00101   L4_VCPU_E_GIC_VTR    = 0x0044,
00102   L4_VCPU_E_GIC_VMCR   = 0x0048,
00103   L4_VCPU_E_GIC_MISR   = 0x004c,
00104   L4_VCPU_E_GIC_EISR   = 0x0050,
00105   L4_VCPU_E_GIC_ELSR   = 0x0054,
00106   L4_VCPU_E_GIC_V2_LR0 = 0x0058,
00107   L4_VCPU_E_GIC_V3_LR0 = 0x8058,
00108 };
```

16.103 riscv/l4/sys/__vcpu-arch.h File Reference

RISC-V-specific vCPU interface.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
```

Include dependency graph for __vcpu-arch.h:



Data Structures

- struct l4_vcpu_arch_state_t

Architecture-specific vCPU state.

- struct l4_vcpu_ipc_regs_t

  vCPU message registers.

Typedefs

- typedef l4_exc_regs_t **l4_vcpu_regs_t**

  vCPU registers.
- typedef struct l4_vcpu_arch_state_t **l4_vcpu_arch_state_t**

  Architecture-specific vCPU state.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**

  vCPU message registers.

Enumerations

- enum { L4_VCPU_STATE_VERSION = 0x1 , **L4_VCPU_STATE_SIZE** = 0x200 , **L4_VCPU_STATE_EXT_SIZE** = L4_PAGESIZE }
- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x400 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.

16.103.1 Detailed Description

RISC-V-specific vCPU interface.
Definition in file __vcpu-arch.h.

16.103.2 Enumeration Type Documentation

16.103.2.1 anonymous enum

```
anonymous enum
```

Enumerator

L4_VCPU_STATE_VERSION	Architecture-specific version ID. This ID must match the version field in the l4_vcpu_state_t structure after enabling vCPU mode or extended vCPU mode for a thread.

Definition at line 16 of file __vcpu-arch.h.

16.104 __vcpu-arch.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00011 #pragma once
00012
00013 #include <l4/sys/types.h>
00014 #include <l4/sys/utcb.h>
00015
00016 enum
00017 {
00024   L4_VCPU_STATE_VERSION = 0x1,
00025
00026   L4_VCPU_STATE_SIZE = 0x200,
00027   L4_VCPU_STATE_EXT_SIZE = L4_PAGESIZE,
00028 };
00029
```

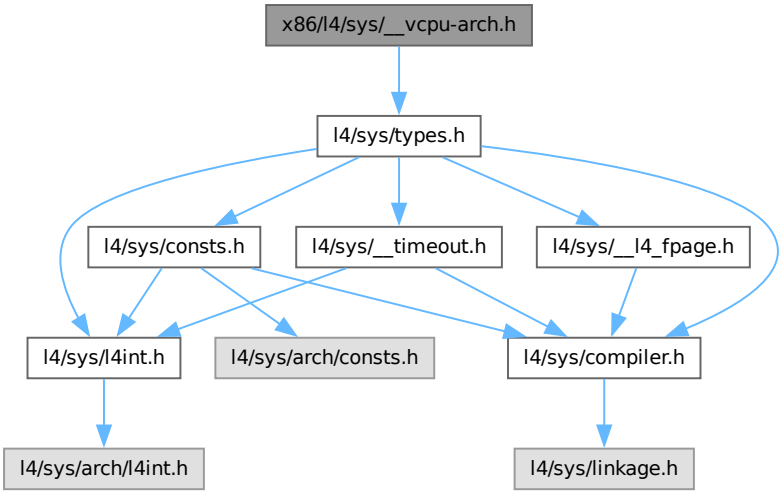
```
00034 enum L4_vcpu_state_offset
00035 {
00036   L4_VCPU_OFFSET_EXT_STATE = 0x400,
00037   L4_VCPU_OFFSET_EXT_INFOS = 0x200,
00038 };
00039
00044 typedef l4_exc_regs_t l4_vcpu_regs_t;
00045
00049 typedef struct l4_vcpu_arch_state_t
00050 {
00051   l4_umword_t host_tp;
00052   l4_umword_t host_gp;
00053 } l4_vcpu_arch_state_t;
00054
00059 typedef struct l4_vcpu_ipc_regs_t
00060 {
00061   l4_msgtag_t tag;      /* a0 */
00062   l4_umword_t dest;     /* a1 */
00063   l4_umword_t timeout;  /* a2 */
00064   l4_umword_t label;    /* a3 */
00065 } l4_vcpu_ipc_regs_t;
```

16.105 x86/l4/sys/__vcpu-arch.h File Reference

x86-specific vCPU interface.

`#include <l4/sys/types.h>`

Include dependency graph for __vcpu-arch.h:



Data Structures

- struct l4_vcpu_regs_t

  vCPU registers.
- struct l4_vcpu_arch_state_t

  Architecture-specific vCPU state.
- struct l4_vcpu_ipc_regs_t

  vCPU message registers.

Typedefs

- typedef struct l4_vcpu_regs_t **l4_vcpu_regs_t**

  vCPU registers.

- typedef struct l4_vcpu_arch_state_t **l4_vcpu_arch_state_t**

  Architecture-specific vCPU state.
- typedef struct l4_vcpu_ipc_regs_t **l4_vcpu_ipc_regs_t**

  vCPU message registers.

Enumerations

- enum { L4_VCPU_STATE_VERSION = 0x46 , **L4_VCPU_STATE_SIZE** = 0x200 , **L4_VCPU_STATE_EXT_SIZE** = L4_PAGESIZE }
- enum L4_vcpu_state_offset { L4_VCPU_OFFSET_EXT_STATE = 0x400 , L4_VCPU_OFFSET_EXT_INFOS = 0x200 }

  Offsets for vCPU state layouts.

16.105.1 Detailed Description

x86-specific vCPU interface.
Definition in file __vcpu-arch.h.

16.105.2 Enumeration Type Documentation

16.105.2.1 anonymous enum

```
anonymous enum
```

Enumerator

L4_VCPU_STATE_VERSION	Architecture-specific version ID. This ID must match the version field in the l4_vcpu_state_t structure after enabling vCPU mode or extended vCPU mode for a thread.

Definition at line 16 of file __vcpu-arch.h.

16.106 __vcpu-arch.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015
00016 enum
00017 {
00024   L4_VCPU_STATE_VERSION = 0x46,
00025
00026   L4_VCPU_STATE_SIZE = 0x200,
00027   L4_VCPU_STATE_EXT_SIZE = L4_PAGESIZE,
00028 };
00029
00034 enum L4_vcpu_state_offset
00035 {
00036   L4_VCPU_OFFSET_EXT_STATE = 0x400,
00037   L4_VCPU_OFFSET_EXT_INFOS = 0x200,
00038 };
00039
00044 typedef struct l4_vcpu_regs_t
00045 {
00046   l4_umword_t es;
00047   l4_umword_t ds;
00048   l4_umword_t gs;
00049   l4_umword_t fs;
00050
```

```
00051   l4_umword_t di;
00052   l4_umword_t si;
00053   l4_umword_t bp;
00054   l4_umword_t pfa;
00055   l4_umword_t bx;
00056   l4_umword_t dx;
00057   l4_umword_t cx;
00058   l4_umword_t ax;
00059
00060   l4_umword_t trapno;
00061   l4_umword_t err;
00062
00063   l4_umword_t ip;
00064   l4_umword_t dummy1;
00065   l4_umword_t flags;
00066   l4_umword_t sp;
00067   l4_umword_t ss;
00068 } l4_vcpu_regs_t;
00069
00073 typedef struct l4_vcpu_arch_state_t {} l4_vcpu_arch_state_t;
00074
00079 typedef struct l4_vcpu_ipc_regs_t
00080 {
00081   l4_umword_t _res[2];
00082   l4_umword_t label;
00083   l4_umword_t _res2[3];
00084   l4_msgtag_t tag;
00085 } l4_vcpu_ipc_regs_t;
```

16.107 ktrace_events.h

```
00001 /* Note, automatically generated from Fiasco binary */
00002 #pragma once
00003
00004 enum L4_ktrace_tbuf_entry_fixed
00005 {
00006   l4_ktrace_tbuf_unused = 0,
00007   l4_ktrace_tbuf_pf = 1,
00008   l4_ktrace_tbuf_ipc = 2,
00009   l4_ktrace_tbuf_ipc_res = 3,
00010   l4_ktrace_tbuf_ipc_trace = 4,
00011   l4_ktrace_tbuf_ke = 5,
00012   l4_ktrace_tbuf_ke_reg = 6,
00013   l4_ktrace_tbuf_breakpoint = 7,
00014   l4_ktrace_tbuf_ke_bin = 8,
00015   l4_ktrace_tbuf_dynentries = 9,
00016   l4_ktrace_tbuf_max = 128,
00017   l4_ktrace_tbuf_hidden = 128,
00018 };
00019
00020 typedef unsigned long L4_ktrace_t__Address;
00021 typedef unsigned long L4_ktrace_t__Cap_index;
00022 typedef void L4_ktrace_t__Context;
00023 typedef void L4_ktrace_t__Context__Drq;
00024 typedef unsigned L4_ktrace_t__Context__Drq_log__Type;
00025 typedef unsigned L4_ktrace_t__Cpu_number;
00026 typedef void L4_ktrace_t__Irq_base;
00027 typedef void L4_ktrace_t__Irq_chip;
00028 typedef void L4_ktrace_t__Kobject;
00029 typedef unsigned long L4_ktrace_t__L4_error;
00030 typedef unsigned long L4_ktrace_t__L4_msg_tag;
00031 typedef unsigned long L4_ktrace_t__L4_obj_ref;
00032 typedef unsigned L4_ktrace_t__L4_timeout_pair;
00033 typedef unsigned long L4_ktrace_t__Mword;
00034 typedef void L4_ktrace_t__Rcu_item;
00035 typedef void L4_ktrace_t__Sched_context;
00036 typedef long L4_ktrace_t__Smword;
00037 typedef void L4_ktrace_t__Space;
00038 typedef unsigned short L4_ktrace_t__Unsigned16;
00039 typedef unsigned int L4_ktrace_t__Unsigned32;
00040 typedef unsigned long long L4_ktrace_t__Unsigned64;
00041 typedef unsigned char L4_ktrace_t__Unsigned8;
00042 typedef void L4_ktrace_t__cxx__Type_info;
00043
00044 typedef struct __attribute__((packed))
00045 {
00046   L4_ktrace_t__Mword _number; /* 0+8 */
00047   L4_ktrace_t__Address _ip; /* 8+8 */
00048   L4_ktrace_t__Unsigned64 _tsc; /* 16+8 */
00049   L4_ktrace_t__Context *_ctx; /* 24+8 */
00050   L4_ktrace_t__Unsigned32 _pmc1; /* 32+4 */
00051   L4_ktrace_t__Unsigned32 _pmc2; /* 36+4 */
00052   L4_ktrace_t__Unsigned32 _kclock; /* 40+4 */
00053   L4_ktrace_t__Unsigned8 _type; /* 44+1 */
```

```
00054   L4_ktrace_t__Unsigned8 _cpu; /* 45+1 */
00055   union __attribute__((__packed__))
00056   {
00057     struct __attribute__((__packed__))
00058     {
00059       char __pre_pad[2];
00060       void *func; /* 48+8 */
00061       L4_ktrace_t__Context *thread; /* 56+8 */
00062       L4_ktrace_t__Context__Drq *rq; /* 64+8 */
00063       L4_ktrace_t__Cpu_number target_cpu; /* 72+4 */
00064       L4_ktrace_t__Context__Drq_log__Type type; /* 76+4 */
00065       char wait; /* 80+1 */
00066     } drq; /* 88 */
00067     struct __attribute__((__packed__))
00068     {
00069       char __pre_pad[2];
00070       L4_ktrace_t__Mword state; /* 48+8 */
00071       L4_ktrace_t__Mword ip; /* 56+8 */
00072       L4_ktrace_t__Mword sp; /* 64+8 */
00073       L4_ktrace_t__Mword space; /* 72+8 */
00074       L4_ktrace_t__Mword err; /* 80+8 */
00075       unsigned char type; /* 88+1 */
00076       unsigned char trap; /* 89+1 */
00077     } vcpu; /* 96 */
00078     struct __attribute__((__packed__))
00079     {
00080       char __pre_pad[2];
00081       L4_ktrace_t__Smword op; /* 48+8 */
00082       L4_ktrace_t__Cap_index buffer; /* 56+8 */
00083       L4_ktrace_t__Mword id; /* 64+8 */
00084       L4_ktrace_t__Mword ram; /* 72+8 */
00085       L4_ktrace_t__Mword newo; /* 80+8 */
00086     } factory; /* 88 */
00087     struct __attribute__((__packed__))
00088     {
00089       char __pre_pad[2];
00090       L4_ktrace_t__Mword gate_dbg_id; /* 48+8 */
00091       L4_ktrace_t__Mword thread_dbg_id; /* 56+8 */
00092       L4_ktrace_t__Mword label; /* 64+8 */
00093     } gate; /* 72 */
00094     struct __attribute__((__packed__))
00095     {
00096       char __pre_pad[2];
00097       L4_ktrace_t__Irq_base *obj; /* 48+8 */
00098       L4_ktrace_t__Irq_chip *chip; /* 56+8 */
00099       L4_ktrace_t__Mword pin; /* 64+8 */
00100     } irq; /* 72 */
00101     struct __attribute__((__packed__))
00102     {
00103       char __pre_pad[2];
00104       L4_ktrace_t__Kobject *obj; /* 48+8 */
00105       L4_ktrace_t__Mword id; /* 56+8 */
00106       L4_ktrace_t__cxx__Type_info *type; /* 64+8 */
00107       L4_ktrace_t__Mword ram; /* 72+8 */
00108     } destroy; /* 80 */
00109     struct __attribute__((__packed__))
00110     {
00111       char __pre_pad[2];
00112       L4_ktrace_t__Cpu_number cpu; /* 48+4 */
00113       char __pad_1[4];
00114       L4_ktrace_t__Rcu_item *item; /* 56+8 */
00115       void *cb; /* 64+8 */
00116       unsigned char event; /* 72+1 */
00117     } rcu; /* 80 */
00118     struct __attribute__((__packed__))
00119     {
00120       char __pre_pad[2];
00121       L4_ktrace_t__Mword id; /* 48+8 */
00122       L4_ktrace_t__Mword mask; /* 56+8 */
00123       L4_ktrace_t__Mword fpage; /* 64+8 */
00124       char map; /* 72+1 */
00125     } tmap; /* 80 */
00126     struct __attribute__((__packed__))
00127     {
00128       char __pre_pad[2];
00129       L4_ktrace_t__Address _address; /* 48+8 */
00130       int _len; /* 56+4 */
00131       char __pad_1[4];
00132       L4_ktrace_t__Mword _value; /* 64+8 */
00133       int _mode; /* 72+4 */
00134     } bp; /* 80 */
00135     struct __attribute__((__packed__))
00136     {
00137       char __pre_pad[2];
00138       L4_ktrace_t__Context *dst; /* 48+8 */
00139       L4_ktrace_t__Address kernel_ip; /* 56+8 */
00140       L4_ktrace_t__Mword lock_cnt; /* 64+8 */
```

```
00141       L4_ktrace_t__Space *from_space; /* 72+8 */
00142       L4_ktrace_t__Sched_context *from_sched; /* 80+8 */
00143       L4_ktrace_t__Mword from_prio; /* 88+8 */
00144     } context_switch; /* 96 */
00145     struct __attribute__((__packed__))
00146     {
00147     } empty; /* 48 */
00148     struct __attribute__((__packed__))
00149     {
00150       char __pre_pad[2];
00151       L4_ktrace_t__L4_msg_tag _tag; /* 48+8 */
00152       L4_ktrace_t__Mword _dword[2]; /* 56+16 */
00153       L4_ktrace_t__L4_obj_ref _dst; /* 72+8 */
00154       L4_ktrace_t__Mword _dbg_id; /* 80+8 */
00155       L4_ktrace_t__Mword _label; /* 88+8 */
00156       L4_ktrace_t__L4_timeout_pair _timeout; /* 96+4 */
00157       char __pad_1[4];
00158       L4_ktrace_t__Unsigned64 _to_abs_rcv; /* 104+8 */
00159     } ipc; /* 112 */
00160     struct __attribute__((__packed__))
00161     {
00162       L4_ktrace_t__Unsigned8 _have_snd; /* 46+1 */
00163       L4_ktrace_t__Unsigned8 _is_np; /* 47+1 */
00164       L4_ktrace_t__L4_msg_tag _tag; /* 48+8 */
00165       L4_ktrace_t__Mword _dword[2]; /* 56+16 */
00166       L4_ktrace_t__L4_error _result; /* 72+8 */
00167       L4_ktrace_t__Mword _from; /* 80+8 */
00168       L4_ktrace_t__L4_obj_ref _dst; /* 88+8 */
00169       L4_ktrace_t__Mword _pair_event; /* 96+8 */
00170     } ipc_res; /* 104 */
00171     struct __attribute__((__packed__))
00172     {
00173       char __pre_pad[2];
00174       union __attribute__((__packed__)) {
00175         char msg[80]; /* 0+80 */
00176         struct __attribute__((__packed__)) {
00177           char tag[2]; /* 0+2 */
00178           char __pad_1[6];
00179           char *ptr; /* 8+8 */
00180         } mptr; /* 0+16 */
00181       } msg; /* 48+80 */
00182     } ke; /* 128 */
00183     struct __attribute__((__packed__))
00184     {
00185       char _msg[80]; /* 46+80 */
00186     } ke_bin; /* 128 */
00187     struct __attribute__((__packed__))
00188     {
00189       char __pre_pad[2];
00190       L4_ktrace_t__Mword v[3]; /* 48+24 */
00191       union __attribute__((__packed__)) {
00192         char msg[56]; /* 0+56 */
00193         struct __attribute__((__packed__)) {
00194           char tag[2]; /* 0+2 */
00195           char __pad_1[6];
00196           char *ptr; /* 8+8 */
00197         } mptr; /* 0+16 */
00198       } msg; /* 72+56 */
00199     } ke_reg; /* 128 */
00200     struct __attribute__((__packed__))
00201     {
00202       char __pre_pad[2];
00203       L4_ktrace_t__Address _pfa; /* 48+8 */
00204       L4_ktrace_t__Mword _error; /* 56+8 */
00205       L4_ktrace_t__Space *_space; /* 64+8 */
00206     } pf; /* 72 */
00207     struct __attribute__((__packed__))
00208     {
00209       unsigned short mode; /* 46+2 */
00210       L4_ktrace_t__Context *owner; /* 48+8 */
00211       unsigned short id; /* 56+2 */
00212       unsigned short prio; /* 58+2 */
00213       char __pad_1[4];
00214       long left; /* 64+8 */
00215       unsigned long quantum; /* 72+8 */
00216     } sched; /* 80 */
00217     struct __attribute__((__packed__))
00218     {
00219       char _trapno; /* 46+1 */
00220       char __pad_1[1];
00221       L4_ktrace_t__Unsigned16 _error; /* 48+2 */
00222       char __pad_2[6];
00223       L4_ktrace_t__Mword _rbp; /* 56+8 */
00224       L4_ktrace_t__Mword _cr2; /* 64+8 */
00225       L4_ktrace_t__Mword _rax; /* 72+8 */
00226       L4_ktrace_t__Mword _rflags; /* 80+8 */
00227       L4_ktrace_t__Mword _rsp; /* 88+8 */
```

```
00228       L4_ktrace_t__Unsigned16 _cs; /* 96+2 */
00229       L4_ktrace_t__Unsigned16 _ds; /* 98+2 */
00230     } trap; /* 104 */
00231     struct __attribute__((__packed__))
00232     {
00233       char _padding[80]; /* 46+80 */
00234       char __post_pad[2]; /* 126+2 */
00235     } fullsize; /* 128 */
00236     struct __attribute__((__packed__))
00237     {
00238       char __pre_pad[2];
00239       L4_ktrace_t__Cap_index cap_idx; /* 48+8 */
00240     } ieh; /* 56 */
00241     struct __attribute__((__packed__))
00242     {
00243       char __pre_pad[2];
00244       L4_ktrace_t__Mword pfa; /* 48+8 */
00245       L4_ktrace_t__Cap_index cap_idx; /* 56+8 */
00246       L4_ktrace_t__Mword err; /* 64+8 */
00247     } ipfh; /* 72 */
00248     struct __attribute__((__packed__))
00249     {
00250       char __pre_pad[2];
00251       L4_ktrace_t__Mword id; /* 48+8 */
00252       L4_ktrace_t__Mword ip; /* 56+8 */
00253       L4_ktrace_t__Mword sp; /* 64+8 */
00254       L4_ktrace_t__Mword op; /* 72+8 */
00255     } exregs; /* 80 */
00256     struct __attribute__((__packed__))
00257     {
00258       char __pre_pad[2];
00259       L4_ktrace_t__Mword state; /* 48+8 */
00260       L4_ktrace_t__Address user_ip; /* 56+8 */
00261       L4_ktrace_t__Cpu_number src_cpu; /* 64+4 */
00262       L4_ktrace_t__Cpu_number target_cpu; /* 68+4 */
00263     } migration; /* 72 */
00264     struct __attribute__((__packed__))
00265     {
00266       char __pre_pad[2];
00267       L4_ktrace_t__Address user_ip; /* 48+8 */
00268     } timer; /* 56 */
00269     struct __attribute__((__packed__))
00270     {
00271       char __pre_pad[2];
00272       L4_ktrace_t__Mword exitcode; /* 48+8 */
00273       L4_ktrace_t__Mword exitinfo1; /* 56+8 */
00274       L4_ktrace_t__Mword exitinfo2; /* 64+8 */
00275       L4_ktrace_t__Mword rip; /* 72+8 */
00276     } svm; /* 80 */
00277   } m;
00278 } l4_tracebuffer_entry_t;
```

16.108 ktrace_events.h

```
00001 /* Note, automatically generated from Fiasco binary */
00002 #pragma once
00003
00004 enum L4_ktrace_tbuf_entry_fixed
00005 {
00006   l4_ktrace_tbuf_unused = 0,
00007   l4_ktrace_tbuf_pf = 1,
00008   l4_ktrace_tbuf_ipc = 2,
00009   l4_ktrace_tbuf_ipc_res = 3,
00010   l4_ktrace_tbuf_ipc_trace = 4,
00011   l4_ktrace_tbuf_ke = 5,
00012   l4_ktrace_tbuf_ke_reg = 6,
00013   l4_ktrace_tbuf_breakpoint = 7,
00014   l4_ktrace_tbuf_ke_bin = 8,
00015   l4_ktrace_tbuf_dynentries = 9,
00016   l4_ktrace_tbuf_max = 128,
00017   l4_ktrace_tbuf_hidden = 128,
00018 };
00019
00020 typedef unsigned long L4_ktrace_t__Address;
00021 typedef unsigned long L4_ktrace_t__Cap_index;
00022 typedef void L4_ktrace_t__Context;
00023 typedef void L4_ktrace_t__Context__Drq;
00024 typedef unsigned L4_ktrace_t__Context__Drq_log__Type;
00025 typedef unsigned L4_ktrace_t__Cpu_number;
00026 typedef void L4_ktrace_t__Irq_base;
00027 typedef void L4_ktrace_t__Irq_chip;
00028 typedef void L4_ktrace_t__Kobject;
00029 typedef unsigned long L4_ktrace_t__L4_error;
00030 typedef unsigned long L4_ktrace_t__L4_msg_tag;
```

```
00031 typedef unsigned long L4_ktrace_t__L4_obj_ref;
00032 typedef unsigned L4_ktrace_t__L4_timeout_pair;
00033 typedef unsigned long L4_ktrace_t__Mword;
00034 typedef void L4_ktrace_t__Rcu_item;
00035 typedef void L4_ktrace_t__Sched_context;
00036 typedef long L4_ktrace_t__Smword;
00037 typedef void L4_ktrace_t__Space;
00038 typedef unsigned int L4_ktrace_t__Unsigned32;
00039 typedef unsigned long long L4_ktrace_t__Unsigned64;
00040 typedef unsigned char L4_ktrace_t__Unsigned8;
00041 typedef void L4_ktrace_t__cxx__Type_info;
00042
00043 typedef struct __attribute__((packed))
00044 {
00045   L4_ktrace_t__Mword _number; /* 0+4 */
00046   L4_ktrace_t__Address _ip; /* 4+4 */
00047   L4_ktrace_t__Unsigned64 _tsc; /* 8+8 */
00048   L4_ktrace_t__Context *_ctx; /* 16+4 */
00049   L4_ktrace_t__Unsigned32 _pmc1; /* 20+4 */
00050   L4_ktrace_t__Unsigned32 _pmc2; /* 24+4 */
00051   L4_ktrace_t__Unsigned32 _kclock; /* 28+4 */
00052   L4_ktrace_t__Unsigned8 _type; /* 32+1 */
00053   L4_ktrace_t__Unsigned8 _cpu; /* 33+1 */
00054   union __attribute__((__packed__))
00055   {
00056     struct __attribute__((__packed__))
00057     {
00058       char __pre_pad[2];
00059       void *func; /* 36+4 */
00060       L4_ktrace_t__Context *thread; /* 40+4 */
00061       L4_ktrace_t__Context__Drq *rq; /* 44+4 */
00062       L4_ktrace_t__Cpu_number target_cpu; /* 48+4 */
00063       L4_ktrace_t__Context__Drq_log__Type type; /* 52+4 */
00064       char wait; /* 56+1 */
00065     } drq; /* 64 */
00066     struct __attribute__((__packed__))
00067     {
00068       char __pre_pad[2];
00069       L4_ktrace_t__Mword state; /* 36+4 */
00070       L4_ktrace_t__Mword ip; /* 40+4 */
00071       L4_ktrace_t__Mword sp; /* 44+4 */
00072       L4_ktrace_t__Mword space; /* 48+4 */
00073       L4_ktrace_t__Mword err; /* 52+4 */
00074       unsigned char type; /* 56+1 */
00075       unsigned char trap; /* 57+1 */
00076     } vcpu; /* 64 */
00077     struct __attribute__((__packed__))
00078     {
00079       char __pre_pad[2];
00080       L4_ktrace_t__Smword op; /* 36+4 */
00081       L4_ktrace_t__Cap_index buffer; /* 40+4 */
00082       L4_ktrace_t__Mword id; /* 44+4 */
00083       L4_ktrace_t__Mword ram; /* 48+4 */
00084       L4_ktrace_t__Mword newo; /* 52+4 */
00085     } factory; /* 56 */
00086     struct __attribute__((__packed__))
00087     {
00088       char __pre_pad[2];
00089       L4_ktrace_t__Mword gate_dbg_id; /* 36+4 */
00090       L4_ktrace_t__Mword thread_dbg_id; /* 40+4 */
00091       L4_ktrace_t__Mword label; /* 44+4 */
00092     } gate; /* 48 */
00093     struct __attribute__((__packed__))
00094     {
00095       char __pre_pad[2];
00096       L4_ktrace_t__Irq_base *obj; /* 36+4 */
00097       L4_ktrace_t__Irq_chip *chip; /* 40+4 */
00098       L4_ktrace_t__Mword pin; /* 44+4 */
00099     } irq; /* 48 */
00100     struct __attribute__((__packed__))
00101     {
00102       char __pre_pad[2];
00103       L4_ktrace_t__Kobject *obj; /* 36+4 */
00104       L4_ktrace_t__Mword id; /* 40+4 */
00105       L4_ktrace_t__cxx__Type_info *type; /* 44+4 */
00106       L4_ktrace_t__Mword ram; /* 48+4 */
00107     } destroy; /* 56 */
00108     struct __attribute__((__packed__))
00109     {
00110       char __pre_pad[2];
00111       L4_ktrace_t__Cpu_number cpu; /* 36+4 */
00112       L4_ktrace_t__Rcu_item *item; /* 40+4 */
00113       void *cb; /* 44+4 */
00114       unsigned char event; /* 48+1 */
00115     } rcu; /* 56 */
00116     struct __attribute__((__packed__))
00117     {
```

```
00118       char __pre_pad[2];
00119       L4_ktrace_t__Mword id; /* 36+4 */
00120       L4_ktrace_t__Mword mask; /* 40+4 */
00121       L4_ktrace_t__Mword fpage; /* 44+4 */
00122       char map; /* 48+1 */
00123     } tmap; /* 56 */
00124     struct __attribute__((__packed__))
00125     {
00126       char __pre_pad[2];
00127       L4_ktrace_t__Address _address; /* 36+4 */
00128       int _len; /* 40+4 */
00129       L4_ktrace_t__Mword _value; /* 44+4 */
00130       int _mode; /* 48+4 */
00131     } bp; /* 56 */
00132     struct __attribute__((__packed__))
00133     {
00134       char __pre_pad[2];
00135       L4_ktrace_t__Context *dst; /* 36+4 */
00136       L4_ktrace_t__Address kernel_ip; /* 40+4 */
00137       L4_ktrace_t__Mword lock_cnt; /* 44+4 */
00138       L4_ktrace_t__Space *from_space; /* 48+4 */
00139       L4_ktrace_t__Sched_context *from_sched; /* 52+4 */
00140       L4_ktrace_t__Mword from_prio; /* 56+4 */
00141     } context_switch; /* 64 */
00142     struct __attribute__((__packed__))
00143     {
00144     } empty; /* 40 */
00145     struct __attribute__((__packed__))
00146     {
00147       char __pre_pad[2];
00148       L4_ktrace_t__L4_msg_tag _tag; /* 36+4 */
00149       L4_ktrace_t__Mword _dword[2]; /* 40+8 */
00150       L4_ktrace_t__L4_obj_ref _dst; /* 48+4 */
00151       L4_ktrace_t__Mword _dbg_id; /* 52+4 */
00152       L4_ktrace_t__Mword _label; /* 56+4 */
00153       L4_ktrace_t__L4_timeout_pair _timeout; /* 60+4 */
00154     } ipc; /* 64 */
00155     struct __attribute__((__packed__))
00156     {
00157       L4_ktrace_t__Unsigned8 _have_snd; /* 34+1 */
00158       L4_ktrace_t__Unsigned8 _is_np; /* 35+1 */
00159       L4_ktrace_t__L4_msg_tag _tag; /* 36+4 */
00160       L4_ktrace_t__Mword _dword[2]; /* 40+8 */
00161       L4_ktrace_t__L4_error _result; /* 48+4 */
00162       L4_ktrace_t__Mword _from; /* 52+4 */
00163       L4_ktrace_t__L4_obj_ref _dst; /* 56+4 */
00164       L4_ktrace_t__Mword _pair_event; /* 60+4 */
00165     } ipc_res; /* 64 */
00166     struct __attribute__((__packed__))
00167     {
00168       char __pre_pad[2];
00169       union __attribute__((__packed__)) {
00170         char msg[24]; /* 0+24 */
00171         struct __attribute__((__packed__)) {
00172           char tag[2]; /* 0+2 */
00173           char __pad_1[2];
00174           char *ptr; /* 4+4 */
00175         } mptr; /* 0+8 */
00176       } msg; /* 36+24 */
00177     } ke; /* 64 */
00178     struct __attribute__((__packed__))
00179     {
00180       char _msg[24]; /* 34+24 */
00181     } ke_bin; /* 64 */
00182     struct __attribute__((__packed__))
00183     {
00184       char __pre_pad[2];
00185       L4_ktrace_t__Mword v[3]; /* 36+12 */
00186       union __attribute__((__packed__)) {
00187         char msg[12]; /* 0+12 */
00188         struct __attribute__((__packed__)) {
00189           char tag[2]; /* 0+2 */
00190           char __pad_1[2];
00191           char *ptr; /* 4+4 */
00192         } mptr; /* 0+8 */
00193       } msg; /* 48+12 */
00194     } ke_reg; /* 64 */
00195     struct __attribute__((__packed__))
00196     {
00197       char __pre_pad[2];
00198       L4_ktrace_t__Address _pfa; /* 36+4 */
00199       L4_ktrace_t__Mword _error; /* 40+4 */
00200       L4_ktrace_t__Space *_space; /* 44+4 */
00201     } pf; /* 48 */
00202     struct __attribute__((__packed__))
00203     {
00204       unsigned short mode; /* 34+2 */
```

```
00205       L4_ktrace_t__Context *owner; /* 36+4 */
00206       unsigned short id; /* 40+2 */
00207       unsigned short prio; /* 42+2 */
00208       long left; /* 44+4 */
00209       unsigned long quantum; /* 48+4 */
00210     } sched; /* 56 */
00211     struct __attribute__((__packed__))
00212     {
00213       char __pre_pad[2];
00214       L4_ktrace_t__Unsigned32 _error; /* 36+4 */
00215       L4_ktrace_t__Mword _cpsr; /* 40+4 */
00216       L4_ktrace_t__Mword _sp; /* 44+4 */
00217     } trap; /* 48 */
00218     struct __attribute__((__packed__))
00219     {
00220       char _padding[24]; /* 34+24 */
00221       char __post_pad[6]; /* 58+6 */
00222     } fullsize; /* 64 */
00223     struct __attribute__((__packed__))
00224     {
00225       char __pre_pad[2];
00226       L4_ktrace_t__Cap_index cap_idx; /* 36+4 */
00227     } ieh; /* 40 */
00228     struct __attribute__((__packed__))
00229     {
00230       char __pre_pad[2];
00231       L4_ktrace_t__Mword pfa; /* 36+4 */
00232       L4_ktrace_t__Cap_index cap_idx; /* 40+4 */
00233       L4_ktrace_t__Mword err; /* 44+4 */
00234     } ipfh; /* 48 */
00235     struct __attribute__((__packed__))
00236     {
00237       char __pre_pad[2];
00238       L4_ktrace_t__Mword id; /* 36+4 */
00239       L4_ktrace_t__Mword ip; /* 40+4 */
00240       L4_ktrace_t__Mword sp; /* 44+4 */
00241       L4_ktrace_t__Mword op; /* 48+4 */
00242     } exregs; /* 56 */
00243     struct __attribute__((__packed__))
00244     {
00245       char __pre_pad[2];
00246       L4_ktrace_t__Mword state; /* 36+4 */
00247       L4_ktrace_t__Address user_ip; /* 40+4 */
00248       L4_ktrace_t__Cpu_number src_cpu; /* 44+4 */
00249       L4_ktrace_t__Cpu_number target_cpu; /* 48+4 */
00250     } migration; /* 56 */
00251     struct __attribute__((__packed__))
00252     {
00253       char __pre_pad[2];
00254       L4_ktrace_t__Address user_ip; /* 36+4 */
00255     } timer; /* 40 */
00256   } m;
00257 } l4_tracebuffer_entry_t;
```

16.109 ktrace_events.h

```
00001 /* Note, automatically generated from Fiasco binary */
00002 #pragma once
00003
00004 enum L4_ktrace_tbuf_entry_fixed
00005 {
00006   l4_ktrace_tbuf_unused = 0,
00007   l4_ktrace_tbuf_pf = 1,
00008   l4_ktrace_tbuf_ipc = 2,
00009   l4_ktrace_tbuf_ipc_res = 3,
00010   l4_ktrace_tbuf_ipc_trace = 4,
00011   l4_ktrace_tbuf_ke = 5,
00012   l4_ktrace_tbuf_ke_reg = 6,
00013   l4_ktrace_tbuf_breakpoint = 7,
00014   l4_ktrace_tbuf_ke_bin = 8,
00015   l4_ktrace_tbuf_dynentries = 9,
00016   l4_ktrace_tbuf_max = 128,
00017   l4_ktrace_tbuf_hidden = 128,
00018 };
00019
00020 typedef unsigned long L4_ktrace_t__Address;
00021 typedef unsigned long L4_ktrace_t__Cap_index;
00022 typedef void L4_ktrace_t__Context;
00023 typedef void L4_ktrace_t__Context__Drq;
00024 typedef unsigned L4_ktrace_t__Context__Drq_log__Type;
00025 typedef unsigned L4_ktrace_t__Cpu_number;
00026 typedef void L4_ktrace_t__Irq_base;
00027 typedef void L4_ktrace_t__Irq_chip;
00028 typedef void L4_ktrace_t__Kobject;
```

```
00029 typedef unsigned long L4_ktrace_t__L4_error;
00030 typedef unsigned long L4_ktrace_t__L4_msg_tag;
00031 typedef unsigned long L4_ktrace_t__L4_obj_ref;
00032 typedef unsigned L4_ktrace_t__L4_timeout_pair;
00033 typedef unsigned long L4_ktrace_t__Mword;
00034 typedef void L4_ktrace_t__Rcu_item;
00035 typedef void L4_ktrace_t__Sched_context;
00036 typedef long L4_ktrace_t__Smword;
00037 typedef void L4_ktrace_t__Space;
00038 typedef unsigned int L4_ktrace_t__Unsigned32;
00039 typedef unsigned long long L4_ktrace_t__Unsigned64;
00040 typedef unsigned char L4_ktrace_t__Unsigned8;
00041 typedef void L4_ktrace_t__cxx__Type_info;
00042
00043 typedef struct __attribute__((packed))
00044 {
00045   L4_ktrace_t__Mword _number; /* 0+8 */
00046   L4_ktrace_t__Address _ip; /* 8+8 */
00047   L4_ktrace_t__Unsigned64 _tsc; /* 16+8 */
00048   L4_ktrace_t__Context *_ctx; /* 24+8 */
00049   L4_ktrace_t__Unsigned32 _pmc1; /* 32+4 */
00050   L4_ktrace_t__Unsigned32 _pmc2; /* 36+4 */
00051   L4_ktrace_t__Unsigned32 _kclock; /* 40+4 */
00052   L4_ktrace_t__Unsigned8 _type; /* 44+1 */
00053   L4_ktrace_t__Unsigned8 _cpu; /* 45+1 */
00054   union __attribute__((__packed__))
00055   {
00056     struct __attribute__((__packed__))
00057     {
00058       char __pre_pad[2];
00059       void *func; /* 48+8 */
00060       L4_ktrace_t__Context *thread; /* 56+8 */
00061       L4_ktrace_t__Context__Drq *rq; /* 64+8 */
00062       L4_ktrace_t__Cpu_number target_cpu; /* 72+4 */
00063       L4_ktrace_t__Context__Drq_log__Type type; /* 76+4 */
00064       char wait; /* 80+1 */
00065     } drq; /* 88 */
00066     struct __attribute__((__packed__))
00067     {
00068       char __pre_pad[2];
00069       L4_ktrace_t__Mword state; /* 48+8 */
00070       L4_ktrace_t__Mword ip; /* 56+8 */
00071       L4_ktrace_t__Mword sp; /* 64+8 */
00072       L4_ktrace_t__Mword space; /* 72+8 */
00073       L4_ktrace_t__Mword err; /* 80+8 */
00074       unsigned char type; /* 88+1 */
00075       unsigned char trap; /* 89+1 */
00076     } vcpu; /* 96 */
00077     struct __attribute__((__packed__))
00078     {
00079       char __pre_pad[2];
00080       L4_ktrace_t__Smword op; /* 48+8 */
00081       L4_ktrace_t__Cap_index buffer; /* 56+8 */
00082       L4_ktrace_t__Mword id; /* 64+8 */
00083       L4_ktrace_t__Mword ram; /* 72+8 */
00084       L4_ktrace_t__Mword newo; /* 80+8 */
00085     } factory; /* 88 */
00086     struct __attribute__((__packed__))
00087     {
00088       char __pre_pad[2];
00089       L4_ktrace_t__Mword gate_dbg_id; /* 48+8 */
00090       L4_ktrace_t__Mword thread_dbg_id; /* 56+8 */
00091       L4_ktrace_t__Mword label; /* 64+8 */
00092     } gate; /* 72 */
00093     struct __attribute__((__packed__))
00094     {
00095       char __pre_pad[2];
00096       L4_ktrace_t__Irq_base *obj; /* 48+8 */
00097       L4_ktrace_t__Irq_chip *chip; /* 56+8 */
00098       L4_ktrace_t__Mword pin; /* 64+8 */
00099     } irq; /* 72 */
00100     struct __attribute__((__packed__))
00101     {
00102       char __pre_pad[2];
00103       L4_ktrace_t__Kobject *obj; /* 48+8 */
00104       L4_ktrace_t__Mword id; /* 56+8 */
00105       L4_ktrace_t__cxx__Type_info *type; /* 64+8 */
00106       L4_ktrace_t__Mword ram; /* 72+8 */
00107     } destroy; /* 80 */
00108     struct __attribute__((__packed__))
00109     {
00110       char __pre_pad[2];
00111       L4_ktrace_t__Cpu_number cpu; /* 48+4 */
00112       char __pad_1[4];
00113       L4_ktrace_t__Rcu_item *item; /* 56+8 */
00114       void *cb; /* 64+8 */
00115       unsigned char event; /* 72+1 */
```

```
00116     } rcu; /* 80 */
00117     struct __attribute__((__packed__))
00118     {
00119       char __pre_pad[2];
00120       L4_ktrace_t__Mword id; /* 48+8 */
00121       L4_ktrace_t__Mword mask; /* 56+8 */
00122       L4_ktrace_t__Mword fpage; /* 64+8 */
00123       char map; /* 72+1 */
00124     } tmap; /* 80 */
00125     struct __attribute__((__packed__))
00126     {
00127       char __pre_pad[2];
00128       L4_ktrace_t__Address _address; /* 48+8 */
00129       int _len; /* 56+4 */
00130       char __pad_1[4];
00131       L4_ktrace_t__Mword _value; /* 64+8 */
00132       int _mode; /* 72+4 */
00133     } bp; /* 80 */
00134     struct __attribute__((__packed__))
00135     {
00136       char __pre_pad[2];
00137       L4_ktrace_t__Context *dst; /* 48+8 */
00138       L4_ktrace_t__Address kernel_ip; /* 56+8 */
00139       L4_ktrace_t__Mword lock_cnt; /* 64+8 */
00140       L4_ktrace_t__Space *from_space; /* 72+8 */
00141       L4_ktrace_t__Sched_context *from_sched; /* 80+8 */
00142       L4_ktrace_t__Mword from_prio; /* 88+8 */
00143     } context_switch; /* 96 */
00144     struct __attribute__((__packed__))
00145     {
00146     } empty; /* 48 */
00147     struct __attribute__((__packed__))
00148     {
00149       char __pre_pad[2];
00150       L4_ktrace_t__L4_msg_tag _tag; /* 48+8 */
00151       L4_ktrace_t__Mword _dword[2]; /* 56+16 */
00152       L4_ktrace_t__L4_obj_ref _dst; /* 72+8 */
00153       L4_ktrace_t__Mword _dbg_id; /* 80+8 */
00154       L4_ktrace_t__Mword _label; /* 88+8 */
00155       L4_ktrace_t__L4_timeout_pair _timeout; /* 96+4 */
00156       char __pad_1[4];
00157       L4_ktrace_t__Unsigned64 _to_abs_rcv; /* 104+8 */
00158     } ipc; /* 112 */
00159     struct __attribute__((__packed__))
00160     {
00161       L4_ktrace_t__Unsigned8 _have_snd; /* 46+1 */
00162       L4_ktrace_t__Unsigned8 _is_np; /* 47+1 */
00163       L4_ktrace_t__L4_msg_tag _tag; /* 48+8 */
00164       L4_ktrace_t__Mword _dword[2]; /* 56+16 */
00165       L4_ktrace_t__L4_error _result; /* 72+8 */
00166       L4_ktrace_t__Mword _from; /* 80+8 */
00167       L4_ktrace_t__L4_obj_ref _dst; /* 88+8 */
00168       L4_ktrace_t__Mword _pair_event; /* 96+8 */
00169     } ipc_res; /* 104 */
00170     struct __attribute__((__packed__))
00171     {
00172       char __pre_pad[2];
00173       union __attribute__((__packed__)) {
00174         char msg[80]; /* 0+80 */
00175         struct __attribute__((__packed__)) {
00176           char tag[2]; /* 0+2 */
00177           char __pad_1[6];
00178           char *ptr; /* 8+8 */
00179         } mptr; /* 0+16 */
00180       } msg; /* 48+80 */
00181     } ke; /* 128 */
00182     struct __attribute__((__packed__))
00183     {
00184       char _msg[80]; /* 46+80 */
00185     } ke_bin; /* 128 */
00186     struct __attribute__((__packed__))
00187     {
00188       char __pre_pad[2];
00189       L4_ktrace_t__Mword v[3]; /* 48+24 */
00190       union __attribute__((__packed__)) {
00191         char msg[56]; /* 0+56 */
00192         struct __attribute__((__packed__)) {
00193           char tag[2]; /* 0+2 */
00194           char __pad_1[6];
00195           char *ptr; /* 8+8 */
00196         } mptr; /* 0+16 */
00197       } msg; /* 72+56 */
00198     } ke_reg; /* 128 */
00199     struct __attribute__((__packed__))
00200     {
00201       char __pre_pad[2];
00202       L4_ktrace_t__Address _pfa; /* 48+8 */
```

```
00203       L4_ktrace_t__Mword _error; /* 56+8 */
00204       L4_ktrace_t__Space *_space; /* 64+8 */
00205     } pf; /* 72 */
00206     struct __attribute__((__packed__))
00207     {
00208       unsigned short mode; /* 46+2 */
00209       L4_ktrace_t__Context *owner; /* 48+8 */
00210       unsigned short id; /* 56+2 */
00211       unsigned short prio; /* 58+2 */
00212       char __pad_1[4];
00213       long left; /* 64+8 */
00214       unsigned long quantum; /* 72+8 */
00215     } sched; /* 80 */
00216     struct __attribute__((__packed__))
00217     {
00218       char __pre_pad[2];
00219       L4_ktrace_t__Unsigned32 _error; /* 48+4 */
00220       char __pad_1[4];
00221       L4_ktrace_t__Mword _cpsr; /* 56+8 */
00222       L4_ktrace_t__Mword _sp; /* 64+8 */
00223     } trap; /* 72 */
00224     struct __attribute__((__packed__))
00225     {
00226       char _padding[80]; /* 46+80 */
00227       char __post_pad[2]; /* 126+2 */
00228     } fullsize; /* 128 */
00229     struct __attribute__((__packed__))
00230     {
00231       char __pre_pad[2];
00232       L4_ktrace_t__Cap_index cap_idx; /* 48+8 */
00233     } ieh; /* 56 */
00234     struct __attribute__((__packed__))
00235     {
00236       char __pre_pad[2];
00237       L4_ktrace_t__Mword pfa; /* 48+8 */
00238       L4_ktrace_t__Cap_index cap_idx; /* 56+8 */
00239       L4_ktrace_t__Mword err; /* 64+8 */
00240     } ipfh; /* 72 */
00241     struct __attribute__((__packed__))
00242     {
00243       char __pre_pad[2];
00244       L4_ktrace_t__Mword id; /* 48+8 */
00245       L4_ktrace_t__Mword ip; /* 56+8 */
00246       L4_ktrace_t__Mword sp; /* 64+8 */
00247       L4_ktrace_t__Mword op; /* 72+8 */
00248     } exregs; /* 80 */
00249     struct __attribute__((__packed__))
00250     {
00251       char __pre_pad[2];
00252       L4_ktrace_t__Mword state; /* 48+8 */
00253       L4_ktrace_t__Address user_ip; /* 56+8 */
00254       L4_ktrace_t__Cpu_number src_cpu; /* 64+4 */
00255       L4_ktrace_t__Cpu_number target_cpu; /* 68+4 */
00256     } migration; /* 72 */
00257     struct __attribute__((__packed__))
00258     {
00259       char __pre_pad[2];
00260       L4_ktrace_t__Address user_ip; /* 48+8 */
00261     } timer; /* 56 */
00262   } m;
00263 } l4_tracebuffer_entry_t;
```

16.110 ktrace_events.h

```
00001 /* Note, automatically generated from Fiasco binary */
00002 #pragma once
00003
00004 enum L4_ktrace_tbuf_entry_fixed
00005 {
00006   l4_ktrace_tbuf_unused = 0,
00007   l4_ktrace_tbuf_pf = 1,
00008   l4_ktrace_tbuf_ipc = 2,
00009   l4_ktrace_tbuf_ipc_res = 3,
00010   l4_ktrace_tbuf_ipc_trace = 4,
00011   l4_ktrace_tbuf_ke = 5,
00012   l4_ktrace_tbuf_ke_reg = 6,
00013   l4_ktrace_tbuf_breakpoint = 7,
00014   l4_ktrace_tbuf_ke_bin = 8,
00015   l4_ktrace_tbuf_dynentries = 9,
00016   l4_ktrace_tbuf_max = 128,
00017   l4_ktrace_tbuf_hidden = 128,
00018 };
00019
00020 typedef unsigned long L4_ktrace_t__Address;
```

```
00021 typedef unsigned long L4_ktrace_t__Cap_index;
00022 typedef void L4_ktrace_t__Context;
00023 typedef void L4_ktrace_t__Context__Drq;
00024 typedef unsigned L4_ktrace_t__Context__Drq_log__Type;
00025 typedef unsigned L4_ktrace_t__Cpu_number;
00026 typedef void L4_ktrace_t__Irq_base;
00027 typedef void L4_ktrace_t__Irq_chip;
00028 typedef void L4_ktrace_t__Kobject;
00029 typedef unsigned long L4_ktrace_t__L4_error;
00030 typedef unsigned long L4_ktrace_t__L4_msg_tag;
00031 typedef unsigned long L4_ktrace_t__L4_obj_ref;
00032 typedef unsigned L4_ktrace_t__L4_timeout_pair;
00033 typedef unsigned long L4_ktrace_t__Mword;
00034 typedef void L4_ktrace_t__Rcu_item;
00035 typedef void L4_ktrace_t__Sched_context;
00036 typedef long L4_ktrace_t__Smword;
00037 typedef void L4_ktrace_t__Space;
00038 typedef unsigned int L4_ktrace_t__Unsigned32;
00039 typedef unsigned long long L4_ktrace_t__Unsigned64;
00040 typedef unsigned char L4_ktrace_t__Unsigned8;
00041 typedef void L4_ktrace_t__cxx__Type_info;
00042
00043 #if __riscv_xlen == 32
00044 typedef struct __attribute__((packed))
00045 {
00046   L4_ktrace_t__Mword _number; /* 0+4 */
00047   L4_ktrace_t__Address _ip; /* 4+4 */
00048   L4_ktrace_t__Unsigned64 _tsc; /* 8+8 */
00049   L4_ktrace_t__Context *_ctx; /* 16+4 */
00050   L4_ktrace_t__Unsigned32 _pmc1; /* 20+4 */
00051   L4_ktrace_t__Unsigned32 _pmc2; /* 24+4 */
00052   L4_ktrace_t__Unsigned32 _kclock; /* 28+4 */
00053   L4_ktrace_t__Unsigned8 _type; /* 32+1 */
00054   L4_ktrace_t__Unsigned8 _cpu; /* 33+1 */
00055   union __attribute__((__packed__))
00056   {
00057     struct __attribute__((__packed__))
00058     {
00059       char __pre_pad[2];
00060       void *func; /* 36+4 */
00061       L4_ktrace_t__Context *thread; /* 40+4 */
00062       L4_ktrace_t__Context__Drq *rq; /* 44+4 */
00063       L4_ktrace_t__Cpu_number target_cpu; /* 48+4 */
00064       L4_ktrace_t__Context__Drq_log__Type type; /* 52+4 */
00065       char wait; /* 56+1 */
00066     } drq; /* 64 */
00067     struct __attribute__((__packed__))
00068     {
00069       char __pre_pad[2];
00070       L4_ktrace_t__Mword state; /* 36+4 */
00071       L4_ktrace_t__Mword ip; /* 40+4 */
00072       L4_ktrace_t__Mword sp; /* 44+4 */
00073       L4_ktrace_t__Mword space; /* 48+4 */
00074       L4_ktrace_t__Mword err; /* 52+4 */
00075       unsigned char type; /* 56+1 */
00076       unsigned char trap; /* 57+1 */
00077     } vcpu; /* 64 */
00078     struct __attribute__((__packed__))
00079     {
00080       char __pre_pad[2];
00081       L4_ktrace_t__Smword op; /* 36+4 */
00082       L4_ktrace_t__Cap_index buffer; /* 40+4 */
00083       L4_ktrace_t__Mword id; /* 44+4 */
00084       L4_ktrace_t__Mword ram; /* 48+4 */
00085       L4_ktrace_t__Mword newo; /* 52+4 */
00086     } factory; /* 56 */
00087     struct __attribute__((__packed__))
00088     {
00089       char __pre_pad[2];
00090       L4_ktrace_t__Mword gate_dbg_id; /* 36+4 */
00091       L4_ktrace_t__Mword thread_dbg_id; /* 40+4 */
00092       L4_ktrace_t__Mword label; /* 44+4 */
00093     } gate; /* 48 */
00094     struct __attribute__((__packed__))
00095     {
00096       char __pre_pad[2];
00097       L4_ktrace_t__Irq_base *obj; /* 36+4 */
00098       L4_ktrace_t__Irq_chip *chip; /* 40+4 */
00099       L4_ktrace_t__Mword pin; /* 44+4 */
00100     } irq; /* 48 */
00101     struct __attribute__((__packed__))
00102     {
00103       char __pre_pad[2];
00104       L4_ktrace_t__Kobject *obj; /* 36+4 */
00105       L4_ktrace_t__Mword id; /* 40+4 */
00106       L4_ktrace_t__cxx__Type_info *type; /* 44+4 */
00107       L4_ktrace_t__Mword ram; /* 48+4 */
```

```
00108     } destroy; /* 56 */
00109     struct __attribute__((__packed__))
00110     {
00111       char __pre_pad[2];
00112       L4_ktrace_t__Cpu_number cpu; /* 36+4 */
00113       L4_ktrace_t__Rcu_item *item; /* 40+4 */
00114       void *cb; /* 44+4 */
00115       unsigned char event; /* 48+1 */
00116     } rcu; /* 56 */
00117     struct __attribute__((__packed__))
00118     {
00119       char __pre_pad[2];
00120       L4_ktrace_t__Mword id; /* 36+4 */
00121       L4_ktrace_t__Mword mask; /* 40+4 */
00122       L4_ktrace_t__Mword fpage; /* 44+4 */
00123       char map; /* 48+1 */
00124     } tmap; /* 56 */
00125     struct __attribute__((__packed__))
00126     {
00127       char __pre_pad[2];
00128       L4_ktrace_t__Address _address; /* 36+4 */
00129       int _len; /* 40+4 */
00130       L4_ktrace_t__Mword _value; /* 44+4 */
00131       int _mode; /* 48+4 */
00132     } bp; /* 56 */
00133     struct __attribute__((__packed__))
00134     {
00135       char __pre_pad[2];
00136       L4_ktrace_t__Context *dst; /* 36+4 */
00137       L4_ktrace_t__Address kernel_ip; /* 40+4 */
00138       L4_ktrace_t__Mword lock_cnt; /* 44+4 */
00139       L4_ktrace_t__Space *from_space; /* 48+4 */
00140       L4_ktrace_t__Sched_context *from_sched; /* 52+4 */
00141       L4_ktrace_t__Mword from_prio; /* 56+4 */
00142     } context_switch; /* 64 */
00143     struct __attribute__((__packed__))
00144     {
00145     } empty; /* 40 */
00146     struct __attribute__((__packed__))
00147     {
00148       char __pre_pad[2];
00149       L4_ktrace_t__L4_msg_tag _tag; /* 36+4 */
00150       L4_ktrace_t__Mword _dword[2]; /* 40+8 */
00151       L4_ktrace_t__L4_obj_ref _dst; /* 48+4 */
00152       L4_ktrace_t__Mword _dbg_id; /* 52+4 */
00153       L4_ktrace_t__Mword _label; /* 56+4 */
00154       L4_ktrace_t__L4_timeout_pair _timeout; /* 60+4 */
00155     } ipc; /* 64 */
00156     struct __attribute__((__packed__))
00157     {
00158       L4_ktrace_t__Unsigned8 _have_snd; /* 34+1 */
00159       L4_ktrace_t__Unsigned8 _is_np; /* 35+1 */
00160       L4_ktrace_t__L4_msg_tag _tag; /* 36+4 */
00161       L4_ktrace_t__Mword _dword[2]; /* 40+8 */
00162       L4_ktrace_t__L4_error _result; /* 48+4 */
00163       L4_ktrace_t__Mword _from; /* 52+4 */
00164       L4_ktrace_t__L4_obj_ref _dst; /* 56+4 */
00165       L4_ktrace_t__Mword _pair_event; /* 60+4 */
00166     } ipc_res; /* 64 */
00167     struct __attribute__((__packed__))
00168     {
00169       char __pre_pad[2];
00170       union __attribute__((__packed__)) {
00171         char msg[24]; /* 0+24 */
00172         struct __attribute__((__packed__)) {
00173           char tag[2]; /* 0+2 */
00174           char __pad_1[2];
00175           char *ptr; /* 4+4 */
00176         } mptr; /* 0+8 */
00177       } msg; /* 36+24 */
00178     } ke; /* 64 */
00179     struct __attribute__((__packed__))
00180     {
00181       char _msg[24]; /* 34+24 */
00182     } ke_bin; /* 64 */
00183     struct __attribute__((__packed__))
00184     {
00185       char __pre_pad[2];
00186       L4_ktrace_t__Mword v[3]; /* 36+12 */
00187       union __attribute__((__packed__)) {
00188         char msg[12]; /* 0+12 */
00189         struct __attribute__((__packed__)) {
00190           char tag[2]; /* 0+2 */
00191           char __pad_1[2];
00192           char *ptr; /* 4+4 */
00193         } mptr; /* 0+8 */
00194       } msg; /* 48+12 */
```

```
00195     } ke_reg; /* 64 */
00196     struct __attribute__((__packed__))
00197     {
00198       char __pre_pad[2];
00199       L4_ktrace_t__Address _pfa; /* 36+4 */
00200       L4_ktrace_t__Mword _error; /* 40+4 */
00201       L4_ktrace_t__Space *_space; /* 44+4 */
00202     } pf; /* 48 */
00203     struct __attribute__((__packed__))
00204     {
00205       unsigned short mode; /* 34+2 */
00206       L4_ktrace_t__Context *owner; /* 36+4 */
00207       unsigned short id; /* 40+2 */
00208       unsigned short prio; /* 42+2 */
00209       long left; /* 44+4 */
00210       unsigned long quantum; /* 48+4 */
00211     } sched; /* 56 */
00212     struct __attribute__((__packed__))
00213     {
00214       char __pre_pad[2];
00215       L4_ktrace_t__Unsigned32 _cause; /* 36+4 */
00216       L4_ktrace_t__Mword _sp; /* 40+4 */
00217     } trap; /* 48 */
00218     struct __attribute__((__packed__))
00219     {
00220       char _padding[24]; /* 34+24 */
00221       char __post_pad[6]; /* 58+6 */
00222     } fullsize; /* 64 */
00223     struct __attribute__((__packed__))
00224     {
00225       char __pre_pad[2];
00226       L4_ktrace_t__Cap_index cap_idx; /* 36+4 */
00227     } ieh; /* 40 */
00228     struct __attribute__((__packed__))
00229     {
00230       char __pre_pad[2];
00231       L4_ktrace_t__Mword pfa; /* 36+4 */
00232       L4_ktrace_t__Cap_index cap_idx; /* 40+4 */
00233       L4_ktrace_t__Mword err; /* 44+4 */
00234     } ipfh; /* 48 */
00235     struct __attribute__((__packed__))
00236     {
00237       char __pre_pad[2];
00238       L4_ktrace_t__Mword id; /* 36+4 */
00239       L4_ktrace_t__Mword ip; /* 40+4 */
00240       L4_ktrace_t__Mword sp; /* 44+4 */
00241       L4_ktrace_t__Mword op; /* 48+4 */
00242     } exregs; /* 56 */
00243     struct __attribute__((__packed__))
00244     {
00245       char __pre_pad[2];
00246       L4_ktrace_t__Mword state; /* 36+4 */
00247       L4_ktrace_t__Address user_ip; /* 40+4 */
00248       L4_ktrace_t__Cpu_number src_cpu; /* 44+4 */
00249       L4_ktrace_t__Cpu_number target_cpu; /* 48+4 */
00250     } migration; /* 56 */
00251     struct __attribute__((__packed__))
00252     {
00253       char __pre_pad[2];
00254       L4_ktrace_t__Address user_ip; /* 36+4 */
00255     } timer; /* 40 */
00256   } m;
00257 } l4_tracebuffer_entry_t;
00258 #else
00259 typedef struct __attribute__((packed))
00260 {
00261   L4_ktrace_t__Mword _number; /* 0+8 */
00262   L4_ktrace_t__Address _ip; /* 8+8 */
00263   L4_ktrace_t__Unsigned64 _tsc; /* 16+8 */
00264   L4_ktrace_t__Context *_ctx; /* 24+8 */
00265   L4_ktrace_t__Unsigned32 _pmc1; /* 32+4 */
00266   L4_ktrace_t__Unsigned32 _pmc2; /* 36+4 */
00267   L4_ktrace_t__Unsigned32 _kclock; /* 40+4 */
00268   L4_ktrace_t__Unsigned8 _type; /* 44+1 */
00269   L4_ktrace_t__Unsigned8 _cpu; /* 45+1 */
00270   union __attribute__((__packed__))
00271   {
00272     struct __attribute__((__packed__))
00273     {
00274       char __pre_pad[2];
00275       void *func; /* 48+8 */
00276       L4_ktrace_t__Context *thread; /* 56+8 */
00277       L4_ktrace_t__Context__Drq *rq; /* 64+8 */
00278       L4_ktrace_t__Cpu_number target_cpu; /* 72+4 */
00279       L4_ktrace_t__Context__Drq_log__Type type; /* 76+4 */
00280       char wait; /* 80+1 */
00281     } drq; /* 88 */
```

```
00282     struct __attribute__((__packed__))
00283     {
00284       char __pre_pad[2];
00285       L4_ktrace_t__Mword state; /* 48+8 */
00286       L4_ktrace_t__Mword ip; /* 56+8 */
00287       L4_ktrace_t__Mword sp; /* 64+8 */
00288       L4_ktrace_t__Mword space; /* 72+8 */
00289       L4_ktrace_t__Mword err; /* 80+8 */
00290       unsigned char type; /* 88+1 */
00291       unsigned char trap; /* 89+1 */
00292     } vcpu; /* 96 */
00293     struct __attribute__((__packed__))
00294     {
00295       char __pre_pad[2];
00296       L4_ktrace_t__Smword op; /* 48+8 */
00297       L4_ktrace_t__Cap_index buffer; /* 56+8 */
00298       L4_ktrace_t__Mword id; /* 64+8 */
00299       L4_ktrace_t__Mword ram; /* 72+8 */
00300       L4_ktrace_t__Mword newo; /* 80+8 */
00301     } factory; /* 88 */
00302     struct __attribute__((__packed__))
00303     {
00304       char __pre_pad[2];
00305       L4_ktrace_t__Mword gate_dbg_id; /* 48+8 */
00306       L4_ktrace_t__Mword thread_dbg_id; /* 56+8 */
00307       L4_ktrace_t__Mword label; /* 64+8 */
00308     } gate; /* 72 */
00309     struct __attribute__((__packed__))
00310     {
00311       char __pre_pad[2];
00312       L4_ktrace_t__Irq_base *obj; /* 48+8 */
00313       L4_ktrace_t__Irq_chip *chip; /* 56+8 */
00314       L4_ktrace_t__Mword pin; /* 64+8 */
00315     } irq; /* 72 */
00316     struct __attribute__((__packed__))
00317     {
00318       char __pre_pad[2];
00319       L4_ktrace_t__Kobject *obj; /* 48+8 */
00320       L4_ktrace_t__Mword id; /* 56+8 */
00321       L4_ktrace_t__cxx__Type_info *type; /* 64+8 */
00322       L4_ktrace_t__Mword ram; /* 72+8 */
00323     } destroy; /* 80 */
00324     struct __attribute__((__packed__))
00325     {
00326       char __pre_pad[2];
00327       L4_ktrace_t__Cpu_number cpu; /* 48+4 */
00328       char __pad_1[4];
00329       L4_ktrace_t__Rcu_item *item; /* 56+8 */
00330       void *cb; /* 64+8 */
00331       unsigned char event; /* 72+1 */
00332     } rcu; /* 80 */
00333     struct __attribute__((__packed__))
00334     {
00335       char __pre_pad[2];
00336       L4_ktrace_t__Mword id; /* 48+8 */
00337       L4_ktrace_t__Mword mask; /* 56+8 */
00338       L4_ktrace_t__Mword fpage; /* 64+8 */
00339       char map; /* 72+1 */
00340     } tmap; /* 80 */
00341     struct __attribute__((__packed__))
00342     {
00343       char __pre_pad[2];
00344       L4_ktrace_t__Address _address; /* 48+8 */
00345       int _len; /* 56+4 */
00346       char __pad_1[4];
00347       L4_ktrace_t__Mword _value; /* 64+8 */
00348       int _mode; /* 72+4 */
00349     } bp; /* 80 */
00350     struct __attribute__((__packed__))
00351     {
00352       char __pre_pad[2];
00353       L4_ktrace_t__Context *dst; /* 48+8 */
00354       L4_ktrace_t__Address kernel_ip; /* 56+8 */
00355       L4_ktrace_t__Mword lock_cnt; /* 64+8 */
00356       L4_ktrace_t__Space *from_space; /* 72+8 */
00357       L4_ktrace_t__Sched_context *from_sched; /* 80+8 */
00358       L4_ktrace_t__Mword from_prio; /* 88+8 */
00359     } context_switch; /* 96 */
00360     struct __attribute__((__packed__))
00361     {
00362     } empty; /* 48 */
00363     struct __attribute__((__packed__))
00364     {
00365       char __pre_pad[2];
00366       L4_ktrace_t__L4_msg_tag _tag; /* 48+8 */
00367       L4_ktrace_t__Mword _dword[2]; /* 56+16 */
00368       L4_ktrace_t__L4_obj_ref _dst; /* 72+8 */
```

```
00369       L4_ktrace_t__Mword _dbg_id; /* 80+8 */
00370       L4_ktrace_t__Mword _label; /* 88+8 */
00371       L4_ktrace_t__L4_timeout_pair _timeout; /* 96+4 */
00372       char __pad_1[4];
00373       L4_ktrace_t__Unsigned64 _to_abs_rcv; /* 104+8 */
00374     } ipc; /* 112 */
00375     struct __attribute__((__packed__))
00376     {
00377       L4_ktrace_t__Unsigned8 _have_snd; /* 46+1 */
00378       L4_ktrace_t__Unsigned8 _is_np; /* 47+1 */
00379       L4_ktrace_t__L4_msg_tag _tag; /* 48+8 */
00380       L4_ktrace_t__Mword _dword[2]; /* 56+16 */
00381       L4_ktrace_t__L4_error _result; /* 72+8 */
00382       L4_ktrace_t__Mword _from; /* 80+8 */
00383       L4_ktrace_t__L4_obj_ref _dst; /* 88+8 */
00384       L4_ktrace_t__Mword _pair_event; /* 96+8 */
00385     } ipc_res; /* 104 */
00386     struct __attribute__((__packed__))
00387     {
00388       char __pre_pad[2];
00389       union __attribute__((__packed__)) {
00390         char msg[80]; /* 0+80 */
00391         struct __attribute__((__packed__)) {
00392           char tag[2]; /* 0+2 */
00393           char __pad_1[6];
00394           char *ptr; /* 8+8 */
00395         } mptr; /* 0+16 */
00396       } msg; /* 48+80 */
00397     } ke; /* 128 */
00398     struct __attribute__((__packed__))
00399     {
00400       char _msg[80]; /* 46+80 */
00401     } ke_bin; /* 128 */
00402     struct __attribute__((__packed__))
00403     {
00404       char __pre_pad[2];
00405       L4_ktrace_t__Mword v[3]; /* 48+24 */
00406       union __attribute__((__packed__)) {
00407         char msg[56]; /* 0+56 */
00408         struct __attribute__((__packed__)) {
00409           char tag[2]; /* 0+2 */
00410           char __pad_1[6];
00411           char *ptr; /* 8+8 */
00412         } mptr; /* 0+16 */
00413       } msg; /* 72+56 */
00414     } ke_reg; /* 128 */
00415     struct __attribute__((__packed__))
00416     {
00417       char __pre_pad[2];
00418       L4_ktrace_t__Address _pfa; /* 48+8 */
00419       L4_ktrace_t__Mword _error; /* 56+8 */
00420       L4_ktrace_t__Space *_space; /* 64+8 */
00421     } pf; /* 72 */
00422     struct __attribute__((__packed__))
00423     {
00424       unsigned short mode; /* 46+2 */
00425       L4_ktrace_t__Context *owner; /* 48+8 */
00426       unsigned short id; /* 56+2 */
00427       unsigned short prio; /* 58+2 */
00428       char __pad_1[4];
00429       long left; /* 64+8 */
00430       unsigned long quantum; /* 72+8 */
00431     } sched; /* 80 */
00432     struct __attribute__((__packed__))
00433     {
00434       char __pre_pad[2];
00435       L4_ktrace_t__Unsigned32 _cause; /* 48+4 */
00436       char __pad_1[4];
00437       L4_ktrace_t__Mword _sp; /* 56+8 */
00438     } trap; /* 64 */
00439     struct __attribute__((__packed__))
00440     {
00441       char _padding[80]; /* 46+80 */
00442       char __post_pad[2]; /* 126+2 */
00443     } fullsize; /* 128 */
00444     struct __attribute__((__packed__))
00445     {
00446       char __pre_pad[2];
00447       L4_ktrace_t__Cap_index cap_idx; /* 48+8 */
00448     } ieh; /* 56 */
00449     struct __attribute__((__packed__))
00450     {
00451       char __pre_pad[2];
00452       L4_ktrace_t__Mword pfa; /* 48+8 */
00453       L4_ktrace_t__Cap_index cap_idx; /* 56+8 */
00454       L4_ktrace_t__Mword err; /* 64+8 */
00455     } ipfh; /* 72 */
```

```
00456     struct __attribute__((__packed__))
00457     {
00458       char __pre_pad[2];
00459       L4_ktrace_t__Mword id; /* 48+8 */
00460       L4_ktrace_t__Mword ip; /* 56+8 */
00461       L4_ktrace_t__Mword sp; /* 64+8 */
00462       L4_ktrace_t__Mword op; /* 72+8 */
00463     } exregs; /* 80 */
00464     struct __attribute__((__packed__))
00465     {
00466       char __pre_pad[2];
00467       L4_ktrace_t__Mword state; /* 48+8 */
00468       L4_ktrace_t__Address user_ip; /* 56+8 */
00469       L4_ktrace_t__Cpu_number src_cpu; /* 64+4 */
00470       L4_ktrace_t__Cpu_number target_cpu; /* 68+4 */
00471     } migration; /* 72 */
00472     struct __attribute__((__packed__))
00473     {
00474       char __pre_pad[2];
00475       L4_ktrace_t__Address user_ip; /* 48+8 */
00476     } timer; /* 56 */
00477   } m;
00478 } l4_tracebuffer_entry_t;
00479 #endif
```

16.111 ktrace_events.h

```
00001 /* Note, automatically generated from Fiasco binary */
00002 #pragma once
00003
00004 enum L4_ktrace_tbuf_entry_fixed
00005 {
00006   l4_ktrace_tbuf_unused = 0,
00007   l4_ktrace_tbuf_pf = 1,
00008   l4_ktrace_tbuf_ipc = 2,
00009   l4_ktrace_tbuf_ipc_res = 3,
00010   l4_ktrace_tbuf_ipc_trace = 4,
00011   l4_ktrace_tbuf_ke = 5,
00012   l4_ktrace_tbuf_ke_reg = 6,
00013   l4_ktrace_tbuf_breakpoint = 7,
00014   l4_ktrace_tbuf_ke_bin = 8,
00015   l4_ktrace_tbuf_dynentries = 9,
00016   l4_ktrace_tbuf_max = 128,
00017   l4_ktrace_tbuf_hidden = 128,
00018 };
00019
00020 typedef unsigned long L4_ktrace_t__Address;
00021 typedef unsigned long L4_ktrace_t__Cap_index;
00022 typedef void L4_ktrace_t__Context;
00023 typedef void L4_ktrace_t__Context__Drq;
00024 typedef unsigned L4_ktrace_t__Context__Drq_log__Type;
00025 typedef unsigned L4_ktrace_t__Cpu_number;
00026 typedef void L4_ktrace_t__Irq_base;
00027 typedef void L4_ktrace_t__Irq_chip;
00028 typedef void L4_ktrace_t__Kobject;
00029 typedef unsigned long L4_ktrace_t__L4_error;
00030 typedef unsigned long L4_ktrace_t__L4_msg_tag;
00031 typedef unsigned long L4_ktrace_t__L4_obj_ref;
00032 typedef unsigned L4_ktrace_t__L4_timeout_pair;
00033 typedef unsigned long L4_ktrace_t__Mword;
00034 typedef void L4_ktrace_t__Rcu_item;
00035 typedef void L4_ktrace_t__Sched_context;
00036 typedef long L4_ktrace_t__Smword;
00037 typedef void L4_ktrace_t__Space;
00038 typedef unsigned short L4_ktrace_t__Unsigned16;
00039 typedef unsigned int L4_ktrace_t__Unsigned32;
00040 typedef unsigned long long L4_ktrace_t__Unsigned64;
00041 typedef unsigned char L4_ktrace_t__Unsigned8;
00042 typedef void L4_ktrace_t__cxx__Type_info;
00043
00044 typedef struct __attribute__((packed))
00045 {
00046   L4_ktrace_t__Mword _number; /* 0+4 */
00047   L4_ktrace_t__Address _ip; /* 4+4 */
00048   L4_ktrace_t__Unsigned64 _tsc; /* 8+8 */
00049   L4_ktrace_t__Context *_ctx; /* 16+4 */
00050   L4_ktrace_t__Unsigned32 _pmc1; /* 20+4 */
00051   L4_ktrace_t__Unsigned32 _pmc2; /* 24+4 */
00052   L4_ktrace_t__Unsigned32 _kclock; /* 28+4 */
00053   L4_ktrace_t__Unsigned8 _type; /* 32+1 */
00054   L4_ktrace_t__Unsigned8 _cpu; /* 33+1 */
00055   union __attribute__((__packed__))
00056   {
00057     struct __attribute__((__packed__))
```

```
00058     {
00059       char __pre_pad[2];
00060       void *func; /* 36+4 */
00061       L4_ktrace_t__Context *thread; /* 40+4 */
00062       L4_ktrace_t__Context__Drq *rq; /* 44+4 */
00063       L4_ktrace_t__Cpu_number target_cpu; /* 48+4 */
00064       L4_ktrace_t__Context__Drq_log__Type type; /* 52+4 */
00065       char wait; /* 56+1 */
00066     } drq; /* 64 */
00067     struct __attribute__((__packed__))
00068     {
00069       char __pre_pad[2];
00070       L4_ktrace_t__Mword state; /* 36+4 */
00071       L4_ktrace_t__Mword ip; /* 40+4 */
00072       L4_ktrace_t__Mword sp; /* 44+4 */
00073       L4_ktrace_t__Mword space; /* 48+4 */
00074       L4_ktrace_t__Mword err; /* 52+4 */
00075       unsigned char type; /* 56+1 */
00076       unsigned char trap; /* 57+1 */
00077     } vcpu; /* 64 */
00078     struct __attribute__((__packed__))
00079     {
00080       char __pre_pad[2];
00081       L4_ktrace_t__Smword op; /* 36+4 */
00082       L4_ktrace_t__Cap_index buffer; /* 40+4 */
00083       L4_ktrace_t__Mword id; /* 44+4 */
00084       L4_ktrace_t__Mword ram; /* 48+4 */
00085       L4_ktrace_t__Mword newo; /* 52+4 */
00086     } factory; /* 56 */
00087     struct __attribute__((__packed__))
00088     {
00089       char __pre_pad[2];
00090       L4_ktrace_t__Mword gate_dbg_id; /* 36+4 */
00091       L4_ktrace_t__Mword thread_dbg_id; /* 40+4 */
00092       L4_ktrace_t__Mword label; /* 44+4 */
00093     } gate; /* 48 */
00094     struct __attribute__((__packed__))
00095     {
00096       char __pre_pad[2];
00097       L4_ktrace_t__Irq_base *obj; /* 36+4 */
00098       L4_ktrace_t__Irq_chip *chip; /* 40+4 */
00099       L4_ktrace_t__Mword pin; /* 44+4 */
00100     } irq; /* 48 */
00101     struct __attribute__((__packed__))
00102     {
00103       char __pre_pad[2];
00104       L4_ktrace_t__Kobject *obj; /* 36+4 */
00105       L4_ktrace_t__Mword id; /* 40+4 */
00106       L4_ktrace_t__cxx__Type_info *type; /* 44+4 */
00107       L4_ktrace_t__Mword ram; /* 48+4 */
00108     } destroy; /* 56 */
00109     struct __attribute__((__packed__))
00110     {
00111       char __pre_pad[2];
00112       L4_ktrace_t__Cpu_number cpu; /* 36+4 */
00113       L4_ktrace_t__Rcu_item *item; /* 40+4 */
00114       void *cb; /* 44+4 */
00115       unsigned char event; /* 48+1 */
00116     } rcu; /* 56 */
00117     struct __attribute__((__packed__))
00118     {
00119       char __pre_pad[2];
00120       L4_ktrace_t__Mword id; /* 36+4 */
00121       L4_ktrace_t__Mword mask; /* 40+4 */
00122       L4_ktrace_t__Mword fpage; /* 44+4 */
00123       char map; /* 48+1 */
00124     } tmap; /* 56 */
00125     struct __attribute__((__packed__))
00126     {
00127       char __pre_pad[2];
00128       L4_ktrace_t__Address _address; /* 36+4 */
00129       int _len; /* 40+4 */
00130       L4_ktrace_t__Mword _value; /* 44+4 */
00131       int _mode; /* 48+4 */
00132     } bp; /* 56 */
00133     struct __attribute__((__packed__))
00134     {
00135       char __pre_pad[2];
00136       L4_ktrace_t__Context *dst; /* 36+4 */
00137       L4_ktrace_t__Address kernel_ip; /* 40+4 */
00138       L4_ktrace_t__Mword lock_cnt; /* 44+4 */
00139       L4_ktrace_t__Space *from_space; /* 48+4 */
00140       L4_ktrace_t__Sched_context *from_sched; /* 52+4 */
00141       L4_ktrace_t__Mword from_prio; /* 56+4 */
00142     } context_switch; /* 64 */
00143     struct __attribute__((__packed__))
00144     {
```

```
00145     } empty; /* 40 */
00146     struct __attribute__((__packed__))
00147     {
00148       char __pre_pad[2];
00149       L4_ktrace_t__L4_msg_tag _tag; /* 36+4 */
00150       L4_ktrace_t__Mword _dword[2]; /* 40+8 */
00151       L4_ktrace_t__L4_obj_ref _dst; /* 48+4 */
00152       L4_ktrace_t__Mword _dbg_id; /* 52+4 */
00153       L4_ktrace_t__Mword _label; /* 56+4 */
00154       L4_ktrace_t__L4_timeout_pair _timeout; /* 60+4 */
00155     } ipc; /* 64 */
00156     struct __attribute__((__packed__))
00157     {
00158       L4_ktrace_t__Unsigned8 _have_snd; /* 34+1 */
00159       L4_ktrace_t__Unsigned8 _is_np; /* 35+1 */
00160       L4_ktrace_t__L4_msg_tag _tag; /* 36+4 */
00161       L4_ktrace_t__Mword _dword[2]; /* 40+8 */
00162       L4_ktrace_t__L4_error _result; /* 48+4 */
00163       L4_ktrace_t__Mword _from; /* 52+4 */
00164       L4_ktrace_t__L4_obj_ref _dst; /* 56+4 */
00165       L4_ktrace_t__Mword _pair_event; /* 60+4 */
00166     } ipc_res; /* 64 */
00167     struct __attribute__((__packed__))
00168     {
00169       char __pre_pad[2];
00170       union __attribute__((__packed__)) {
00171         char msg[24]; /* 0+24 */
00172         struct __attribute__((__packed__)) {
00173           char tag[2]; /* 0+2 */
00174           char __pad_1[2];
00175           char *ptr; /* 4+4 */
00176         } mptr; /* 0+8 */
00177       } msg; /* 36+24 */
00178     } ke; /* 64 */
00179     struct __attribute__((__packed__))
00180     {
00181       char _msg[24]; /* 34+24 */
00182     } ke_bin; /* 64 */
00183     struct __attribute__((__packed__))
00184     {
00185       char __pre_pad[2];
00186       L4_ktrace_t__Mword v[3]; /* 36+12 */
00187       union __attribute__((__packed__)) {
00188         char msg[12]; /* 0+12 */
00189         struct __attribute__((__packed__)) {
00190           char tag[2]; /* 0+2 */
00191           char __pad_1[2];
00192           char *ptr; /* 4+4 */
00193         } mptr; /* 0+8 */
00194       } msg; /* 48+12 */
00195     } ke_reg; /* 64 */
00196     struct __attribute__((__packed__))
00197     {
00198       char __pre_pad[2];
00199       L4_ktrace_t__Address _pfa; /* 36+4 */
00200       L4_ktrace_t__Mword _error; /* 40+4 */
00201       L4_ktrace_t__Space *_space; /* 44+4 */
00202     } pf; /* 48 */
00203     struct __attribute__((__packed__))
00204     {
00205       unsigned short mode; /* 34+2 */
00206       L4_ktrace_t__Context *owner; /* 36+4 */
00207       unsigned short id; /* 40+2 */
00208       unsigned short prio; /* 42+2 */
00209       long left; /* 44+4 */
00210       unsigned long quantum; /* 48+4 */
00211     } sched; /* 56 */
00212     struct __attribute__((__packed__))
00213     {
00214       L4_ktrace_t__Unsigned8 _trapno; /* 34+1 */
00215       char __pad_1[1];
00216       L4_ktrace_t__Unsigned16 _error; /* 36+2 */
00217       char __pad_2[2];
00218       L4_ktrace_t__Mword _ebp; /* 40+4 */
00219       L4_ktrace_t__Mword _cr2; /* 44+4 */
00220       L4_ktrace_t__Mword _eax; /* 48+4 */
00221       L4_ktrace_t__Mword _eflags; /* 52+4 */
00222       L4_ktrace_t__Mword _esp; /* 56+4 */
00223       L4_ktrace_t__Unsigned16 _cs; /* 60+2 */
00224       L4_ktrace_t__Unsigned16 _ds; /* 62+2 */
00225     } trap; /* 64 */
00226     struct __attribute__((__packed__))
00227     {
00228       char _padding[24]; /* 34+24 */
00229       char __post_pad[6]; /* 58+6 */
00230     } fullsize; /* 64 */
00231     struct __attribute__((__packed__))
```

```
00232     {
00233       char __pre_pad[2];
00234       L4_ktrace_t__Cap_index cap_idx; /* 36+4 */
00235     } ieh; /* 40 */
00236     struct __attribute__((__packed__))
00237     {
00238       char __pre_pad[2];
00239       L4_ktrace_t__Mword pfa; /* 36+4 */
00240       L4_ktrace_t__Cap_index cap_idx; /* 40+4 */
00241       L4_ktrace_t__Mword err; /* 44+4 */
00242     } ipfh; /* 48 */
00243     struct __attribute__((__packed__))
00244     {
00245       char __pre_pad[2];
00246       L4_ktrace_t__Mword id; /* 36+4 */
00247       L4_ktrace_t__Mword ip; /* 40+4 */
00248       L4_ktrace_t__Mword sp; /* 44+4 */
00249       L4_ktrace_t__Mword op; /* 48+4 */
00250     } exregs; /* 56 */
00251     struct __attribute__((__packed__))
00252     {
00253       char __pre_pad[2];
00254       L4_ktrace_t__Mword state; /* 36+4 */
00255       L4_ktrace_t__Address user_ip; /* 40+4 */
00256       L4_ktrace_t__Cpu_number src_cpu; /* 44+4 */
00257       L4_ktrace_t__Cpu_number target_cpu; /* 48+4 */
00258     } migration; /* 56 */
00259     struct __attribute__((__packed__))
00260     {
00261       char __pre_pad[2];
00262       L4_ktrace_t__Address user_ip; /* 36+4 */
00263     } timer; /* 40 */
00264     struct __attribute__((__packed__))
00265     {
00266       char __pre_pad[2];
00267       L4_ktrace_t__Mword exitcode; /* 36+4 */
00268       L4_ktrace_t__Mword exitinfo1; /* 40+4 */
00269       L4_ktrace_t__Mword exitinfo2; /* 44+4 */
00270       L4_ktrace_t__Mword rip; /* 48+4 */
00271     } svm; /* 56 */
00272   } m;
00273 } l4_tracebuffer_entry_t;
```

16.112 amd64/l4/sys/linkage.h File Reference

Linkage.

Macros

- #define **L4_CV**

  Define calling convention.

16.112.1 Detailed Description

Linkage.
Definition in file linkage.h.

16.113 linkage.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef __L4__SYS__ARCH_AMD64__LINKAGE_H__
00015 #define __L4__SYS__ARCH_AMD64__LINKAGE_H__
00016
00017 #ifdef __ASSEMBLY__
00018
00019 #ifndef ENTRY
```

```
00020 #define ENTRY(name) \
00021   .globl name; \
00022   .p2align(2); \
00023   name:
00024
00025 #endif /* __ASSEMBLY__ */
00026 #endif /* ! ENTRY */
00027
00028 #define L4_FASTCALL(x)     x
00029 #define l4_fastcall
00030
00036 #define L4_CV
00037
00038 #endif /* ! __L4__SYS__ARCH_AMD64__LINKAGE_H__ */
```

16.114 arm/l4/sys/linkage.h File Reference

Linkage.

Macros

- #define **L4_CV**

  Define calling convention.

16.114.1 Detailed Description

Linkage.
Definition in file linkage.h.

16.115 linkage.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #ifndef __L4__SYS__ARCH_ARM__LINKAGE_H__
00014 #define __L4__SYS__ARCH_ARM__LINKAGE_H__
00015
00016 #ifdef __ASSEMBLY__
00017 #ifndef ENTRY
00018 #define ENTRY(name) \
00019   .globl name; \
00020   .p2align(2); \
00021   name:
00022 #endif
00023 #endif
00024
00025 #define L4_FASTCALL(x)  x
00026 #define l4_fastcall
00027
00033 #define L4_CV
00034
00035 #ifdef __PIC__
00036 # define L4_LONG_CALL
00037 #else
00038 # define L4_LONG_CALL __attribute__((long_call))
00039 #endif
00040
00041 #endif /* ! __L4__SYS__ARCH_ARM__LINKAGE_H__ */
```

16.116 linkage.h

```
00001 #pragma once
00002
00008 #define L4_CV
00009
00010 #define L4_FASTCALL(x)  x
00011 #define l4_fastcall
```

16.117 riscv/l4/sys/linkage.h File Reference

Linkage.

Macros

- #define **L4_CV**

  Define calling convention.

16.117.1 Detailed Description

Linkage.
Definition in file linkage.h.

16.118 linkage.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * Copyright (C) 2021, 2024-2025 Kernkonzept GmbH.
00008  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #ifdef __ASSEMBLY__
00015
00016 #ifndef ENTRY
00017 #define ENTRY(name) \
00018   .globl name; \
00019   .p2align(2); \
00020   name:
00021
00022 #endif /* ! ENTRY */
00023 #endif /* __ASSEMBLY__ */
00024
00030 #define L4_CV
00031
00032 #define L4_FASTCALL(x)  x
00033 #define l4_fastcall
```

16.119 x86/l4/sys/linkage.h File Reference

Linkage.

Macros

- #define **L4_CV**

  Define calling convention.

16.119.1 Detailed Description

Linkage.
Definition in file linkage.h.

16.120 linkage.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
```

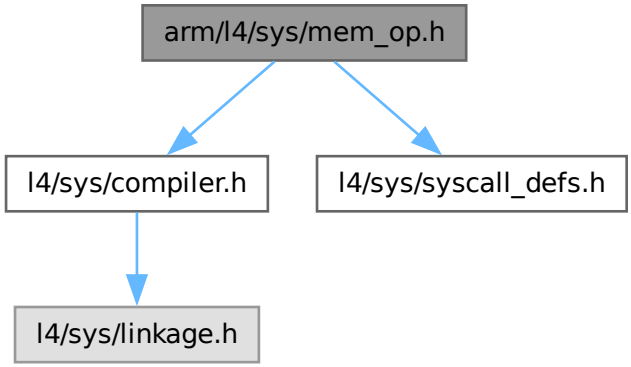
```
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef __L4__SYS__ARCH_X86__LINKAGE_H__
00015 #define __L4__SYS__ARCH_X86__LINKAGE_H__
00016
00017 #ifdef __ASSEMBLY__
00018
00019 #ifndef ENTRY
00020 #define ENTRY(name) \
00021   .globl name; \
00022   .p2align(2); \
00023   name:
00024
00025 #endif /* ! ENTRY */
00026 #endif /* __ASSEMBLY__ */
00027
00028 #define L4_FASTCALL(x)  x __attribute__((regparm(3)))
00029 #define l4_fastcall __attribute__((regparm(3)))
00030
00036 #define L4_CV   __attribute__((regparm(0)))
00037
00038 #endif /* ! __L4__SYS__ARCH_X86__LINKAGE_H__ */
```

16.121 arm/l4/sys/mem_op.h File Reference

Memory access functions (ARM specific).

```
#include <l4/sys/compiler.h>
#include <l4/sys/syscall_defs.h>
```

Include dependency graph for mem_op.h:



Enumerations

- enum L4_mem_op_widths { L4_MEM_WIDTH_1BYTE = 0 , L4_MEM_WIDTH_2BYTE = 1 , L4_MEM_WIDTH_4BYTE = 2 }

  Memory access width definitions.

Functions

- unsigned long l4_mem_read (unsigned long virtaddress, unsigned width)

  Read user task memory from kernel privilege level.
- void l4_mem_write (unsigned long virtaddress, unsigned width, unsigned long value)

  Write user task memory from kernel privilege level.
- unsigned long **l4_mem_arm_op_call** (unsigned long op, unsigned long va, unsigned long width, unsigned long value)

Implementations.

16.121.1 Detailed Description

Memory access functions (ARM specific).

Date

2010-10

Author

Adam Lackorzynski adam@os.inf.tu-dresden.de

Definition in file mem_op.h.

16.122 mem_op.h

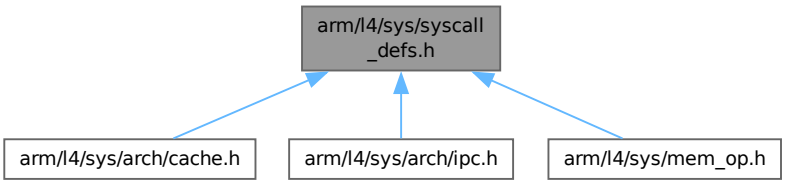
Go to the documentation of this file.

```
00001
00009 /*
00010  * (c) 2010 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #ifndef __L4SYS__INCLUDE__ARCH_ARM__MEM_OP_H__
00016 #define __L4SYS__INCLUDE__ARCH_ARM__MEM_OP_H__
00017
00018 #include <l4/sys/compiler.h>
00019 #include <l4/sys/syscall_defs.h>
00020
00021 L4_BEGIN_DECLS
00022
00035
00040 enum L4_mem_op_widths
00041 {
00042   L4_MEM_WIDTH_1BYTE = 0,
00043   L4_MEM_WIDTH_2BYTE = 1,
00044   L4_MEM_WIDTH_4BYTE = 2,
00045 };
00046
00059 L4_INLINE unsigned long
00060 l4_mem_read(unsigned long virtaddress, unsigned width);
00061
00074 L4_INLINE void
00075 l4_mem_write(unsigned long virtaddress, unsigned width,
00076              unsigned long value);
00077
00078 enum L4_mem_ops
00079 {
00080   L4_MEM_OP_MEM_READ  = 0x10,
00081   L4_MEM_OP_MEM_WRITE = 0x11,
00082 };
00083
00087 L4_INLINE unsigned long
00088 l4_mem_arm_op_call(unsigned long op,
00089                    unsigned long va,
00090                    unsigned long width,
00091                    unsigned long value);
00092
00094
00095 L4_INLINE unsigned long
00096 l4_mem_arm_op_call(unsigned long op,
00097                    unsigned long va,
00098                    unsigned long width,
00099                    unsigned long value)
00100 {
00101   register unsigned long _op    __asm__ ("r0") = op;
00102   register unsigned long _va    __asm__ ("r1") = va;
00103   register unsigned long _width __asm__ ("r2") = width;
00104   register unsigned long _value __asm__ ("r3") = value;
00105
00106   __asm__ __volatile__
00107     ("@ l4_cache_op_arm_call(start) \n\t"
00108      "mov     r5, %[sc]             \n\t"
00109      "blx     __l4_sys_syscall      \n\t"
00110      "@ l4_cache_op_arm_call(end)   \n\t"
00111        :
```

```
00112   "=r" (_op),
00113   "=r" (_va),
00114   "=r" (_width),
00115         "=r" (_value)
00116        :
00117        [sc] "i" (L4_SYSCALL_MEM_OP),
00118   "0" (_op),
00119   "1" (_va),
00120   "2" (_width),
00121         "3" (_value)
00122        :
00123   "cc", "memory", "r5", "ip", "lr"
00124        );
00125
00126   return _value;
00127 }
00128
00129 L4_INLINE unsigned long
00130 l4_mem_read(unsigned long virtaddress, unsigned width)
00131 {
00132   return l4_mem_arm_op_call(L4_MEM_OP_MEM_READ, virtaddress, width, 0);
00133 }
00134
00135 L4_INLINE void
00136 l4_mem_write(unsigned long virtaddress, unsigned width,
00137              unsigned long value)
00138 {
00139   l4_mem_arm_op_call(L4_MEM_OP_MEM_WRITE, virtaddress, width, value);
00140 }
00141
00142 L4_END_DECLS
00143
00144 #endif /* ! __L4SYS__INCLUDE__ARCH_ARM__MEM_OP_H__ */
```

16.123 arm/l4/sys/syscall_defs.h File Reference

Syscall entry definitions.
This graph shows which files directly or indirectly include this file:



16.123.1 Detailed Description

Syscall entry definitions.
Definition in file syscall_defs.h.

16.124 syscall_defs.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #ifndef __L4SYS__ARCH_ARM__L4API_L4F__SYSCALL_DEFS_H__
00012 #define __L4SYS__ARCH_ARM__L4API_L4F__SYSCALL_DEFS_H__
00013
00014 #define L4_SYSCALL_INVOKE    (0)
00015 #define L4_SYSCALL_MEM_OP               (1)
```

```
00016
00017 #endif /* __L4SYS__ARCH_ARM__L4API_L4F__SYSCALL_DEFS_H__ */
```

16.125 vm.h

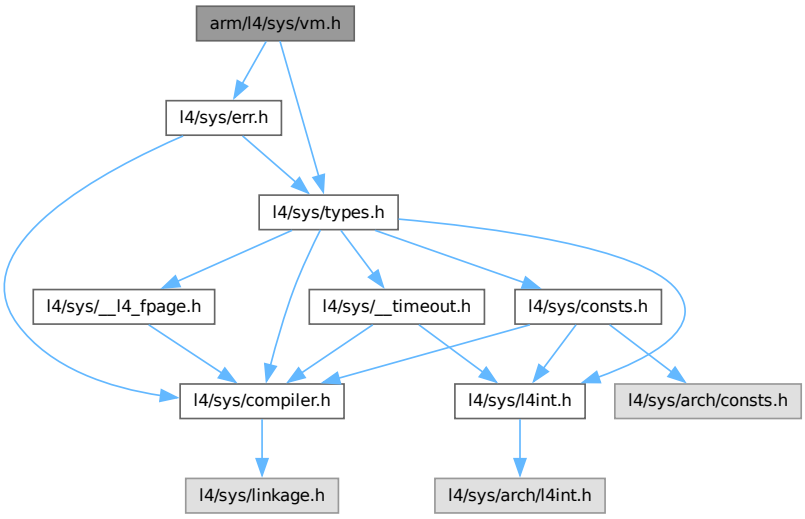
```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/__vm-svm.h>
00015 #include <l4/sys/__vm-vmx.h>
```

16.126 arm/l4/sys/vm.h File Reference

ARM virtualization interface.

```
#include <l4/sys/err.h>
#include <l4/sys/types.h>
```

Include dependency graph for vm.h:



Data Structures

- struct l4_vm_tz_state

  state structure for TrustZone VMs

16.126.1 Detailed Description

ARM virtualization interface.
Definition in file vm.h.

16.127 vm.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/err.h>
00015 #include <l4/sys/types.h>
00016
00022
00027 struct l4_vm_tz_state_mode
00028 {
00029   l4_umword_t sp;
00030   l4_umword_t lr;
00031   l4_umword_t spsr;
00032 };
00033
00034 struct l4_vm_tz_state_irq_inject
00035 {
00036   l4_uint32_t group;
00037   l4_uint32_t irqs[8];
00038 };
00039
00044 struct l4_vm_tz_state
00045 {
00046   l4_umword_t r[13]; // r0 - r12
00047
00048   l4_umword_t sp_usr;
00049   l4_umword_t lr_usr;
00050
00051   struct l4_vm_tz_state_mode irq;
00052
00053   l4_umword_t r_fiq[5]; // r8 - r12
00054   struct l4_vm_tz_state_mode fiq;
00055   struct l4_vm_tz_state_mode abt;
00056   struct l4_vm_tz_state_mode und;
00057   struct l4_vm_tz_state_mode svc;
00058
00059   l4_umword_t pc;
00060   l4_umword_t cpsr;
00061
00062   l4_umword_t pending_events;
00063   l4_uint32_t cpacr;
00064   l4_umword_t cp10_fpexc;
00065
00066   l4_umword_t pfs;
00067   l4_umword_t pfa;
00068   l4_umword_t exit_reason;
00069
00070   struct l4_vm_tz_state_irq_inject irq_inject;
00071 };
00072
00073 enum L4_vm_exit_reason
00074 {
00075   L4_vm_exit_reason_vmm_call   = 1,
00076   L4_vm_exit_reason_inst_abort = 2,
00077   L4_vm_exit_reason_data_abort = 3,
00078   L4_vm_exit_reason_irq        = 4,
00079   L4_vm_exit_reason_fiq        = 5,
00080   L4_vm_exit_reason_undef      = 6,
00081 };
00082
00083 L4_INLINE int
00084 l4_vm_tz_irq_inject(struct l4_vm_tz_state *state, unsigned irq);
00085
00086 L4_INLINE int
00087 l4_vm_tz_irq_inject(struct l4_vm_tz_state *state, unsigned irq)
00088 {
00089   if (irq > sizeof(state->irq_inject.irqs) * 8)
00090     return -L4_EINVAL;
00091
00092   unsigned g = irq / 32;
00093   state->irq_inject.group   |= 1 << g;
00094   state->irq_inject.irqs[g] |= 1 << (irq & 31);
00095
00096   return 0;
00097 }
```

16.128 vm.h

```
00001
00002
```

16.129 vm.h

```
00001 /*
00002  * Copyright (C) 2024 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/vcpu.h>
00010
00011 enum
00012 {
00014   L4_vm_hstatus_vsbe       = 1UL << 5,
00016   L4_vm_hstatus_gva        = 1UL << 6,
00018   L4_vm_hstatus_spvp       = 1UL << 8,
00020   L4_vm_hstatus_vtw        = 1UL << 21,
00021
00022   // Controls the effective XLEN for VS-mode, only available on RV64 and only if
00023   // supported by the hardware.
00024   L4_vm_hstatus_vsxl_32    = 1UL,
00025   L4_vm_hstatus_vsxl_64    = 2UL,
00026   L4_vm_hstatus_vsxl_128   = 3UL,
00027   L4_vm_hstatus_vsxl_shift = 32,
00028 };
00029
00030 typedef enum L4_vm_rfnc
00031 {
00032   L4_vm_rfnc_none            = 0,
00033   L4_vm_rfnc_fence_i         = 1,
00034   L4_vm_rfnc_sfence_vma      = 2,
00035   L4_vm_rfnc_sfence_vma_asid = 3,
00036 } L4_vm_rfnc;
00037
00038 enum
00039 {
00040   L4_vm_hvip_vssip = 1UL << 2,
00041   L4_vm_hvip_vstip = 1UL << 6,
00042   L4_vm_hvip_vseip = 1UL << 10,
00043 };
00044
00050 typedef struct l4_vm_state_t
00051 {
00052   l4_umword_t hedeleg;
00053   l4_umword_t hideleg;
00054
00055   l4_umword_t hvip;
00056   l4_umword_t hip; // read-only
00057   l4_umword_t hie;
00058
00059   l4_uint64_t htimedelta;
00060
00061   l4_umword_t htval;
00062   l4_umword_t htinst;
00063
00064   l4_umword_t vsstatus;
00065   l4_umword_t vstvec;
00066   l4_umword_t vsscratch;
00067   l4_umword_t vsepc;
00068   l4_umword_t vscause;
00069   l4_umword_t vstval;
00070   l4_umword_t vsatp;
00071   l4_uint64_t vstimecmp;
00072
00073   // Indicates that a hypervisor load/store instruction failed. VMM is
00074   // responsible for resetting this value before executing a hypervisor/load
00075   // store instruction.
00076   l4_uint8_t hlsi_failed;
00077
00078   l4_uint8_t remote_fence;
00079   l4_umword_t remote_fence_hart_mask;
00080   l4_umword_t remote_fence_start_addr;
00081   l4_umword_t remote_fence_size;
00082   l4_umword_t remote_fence_asid;
00083 } l4_vm_state_t;
00084
00085
```

```
00086 L4_INLINE l4_vm_state_t *
00087 l4_vm_state(l4_vcpu_state_t *vcpu) L4_NOTHROW;
00088
00089 L4_INLINE l4_vm_state_t *
00090 l4_vm_state(l4_vcpu_state_t *vcpu) L4_NOTHROW
00091 { return (l4_vm_state_t *)((char *)vcpu + 0x400); }
```

16.130 vm.h

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Henning Schild <hschild@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/__vm-svm.h>
00016 #include <l4/sys/__vm-vmx.h>
```

16.131 amd64/l4/util/arch/l4_macros.h File Reference

Main function.

16.131.1 Detailed Description

Main function.

Date

08/29/2000

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file l4_macros.h.

16.132 l4_macros.h

Go to the documentation of this file.

```
00001
00007
00008 /*
00009  * (c) 2006-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #ifndef _L4UTIL__ARCH_AMD64__L4_MACROS_H
00015 #define _L4UTIL__ARCH_AMD64__L4_MACROS_H
00016
00017 #ifndef l4_addr_fmt
00018 #  define l4_addr_fmt   "%016lx"
00019 #endif
00020
00021 #endif /* !_L4UTIL__ARCH_AMD64__L4_MACROS_H */
```

16.133 arm/l4/util/arch/l4_macros.h File Reference

Main function.

16.133.1 Detailed Description

Main function.

Date

08/29/2000

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file l4_macros.h.

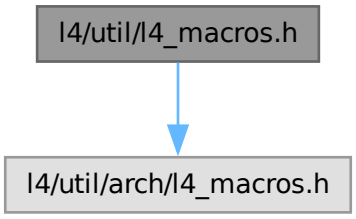
16.134 l4_macros.h

Go to the documentation of this file.

```
00001
00007
00008 /*
00009  * (c) 2006-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #ifndef _L4UTIL__ARCH_ARM__L4_MACROS_H
00015 #define _L4UTIL__ARCH_ARM__L4_MACROS_H
00016
00017 #ifndef l4_addr_fmt
00018 #  define l4_addr_fmt   "%08lx"
00019 #endif
00020
00021 #endif /* !_L4UTIL__ARCH_ARM__L4_MACROS_H */
```

16.135 l4/util/l4_macros.h File Reference

Some useful generic macros, L4f version.
`#include <l4/util/arch/l4_macros.h>`
Include dependency graph for l4_macros.h:



16.135.1 Detailed Description

Some useful generic macros, L4f version.

Date

11/12/2002

Author

Lars Reuther reuther@os.inf.tu-dresden.de

Definition in file l4_macros.h.

16.136 l4_macros.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00008 /*
00009  * (c) 2000-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 /*****************************************************************************/
00015
00016 #pragma once
00017
00018 #include <l4/util/arch/l4_macros.h>
00019
00020 /*****************************************************************************
00021  *** generic macros
00022  *****************************************************************************/
00023
00024 /* generate L4 thread id printf string */
00025 #ifndef l4util_idstr
00026 #  define l4util_idfmt          "%lx"
00027 #  define l4util_idfmt_adjust   "%04lx"
00028 #  define l4util_idstr(tid)     (tid » L4_CAP_SHIFT)
00029 #endif
00030
```

16.137 x86/l4/util/arch/l4_macros.h File Reference

Main function.

16.137.1 Detailed Description

Main function.

Date

08/29/2000

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file l4_macros.h.

16.138 l4_macros.h

Go to the documentation of this file.

```
00001
00007
00008 /*
00009  * (c) 2006-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014
00015 #ifndef _L4UTIL__ARCH_X86__L4_MACROS_H
00016 #define _L4UTIL__ARCH_X86__L4_MACROS_H
00017
00018 #ifndef l4_addr_fmt
00019 #  define l4_addr_fmt    "%08lx"
00020 #endif
00021
00022 #endif /* !_L4UTIL__ARCH_X86__L4_MACROS_H */
```

16.139 thread.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
```

```
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.140 thread.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *            Frank Mehnert <frank.mehnert@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 /* Similar to signal handler: Align stack pointer and skip the red zone. */
00011 #define L4UTIL_THREAD_CXX_FUNC_IMPL_INTERRUPT_STUB(from_asm_name) \
00012   "sub $128, %rsp   \n" \
00013   "and $~0xf, %rsp  \n" \
00014   "cld              \n" \
00015   "call " L4_stringify(from_asm_name) "\n"
```

16.141 arm/l4/sys/arch/thread.h File Reference

ARM-specific thread related definitions.

Enumerations

- enum L4_thread_ex_regs_flags_arm { L4_THREAD_EX_REGS_ARM_SET_EL_MASK = 0x3 << 24 , L4_THREAD_EX_REGS_ARM_SET_EL_KEEP = 0x0 << 24 , L4_THREAD_EX_REGS_ARM_SET_EL_EL0 = 0x1 << 24 , L4_THREAD_EX_REGS_ARM_SET_EL_EL1 = 0x2 << 24 }

  Arm specific L4::Thread::ex_regs() flags.

Functions

- l4_msgtag_t **l4_thread_arm_set_tpidruro** (l4_cap_idx_t thread, l4_addr_t tpidruro) L4_NOTHROW

  Set the TPIDRURO thread specific register.

16.141.1 Detailed Description

ARM-specific thread related definitions.
Definition in file thread.h.

16.142 thread.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 // Use the full documentation from ARM64. Otherwise \parameters and \return
00014 // would occur twice in the Doxygen documentation of this function.
00018 L4_INLINE l4_msgtag_t
00019 l4_thread_arm_set_tpidruro(l4_cap_idx_t thread, l4_addr_t tpidruro) L4_NOTHROW;
00020
00025 L4_INLINE l4_msgtag_t
00026 l4_thread_arm_set_tpidruro_u(l4_cap_idx_t thread, l4_addr_t tpidruro,
00027                              l4_utcb_t *utcb) L4_NOTHROW;
00028
00037 enum L4_thread_ex_regs_flags_arm
00038 {
```

```
00040   L4_THREAD_EX_REGS_ARM_SET_EL_MASK      = 0x3 « 24,
00042   L4_THREAD_EX_REGS_ARM_SET_EL_KEEP      = 0x0 « 24,
00044   L4_THREAD_EX_REGS_ARM_SET_EL_EL0       = 0x1 « 24,
00046   L4_THREAD_EX_REGS_ARM_SET_EL_EL1       = 0x2 « 24,
00047 };
00048
00049 /* IMPLEMENTATION ----------------------------------------------------*/
00050
00051 L4_INLINE l4_msgtag_t
00052 l4_thread_arm_set_tpidruro_u(l4_cap_idx_t thread, l4_addr_t tpidruro,
00053                              l4_utcb_t *utcb) L4_NOTHROW
00054 {
00055   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00056   v->mr[0] = L4_THREAD_ARM_TPIDRURO_OP;
00057   v->mr[1] = tpidruro;
00058   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2, 0, 0),
00059                      L4_IPC_NEVER);
00060 }
00061
00062 L4_INLINE l4_msgtag_t
00063 l4_thread_arm_set_tpidruro(l4_cap_idx_t thread, l4_addr_t tpidruro) L4_NOTHROW
00064 {
00065   return l4_thread_arm_set_tpidruro_u(thread, tpidruro, l4_utcb());
00066 }
```

16.143 thread.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #define L4UTIL_THREAD_CXX_FUNC_PROTO(fn_name, ...) \
00010   [[noreturn]] static void fn_name(__VA_ARGS__) \
00011   asm (L4_stringify(fn_name ## _stub)) \
00012   __attribute__((target("arm"))); \
00013   [[noreturn]] static void fn_name ## _from_asm(__VA_ARGS__) \
00014   asm (L4_stringify(fn_name ## _from_asm))
00015
00016 /* Similar to signal handler: Align stack pointer. */
00017 #define L4UTIL_THREAD_CXX_FUNC_IMPL_INTERRUPT_STUB(from_asm_name) \
00018   ".arm           \n" \
00019   "bic sp, sp, #7 \n" \
00020   "bl " L4_stringify(from_asm_name) "\n"
```

16.144 arm64/l4/sys/arch/thread.h File Reference

ARM64-specific thread related definitions.

Enumerations

- enum L4_thread_ex_regs_flags_arm64 { L4_THREAD_EX_REGS_ARM64_SET_EL_MASK = 0x3 << 24 , L4_THREAD_EX_REGS_ARM64_SET_EL_KEEP = 0x0 << 24 , L4_THREAD_EX_REGS_ARM64_SET_EL_EL0 = 0x1 << 24 , L4_THREAD_EX_REGS_ARM64_SET_EL_EL1 = 0x2 << 24 }

  Arm64 specific L4::Thread::ex_regs() flags.

Functions

- l4_msgtag_t l4_thread_arm_set_tpidruro (l4_cap_idx_t thread, l4_addr_t tpidruro) L4_NOTHROW

  Set the TPIDRURO thread specific register.

16.144.1 Detailed Description

ARM64-specific thread related definitions.
Definition in file thread.h.

16.145 thread.h

Go to the documentation of this file.

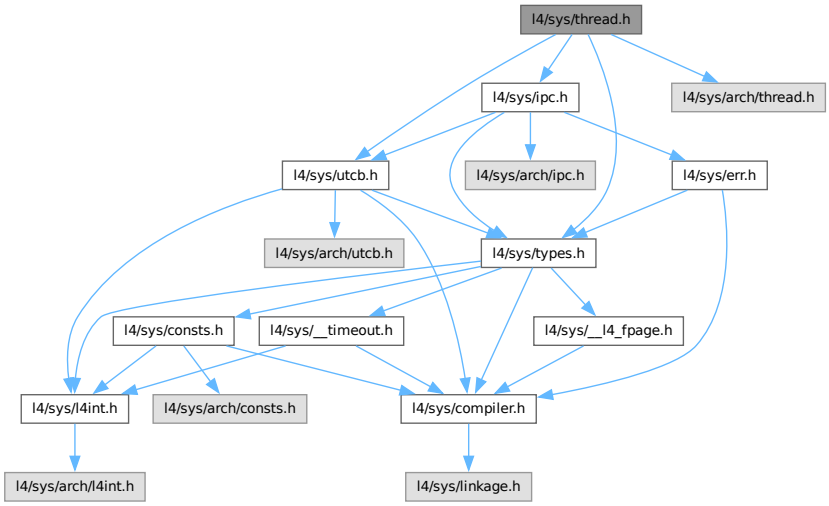
```
00001
00005 /*
00006  * (c) 2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00025 L4_INLINE l4_msgtag_t
00026 l4_thread_arm_set_tpidruro(l4_cap_idx_t thread, l4_addr_t tpidruro) L4_NOTHROW;
00027
00032 L4_INLINE l4_msgtag_t
00033 l4_thread_arm_set_tpidruro_u(l4_cap_idx_t thread, l4_addr_t tpidruro,
00034                              l4_utcb_t *utcb) L4_NOTHROW;
00035
00044 enum L4_thread_ex_regs_flags_arm64
00045 {
00047   L4_THREAD_EX_REGS_ARM64_SET_EL_MASK     = 0x3 << 24,
00049   L4_THREAD_EX_REGS_ARM64_SET_EL_KEEP     = 0x0 << 24,
00051   L4_THREAD_EX_REGS_ARM64_SET_EL_EL0      = 0x1 << 24,
00053   L4_THREAD_EX_REGS_ARM64_SET_EL_EL1      = 0x2 << 24,
00054 };
00055
00056 /* IMPLEMENTATION ---------------------------------------------------------*/
00057
00058 L4_INLINE l4_msgtag_t
00059 l4_thread_arm_set_tpidruro_u(l4_cap_idx_t thread, l4_addr_t tpidruro,
00060                              l4_utcb_t *utcb) L4_NOTHROW
00061 {
00062   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00063   v->mr[0] = L4_THREAD_ARM_TPIDRURO_OP;
00064   v->mr[1] = tpidruro;
00065   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2, 0, 0),
00066                      L4_IPC_NEVER);
00067 }
00068
00069 L4_INLINE l4_msgtag_t
00070 l4_thread_arm_set_tpidruro(l4_cap_idx_t thread, l4_addr_t tpidruro) L4_NOTHROW
00071 {
00072   return l4_thread_arm_set_tpidruro_u(thread, tpidruro, l4_utcb());
00073 }
```

16.146 l4/sys/thread.h File Reference

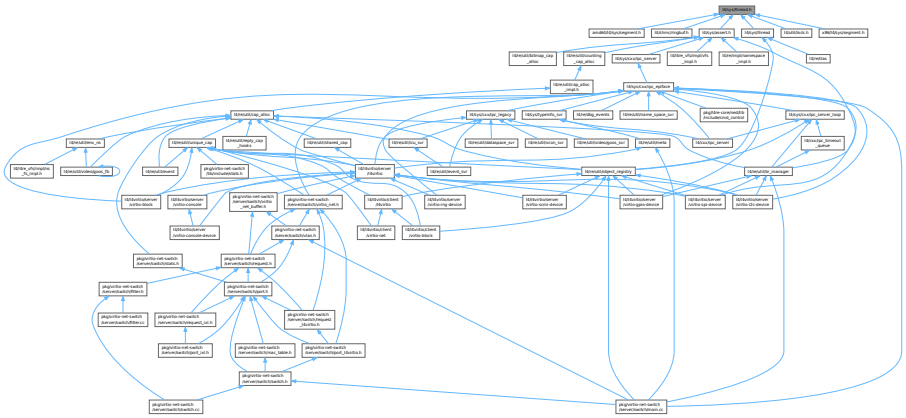
Common thread related definitions.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
#include <l4/sys/arch/thread.h>
```

Include dependency graph for thread.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum L4_thread_ops {
  L4_THREAD_CONTROL_OP = 0UL , L4_THREAD_EX_REGS_OP = 1UL , L4_THREAD_SWITCH_OP = 2UL , L4_THREAD_STATS_OP = 3UL ,
  L4_THREAD_VCPU_RESUME_OP = 4UL , L4_THREAD_REGISTER_DELETE_IRQ_OP = 5UL ,
  L4_THREAD_MODIFY_SENDER_OP = 6UL , L4_THREAD_VCPU_CONTROL_OP = 7UL ,
  L4_THREAD_VCPU_CONTROL_EXT_OP = L4_THREAD_VCPU_CONTROL_OP | 0x10000 , L4_THREAD_REGISTER_DO
  = 8UL , L4_THREAD_PF_TRAMP_CONTROL_OP = 9UL , L4_THREAD_X86_GDT_OP = 0x10UL ,
  L4_THREAD_ARM_TPIDRURO_OP = 0x10UL , L4_THREAD_AMD64_SET_SEGMENT_BASE_OP = 0x12UL , L4_THREAD_AMD64_GET_SEGMENT_INFO_OP = 0x13UL , L4_THREAD_OPCODE_MASK = 0xffff }

  Operations on thread objects.
- enum L4_thread_control_flags { L4_THREAD_CONTROL_SET_PAGER = 0x0010000 , L4_THREAD_CONTROL_BIND_TASK = 0x0200000 , L4_THREAD_CONTROL_ALIEN = 0x0400000 , L4_THREAD_CONTROL_SET_EXC_HANDLER = 0x1000000 }

  Flags for the thread control operation.

- enum L4_thread_control_mr_indices { L4_THREAD_CONTROL_MR_IDX_FLAGS = 0 , L4_THREAD_CONTROL_MR_IDX_PAGER = 1 , L4_THREAD_CONTROL_MR_IDX_EXC_HANDLER = 2 , L4_THREAD_CONTROL_MR_IDX_FLAG_VALS = 4 , L4_THREAD_CONTROL_MR_IDX_BIND_UTCB = 5 , L4_THREAD_CONTROL_MR_IDX_BIND_TASK = 6 }

  Indices for the values in the message register for thread control.
- enum L4_thread_ex_regs_flags { L4_THREAD_EX_REGS_CANCEL = 0x10000UL , L4_THREAD_EX_REGS_TRIGGER_EXC = 0x20000UL , L4_THREAD_EX_REGS_ARCH_MASK = 0xff000000UL }

  Flags for the thread ex-regs operation.
- enum L4_pf_tramp_control_op { L4_THREAD_PF_TRAMP_CONTROL_OP_SETUP = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x00000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_RESUME = (L4_THREAD_PF_TRAMP_↩ CONTROL_OP | 0x10000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_REFLECT = (L4_THREAD_↩ PF_TRAMP_CONTROL_OP | 0x20000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_DISABLE = (L4↩ _THREAD_PF_TRAMP_CONTROL_OP | 0x30000UL) , L4_THREAD_PF_TRAMP_CONTROL_OP_ENABLE = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x40000UL) }

  Sub-opcodes for L4_THREAD_PF_TRAMP_CONTROL_OP.

Functions

- l4_msgtag_t l4_thread_ex_regs (l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp, l4_umword_t flags) L4_NOTHROW

  Exchange basic thread registers.
- l4_msgtag_t l4_thread_ex_regs_u (l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp, l4_umword_t flags, l4_utcb_t *utcb) L4_NOTHROW

  Exchange basic thread registers.
- l4_msgtag_t l4_thread_ex_regs_ret (l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp, l4_umword_t *flags) L4_NOTHROW

  Exchange basic thread registers and return previous values.
- l4_msgtag_t l4_thread_ex_regs_ret_u (l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp, l4_umword_t *flags, l4_utcb_t *utcb) L4_NOTHROW

  Exchange basic thread registers and return previous values.
- void l4_thread_control_start (void) L4_NOTHROW

  Start a thread control API sequence.
- void l4_thread_control_pager (l4_cap_idx_t pager) L4_NOTHROW

  Set the pager.
- void l4_thread_control_exc_handler (l4_cap_idx_t exc_handler) L4_NOTHROW

  Set the exception handler.
- void l4_thread_control_bind (l4_utcb_t *thread_utcb, l4_cap_idx_t task) L4_NOTHROW

  Bind the thread to a task.
- void l4_thread_control_alien (int on) L4_NOTHROW

  Enable alien mode.
- l4_msgtag_t l4_thread_control_commit (l4_cap_idx_t thread) L4_NOTHROW

  Commit the thread control parameters.
- l4_msgtag_t l4_thread_yield (void) L4_NOTHROW

  Yield current time slice.
- l4_msgtag_t l4_thread_switch (l4_cap_idx_t to_thread) L4_NOTHROW

  Switch to another thread (and donate the remaining time slice).
- l4_msgtag_t l4_thread_stats_time (l4_cap_idx_t thread, l4_kernel_clock_t *us) L4_NOTHROW

  Get consumed time of thread in µs.
- l4_msgtag_t l4_thread_vcpu_resume_start (void) L4_NOTHROW

vCPU return from event handler.

- l4_msgtag_t l4_thread_vcpu_resume_commit (l4_cap_idx_t thread, l4_msgtag_t tag) L4_NOTHROW

  Commit vCPU resume.
- l4_msgtag_t l4_thread_vcpu_control (l4_cap_idx_t thread, l4_addr_t vcpu_state) L4_NOTHROW

  Enable the vCPU feature for the thread.
- l4_msgtag_t l4_thread_vcpu_control_u (l4_cap_idx_t thread, l4_addr_t vcpu_state, l4_utcb_t *utcb) L4_NOTHROW

  Enable the vCPU feature for the thread.
- l4_msgtag_t l4_thread_vcpu_control_ext (l4_cap_idx_t thread, l4_addr_t ext_vcpu_state) L4_NOTHROW

  Enable the extended vCPU feature for the thread.
- l4_msgtag_t l4_thread_vcpu_control_ext_u (l4_cap_idx_t thread, l4_addr_t ext_vcpu_state, l4_utcb_t *utcb) L4_NOTHROW

  Enable the extended vCPU feature for the thread.
- l4_msgtag_t l4_thread_register_del_irq (l4_cap_idx_t thread, l4_cap_idx_t irq) L4_NOTHROW

  Register an IRQ that will trigger upon deletion events.
- l4_msgtag_t l4_thread_modify_sender_start (void) L4_NOTHROW

  Start a thread sender modification sequence.
- int l4_thread_modify_sender_add (l4_umword_t match_mask, l4_umword_t match, l4_umword_t del_bits, l4_umword_t add_bits, l4_msgtag_t *tag) L4_NOTHROW

  Add a modification pattern to a sender modification sequence.
- l4_msgtag_t l4_thread_modify_sender_commit (l4_cap_idx_t thread, l4_msgtag_t tag) L4_NOTHROW

  Apply (commit) a sender modification sequence.
- l4_msgtag_t l4_thread_register_doorbell_irq (l4_cap_idx_t thread, l4_cap_idx_t irq) L4_NOTHROW

  Register an IRQ that will trigger when a forwarded virtual interrupt is pending.
- l4_msgtag_t l4_thread_pf_trampoline_setup (l4_cap_idx_t thread, l4_addr_t pf_tramp_state) L4_NOTHROW

  Setup page fault trampoline handler.
- l4_msgtag_t l4_thread_pf_trampoline_resume (l4_cap_idx_t thread) L4_NOTHROW

  Resume from page fault trampoline handler.
- l4_msgtag_t l4_thread_pf_trampoline_reflect (l4_cap_idx_t thread) L4_NOTHROW

  Page fault trampoline handler reflects page fault to exception handler.
- l4_msgtag_t l4_thread_pf_trampoline_disable (l4_cap_idx_t thread, int *was_enabled) L4_NOTHROW

  Disable the page fault trampoline handling for this thread.
- l4_msgtag_t l4_thread_pf_trampoline_enable (l4_cap_idx_t thread) L4_NOTHROW

  Re-enable the page fault trampoline handling for this thread.

16.146.1 Detailed Description

Common thread related definitions.
Definition in file thread.h.

16.147 thread.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/types.h>
00017 #include <l4/sys/utcb.h>
00018 #include <l4/sys/ipc.h>
```

```
00019
00054
00055
00083 L4_INLINE l4_msgtag_t
00084 l4_thread_ex_regs(l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp,
00085                   l4_umword_t flags) L4_NOTHROW;
00086
00093 L4_INLINE l4_msgtag_t
00094 l4_thread_ex_regs_u(l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp,
00095                     l4_umword_t flags, l4_utcb_t *utcb) L4_NOTHROW;
00096
00129 L4_INLINE l4_msgtag_t
00130 l4_thread_ex_regs_ret(l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp,
00131                       l4_umword_t *flags) L4_NOTHROW;
00132
00139 L4_INLINE l4_msgtag_t
00140 l4_thread_ex_regs_ret_u(l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp,
00141                         l4_umword_t *flags, l4_utcb_t *utcb) L4_NOTHROW;
00142
00143
00144
00170
00190 L4_INLINE void
00191 l4_thread_control_start(void) L4_NOTHROW;
00192
00197 L4_INLINE void
00198 l4_thread_control_start_u(l4_utcb_t *utcb) L4_NOTHROW;
00199
00209 L4_INLINE void
00210 l4_thread_control_pager(l4_cap_idx_t pager) L4_NOTHROW;
00211
00216 L4_INLINE void
00217 l4_thread_control_pager_u(l4_cap_idx_t pager, l4_utcb_t *utcb) L4_NOTHROW;
00218
00228 L4_INLINE void
00229 l4_thread_control_exc_handler(l4_cap_idx_t exc_handler) L4_NOTHROW;
00230
00235 L4_INLINE void
00236 l4_thread_control_exc_handler_u(l4_cap_idx_t exc_handler,
00237                                 l4_utcb_t *utcb) L4_NOTHROW;
00238
00266 L4_INLINE void
00267 l4_thread_control_bind(l4_utcb_t *thread_utcb,
00268                        l4_cap_idx_t task) L4_NOTHROW;
00269
00274 L4_INLINE void
00275 l4_thread_control_bind_u(l4_utcb_t *thread_utcb,
00276                          l4_cap_idx_t task, l4_utcb_t *utcb) L4_NOTHROW;
00277
00301 L4_INLINE void
00302 l4_thread_control_alien(int on) L4_NOTHROW;
00303
00308 L4_INLINE void
00309 l4_thread_control_alien_u(l4_utcb_t *utcb, int on) L4_NOTHROW;
00310
00311
00312
00313
00330 L4_INLINE l4_msgtag_t
00331 l4_thread_control_commit(l4_cap_idx_t thread) L4_NOTHROW;
00332
00337 L4_INLINE l4_msgtag_t
00338 l4_thread_control_commit_u(l4_cap_idx_t thread, l4_utcb_t *utcb) L4_NOTHROW;
00339
00346 L4_INLINE l4_msgtag_t
00347 l4_thread_yield(void) L4_NOTHROW;
00348
00357 L4_INLINE l4_msgtag_t
00358 l4_thread_switch(l4_cap_idx_t to_thread) L4_NOTHROW;
00359
00364 L4_INLINE l4_msgtag_t
00365 l4_thread_switch_u(l4_cap_idx_t to_thread, l4_utcb_t *utcb) L4_NOTHROW;
00366
00367
00368
00378 L4_INLINE l4_msgtag_t
00379 l4_thread_stats_time(l4_cap_idx_t thread, l4_kernel_clock_t *us) L4_NOTHROW;
00380
00385 L4_INLINE l4_msgtag_t
00386 l4_thread_stats_time_u(l4_cap_idx_t thread, l4_kernel_clock_t *us,
00387                        l4_utcb_t *utcb) L4_NOTHROW;
00388
00389
00400 L4_INLINE l4_msgtag_t
00401 l4_thread_vcpu_resume_start(void) L4_NOTHROW;
00402
00407 L4_INLINE l4_msgtag_t
```

```
00408 l4_thread_vcpu_resume_start_u(l4_utcb_t *utcb) L4_NOTHROW;
00409
00457 L4_INLINE l4_msgtag_t
00458 l4_thread_vcpu_resume_commit(l4_cap_idx_t thread,
00459                               l4_msgtag_t tag) L4_NOTHROW;
00460
00465 L4_INLINE l4_msgtag_t
00466 l4_thread_vcpu_resume_commit_u(l4_cap_idx_t thread,
00467                                l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW;
00468
00469
00489 L4_INLINE l4_msgtag_t
00490 l4_thread_vcpu_control(l4_cap_idx_t thread, l4_addr_t vcpu_state) L4_NOTHROW;
00491
00499 L4_INLINE l4_msgtag_t
00500 l4_thread_vcpu_control_u(l4_cap_idx_t thread, l4_addr_t vcpu_state,
00501                          l4_utcb_t *utcb) L4_NOTHROW;
00502
00534 L4_INLINE l4_msgtag_t
00535 l4_thread_vcpu_control_ext(l4_cap_idx_t thread, l4_addr_t ext_vcpu_state) L4_NOTHROW;
00536
00544 L4_INLINE l4_msgtag_t
00545 l4_thread_vcpu_control_ext_u(l4_cap_idx_t thread, l4_addr_t ext_vcpu_state,
00546                              l4_utcb_t *utcb) L4_NOTHROW;
00547
00548
00572 L4_INLINE l4_msgtag_t
00573 l4_thread_register_del_irq(l4_cap_idx_t thread, l4_cap_idx_t irq) L4_NOTHROW;
00574
00579 L4_INLINE l4_msgtag_t
00580 l4_thread_register_del_irq_u(l4_cap_idx_t thread, l4_cap_idx_t irq,
00581                              l4_utcb_t *utcb) L4_NOTHROW;
00582
00604 L4_INLINE l4_msgtag_t
00605 l4_thread_modify_sender_start(void) L4_NOTHROW;
00606
00611 L4_INLINE l4_msgtag_t
00612 l4_thread_modify_sender_start_u(l4_utcb_t *u) L4_NOTHROW;
00613
00638 L4_INLINE int
00639 l4_thread_modify_sender_add(l4_umword_t match_mask,
00640                             l4_umword_t match,
00641                             l4_umword_t del_bits,
00642                             l4_umword_t add_bits,
00643                             l4_msgtag_t *tag) L4_NOTHROW;
00644
00649 L4_INLINE int
00650 l4_thread_modify_sender_add_u(l4_umword_t match_mask,
00651                               l4_umword_t match,
00652                               l4_umword_t del_bits,
00653                               l4_umword_t add_bits,
00654                               l4_msgtag_t *tag, l4_utcb_t *u) L4_NOTHROW;
00655
00681 L4_INLINE l4_msgtag_t
00682 l4_thread_modify_sender_commit(l4_cap_idx_t thread, l4_msgtag_t tag) L4_NOTHROW;
00683
00688 L4_INLINE l4_msgtag_t
00689 l4_thread_modify_sender_commit_u(l4_cap_idx_t thread, l4_msgtag_t tag,
00690                                  l4_utcb_t *u) L4_NOTHROW;
00691
00692
00713 L4_INLINE l4_msgtag_t
00714 l4_thread_register_doorbell_irq(l4_cap_idx_t thread,
00715                                 l4_cap_idx_t irq) L4_NOTHROW;
00716
00721 L4_INLINE l4_msgtag_t
00722 l4_thread_register_doorbell_irq_u(l4_cap_idx_t thread, l4_cap_idx_t irq,
00723                                   l4_utcb_t *u) L4_NOTHROW;
00724
00750 L4_INLINE l4_msgtag_t
00751 l4_thread_pf_trampoline_setup(l4_cap_idx_t thread,
00752                               l4_addr_t pf_tramp_state) L4_NOTHROW;
00753
00758 L4_INLINE l4_msgtag_t
00759 l4_thread_pf_trampoline_setup_u(l4_cap_idx_t thread, l4_addr_t pf_tramp_state,
00760                                 l4_utcb_t *utcb) L4_NOTHROW;
00761
00771 L4_INLINE l4_msgtag_t
00772 l4_thread_pf_trampoline_resume(l4_cap_idx_t thread) L4_NOTHROW;
00773
00778 L4_INLINE l4_msgtag_t
00779 l4_thread_pf_trampoline_resume_u(l4_cap_idx_t thread,
00780                                  l4_utcb_t *utcb) L4_NOTHROW;
00781
00792 L4_INLINE l4_msgtag_t
00793 l4_thread_pf_trampoline_reflect(l4_cap_idx_t thread) L4_NOTHROW;
00794
```

```
00799 L4_INLINE l4_msgtag_t
00800 l4_thread_pf_trampoline_reflect_u(l4_cap_idx_t thread,
00801                                   l4_utcb_t *utcb) L4_NOTHROW;
00802
00811 L4_INLINE l4_msgtag_t
00812 l4_thread_pf_trampoline_disable(l4_cap_idx_t thread, int *was_enabled) L4_NOTHROW;
00813
00818 L4_INLINE l4_msgtag_t
00819 l4_thread_pf_trampoline_disable_u(l4_cap_idx_t thread, int *was_enabled,
00820                                   l4_utcb_t *utcb) L4_NOTHROW;
00821
00828 L4_INLINE l4_msgtag_t
00829 l4_thread_pf_trampoline_enable(l4_cap_idx_t thread) L4_NOTHROW;
00830
00835 L4_INLINE l4_msgtag_t
00836 l4_thread_pf_trampoline_enable_u(l4_cap_idx_t thread,
00837                                  l4_utcb_t *utcb) L4_NOTHROW;
00838
00839
00846 enum L4_thread_ops
00847 {
00848   L4_THREAD_CONTROL_OP                = 0UL,
00849   L4_THREAD_EX_REGS_OP                = 1UL,
00850   L4_THREAD_SWITCH_OP                 = 2UL,
00851   L4_THREAD_STATS_OP                  = 3UL,
00852   L4_THREAD_VCPU_RESUME_OP            = 4UL,
00853   L4_THREAD_REGISTER_DELETE_IRQ_OP    = 5UL,
00854   L4_THREAD_MODIFY_SENDER_OP          = 6UL,
00855   L4_THREAD_VCPU_CONTROL_OP           = 7UL,
00856   L4_THREAD_VCPU_CONTROL_EXT_OP       = L4_THREAD_VCPU_CONTROL_OP | 0x10000,
00857   L4_THREAD_REGISTER_DOORBELL_IRQ_OP  = 8UL,
00858   L4_THREAD_PF_TRAMP_CONTROL_OP       = 9UL,
00859   L4_THREAD_X86_GDT_OP                = 0x10UL,
00860   L4_THREAD_ARM_TPIDRURO_OP           = 0x10UL,
00861   L4_THREAD_AMD64_SET_SEGMENT_BASE_OP = 0x12UL,
00862   L4_THREAD_AMD64_GET_SEGMENT_INFO_OP = 0x13UL,
00863   L4_THREAD_OPCODE_MASK               = 0xffff,
00864 };
00865
00876 enum L4_thread_control_flags
00877 {
00879   L4_THREAD_CONTROL_SET_PAGER       = 0x0010000,
00881   L4_THREAD_CONTROL_BIND_TASK       = 0x0200000,
00883   L4_THREAD_CONTROL_ALIEN           = 0x0400000,
00885   L4_THREAD_CONTROL_SET_EXC_HANDLER = 0x1000000,
00886 };
00887
00897 enum L4_thread_control_mr_indices
00898 {
00899   L4_THREAD_CONTROL_MR_IDX_FLAGS       = 0,
00900   L4_THREAD_CONTROL_MR_IDX_PAGER       = 1,
00901   L4_THREAD_CONTROL_MR_IDX_EXC_HANDLER = 2,
00902   L4_THREAD_CONTROL_MR_IDX_FLAG_VALS   = 4,
00903   L4_THREAD_CONTROL_MR_IDX_BIND_UTCB   = 5,
00904   L4_THREAD_CONTROL_MR_IDX_BIND_TASK   = 6,
00905 };
00906
00912 enum L4_thread_ex_regs_flags
00913 {
00914   L4_THREAD_EX_REGS_CANCEL            = 0x10000UL,
00915   L4_THREAD_EX_REGS_TRIGGER_EXCEPTION = 0x20000UL,
00916
00917   L4_THREAD_EX_REGS_ARCH_MASK         = 0xff000000UL,
00918 };
00919
00925 enum L4_pf_tramp_control_op
00926 {
00928   L4_THREAD_PF_TRAMP_CONTROL_OP_SETUP   = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x00000UL),
00930   L4_THREAD_PF_TRAMP_CONTROL_OP_RESUME  = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x10000UL),
00932   L4_THREAD_PF_TRAMP_CONTROL_OP_REFLECT = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x20000UL),
00940   L4_THREAD_PF_TRAMP_CONTROL_OP_DISABLE = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x30000UL),
00947   L4_THREAD_PF_TRAMP_CONTROL_OP_ENABLE = (L4_THREAD_PF_TRAMP_CONTROL_OP | 0x40000UL),
00948 };
00949
00950 /* IMPLEMENTATION ----------------------------------------------------------*/
00951
00952 #include <l4/sys/ipc.h>
00953 #include <l4/sys/types.h>
00954
00955 L4_INLINE l4_msgtag_t
00956 l4_thread_ex_regs_u(l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp,
00957                     l4_umword_t flags, l4_utcb_t *utcb) L4_NOTHROW
00958 {
00959   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00960   v->mr[0] = L4_THREAD_EX_REGS_OP | flags;
00961   v->mr[1] = ip;
00962   v->mr[2] = sp;
```

```
00963   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 3, 0, 0), L4_IPC_NEVER);
00964 }
00965
00966 L4_INLINE l4_msgtag_t
00967 l4_thread_ex_regs_ret_u(l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp,
00968                         l4_umword_t *flags, l4_utcb_t *utcb) L4_NOTHROW
00969 {
00970   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00971   l4_msgtag_t ret = l4_thread_ex_regs_u(thread, *ip, *sp, *flags, utcb);
00972   if (l4_error_u(ret, utcb))
00973     return ret;
00974
00975   *flags = v->mr[0];
00976   *ip    = v->mr[1];
00977   *sp    = v->mr[2];
00978   return ret;
00979 }
00980
00981 L4_INLINE void
00982 l4_thread_control_start_u(l4_utcb_t *utcb) L4_NOTHROW
00983 {
00984   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00985   v->mr[L4_THREAD_CONTROL_MR_IDX_FLAGS] = L4_THREAD_CONTROL_OP;
00986 }
00987
00988 L4_INLINE void
00989 l4_thread_control_pager_u(l4_cap_idx_t pager, l4_utcb_t *utcb) L4_NOTHROW
00990 {
00991   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00992   v->mr[L4_THREAD_CONTROL_MR_IDX_FLAGS] |= L4_THREAD_CONTROL_SET_PAGER;
00993   v->mr[L4_THREAD_CONTROL_MR_IDX_PAGER]  = pager;
00994 }
00995
00996 L4_INLINE void
00997 l4_thread_control_exc_handler_u(l4_cap_idx_t exc_handler,
00998                                 l4_utcb_t *utcb) L4_NOTHROW
00999 {
01000   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01001   v->mr[L4_THREAD_CONTROL_MR_IDX_FLAGS]       |= L4_THREAD_CONTROL_SET_EXC_HANDLER;
01002   v->mr[L4_THREAD_CONTROL_MR_IDX_EXC_HANDLER]  = exc_handler;
01003 }
01004
01005 L4_INLINE void
01006 l4_thread_control_bind_u(l4_utcb_t *thread_utcb, l4_cap_idx_t task,
01007                          l4_utcb_t *utcb) L4_NOTHROW
01008 {
01009   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01010   v->mr[L4_THREAD_CONTROL_MR_IDX_FLAGS]         |= L4_THREAD_CONTROL_BIND_TASK;
01011   v->mr[L4_THREAD_CONTROL_MR_IDX_BIND_UTCB]      = (l4_addr_t)thread_utcb;
01012   v->mr[L4_THREAD_CONTROL_MR_IDX_BIND_TASK]      = L4_ITEM_MAP;
01013   v->mr[L4_THREAD_CONTROL_MR_IDX_BIND_TASK + 1]  = l4_obj_fpage(task, 0, L4_CAP_FPAGE_RWS).raw;
01014 }
01015
01016 L4_INLINE void
01017 l4_thread_control_alien_u(l4_utcb_t *utcb, int on) L4_NOTHROW
01018 {
01019   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01020   v->mr[L4_THREAD_CONTROL_MR_IDX_FLAGS]     |= L4_THREAD_CONTROL_ALIEN;
01021   v->mr[L4_THREAD_CONTROL_MR_IDX_FLAG_VALS] |= on ? L4_THREAD_CONTROL_ALIEN : 0;
01022 }
01023
01024 L4_INLINE l4_msgtag_t
01025 l4_thread_control_commit_u(l4_cap_idx_t thread, l4_utcb_t *utcb) L4_NOTHROW
01026 {
01027   int items = 0;
01028   if (l4_utcb_mr_u(utcb)->mr[L4_THREAD_CONTROL_MR_IDX_FLAGS] & L4_THREAD_CONTROL_BIND_TASK)
01029     items = 1;
01030   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 6, items, 0), L4_IPC_NEVER);
01031 }
01032
01033
01034 L4_INLINE l4_msgtag_t
01035 l4_thread_yield(void) L4_NOTHROW
01036 {
01037   l4_ipc_receive(L4_INVALID_CAP, NULL, L4_IPC_BOTH_TIMEOUT_0);
01038   return l4_msgtag(0, 0, 0, 0);
01039 }
01040
01041 /* Preliminary, to be changed */
01042 L4_INLINE l4_msgtag_t
01043 l4_thread_switch_u(l4_cap_idx_t to_thread, l4_utcb_t *utcb) L4_NOTHROW
01044 {
01045   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01046   v->mr[0] = L4_THREAD_SWITCH_OP;
01047   return l4_ipc_call(to_thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0), L4_IPC_NEVER);
01048 }
01049
```

```
01050
01051 L4_INLINE l4_msgtag_t
01052 l4_thread_stats_time_u(l4_cap_idx_t thread, l4_kernel_clock_t *us,
01053                        l4_utcb_t *utcb) L4_NOTHROW
01054 {
01055   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01056   l4_msgtag_t res;
01057
01058   v->mr[0] = L4_THREAD_STATS_OP;
01059
01060   res = l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0), L4_IPC_NEVER);
01061
01062   if (l4_msgtag_has_error(res))
01063     return res;
01064
01065   *us = v->mr64[l4_utcb_mr64_idx(0)];
01066
01067   return res;
01068 }
01069
01070 L4_INLINE l4_msgtag_t
01071 l4_thread_vcpu_resume_start_u(l4_utcb_t *utcb) L4_NOTHROW
01072 {
01073   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01074   v->mr[0] = L4_THREAD_VCPU_RESUME_OP;
01075   return l4_msgtag(L4_PROTO_THREAD, 1, 0, 0);
01076 }
01077
01078 L4_INLINE l4_msgtag_t
01079 l4_thread_vcpu_resume_commit_u(l4_cap_idx_t thread,
01080                                l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW
01081 {
01082   return l4_ipc_call(thread, utcb, tag, L4_IPC_NEVER);
01083 }
01084
01085 L4_INLINE l4_msgtag_t
01086 l4_thread_ex_regs(l4_cap_idx_t thread, l4_addr_t ip, l4_addr_t sp,
01087                   l4_umword_t flags) L4_NOTHROW
01088 {
01089   return l4_thread_ex_regs_u(thread, ip, sp, flags, l4_utcb());
01090 }
01091
01092 L4_INLINE l4_msgtag_t
01093 l4_thread_ex_regs_ret(l4_cap_idx_t thread, l4_addr_t *ip, l4_addr_t *sp,
01094                       l4_umword_t *flags) L4_NOTHROW
01095 {
01096   return l4_thread_ex_regs_ret_u(thread, ip, sp, flags, l4_utcb());
01097 }
01098
01099 L4_INLINE void
01100 l4_thread_control_start(void) L4_NOTHROW
01101 {
01102   l4_thread_control_start_u(l4_utcb());
01103 }
01104
01105 L4_INLINE void
01106 l4_thread_control_pager(l4_cap_idx_t pager) L4_NOTHROW
01107 {
01108   l4_thread_control_pager_u(pager, l4_utcb());
01109 }
01110
01111 L4_INLINE void
01112 l4_thread_control_exc_handler(l4_cap_idx_t exc_handler) L4_NOTHROW
01113 {
01114   l4_thread_control_exc_handler_u(exc_handler, l4_utcb());
01115 }
01116
01117
01118 L4_INLINE void
01119 l4_thread_control_bind(l4_utcb_t *thread_utcb, l4_cap_idx_t task) L4_NOTHROW
01120 {
01121   l4_thread_control_bind_u(thread_utcb, task, l4_utcb());
01122 }
01123
01124 L4_INLINE void
01125 l4_thread_control_alien(int on) L4_NOTHROW
01126 {
01127   l4_thread_control_alien_u(l4_utcb(), on);
01128 }
01129
01130 L4_INLINE l4_msgtag_t
01131 l4_thread_control_commit(l4_cap_idx_t thread) L4_NOTHROW
01132 {
01133   return l4_thread_control_commit_u(thread, l4_utcb());
01134 }
01135
01136
```

```
01137
01138
01139 L4_INLINE l4_msgtag_t
01140 l4_thread_switch(l4_cap_idx_t to_thread) L4_NOTHROW
01141 {
01142   return l4_thread_switch_u(to_thread, l4_utcb());
01143 }
01144
01145
01146
01147
01148 L4_INLINE l4_msgtag_t
01149 l4_thread_stats_time(l4_cap_idx_t thread, l4_kernel_clock_t *us) L4_NOTHROW
01150 {
01151   return l4_thread_stats_time_u(thread, us, l4_utcb());
01152 }
01153
01154 L4_INLINE l4_msgtag_t
01155 l4_thread_vcpu_resume_start(void) L4_NOTHROW
01156 {
01157   return l4_thread_vcpu_resume_start_u(l4_utcb());
01158 }
01159
01160 L4_INLINE l4_msgtag_t
01161 l4_thread_vcpu_resume_commit(l4_cap_idx_t thread,
01162                              l4_msgtag_t tag) L4_NOTHROW
01163 {
01164   return l4_thread_vcpu_resume_commit_u(thread, tag, l4_utcb());
01165 }
01166
01167
01168 L4_INLINE l4_msgtag_t
01169 l4_thread_register_del_irq_u(l4_cap_idx_t thread, l4_cap_idx_t irq,
01170                              l4_utcb_t *u) L4_NOTHROW
01171 {
01172   l4_msg_regs_t *m = l4_utcb_mr_u(u);
01173   m->mr[0] = L4_THREAD_REGISTER_DELETE_IRQ_OP;
01174   m->mr[1] = l4_map_obj_control(0,0);
01175   m->mr[2] = l4_obj_fpage(irq, 0, L4_CAP_FPAGE_RWS).raw;
01176   return l4_ipc_call(thread, u, l4_msgtag(L4_PROTO_THREAD, 1, 1, 0), L4_IPC_NEVER);
01177
01178 }
01179
01180 L4_INLINE l4_msgtag_t
01181 l4_thread_register_del_irq(l4_cap_idx_t thread, l4_cap_idx_t irq) L4_NOTHROW
01182 {
01183   return l4_thread_register_del_irq_u(thread, irq, l4_utcb());
01184 }
01185
01186
01187 L4_INLINE l4_msgtag_t
01188 l4_thread_vcpu_control_u(l4_cap_idx_t thread, l4_addr_t vcpu_state,
01189                          l4_utcb_t *utcb) L4_NOTHROW
01190 {
01191   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01192   v->mr[0] = L4_THREAD_VCPU_CONTROL_OP;
01193   v->mr[1] = vcpu_state;
01194   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2, 0, 0), L4_IPC_NEVER);
01195 }
01196
01197 L4_INLINE l4_msgtag_t
01198 l4_thread_vcpu_control(l4_cap_idx_t thread, l4_addr_t vcpu_state) L4_NOTHROW
01199 { return l4_thread_vcpu_control_u(thread, vcpu_state, l4_utcb()); }
01200
01201
01202 L4_INLINE l4_msgtag_t
01203 l4_thread_vcpu_control_ext_u(l4_cap_idx_t thread, l4_addr_t ext_vcpu_state,
01204                              l4_utcb_t *utcb) L4_NOTHROW
01205 {
01206   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
01207   v->mr[0] = L4_THREAD_VCPU_CONTROL_EXT_OP;
01208   v->mr[1] = ext_vcpu_state;
01209   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2, 0, 0), L4_IPC_NEVER);
01210 }
01211
01212 L4_INLINE l4_msgtag_t
01213 l4_thread_vcpu_control_ext(l4_cap_idx_t thread, l4_addr_t ext_vcpu_state) L4_NOTHROW
01214 { return l4_thread_vcpu_control_ext_u(thread, ext_vcpu_state, l4_utcb()); }
01215
01216 L4_INLINE l4_msgtag_t
01217 l4_thread_modify_sender_start_u(l4_utcb_t *u) L4_NOTHROW
01218 {
01219   l4_msg_regs_t *m = l4_utcb_mr_u(u);
01220   m->mr[0] = L4_THREAD_MODIFY_SENDER_OP;
01221   return l4_msgtag(L4_PROTO_THREAD, 1, 0, 0);
01222 }
01223
```

```
01224 L4_INLINE int
01225 l4_thread_modify_sender_add_u(l4_umword_t match_mask,
01226                               l4_umword_t match,
01227                               l4_umword_t del_bits,
01228                               l4_umword_t add_bits,
01229                               l4_msgtag_t *tag, l4_utcb_t *u) L4_NOTHROW
01230 {
01231   l4_msg_regs_t *m = l4_utcb_mr_u(u);
01232   unsigned w = l4_msgtag_words(*tag);
01233   if (w >= L4_UTCB_GENERIC_DATA_SIZE - 4)
01234     return -L4_ENOMEM;
01235
01236   m->mr[w]   = match_mask;
01237   m->mr[w+1] = match;
01238   m->mr[w+2] = del_bits;
01239   m->mr[w+3] = add_bits;
01240
01241   *tag = l4_msgtag(l4_msgtag_label(*tag), w + 4, 0, 0);
01242
01243   return 0;
01244 }
01245
01246 L4_INLINE l4_msgtag_t
01247 l4_thread_modify_sender_commit_u(l4_cap_idx_t thread, l4_msgtag_t tag,
01248                                  l4_utcb_t *u) L4_NOTHROW
01249 {
01250   return l4_ipc_call(thread, u, tag, L4_IPC_NEVER);
01251 }
01252
01253 L4_INLINE l4_msgtag_t
01254 l4_thread_modify_sender_start(void) L4_NOTHROW
01255 {
01256   return l4_thread_modify_sender_start_u(l4_utcb());
01257 }
01258
01259 L4_INLINE int
01260 l4_thread_modify_sender_add(l4_umword_t match_mask,
01261                             l4_umword_t match,
01262                             l4_umword_t del_bits,
01263                             l4_umword_t add_bits,
01264                             l4_msgtag_t *tag) L4_NOTHROW
01265 {
01266   return l4_thread_modify_sender_add_u(match_mask, match,
01267                                        del_bits, add_bits, tag, l4_utcb());
01268 }
01269
01270 L4_INLINE l4_msgtag_t
01271 l4_thread_modify_sender_commit(l4_cap_idx_t thread, l4_msgtag_t tag) L4_NOTHROW
01272 {
01273   return l4_thread_modify_sender_commit_u(thread, tag, l4_utcb());
01274 }
01275
01276
01277 L4_INLINE l4_msgtag_t
01278 l4_thread_register_doorbell_irq_u(l4_cap_idx_t thread, l4_cap_idx_t irq,
01279                                   l4_utcb_t *u) L4_NOTHROW
01280 {
01281   l4_msg_regs_t *m = l4_utcb_mr_u(u);
01282   m->mr[0] = L4_THREAD_REGISTER_DOORBELL_IRQ_OP;
01283   m->mr[1] = l4_map_obj_control(0,0);
01284   m->mr[2] = l4_obj_fpage(irq, 0, L4_CAP_FPAGE_RWS).raw;
01285   return l4_ipc_call(thread, u, l4_msgtag(L4_PROTO_THREAD, 1, 1, 0),
01286                      L4_IPC_NEVER);
01287 }
01288
01289 L4_INLINE l4_msgtag_t
01290 l4_thread_register_doorbell_irq(l4_cap_idx_t thread,
01291                                 l4_cap_idx_t irq) L4_NOTHROW
01292 {
01293   return l4_thread_register_doorbell_irq_u(thread, irq, l4_utcb());
01294 }
01295
01296
01297 L4_INLINE l4_msgtag_t
01298 l4_thread_pf_trampoline_setup(l4_cap_idx_t thread,
01299                               l4_addr_t pf_tramp_state) L4_NOTHROW
01300 {
01301   return l4_thread_pf_trampoline_setup_u(thread, pf_tramp_state, l4_utcb());
01302 }
01303
01304 L4_INLINE l4_msgtag_t
01305 l4_thread_pf_trampoline_setup_u(l4_cap_idx_t thread, l4_addr_t pf_tramp_state,
01306                                 l4_utcb_t *utcb) L4_NOTHROW
01307 {
01308   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
01309   m->mr[0] = L4_THREAD_PF_TRAMP_CONTROL_OP_SETUP;
01310   m->mr[1] = pf_tramp_state;
```

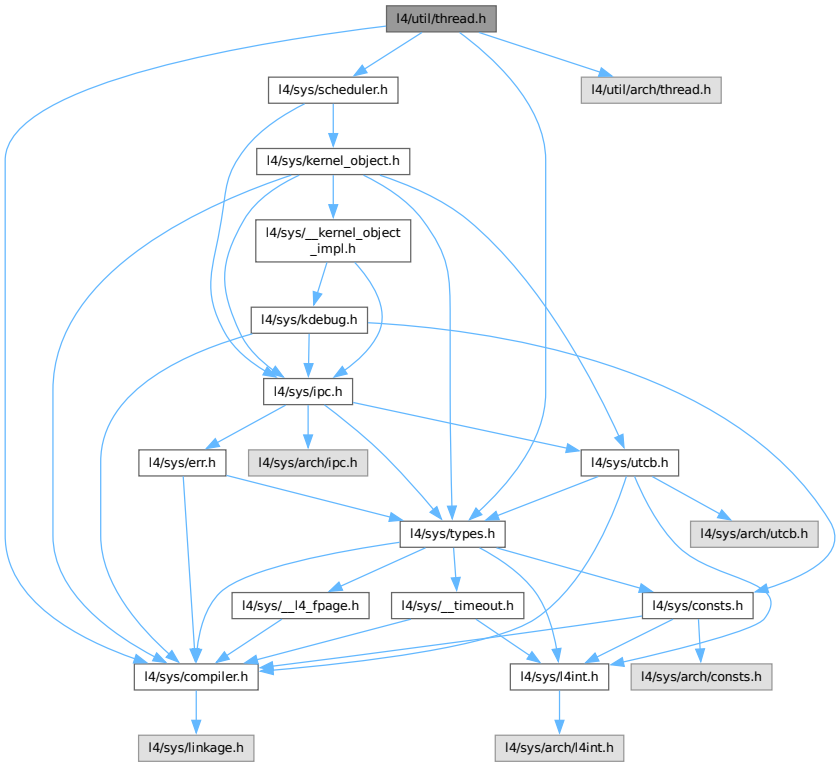
```
01311   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 2, 0, 0),
01312                      L4_IPC_NEVER);
01313 }
01314
01315 L4_INLINE l4_msgtag_t
01316 l4_thread_pf_trampoline_resume(l4_cap_idx_t thread) L4_NOTHROW
01317 {
01318   return l4_thread_pf_trampoline_resume_u(thread, l4_utcb());
01319 }
01320
01321 L4_INLINE l4_msgtag_t
01322 l4_thread_pf_trampoline_resume_u(l4_cap_idx_t thread, l4_utcb_t *utcb) L4_NOTHROW
01323 {
01324   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
01325   m->mr[0] = L4_THREAD_PF_TRAMP_CONTROL_OP_RESUME;
01326   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0),
01327                      L4_IPC_NEVER);
01328 }
01329
01330 L4_INLINE l4_msgtag_t
01331 l4_thread_pf_trampoline_reflect(l4_cap_idx_t thread) L4_NOTHROW
01332 {
01333   return l4_thread_pf_trampoline_reflect_u(thread, l4_utcb());
01334 }
01335
01336 L4_INLINE l4_msgtag_t
01337 l4_thread_pf_trampoline_reflect_u(l4_cap_idx_t thread, l4_utcb_t *utcb) L4_NOTHROW
01338 {
01339   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
01340   m->mr[0] = L4_THREAD_PF_TRAMP_CONTROL_OP_REFLECT;
01341   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0),
01342                      L4_IPC_NEVER);
01343 }
01344
01345 L4_INLINE l4_msgtag_t
01346 l4_thread_pf_trampoline_disable(l4_cap_idx_t thread, int *was_enabled) L4_NOTHROW
01347 {
01348   return l4_thread_pf_trampoline_disable_u(thread, was_enabled, l4_utcb());
01349 }
01350
01351 L4_INLINE l4_msgtag_t
01352 l4_thread_pf_trampoline_disable_u(l4_cap_idx_t thread, int *was_enabled,
01353                                   l4_utcb_t *utcb) L4_NOTHROW
01354 {
01355   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
01356   l4_msgtag_t res;
01357
01358   m->mr[0] = L4_THREAD_PF_TRAMP_CONTROL_OP_DISABLE;
01359   res = l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0),
01360                     L4_IPC_NEVER);
01361
01362   if (was_enabled)
01363     *was_enabled = m->mr[0];
01364   return res;
01365 }
01366
01367 L4_INLINE l4_msgtag_t
01368 l4_thread_pf_trampoline_enable(l4_cap_idx_t thread) L4_NOTHROW
01369 {
01370   return l4_thread_pf_trampoline_enable_u(thread, l4_utcb());
01371 }
01372
01373 L4_INLINE l4_msgtag_t
01374 l4_thread_pf_trampoline_enable_u(l4_cap_idx_t thread, l4_utcb_t *utcb) L4_NOTHROW
01375 {
01376   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
01377   m->mr[0] = L4_THREAD_PF_TRAMP_CONTROL_OP_ENABLE;
01378   return l4_ipc_call(thread, utcb, l4_msgtag(L4_PROTO_THREAD, 1, 0, 0),
01379                      L4_IPC_NEVER);
01380 }
01381
01382 #include <l4/sys/arch/thread.h>
```

16.148 l4/util/thread.h File Reference

Low-level Thread Functions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/sys/scheduler.h>
#include <l4/util/arch/thread.h>
```

Include dependency graph for thread.h:



Macros

- #define __L4UTIL_THREAD_FUNC(name)

  Defines a wrapper function that sets up the registers according to the calling conventions for the architecture.
- #define _L4UTIL_THREAD_CXX_FUNC_IMPL_(suffix, class, fn_name, from_asm_name, ...)

  Implement stub and handler.
- #define L4UTIL_THREAD_CXX_FUNC_PROTO(fn_name, ...)

  Declare static C++ class method which can be called as handler were only stack and instruction pointer are in a well-defined state.
- #define L4UTIL_THREAD_CXX_FUNC_IMPL(class, fn_name, ...)

  Implement static C++ class method which can be called as handler were only stack and instruction pointer are in a well-defined state.
- #define L4UTIL_THREAD_CXX_FUNC_INTERRUPT_IMPL(class, fn_name, ...)

  Implement static C++ class method which can be called as handler were only stack and instruction pointer are in a well-defined state.

16.148.1 Detailed Description

Low-level Thread Functions.

Date

1997

Author

Sebastian Schönberg

Definition in file thread.h.

16.148.2 Macro Definition Documentation

16.148.2.1 __L4UTIL_THREAD_FUNC

```
#define __L4UTIL_THREAD_FUNC(
              name)
```

Value:

```
void L4_NORETURN name(void)
```

Defines a wrapper function that sets up the registers according to the calling conventions for the architecture.
Use this as a function header when starting a low-level thread where only stack and instruction pointer are in a well-defined state.
Example:

```
L4UTIL_THREAD_FUNC(helper_thread)
{
  l4_infinite_loop();
}

thread_cap->ex_regs((l4_umword_t)helper_thread, stack_addr);
```

Definition at line 74 of file thread.h.

16.148.2.2 _L4UTIL_THREAD_CXX_FUNC_IMPL_

```
#define _L4UTIL_THREAD_CXX_FUNC_IMPL_(
              suffix,
              class,
              fn_name,
              from_asm_name,
              ...)
```

Value:

```
  asm (".global " L4_stringify(fn_name ## _stub)                  "\n"          \
       ".type " L4_stringify(fn_name ## _stub) " STT_FUNC          \n"          \
       L4_stringify(fn_name ## _stub) ":                           \n"          \
  L4UTIL_THREAD_CXX_FUNC_IMPL ## suffix ## _STUB(from_asm_name)                  \
      );                                                                         \
                                                                                 \
  [[noreturn]] void __attribute__((used)) class::from_asm_name(__VA_ARGS__)
```

Implement stub and handler.
For 'Foo::foo(int a, int b)' this macro expands into:

```
asm (".global foo_stub    \n"
     "foo_stub:           \n"
     ... align stack pointer ...
     "<call> foo_from_asm \n");

[[noreturn]] static void __attribute__((used))
Foo::foo(int a, int b) asm ("foo_from_asm")
```

Definition at line 102 of file thread.h.

16.148.2.3 L4UTIL_THREAD_CXX_FUNC_IMPL

```
#define L4UTIL_THREAD_CXX_FUNC_IMPL(
              class,
              fn_name,
              ...)
```

Value:

```
  [[noreturn]] void class::fn_name(__VA_ARGS__)
```

Implement static C++ class method which can be called as handler were only stack and instruction pointer are in a well-defined state.
This is important for certain architectures defining global registers or for architectures like AMD64 defining a "red zone" (a reserved fixed-size area below the current stack pointer to be used for temporary data).
The first two parameters of this macro define class name and method name, followed by up to three function parameters.
Use these macros like follows:

```
class Foo
{
  L4UTIL_THREAD_CXX_FUNC_PROTO(handler, int param1, long param2);
```

```
};

L4UTIL_THREAD_CXX_FUNC_IMPL(Foo, handler, int param1, long param2)
{
  printf("param1 = %d, param2 = %ld\n", param1, param2);
}
```

to declare the method

```
[[noreturn]] void Foo::handler(int param1, long param2);
```

Note

Use together with L4UTIL_THREAD_CXX_FUNC_PROTO().

Definition at line 176 of file thread.h.

16.148.2.4 L4UTIL_THREAD_CXX_FUNC_INTERRUPT_IMPL

```
#define L4UTIL_THREAD_CXX_FUNC_INTERRUPT_IMPL(
                class,
                fn_name,
                ...)
```

Value:

```
  _L4UTIL_THREAD_CXX_FUNC_IMPL(_INTERRUPT, class, fn_name, ##__VA_ARGS__)
```

Implement static C++ class method which can be called as handler were only stack and instruction pointer are in a well-defined state.
In contrast to L4UTIL_THREAD_CXX_FUNC_IMPL(), assume that this function may interrupt code executed at another user-level context and there are adaptions required to the stack pointer (alignment, consider the "red zone" on AMD64, etc.)
Definition at line 194 of file thread.h.

16.148.2.5 L4UTIL_THREAD_CXX_FUNC_PROTO

```
#define L4UTIL_THREAD_CXX_FUNC_PROTO(
                fn_name,
                ...)
```

Value:

```
   [[noreturn]] static void fn_name(__VA_ARGS__) \
   asm (L4_stringify(fn_name ## _stub)); \
   [[noreturn]] static void fn_name ## _from_asm(__VA_ARGS__) \
   asm (L4_stringify(fn_name ## _from_asm))
```

Declare static C++ class method which can be called as handler were only stack and instruction pointer are in a well-defined state.
Architecture-specific implementations may override this macro to use certain function attributes (e.g. **attribute**((regparm(3))) on x86).

Note

Use together with L4UTIL_THREAD_CXX_FUNC_IMPL() or L4UTIL_THREAD_CXX_FUNC_IMPL_SAME↩_STACK().

Definition at line 127 of file thread.h.

16.149 thread.h

Go to the documentation of this file.

```
00001
00007
00008 /*
00009  * (c) 2003-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/compiler.h>
00017 #include <l4/sys/types.h>
```

```
00018 #include <l4/sys/scheduler.h>
00019
00020 #include <l4/util/arch/thread.h>
00021
00022 L4_BEGIN_DECLS
00023
00028
00046 L4_CV long
00047 l4util_create_thread(l4_cap_idx_t id, l4_utcb_t *thread_utcb,
00048                      l4_cap_idx_t factory,
00049                      l4_umword_t pc, l4_umword_t sp, l4_cap_idx_t pager,
00050                      l4_cap_idx_t task,
00051                      l4_cap_idx_t scheduler, l4_sched_param_t scp) L4_NOTHROW;
00052
00053 L4_END_DECLS
00054
00055 #ifndef L4UTIL_THREAD_FUNC
00074 # define __L4UTIL_THREAD_FUNC(name) void L4_NORETURN name(void)
00075 # define L4UTIL_THREAD_FUNC(name) __L4UTIL_THREAD_FUNC(name)
00076 # define __L4UTIL_THREAD_STATIC_FUNC(name) static L4_NORETURN void name(void)
00077 # define L4UTIL_THREAD_STATIC_FUNC(name) __L4UTIL_THREAD_STATIC_FUNC(name)
00078 #endif
00079
00080 #ifndef L4UTIL_THREAD_CXX_FUNC_HELPER_PROTO_ATTR
00081 # define L4UTIL_THREAD_CXX_FUNC_HELPER_PROTO_ATTR
00082 #endif
00083 #ifndef L4UTIL_THREAD_CXX_FUNC_INTERRUPT_HELPER_PROTO_ATTR
00084 # define L4UTIL_THREAD_CXX_FUNC_INTERRUPT_HELPER_PROTO_ATTR
00085 #endif
00086
00102 #define _L4UTIL_THREAD_CXX_FUNC_IMPL_(suffix, class, fn_name, from_asm_name, ...)\
00103   asm (".global " L4_stringify(fn_name ## _stub)                  "\n"         \
00104        ".type " L4_stringify(fn_name ## _stub) " STT_FUNC          \n"         \
00105        L4_stringify(fn_name ## _stub) ":                           \n"         \
00106   L4UTIL_THREAD_CXX_FUNC_IMPL ## suffix ## _STUB(from_asm_name)                 \
00107       );                                                                       \
00108                                                                                \
00109   [[noreturn]] void __attribute__((used)) class::from_asm_name(__VA_ARGS__)
00110
00111 #define _L4UTIL_THREAD_CXX_FUNC_IMPL(suffix, class, fn_name, ...)              \
00112   _L4UTIL_THREAD_CXX_FUNC_IMPL_(suffix, class, fn_name, fn_name ## _from_asm,  \
00113                                 ##__VA_ARGS__)
00114
00115 #ifndef L4UTIL_THREAD_CXX_FUNC_PROTO
00116
00127 # define L4UTIL_THREAD_CXX_FUNC_PROTO(fn_name, ...) \
00128    [[noreturn]] static void fn_name(__VA_ARGS__) \
00129    asm (L4_stringify(fn_name ## _stub)); \
00130    [[noreturn]] static void fn_name ## _from_asm(__VA_ARGS__) \
00131    asm (L4_stringify(fn_name ## _from_asm))
00132
00133 #endif
00134
00168
00169 #ifdef L4UTIL_THREAD_CXX_FUNC_IMPL_STUB
00170
00171 # define L4UTIL_THREAD_CXX_FUNC_IMPL(class, fn_name, ...) \
00172    _L4UTIL_THREAD_CXX_FUNC_IMPL(, class, fn_name, ##__VA_ARGS__)
00173
00174 #else /* !L4UTIL_THREAD_CXX_FUNC_IMPL_STUB */
00175
00176 # define L4UTIL_THREAD_CXX_FUNC_IMPL(class, fn_name, ...) \
00177    [[noreturn]] void class::fn_name(__VA_ARGS__)
00178
00179 #endif
00180
00190 #ifndef L4UTIL_THREAD_CXX_FUNC_IMPL_INTERRUPT_STUB
00191 # error architecture-specific L4UTIL_THREAD_CXX_FUNC_IMPL_INTERRUPT_STUB missing
00192 #endif
00193
00194 #define L4UTIL_THREAD_CXX_FUNC_INTERRUPT_IMPL(class, fn_name, ...) \
00195   _L4UTIL_THREAD_CXX_FUNC_IMPL(_INTERRUPT, class, fn_name, ##__VA_ARGS__)
```

16.150 thread.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.151 thread.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.152 thread.h

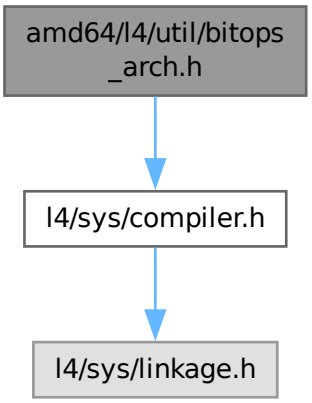
```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *            Frank Mehnert <frank.mehnert@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #define L4UTIL_THREAD_CXX_FUNC_HELPER_PROTO_ATTR \
00011   __attribute__((regparm(3)))
00012
00013 #define L4UTIL_THREAD_CXX_FUNC_PROTO(fn_name, ...) \
00014   [[noreturn]] static void fn_name(__VA_ARGS__) \
00015   asm (L4_stringify(fn_name ## _stub)) \
00016   L4UTIL_THREAD_CXX_FUNC_HELPER_PROTO_ATTR; \
00017   [[noreturn]] static void fn_name ## _from_asm(__VA_ARGS__) \
00018   asm (L4_stringify(fn_name ## _from_asm)) \
00019   L4UTIL_THREAD_CXX_FUNC_HELPER_PROTO_ATTR
00020
00021 #define L4UTIL_THREAD_CXX_FUNC_INTERRUPT_HELPER_PROTO_ATTR \
00022   L4UTIL_THREAD_CXX_FUNC_HELPER_PROTO_ATTR
00023
00024 /* Similar to signal handler: Align stack pointer. */
00025 #define L4UTIL_THREAD_CXX_FUNC_IMPL_INTERRUPT_STUB(from_asm_name) \
00026   "and $~0xf, %esp  \n" \
00027   "cld              \n" \
00028   "call " L4_stringify(from_asm_name) "\n"
```

16.153 amd64/l4/util/bitops_arch.h File Reference

amd64 bit manipulation functions

`#include <l4/sys/compiler.h>`

Include dependency graph for bitops_arch.h:



16.153.1 Detailed Description

amd64 bit manipulation functions
Definition in file bitops_arch.h.

16.154 bitops_arch.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2000-2009 Technische Universität Dresden (Germany)
00003  * Copyright (C) 2016, 2022, 2024-2025 Kernkonzept GmbH. All rights reserved.
00004  * Author(s): Lars Reuther <reuther@os.inf.tu-dresden.de>
00005  *            Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00006  *            Frank Mehnert <frank.mehnert@kernkonzept.com>
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010
00016
00017 #pragma once
00018
00019 #include <l4/sys/compiler.h>
00020
00021 /*
00022  * Note: The following Assembler statement may produce wrong code:
00023  *   asm volatile ("btsl %1, %2" : "=@ccc"(r) : "Jr"(63), "m"(m) : "memory");
00024  *
00025  * The compiler might chose the first variant because the bit number is smaller
00026  * than 64. However, 'bts' is encoded as 32-bit variant ('btsl') and thus only
00027  * supports immediate bit values up to 31. Some assemblers support immediate
00028  * offsets > 31 by adapting the memory address accordingly but GAS does not.
00029  * With GAS, the instruction will encode an immediate value of 63 but the CPU
00030  * will set bit 31 instead of bit 63!
00031  *
00032  * Therefore, if we would use 'btsl' instead of 'btsq', the correct constraint
00033  * for the bit number parameter would be "Ir" instead of "Jr".
00034  */
00035
00036 L4_BEGIN_DECLS
00037
00038 /* set bit */
00039 #define __L4UTIL_BITOPS_HAVE_ARCH_SET_BIT
00040 L4_INLINE void
00041 l4util_set_bit(int b, volatile l4_umword_t * dest)
00042 {
00043   __asm__ __volatile__
00044     (
00045      "lock; btsq  %1,%0   \n\t"
00046      :
00047      :
00048      "m"   (*dest),   /* 0 mem, destination operand */
00049      "Jr"  ((l4_umword_t)b) /* 1, bit number */
00050      :
00051      "memory", "cc"
00052      );
00053 }
00054
00055 /* clear bit */
00056 #define __L4UTIL_BITOPS_HAVE_ARCH_CLEAR_BIT
00057 L4_INLINE void
00058 l4util_clear_bit(int b, volatile l4_umword_t * dest)
00059 {
00060   __asm__ __volatile__
00061     (
00062      "lock; btrq  %1,%0   \n\t"
00063      :
00064      :
00065      "m"   (*dest),   /* 0 mem, destination operand */
00066      "Jr"  ((l4_umword_t)b) /* 1, bit number */
00067      :
00068      "memory", "cc"
00069      );
00070 }
00071
00072 /* change bit */
00073 #define __L4UTIL_BITOPS_HAVE_ARCH_COMPLEMENT_BIT
00074 L4_INLINE void
00075 l4util_complement_bit(int b, volatile l4_umword_t * dest)
00076 {
00077   __asm__ __volatile__
00078     (
00079      "lock; btcq  %1,%0   \n\t"
00080      :
```

```
00081       :
00082       "m"   (*dest),   /* 0 mem, destination operand */
00083       "Jr"  ((l4_umword_t)b) /* 1, bit number */
00084       :
00085       "memory", "cc"
00086       );
00087 }
00088
00089 /* test bit */
00090 #define __L4UTIL_BITOPS_HAVE_ARCH_TEST_BIT
00091 L4_INLINE int
00092 l4util_test_bit(int b, const volatile l4_umword_t * dest)
00093 {
00094   l4_int8_t bit;
00095
00096   __asm__ __volatile__
00097     (
00098       "btq   %2,%1   \n\t"
00099       :
00100       "=@ccc" (bit)    /* 0,     old bit value */
00101       :
00102       "m"   (*dest),   /* 1 mem, destination operand */
00103       "Jr"  ((l4_umword_t)b) /* 2, bit number */
00104       :
00105       "memory"
00106       );
00107
00108   return bit;
00109 }
00110
00111 /* bit test and set */
00112 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_SET
00113 L4_INLINE int
00114 l4util_bts(int b, volatile l4_umword_t * dest)
00115 {
00116   l4_int8_t bit;
00117
00118   __asm__ __volatile__
00119     (
00120       "lock; btsq  %2,%1   \n\t"
00121       :
00122       "=@ccc" (bit)    /* 0,     old bit value */
00123       :
00124       "m"   (*dest),   /* 1 mem, destination operand */
00125       "Jr"  ((l4_umword_t)b) /* 2, bit number */
00126       :
00127       "memory"
00128       );
00129
00130   return bit;
00131 }
00132
00133 /* bit test and reset */
00134 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_RESET
00135 L4_INLINE int
00136 l4util_btr(int b, volatile l4_umword_t * dest)
00137 {
00138   l4_int8_t bit;
00139
00140   __asm__ __volatile__
00141     (
00142       "lock; btrq  %2,%1   \n\t"
00143       :
00144       "=@ccc" (bit)    /* 0,     old bit value */
00145       :
00146       "m"   (*dest),   /* 1 mem, destination operand */
00147       "Jr"  ((l4_umword_t)b) /* 2, bit number */
00148       :
00149       "memory"
00150       );
00151
00152   return bit;
00153 }
00154
00155 /* bit test and complement */
00156 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_COMPLEMENT
00157 L4_INLINE int
00158 l4util_btc(int b, volatile l4_umword_t * dest)
00159 {
00160   l4_int8_t bit;
00161
00162   __asm__ __volatile__
00163     (
00164       "lock; btcq  %2,%1   \n\t"
00165       :
00166       "=@ccc" (bit)    /* 0,     old bit value */
00167       :
```

```
00168       "m"   (*dest),   /* 1 mem, destination operand */
00169       "Jr"  ((l4_umword_t)b) /* 2, bit number */
00170       :
00171       "memory"
00172       );
00173
00174     return bit;
00175 }
00176
00177 /* bit scan reverse */
00178 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_SCAN_REVERSE
00179 L4_INLINE int
00180 l4util_bsr(l4_umword_t word)
00181 {
00182   l4_umword_t tmp;
00183
00184   if (L4_UNLIKELY(word == 0))
00185     return -1;
00186
00187   __asm__ __volatile__
00188     (
00189      "bsrq %1,%0 \n\t"
00190      :
00191      "=r" (tmp)        /* 0, index of most significant set bit */
00192      :
00193      "r"  (word)       /* 1, argument */
00194      );
00195
00196   return tmp;
00197 }
00198
00199 /* bit scan forward */
00200 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_SCAN_FORWARD
00201 L4_INLINE int
00202 l4util_bsf(l4_umword_t word)
00203 {
00204   l4_umword_t tmp;
00205
00206   if (L4_UNLIKELY(word == 0))
00207     return -1;
00208
00209   __asm__ __volatile__
00210     (
00211      "bsfq %1,%0 \n\t"
00212      :
00213      "=r" (tmp)        /* 0, index of least significant set bit */
00214      :
00215      "r"  (word)       /* 1, argument */
00216      );
00217
00218   return tmp;
00219 }
00220
00221 #define __L4UTIL_BITOPS_HAVE_ARCH_FIND_FIRST_SET_BIT
00222 L4_INLINE int
00223 l4util_find_first_set_bit(const void * dest, l4_size_t size)
00224 {
00225   l4_mword_t dummy0, dummy1, res;
00226
00227   __asm__ __volatile__
00228     (
00229      "repe; scasq               \n\t"
00230      "jz    1f                  \n\t"
00231      "lea  -8(%%rdi),%%rdi      \n\t"
00232      "bsf  (%%rdi),%%rax        \n"
00233      "1:                        \n\t"
00234      "sub  %%rbx,%%rdi          \n\t"
00235      "shl  $3,%%rdi             \n\t"
00236      "add  %%rdi,%%rax          \n\t"
00237      :
00238      "=a" (res), "=c" (dummy0), "=D" (dummy1)
00239      :
00240      "a" (0), "b" (dest), "c" ((size + 63) » 6), "D" (dest)
00241      :
00242      "cc", "memory");
00243
00244   return res;
00245 }
00246
00247 #define __L4UTIL_BITOPS_HAVE_ARCH_FIND_FIRST_ZERO_BIT
00248 L4_INLINE int
00249 l4util_find_first_zero_bit(const void * dest, l4_size_t size)
00250 {
00251   l4_mword_t dummy0, dummy1, dummy2, res;
00252
00253   if (!size)
00254     return 0;
```

```
00255
00256   __asm__ __volatile__
00257     (
00258      "repe;  scasq              \n\t"
00259      "je     1f                 \n\t"
00260      "xor   -8(%%rdi),%%rax     \n\t"
00261      "sub   $8,%%rdi            \n\t"
00262      "bsf   %%rax,%%rdx         \n"
00263      "1:                        \n\t"
00264      "sub   %%rsi,%%rdi         \n\t"
00265      "shl   $3,%%rdi            \n\t"
00266      "add   %%rdi,%%rdx         \n\t"
00267      :
00268      "=a" (dummy0), "=c" (dummy1), "=d" (res), "=D" (dummy2)
00269      :
00270      "a" (~0UL), "c" ((size + 63) » 6), "d" (0), "D" (dest), "S" (dest)
00271      :
00272      "cc", "memory");
00273
00274   return res;
00275 }
00276
00277 L4_END_DECLS
```

16.155 arm/l4/util/bitops_arch.h File Reference

ARM specific implementation of bitops functions.

16.155.1 Detailed Description

ARM specific implementation of bitops functions.
Definition in file bitops_arch.h.

16.156 bitops_arch.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #ifndef __L4UTIL__ARCH_ARM__BITOPS_ARCH_H__
00011 #define __L4UTIL__ARCH_ARM__BITOPS_ARCH_H__
00012
00013
00014 #endif /* ! __L4UTIL__ARCH_ARM__BITOPS_ARCH_H__ */
```

16.157 x86/l4/util/bitops_arch.h File Reference

x86 bit manipulation functions

16.157.1 Detailed Description

x86 bit manipulation functions
Definition in file bitops_arch.h.

16.158 bitops_arch.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2000-2009 Technische Universität Dresden (Germany)
00003  * Copyright (C) 2016, 2022, 2024-2025 Kernkonzept GmbH. All rights reserved.
00004  * Author(s): Lars Reuther <reuther@os.inf.tu-dresden.de>
00005  *            Frank Mehnert <frank.mehnert@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
```

```
00015
00016 #pragma once
00017
00018 L4_BEGIN_DECLS
00019
00020 /* set bit */
00021 #define __L4UTIL_BITOPS_HAVE_ARCH_SET_BIT
00022 L4_INLINE void
00023 l4util_set_bit(int b, volatile l4_umword_t * dest)
00024 {
00025   __asm__ __volatile__
00026     (
00027      "lock; btsl  %1,%0   \n\t"
00028      :
00029      :
00030      "m"   (*dest),   /* 0 mem, destination operand */
00031      "Ir"  (b)       /* 1,     bit number */
00032      :
00033      "memory", "cc"
00034      );
00035 }
00036
00037 /* clear bit */
00038 #define __L4UTIL_BITOPS_HAVE_ARCH_CLEAR_BIT
00039 L4_INLINE void
00040 l4util_clear_bit(int b, volatile l4_umword_t * dest)
00041 {
00042   __asm__ __volatile__
00043     (
00044      "lock; btrl  %1,%0   \n\t"
00045      :
00046      :
00047      "m"   (*dest),   /* 0 mem, destination operand */
00048      "Ir"  (b)        /* 1,     bit number */
00049      :
00050      "memory", "cc"
00051      );
00052 }
00053
00054 /* change bit */
00055 #define __L4UTIL_BITOPS_HAVE_ARCH_COMPLEMENT_BIT
00056 L4_INLINE void
00057 l4util_complement_bit(int b, volatile l4_umword_t * dest)
00058 {
00059   __asm__ __volatile__
00060     (
00061      "lock; btcl  %1,%0   \n\t"
00062      :
00063      :
00064      "m"   (*dest),   /* 0 mem, destination operand */
00065      "Ir"  (b)        /* 1,     bit number */
00066      :
00067      "memory", "cc"
00068      );
00069 }
00070
00071 /* test bit */
00072 #define __L4UTIL_BITOPS_HAVE_ARCH_TEST_BIT
00073 L4_INLINE int
00074 l4util_test_bit(int b, const volatile l4_umword_t * dest)
00075 {
00076   l4_int8_t bit;
00077
00078   __asm__ __volatile__
00079     (
00080      "btl   %2,%1   \n\t"
00081      :
00082      "=@ccc" (bit)    /* 0,     old bit value */
00083      :
00084      "m"   (*dest),   /* 1 mem, destination operand */
00085      "Ir"  (b)        /* 2,     bit number */
00086      :
00087      "memory"
00088      );
00089
00090   return bit;
00091 }
00092
00093 /* bit test and set */
00094 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_SET
00095 L4_INLINE int
00096 l4util_bts(int b, volatile l4_umword_t * dest)
00097 {
00098   l4_int8_t bit;
00099
00100   __asm__ __volatile__
00101     (
```

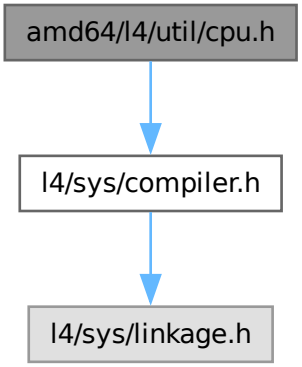
```
00102       "lock; btsl  %2,%1   \n\t"
00103       :
00104       "=@ccc" (bit)     /* 0,     old bit value */
00105       :
00106       "m"   (*dest),    /* 1 mem, destination operand */
00107       "Ir"  (b)         /* 2,     bit number */
00108       :
00109       "memory"
00110       );
00111
00112   return bit;
00113 }
00114
00115 /* bit test and reset */
00116 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_RESET
00117 L4_INLINE int
00118 l4util_btr(int b, volatile l4_umword_t * dest)
00119 {
00120   l4_int8_t bit;
00121
00122   __asm__ __volatile__
00123     (
00124       "lock; btrl  %2,%1   \n\t"
00125       :
00126       "=@ccc" (bit)     /* 0,     old bit value */
00127       :
00128       "m"   (*dest),    /* 1 mem, destination operand */
00129       "Ir"  (b)         /* 2,     bit number */
00130       :
00131       "memory"
00132       );
00133
00134   return bit;
00135 }
00136
00137 /* bit test and complement */
00138 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_COMPLEMENT
00139 L4_INLINE int
00140 l4util_btc(int b, volatile l4_umword_t * dest)
00141 {
00142   l4_int8_t bit;
00143
00144   __asm__ __volatile__
00145     (
00146       "lock; btcl  %2,%1   \n\t"
00147       :
00148       "=@ccc" (bit)     /* 0,     old bit value */
00149       :
00150       "m"   (*dest),    /* 1 mem, destination operand */
00151       "Ir"  (b)         /* 2,     bit number */
00152       :
00153       "memory"
00154       );
00155
00156   return bit;
00157 }
00158
00159 /* bit scan reverse */
00160 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_SCAN_REVERSE
00161 L4_INLINE int
00162 l4util_bsr(l4_umword_t word)
00163 {
00164   int tmp;
00165
00166   if (L4_UNLIKELY(word == 0))
00167     return -1;
00168
00169   __asm__ __volatile__
00170     (
00171       "bsrl %1,%0 \n\t"
00172       :
00173       "=r" (tmp)        /* 0, index of most significant set bit */
00174       :
00175       "r"  (word)       /* 1, argument */
00176       );
00177
00178   return tmp;
00179 }
00180
00181 /* bit scan forward */
00182 #define __L4UTIL_BITOPS_HAVE_ARCH_BIT_SCAN_FORWARD
00183 L4_INLINE int
00184 l4util_bsf(l4_umword_t word)
00185 {
00186   int tmp;
00187
00188   if (L4_UNLIKELY(word == 0))
```

```
00189     return -1;
00190
00191   __asm__ __volatile__
00192     (
00193      "bsfl %1,%0 \n\t"
00194      :
00195      "=r" (tmp)        /* 0, index of least significant set bit */
00196      :
00197      "r"  (word)       /* 1, argument */
00198      );
00199
00200   return tmp;
00201 }
00202
00203 #define __L4UTIL_BITOPS_HAVE_ARCH_FIND_FIRST_SET_BIT
00204 L4_INLINE int
00205 l4util_find_first_set_bit(const void * dest, l4_size_t size)
00206 {
00207   l4_mword_t dummy0, dummy1, res;
00208
00209   __asm__ __volatile__
00210     (
00211      "repe; scasl               \n\t"
00212      "jz    1f                  \n\t"
00213      "lea  -4(%%edi),%%edi      \n\t"
00214      "bsf  (%%edi),%%eax        \n"
00215      "1:                        \n\t"
00216      "sub  %%esi,%%edi          \n\t"
00217      "shl  $3,%%edi             \n\t"
00218      "add  %%edi,%%eax          \n\t"
00219      :
00220      "=a" (res), "=c" (dummy0), "=D" (dummy1)
00221      :
00222      "a" (0), "c" ((size + 31) » 5), "D" (dest), "S" (dest)
00223      :
00224      "cc", "memory");
00225
00226   return res;
00227 }
00228
00229 #define __L4UTIL_BITOPS_HAVE_ARCH_FIND_FIRST_ZERO_BIT
00230 L4_INLINE int
00231 l4util_find_first_zero_bit(const void * dest, l4_size_t size)
00232 {
00233   l4_mword_t dummy0, dummy1, dummy2, res;
00234
00235   if (!size)
00236     return 0;
00237
00238   __asm__ __volatile__
00239     (
00240      "repe;  scasl              \n\t"
00241      "je     1f                 \n\t"
00242      "xor   -4(%%edi),%%eax     \n\t"
00243      "sub   $4,%%edi            \n\t"
00244      "bsf   %%eax,%%edx         \n"
00245      "1:                        \n\t"
00246      "sub   %%esi,%%edi         \n\t"
00247      "shl   $3,%%edi            \n\t"
00248      "add   %%edi,%%edx         \n\t"
00249      :
00250      "=a" (dummy0), "=c" (dummy1), "=d" (res), "=D" (dummy2)
00251      :
00252      "a" (~0UL), "c" ((size + 31) » 5), "d" (0), "D" (dest), "S" (dest)
00253      :
00254      "cc", "memory");
00255
00256   return res;
00257 }
00258
00259 L4_END_DECLS
```

16.159 amd64/l4/util/cpu.h File Reference

CPU related functions.

`#include <l4/sys/compiler.h>`
Include dependency graph for cpu.h:



Functions

- int l4util_cpu_has_cpuid (void)

  Check whether the CPU supports the "cpuid" instruction.
- unsigned int l4util_cpu_capabilities (void)

  Returns the CPU capabilities if the "cpuid" instruction is available.
- unsigned int l4util_cpu_capabilities_nocheck (void)

  Returns the CPU capabilities.
- void **l4util_cpu_cpuid** (unsigned long mode, unsigned long ∗eax, unsigned long ∗ebx, unsigned long ∗ecx, unsigned long ∗edx)

  Generic CPUID access function.

16.159.1 Detailed Description

CPU related functions.

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file cpu.h.

16.160 cpu.h

Go to the documentation of this file.

```
00001
00006
00007 /*
00008  * (c) 2004-2009 Author(s)
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #ifndef __L4_UTIL_CPU_H
00014 #define __L4_UTIL_CPU_H
00015
00016 #include <l4/sys/compiler.h>
00017
00018 L4_BEGIN_DECLS
00019
```

```
00025
00031 L4_INLINE int          l4util_cpu_has_cpuid(void);
00032
00039 L4_INLINE unsigned int l4util_cpu_capabilities(void);
00040
00046 L4_INLINE unsigned int l4util_cpu_capabilities_nocheck(void);
00047
00051 L4_INLINE void
00052 l4util_cpu_cpuid(unsigned long mode,
00053                  unsigned long *eax, unsigned long *ebx,
00054                  unsigned long *ecx, unsigned long *edx);
00055
00057 static inline void
00058 l4util_cpu_pause(void)
00059 {
00060   __asm__ __volatile__ ("rep; nop");
00061 }
00062
00063 L4_INLINE int
00064 l4util_cpu_has_cpuid(void)
00065 {
00066   return 1;
00067 }
00068
00069 L4_INLINE void
00070 l4util_cpu_cpuid(unsigned long mode,
00071                  unsigned long *eax, unsigned long *ebx,
00072                  unsigned long *ecx, unsigned long *edx)
00073 {
00074   asm volatile("cpuid"
00075                : "=a" (*eax),
00076                  "=b" (*ebx),
00077                  "=c" (*ecx),
00078                  "=d" (*edx)
00079                : "a"  (mode)
00080                );
00081 }
00082
00083 L4_INLINE unsigned int
00084 l4util_cpu_capabilities_nocheck(void)
00085 {
00086   unsigned long dummy, capability;
00087
00088   /* get CPU capabilities */
00089   l4util_cpu_cpuid(1, &dummy, &dummy, &dummy, &capability);
00090
00091   return capability;
00092 }
00093
00094 L4_INLINE unsigned int
00095 l4util_cpu_capabilities(void)
00096 {
00097   if (!l4util_cpu_has_cpuid())
00098     return 0; /* CPU has not cpuid instruction */
00099
00100   return l4util_cpu_capabilities_nocheck();
00101 }
00102
00103 L4_END_DECLS
00104
00105 #endif
00106
```

16.161 arm/l4/util/cpu.h File Reference

CPU related functions.

16.161.1 Detailed Description

CPU related functions.

Author

Adam Lackorzynski adam@os.inf.tu-dresden.de

Definition in file cpu.h.

16.162 cpu.h

Go to the documentation of this file.

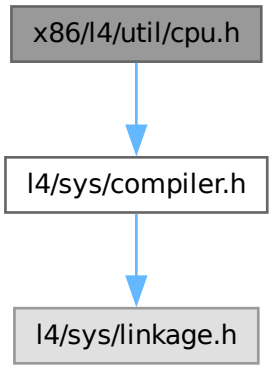
```
00001
00007
00008 /*
00009  * (c) 2004-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #ifndef __L4_UTIL__ARCH_ARM__CPU_H__
00015 #define __L4_UTIL__ARCH_ARM__CPU_H__
00016
00017 /* Nothing yet */
00018
00019 #endif /* __L4_UTIL__ARCH_ARM__CPU_H__ */
```

16.163 x86/l4/util/cpu.h File Reference

CPU related functions.

`#include <l4/sys/compiler.h>`

Include dependency graph for cpu.h:



Functions

- int l4util_cpu_has_cpuid (void)

  Check whether the CPU supports the "cpuid" instruction.
- unsigned int l4util_cpu_capabilities (void)

  Returns the CPU capabilities if the "cpuid" instruction is available.
- unsigned int l4util_cpu_capabilities_nocheck (void)

  Returns the CPU capabilities.
- void **l4util_cpu_cpuid** (unsigned long mode, unsigned long ∗eax, unsigned long ∗ebx, unsigned long ∗ecx, unsigned long ∗edx)

  Generic CPUID access function.

16.163.1 Detailed Description

CPU related functions.

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file cpu.h.

16.164 cpu.h

Go to the documentation of this file.

```
00001
00006
00007 /*
00008  * (c) 2004-2009 Author(s)
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #ifndef __L4_UTIL_CPU_H
00014 #define __L4_UTIL_CPU_H
00015
00016 #include <l4/sys/compiler.h>
00017
00018 L4_BEGIN_DECLS
00019
00025
00031 L4_INLINE int          l4util_cpu_has_cpuid(void);
00032
00039 L4_INLINE unsigned int l4util_cpu_capabilities(void);
00040
00046 L4_INLINE unsigned int l4util_cpu_capabilities_nocheck(void);
00047
00051 L4_INLINE void
00052 l4util_cpu_cpuid(unsigned long mode,
00053                  unsigned long *eax, unsigned long *ebx,
00054                  unsigned long *ecx, unsigned long *edx);
00055
00057 static inline void
00058 l4util_cpu_pause(void)
00059 {
00060   __asm__ __volatile__ ("rep; nop");
00061 }
00062
00063 L4_INLINE int
00064 l4util_cpu_has_cpuid(void)
00065 {
00066   unsigned long eax;
00067
00068   asm volatile("pushl %%ebx             \t\n"
00069                "pushfl       \t\n"
00070                "popl %%eax    \t\n" /* get eflags */
00071                "movl %%eax, %%ebx \t\n" /* save it */
00072                "xorl $0x200000, %%eax \t\n" /* toggle ID bit */
00073                "pushl %%eax   \t\n"
00074                "popfl     \t\n" /* set again */
00075                "pushfl       \t\n"
00076                "popl %%eax    \t\n" /* get it again */
00077                "xorl %%ebx, %%eax \t\n"
00078                "pushl %%ebx   \t\n"
00079                "popfl     \t\n" /* restore saved flags */
00080                "popl %%ebx              \t\n"
00081                : "=a" (eax)
00082                : /* no input */
00083                );
00084
00085   return eax & 0x200000;
00086 }
00087
00088 L4_INLINE void
00089 l4util_cpu_cpuid(unsigned long mode,
00090                  unsigned long *eax, unsigned long *ebx,
00091                  unsigned long *ecx, unsigned long *edx)
00092 {
00093   asm volatile("pushl %%ebx      \t\n"
00094                "cpuid            \t\n"
00095                "mov %%ebx, %%esi \t\n"
00096                "popl %%ebx       \t\n"
00097                : "=a" (*eax),
00098                  "=S" (*ebx),
```

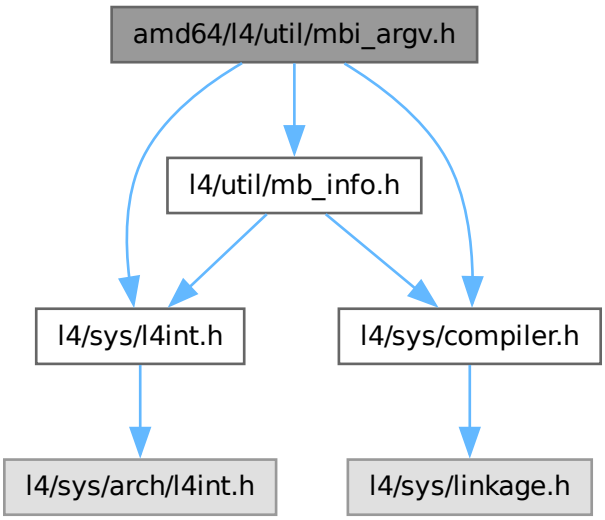
```
00099                   "=c" (*ecx),
00100                   "=d" (*edx)
00101                 : "a"  (mode));
00102 }
00103
00104 L4_INLINE unsigned int
00105 l4util_cpu_capabilities_nocheck(void)
00106 {
00107   unsigned long dummy, capability;
00108
00109   /* get CPU capabilities */
00110   l4util_cpu_cpuid(1, &dummy, &dummy, &dummy, &capability);
00111
00112   return capability;
00113 }
00114
00115 L4_INLINE unsigned int
00116 l4util_cpu_capabilities(void)
00117 {
00118   if (!l4util_cpu_has_cpuid())
00119     return 0; /* CPU has not cpuid instruction */
00120
00121   return l4util_cpu_capabilities_nocheck();
00122 }
00123
00124 L4_END_DECLS
00125
00126 #endif
00127
```

16.165 amd64/l4/util/mbi_argv.h File Reference

command line handling

```
#include <l4/sys/l4int.h>
#include <l4/util/mb_info.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for mbi_argv.h:



16.165.1 Detailed Description

command line handling

Date

2003

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file mbi_argv.h.

16.166 mbi_argv.h

Go to the documentation of this file.

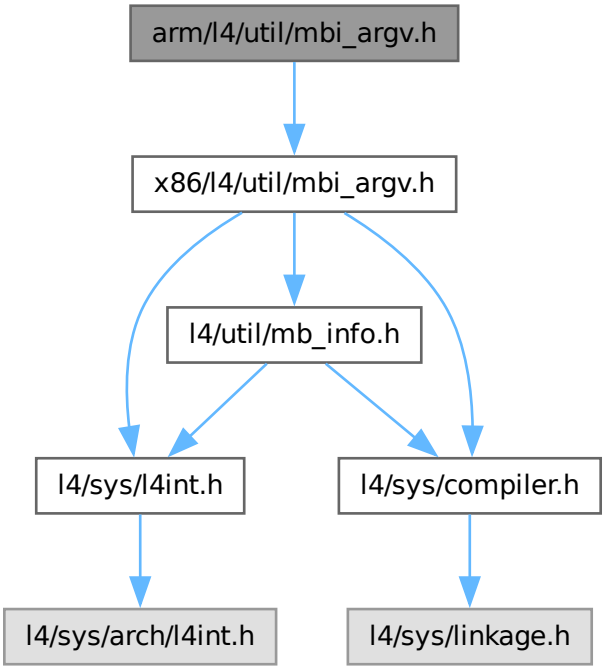
```
00001
00007
00008 /*
00009  * (c) 2003-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #ifndef L4UTIL_MBI_ARGV
00015 #define L4UTIL_MBI_ARGV
00016
00017 #include <l4/sys/l4int.h>
00018 #include <l4/util/mb_info.h>
00019 #include <l4/sys/compiler.h>
00020
00021 L4_BEGIN_DECLS
00022
00023 L4_CV void l4util_mbi_to_argv(l4_mword_t flag, l4util_mb_info_t *mbi);
00024
00025 extern int  l4util_argc;
00026 extern char *l4util_argv[];
00027
00028 L4_END_DECLS
00029
00030 #endif
00031
```

16.167 arm/l4/util/mbi_argv.h File Reference

Multiboot.

```
#include <x86/l4/util/mbi_argv.h>
```

Include dependency graph for mbi_argv.h:



16.167.1 Detailed Description

Multiboot.
Definition in file mbi_argv.h.

16.168 mbi_argv.h

Go to the documentation of this file.

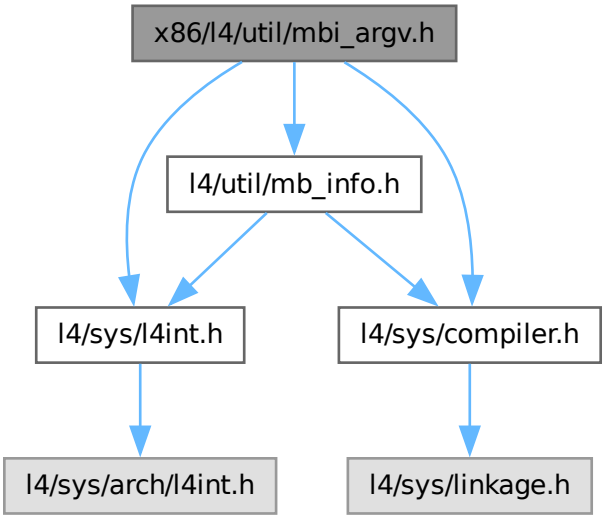
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 /* If this persists, move it to a generic place */
00011 #include <x86/l4/util/mbi_argv.h>
```

16.169 x86/l4/util/mbi_argv.h File Reference

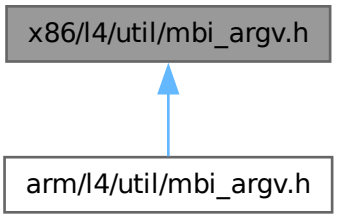
command line handling

```
#include <l4/sys/l4int.h>
#include <l4/util/mb_info.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for mbi_argv.h:



This graph shows which files directly or indirectly include this file:



16.169.1 Detailed Description

command line handling

Date

2003

Author

Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file mbi_argv.h.

16.170 mbi_argv.h

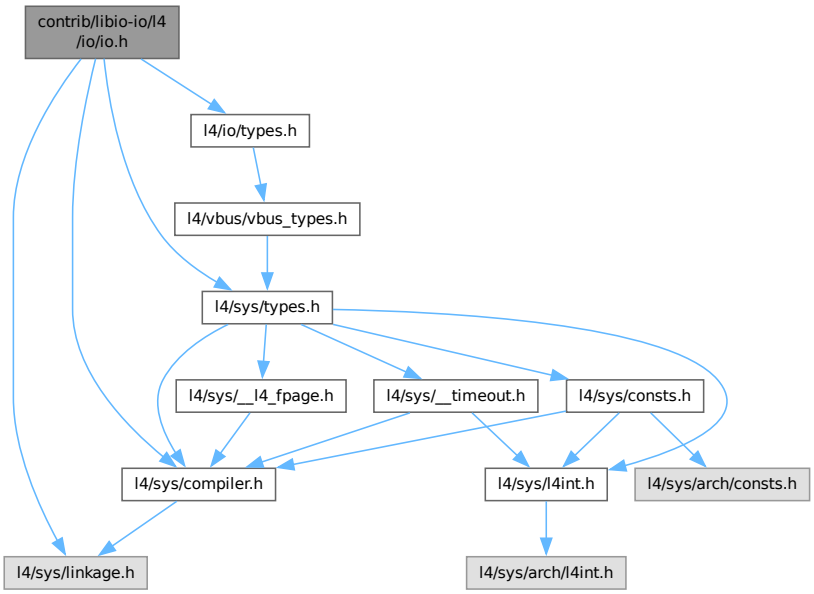
Go to the documentation of this file.

```
00001
00007
00008 /*
00009  * (c) 2003-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #ifndef L4UTIL_MBI_ARGV
00015 #define L4UTIL_MBI_ARGV
00016
00017 #include <l4/sys/l4int.h>
00018 #include <l4/util/mb_info.h>
00019 #include <l4/sys/compiler.h>
00020
00021 L4_BEGIN_DECLS
00022
00023 void l4util_mbi_to_argv(l4_mword_t flag, l4util_mb_info_t *mbi);
00024
00025 extern int  l4util_argc;
00026 extern char *l4util_argv[];
00027
00028 L4_END_DECLS
00029
00030 #endif
00031
```

16.171 contrib/libio-io/l4/io/io.h File Reference

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/sys/linkage.h>
#include <l4/io/types.h>
```

Include dependency graph for io.h:



Functions

- l4_cap_idx_t l4io_request_icu (void)

  Request the ICU object of the client.

- long l4io_request_iomem (l4_addr_t phys, unsigned long size, int flags, l4_addr_t *virt)

  Request an IO memory region.

- long l4io_request_iomem_region (l4_addr_t phys, l4_addr_t virt, unsigned long size, int flags)

  Request an IO memory region and map it to a specified region.
- long l4io_release_iomem (l4_addr_t virt, unsigned long size)

  Release an IO memory region.
- long l4io_request_ioport (unsigned portnum, unsigned len)

  Request an IO port region.
- long l4io_release_ioport (unsigned portnum, unsigned len)

  Release an IO port region.
- l4io_device_handle_t l4io_get_root_device (void)

  Get root device handle of the device bus.
- int l4io_iterate_devices (l4io_device_handle_t *devhandle, l4io_device_t *dev, l4io_resource_handle_t *reshandle)

  Iterate over the device bus.
- int l4io_lookup_device (const char *devname, l4io_device_handle_t *dev_handle, l4io_device_t *dev, l4io_resource_handle_t *res_handle)

  Find a device by name.
- int l4io_lookup_resource (l4io_device_handle_t devhandle, enum l4io_resource_types_t type, l4io_resource_handle_t *reshandle, l4io_resource_t *res)

  Request a specific resource from a device description.
- l4_addr_t l4io_request_resource_iomem (l4io_device_handle_t devhandle, l4io_resource_handle_t *reshandle)

  Request IO memory.
- void l4io_request_all_ioports (void(*res_cb)(l4vbus_resource_t const *res))

  Request all available IO-port resources.
- int l4io_has_resource (enum l4io_resource_types_t type, l4vbus_paddr_t start, l4vbus_paddr_t end)

  Check if a resource is available.

16.171.1 Function Documentation

16.171.1.1 l4io_get_root_device()

```
l4io_device_handle_t l4io_get_root_device (
            void )  [inline]
```

Get root device handle of the device bus.

Returns

root device handle

Definition at line 257 of file io.h.

16.171.1.2 l4io_iterate_devices()

```
int l4io_iterate_devices (
            l4io_device_handle_t * devhandle,
            l4io_device_t * dev,
            l4io_resource_handle_t * reshandle)
```

Iterate over the device bus.

Parameters

in,out	*devhandle*	Device handle to start iterating at. The next device handle is returned here.
out	*dev*	Device information, may be NULL.
out	*reshandle*	Resource handle.

Returns

0 on success, error code otherwise

References L4_CV, and L4_EXPORT.

16.171.1.3 l4io_request_all_ioports()

```
void l4io_request_all_ioports (
            void(* res_cb )(l4vbus_resource_t const *res))
```

Request all available IO-port resources.

Parameters

res_cb	Callback function called for every port resource found, give NULL for no callback.

References L4_CV, and L4_EXPORT.

16.171.1.4 l4io_request_icu()

```
l4_cap_idx_t l4io_request_icu (
            void )
```

Request the ICU object of the client.

Returns

Client ICU object, an invalid capability selector is returned if no ICU is available.

References L4_CV, and L4_EXPORT.

16.172 io.h

Go to the documentation of this file.

```
00001
00004 /*
00005  * (c) 2008-2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00006  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010
00011
00012 #pragma once
00013
00014 #include <l4/sys/compiler.h>
00015 #include <l4/sys/types.h>
00016 #include <l4/sys/linkage.h>
00017 #include <l4/io/types.h>
00018
00019 L4_BEGIN_DECLS
00020
00024
00037 L4_CV long L4_EXPORT
00038 l4io_request_irq(int irqnum, l4_cap_idx_t irqcap);
00039
00046 L4_CV l4_cap_idx_t L4_EXPORT
00047 l4io_request_icu(void);
00048
00060 L4_CV long L4_EXPORT
00061 l4io_release_irq(int irqnum, l4_cap_idx_t irq_cap);
00062
00087 L4_CV long L4_EXPORT
00088 l4io_request_iomem(l4_addr_t phys, unsigned long size, int flags,
00089                    l4_addr_t *virt);
00090
00112 L4_CV long L4_EXPORT
00113 l4io_request_iomem_region(l4_addr_t phys, l4_addr_t virt,
00114                           unsigned long size, int flags);
00115
00123 L4_CV long L4_EXPORT
00124 l4io_release_iomem(l4_addr_t virt, unsigned long size);
00125
```

```
00135 L4_CV long L4_EXPORT
00136 l4io_request_ioport(unsigned portnum, unsigned len);
00137
00147 L4_CV long L4_EXPORT
00148 l4io_release_ioport(unsigned portnum, unsigned len);
00149
00150
00151 /* -------------- Device handling --------------------- */
00152
00158 L4_INLINE
00159 l4io_device_handle_t l4io_get_root_device(void);
00160
00171 L4_CV int L4_EXPORT
00172 l4io_iterate_devices(l4io_device_handle_t *devhandle,
00173                      l4io_device_t *dev, l4io_resource_handle_t *reshandle);
00174
00187 L4_CV int L4_EXPORT
00188 l4io_lookup_device(const char *devname,
00189                    l4io_device_handle_t *dev_handle,
00190                    l4io_device_t *dev, l4io_resource_handle_t *res_handle);
00191
00207 L4_CV int L4_EXPORT
00208 l4io_lookup_resource(l4io_device_handle_t devhandle,
00209                      enum l4io_resource_types_t type,
00210                      l4io_resource_handle_t *reshandle,
00211                      l4io_resource_t *res);
00212
00213
00214 /* --------------- Convenience functions ----------------- */
00215
00228 L4_CV l4_addr_t L4_EXPORT
00229 l4io_request_resource_iomem(l4io_device_handle_t devhandle,
00230                             l4io_resource_handle_t *reshandle);
00231
00238 L4_CV void L4_EXPORT
00239 l4io_request_all_ioports(void (*res_cb)(l4vbus_resource_t const *res));
00240
00249 L4_CV int L4_EXPORT
00250 l4io_has_resource(enum l4io_resource_types_t type,
00251                   l4vbus_paddr_t start, l4vbus_paddr_t end);
00252
00253 /* ------------------------------------------------------- */
00254 /* Implementations */
00255
00256 L4_INLINE
00257 l4io_device_handle_t l4io_get_root_device(void)
00258 { return 0; }
00259
00260 L4_END_DECLS
```

16.173 l4/cxx/alloc.h File Reference

Alloc list.

Data Structures

- class L4::Alloc_list

  A simple list-based allocator.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.173.1 Detailed Description

Alloc list.
Definition in file alloc.h.

16.174 alloc.h

Go to the documentation of this file.

```
00001
```

```
00005 /*
00006  * (c) 2004-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00007  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 namespace L4 {
00015
00020   class Alloc_list
00021   {
00022   public:
00023     Alloc_list() : _free(0) {}
00024     Alloc_list(void *blk, unsigned long size) : _free(0)
00025     { free( blk, size); }
00026
00027     void free(void *blk, unsigned long size);
00028     void *alloc(unsigned long size);
00029
00030   private:
00031     struct Elem
00032     {
00033       Elem *next;
00034       unsigned long size;
00035     };
00036
00037     Elem *_free;
00038   };
00039 }
```

16.175 arith

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 namespace cxx { namespace arith {
00012
00027 template<typename N, typename D>
00028 constexpr N
00029 div_ceil(N const &n, D const &d)
00030 {
00031   // Since C++11 the "quotient is truncated towards zero (fractional part is
00032   // discarded)". Thus a negative quotient is already ceiled, whereas a
00033   // positive quotient is floored. Furthermore, since C++11 the sign of the
00034   // % operator is no longer implementation defined, thus we can use n % d to
00035   // detect if the quotient is positive (n % d >= 0) and was truncated (n % d !=
00036   // 0). In that case, we add one to round to the next largest integer.
00037   return n / d + (n % d > 0);
00038 }
00039
00047 template< unsigned long V >
00048 struct Ld
00049 {
00050   enum { value = Ld<V / 2>::value + 1 };
00051 };
00052
00053 template<>
00054 struct Ld<0>
00055 {
00056   enum { value = ~0UL };
00057 };
00058
00059 template<>
00060 struct Ld<1>
00061 {
00062   enum { value = 0 };
00063 };
00064
00072 constexpr unsigned
00073 log2u(unsigned val)
00074 {
00075   return 8 * sizeof(val) - __builtin_clz(val) - 1;
00076 }
00077
00079 constexpr unsigned
```

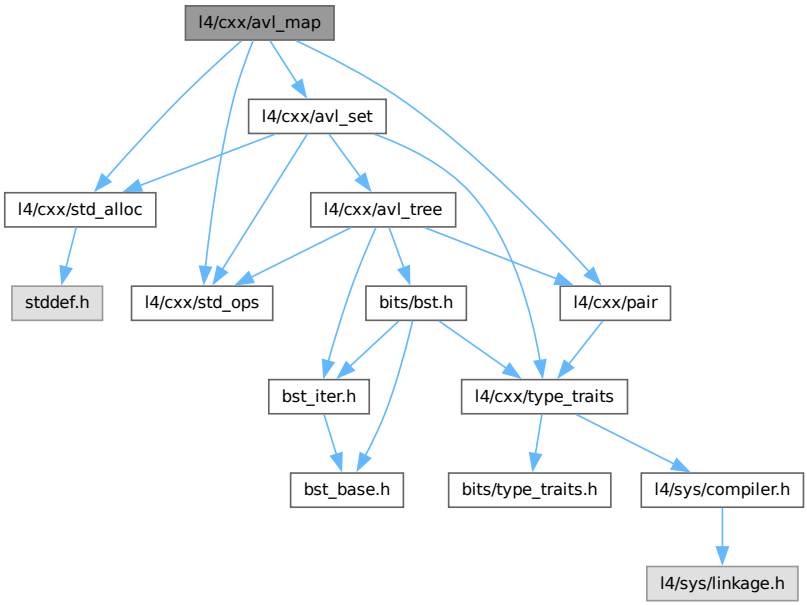
```
00080 log2u(unsigned long val)
00081 {
00082   return 8 * sizeof(val) - __builtin_clzl(val) - 1;
00083 }
00084
00086 constexpr unsigned
00087 log2u(unsigned long long val)
00088 {
00089   return 8 * sizeof(val) - __builtin_clzll(val) - 1;
00090 }
00091
00100 template<typename T>
00101 constexpr unsigned
00102 log2u_ceil(T val)
00103 {
00104   return val == 1 ? 0 : log2u(val - 1) + 1;
00105 }
00106
00107 }}
```

16.176 l4/cxx/avl_map File Reference

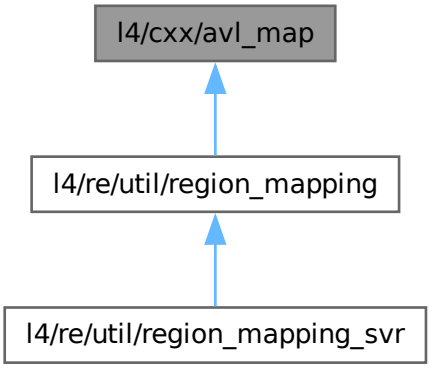
AVL map.

```
#include <l4/cxx/std_alloc>
#include <l4/cxx/std_ops>
#include <l4/cxx/pair>
#include <l4/cxx/avl_set>
```

Include dependency graph for avl_map:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct cxx::Bits::Avl_map_get_key< KEY_TYPE >

  Key-getter for Avl_map.
- class cxx::Avl_map< KEY_TYPE, DATA_TYPE, COMPARE, ALLOC >

  AVL tree based associative container.

Namespaces

- namespace cxx

  Our C++ library.
- namespace cxx::Bits

  Internal helpers for the cxx package.

16.176.1 Detailed Description

AVL map.
Definition in file avl_map.

16.177 avl_map

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #pragma once
00014
00015 #include <l4/cxx/std_alloc>
00016 #include <l4/cxx/std_ops>
00017 #include <l4/cxx/pair>
00018 #include <l4/cxx/avl_set>
00019
00020 namespace cxx {
00021 namespace Bits {
00022
00024 template<typename KEY_TYPE>
```

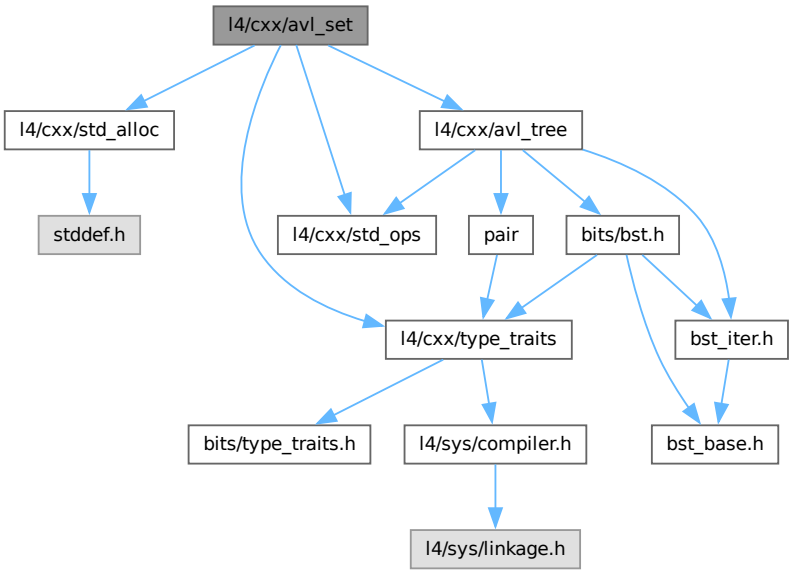
```
00025 struct Avl_map_get_key
00026 {
00027   typedef KEY_TYPE Key_type;
00028   template<typename NODE>
00029   static Key_type const &key_of(NODE const *n)
00030   { return n->item.first; }
00031 };
00032 }
00033
00042 template< typename KEY_TYPE, typename DATA_TYPE,
00043   template<typename A> class COMPARE = Lt_functor,
00044   template<typename B> class ALLOC = New_allocator >
00045 class Avl_map :
00046   public Bits::Base_avl_set<Pair<KEY_TYPE, DATA_TYPE>,
00047                             COMPARE<KEY_TYPE>, ALLOC,
00048                             Bits::Avl_map_get_key<KEY_TYPE> >
00049 {
00050 private:
00051   typedef Pair<KEY_TYPE, DATA_TYPE> Local_item_type;
00052   typedef Bits::Base_avl_set<Local_item_type, COMPARE<KEY_TYPE>, ALLOC,
00053                              Bits::Avl_map_get_key<KEY_TYPE> > Base_type;
00054
00055 public:
00057   typedef COMPARE<KEY_TYPE> Key_compare;
00059   typedef KEY_TYPE Key_type;
00061   typedef DATA_TYPE Data_type;
00063   typedef typename Base_type::Node Node;
00065   typedef typename Base_type::Node_allocator Node_allocator;
00066
00067   typedef typename Base_type::Iterator Iterator;
00068   typedef typename Base_type::Iterator iterator;
00069   typedef typename Base_type::Const_iterator Const_iterator;
00070   typedef typename Base_type::Const_iterator const_iterator;
00071   typedef typename Base_type::Rev_iterator Rev_iterator;
00072   typedef typename Base_type::Rev_iterator reverse_iterator;
00073   typedef typename Base_type::Const_rev_iterator Const_rev_iterator;
00074   typedef typename Base_type::Const_rev_iterator const_reverse_iterator;
00075
00080   Avl_map(Node_allocator const &alloc = Node_allocator())
00081     : Base_type(alloc)
00082   {}
00083
00099   cxx::Pair<Iterator, int> insert(Key_type const &key, Data_type const &data)
00100   { return Base_type::insert(Pair<Key_type, Data_type>(key, data)); }
00101
00116   template<typename... Args>
00117   cxx::Pair<Iterator, int> emplace(Args &&...args)
00118   { return Base_type::emplace(cxx::forward<Args>(args)...); }
00119
00125   Data_type const &operator [] (Key_type const &key) const &
00126   { return this->find_node(key)->second; }
00127
00128   Data_type const &operator [] (Key_type const &key) const && = delete;
00129
00139   Data_type &operator [] (Key_type const &key) &
00140   {
00141     Node n = this->find_node(key);
00142     if (n)
00143       return const_cast<Data_type&>(n->second);
00144     else
00145       return insert(key, Data_type()).first->second;
00146   }
00147 };
00148
00149 }
00150
```

16.178 l4/cxx/avl_set File Reference

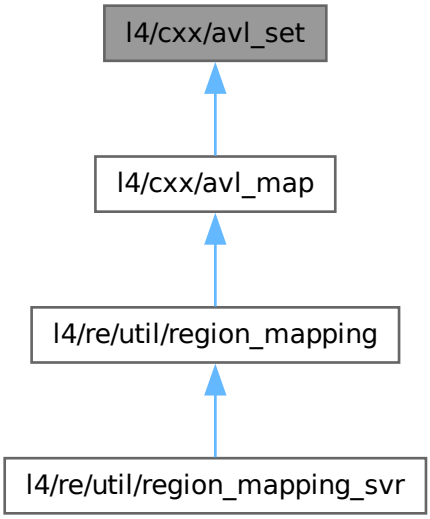
AVL set.

```
#include <l4/cxx/std_alloc>
#include <l4/cxx/std_ops>
#include <l4/cxx/type_traits>
#include <l4/cxx/avl_tree>
```

Include dependency graph for avl_set:



This graph shows which files directly or indirectly include this file:



Data Structures

- class cxx::Bits::Avl_set_iter< Node, Key, Node_op >

  Generic iterator for the AVL-tree based set.
- struct cxx::Bits::Avl_set_get_key< KEY_TYPE >

Internal, key-getter for Avl_set nodes.

- class cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >

  AVL set with internally managed nodes.
- class cxx::Bits::Base_avl_set< ITEM_TYPE, COMPARE, ALLOC, GET_KEY >::Node

  A smart pointer to a tree item.
- class cxx::Avl_set< ITEM_TYPE, COMPARE, ALLOC >

  AVL set for simple comparable items.

Namespaces

- namespace cxx

  Our C++ library.
- namespace cxx::Bits

  Internal helpers for the cxx package.

16.178.1 Detailed Description

AVL set.
Definition in file avl_set.

16.179 avl_set

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Carsten Weinhold <weinhold@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/cxx/std_alloc>
00017 #include <l4/cxx/std_ops>
00018 #include <l4/cxx/type_traits>
00019 #include <l4/cxx/avl_tree>
00020
00021 struct Avl_set_tester;
00022
00023 namespace cxx {
00024 namespace Bits {
00025
00034 template<typename Node, typename Key, typename Node_op>
00035 class Avl_set_iter : public __Bst_iter_b<Node, Node_op>
00036 {
00037 private:
00039   typedef __Bst_iter_b<Node, Node_op> Base;
00040
00042   typedef typename Type_traits<Key>::Non_const_type Non_const_key;
00043
00045   typedef Avl_set_iter<Node, Non_const_key, Node_op> Non_const_iter;
00046
00047   using Base::_n;
00048   using Base::_r;
00049   using Base::inc;
00050
00051 public:
00053   Avl_set_iter() = default;
00054
00059   Avl_set_iter(Node const *t) : Base(t) {}
00060
00065   Avl_set_iter(Base const &o) : Base(o) {}
00066
00068   Avl_set_iter(Non_const_iter const &o)
00069   : Base(o) {}
00070
00072   Avl_set_iter &operator = (Non_const_iter const &o)
00073   { Base::operator = (o); return *this; }
00074
00080   Key &operator * () const { return const_cast<Node*>(_n)->item; }
```

```
00081
00087   Key *operator -> () const { return &const_cast<Node*>(_n)->item; }
00088
00092   Avl_set_iter &operator ++ () { inc(); return *this; }
00093
00097   Avl_set_iter operator ++ (int)
00098   { Avl_set_iter tmp = *this; inc(); return tmp; }
00099 };
00100
00102 template<typename KEY_TYPE>
00103 struct Avl_set_get_key
00104 {
00105   typedef KEY_TYPE Key_type;
00106   template<typename NODE>
00107   static Key_type const &key_of(NODE const *n)
00108   { return n->item; }
00109 };
00110
00124 template<typename ITEM_TYPE, class COMPARE,
00125          template<typename A> class ALLOC,
00126          typename GET_KEY>
00127 class Base_avl_set
00128 {
00129   friend struct ::Avl_set_tester;
00130
00131 public:
00138   enum
00139   {
00140     E_noent =  2,
00141     E_exist = 17,
00142     E_nomem = 12,
00143     E_inval = 22
00144   };
00145
00147   typedef ITEM_TYPE Item_type;
00148
00150   typedef GET_KEY Get_key;
00151
00153   typedef typename GET_KEY::Key_type Key_type;
00154
00156   typedef typename Type_traits<Item_type>::Const_type Const_item_type;
00157
00159   typedef COMPARE Item_compare;
00160
00161 private:
00163   class _Node : public Avl_tree_node
00164   {
00165   public:
00167     Item_type item;
00168
00169     _Node() = default;
00170
00171     _Node(Item_type const &item) : Avl_tree_node(), item(item) {}
00172
00173     template<typename ...ARGS>
00174     _Node(ARGS &&...args) : Avl_tree_node(), item(cxx::forward<ARGS>(args)...)
00175     {}
00176   };
00177
00178 public:
00182   class Node
00183   {
00184   private:
00185     friend class Base_avl_set<ITEM_TYPE, COMPARE, ALLOC, GET_KEY>;
00186
00187     _Node const *_n;
00188
00189     explicit Node(_Node const *n) : _n(n) {}
00190
00191   public:
00193     Node() : _n(0) {}
00194
00200     Item_type const &operator * () { return _n->item; }
00201
00207     Item_type const *operator -> () { return &_n->item; }
00208
00214     bool valid() const { return _n; }
00215
00217     operator Item_type const * () { return _n ? &_n->item : 0; }
00218   };
00219
00221   typedef ALLOC<_Node> Node_allocator;
00222
00223 private:
00224   typedef Avl_tree<_Node, GET_KEY, COMPARE> Tree;
00225
00226   Tree _tree;
```

```
00227
00229   Node_allocator _alloc;
00230
00231   typedef typename Tree::Fwd_iter_ops Fwd;
00232   typedef typename Tree::Rev_iter_ops Rev;
00233
00239   void deep_copy(Base_avl_set const &o)
00240   {
00241     for (Const_iterator i = o.begin(); i != o.end(); ++i)
00242       insert(*i);
00243   }
00244
00245 public:
00246   typedef typename Type_traits<Item_type>::Param_type Item_param_type;
00247
00249   typedef Avl_set_iter<_Node, Item_type, Fwd> Iterator;
00250   typedef Iterator iterator;
00252   typedef Avl_set_iter<_Node, Const_item_type, Fwd> Const_iterator;
00253   typedef Const_iterator const_iterator;
00255   typedef Avl_set_iter<_Node, Item_type, Rev> Rev_iterator;
00256   typedef Rev_iterator reverse_iterator;
00258   typedef Avl_set_iter<_Node, Const_item_type, Rev> Const_rev_iterator;
00259   typedef Const_rev_iterator const_reverse_iterator;
00260
00268   explicit Base_avl_set(Node_allocator const &alloc = Node_allocator())
00269     : _tree(), _alloc(alloc)
00270   {}
00271
00272   ~Base_avl_set()
00273   { clear(); }
00274
00283   Base_avl_set(Base_avl_set const &o,
00284                Node_allocator const &alloc = Node_allocator())
00285     : _tree(), _alloc(alloc)
00286   { deep_copy(o); }
00287
00295   Base_avl_set &operator = (Base_avl_set const &o)
00296   {
00297     if (this != &o)
00298       {
00299         clear();
00300         deep_copy(o);
00301       }
00302
00303     return *this;
00304   }
00305
00323   cxx::Pair<Iterator, int> insert(Item_type const &item);
00324
00343   template<typename... Args>
00344   cxx::Pair<Iterator, int> emplace(Args&&... args);
00345
00349   void clear() noexcept
00350   {
00351     _tree.remove_all([this](_Node *n)
00352                      {
00353                        n->~_Node();
00354                        _alloc.free(n);
00355                      });
00356   }
00357
00366   int remove(Key_type const &item)
00367   {
00368     _Node *n = _tree.remove(item);
00369
00370     if (n)
00371       {
00372         n->~_Node();
00373         _alloc.free(n);
00374         return 0;
00375       }
00376
00377     return -E_noent;
00378   }
00379
00384   int erase(Key_type const &item)
00385   { return remove(item); }
00386
00395   Node find_node(Key_type const &item) const
00396   { return Node(_tree.find_node(item)); }
00397
00406   Node lower_bound_node(Key_type const &key) const
00407   { return Node(_tree.lower_bound_node(key)); }
00408
00409   Node lower_bound_node(Key_type &&key) const
00410   { return Node(_tree.lower_bound_node(key)); }
00411
```

```
00417   Const_iterator begin() const { return _tree.begin(); }
00418
00424   Const_iterator end() const   { return _tree.end(); }
00425
00431   Iterator begin() { return _tree.begin(); }
00432
00438   Iterator end()   { return _tree.end(); }
00439
00445   Const_rev_iterator rbegin() const { return _tree.rbegin(); }
00446
00452   Const_rev_iterator rend() const   { return _tree.rend(); }
00453
00459   Rev_iterator rbegin() { return _tree.rbegin(); }
00460
00466   Rev_iterator rend()   { return _tree.rend(); }
00467
00468   Const_iterator find(Key_type const &item) const
00469   { return _tree.find(item); }
00470
00471 #ifdef __DEBUG_L4_AVL
00472   bool rec_dump(bool print)
00473   {
00474     return _tree.rec_dump(print);
00475   }
00476 #endif
00477 };
00478
00479 //------------------------------------------------------------------------
00480 /* Implementation of AVL Tree */
00481
00482 /* Insert new _Node. */
00483 template<typename Item, class Compare, template<typename A> class Alloc, typename KEY_TYPE>
00484 Pair<typename Base_avl_set<Item, Compare, Alloc, KEY_TYPE>::Iterator, int>
00485 Base_avl_set<Item, Compare, Alloc, KEY_TYPE>::insert(Item const &item)
00486 {
00487   _Node *n = _alloc.alloc();
00488   if (!n)
00489     return cxx::pair(end(), -E_nomem);
00490
00491   new (n, Nothrow()) _Node(item);
00492   Pair<_Node *, bool> err = _tree.insert(n);
00493   if (!err.second)
00494     {
00495       n->~_Node();
00496       _alloc.free(n);
00497     }
00498
00499   return cxx::pair(Iterator(typename Tree::Iterator(err.first, err.first)), err.second ? 0 :
      -E_exist);
00500 }
00501
00502 /* In-place insert new _Node. */
00503 template<typename Item, class Compare, template<typename A> class Alloc, typename KEY_TYPE>
00504 template<typename... Args>
00505 Pair<typename Base_avl_set<Item, Compare, Alloc, KEY_TYPE>::Iterator, int>
00506 Base_avl_set<Item, Compare, Alloc, KEY_TYPE>::emplace(Args&&... args)
00507 {
00508   _Node *n = _alloc.alloc();
00509   if (!n)
00510     return cxx::pair(end(), -E_nomem);
00511
00512   new (n, Nothrow()) _Node(cxx::forward<Args>(args)...);
00513   Pair<_Node *, bool> err = _tree.insert(n);
00514   if (!err.second)
00515     {
00516       n->~_Node();
00517       _alloc.free(n);
00518     }
00519
00520   return cxx::pair(Iterator(typename Tree::Iterator(err.first, err.first)), err.second ? 0 :
      -E_exist);
00521 }
00522
00523 } // namespace Bits
00524
00536 template<typename ITEM_TYPE, template<typename T> class COMPARE = Lt_functor,
00537          template<typename A> class ALLOC = New_allocator>
00538 class Avl_set :
00539   public Bits::Base_avl_set<ITEM_TYPE, COMPARE<ITEM_TYPE>, ALLOC,
00540                             Bits::Avl_set_get_key<ITEM_TYPE»
00541 {
00542 private:
00543   typedef Bits::Base_avl_set<ITEM_TYPE, COMPARE<ITEM_TYPE>, ALLOC,
00544                              Bits::Avl_set_get_key<ITEM_TYPE>> Base;
00545
00546 public:
00547   typedef typename Base::Node_allocator Node_allocator;
```

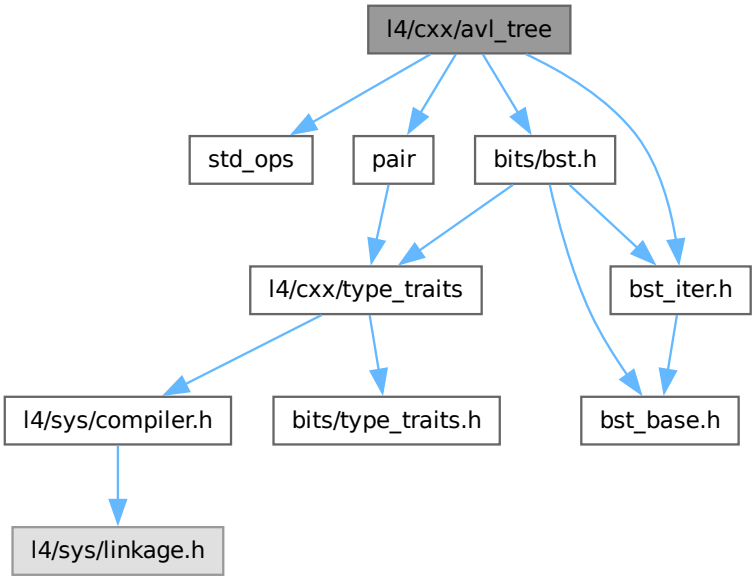
```
00548   Avl_set() = default;
00549   Avl_set(Node_allocator const &alloc)
00550   : Base(alloc)
00551   {}
00552 };
00553
00554 } // namespace cxx
```

16.180 l4/cxx/avl_tree File Reference

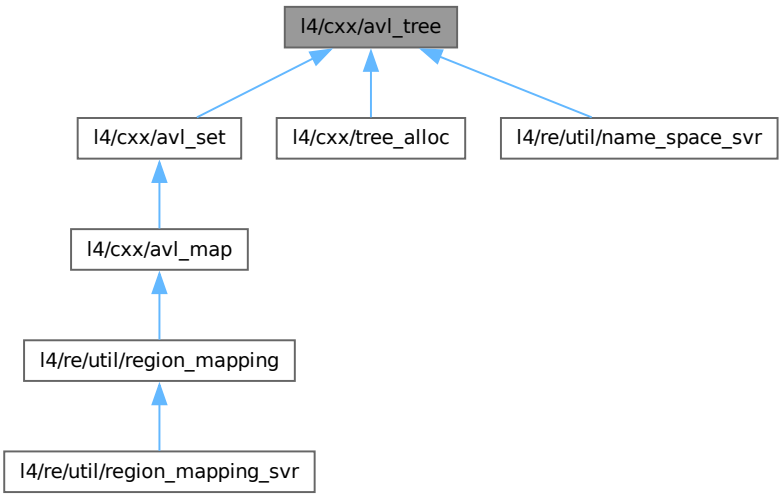
AVL tree.

```
#include "std_ops"
#include "pair"
#include "bits/bst.h"
#include "bits/bst_iter.h"
```

Include dependency graph for avl_tree:



This graph shows which files directly or indirectly include this file:



Data Structures

- class cxx::Avl_tree_node

  Node of an AVL tree.
- class cxx::Avl_tree< Node, Get_key, Compare >

  A generic AVL tree.

Namespaces

- namespace cxx

  Our C++ library.

16.180.1 Detailed Description

AVL tree.
Definition in file avl_tree.

16.181 avl_tree

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Carsten Weinhold <weinhold@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include "std_ops"
00017 #include "pair"
00018
00019 #include "bits/bst.h"
00020 #include "bits/bst_iter.h"
00021
00022 struct Avl_set_tester;
00023
```

```
00024 namespace cxx {
00025
00029 class Avl_tree_node : public Bits::Bst_node
00030 {
00031   friend struct ::Avl_set_tester;
00032
00033 private:
00034   template< typename Node, typename Get_key, typename Compare >
00035   friend class Avl_tree;
00036
00038   typedef Bits::Direction Bal;
00040   typedef Bits::Direction Dir;
00041
00042   // We are a final BST node, hide interior.
00044   using Bits::Bst_node::next;
00045   using Bits::Bst_node::next_p;
00046   using Bits::Bst_node::rotate;
00048
00050   Bal _balance;
00051
00052 protected:
00054   Avl_tree_node() = default;
00055
00056 private:
00057   Avl_tree_node(Avl_tree_node const &o) = delete;
00058   Avl_tree_node(Avl_tree_node &&o) = delete;
00059
00061   Avl_tree_node &operator = (Avl_tree_node const &o) = default;
00063   Avl_tree_node &operator = (Avl_tree_node &&o) = default;
00064
00066   explicit Avl_tree_node(bool) : Bits::Bst_node(true), _balance(Dir::N) {}
00067
00069   static Bits::Bst_node *rotate2(Bst_node **t, Bal idir, Bal pre);
00070
00072   bool balanced() const { return _balance == Bal::N; }
00073
00075   Bal balance() const { return _balance; }
00076
00078   void balance(Bal b) { _balance = b; }
00079 };
00080
00081
00098 template< typename Node, typename Get_key,
00099           typename Compare = Lt_functor<typename Get_key::Key_type> >
00100 class Avl_tree : public Bits::Bst<Node, Get_key, Compare>
00101 {
00102 private:
00103   typedef Bits::Bst<Node, Get_key, Compare> Bst;
00104
00106   using Bst::_head;
00107
00109   using Bst::k;
00110
00112   typedef typename Avl_tree_node::Bal Bal;
00114   typedef typename Avl_tree_node::Bal Dir;
00115
00116   Avl_tree(Avl_tree const &o) = delete;
00117   Avl_tree &operator = (Avl_tree const &o) = delete;
00118   Avl_tree(Avl_tree &&o) = delete;
00119   Avl_tree &operator = (Avl_tree &&o) = delete;
00120
00121 public:
00123   typedef typename Bst::Key_type Key_type;
00124   typedef typename Bst::Key_param_type Key_param_type;
00126
00127   // Grab iterator types from Bst
00130   typedef typename Bst::Iterator Iterator;
00132   typedef typename Bst::Const_iterator Const_iterator;
00134   typedef typename Bst::Rev_iterator Rev_iterator;
00136   typedef typename Bst::Const_rev_iterator Const_rev_iterator;
00138
00146   Pair<Node *, bool> insert(Node *new_node);
00147
00154   Node *remove(Key_param_type key);
00158   Node *erase(Key_param_type key) { return remove(key); }
00159
00161   Avl_tree() = default;
00162
00164   ~Avl_tree() noexcept
00165   {
00166     this->remove_all([](Node *){});
00167   }
00168
00169 #ifdef __DEBUG_L4_AVL
00170   bool rec_dump(Avl_tree_node *n, int depth, int *dp, bool print, char pfx);
00171   bool rec_dump(bool print)
00172   {
```

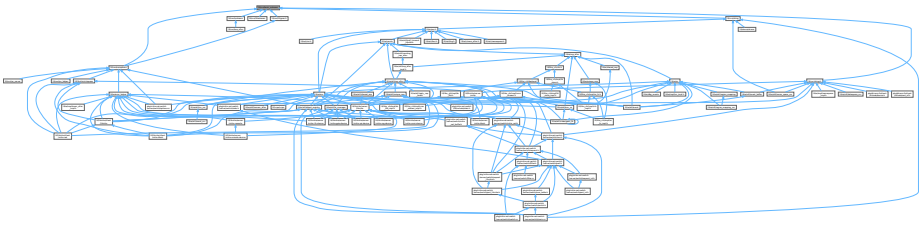
```
00173     int dp=0;
00174     return rec_dump(static_cast<Avl_tree_node *>(_head), 0, &dp, print, '+');
00175   }
00176 #endif
00177 };
00178
00179
00180 //------------------------------------------------------------------------
00181 /* IMPLEMENTATION: Bits::__Bst_iter_b */
00182
00183
00184 inline
00185 Bits::Bst_node *
00186 Avl_tree_node::rotate2(Bst_node **t, Bal idir, Bal pre)
00187 {
00188   typedef Bits::Bst_node N;
00189   typedef Avl_tree_node A;
00190   N *tmp[2] = { *t, N::next(*t, idir) };
00191   *t = N::next(tmp[1], !idir);
00192   A *n = static_cast<A*>(*t);
00193
00194   N::next(tmp[0], idir, N::next(n, !idir));
00195   N::next(tmp[1], !idir, N::next(n, idir));
00196   N::next(n, !idir, tmp[0]);
00197   N::next(n, idir, tmp[1]);
00198
00199   n->balance(Bal::N);
00200
00201   if (pre == Bal::N)
00202     {
00203       static_cast<A*>(tmp[0])->balance(Bal::N);
00204       static_cast<A*>(tmp[1])->balance(Bal::N);
00205       return nullptr;
00206     }
00207
00208   static_cast<A*>(tmp[pre != idir])->balance(!pre);
00209   static_cast<A*>(tmp[pre == idir])->balance(Bal::N);
00210
00211   return N::next(tmp[pre == idir], !pre);
00212 }
00213
00214 //------------------------------------------------------------------------
00215 /* Implementation of AVL Tree */
00216
00217 /* Insert new _Node. */
00218 template< typename Node, typename Get_key, class Compare>
00219 Pair<Node *, bool>
00220 Avl_tree<Node, Get_key, Compare>::insert(Node *new_node)
00221 {
00222   typedef Avl_tree_node A;
00223   typedef Bits::Bst_node N;
00224   N **t = &_head; /* search variable */
00225   N **s = &_head; /* node where rebalancing may occur */
00226   Key_param_type new_key = Get_key::key_of(new_node);
00227
00228   // search insertion point
00229   for (N *p; (p = *t);)
00230     {
00231       Dir b = this->dir(new_key, p);
00232       if (b == Dir::N)
00233   return pair(static_cast<Node*>(p), false);
00234
00235       if (!static_cast<A const *>(p)->balanced())
00236   s = t;
00237
00238       t = A::next_p(p, b);
00239     }
00240
00241   *static_cast<A*>(new_node) = A(true);
00242   *t = new_node;
00243
00244   N *n = *s;
00245   A *a = static_cast<A*>(n);
00246   if (!a->balanced())
00247     {
00248       A::Bal b(this->greater(new_key, n));
00249       if (a->balance() != b)
00250   {
00251     // ok we got in balance the shorter subtree go higher
00252     a->balance(Bal::N);
00253     // propagate the new balance down to the new node
00254     n = A::next(n, b);
00255   }
00256       else if (b == Bal(this->greater(new_key, A::next(n, b))))
00257   {
00258     // left-left or right-right case -> single rotation
00259     A::rotate(s, b);
```

```
00260     a->balance(Bal::N);
00261     static_cast<A*>(*s)->balance(Bal::N);
00262     n = A::next(*s, b);
00263   }
00264       else
00265   {
00266     // need a double rotation
00267     n = A::next(A::next(n, b), !b);
00268     n = A::rotate2(s, b, n == new_node ? Bal::N : Bal(this->greater(new_key, n)));
00269   }
00270     }
00271
00272   for (A::Bal b; n && n != new_node; static_cast<A*>(n)->balance(b), n = A::next(n, b))
00273     b = Bal(this->greater(new_key, n));
00274
00275   return pair(new_node, true);
00276 }
00277
00278
00279 /* remove an element */
00280 template< typename Node, typename Get_key, class Compare>
00281 inline
00282 Node *Avl_tree<Node, Get_key, Compare>::remove(Key_param_type key)
00283 {
00284   typedef Avl_tree_node A;
00285   typedef Bits::Bst_node N;
00286   N **q = &_head; /* search variable */
00287   N **s = &_head; /* last ('deepest') node on the search path to q
00288                    * with balance 0, at this place the rebalancing
00289                    * stops in any case */
00290   N **t = nullptr;
00291   Dir dir;
00292
00293   // find target node and rebalancing entry
00294   for (N *n; (n = *q); q = A::next_p(n, dir))
00295     {
00296       dir = Dir(this->greater(key, n));
00297       if (dir == Dir::L && !this->greater(k(n), key))
00298   /* found node */
00299   t = q;
00300
00301       if (!A::next(n, dir))
00302   break;
00303
00304       A const *a = static_cast<A const *>(n);
00305       if (a->balanced() || (a->balance() == !dir && A::next<A>(n, !dir)->balanced()))
00306   s = q;
00307     }
00308
00309   // nothing found
00310   if (!t)
00311     return nullptr;
00312
00313   A *i = static_cast<A*>(*t);
00314
00315   for (N *n; (n = *s); s = A::next_p(n, dir))
00316     {
00317       dir = Dir(this->greater(key, n));
00318
00319       if (!A::next(n, dir))
00320   break;
00321
00322       A *a = static_cast<A*>(n);
00323       // got one out of balance
00324       if (a->balanced())
00325   a->balance(!dir);
00326       else if (a->balance() == dir)
00327   a->balance(Bal::N);
00328       else
00329   {
00330     // we need rotations to get in balance
00331     Bal b = A::next<A>(n, !dir)->balance();
00332     if (b == dir)
00333       A::rotate2(s, !dir, A::next<A>(A::next(n, !dir), dir)->balance());
00334     else
00335       {
00336         A::rotate(s, !dir);
00337         if (b != Bal::N)
00338     {
00339       a->balance(Bal::N);
00340       static_cast<A*>(*s)->balance(Bal::N);
00341     }
00342         else
00343     {
00344       a->balance(!dir);
00345       static_cast<A*>(*s)->balance(dir);
00346     }
```

```
00347       }
00348     if (n == i)
00349       t = A::next_p(*s, dir);
00350   }
00351     }
00352
00353   A *n = static_cast<A*>(*q);
00354   *t = n;
00355   *q = A::next(n, !dir);
00356   *n = *i;
00357
00358   return static_cast<Node*>(i);
00359 }
00360
00361 #ifdef __DEBUG_L4_AVL
00362 template< typename Node, typename Get_key, class Compare>
00363 bool Avl_tree<Node, Get_key, Compare>::rec_dump(Avl_tree_node *n, int depth, int *dp, bool print, char
      pfx)
00364 {
00365   typedef Avl_tree_node A;
00366
00367   if (!n)
00368     return true;
00369
00370   int dpx[2] = {depth,depth};
00371   bool res = true;
00372
00373   res = rec_dump(A::next<A>(n, Dir::R), depth + 1, dpx + 1, print, '/');
00374
00375   if (print)
00376     {
00377       fprintf(stderr, "%2d: [%8p] b=%1d: ", depth, n, (int)n->balance().d);
00378
00379       for (int i = 0; i < depth; ++i)
00380   std::cerr « "    ";
00381
00382       std::cerr « pfx « (static_cast<Node*>(n)->item) « std::endl;
00383     }
00384
00385   res = res & rec_dump(A::next<A>(n, Dir::L), depth + 1, dpx, print, '\\');
00386
00387   int b = dpx[1] - dpx[0];
00388
00389   if (b < 0)
00390     *dp = dpx[0];
00391   else
00392     *dp = dpx[1];
00393
00394   Bal x = n->balance();
00395   if ((b < -1 || b > 1) ||
00396       (b == 0 && x != Bal::N) ||
00397       (b == -1 && x != Bal::L) ||
00398       (b == 1 && x != Bal::R))
00399     {
00400       if (print)
00401   fprintf(stderr, "%2d: [%8p] b=%1d: balance error %d\n", depth, n, (int)n->balance().d, b);
00402       return false;
00403     }
00404   return res;
00405 }
00406 #endif
00407
00408 }
00409
```

16.182 l4/cxx/basic_ostream File Reference

Basic IO stream.
This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::IOModifier

  Modifier class for the IO stream.

Namespaces

- namespace L4

  L4 low-level kernel interface.

Variables

- IOModifier const **L4::hex**

  Modifies the stream to print numbers as hexadecimal values.
- IOModifier const **L4::dec**

  Modifies the stream to print numbers as decimal values.

16.182.1 Detailed Description

Basic IO stream.
Definition in file basic_ostream.

16.183 basic_ostream

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 namespace L4 {
00015
00022   class IOModifier
00023   {
00024   public:
00025     IOModifier(int x) : mod(x) {}
00026     bool operator == (IOModifier o) { return mod == o.mod; }
00027     bool operator != (IOModifier o) { return mod != o.mod; }
00028     int mod;
00029   };
00030
00035   class IOBackend
00036   {
00037   public:
00038     typedef int Mode;
00039
00040   protected:
00041     friend class BasicOStream;
00042
00043     IOBackend()
00044     : int_mode(10)
00045     {}
00046
00047     virtual ~IOBackend() {}
00048
00049     virtual void write(char const *str, unsigned len) = 0;
00050
00051   private:
00052     void write(IOModifier m);
00053     void write(long long int c, int len);
00054     void write(long long unsigned c, int len);
00055     void write(long long unsigned c, unsigned char base = 10,
00056                unsigned char len = 0, char pad = ' ');
00057
00058     Mode mode() const
00059     { return int_mode; }
00060
00061     void mode(Mode m)
00062     { int_mode = m; }
```

```
00063
00064     int int_mode;
00065   };
00066
00071   class BasicOStream
00072   {
00073   public:
00074     BasicOStream(IOBackend *b)
00075     : iob(b)
00076     {}
00077
00078     void write(char const *str, unsigned len)
00079     {
00080       if (iob)
00081         iob->write(str, len);
00082     }
00083
00084     void write(long long int c, int len)
00085     {
00086       if (iob)
00087         iob->write(c, len);
00088     }
00089
00090     void write(long long unsigned c, unsigned char base = 10,
00091                unsigned char len = 0, char pad = ' ')
00092     {
00093       if (iob)
00094         iob->write(c, base, len, pad);
00095     }
00096
00097     void write(long long unsigned c, int len)
00098     {
00099       if (iob)
00100         iob->write(c, len);
00101     }
00102
00103     void write(IOModifier m)
00104     {
00105       if (iob)
00106         iob->write(m);
00107     }
00108
00109     IOBackend::Mode be_mode() const
00110     {
00111       if (iob)
00112         return iob->mode();
00113       return 0;
00114     }
00115
00116     void be_mode(IOBackend::Mode m)
00117     {
00118       if (iob)
00119         iob->mode(m);
00120     }
00121
00122   private:
00123     IOBackend *iob;
00124   };
00125
00130   class IONumFmt
00131   {
00132   public:
00133     IONumFmt(unsigned long long n, unsigned char base = 10,
00134              unsigned char len = 0, char pad = ' ')
00135       : n(n), base(base), len(len), pad(pad)
00136     {}
00137
00138   BasicOStream &print(BasicOStream &o) const;
00139
00140   private:
00141     unsigned long long n;
00142     unsigned char base, len;
00143     char pad;
00144   };
00145
00146   inline IONumFmt n_hex(unsigned long long n) { return IONumFmt(n, 16); }
00147
00151   extern IOModifier const hex;
00152
00156   extern IOModifier const dec;
00157
00158   inline
00159   BasicOStream &IONumFmt::print(BasicOStream &o) const
00160   {
00161     o.write(n, base, len, pad);
00162     return o;
00163   }
```

```
00164 }
00165
00166
00167 // Implementation
00168
00169 inline
00170 L4::BasicOStream &
00171 operator « (L4::BasicOStream &s, char const * const str)
00172 {
00173   if (!str)
00174     {
00175       s.write("(NULL)", 6);
00176       return s;
00177     }
00178
00179   unsigned l = 0;
00180   for (; str[l] != 0; l++)
00181     ;
00182   s.write(str, l);
00183   return s;
00184 }
00185
00186 inline
00187 L4::BasicOStream &
00188 operator « (L4::BasicOStream &s, signed short u)
00189 {
00190   s.write(static_cast<long long signed>(u), -1);
00191   return s;
00192 }
00193
00194 inline
00195 L4::BasicOStream &
00196 operator « (L4::BasicOStream &s, signed u)
00197 {
00198   s.write(static_cast<long long signed>(u), -1);
00199   return s;
00200 }
00201
00202 inline
00203 L4::BasicOStream &
00204 operator « (L4::BasicOStream &s, signed long u)
00205 {
00206   s.write(static_cast<long long signed>(u), -1);
00207   return s;
00208 }
00209
00210 inline
00211 L4::BasicOStream &
00212 operator « (L4::BasicOStream &s, signed long long u)
00213 {
00214   s.write(u, -1);
00215   return s;
00216 }
00217
00218 inline
00219 L4::BasicOStream &
00220 operator « (L4::BasicOStream &s, unsigned short u)
00221 {
00222   s.write(static_cast<long long unsigned>(u), -1);
00223   return s;
00224 }
00225
00226 inline
00227 L4::BasicOStream &
00228 operator « (L4::BasicOStream &s, unsigned u)
00229 {
00230   s.write(static_cast<long long unsigned>(u), -1);
00231   return s;
00232 }
00233
00234 inline
00235 L4::BasicOStream &
00236 operator « (L4::BasicOStream &s, unsigned long u)
00237 {
00238   s.write(static_cast<long long unsigned>(u), -1);
00239   return s;
00240 }
00241
00242 inline
00243 L4::BasicOStream &
00244 operator « (L4::BasicOStream &s, unsigned long long u)
00245 {
00246   s.write(u, -1);
00247   return s;
00248 }
00249
00250 inline
```

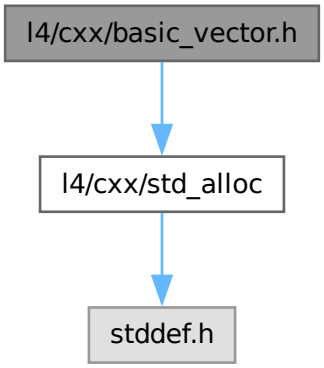
```
00251 L4::BasicOStream &
00252 operator « (L4::BasicOStream &s, void const *u)
00253 {
00254   long unsigned x = reinterpret_cast<long unsigned>(u);
00255   L4::IOBackend::Mode mode = s.be_mode();
00256   s.write(L4::hex);
00257   s.write(static_cast<long long unsigned>(x), -1);
00258   s.be_mode(mode);
00259   return s;
00260 }
00261
00262 inline
00263 L4::BasicOStream &
00264 operator « (L4::BasicOStream &s, L4::IOModifier m)
00265 {
00266   s.write(m);
00267   return s;
00268 }
00269
00270 inline
00271 L4::BasicOStream &
00272 operator « (L4::BasicOStream &s, char c)
00273 {
00274   s.write(&c, 1);
00275   return s;
00276 }
00277
00278 inline
00279 L4::BasicOStream &
00280 operator « (L4::BasicOStream &o, L4::IONumFmt const &n)
00281 { return n.print(o); }
```

16.184 l4/cxx/basic_vector.h File Reference

Basic vector.

`#include <l4/cxx/std_alloc>`

Include dependency graph for basic_vector.h:



Namespaces

- namespace cxx

  Our C++ library.

16.184.1 Detailed Description

Basic vector.

Definition in file basic_vector.h.

16.185 basic_vector.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/cxx/std_alloc>
00014
00015 namespace cxx {
00016
00017 template< typename T >
00018 class Basic_vector
00019 {
00020 public:
00021   Basic_vector(T *array, unsigned long capacity)
00022   : _array(array), _capacity(capacity)
00023   {
00024     for (unsigned long i = 0; i < capacity; ++i)
00025       new (&_array[i]) T();
00026   }
00027
00028 private:
00029   T *_array;
00030   unsigned long _capacity;
00031 };
00032
00033 };
```

16.186 bitfield

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2012 Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include "type_list"
00012
00014 namespace cxx {
00015
00023 template<typename T, unsigned LSB, unsigned MSB>
00024 class Bitfield
00025 {
00026 private:
00027   typedef remove_reference_t<T> Base_type;
00028
00029   static_assert(MSB >= LSB, "boundary mismatch in bit-field definition");
00030   static_assert(MSB < sizeof(Base_type) * 8, "MSB outside of bit-field type");
00031   static_assert(LSB < sizeof(Base_type) * 8, "LSB outside of bit-field type");
00032
00038   template<unsigned BITS> struct Best_type
00039   {
00040     template< typename TY > struct Cmp { enum { value = (BITS <= sizeof(TY)*8) }; };
00041     typedef cxx::type_list<
00042       unsigned char,
00043       unsigned short,
00044       unsigned int,
00045       unsigned long,
00046       unsigned long long
00047     > Unsigned_types;
00048     typedef cxx::find_type_t<Unsigned_types, Cmp> Type;
00049   };
00050
00051 public:
00052   enum
00053   {
00054     Bits  = MSB + 1 - LSB,
00055     Lsb = LSB,
00056     Msb = MSB,
00057   };
00058
00060   static constexpr Base_type Low_mask
00061     = Base_type(~0ULL) >> (sizeof(Base_type) * 8 - Bits);
```

```
00063   static constexpr Base_type Mask = Low_mask « Lsb;
00064
00071   typedef typename Best_type<Bits>::Type Bits_type;
00072
00079   typedef typename Best_type<Bits + Lsb>::Type Shift_type;
00080
00081 private:
00082   static_assert(sizeof(Bits_type)*8 >= Bits, "error finding the type to store the bits");
00083   static_assert(sizeof(Shift_type)*8 >= Bits + Lsb, "error finding the type to keep the shifted
      bits");
00084   static_assert(sizeof(Bits_type) <= sizeof(Base_type), "size mismatch for Bits_type");
00085   static_assert(sizeof(Shift_type) <= sizeof(Base_type), "size mismatch for Shift_type");
00086   static_assert(sizeof(Bits_type) <= sizeof(Shift_type), "size mismatch for Shift_type and
      Bits_type");
00087
00088 public:
00096   static constexpr Bits_type get(Shift_type val)
00097   { return (val » Lsb) & Low_mask; }
00098
00109   static constexpr Base_type get_unshifted(Shift_type val)
00110   { return val & Mask; }
00111
00124   static constexpr Base_type set_dirty(Base_type dest, Shift_type val)
00125   {
00126     //assert (!(val & ~Low_mask));
00127     return (dest & ~Mask) | (val « Lsb);
00128   }
00129
00144   static constexpr Base_type set_unshifted_dirty(Base_type dest, Shift_type val)
00145   {
00146     //assert (!(val & ~Mask));
00147     return (dest & ~Mask) | val;
00148   }
00149
00158   static Base_type set(Base_type dest, Bits_type val)
00159   { return set_dirty(dest, val & Low_mask); }
00160
00170   static Base_type set_unshifted(Base_type dest, Shift_type val)
00171   { return set_unshifted_dirty(dest, val & Mask); }
00172
00184   static constexpr Base_type val_dirty(Shift_type val) { return val « Lsb; }
00185
00193   static constexpr Base_type val(Bits_type val) { return val_dirty(val & Low_mask); }
00194
00203   static constexpr Base_type val_unshifted(Shift_type val) { return val & Mask; }
00204
00206   template< typename TT >
00207   class Value_base
00208   {
00209   private:
00210     TT v;
00211
00212   public:
00213     constexpr Value_base(TT t) : v(t) {}
00214     constexpr Bits_type get() const { return Bitfield::get(v); }
00215     constexpr Base_type get_unshifted() const { return Bitfield::get_unshifted(v); }
00216
00217     void set(Bits_type val) { v = Bitfield::set(v, val); }
00218     void set_dirty(Bits_type val) { v = Bitfield::set_dirty(v, val); }
00219     void set_unshifted(Shift_type val) { v = Bitfield::set_unshifted(v, val); }
00220     void set_unshifted_dirty(Shift_type val) { v = Bitfield::set_unshifted_dirty(v, val); }
00221   };
00222
00224   template< typename TT >
00225   class Value : public Value_base<TT>
00226   {
00227   public:
00228     constexpr Value(TT t) : Value_base<TT>(t) {}
00229     constexpr operator Bits_type () const { return this->get(); }
00230     constexpr Value &operator = (Bits_type val) { this->set(val); return *this; }
00231     constexpr Value &operator = (Value const &val)
00232     { this->set(val.get()); return *this; }
00233     Value(Value const &) = default;
00234   };
00235
00237   template< typename TT >
00238   class Value_unshifted : public Value_base<TT>
00239   {
00240   public:
00241     constexpr Value_unshifted(TT t) : Value_base<TT>(t) {}
00242     constexpr operator Shift_type () const { return this->get_unshifted(); }
00243     constexpr Value_unshifted &operator = (Shift_type val) { this->set_unshifted(val); return *this; }
00244     constexpr Value_unshifted &operator = (Value_unshifted const &val)
00245     { this->set_unshifted(val.get_unshifted()); return *this; }
00246     Value_unshifted(Value_unshifted const &) = default;
00247   };
00248
```

```
00250   typedef Value<Base_type &> Ref;
00252   typedef Value<Base_type volatile &> Ref_volatile;
00254   typedef Value<Base_type const> Val;
00255
00257   typedef Value_unshifted<Base_type &> Ref_unshifted;
00259   typedef Value_unshifted<Base_type volatile &> Ref_unshifted_volatile;
00261   typedef Value_unshifted<Base_type const> Val_unshifted;
00262 };
00263
00264 #define CXX_BITFIELD_MEMBER(LSB, MSB, name, data_member) \
00265  \
00266  \
00267   typedef cxx::Bitfield<decltype(data_member), LSB, MSB> name ## _bfm_t; \
00268  \
00269   constexpr typename name ## _bfm_t::Val name() const { return data_member; } \
00270   typename name ## _bfm_t::Val name() const volatile { return data_member; } \
00271  \
00272   constexpr typename name ## _bfm_t::Ref name() { return data_member; } \
00273   typename name ## _bfm_t::Ref_volatile name() volatile { return data_member; } \
00274
00275
00276 #define CXX_BITFIELD_MEMBER_RO(LSB, MSB, name, data_member) \
00277  \
00278  \
00279   typedef cxx::Bitfield<decltype(data_member), LSB, MSB> name ## _bfm_t; \
00280  \
00281   constexpr typename name ## _bfm_t::Val name() const { return data_member; } \
00282   typename name ## _bfm_t::Val name() const volatile { return data_member; } \
00283
00284
00285 #define CXX_BITFIELD_MEMBER_UNSHIFTED(LSB, MSB, name, data_member) \
00286  \
00287  \
00288   typedef cxx::Bitfield<decltype(data_member), LSB, MSB> name ## _bfm_t; \
00289  \
00290   constexpr typename name ## _bfm_t::Val_unshifted name() const { return data_member; } \
00291   typename name ## _bfm_t::Val_unshifted name() const volatile { return data_member; } \
00292  \
00293   constexpr typename name ## _bfm_t::Ref_unshifted name() { return data_member; } \
00294   typename name ## _bfm_t::Ref_unshifted_volatile name() volatile { return data_member; } \
00295
00296
00297 #define CXX_BITFIELD_MEMBER_UNSHIFTED_RO(LSB, MSB, name, data_member) \
00298  \
00299  \
00300   typedef cxx::Bitfield<decltype(data_member), LSB, MSB> name ## _bfm_t; \
00301  \
00302   constexpr typename name ## _bfm_t::Val_unshifted name() const { return data_member; } \
00303   typename name ## _bfm_t::Val_unshifted name() const volatile { return data_member; } \
00304
00305 }
```

16.187 bitmap

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2014 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 namespace cxx {
00012
00018 class Bitmap_base
00019 {
00020 protected:
00024   typedef unsigned long word_type;
00025
00026   enum
00027   {
00028     W_bits = sizeof(word_type) * 8,
00029     C_bits = 8,
00030   };
00031
00035   word_type *_bits;
00036
00044   static unsigned word_index(unsigned bit) { return bit / W_bits; }
00045
00053   static unsigned bit_index(unsigned bit) { return bit % W_bits; }
00054
00058   class Bit
```

```
00059   {
00060     Bitmap_base *_bm;
00061     long _bit;
00062
00063   public:
00064     Bit(Bitmap_base *bm, long bit) : _bm(bm), _bit(bit) {}
00065     Bit &operator = (bool val) { _bm->bit(_bit, val); return *this; }
00066     operator bool () const { return _bm->bit(_bit); }
00067   };
00068
00069 public:
00070   explicit Bitmap_base(void *bits) noexcept : _bits(reinterpret_cast<word_type *>(bits)) {}
00071
00073   static long words(long bits) noexcept { return (bits + W_bits -1) / W_bits; }
00074   static long bit_buffer_bytes(long bits) noexcept
00075   { return words(bits) * W_bits / 8; }
00076
00078   template< long BITS >
00079   class Word
00080   {
00081   public:
00082     typedef unsigned long Type;
00083     enum
00084     {
00085       Size = (BITS + W_bits - 1) / W_bits
00086     };
00087   };
00088
00090   static long chars(long bits) noexcept
00091   { return (bits + C_bits -1) / C_bits; }
00092
00094   template< long BITS >
00095   class Char
00096   {
00097   public:
00098     typedef unsigned char Type;
00099     enum
00100     {
00101       Size = (BITS + C_bits - 1) / C_bits
00102     };
00103   };
00104
00111   void bit(long bit, bool on) noexcept;
00112
00118   void clear_bit(long bit) noexcept;
00119
00127   void atomic_clear_bit(long bit) noexcept;
00128
00136   word_type atomic_get_and_clear(long bit) noexcept;
00137
00143   void set_bit(long bit) noexcept;
00144
00152   void atomic_set_bit(long bit) noexcept;
00153
00161   word_type atomic_get_and_set(long bit) noexcept;
00162
00171   word_type bit(long bit) const noexcept;
00172
00181   word_type operator [] (long bit) const noexcept
00182   { return this->bit(bit); }
00183
00191   Bit operator [] (long bit) noexcept
00192   { return Bit(this, bit); }
00193
00205   long scan_zero(long max_bit, long start_bit = 0) const noexcept;
00206
00207   void *bit_buffer() const noexcept { return _bits; }
00208
00209 protected:
00210   static int _bzl(unsigned long w) noexcept;
00211 };
00212
00213
00219 template<int BITS>
00220 class Bitmap : public Bitmap_base
00221 {
00222 private:
00223   char _bits[Bitmap_base::Char<BITS>::Size];
00224
00225 public:
00227   Bitmap() noexcept : Bitmap_base(_bits) {}
00228   Bitmap(Bitmap<BITS> const &o) noexcept : Bitmap_base(_bits)
00229   { __builtin_memcpy(_bits, o._bits, sizeof(_bits)); }
00242   long scan_zero(long start_bit = 0) const noexcept;
00243
00244   void clear_all()
00245   { __builtin_memset(_bits, 0, sizeof(_bits)); }
```

```
00246 };
00247
00248
00249 inline
00250 void
00251 Bitmap_base::bit(long bit, bool on) noexcept
00252 {
00253   long idx = word_index(bit);
00254   long b   = bit_index(bit);
00255   _bits[idx] = (_bits[idx] & ~(1UL << b)) | (static_cast<unsigned long>(on) << b);
00256 }
00257
00258 inline
00259 void
00260 Bitmap_base::clear_bit(long bit) noexcept
00261 {
00262   long idx = word_index(bit);
00263   long b   = bit_index(bit);
00264   _bits[idx] &= ~(1UL << b);
00265 }
00266
00267 inline
00268 void
00269 Bitmap_base::atomic_clear_bit(long bit) noexcept
00270 {
00271   long idx = word_index(bit);
00272   long b   = bit_index(bit);
00273   word_type mask = 1UL << b;
00274   __atomic_and_fetch(&_bits[idx], ~mask, __ATOMIC_RELAXED);
00275 }
00276
00277 inline
00278 Bitmap_base::word_type
00279 Bitmap_base::atomic_get_and_clear(long bit) noexcept
00280 {
00281   long idx = word_index(bit);
00282   long b   = bit_index(bit);
00283   word_type mask = 1UL << b;
00284   return __atomic_fetch_and(&_bits[idx], ~mask, __ATOMIC_RELAXED) & mask;
00285 }
00286
00287 inline
00288 void
00289 Bitmap_base::set_bit(long bit) noexcept
00290 {
00291   long idx = word_index(bit);
00292   long b   = bit_index(bit);
00293   _bits[idx] |= (1UL << b);
00294 }
00295
00296 inline
00297 void
00298 Bitmap_base::atomic_set_bit(long bit) noexcept
00299 {
00300   long idx = word_index(bit);
00301   long b   = bit_index(bit);
00302   word_type mask = 1UL << b;
00303   __atomic_or_fetch(&_bits[idx], mask, __ATOMIC_RELAXED);
00304 }
00305
00306 inline
00307 Bitmap_base::word_type
00308 Bitmap_base::atomic_get_and_set(long bit) noexcept
00309 {
00310   long idx = word_index(bit);
00311   long b   = bit_index(bit);
00312   word_type mask = 1UL << b;
00313   return __atomic_fetch_or(&_bits[idx], mask, __ATOMIC_RELAXED) & mask;
00314 }
00315
00316 inline
00317 Bitmap_base::word_type
00318 Bitmap_base::bit(long bit) const noexcept
00319 {
00320   long idx = word_index(bit);
00321   long b   = bit_index(bit);
00322   return _bits[idx] & (1UL << b);
00323 }
00324
00325 inline
00326 int
00327 Bitmap_base::_bzl(unsigned long w) noexcept
00328 {
00329   for (int i = 0; i < W_bits; ++i, w >>= 1)
00330     {
00331       if ((w & 1) == 0)
00332         return i;
```

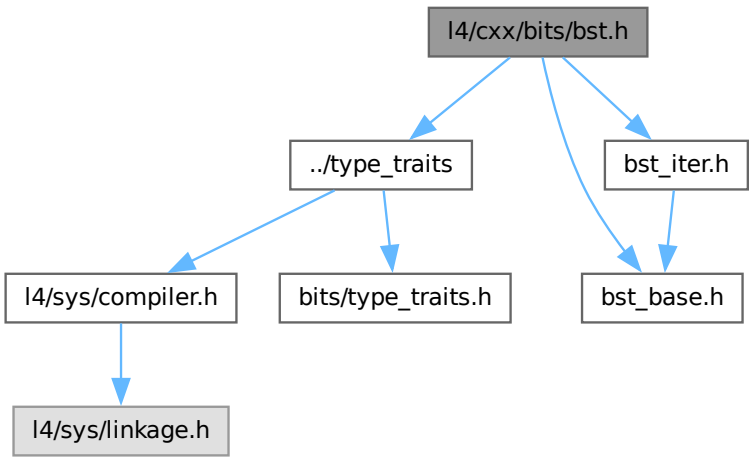
```
00333     }
00334   return -1;
00335 }
00336
00337 inline
00338 long
00339 Bitmap_base::scan_zero(long max_bit, long start_bit) const noexcept
00340 {
00341   if (!(operator [] (start_bit)))
00342     return start_bit;
00343
00344   long idx = word_index(start_bit);
00345
00346   max_bit -= start_bit & ~(W_bits - 1);
00347
00348   for (; max_bit > 0; max_bit -= W_bits, ++idx)
00349     {
00350       if (_bits[idx] == 0)
00351         return idx * W_bits;
00352
00353       if (_bits[idx] != ~0UL)
00354         {
00355           long zbit = _bzl(_bits[idx]);
00356           return zbit < max_bit ? idx * W_bits + zbit : -1;
00357         }
00358     }
00359
00360   return -1;
00361 }
00362
00363 template<int BITS> inline
00364 long
00365 Bitmap<BITS>::scan_zero(long start_bit) const noexcept
00366 {
00367   return Bitmap_base::scan_zero(BITS, start_bit);
00368 }
00369
00370 };
```

16.188 l4/cxx/bits/bst.h File Reference

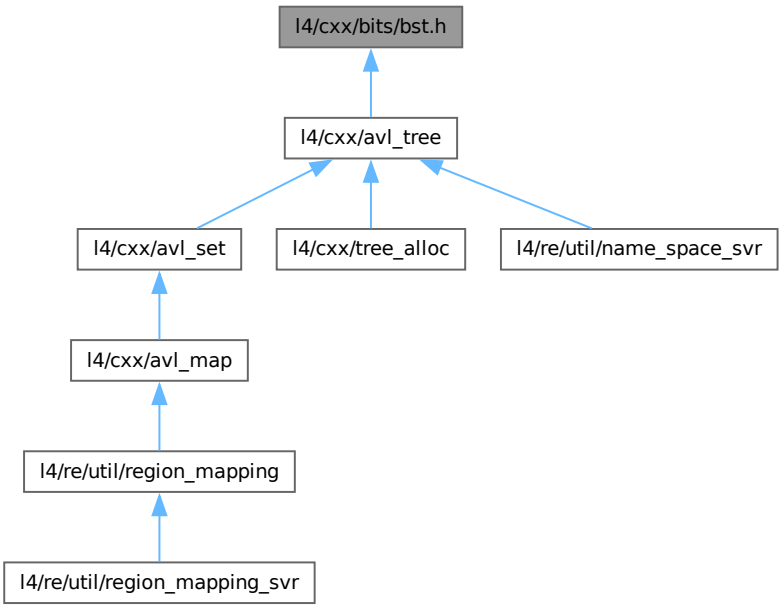
AVL tree.

```
#include "../type_traits"
#include "bst_base.h"
#include "bst_iter.h"
```

Include dependency graph for bst.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- class cxx::Bits::Bst< Node, Get_key, Compare >

  Basic binary search tree (BST).

Namespaces

- namespace cxx

  Our C++ library.
- namespace cxx::Bits

  Internal helpers for the cxx package.

16.188.1 Detailed Description

AVL tree.
Definition in file bst.h.

16.189 bst.h

Go to the documentation of this file.

```
00001 // vi:ft=cpp
00006 /*
00007  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Carsten Weinhold <weinhold@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include "../type_traits"
00016 #include "bst_base.h"
00017 #include "bst_iter.h"
00018
```

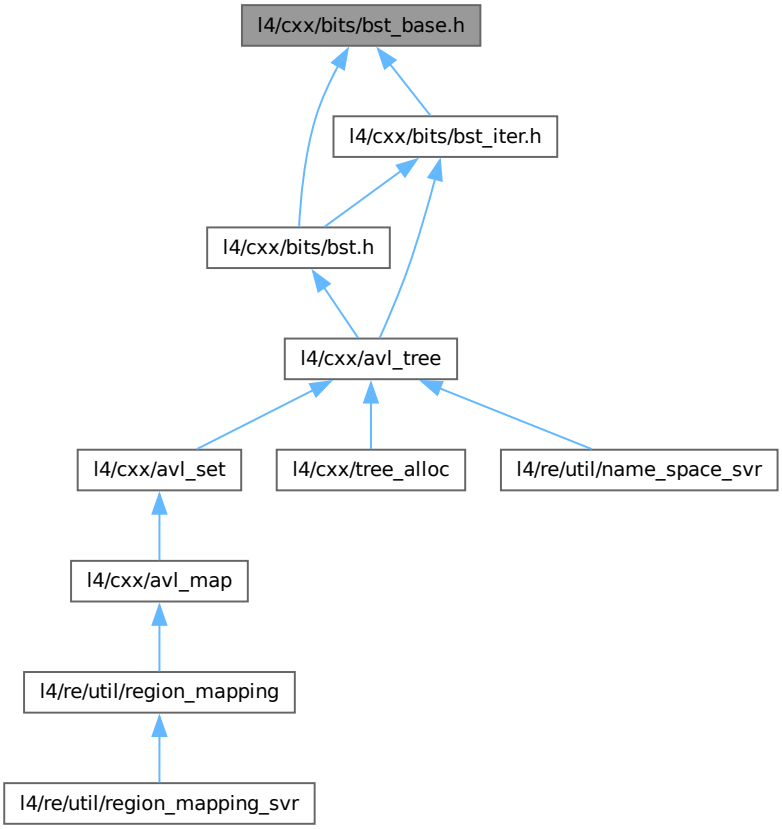
```
00019 struct Avl_set_tester;
00020
00021 namespace cxx { namespace Bits {
00022
00030 template< typename Node, typename Get_key, typename Compare >
00031 class Bst
00032 {
00033   friend struct ::Avl_set_tester;
00034
00035 private:
00036   typedef Direction Dir;
00037
00039   struct Fwd
00040   {
00041     static Node *child(Node const *n, Direction d)
00042     { return Bst_node::next<Node>(n, d); }
00043
00044     static bool cmp(Node const *l, Node const *r)
00045     { return Compare()(Get_key::key_of(l), Get_key::key_of(r)); }
00046   };
00047
00049   struct Rev
00050   {
00051     static Node *child(Node const *n, Direction d)
00052     { return Bst_node::next<Node>(n, !d); }
00053
00054     static bool cmp(Node const *l, Node const *r)
00055     { return Compare()(Get_key::key_of(r), Get_key::key_of(l)); }
00056   };
00057
00058 public:
00060   typedef typename Get_key::Key_type Key_type;
00062   typedef typename Type_traits<Key_type>::Param_type Key_param_type;
00063
00065   typedef Fwd Fwd_iter_ops;
00067   typedef Rev Rev_iter_ops;
00068
00070
00072   typedef __Bst_iter<Node, Node, Fwd> Iterator;
00074   typedef __Bst_iter<Node, Node const, Fwd> Const_iterator;
00076   typedef __Bst_iter<Node, Node, Rev> Rev_iterator;
00078   typedef __Bst_iter<Node, Node const, Rev> Const_rev_iterator;
00080
00081 protected:
00090
00092   Bst_node *_head;
00093
00095   Bst() : _head(nullptr) {}
00096
00098   Node *head() const { return static_cast<Node*>(_head); }
00099
00101   static Key_type k(Bst_node const *n)
00102   { return Get_key::key_of(static_cast<Node const *>(n)); }
00103
00112   static Dir dir(Key_param_type l, Key_param_type r)
00113   {
00114     Compare cmp;
00115     Dir d(cmp(r, l));
00116     if (d == Direction::L && !cmp(l, r))
00117       return Direction::N;
00118     return d;
00119   }
00120
00129   static Dir dir(Key_param_type l, Bst_node const *r)
00130   { return dir(l, k(r)); }
00131
00133   static bool greater(Key_param_type l, Key_param_type r)
00134   { return Compare()(r, l); }
00135
00137   static bool greater(Key_param_type l, Bst_node const *r)
00138   { return greater(l, k(r)); }
00139
00141   static bool greater(Bst_node const *l, Bst_node const *r)
00142   { return greater(k(l), k(r)); }
00144
00151   template<typename FUNC>
00152   static void remove_tree(Bst_node *head, FUNC &&callback)
00153   {
00154     if (Bst_node *n = Bst_node::next(head, Dir::L))
00155       remove_tree(n, callback);
00156
00157     if (Bst_node *n = Bst_node::next(head, Dir::R))
00158       remove_tree(n, callback);
00159
00160     callback(static_cast<Node *>(head));
00161   }
00162
```

```
00163 public:
00164
00173   Const_iterator begin() const { return Const_iterator(head()); }
00178   Const_iterator end() const { return Const_iterator(); }
00179
00184   Iterator begin() { return Iterator(head()); }
00189   Iterator end() { return Iterator(); }
00190
00195   Const_rev_iterator rbegin() const { return Const_rev_iterator(head()); }
00200   Const_rev_iterator rend() const { return Const_rev_iterator(); }
00201
00206   Rev_iterator rbegin() { return Rev_iterator(head()); }
00211   Rev_iterator rend() { return Rev_iterator(); }
00213
00214
00219
00225   Node *find_node(Key_param_type key) const;
00226
00233   Node *lower_bound_node(Key_param_type key) const;
00234
00241   Node *last_less_equal_node(Key_param_type key) const;
00242
00249   Const_iterator find(Key_param_type key) const;
00250
00259   template<typename FUNC>
00260   void remove_all(FUNC &&callback)
00261   {
00262     if (!_head)
00263       return;
00264
00265     Bst_node *head = _head;
00266     _head = nullptr;
00267     remove_tree(head, cxx::forward<FUNC>(callback));
00268   }
00269
00270
00272 };
00273
00274 /* find an element */
00275 template< typename Node, typename Get_key, class Compare>
00276 inline
00277 Node *
00278 Bst<Node, Get_key, Compare>::find_node(Key_param_type key) const
00279 {
00280   Dir d;
00281
00282   for (Bst_node *q = _head; q; q = Bst_node::next(q, d))
00283     {
00284       d = dir(key, q);
00285       if (d == Dir::N)
00286   return static_cast<Node*>(q);
00287     }
00288   return nullptr;
00289 }
00290
00291 template< typename Node, typename Get_key, class Compare>
00292 inline
00293 Node *
00294 Bst<Node, Get_key, Compare>::lower_bound_node(Key_param_type key) const
00295 {
00296   Dir d;
00297   Bst_node *r = nullptr;
00298
00299   for (Bst_node *q = _head; q; q = Bst_node::next(q, d))
00300     {
00301       d = dir(key, q);
00302       if (d == Dir::L)
00303   r = q; // found a node greater than key
00304       else if (d == Dir::N)
00305   return static_cast<Node*>(q);
00306     }
00307   return static_cast<Node*>(r);
00308 }
00309
00310 template< typename Node, typename Get_key, class Compare>
00311 inline
00312 Node *
00313 Bst<Node, Get_key, Compare>::last_less_equal_node(Key_param_type key) const
00314 {
00315   Dir d;
00316   Bst_node *l = nullptr;
00317
00318   for (Bst_node *q = _head; q; q = Bst_node::next(q, d))
00319     {
00320       d = dir(key, q);
00321       if (d == Dir::R)
00322         l = q; // found a node lower than key
```

```
00323       else if (d == Dir::N)
00324         return static_cast<Node*>(q);
00325     }
00326   return static_cast<Node*>(l);
00327 }
00328
00329 /* find an element */
00330 template< typename Node, typename Get_key, class Compare>
00331 inline
00332 typename Bst<Node, Get_key, Compare>::Const_iterator
00333 Bst<Node, Get_key, Compare>::find(Key_param_type key) const
00334 {
00335   Bst_node *q = _head;
00336   Bst_node *r = q;
00337
00338   for (Dir d; q; q = Bst_node::next(q, d))
00339     {
00340       d = dir(key, q);
00341       if (d == Dir::N)
00342   return Iterator(static_cast<Node*>(q), static_cast<Node *>(r));
00343
00344       if (d != Dir::L && q == r)
00345   r = Bst_node::next(q, d);
00346     }
00347   return Iterator();
00348 }
00349
00350 }}
```

16.190 l4/cxx/bits/bst_base.h File Reference

AVL tree.
This graph shows which files directly or indirectly include this file:



Data Structures

- struct cxx::Bits::Direction

  The direction to go in a binary search tree.
- class cxx::Bits::Bst_node

  Basic type of a node in a binary search tree (BST).

Namespaces

- namespace cxx

  Our C++ library.
- namespace cxx::Bits

  Internal helpers for the cxx package.

16.190.1 Detailed Description

AVL tree.
Definition in file bst_base.h.

16.191 bst_base.h

Go to the documentation of this file.

```
00001 // vi:ft=cpp
00006 /*
00007  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Carsten Weinhold <weinhold@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 /*
00017  * This file contains very basic bits for implementing binary search trees
00018  */
00019 namespace cxx {
00023 namespace Bits {
00024
00028 struct Direction
00029 {
00031   enum Direction_e
00032   {
00033     L = 0,
00034     R = 1,
00035     N = 2
00036   };
00037   unsigned char d;
00038
00040   Direction() = default;
00041
00043   Direction(Direction_e d) : d(d) {}
00044
00046   explicit Direction(bool b) : d(Direction_e(b)) /*d(b ? R : L)*/ {}
00047
00052   Direction operator ! () const { return Direction(!d); }
00053
00055
00057   bool operator == (Direction_e o) const { return d == o; }
00059   bool operator != (Direction_e o) const { return d != o; }
00061   bool operator == (Direction o) const { return d == o.d; }
00063   bool operator != (Direction o) const { return d != o.d; }
00065 };
00066
00070 class Bst_node
00071 {
00072   // all BSTs are friends
00073   template< typename Node, typename Get_key, typename Compare >
00074   friend class Bst;
00075
00076 protected:
00085
00087   static Bst_node *next(Bst_node const *p, Direction d)
00088   { return p->_c[d.d]; }
```

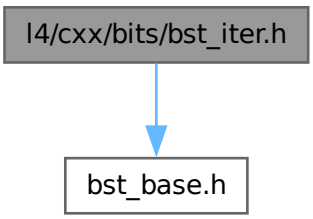
```
00089
00091   static void next(Bst_node *p, Direction d, Bst_node *n)
00092   { p->_c[d.d] = n; }
00093
00095   static Bst_node **next_p(Bst_node *p, Direction d)
00096   { return &p->_c[d.d]; }
00097
00099   template< typename Node > static
00100   Node *next(Bst_node const *p, Direction d)
00101   { return static_cast<Node *>(p->_c[d.d]); }
00102
00104   static void rotate(Bst_node **t, Direction idir);
00106
00107 private:
00108   Bst_node *_c[2];
00109
00110 protected:
00112   Bst_node() {}
00113
00115   explicit Bst_node(bool) { _c[0] = _c[1] = 0; }
00116 };
00117
00118 inline
00119 void
00120 Bst_node::rotate(Bst_node **t, Direction idir)
00121 {
00122   Bst_node *tmp = *t;
00123   *t = next(tmp, idir);
00124   next(tmp, idir, next(*t, !idir));
00125   next(*t, !idir, tmp);
00126 }
00127
00128 }}
```

16.192 l4/cxx/bits/bst_iter.h File Reference

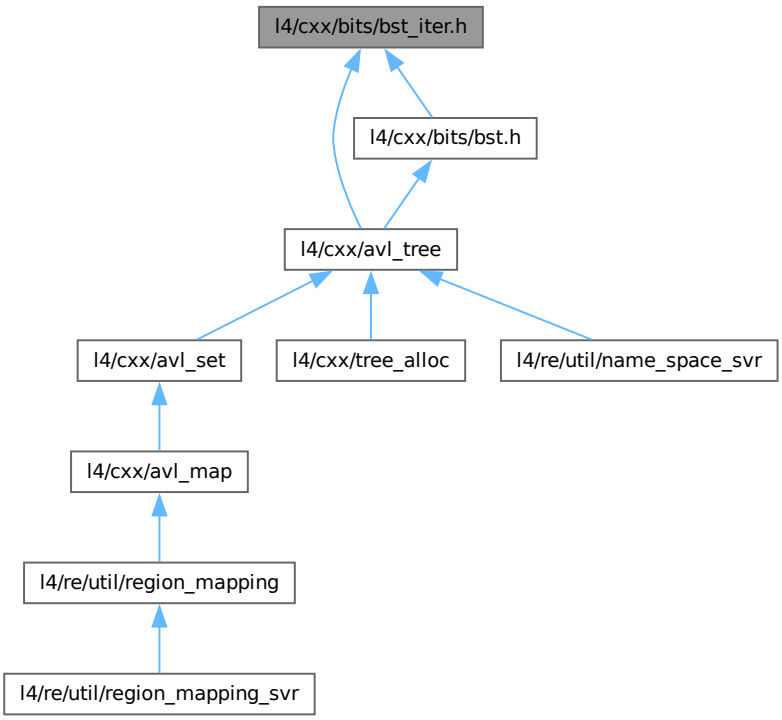
AVL tree.

`#include "bst_base.h"`

Include dependency graph for bst_iter.h:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace cxx

  Our C++ library.
- namespace cxx::Bits

  Internal helpers for the cxx package.

16.192.1 Detailed Description

AVL tree.
Definition in file bst_iter.h.

16.193 bst_iter.h

Go to the documentation of this file.

```
00001 // vi:ft=cpp
00006 /*
00007  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Carsten Weinhold <weinhold@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include "bst_base.h"
00017
00018 namespace cxx { namespace Bits {
00019
00028 template< typename Node, typename Node_op >
```

```
00029 class __Bst_iter_b
00030 {
00031 protected:
00032   typedef Direction Dir;
00033   Node const *_n;
00034   Node const *_r;
00035
00037   __Bst_iter_b() : _n(0), _r(0) {}
00038
00044   __Bst_iter_b(Node const *t)
00045     : _n(t), _r(_n)
00046   { _downmost(); }
00047
00048   __Bst_iter_b(Node const *t, Node const *r)
00049     : _n(t), _r(r)
00050   {}
00051
00053   inline void _downmost();
00054
00056   inline void inc();
00057
00058 public:
00060   bool operator == (__Bst_iter_b const &o) const { return _n == o._n; }
00062   bool operator != (__Bst_iter_b const &o) const { return _n != o._n; }
00063 };
00064
00073 template< typename Node, typename Node_type, typename Node_op >
00074 class __Bst_iter : public __Bst_iter_b<Node, Node_op>
00075 {
00076 private:
00078   typedef __Bst_iter_b<Node, Node_op> Base;
00079
00080   using Base::_n;
00081   using Base::_r;
00082   using Base::inc;
00083
00084 public:
00086   __Bst_iter() {}
00087
00093   __Bst_iter(Node const *t) : Base(t) {}
00094   __Bst_iter(Node const *t, Node const *r) : Base(t, r) {}
00095
00096 //  template<typename Key2>
00097   __Bst_iter(Base const &o) : Base(o) {}
00098
00103   Node_type &operator * () const { return *const_cast<Node *>(_n); }
00108   Node_type *operator -> () const { return const_cast<Node *>(_n); }
00112   __Bst_iter &operator ++ () { inc(); return *this; }
00116   __Bst_iter &operator ++ (int)
00117   { __Bst_iter tmp = *this; inc(); return tmp; }
00118 };
00119
00120
00121 //----------------------------------------------------------------------------
00122 /* IMPLEMENTATION: __Bst_iter_b */
00123
00124 template< typename Node, typename Node_op>
00125 inline
00126 void __Bst_iter_b<Node, Node_op>::_downmost()
00127 {
00128   while (_n)
00129     {
00130       Node *n = Node_op::child(_n, Dir::L);
00131       if (n)
00132   _n = n;
00133       else
00134   return;
00135     }
00136 }
00137
00138 template< typename Node, typename Node_op>
00139 void __Bst_iter_b<Node, Node_op>::inc()
00140 {
00141   if (!_n)
00142     return;
00143
00144   if (_n == _r)
00145     {
00146       _r = _n = Node_op::child(_r, Dir::R);
00147       _downmost();
00148       return;
00149     }
00150
00151   if (Node_op::child(_n, Dir::R))
00152     {
00153       _n = Node_op::child(_n, Dir::R);
00154       _downmost();
```

```
00155       return;
00156     }
00157
00158   Node const *q = _r;
00159   Node const *p = _r;
00160   while (1)
00161     {
00162       if (Node_op::cmp(_n, q))
00163   {
00164     p = q;
00165     q = Node_op::child(q, Dir::L);
00166   }
00167       else if (_n == q || Node_op::child(q, Dir::R) == _n)
00168   {
00169     _n = p;
00170     return;
00171   }
00172       else
00173   q = Node_op::child(q, Dir::R);
00174     }
00175 }
00176
00177 }}
```

16.194 list_basics.h

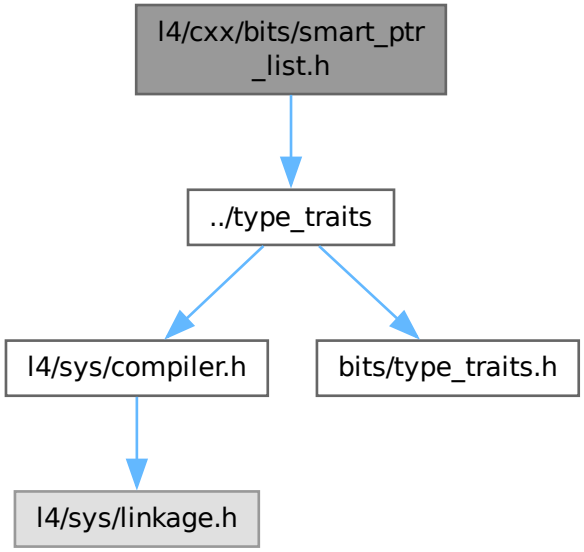
```
00001 /*
00002  * (c) 2011 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 namespace cxx { namespace Bits {
00011
00012 template< typename T >
00013 class List_iterator_end_ptr
00014 {
00015 private:
00016   template< typename U > friend class Basic_list;
00017   static void * const _end;
00018 };
00019
00020 template< typename T >
00021 void * const List_iterator_end_ptr<T>::_end = nullptr;
00022
00023 template< typename VALUE_T, typename TYPE >
00024 struct Basic_list_policy
00025 {
00026   typedef VALUE_T *Value_type;
00027   typedef VALUE_T const *Const_value_type;
00028   typedef TYPE **Type;
00029   typedef TYPE *Const_type;
00030   typedef TYPE *Head_type;
00031   typedef TYPE Item_type;
00032
00033   static Type next(Type c) { return &(*c)->_n; }
00034   static Const_type next(Const_type c) { return c->_n; }
00035 };
00036
00038 template< typename POLICY >
00039 class Basic_list
00040 {
00041   Basic_list(Basic_list const &) = delete;
00042   void operator = (Basic_list const &) = delete;
00043
00044 public:
00045   typedef typename POLICY::Value_type Value_type;
00046   typedef typename POLICY::Const_value_type Const_value_type;
00047
00048   class Iterator
00049   {
00050   private:
00051     typedef typename POLICY::Type Internal_type;
00052
00053   public:
00054     typedef typename POLICY::Value_type value_type;
00055     typedef typename POLICY::Value_type Value_type;
00056
00057     Value_type operator * () const { return static_cast<Value_type>(*_c); }
00058     Value_type operator -> () const { return static_cast<Value_type>(*_c); }
00059     Iterator operator ++ () { _c = POLICY::next(_c); return *this; }
```

```
00060
00061     friend bool operator == (Iterator const &lhs, Iterator const &rhs)
00062     { return *lhs._c == *rhs._c; }
00063     friend bool operator != (Iterator const &lhs, Iterator const &rhs)
00064     { return *lhs._c != *rhs._c; }
00065
00066     Iterator() : _c(__end()) {}
00067
00068   private:
00069     friend class Basic_list;
00070     static Internal_type __end()
00071     {
00072       union X { Internal_type l; void * const *v; } z;
00073       z.v = &Bits::List_iterator_end_ptr<void>::_end;
00074       return z.l;
00075     }
00076
00077     explicit Iterator(Internal_type i) : _c(i) {}
00078
00079     Internal_type _c;
00080   };
00081
00082   class Const_iterator
00083   {
00084   private:
00085     typedef typename POLICY::Const_type Internal_type;
00086
00087   public:
00088     typedef typename POLICY::Value_type value_type;
00089     typedef typename POLICY::Value_type Value_type;
00090
00091     Value_type operator * () const { return static_cast<Value_type>(_c); }
00092     Value_type operator -> () const { return static_cast<Value_type>(_c); }
00093     Const_iterator operator ++ () { _c = POLICY::next(_c); return *this; }
00094
00095     friend bool operator == (Const_iterator const &lhs, Const_iterator const &rhs)
00096     { return lhs._c == rhs._c; }
00097     friend bool operator != (Const_iterator const &lhs, Const_iterator const &rhs)
00098     { return lhs._c != rhs._c; }
00099
00100     Const_iterator() {}
00101     Const_iterator(Iterator const &o) : _c(*o) {}
00102
00103   private:
00104     friend class Basic_list;
00105
00106     explicit Const_iterator(Internal_type i) : _c(i) {}
00107
00108     Internal_type _c;
00109   };
00110
00111   // BSS allocation
00112   explicit Basic_list(bool) {}
00113   constexpr Basic_list() : _f(nullptr) {}
00114
00115   Basic_list(Basic_list &&o) : _f(o._f)
00116   {
00117     o.clear();
00118   }
00119
00120   Basic_list &operator = (Basic_list &&o) &
00121   {
00122     if (&o != this)
00123       {
00124         _f = o._f;
00125         o.clear();
00126       }
00127
00128     return *this;
00129   }
00130
00132   bool empty() const { return !_f; }
00134   Value_type front() const { return static_cast<Value_type>(_f); }
00135
00141   void clear() { _f = nullptr; }
00142
00144   Iterator begin() { return Iterator(&_f); }
00146   Const_iterator begin() const { return Const_iterator(_f); }
00154   static Const_iterator iter(Const_value_type c) { return Const_iterator(c); }
00156   Const_iterator end() const { return Const_iterator(nullptr); }
00158   Iterator end() { return Iterator(); }
00159
00160 protected:
00161   static typename POLICY::Type __get_internal(Iterator const &i) { return i._c; }
00162   static Iterator __iter(typename POLICY::Type c) { return Iterator(c); }
00163
00165   typename POLICY::Head_type _f;
```

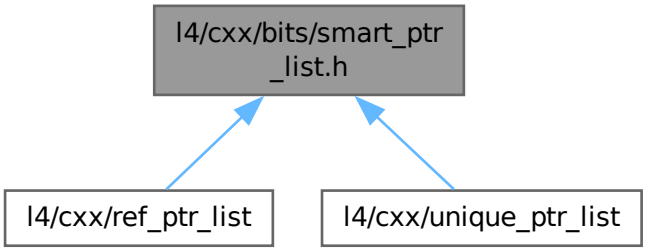
```
00166 };
00167
00168 }}
00169
```

16.195 l4/cxx/bits/smart_ptr_list.h File Reference

Implementation of a list of smart-pointer-managed objects.
`#include "../type_traits"`
Include dependency graph for smart_ptr_list.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- class cxx::Bits::Smart_ptr_list_item< T, STORE_T >

  List item for an arbitrary item in a Smart_ptr_list.

- class cxx::Bits::Smart_ptr_list< ITEM >

  List of smart-pointer-managed objects.

Namespaces

- namespace cxx

  Our C++ library.
- namespace cxx::Bits

  Internal helpers for the cxx package.

16.195.1 Detailed Description

Implementation of a list of smart-pointer-managed objects.
Definition in file smart_ptr_list.h.

16.196 smart_ptr_list.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * Copyright (C) 2018, 2022, 2024 Kernkonzept GmbH.
00007  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include "../type_traits"
00014
00015 namespace cxx { namespace Bits {
00016
00026 template <typename T, typename STORE_T>
00027 class Smart_ptr_list_item
00028 {
00029   using Value_type = T;
00030   using Storage_type = STORE_T;
00031
00032   template<typename U> friend class Smart_ptr_list;
00033   Storage_type _n;
00034 };
00035
00045 template <typename ITEM>
00046 class Smart_ptr_list
00047 {
00048   using Value_type = typename ITEM::Value_type;
00049   using Next_type = typename ITEM::Storage_type;
00050
00051 public:
00052   class Iterator
00053   {
00054   public:
00055     Iterator() : _c(nullptr) {}
00056
00057     Value_type *operator * () const { return _c; }
00058     Value_type *operator -> () const { return _c; }
00059
00060     Iterator operator ++ ()
00061     {
00062       _c = _c->_n.get();
00063       return *this;
00064     }
00065
00066     bool operator == (Iterator const &o) const { return _c == o._c; }
00067     bool operator != (Iterator const &o) const { return !operator == (o); }
00068
00069   private:
00070     friend class Smart_ptr_list;
00071
00072     explicit Iterator(Value_type *i) : _c(i) {}
00073
00074     Value_type *_c;
00075   };
00076
00077   class Const_iterator
00078   {
00079   public:
```

```
00080     Const_iterator() : _c(nullptr) {}
00081
00082     Value_type const *operator * () const { return _c; }
00083     Value_type const *operator -> () const { return _c; }
00084
00085     Const_iterator operator ++ ()
00086     {
00087       _c = _c->_n.get();
00088       return *this;
00089     }
00090
00091     bool operator == (Const_iterator const &o) const { return _c == o._c; }
00092     bool operator != (Const_iterator const &o) const { return !operator == (o); }
00093
00094   private:
00095     friend class Smart_ptr_list;
00096
00097     explicit Const_iterator(Value_type const *i) : _c(i) {}
00098
00099     Value_type const *_c;
00100   };
00101
00102   Smart_ptr_list() : _b(&_f) {}
00103
00105   void push_front(Next_type &&e)
00106   {
00107     e->_n = cxx::move(this->_f);
00108     this->_f = cxx::move(e);
00109
00110     if (_b == &_f)
00111       _b = &(_f->_n);
00112   }
00113
00115   void push_front(Next_type const &e)
00116   {
00117     e->_n = cxx::move(this->_f);
00118     this->_f = e;
00119
00120     if (_b == &_f)
00121       _b = &(_f->_n);
00122   }
00123
00125   void push_back(Next_type &&e)
00126   {
00127     *_b = cxx::move(e);
00128     _b = &((*_b)->_n);
00129   }
00130
00132   void push_back(Next_type const &e)
00133   {
00134     *_b = e;
00135     _b = &((*_b)->_n);
00136   }
00137
00139   Value_type *front() const
00140   { return _f.get(); }
00141
00149   Next_type pop_front()
00150   {
00151     Next_type ret = cxx::move(_f);
00152
00153     if (ret)
00154       _f = cxx::move(ret->_n);
00155
00156     if (!_f)
00157       _b = &_f;
00158
00159     return ret;
00160   }
00161
00163   bool empty() const
00164   { return !_f; }
00165
00166   Iterator begin() { return Iterator(_f.get()); }
00167   Iterator end() { return Iterator(); }
00168
00169   Const_iterator begin() const { return Const_iterator(_f.get()); }
00170   Const_iterator end() const { return Const_iterator(); }
00171
00172   Const_iterator cbegin() const { return const_iterator(_f.get()); }
00173   Const_iterator cend() const { return Const_iterator(); }
00174
00175 private:
00176   Next_type _f;
00177   Next_type *_b;
00178 };
00179
```

```
00180 } }
```

16.197 type_traits.h

```
00001 // vi:ft=cpp
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 namespace cxx {
00013
00014 class Null_type;
00015
00016 template<bool flag, typename T, typename F>
00017 struct Select { using Type = T; };
00018
00019 template<typename T, typename F>
00020 struct Select<false, T, F> { using Type = F; };
00021
00022 template<typename T, typename U>
00023 class Conversion
00024 {
00025   using S = char;
00026
00027   class B { char dummy[2]; };
00028
00029   static S test(U);
00030   static B test(...);
00031   static T make_T();
00032
00033 public:
00034   static constexpr bool exists = sizeof(test(make_T())) == sizeof(S);
00035   static constexpr bool two_way = exists && Conversion<U, T>::exists;
00036   static constexpr bool exists_2_way = two_way;
00037   static constexpr bool same_type = false;
00038 };
00039
00040 template<>
00041 class Conversion<void, void>
00042 {
00043 public:
00044   static constexpr bool exists = true;
00045   static constexpr bool two_way = true;
00046   static constexpr bool exists_2_way = two_way;
00047   static constexpr bool same_type = true;
00048 };
00049
00050 template<typename T>
00051 class Conversion<T, T>
00052 {
00053 public:
00054   static constexpr bool exists = true;
00055   static constexpr bool two_way = true;
00056   static constexpr bool exists_2_way = two_way;
00057   static constexpr bool same_type = true;
00058 };
00059
00060 template<typename T>
00061 class Conversion<void, T>
00062 {
00063 public:
00064   static constexpr bool exists = false;
00065   static constexpr bool two_way = false;
00066   static constexpr bool exists_2_way = two_way;
00067   static constexpr bool same_type = false;
00068 };
00069
00070 template<typename T>
00071 class Conversion<T, void>
00072 {
00073 public:
00074   static constexpr bool exists = false;
00075   static constexpr bool two_way = false;
00076   static constexpr bool exists_2_way = two_way;
00077   static constexpr bool same_type = false;
00078 };
00079
00080 namespace TT
```

```
00081 {
00082   template<typename U>
00083   struct Pointer_traits
00084   {
00085     using Pointee = Null_type;
00086     static constexpr bool value = false;
00087   };
00088
00089   template<typename U>
00090   struct Pointer_traits<U *>
00091   {
00092     using Pointee = U;
00093     static constexpr bool value = true;
00094   };
00095
00096   template<typename U>
00097   struct Ref_traits
00098   {
00099     using Referee = U;
00100     static constexpr bool value = false;
00101   };
00102
00103   template<typename U>
00104   struct Ref_traits<U &>
00105   {
00106     using Referee = U;
00107     static constexpr bool value = true;
00108   };
00109
00110   template<typename U>
00111   struct Add_ref { using Type = U &; };
00112
00113   template<typename U>
00114   struct Add_ref<U &> { using Type = U; };
00115
00116   template<typename U>
00117   struct PMF_traits
00118   { static constexpr bool value = false; };
00119
00120   template<typename U, typename F>
00121   struct PMF_traits<U F:: *>
00122   { static constexpr bool value = true; };
00123
00124   template<typename U>
00125   struct Is_unsigned
00126   { static constexpr bool value = false; };
00127
00128   template<>
00129   struct Is_unsigned<unsigned>
00130   { static constexpr bool value = true; };
00131
00132   template<>
00133   struct Is_unsigned<unsigned char>
00134   { static constexpr bool value = true; };
00135
00136   template<>
00137   struct Is_unsigned<unsigned short>
00138   { static constexpr bool value = true; };
00139
00140   template<>
00141   struct Is_unsigned<unsigned long>
00142   { static constexpr bool value = true; };
00143
00144   template<>
00145   struct Is_unsigned<unsigned long long>
00146   { static constexpr bool value = true; };
00147
00148   template<typename U>
00149   struct Is_signed
00150   { static constexpr bool value = false; };
00151
00152   template<>
00153   struct Is_signed<signed>
00154   { static constexpr bool value = true; };
00155
00156   template<>
00157   struct Is_signed<signed char>
00158   { static constexpr bool value = true; };
00159
00160   template<>
00161   struct Is_signed<signed short>
00162   { static constexpr bool value = true; };
00163
00164   template<>
00165   struct Is_signed<signed long>
00166   { static constexpr bool value = true; };
00167
```

```
00168   template<>
00169   struct Is_signed<signed long long>
00170   { static constexpr bool value = true; };
00171
00172   template<typename U>
00173   struct Is_int
00174   { static constexpr bool value = false; };
00175
00176   template<>
00177   struct Is_int<char>
00178   { static constexpr bool value = true; };
00179
00180   template<>
00181   struct Is_int<bool>
00182   { static constexpr bool value = true; };
00183
00184   template<>
00185   struct Is_int<wchar_t>
00186   { static constexpr bool value = true; };
00187
00188   template<typename U>
00189   struct Is_float
00190   { static constexpr bool value = false; };
00191
00192   template<>
00193   struct Is_float<float>
00194   { static constexpr bool value = true; };
00195
00196   template<>
00197   struct Is_float<double>
00198   { static constexpr bool value = true; };
00199
00200   template<>
00201   struct Is_float<long double>
00202   { static constexpr bool value = true; };
00203
00204   template<typename T>
00205   struct Const_traits
00206   {
00207     using Type = T;
00208     using Const_type = const T;
00209     static constexpr bool value = false;
00210   };
00211
00212   template<typename T>
00213   struct Const_traits<const T>
00214   {
00215     using Type = T;
00216     using Const_type = const T;
00217     static constexpr bool value = true;
00218   };
00219 };
00220
00221 template<typename T>
00222 struct Type_traits
00223 {
00224   static constexpr bool is_unsigned = TT::Is_unsigned<T>::value;
00225   static constexpr bool is_signed = TT::Is_signed<T>::value;
00226
00227   static constexpr bool is_int = TT::Is_int<T>::value;
00228   static constexpr bool is_float = TT::Is_float<T>::value;
00229
00230   static constexpr bool is_pointer = TT::Pointer_traits<T>::value;
00231   static constexpr bool is_pointer_to_member = TT::PMF_traits<T>::value;
00232   static constexpr bool is_reference = TT::Ref_traits<T>::value;
00233
00234   static constexpr bool is_scalar = is_unsigned || is_signed || is_int
00235     || is_pointer || is_pointer_to_member || is_reference;
00236
00237   static constexpr bool is_fundamental = is_unsigned || is_signed || is_float
00238     || Conversion<T, void>::same_type;
00239
00240   static constexpr bool is_const = TT::Const_traits<T>::value;
00241
00253   static constexpr unsigned long align(unsigned long address)
00254   { return (address + alignof(T) - 1UL) & ~(alignof(T) - 1UL); }
00255
00256   using Param_type = typename Select<is_scalar, T, typename TT::Add_ref<typename
      TT::Const_traits<T>::Const_type>::Type>::Type;
00257
00258   using Pointee_type = typename TT::Pointer_traits<T>::Pointee;
00259   using Referee_type = typename TT::Ref_traits<T>::Referee;
00260   using Non_const_type = typename TT::Const_traits<T>::Type;
00261   using Const_type = typename TT::Const_traits<T>::Const_type;
00262 };
00263
00264 };
```

16.198 buddy_alloc

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2026 Kernkonzept GmbH.
00004  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/cxx/arith>
00012 #include <l4/cxx/minmax>
00013 #include <l4/cxx/type_traits>
00014 #include <l4/sys/compiler.h>
00015 #include <l4/sys/consts.h>
00016 #include <l4/sys/l4int.h>
00017
00018 #include <cassert>
00019 #include <cstddef>
00020 #include <cstdio>
00021
00022 namespace cxx
00023 {
00024
00056 class Buddy_alloc
00057 {
00058 public:
00059   static constexpr bool Debug_alloc = false;
00060 #ifdef NDEBUG
00061   static constexpr bool Print_warnings = false;
00062 #else
00063   static constexpr bool Print_warnings = true;
00064 #endif
00065
00066 public:
00067   static constexpr unsigned Min_order = L4_PAGESHIFT;
00068   static constexpr size_t Min_size = 1UL << Min_order;
00069
00070   // OPTIMIZE: Use only exactly as many bits as necessary per level.
00071   using Order_free = l4_uint8_t;
00072
00073   static constexpr unsigned long Invalid_node_index = 0;
00074   static constexpr unsigned long Root_node_index = 1;
00075
00076   struct Node_ptr
00077   {
00078     unsigned long index; // 1-based index
00079     unsigned level;
00080
00081     Node_ptr() : index(Invalid_node_index), level(0) {}
00082     Node_ptr(unsigned long index, unsigned level) : index(index), level(level)
00083     {}
00084
00085     Node_ptr parent() const
00086     {
00087       assert(!is_root());
00088       return Node_ptr{index / 2, level + 1};
00089     }
00090
00091     Node_ptr left_child() const
00092     {
00093       assert(!is_leaf());
00094       return Node_ptr{index * 2, level - 1};
00095     }
00096
00097     Node_ptr right_child() const
00098     {
00099       assert(!is_leaf());
00100       return Node_ptr{(index * 2) + 1, level - 1};
00101     }
00102
00103     bool valid() const { return index != Invalid_node_index; }
00104     bool is_left() const { return index % 2 == 0; }
00105     bool is_right() const { return index % 2 == 1; }
00106     bool is_root() const { return index == Root_node_index; }
00107     bool is_leaf() const { return level == 0; }
00108
00109     friend constexpr bool operator==(Node_ptr const &lhs,
00110                                      Node_ptr const &rhs)
00111     { return lhs.index == rhs.index && lhs.level == rhs.level; }
00112
00113     friend constexpr bool operator!=(Node_ptr const &lhs,
00114                                      Node_ptr const &rhs)
00115     { return !(lhs == rhs); }
```

```
00116   };
00117
00124   static constexpr size_t metadata_bytes(l4_addr_t min_addr, l4_addr_t max_addr)
00125   {
00126     return num_tree_nodes(min_addr, max_addr) * sizeof(Order_free);
00127   }
00128
00129   bool initialized() const { return _tree != nullptr; }
00130
00139   void init(l4_addr_t min_addr, l4_addr_t max_addr,
00140             unsigned char *metadata_addr, size_t metadata_size)
00141   {
00142     assert(metadata_bytes(min_addr, max_addr) <= metadata_size);
00143
00144     l4_uint64_t max_mem_size;
00145     calc_mem_range(min_addr, max_addr, &_base, &max_mem_size);
00146     _base = to_min_size_units(_base);
00147     _max_mem_size = to_min_size_units(max_mem_size);
00148     _max_level = cxx::arith::log2u(_max_mem_size);
00149     _tree = metadata_addr;
00150     // Initially the entire tree is unavailable.
00151     __builtin_memset(_tree, 0, metadata_size);
00152
00153     if constexpr (Debug_alloc)
00154       {
00155         printf("Buddy allocator info:\n");
00156         printf("  Metadata size: %zu (%zu KiB)\n",
00157                metadata_size, metadata_size / 1024);
00158         printf("  Base address: %#lx\n", from_min_size_units(_base));
00159         printf("  Max mem size: %#llx\n", _max_mem_size * l4_uint64_t{Min_size});
00160         printf("  Max mem order: %u\n", _max_level + Min_order);
00161         printf("  Range: [%#lx, %#lx]\n", min_addr, max_addr);
00162         printf("  Max level: %u\n", _max_level);
00163         printf("  Total number of nodes: %lu\n",
00164                num_tree_nodes(min_addr, max_addr));
00165         printf("  Levels:\n");
00166         for (int level = _max_level; level >= 0; level--)
00167           {
00168             printf("    %2d: size=%#llx start_index=%ld, nodes=%ld\n", level,
00169                    block_size_for_level(level) * l4_uint64_t{Min_size},
00170                    level_start_index(level), nodes_in_level(level));
00171           }
00172       }
00173   }
00174
00183   inline void add_mem(void *mem, size_t size);
00184
00201   inline void *alloc(size_t size, size_t align, l4_addr_t lower = 0,
00202                      l4_addr_t upper = ~0UL);
00203
00231   inline void *alloc_max(size_t min, size_t *max, size_t align,
00232                          size_t granularity, l4_addr_t lower = 0,
00233                          l4_addr_t upper = ~0UL);
00234
00244   inline void free(void *block, size_t size);
00245
00251   inline size_t avail() const;
00252
00253   template<typename DBG>
00254   void dump_free(DBG &out) const;
00255
00256 private:
00257   struct Mem_range
00258   {
00259     l4_addr_t start;
00260     l4_addr_t end; // inclusive
00261
00262     Mem_range() : start(static_cast<l4_addr_t>(-1)), end(0) {}
00263     Mem_range(l4_addr_t start, l4_addr_t end) : start(start), end(end)
00264     { assert(valid()); }
00265
00266     bool valid() const
00267     { return start <= end; }
00268
00269     size_t size() const
00270     { return end - start + 1; }
00271
00272     friend bool operator < (Mem_range const &lhs, Mem_range const &rhs)
00273     { return lhs.end < rhs.start; }
00274
00275     bool overlaps(Mem_range const &o) const
00276     { return !(*this < o) && !(o < *this); }
00277
00278     bool contains(Mem_range const &o) const
00279     { return start <= o.start && end >= o.end; }
00280
00281     Mem_range intersect(Mem_range const &o) const
```

```
00282     {
00283       if (!overlaps(o))
00284         return Mem_range();
00285
00286       return Mem_range{start > o.start ? start : o.start,
00287                        end < o.end ? end : o.end};
00288     }
00289   };
00290
00292   template<typename T>
00293   static constexpr T ceil_power_of_two(T val)
00294   {
00295     return T{1} << cxx::arith::log2u_ceil(val);
00296   }
00297
00298   template<typename T>
00299   static constexpr T trunc_power_of_two(T val)
00300   {
00301     return T{1} << cxx::arith::log2u(val);
00302   }
00303
00304   template<typename T>
00305   static constexpr bool is_power_of_two(T val)
00306   {
00307     return val > 0 && (val & (val - 1)) == 0;
00308   }
00309
00310   template<typename T, typename B>
00311   static constexpr T ceil_to(T val, B boundary)
00312   {
00313     assert(is_power_of_two(boundary));
00314     return (val + boundary - 1) & ~T{boundary - 1};
00315   }
00316
00317   template<typename T, typename B>
00318   static constexpr T trunc_to(T val, B boundary)
00319   {
00320     assert(is_power_of_two(boundary));
00321     return val & ~T{boundary - 1};
00322   }
00323
00324   template<typename T, typename B>
00325   static constexpr bool is_aligned_to(T val, B boundary)
00326   {
00327     return trunc_to(val, boundary) == val;
00328   }
00329
00330   static constexpr unsigned trailing_zeroes(unsigned val)
00331   {
00332     return val ? __builtin_ctz(val) : sizeof(unsigned) * 8;
00333   }
00334
00335   static constexpr unsigned trailing_zeroes(unsigned long val)
00336   {
00337     return val ? __builtin_ctzl(val) : sizeof(unsigned long) * 8;
00338   }
00339
00341   template<typename T>
00342   static constexpr T to_min_size_units(T val)
00343   {
00344     assert(is_aligned_to(val, Min_size));
00345     return val / Min_size;
00346   }
00347
00349   template<typename T>
00350   static constexpr T from_min_size_units(T val)
00351   {
00352     assert((val * Min_size) / Min_size == val);
00353     return val * Min_size;
00354   }
00355
00367   static constexpr void calc_mem_range(l4_addr_t min_addr, l4_addr_t max_addr,
00368                                        l4_addr_t *base_addr,
00369                                        l4_uint64_t *max_size)
00370   {
00371     assert(min_addr < max_addr);
00372     l4_uint64_t raw_size = max_addr - min_addr + l4_uint64_t{1};
00373     assert(raw_size >= Min_size);
00374
00375     *max_size = ceil_power_of_two(raw_size);
00376     *base_addr = trunc_to(l4_uint64_t{min_addr}, *max_size);
00377     // Adjust max block size and base address, until they cover the entire
00378     // requested memory area.
00379     // The covered range is [base_addr, base_addr + max_size - 1], thus
00380     // `max_addr` is only included if `max_size > max_addr - base_addr`.
00381     while (*max_size <= max_addr - *base_addr)
00382       {
```

```
00383         // Max address not included after alignment, use next power of two.
00384         assert(*max_size < (l4_uint64_t{1} << 63));
00385         *max_size *= 2;
00386         *base_addr = trunc_to(l4_uint64_t{min_addr}, *max_size);
00387       }
00388   }
00389
00390   static constexpr unsigned long num_tree_nodes(l4_addr_t min_addr,
00391                                                 l4_addr_t max_addr)
00392   {
00393     l4_addr_t base_addr = 0;
00394     l4_uint64_t max_mem_size = 0;
00395     calc_mem_range(min_addr, max_addr, &base_addr, &max_mem_size);
00396     // OPTIMIZE: Only allocate tree storage for the memory between min_range and
00397     //           max_range.
00398     auto actual_nodes = ((2 * max_mem_size) - 1) / Min_size;
00399     // The tree uses 1-based indexes for efficient parent/child navigation. For
00400     // simplicity the node at index 0 is unused.
00401     return actual_nodes + 1;
00402   }
00403
00404   unsigned long nodes_in_level(unsigned level) const
00405   {
00406     return 1UL << (_max_level - level);
00407   }
00408
00409   unsigned long level_start_index(unsigned level) const
00410   {
00411     return nodes_in_level(level);
00412   }
00413
00414   static unsigned level_for_block_size(size_t size)
00415   {
00416     assert(is_power_of_two(size)); // power of two, so a block size.
00417     return cxx::arith::log2u(size);
00418   }
00419
00428   static l4_size_t block_size_for_level(unsigned level)
00429   {
00430     return l4_size_t{1} << level;
00431   }
00432
00433   Node_ptr node_for_block_level(l4_addr_t addr, unsigned level) const
00434   {
00435     size_t node_size = block_size_for_level(level);
00436
00437     assert(addr >= _base);
00438     assert(addr + node_size > addr);
00439     assert(addr + node_size <= _base + _max_mem_size);
00440     assert(is_aligned_to(addr, node_size));
00441
00442     unsigned long index = level_start_index(level) + ((addr - _base) / node_size);
00443     return Node_ptr{index, level};
00444   }
00445
00446   Node_ptr node_for_block(l4_addr_t addr, size_t node_size) const
00447   {
00448     assert(addr >= _base);
00449     assert(addr + node_size > addr);
00450     assert(addr + node_size <= _base + _max_mem_size);
00451     assert(is_aligned_to(addr, node_size));
00452
00453     unsigned level = level_for_block_size(node_size);
00454     unsigned long index = level_start_index(level) + ((addr - _base) / node_size);
00455     return Node_ptr{index, level};
00456   }
00457
00458   l4_addr_t block_start_addr(Node_ptr node) const
00459   {
00460     size_t size = block_size_for_level(node.level);
00461     size_t offset = (node.index - level_start_index(node.level)) * size;
00462     return _base + offset;
00463   }
00464
00465   l4_addr_t block_end_addr(Node_ptr node) const
00466   {
00467     l4_addr_t block_start = block_start_addr(node);
00468     size_t block_size = block_size_for_level(node.level);
00469     return block_start + block_size - 1;
00470   }
00471
00472   Mem_range block_range(Node_ptr node) const
00473   {
00474     return Mem_range{block_start_addr(node), block_end_addr(node)};
00475   }
00476
00477   static bool fits_level(Order_free node_order, unsigned level)
```

```
00478   {
00479     // Because 0 marks allocated nodes, the largest free order of node is stored
00480     // as level+1.
00481     return node_order > level;
00482   }
00483
00489   static unsigned min_level_required_for_size(size_t size)
00490   {
00491     // The intuition for this computation comes from looking at the worst case.
00492     // In the following example 1 unit corresponds to Min_size.
00493     // The "worst" placement that avoids an aligned block of size B is:
00494     //   - Start 1 unit after a block boundary.
00495     //   - End 1 unit before the block boundary after the next block.
00496     // The interval spanned by these two almost complete blocks is `B - 1` each,
00497     // so `2B - 2` in total. From that we can derive that each span with a
00498     // length `n > 2B - 2` or `n >= 2B - 1` must contain an aligned block of
00499     // size B. Solve for B, and arrive at: `min_B = (n + 1) / 2`
00500     return cxx::arith::log2u((size + 1) / 2);
00501   }
00502
00503   Order_free node_get(Node_ptr node) const
00504   {
00505     assert(node.valid());
00506     return _tree[node.index];
00507   }
00508
00509   void node_set(Node_ptr node, Order_free largest_order)
00510   {
00511     _tree[node.index] = largest_order;
00512   }
00513
00520   bool node_is_free(Node_ptr node) const
00521   {
00522     return node_get(node) == node.level + 1;
00523   }
00524
00526   bool node_is_used(Node_ptr node) const { return node_get(node) == 0; }
00527
00528   void node_set_free(Node_ptr node) { node_set(node, node.level + 1); }
00529   void node_set_used(Node_ptr node) { node_set(node, 0); }
00530
00531   Node_ptr root_node() const { return Node_ptr{Root_node_index, _max_level}; }
00532
00533   bool node_is_seperately_allocated(Node_ptr node)
00534   {
00535     // If both children of the node are marked as used, the node was not
00536     // allocated as a whole, but rather both child nodes separately by
00537     // two independent allocations. Freeing it as a single node would leave
00538     // the children behind as used and thus corrupt the tree.
00539     return !node.is_leaf() && node_is_used(node.left_child())
00540            && node_is_used(node.right_child());
00541   }
00542
00543   enum class Walk_dir
00544   {
00545     Descend, // Descend into the children of the node.
00546     Next,    // Go to next node (sibling, or up through parent chain).
00547     Stop,    // Stop tree walk.
00548   };
00549
00559   template<typename CB>
00560   bool tree_walk(CB const &cb, Node_ptr root) const
00561   {
00562     // Invokes callback and returns whether tree walk should descend further.
00563     auto handle_node = [&cb](Node_ptr &node)
00564       {
00565         Walk_dir dir = cb(node);
00566         if (dir == Walk_dir::Descend && node.is_leaf())
00567           dir = Walk_dir::Next;
00568         return dir;
00569       };
00570
00571     if (handle_node(root) != Walk_dir::Descend)
00572       return true;
00573
00574     Node_ptr cur = root.left_child();
00575     for (;;)
00576       {
00577         auto dir = handle_node(cur);
00578         if (dir == Walk_dir::Stop)
00579           return false;
00580
00581         if (dir == Walk_dir::Descend)
00582           {
00583             cur = cur.left_child();
00584             continue;
00585           }
```

```
00586
00587         // Walk_dir::Next
00588         if (cur.is_left())
00589           cur = cur.parent().right_child();
00590         else if (cur.is_right())
00591           {
00592             // Bubble up chain of parents to determine next node.
00593             Node_ptr parent = cur.parent();
00594             while (parent != root && parent.is_right())
00595               parent = parent.parent();
00596             if (parent == root)
00597               return true; // walk done
00598             cur = parent.parent().right_child();
00599           }
00600       }
00601   }
00602
00606   template<typename CB>
00607   void tree_walk_free(CB const &cb) const
00608   {
00609     tree_walk([this, &cb](Node_ptr const &node)
00610       {
00611         if (node_is_free(node))
00612           {
00613             cb(node);
00614             return Walk_dir::Next; // encountered free node, bubble up
00615           }
00616
00617         // Descend only if node is split.
00618         return node_is_used(node) ? Walk_dir::Next : Walk_dir::Descend;
00619       }, root_node());
00620   }
00621
00631   Node_ptr find_bounded_root(unsigned desired_level,
00632                              Mem_range const &alloc_range)
00633   {
00634     Node_ptr node = root_node();
00635     while (node.level > desired_level)
00636       {
00637         // Must not descend into subtree shadowed by an allocated node.
00638         if (node_is_used(node))
00639           break;
00640
00641         auto left = node.left_child();
00642         auto right = node.right_child();
00643         if (block_range(left).contains(alloc_range))
00644           node = left; // Left child contains range.
00645         else if (block_range(right).contains(alloc_range))
00646           node = right; // Rights child contains range.
00647         else
00648           break; // Parent node contains range (or is the root of the tree).
00649       }
00650     return node;
00651   }
00652
00653   static Node_ptr next_node(Node_ptr node, Node_ptr root)
00654   {
00655     assert(node.valid());
00656     if (L4_UNLIKELY(node == root))
00657       return Node_ptr();
00658
00659     if (node.is_left())
00660       node = node.parent().right_child();
00661     else if (node.is_right())
00662       {
00663         // Bubble up chain of parents to determine next node.
00664         Node_ptr parent = node.parent();
00665         while (parent != root && parent.is_right())
00666           parent = parent.parent();
00667         if (parent == root)
00668           return Node_ptr();
00669         node = parent.parent().right_child();
00670       }
00671     return node;
00672   }
00673
00674   static Node_ptr prev_node(Node_ptr node, Node_ptr root)
00675   {
00676     assert(node.valid());
00677     if (L4_UNLIKELY(node == root))
00678       return Node_ptr();
00679
00680     if (node.is_right())
00681       node = node.parent().left_child();
00682     else if (node.is_left())
00683       {
00684         // Bubble up chain of parents to determine next node.
```

```
00685         Node_ptr parent = node.parent();
00686         while (parent != root && parent.is_left())
00687           parent = parent.parent();
00688         if (parent == root)
00689           return Node_ptr();
00690         node = parent.parent().left_child();
00691       }
00692     return node;
00693   }
00694
00695   Node_ptr next_adjacent_free(Node_ptr node, Node_ptr root)
00696   {
00697     Node_ptr next = next_node(node, root);
00698     if (!next.valid())
00699       return Node_ptr();
00700
00701     while (!node_is_free(next))
00702       {
00703         if (next.is_leaf() || node_is_used(next))
00704           return Node_ptr();
00705         next = next.left_child();
00706       }
00707     return next;
00708   }
00709
00710   Node_ptr prev_adjacent_free(Node_ptr node, Node_ptr root)
00711   {
00712     Node_ptr prev = prev_node(node, root);
00713     if (!prev.valid())
00714       return Node_ptr();
00715
00716     while (!node_is_free(prev))
00717       {
00718         if (prev.is_leaf() || node_is_used(prev))
00719           return Node_ptr();
00720         prev = prev.right_child();
00721       }
00722     return prev;
00723   }
00724
00730   Node_ptr next_node_in_range(l4_addr_t cur_addr, l4_size_t remaining_size)
00731   {
00732     unsigned next_level = cxx::min(
00733       trailing_zeroes(cur_addr),
00734       trailing_zeroes(trunc_power_of_two(remaining_size)));
00735     return node_for_block_level(cur_addr, next_level);
00736   }
00737
00738   [[nodiscard]] static bool normalize_size_align(size_t &size, size_t &align)
00739   {
00740     size = ceil_to(size, Min_size);
00741     if (L4_UNLIKELY(size == 0))
00742       return false; // Either size was zero, or too large and ceil overflowed.
00743
00744     if (L4_UNLIKELY(!is_power_of_two(align) || align > size))
00745       return false;
00746     align = ceil_to(align, Min_size);
00747     return true;
00748   }
00749
00750   [[nodiscard]] static bool normalize_bounds(l4_addr_t &lower, l4_addr_t &upper,
00751                                              size_t size, size_t align)
00752   {
00753     // Ceil lower bound to alignment.
00754     l4_addr_t aligned_lower = ceil_to(lower, align);
00755     if (L4_UNLIKELY(aligned_lower < lower))
00756       return false; // Overflow, no aligned address within the bounds.
00757     lower = aligned_lower;
00758
00759     // Truncate upper bound to alignment.
00760     if (L4_UNLIKELY(upper < Min_size - 1))
00761       return false;
00762     // Note that upper + 1 can wrap to zero, still the result is correct.
00763     upper = trunc_to(upper + 1, Min_size) - 1;
00764
00765     if (L4_UNLIKELY(lower > upper))
00766       return false;
00767
00768     return upper - lower >= size - 1;
00769   }
00770
00771   class Alloc_walk
00772   {
00773   public:
00774     Alloc_walk(Buddy_alloc &a, l4_size_t min_size, l4_size_t max_size,
00775                l4_size_t align, Mem_range alloc_bounds, Node_ptr base_node)
00776     : a(a),
```

```
00777       min_size(min_size),
00778       max_size(max_size),
00779       align(align),
00780       alloc_bounds(alloc_bounds),
00781       base_node(base_node),
00782       min_anchor_level(min_level_required_for_size(min_size))
00783     {}
00784
00785     Buddy_alloc &a;
00786     l4_size_t const min_size;
00787     l4_size_t const max_size;
00788     l4_size_t const align;
00789     Mem_range const alloc_bounds;
00790     Node_ptr const base_node;
00794     unsigned min_anchor_level;
00795     Node_ptr start_node;
00796     // The following members are only valid if start_node is valid.
00797     Node_ptr end_node;
00798     unsigned max_level = 0;
00799     Mem_range free_range;
00800
00801     [[nodiscard]] bool add_free_node(Node_ptr const &node,
00802                                      Mem_range const &intersect)
00803     {
00804       if (!start_node.valid())
00805         {
00806           // Apply alignment constraints.
00807           auto aligned_start = ceil_to(intersect.start, align);
00808           if (aligned_start > intersect.end)
00809             // Aligned start after end of node.
00810             return false;
00811
00812           start_node = node;
00813           end_node = Node_ptr();
00814           free_range.start = aligned_start;
00815           free_range.end = intersect.end;
00816           max_level = node.level;
00817         }
00818       else
00819         {
00820           end_node = node;
00821           assert(free_range.end + 1 == intersect.start);
00822           free_range.end = intersect.end;
00823           max_level = cxx::max(max_level, node.level);
00824         }
00825       return true;
00826     }
00827
00828     void reset_free_range()
00829     {
00830       start_node = Node_ptr();
00831       max_level = 0;
00832     }
00833
00846     template<typename CB>
00847     void search(CB const &eval_alloc);
00848
00858     inline bool try_alloc();
00859
00860   private:
00869     static bool may_align(unsigned cur_level, l4_size_t align)
00870     {
00871       return block_size_for_level(cur_level) > align;
00872     }
00873
00874     inline void expand_start();
00875     inline void expand_back();
00876   };
00877
00878
00888   inline void *alloc_size_aligned(Node_ptr const &root, unsigned alloc_level);
00889
00890   [[nodiscard]] void *alloc_single_node(Node_ptr node)
00891   {
00892     assert(node_is_free(node));
00893     node_set_used(node);
00894     update_parents_after_alloc(node);
00895     return reinterpret_cast<void *>(from_min_size_units(block_start_addr(node)));
00896   }
00897
00899   void *alloc_partial(Node_ptr node, l4_size_t partial_size)
00900   {
00901     assert(node_is_free(node));
00902     Node_ptr cur_node = node;
00903     l4_size_t remaining_size = partial_size;
00904     for (;;)
00905       {
```

```
00906         l4_size_t node_size = block_size_for_level(cur_node.level);
00907         // Covers entire node.
00908         if (remaining_size == node_size)
00909           {
00910             node_set_used(cur_node);
00911             remaining_size -= node_size;
00912             update_parents_after_alloc(cur_node);
00913             break;
00914           }
00915         // Covers entire left child of node.
00916         else if (remaining_size > node_size / 2)
00917           {
00918             node_set_used(cur_node.left_child());
00919             remaining_size -= node_size / 2;
00920             cur_node = cur_node.right_child();
00921           }
00922         // Covers part of left child of node.
00923         else
00924           cur_node = cur_node.left_child();
00925       }
00926     return reinterpret_cast<void *>(from_min_size_units(block_start_addr(node)));
00927   }
00928
00930   [[nodiscard]] void *alloc_node_range(Node_ptr node, l4_size_t size)
00931   {
00932     void *result = nullptr;
00933     l4_addr_t cur_addr = block_start_addr(node);
00934     l4_size_t remaining_size = size;
00935     while (remaining_size > 0)
00936       {
00937         assert(node_is_free(node));
00938         assert(cur_addr == block_start_addr(node));
00939         l4_size_t node_size = block_size_for_level(node.level);
00940         assert(node_size <= remaining_size);
00941
00942         void *node_ptr = alloc_single_node(node);
00943         if (result == nullptr)
00944           result = node_ptr;
00945
00946         cur_addr += node_size;
00947         remaining_size -= node_size;
00948         if (remaining_size == 0)
00949           break;
00950
00951         node = next_node_in_range(cur_addr, remaining_size);
00952       }
00953     return result;
00954   }
00955
00970   inline void *alloc_from_search_range(Node_ptr start_node, Node_ptr end_node,
00971                                        Mem_range free_range, l4_size_t size);
00972
00973   [[nodiscard]] bool free_single_node(Node_ptr node)
00974   {
00975     // Double-free or free at different level than alloc.
00976     if (L4_UNLIKELY(!node_is_used(node) || node_is_seperately_allocated(node)))
00977       return false;
00978
00979     // Mark node as free.
00980     node_set_free(node);
00981     update_parents_after_free(node);
00982     return true;
00983   }
00984
00986   void update_parents_after_alloc(Node_ptr node)
00987   {
00988     Node_ptr cur = node;
00989     while (!cur.is_root())
00990       {
00991         Node_ptr parent = cur.parent();
00992         Order_free largest_order_left = node_get(parent.left_child());
00993         Order_free largest_order_right = node_get(parent.right_child());
00994         Order_free new_largest_order = cxx::max(largest_order_left,
00995                                                 largest_order_right);
00996         if (new_largest_order == node_get(parent))
00997           // Parent largest order unchanged, we can stop.
00998           break;
00999         node_set(parent, new_largest_order);
01000         cur = parent;
01001       }
01002   }
01003
01005   void update_parents_after_free(Node_ptr node)
01006   {
01007     Node_ptr cur = node;
01008     // Update parents in tree.
01009     while (!cur.is_root())
```

```
01010       {
01011         Node_ptr parent = cur.parent();
01012         Order_free largest_order_left = node_get(parent.left_child());
01013         Order_free largest_order_right = node_get(parent.right_child());
01014         bool left_free = largest_order_left == cur.level + 1;
01015         if (largest_order_left == largest_order_right && left_free)
01016           {
01017             // Both children are free, so mark the parent as free.
01018             node_set_free(parent);
01019           }
01020         else
01021           {
01022             Order_free new_largest_order = cxx::max(largest_order_left,
01023                                                     largest_order_right);
01024             if (new_largest_order == node_get(parent))
01025               // Parent largest order unchanged, we can stop.
01026               break;
01027             node_set(parent, new_largest_order);
01028           }
01029         cur = parent;
01030       }
01031   }
01032
01039   void mark_subtree_free(Node_ptr node)
01040   {
01041     // The nodes of a level are stored consecutively, thus the descendants of a
01042     // node are stored as contiguous range on every level.
01043     unsigned long first_index = node.index;
01044     unsigned long nodes_in_level = 1;
01045     for (unsigned level = node.level;; --level)
01046       {
01047         __builtin_memset(&_tree[first_index], level + 1, nodes_in_level);
01048         if (level == 0)
01049           break;
01050         first_index *= 2;
01051         nodes_in_level *= 2;
01052       }
01053
01054     update_parents_after_free(node);
01055   }
01056
01057   l4_addr_t _base;         // in Min_size units
01058   l4_size_t _max_mem_size; // in Min_size units
01059   unsigned _max_level;
01060   l4_uint8_t *_tree = nullptr;
01061 };
01062
01063 template<typename CB>
01064 void
01065 Buddy_alloc::Alloc_walk::search(CB const &eval_alloc)
01066 {
01067   bool completed = a.tree_walk([this, &eval_alloc](Node_ptr &node)
01068     {
01069       if (!a.node_is_free(node))
01070         {
01071           // Encountered non-free node, evaluate alloc.
01072           if (start_node.valid())
01073             {
01074               if (eval_alloc())
01075                 return Walk_dir::Stop;
01076
01077               if (end_node.valid())
01078                 {
01079                   // Skip free nodes discovered during try_alloc().
01080                   node = end_node;
01081                   return Walk_dir::Next;
01082                 }
01083             }
01084
01085           if (!fits_level(a.node_get(node), min_anchor_level))
01086             return Walk_dir::Next;
01087
01088           return Walk_dir::Descend;
01089         }
01090
01091       Mem_range node_range = a.block_range(node);
01092       Mem_range intersect = alloc_bounds.intersect(node_range);
01093       if (!intersect.valid()
01094           || intersect.size() < block_size_for_level(min_anchor_level))
01095         return Walk_dir::Next; // out of bounds
01096
01097       if (!add_free_node(node, intersect))
01098         return Walk_dir::Next;
01099
01100       if (intersect.end < node_range.end)
01101         {
01102           // The end of the node lies outside the alloc range, we reached the end.
```

```
01103           eval_alloc();
01104           return Walk_dir::Stop;
01105         }
01106
01107       if (free_range.size() >= max_size)
01108         {
01109           if (eval_alloc())
01110             return Walk_dir::Stop;
01111
01112           if (end_node.valid())
01113             // Skip free nodes discovered during try_alloc().
01114             node = end_node;
01115         }
01116
01117       return Walk_dir::Next;
01118
01119       // OPTIMIZE:
01120       // Try to not fragment too much, only x-levels below anchor_level.
01121       // Take remaining size in relation to min_anchor size into consideration.
01122       // Introduce a fragmentation / wasted memory threshold that decides
01123       // whether to try size align alloc, or descend further.
01124     }, base_node);
01125
01126   // In case the walk stopped because it reached the end of the tree, we need to
01127   // evaluate a pending free range.
01128   if (completed && start_node.valid())
01129     eval_alloc();
01130 }
01131
01132 bool
01133 Buddy_alloc::Alloc_walk::try_alloc()
01134 {
01135   assert(start_node.valid());
01136
01137   // OPTIMIZE:
01138   // How to best position the allocation?
01139   // Idea could be to try size-aligned allocation for start and end node to avoid unnecessary
      splitting.
01140   // Or some limits relative to max_level / min_anchor_level.
01141   // So in other words, expand start_node and end_node in multiple phases, with different conditions.
01142   // 1. Only nodes greater/equal min_anchor_level, front and then back if necessary.
01143   // 2. Only nodes greater/equal min_anchor_level - 1, front and then back if necessary.
01144   // 3. ...
01145   // (if the level available at the front is larger than at the back, but
01146   // the later is sufficient to serve the allocation, prefer it)
01147
01148   // Need to search before (searches for nodes below min_anchor_level).
01149   expand_start();
01150   assert(is_aligned_to(free_range.start, align));
01151   expand_back();
01152
01153   if (free_range.size() < min_size)
01154     {
01155       // Failed to alloc...
01156       reset_free_range();
01157       return false;
01158     }
01159
01160   return true;
01161 }
01162
01163 void
01164 Buddy_alloc::Alloc_walk::expand_start()
01165 {
01166   while (free_range.size() < max_size
01167          && free_range.start == a.block_start_addr(start_node))
01168     {
01169       // Searching further back does not make sense, since we know
01170       // everything we might find will not align.
01171       if (!may_align(start_node.level, align))
01172         break;
01173
01174       // OPTIMIZE: Since we only search levels below min_anchor_level, we
01175       // can do some lower bound calculation to figure out if search even
01176       // makes sense.
01177       Node_ptr prev = a.prev_adjacent_free(start_node, base_node);
01178       if (!prev.valid())
01179         break;
01180
01181       Mem_range intersect = alloc_bounds.intersect(a.block_range(prev));
01182       if (!intersect.valid())
01183         break;
01184
01185       auto aligned_start = ceil_to(intersect.start, align);
01186       if (aligned_start > intersect.end)
01187         // Aligned start after end of node.
01188         break;
```

```
01189
01190       if (!end_node.valid())
01191         end_node = start_node;
01192
01193       start_node = prev;
01194       max_level = cxx::max(max_level, prev.level);
01195       free_range.start = aligned_start;
01196     }
01197 }
01198
01199 void
01200 Buddy_alloc::Alloc_walk::expand_back()
01201 {
01202   while (free_range.size() < max_size
01203          && (!end_node.valid() || free_range.end == a.block_end_addr(end_node)))
01204     {
01205       Node_ptr next = a.next_adjacent_free(
01206         !end_node.valid() ? start_node : end_node, base_node);
01207       if (!next.valid())
01208         break;
01209
01210       Mem_range intersect = alloc_bounds.intersect(a.block_range(next));
01211       if (!intersect.valid())
01212         break;
01213
01214       end_node = next;
01215       max_level = cxx::max(max_level, next.level);
01216       free_range.end = intersect.end;
01217     }
01218 }
01219
01220 void *
01221 Buddy_alloc::alloc_size_aligned(Node_ptr const &root, unsigned alloc_level)
01222 {
01223   // Check the largest free order of the root node, mostly to prevent descending
01224   // to children shadowed by a fully allocated root node, but also as an early
01225   // exit in case it cannot fulfill the allocation.
01226   if (!fits_level(node_get(root), alloc_level))
01227     return nullptr; // out of memory
01228
01229   Node_ptr node = root;
01230   while (node.level > alloc_level)
01231     {
01232       auto left = node.left_child();
01233       auto right = node.right_child();
01234       Order_free largest_order_left = node_get(left);
01235       Order_free largest_order_right = node_get(right);
01236       if (fits_level(largest_order_left, alloc_level))
01237         {
01238           if (largest_order_left > largest_order_right
01239               && fits_level(largest_order_right, alloc_level))
01240             node = right;
01241           else
01242             node = left;
01243         }
01244       else if (largest_order_right > alloc_level)
01245         node = right;
01246       else
01247         break;
01248     }
01249
01250   if (!fits_level(node_get(node), alloc_level))
01251     return nullptr; // out of memory
01252
01253   return alloc_single_node(node);
01254 }
01255
01256 void *
01257 Buddy_alloc::alloc_from_search_range(Node_ptr start_node, Node_ptr end_node,
01258                                      Mem_range free_range, l4_size_t size)
01259 {
01260   if (free_range.start == block_start_addr(start_node) && !end_node.valid())
01261     // Allocate from a single node.
01262     return alloc_partial(start_node, size);
01263
01264
01265   // Find actual start node, taking intersect into account.
01266   while (free_range.start != block_start_addr(start_node))
01267     {
01268       start_node = block_start_addr(start_node.right_child()) > free_range.start
01269                      ? start_node.left_child()
01270                      : start_node.right_child();
01271     }
01272
01273   // Allocate multiple nodes, which are descendants of the single original
01274   // start_node.
01275   if (!end_node.valid())
```

```
01276     {
01277       // Find actual start node, in case the start node is still larger than the
01278       // requested size.
01279       while (block_size_for_level(start_node.level) > size)
01280         start_node = start_node.left_child();
01281
01282       return alloc_node_range(start_node, size);
01283     }
01284
01285   // Find actual end node, taking intersect into account.
01286   while (free_range.end != block_end_addr(end_node))
01287     end_node = block_end_addr(end_node.left_child()) >= free_range.end
01288                  ? end_node.left_child()
01289                  : end_node.right_child();
01290
01291   assert(free_range.start == block_start_addr(start_node));
01292   // min() in case we decided to only allocate a sub-range of the detected
01293   // range, for example because of granularity constraints.
01294   l4_size_t front_size =
01295     cxx::min<l4_size_t>(block_start_addr(end_node) - free_range.start, size);
01296   void *mem = alloc_node_range(start_node, front_size);
01297
01298   // The above alloc_free_range() could take the entire range, including the
01299   // tail, but alloc_partial is more efficient due to less
01300   // update_parents_after_alloc() calls.
01301   if (front_size != size)
01302     alloc_partial(end_node, size - front_size);
01303   return mem;
01304 }
01305
01306 void
01307 Buddy_alloc::add_mem(void *mem, size_t size)
01308 {
01309   assert(initialized());
01310
01311   l4_addr_t start = reinterpret_cast<l4_addr_t>(mem);
01312   l4_addr_t aligned_start = ceil_to(start, Min_size);
01313   // Block at address zero must never be handed out by alloc(), because nullptr
01314   // represents a failed allocation.
01315   if (aligned_start == 0)
01316     aligned_start = Min_size;
01317
01318   size_t skipped_size = aligned_start - start;
01319   if (size <= skipped_size)
01320     return;
01321   size = trunc_to(size - skipped_size, Min_size);
01322
01323   aligned_start = to_min_size_units(aligned_start);
01324   size = to_min_size_units(size);
01325
01326   while (size > 0)
01327     {
01328       // Add the largest size-aligned block that fits the remaining size and
01329       // mark its entire subtree as free. The naive way of adding Min_size
01330       // blocks bottom up, is slow due to the frequent parent updates.
01331       Node_ptr node = next_node_in_range(aligned_start, size);
01332       size_t block_size = block_size_for_level(node.level);
01333
01334       if (L4_UNLIKELY(!node_is_used(node)))
01335         {
01336           // The node is free or split, i.e. at least parts of the memory were
01337           // already added before.
01338           if constexpr (Print_warnings)
01339             printf("Detected addition of already available memory at %#lx (size=%#zx).\n",
01340                    from_min_size_units(aligned_start), from_min_size_units(block_size));
01341           return;
01342         }
01343       mark_subtree_free(node);
01344
01345       aligned_start += block_size;
01346       size -= block_size;
01347     }
01348 }
01349
01350 void *
01351 Buddy_alloc::alloc(size_t size, size_t align, l4_addr_t lower, l4_addr_t upper)
01352 {
01353   if (L4_UNLIKELY(!initialized()))
01354     return nullptr;
01355
01356   if (L4_UNLIKELY(!normalize_size_align(size, align)))
01357     return nullptr;
01358
01359   if (L4_UNLIKELY(!normalize_bounds(lower, upper, size, align)))
01360     return nullptr;
01361
01362   // Convert arguments to Min_size units.
```

```
01363   size = to_min_size_units(size);
01364   align = to_min_size_units(align);
01365   lower = to_min_size_units(lower);
01366   upper = upper / Min_size; // inclusive, thus not aligned, truncation is fine.
01367
01368   unsigned size_aligned_level = level_for_block_size(ceil_power_of_two(size));
01369   Mem_range alloc_range(lower, upper);
01370   Node_ptr base_node = find_bounded_root(size_aligned_level, alloc_range);
01371
01372   // In case the alloc range contains the base node, so either larger then the
01373   // root node or exactly aligning with a subnode, we can use the unbounded
01374   // allocation algorithm on the subtree spanned by the base node.
01375   if (alloc_range.contains(block_range(base_node)) && is_power_of_two(size))
01376     {
01377       if (void *block = alloc_size_aligned(base_node, size_aligned_level);
01378           L4_LIKELY(block != nullptr))
01379         return block;
01380
01381       if (size == align)
01382         return nullptr;
01383
01384       // Search for non-size-aligned allocation opportunity...
01385     }
01386
01387   Alloc_walk walk(*this, size, size, align, alloc_range, base_node);
01388   // OPTIMIZE ideas:
01389   //   - Special case for small sizes, where min_anchor_block_size==size.
01390   //   - For smaller sizes just try to find a perfect aligned fit. And only if
01391   //     that fails try harder.
01392   //   - For larger sizes above e.g. 64 MB try harder, with Alloc_walk.
01393   //   - If the block we split is much larger than our target size, maybe
01394   //     continue searching?
01395   walk.search([&]() { return walk.try_alloc(); });
01396   if (!walk.start_node.valid())
01397     return nullptr;
01398
01399   return alloc_from_search_range(walk.start_node, walk.end_node,
01400                                  walk.free_range, walk.min_size);
01401 }
01402
01403 void *
01404 Buddy_alloc::alloc_max(size_t min, size_t *max, size_t align,
01405                        size_t granularity, l4_addr_t lower, l4_addr_t upper)
01406 {
01407   if (L4_UNLIKELY(!initialized()))
01408     return nullptr;
01409
01410   if (L4_UNLIKELY(!is_power_of_two(granularity) || granularity > align))
01411     return nullptr;
01412   granularity = ceil_to(granularity, Min_size);
01413
01414   if (L4_UNLIKELY(!normalize_size_align(min, align)))
01415     return nullptr;
01416
01417   // The allocation size is truncated to a multiple of the granularity in the
01418   // end. Thus also the minimum size must be a multiple of the granularity.
01419   // Otherwise the truncation could yield a size below minimum size.
01420   min = ceil_to(min, granularity);
01421   if (L4_UNLIKELY(min == 0))
01422     return nullptr; // Too large, overflow.
01423
01424   l4_size_t max_ = trunc_to(*max, granularity);
01425   if (L4_UNLIKELY(min > max_))
01426     return nullptr;
01427
01428   if (L4_UNLIKELY(!normalize_bounds(lower, upper, min, align)))
01429     return nullptr;
01430
01431   // Convert arguments to Min_size units.
01432   min = to_min_size_units(min);
01433   max_ = to_min_size_units(max_);
01434   align = to_min_size_units(align);
01435   granularity = to_min_size_units(granularity);
01436   lower = to_min_size_units(lower);
01437   upper = upper / Min_size; // inclusive, thus not aligned, truncation is fine.
01438
01439   unsigned size_aligned_max_level = level_for_block_size(trunc_power_of_two(max_));
01440   Mem_range alloc_range(lower, upper);
01441   Node_ptr base_node = find_bounded_root(size_aligned_max_level, alloc_range);
01442   if (alloc_range.contains(block_range(base_node)) && is_power_of_two(max_))
01443     {
01444       if (void *block = alloc_size_aligned(base_node, size_aligned_max_level);
01445           L4_LIKELY(block != nullptr))
01446         {
01447           *max = from_min_size_units(max_);
01448           return block;
01449         }
```

```
01450
01451       // Search for smaller or non-size-aligned allocation opportunity...
01452     }
01453
01454   // Tree walk that only considers nodes within [lower, upper] to search for
01455   // suitable free node.
01456
01457   Node_ptr best_start_node;
01458   Node_ptr best_end_node;
01459   Mem_range best_free_range;
01460
01461   Alloc_walk walk(*this, min, max_, align, alloc_range, base_node);
01462   walk.search([&]()
01463     {
01464       if (!walk.try_alloc())
01465         return false;
01466
01467       // OPTIMIZE: Take into account other parameters, such as wasted memory /
01468       // splitting of larger blocks.
01469       if (!best_start_node.valid()
01470           || walk.free_range.size() > best_free_range.size())
01471         {
01472           best_start_node = walk.start_node;
01473           best_end_node = walk.end_node;
01474           best_free_range = walk.free_range;
01475
01476           if (best_free_range.size() >= max_)
01477             return true; // found area that can provide max
01478
01479           // Raise the min_anchor_level dynamically.
01480           walk.min_anchor_level = min_level_required_for_size(
01481             best_free_range.size());
01482         }
01483
01484       // Continue the scan until we find a range >= max_ or reach the end.
01485       walk.reset_free_range();
01486       return false;
01487     });
01488
01489   if (!best_start_node.valid())
01490     return nullptr;
01491
01492   max_ = cxx::min(walk.max_size, best_free_range.size());
01493   max_ = trunc_to(max_, granularity);
01494   *max = from_min_size_units(max_);
01495   return alloc_from_search_range(best_start_node, best_end_node,
01496                                  best_free_range, max_);
01497 }
01498
01499 void
01500 Buddy_alloc::free(void *block, size_t size)
01501 {
01502   if (L4_UNLIKELY(!initialized()))
01503     return;
01504
01505   size = ceil_to(size, Min_size);
01506   if (L4_UNLIKELY(size == 0))
01507     return; // Either zero size or too large and ceil overflowed.
01508
01509   if (L4_UNLIKELY(block == nullptr))
01510     {
01511       // alloc() never hands out a block address of zero.
01512       if constexpr (Print_warnings)
01513         printf("Invalid free of nullptr (size=%#zx).\n", size);
01514       return;
01515     }
01516
01517   l4_addr_t block_addr = reinterpret_cast<l4_addr_t>(block);
01518   if (L4_UNLIKELY(!is_aligned_to(block_addr, Min_size)))
01519     {
01520       if constexpr (Print_warnings)
01521         printf("Invalid free of misaligned address %#lx (size=%#zx).\n",
01522                block_addr, size);
01523       return;
01524     }
01525
01526   // Convert arguments to Min_size units.
01527   size = to_min_size_units(size);
01528   block_addr = to_min_size_units(block_addr);
01529
01530   // Reject blocks outside of the memory area managed by the.
01531   if (L4_UNLIKELY(block_addr < _base || size > _max_mem_size
01532                   || block_addr - _base > _max_mem_size - size))
01533     {
01534       if constexpr (Print_warnings)
01535         printf("Invalid free of %#lx (size=%#zx) outside of the managed area.\n",
01536                from_min_size_units(block_addr), from_min_size_units(size));
```

```
01537       return;
01538     }
01539
01540   // Single size-aligned block.
01541   if (is_power_of_two(size) && is_aligned_to(block_addr, size))
01542     {
01543       Node_ptr node = node_for_block(block_addr, size);
01544       if (!free_single_node(node))
01545         if constexpr (Print_warnings)
01546           printf("Double free of %#lx (size=%#zx) or free with different size.\n",
01547                  from_min_size_units(block_addr), from_min_size_units(size));
01548       return;
01549     }
01550
01551   // From the alignment of the start address we figure out an upper bound level,
01552   // from which we search left until we find a used block at the given address.
01553   unsigned base_level = cxx::min(trailing_zeroes(block_addr), _max_level);
01554   // Since used nodes never can be shadowed (only free nodes can), it is safe to
01555   // start at an arbitrary level of the tree. If we encounter a used node, we
01556   // can be sure that it is actually used.
01557   Node_ptr node = node_for_block_level(block_addr, base_level);
01558
01559   // Descend from "upper bound level" to node at the same address marked as used.
01560   while (!node_is_used(node) || node_is_seperately_allocated(node))
01561     {
01562       if (L4_UNLIKELY(node.is_leaf()))
01563         {
01564           if constexpr (Print_warnings)
01565             printf("Double free of %#lx (size=%#zx).\n",
01566                    from_min_size_units(block_addr), from_min_size_units(size));
01567           return;
01568         }
01569
01570       node = node.left_child();
01571     }
01572
01573   // Now we have the first block of the allocation, now we iterate until we
01574   // reached end of allocation.
01575   l4_addr_t cur_addr = block_addr;
01576   size_t remaining_size = size;
01577   for (;;)
01578     {
01579       l4_size_t block_size = block_size_for_level(node.level);
01580       if (L4_UNLIKELY(block_size > remaining_size))
01581         {
01582           if constexpr (Print_warnings)
01583             printf("Free of %#lx with wrong size (block_size=%#zx vs. remaining_size=%#zx).\n",
01584                    from_min_size_units(block_addr),
01585                    from_min_size_units(block_size),
01586                    from_min_size_units(remaining_size));
01587           return;
01588         }
01589
01590       // OPTIMIZE: Batch the parent update_parents_after_free() calls?
01591       if (!free_single_node(node))
01592         if constexpr (Print_warnings)
01593           printf("Double free of %#lx (size=%#zx) or free with different size.\n",
01594                  from_min_size_units(block_addr), from_min_size_units(size));
01595
01596       cur_addr += block_size;
01597       remaining_size -= block_size;
01598       if (remaining_size == 0)
01599         break; // we are done :)
01600
01601       node = next_node_in_range(cur_addr, remaining_size);
01602     }
01603 }
01604
01610 size_t
01611 Buddy_alloc::avail() const
01612 {
01613   if (L4_UNLIKELY(!initialized()))
01614     return 0;
01615
01616   size_t avail = 0;
01617   tree_walk_free([&avail](Node_ptr const &node)
01618     { avail += block_size_for_level(node.level); });
01619   return from_min_size_units(avail);
01620 }
01621
01622 template<typename DBG>
01623 void
01624 Buddy_alloc::dump_free(DBG &out) const
01625 {
01626   if (L4_UNLIKELY(!initialized()))
01627     {
01628       out.printf("Buddy_alloc [UNITIALIZED]\n");
```

```
01629       return;
01630     }
01631
01632   l4_uint64_t total = 0;
01633   out.printf("Buddy_alloc [%zu,%u]\n", Min_size, _max_level);
01634
01635   // Stack-allocate entries to cover the maximum possible number of levels.
01636   size_t levels_avail[(sizeof(l4_addr_t) * 8) - Min_order + 1] = {};
01637   assert(_max_level < cxx::array_size(levels_avail));
01638   tree_walk_free([&levels_avail](Node_ptr const &node)
01639     { levels_avail[node.level] += 1; });
01640
01641   auto format_size = [](l4_uint64_t *size, unsigned threshold) -> char const *
01642     {
01643       static_assert(Min_size >= 1024); // 2^64 == 16 EiB
01644       static constexpr char const *const unitstr[7] =
01645         { "Byte", "KiB", "MiB", "GiB", "TiB", "PiB", "EiB" };
01646
01647       unsigned i;
01648       for (i = 0; i + 1 < cxx::array_size(unitstr) && *size > (threshold << 10); ++i)
01649         *size >>= 10;
01650       return unitstr[i];
01651     };
01652
01653   for (unsigned level = 0; level <= _max_level; level++)
01654     {
01655       l4_uint64_t level_size = block_size_for_level(level) * l4_uint64_t{Min_size};
01656       l4_uint64_t size = level_size;
01657       char const *unit = format_size(&size, 2);
01658       out.printf("  %2u: [%4llu %s]", level, size, unit);
01659
01660       l4_uint64_t avail = levels_avail[level] * level_size;
01661       size_t avail_blocks = levels_avail[level];
01662       size = avail;
01663       unit = format_size(&size, 8);
01664       out.cprintf(" %zu free blocks == %4llu %-4s (%llu bytes)\n",
01665                   avail_blocks, size, unit, avail);
01666
01667       total += avail;
01668     }
01669
01670   l4_uint64_t size = total;
01671   char const *unit = format_size(&size, 8);
01672   out.printf("sum of available memory: %llu %s (%llu bytes)\n",
01673              size, unit, total);
01674 }
01675
01676 } // namespace cxx
```

16.199 dlist

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2011 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 namespace cxx {
00012
00013 class D_list_item
00014 {
00015 public:
00016   constexpr D_list_item() : _dli_next(nullptr), _dli_prev(nullptr) {}
00017
00018   D_list_item(D_list_item const &) = delete;
00019   void operator = (D_list_item const &) = delete;
00020
00021 private:
00022   friend struct D_list_item_policy;
00023
00024   D_list_item *_dli_next, *_dli_prev;
00025 };
00026
00027 struct D_list_item_policy
00028 {
00029   typedef D_list_item Item;
00030   static constexpr D_list_item *&prev(D_list_item *e) { return e->_dli_prev; }
00031   static constexpr D_list_item *&next(D_list_item *e) { return e->_dli_next; }
00032   static constexpr D_list_item *prev(D_list_item const *e) { return e->_dli_prev; }
00033   static constexpr D_list_item *next(D_list_item const *e) { return e->_dli_next; }
```

```
00034 };
00035
00036 template< typename T >
00037 struct Sd_list_head_policy
00038 {
00039   typedef T *Head_type;
00040   static constexpr T *head(Head_type h) { return h; }
00041   static constexpr void set_head(Head_type &h, T *v) { h = v; }
00042 };
00043
00044 template<
00045   typename T,
00046   typename C = D_list_item_policy
00047 >
00048 class D_list_cyclic
00049 {
00050 protected:
00051   template< typename VALUE, typename ITEM >
00052   class __Iterator
00053   {
00054   public:
00055     typedef VALUE *Value_type;
00056     typedef VALUE *value_type;
00057
00058     __Iterator() {}
00059
00060     friend bool operator == (__Iterator const &lhs, __Iterator const &rhs)
00061     { return lhs._c == rhs._c; }
00062
00063     friend bool operator != (__Iterator const &lhs, __Iterator const &rhs)
00064     { return lhs._c != rhs._c; }
00065
00066     __Iterator &operator ++ ()
00067     {
00068       _c = C::next(_c);
00069       return *this;
00070     }
00071
00072     __Iterator &operator -- ()
00073     {
00074       _c = C::prev(_c);
00075       return *this;
00076     }
00077
00078     Value_type operator * () const { return static_cast<Value_type>(_c); }
00079     Value_type operator -> () const { return static_cast<Value_type>(_c); }
00080
00081   protected:
00082     friend class D_list_cyclic;
00083
00084     explicit __Iterator(ITEM *s) : _c(s) {}
00085
00086     ITEM *_c;
00087   };
00088
00089 public:
00090   typedef T *Value_type;
00091   typedef T *value_type;
00092   typedef __Iterator<T, typename C::Item> Iterator;
00093   typedef Iterator Const_iterator;
00094
00095   static void remove(T *e)
00096   {
00097     C::next(C::prev(e)) = C::next(e);
00098     C::prev(C::next(e)) = C::prev(e);
00099     C::next(e) = nullptr;
00100   }
00101
00102   static Iterator erase(Iterator const &e)
00103   {
00104     typename C::Item *n = C::next(*e);
00105     remove(*e);
00106     return __iter(n);
00107   }
00108
00109   static Iterator iter(T const *e) { return Iterator(const_cast<T*>(e)); }
00110
00111   static bool in_list(T const *e) { return C::next(const_cast<T*>(e)); }
00112   static bool has_sibling(T const *e) { return C::next(const_cast<T*>(e)) != e; }
00113
00114   static Iterator insert_after(T *e, Iterator const &pos)
00115   {
00116     C::prev(e) = pos._c;
00117     C::next(e) = C::next(pos._c);
00118     C::prev(C::next(pos._c)) = e;
00119     C::next(pos._c) = e;
00120     return pos;
```

```
00121   }
00122
00123   static Iterator insert_before(T *e, Iterator const &pos)
00124   {
00125     C::next(e) = pos._c;
00126     C::prev(e) = C::prev(pos._c);
00127     C::next(C::prev(pos._c)) = e;
00128     C::prev(pos._c) = e;
00129     return pos;
00130   }
00131
00132 protected:
00133   static constexpr void self_insert(typename C::Item *e)
00134   { C::next(e) = C::prev(e) = e; }
00135
00136   static void remove_last(T *e)
00137   { C::next(e) = nullptr; }
00138
00145   static void splice_heads(Const_iterator pos, typename C::Item *other_list)
00146   {
00147     typename C::Item *ins_next = pos._c;
00148     typename C::Item *ins_prev = C::prev(pos._c);
00149     typename C::Item *other_head = C::next(other_list);
00150     typename C::Item *other_tail = C::prev(other_list);
00151
00152     C::next(ins_prev) = other_head;
00153     C::prev(other_head) = ins_prev;
00154     C::prev(ins_next) = other_tail;
00155     C::next(other_tail) = ins_next;
00156   }
00157
00158   static Iterator __iter(typename C::Item *e) { return Iterator(e); }
00159 };
00160
00161 template<
00162   typename T,
00163   typename C = D_list_item_policy,
00164   typename H = Sd_list_head_policy<T>,
00165   bool BSS = false
00166 >
00167 class Sd_list : public D_list_cyclic<T, C>
00168 {
00169 private:
00170   typedef D_list_cyclic<T, C> Base;
00171
00172 public:
00173   class Iterator : public Base::Iterator
00174   {
00175   public:
00176     Iterator &operator ++ () &
00177     {
00178       if (this->_c)
00179         Base::Iterator::operator ++ ();
00180
00181       if (this->_c == _h)
00182         this->_c = nullptr;
00183
00184       return *this;
00185     }
00186
00187     Iterator &operator -- () = delete;
00188
00189   private:
00190     friend class Sd_list;
00191
00192     explicit Iterator(T *h) : Base::Iterator(h), _h(h) {}
00193     typename C::Item *_h;
00194   };
00195
00196   class R_iterator : public Base::Iterator
00197   {
00198   public:
00199     R_iterator &operator ++ () &
00200     {
00201       if (this->_c)
00202         Base::Iterator::operator -- ();
00203
00204       if (this->_c == _h)
00205         this->_c = nullptr;
00206
00207       return *this;
00208     }
00209
00210     R_iterator &operator -- () = delete;
00211
00212   private:
00213     friend class Sd_list;
```

```
00214
00215     explicit R_iterator(T *h) : Base::Iterator(h), _h(h) {}
00216     typename C::Item *_h;
00217   };
00218
00219   //typedef typename Base::Iterator Iterator;
00220   enum Pos
00221   { Back, Front };
00222
00223   constexpr Sd_list()
00224   {
00225     if (!BSS)
00226       H::set_head(_f, nullptr);
00227   }
00228
00229   bool empty() const { return !H::head(_f); }
00230   T *front() const { return H::head(_f); }
00231
00232   void remove(T *e)
00233   {
00234     T *h = H::head(_f);
00235     if (e == C::next(e)) // must be the last
00236       {
00237         Base::remove_last(e);
00238         H::set_head(_f, nullptr);
00239         return;
00240       }
00241
00242     if (e == H::head(_f))
00243       H::set_head(_f, static_cast<T*>(C::next(h)));
00244
00245     Base::remove(e);
00246   }
00247
00248   Iterator erase(Iterator const &e)
00249   {
00250     Iterator next = e;
00251     ++next;
00252
00253     remove(*e);
00254     return next;
00255   }
00256
00257   void push(T *e, Pos pos)
00258   {
00259     T *h = H::head(_f);
00260     if (!h)
00261       {
00262         Base::self_insert(e);
00263         H::set_head(_f, e);
00264       }
00265     else
00266       {
00267         Base::insert_before(e, this->iter(h));
00268         if (pos == Front)
00269           H::set_head(_f, e);
00270       }
00271   }
00272
00273   void push_back(T *e) { push(e, Back); }
00274   void push_front(T *e) { push(e, Front); }
00275   void rotate_to(T *h) { H::set_head(_f, h); }
00276
00277   typename H::Head_type const &head() const & { return _f; }
00278   typename H::Head_type const &head() const && = delete;
00279   typename H::Head_type &head() & { return _f; }
00280
00281   Iterator begin() { return Iterator(H::head(_f)); }
00282   Iterator end() { return Iterator(nullptr); }
00283
00284   R_iterator rbegin()
00285   {
00286     if (head())
00287       return R_iterator(static_cast<T*>(C::prev(H::head(_f))));
00288     return R_iterator(nullptr);
00289   }
00290   R_iterator rend() { return R_iterator(nullptr); }
00291
00292 private:
00293   Sd_list(Sd_list const &);
00294   void operator = (Sd_list const &);
00295
00296   typename H::Head_type _f;
00297 };
00298
00299 template<
00300   typename T,
```

```
00301   typename C = D_list_item_policy,
00302   bool BSS = false
00303 >
00304 class D_list : public D_list_cyclic<T, C>
00305 {
00306 private:
00307   typedef D_list_cyclic<T, C> Base;
00308   typedef typename C::Item Internal_type;
00309
00310 public:
00311   enum Pos
00312   { Back, Front };
00313
00314   typedef typename Base::Iterator Iterator;
00315   typedef typename Base::Const_iterator Const_iterator;
00316   typedef T* value_type;
00317   typedef T* Value_type;
00318
00319   constexpr D_list() { this->self_insert(&_h); }
00320   ~D_list() { clear(); }
00321
00322   D_list(D_list &&o)
00323   {
00324     if (o.empty())
00325       {
00326         this->self_insert(&_h);
00327       }
00328     else
00329       {
00330         Internal_type *p = C::prev(&o._h);
00331         Internal_type *n = C::next(&o._h);
00332         C::prev(&_h) = p;
00333         C::next(&_h) = n;
00334         C::next(p) = &_h;
00335         C::prev(n) = &_h;
00336         o.self_insert(&o._h);
00337       }
00338   }
00339
00340   D_list &operator=(D_list &&o)
00341   {
00342     if (&o == this)
00343       return *this;
00344
00345     clear();
00346
00347     if (!o.empty())
00348       {
00349         Internal_type *p = C::prev(&o._h);
00350         Internal_type *n = C::next(&o._h);
00351         C::prev(&_h) = p;
00352         C::next(&_h) = n;
00353         C::next(p) = &_h;
00354         C::prev(n) = &_h;
00355         o.self_insert(&o._h);
00356       }
00357
00358     return *this;
00359   }
00360
00361   D_list(D_list const &) = delete;
00362   void operator = (D_list const &) = delete;
00363
00364   void splice(Const_iterator pos, D_list &&other)
00365   {
00366     if (other.empty())
00367       return;
00368
00369     Base::splice_heads(pos, &other._h);
00370     other.self_insert(&other._h);
00371   }
00372
00373   bool empty() const { return C::next(&_h) == &_h; }
00374
00375   static void remove(T *e) { Base::remove(e); }
00376   Iterator erase(Iterator const &e) { return Base::erase(e); }
00377
00378   void clear()
00379   {
00380     // Just clear the _dli_next pointers of all elements. It is the indicator
00381     // that an element is not on a list.
00382     Internal_type *i = C::next(&_h);
00383     while (i != &_h)
00384       {
00385         Internal_type *d = i;
00386         i = C::next(i);
00387         C::next(d) = nullptr;
```

```
00388       }
00389
00390     this->self_insert(&_h);
00391   }
00392
00393   void push(T *e, Pos pos)
00394   {
00395     if (pos == Front)
00396       Base::insert_after(e, end());
00397     else
00398       Base::insert_before(e, end());
00399   }
00400
00401   void push_back(T *e) { push(e, Back); }
00402   void push_front(T *e) { push(e, Front); }
00403
00409   T *pop_back()
00410   {
00411     Iterator i = end();
00412     --i;
00413     T *ret = *i;
00414     remove(ret);
00415     return ret;
00416   }
00417
00423   T *pop_front()
00424   {
00425     T *ret = *begin();
00426     remove(ret);
00427     return ret;
00428   }
00429
00430   Iterator begin() const { return this->__iter(C::next(const_cast<Internal_type *>(&_h))); }
00431   Iterator end() const { return this->__iter(const_cast<Internal_type *>(&_h)); }
00432
00433   bool has_sibling(T const *e)
00434   {
00435     return C::next(const_cast<T*>(e)) != &_h
00436       || C::prev(const_cast<T*>(e)) != &_h;
00437   }
00438
00439 private:
00440   Internal_type _h;
00441 };
00442
00443 }
00444
```

16.200 elide_dtor

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2026 Kernkonzept GmbH.
00004  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/cxx/type_traits>
00012 #include <stddef.h>
00013
00014 namespace cxx {
00015
00027 template< typename T >
00028 class Elide_dtor
00029 {
00030 private:
00031   // Small helper struct so that we don't have to define a global operator new.
00032   struct X : T
00033   {
00034     constexpr void *operator new (size_t, void *p) noexcept { return p; }
00035     constexpr void operator delete (void *) {}
00036
00037     constexpr X() = default;
00038
00039     template<typename ...Args>
00040     constexpr X(Args && ...a) : T(cxx::forward<Args>(a)...) {}
00041
00042     constexpr X(T const &o) : T(o) {}
00043
00044     constexpr X(T &&o) : T(cxx::move(o)) {}
00045   };
```

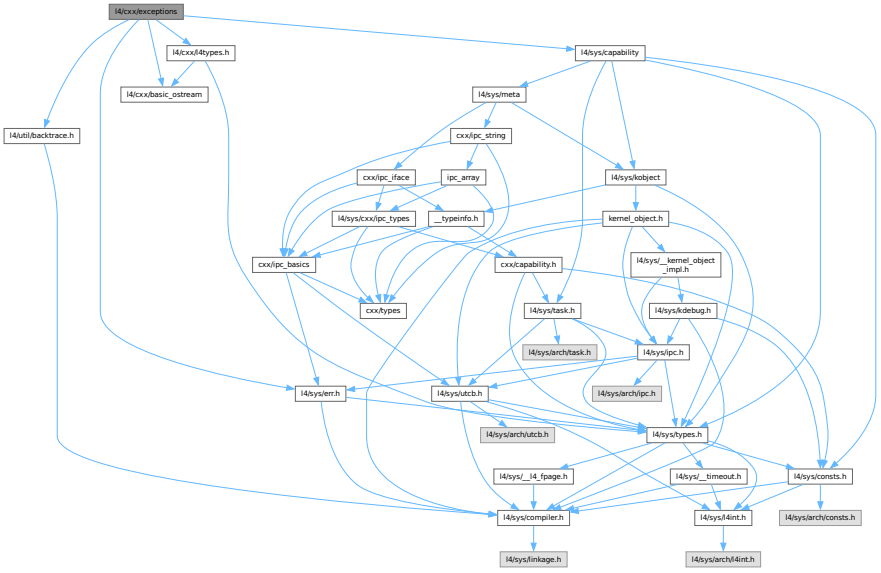
```
00046
00047 public:
00048   template< typename ...Args >
00049   explicit constexpr Elide_dtor(Args && ...args)
00050   { new (_s) X(cxx::forward<Args>(args)...); }
00051
00052   explicit constexpr Elide_dtor(T const &o)
00053   { new (_s) X(o); }
00054
00055   explicit constexpr Elide_dtor(T &&o)
00056   { new (_s) X(cxx::move(o)); }
00057
00058   Elide_dtor(Elide_dtor const &) = delete;
00059   Elide_dtor(Elide_dtor &&) = delete;
00060
00061   ~Elide_dtor() = default;
00062
00063         T *operator -> ()       { return get(); }
00064   const T *operator -> () const { return get(); }
00065
00066         T *operator & ()        { return get(); }
00067   const T *operator & () const { return get(); }
00068
00069 private:
00070         T *get()        { return reinterpret_cast<X       *>(_s); }
00071   const T *get() const { return reinterpret_cast<X const *>(_s); }
00072
00073   alignas(X) char _s[sizeof(X)];
00074 };
00075
00076 }
```

16.201 l4/cxx/exceptions File Reference

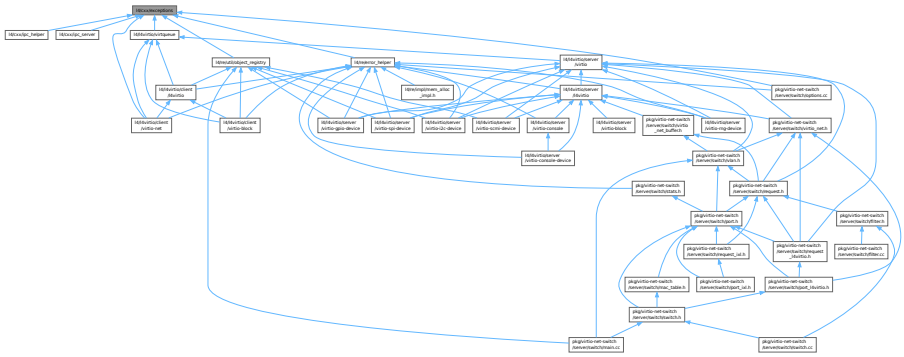
Base exceptions.

```
#include <l4/cxx/l4types.h>
#include <l4/cxx/basic_ostream>
#include <l4/sys/err.h>
#include <l4/sys/capability>
#include <l4/util/backtrace.h>
```

Include dependency graph for exceptions:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Exception_tracer

  Back-trace support for exceptions.
- class L4::Base_exception

  Base class for all exceptions, thrown by the L4Re framework.
- class L4::Runtime_error

  Exception for an abstract runtime error.
- class L4::Out_of_memory

  Exception signalling insufficient memory.
- class L4::Element_already_exists

  Exception for duplicate element insertions.
- class L4::Unknown_error

  Exception for an unknown condition.
- class L4::Element_not_found

  Exception for a failed lookup (element not found).
- class L4::Invalid_capability

  Indicates that an invalid object was invoked.
- class L4::Com_error

  Error conditions during IPC.
- class L4::Bounds_error

  Access out of bounds.

Namespaces

- namespace L4

  L4 low-level kernel interface.

Macros

- #define **L4_CXX_EXCEPTION_BACKTRACE** 20

  Number of instruction pointers in backtrace.

16.201.1 Detailed Description

Base exceptions.
Definition in file exceptions.

16.202 exceptions

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/cxx/l4types.h>
00017 #include <l4/cxx/basic_ostream>
00018 #include <l4/sys/err.h>
00019 #include <l4/sys/capability>
00020
00021
00027
00028 #ifndef L4_CXX_NO_EXCEPTION_BACKTRACE
00029 # define L4_CXX_EXCEPTION_BACKTRACE 20
00030 #endif
00031
00032 #if defined(L4_CXX_EXCEPTION_BACKTRACE)
00033 #include <l4/util/backtrace.h>
00034 #endif
00035
00037 namespace L4
00038 {
00051   class Exception_tracer
00052   {
00053 #if defined(L4_CXX_EXCEPTION_BACKTRACE)
00054   private:
00055     void *_pc_array[L4_CXX_EXCEPTION_BACKTRACE];
00056     int   _frame_cnt;
00057
00058   protected:
00062 #if defined(__PIC__)
00063     Exception_tracer() noexcept : _frame_cnt(0) {}
00064 #else
00065     Exception_tracer() noexcept
00066     : _frame_cnt(l4util_backtrace(_pc_array, L4_CXX_EXCEPTION_BACKTRACE)) {}
00067 #endif
00068
00069   public:
00073     void const *const *pc_array() const noexcept { return _pc_array; }
00077     int frame_count() const noexcept { return _frame_cnt; }
00078 #else
00079   protected:
00083     Exception_tracer() noexcept {}
00084
00085   public:
00089     void const *const *pc_array() const noexcept { return 0; }
00093     int frame_count() const noexcept { return 0; }
00094 #endif
00095   };
00096
00105   class Base_exception : public Exception_tracer
00106   {
00107   protected:
00109     Base_exception() noexcept {}
00110
00111   public:
00115     virtual char const *str() const noexcept = 0;
00116
00118     virtual ~Base_exception() noexcept {}
00119   };
00120
00128   class Runtime_error : public Base_exception
00129   {
00130   private:
00131     long _errno;
00132     char _extra[80];
00133
00134   public:
00141     explicit Runtime_error(long err_no, char const *extra = 0) noexcept
00142       : _errno(err_no)
00143     {
00144       if (!extra)
00145         _extra[0] = 0;
00146       else
00147         {
00148           unsigned i = 0;
00149           for (; i < sizeof(_extra) && extra[i]; ++i)
00150             _extra[i] = extra[i];
```

```
00151           _extra[i < sizeof(_extra) ? i : sizeof(_extra) - 1] = 0;
00152         }
00153     }
00154     char const *str() const noexcept override
00155     { return l4sys_errtostr(_errno); }
00156
00162     char const *extra_str() const { return _extra; }
00163     ~Runtime_error() noexcept {}
00164
00170     long err_no() const noexcept { return _errno; }
00171   };
00172
00177   class Out_of_memory : public Runtime_error
00178   {
00179   public:
00181     explicit Out_of_memory(char const *extra = "") noexcept
00182     : Runtime_error(-L4_ENOMEM, extra) {}
00184     ~Out_of_memory() noexcept {}
00185   };
00186
00187
00192   class Element_already_exists : public Runtime_error
00193   {
00194   public:
00195     explicit Element_already_exists(char const *e = "") noexcept
00196     : Runtime_error(-L4_EEXIST, e) {}
00197     ~Element_already_exists() noexcept {}
00198   };
00199
00208   class Unknown_error : public Base_exception
00209   {
00210   public:
00211     Unknown_error() noexcept {}
00212     char const *str() const noexcept override { return "unknown error"; }
00213     ~Unknown_error() noexcept {}
00214   };
00215
00220   class Element_not_found : public Runtime_error
00221   {
00222   public:
00223     explicit Element_not_found(char const *e = "") noexcept
00224     : Runtime_error(-L4_ENOENT, e) {}
00225   };
00226
00234   class Invalid_capability : public Base_exception
00235   {
00236   private:
00237     Cap<void> const _o;
00238
00239   public:
00244     explicit Invalid_capability(Cap<void> const &o) noexcept : _o(o) {}
00245     template< typename T>
00246     explicit Invalid_capability(Cap<T> const &o) noexcept : _o(o.cap()) {}
00247     char const *str() const noexcept override { return "invalid object"; }
00248
00253     Cap<void> const &cap() const noexcept { return _o; }
00254     ~Invalid_capability() noexcept {}
00255   };
00256
00263   class Com_error : public Runtime_error
00264   {
00265   public:
00270     explicit Com_error(long err) noexcept : Runtime_error(err) {}
00271
00272     ~Com_error() noexcept {}
00273   };
00274
00278   class Bounds_error : public Runtime_error
00279   {
00280   public:
00281     explicit Bounds_error(char const *e = "") noexcept
00282     : Runtime_error(-L4_ERANGE, e) {}
00283     ~Bounds_error() noexcept {}
00284   };
00286 };
00287
00288 inline
00289 L4::BasicOStream &
00290 operator « (L4::BasicOStream &o, L4::Base_exception const &e)
00291 {
00292   o « "Exception: " « e.str() « ".\n";
00293   if (e.frame_count())
00294     {
00295       o « "Backtrace:\n";
00296       for (int i = 0; i < e.frame_count(); ++i)
00297         o « "  " « L4::n_hex(l4_addr_t(e.pc_array()[i])) « '\n';
00298     }
```

```
00299
00300   return o;
00301 }
00302
00303 inline
00304 L4::BasicOStream &
00305 operator « (L4::BasicOStream &o, L4::Runtime_error const &e)
00306 {
00307   o « "Exception: " « e.str();
00308   if (e.extra_str() && e.extra_str()[0])
00309     o « ": " « e.extra_str();
00310   o « ".\n";
00311   if (e.frame_count())
00312     {
00313       o « "Backtrace:\n";
00314       for (int i = 0; i < e.frame_count(); ++i)
00315         o « "  " « L4::n_hex(l4_addr_t(e.pc_array()[i])) « '\n';
00316     }
00317
00318   return o;
00319 }
```

16.203 hlist

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2011 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include "bits/list_basics.h"
00012 #include "type_traits"
00013
00014 namespace cxx {
00015
00021 template<typename ELEM_TYPE>
00022 class H_list_item_t
00023 {
00024 public:
00030   constexpr H_list_item_t() : _n(nullptr), _pn(nullptr) {}
00037   ~H_list_item_t() noexcept { l_remove(); }
00038
00039 private:
00040   H_list_item_t(H_list_item_t const &) = delete;
00041
00042   template<typename T, typename P> friend class H_list;
00043   template<typename T, typename X> friend struct Bits::Basic_list_policy;
00044
00045   void l_remove() noexcept
00046   {
00047     if (!_pn)
00048       return;
00049
00050     *_pn = _n;
00051     if (_n)
00052       _n->_pn = _pn;
00053
00054     _pn = nullptr;
00055   }
00056
00057   H_list_item_t *_n, **_pn;
00058 };
00059
00061 typedef H_list_item_t<void> H_list_item;
00062
00068 template< typename T, typename POLICY = Bits::Basic_list_policy< T, H_list_item> >
00069 class H_list : public Bits::Basic_list<POLICY>
00070 {
00071 private:
00072   typedef typename POLICY::Item_type Item;
00073   typedef Bits::Basic_list<POLICY> Base;
00074   H_list(H_list const &);
00075   void operator = (H_list const &);
00076
00077 public:
00078   typedef typename Base::Iterator Iterator;
00079
00080   // BSS allocation
00081   explicit H_list(bool x) : Base(x) {}
00082   constexpr H_list() : Base() {}
```

```
00083
00093   static Iterator iter(T *c) { return Base::__iter(c->Item::_pn); }
00094
00096   static bool in_list(T const *e) { return e->Item::_pn; }
00097
00099   void add(T *e)
00100   {
00101     if (this->_f)
00102       this->_f->_pn = &e->Item::_n;
00103     e->Item::_n = this->_f;
00104     e->Item::_pn = &this->_f;
00105     this->_f = static_cast<Item*>(e);
00106   }
00107
00109   void push_front(T *e) { add(e); }
00110
00116   T *pop_front()
00117   {
00118     T *r = this->front();
00119     remove(r);
00120     return r;
00121   }
00122
00133   Iterator insert(T *e, Iterator const &pred)
00134   {
00135     Item **x = &this->_f;
00136     if (pred != Base::end())
00137       x = &(*pred)->_n;
00138
00139     e->Item::_n = *x;
00140
00141     if (*x)
00142       (*x)->_pn = &(e->Item::_n);
00143
00144     e->Item::_pn = x;
00145     *x = static_cast<Item*>(e);
00146     return iter(e);
00147   }
00148
00160   static Iterator insert_after(T *e, Iterator const &pred)
00161   {
00162     Item **x = &(*pred)->_n;
00163     e->Item::_n = *x;
00164
00165     if (*x)
00166       (*x)->_pn = &(e->Item::_n);
00167
00168     e->Item::_pn = x;
00169     *x = static_cast<Item*>(e);
00170     return iter(e);
00171   }
00172
00180   static void insert_before(T *e, Iterator const &succ)
00181   {
00182     Item **x = Base::__get_internal(succ);
00183
00184     e->Item::_n = *x;
00185     e->Item::_pn = x;
00186
00187     if (*x)
00188       (*x)->_pn = &e->Item::_n;
00189
00190     *x = static_cast<Item*>(e);
00191   }
00192
00204   static void replace(T *p, T *e)
00205   {
00206     e->Item::_n = p->Item::_n;
00207     e->Item::_pn = p->Item::_pn;
00208     *(p->Item::_pn) = static_cast<Item*>(e);
00209     if (e->Item::_n)
00210       e->Item::_n->_pn = &(e->Item::_n);
00211
00212     p->Item::_pn = nullptr;
00213   }
00214
00220   static void remove(T *e)
00221   { e->Item::l_remove(); }
00222
00236   static Iterator erase(Iterator const &e)
00237   { e->Item::l_remove(); return e; }
00238 };
00239
00247 template< typename T >
00248 struct H_list_t : H_list<T, Bits::Basic_list_policy< T, H_list_item_t<T> > >
00249 {
00250   H_list_t() = default;
```

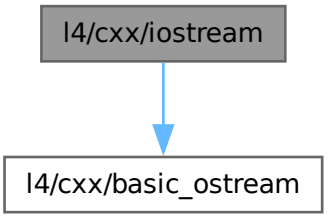
```
00251   H_list_t(bool b)
00252   : H_list<T, Bits::Basic_list_policy< T, H_list_item_t<T> > >(b)
00253   {};
00254 };
00255
00256 template< typename T >
00257 class H_list_bss : public H_list<T>
00258 {
00259 public:
00260   H_list_bss() : H_list<T>(true) {}
00261 };
00262
00263 template< typename T >
00264 class H_list_t_bss : public H_list_t<T>
00265 {
00266 public:
00267   H_list_t_bss() : H_list_t<T>(true) {}
00268 };
00269
00270
00271 }
```

16.204 l4/cxx/iostream File Reference

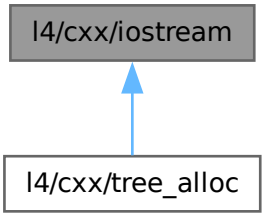
IO Stream.

`#include <l4/cxx/basic_ostream>`

Include dependency graph for iostream:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4

  L4 low-level kernel interface.

Variables

- BasicOStream **L4::cout**

  Standard output stream.
- BasicOStream **L4::cerr**

  Standard error stream.

16.204.1 Detailed Description

IO Stream.
Definition in file iostream.

16.205 iostream

Go to the documentation of this file.

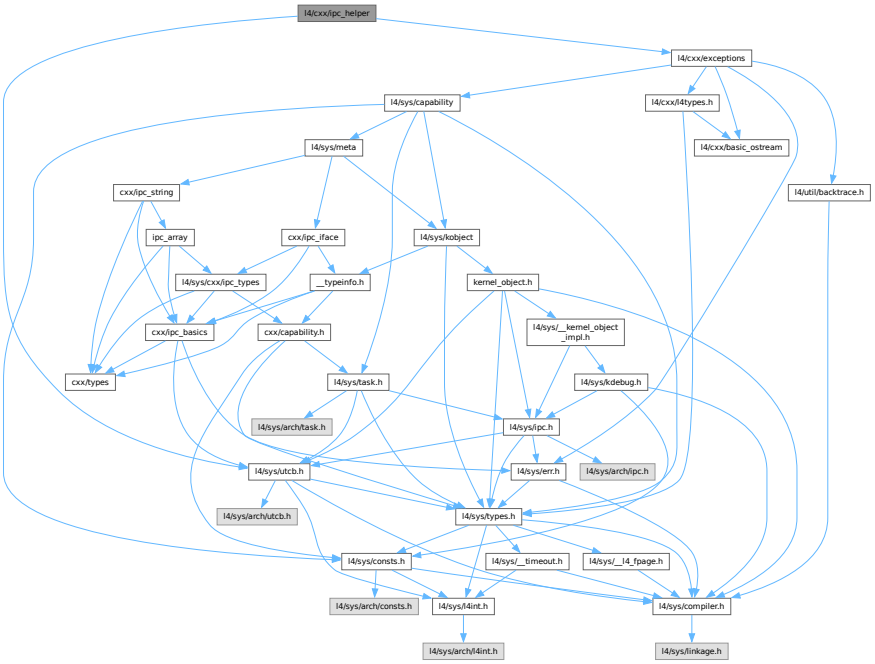
```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2004-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/cxx/basic_ostream>
00017
00018 namespace L4 {
00019
00023   extern BasicOStream cout;
00024
00028   extern BasicOStream cerr;
00029
00030   extern void iostream_init();
00031
00032   static void  __attribute__((used, constructor)) __iostream_init()
00033   { iostream_init(); }
00034 };
```

16.206 l4/cxx/ipc_helper File Reference

IPC helper.

```
#include <l4/cxx/exceptions>
#include <l4/sys/utcb.h>
```

Include dependency graph for ipc_helper:



Namespaces

- namespace L4

  L4 low-level kernel interface.

Functions

- void L4::throw_ipc_exception (L4::Cap< void > const &o, l4_msgtag_t const &err, l4_utcb_t *utcb)

  Throw an L4 IPC error as exception.
- void L4::throw_ipc_exception (void const *o, l4_msgtag_t const &err, l4_utcb_t *utcb)

  Throw an L4 IPC error as exception.

16.206.1 Detailed Description

IPC helper.
Definition in file ipc_helper.

16.207 ipc_helper

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/cxx/exceptions>
00016 #include <l4/sys/utcb.h>
00017
00021
00022 namespace L4
```

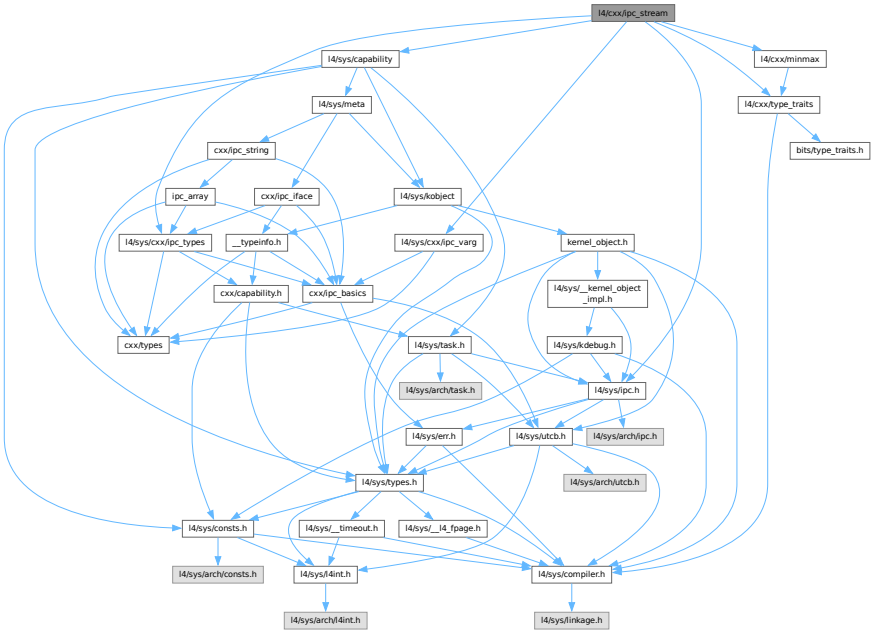
```
00023 {
00024 #ifdef __EXCEPTIONS
00033   inline void
00034   throw_ipc_exception([[maybe_unused]] L4::Cap<void> const &o,
00035                       l4_msgtag_t const &err, l4_utcb_t *utcb)
00036   {
00037     if (err.has_error())
00038       throw (L4::Com_error(l4_error_u(err, utcb)));
00039   }
00040
00049   inline void
00050   throw_ipc_exception(void const *o, l4_msgtag_t const &err,
00051                       l4_utcb_t *utcb)
00052   { throw_ipc_exception(L4::Cap<void>(o), err, utcb); }
00053 #endif
00054
00055 }
```

16.208 l4/cxx/ipc_stream File Reference

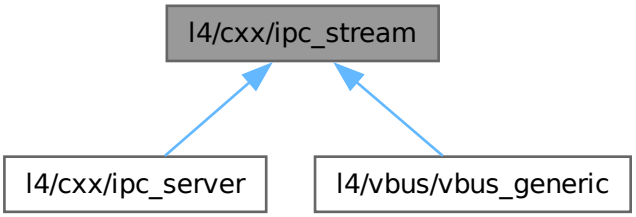
IPC stream.

```
#include <l4/sys/ipc.h>
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/cxx/ipc_varg>
#include <l4/cxx/type_traits>
#include <l4/cxx/minmax>
```

Include dependency graph for ipc_stream:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Ipc::Str_cp_in< T >

  Abstraction for extracting a zero-terminated string from an Ipc::Istream.
- class L4::Ipc::Msg_ptr< T >

  Pointer to an element of type T in an Ipc::Istream.
- class L4::Ipc::Istream

  Input stream for IPC unmarshalling.
- class L4::Ipc::Ostream

  Output stream for IPC marshalling.
- class L4::Ipc::Iostream

  Input/Output stream for IPC [un]marshalling.

Namespaces

- namespace L4

  L4 low-level kernel interface.
- namespace L4::Ipc

  IPC related functionality.

Functions

- template<typename T>
  Internal::Buf_cp_out< T > L4::Ipc::buf_cp_out (T const *v, unsigned long size)

  Insert an array into an Ipc::Ostream.
- template<typename T>
  Internal::Buf_cp_in< T > L4::Ipc::buf_cp_in (T *v, unsigned long &size)

  Extract an array from an Ipc::Istream.
- template<typename T>
  Str_cp_in< T > L4::Ipc::str_cp_in (T *v, unsigned long &size)

  Create a Str_cp_in for the given values.
- template<typename T>
  Msg_ptr< T > L4::Ipc::msg_ptr (T *&p)

  Create an Msg_ptr to adjust the given pointer.
- template<typename T>
  Internal::Buf_in< T > L4::Ipc::buf_in (T *&v, unsigned long &size)

  Return a pointer to stream array data.
- L4::Ipc::Istream & operator>> (L4::Ipc::Istream &s, bool &v)

Extract one element of type T from the stream s.

- L4::Ipc::Istream & operator>> (L4::Ipc::Istream &s, l4_msgtag_t &v)

  Extract the L4 message tag from the stream s.

- template<typename T>
  L4::Ipc::Istream & operator>> (L4::Ipc::Istream &s, L4::Ipc::Internal::Buf_in< T > const &v)

  Extract an array of T elements from the stream s.

- template<typename T>
  L4::Ipc::Istream & operator>> (L4::Ipc::Istream &s, L4::Ipc::Msg_ptr< T > const &v)

  Extract an element of type T from the stream s.

- template<typename T>
  L4::Ipc::Istream & operator>> (L4::Ipc::Istream &s, L4::Ipc::Internal::Buf_cp_in< T > const &v)

  Extract an array of T elements from the stream s.

- template<typename T>
  L4::Ipc::Istream & operator>> (L4::Ipc::Istream &s, L4::Ipc::Str_cp_in< T > const &v)

  Extract a zero-terminated string from the stream.

- L4::Ipc::Ostream & operator<< (L4::Ipc::Ostream &s, bool v)

  Insert an element to type T into the stream s.

- L4::Ipc::Ostream & operator<< (L4::Ipc::Ostream &s, l4_msgtag_t const &v)

  Insert the L4 message tag into the stream s.

- template<typename T>
  L4::Ipc::Ostream & operator<< (L4::Ipc::Ostream &s, L4::Ipc::Internal::Buf_cp_out< T > const &v)

  Insert an array with elements of type T into the stream s.

- L4::Ipc::Ostream & operator<< (L4::Ipc::Ostream &s, char const *v)

  Insert a zero terminated character string into the stream s.

- template<typename T>
  T L4::Ipc::read (Istream &s)

  Read a value out of a stream.

16.208.1 Detailed Description

IPC stream.
Definition in file ipc_stream.

16.208.2 Function Documentation

16.208.2.1 operator<<() [1/4]

```
L4::Ipc::Ostream & operator<< (
            L4::Ipc::Ostream & s,
            bool v)  [inline]
```

Insert an element to type T into the stream s.

Parameters

s	The stream to insert the element v.
v	The element to insert.

Returns

The stream `s`.

Definition at line 1197 of file ipc_stream.
References L4::Ipc::Ostream::put().
Here is the call graph for this function:



16.208.2.2 operator<<() [2/4]

```
L4::Ipc::Ostream & operator<< (
            L4::Ipc::Ostream & s,
            char const * v)  [inline]
```

Insert a zero terminated character string into the stream `s`.

Parameters

s	The stream to insert the string `v`.
v	The string to insert.

Returns

The stream `s`.

This operator produces basically the same content as the array insertion, however the length of the array is calculated using `strlen(v) + 1` The string is copied into the message including the trailing zero.
Definition at line 1269 of file ipc_stream.
References L4::Ipc::Ostream::put().
Here is the call graph for this function:



16.208.2.3 operator<<() [3/4]

```
template<typename T>
L4::Ipc::Ostream & operator<< (
            L4::Ipc::Ostream & s,
            L4::Ipc::Internal::Buf_cp_out< T > const & v)  [inline]
```

Insert an array with elements of type T into the stream s.

Parameters

s	The stream to insert the array v.
v	The array to insert (see Ipc::Buf_cp_out()).

Returns

The stream s.

Definition at line 1248 of file ipc_stream.
References L4::Ipc::Ostream::put().
Here is the call graph for this function:



16.208.2.4 operator<<() [4/4]

```
L4::Ipc::Ostream & operator<< (
            L4::Ipc::Ostream & s,
            l4_msgtag_t const & v)  [inline]
```

Insert the L4 message tag into the stream s.

Parameters

s	The stream to insert the tag v.
v	The L4 message tag to insert.

Returns

The stream s.

Note

Only one message tag can be inserted into a stream. Multiple insertions simply overwrite previous insertions.

Definition at line 1232 of file ipc_stream.
References L4::Ipc::Ostream::tag().
Here is the call graph for this function:



16.208.2.5 operator>>() [1/6]

```
L4::Ipc::Istream & operator>> (
            L4::Ipc::Istream & s,
            bool & v)  [inline]
```

Extract one element of type T from the stream s.

Parameters

	s	The stream to extract from.
out	*v*	Extracted value.

Returns

The stream s.

Definition at line 1044 of file ipc_stream.
References L4::Ipc::Istream::get().
Here is the call graph for this function:



16.208.2.6 operator>>() [2/6]

```
template<typename T>
L4::Ipc::Istream & operator>> (
            L4::Ipc::Istream & s,
            L4::Ipc::Internal::Buf_cp_in< T > const & v)  [inline]
```

Extract an array of T elements from the stream s.

Parameters

	s	The stream to extract from.
out	*v*	Buffer description to copy the array to (Ipc::Buf_cp_out()).

Returns

The stream `s`.

This operator does a copy out of the data into the given buffer.
See Ipc::Buf_in, Ipc::Buf_cp_in, and Ipc::Buf_cp_out.
Definition at line 1151 of file ipc_stream.
References L4::Ipc::Istream::get().
Here is the call graph for this function:



16.208.2.7 operator>>() [3/6]

```
template<typename T>
L4::Ipc::Istream & operator>> (
            L4::Ipc::Istream & s,
            L4::Ipc::Internal::Buf_in< T > const & v)  [inline]
```

Extract an array of `T` elements from the stream `s`.

Parameters

	s	The stream to extract from.
out	*v*	Pointer to the extracted array (ipc_buf_in()).

Returns

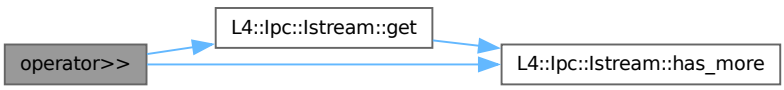
The stream `s`.

This operator actually does not copy out the data in the array, but returns a pointer into the message buffer itself. This means that the data is only valid as long as there is no new data inserted into the stream.

Note

If array does not fit into transmitted words size will be set to zero. Client has to implement check against zero.

See Ipc::Buf_in, Ipc::Buf_cp_in, and Ipc::Buf_cp_out.
Definition at line 1103 of file ipc_stream.
References L4::Ipc::Istream::get(), and L4::Ipc::Istream::has_more().
Here is the call graph for this function:



16.208.2.8 operator>>() [4/6]

```
template<typename T>
L4::Ipc::Istream & operator>> (
            L4::Ipc::Istream & s,
            L4::Ipc::Msg_ptr< T > const & v)  [inline]
```

Extract an element of type T from the stream s.

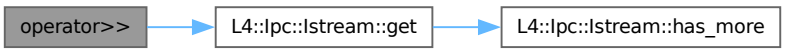
Parameters

	s	The stream to extract from.
out	*v*	Pointer to the extracted element.

Returns

The stream s.

This operator actually does not copy out the data, but returns a pointer into the message buffer itself. This means that the data is only valid as long as there is no new data inserted into the stream.
See Msg_ptr.
Definition at line 1130 of file ipc_stream.
References L4::Ipc::Istream::get().
Here is the call graph for this function:



16.208.2.9 operator>>() [5/6]

```
template<typename T>
L4::Ipc::Istream & operator>> (
            L4::Ipc::Istream & s,
            L4::Ipc::Str_cp_in< T > const & v)  [inline]
```

Extract a zero-terminated string from the stream.

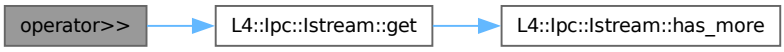
Parameters

	s	The stream to extract from.
out	*v*	Buffer description to copy the array to (Ipc::Str_cp_out()).

Returns

The stream `s`.

This operator does a copy out of the data into the given buffer.
Definition at line 1172 of file ipc_stream.
References L4::Ipc::Istream::get().
Here is the call graph for this function:



16.208.2.10 operator>>() [6/6]

```
L4::Ipc::Istream & operator>> (
            L4::Ipc::Istream & s,
            l4_msgtag_t & v)  [inline]
```

Extract the L4 message tag from the stream `s`.

Parameters

	s	The stream to extract from.
out	*v*	The extracted tag.

Returns

The stream `s`.

Definition at line 1078 of file ipc_stream.
References L4::Ipc::Istream::tag().
Here is the call graph for this function:



16.209 ipc_stream

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
```

```
00014 #pragma once
00015
00016 #include <l4/sys/ipc.h>
00017 #include <l4/sys/capability>
00018 #include <l4/sys/cxx/ipc_types>
00019 #include <l4/sys/cxx/ipc_varg>
00020 #include <l4/cxx/type_traits>
00021 #include <l4/cxx/minmax>
00022
00023 namespace L4 {
00024 namespace Ipc {
00025
00026 class Ostream;
00027 class Istream;
00028
00029 namespace Internal {
00047 template< typename T >
00048 class Buf_cp_out
00049 {
00050 public:
00057   Buf_cp_out(T const *v, unsigned long size) : _v(v), _s(size) {}
00058
00066   unsigned long size() const { return _s; }
00067
00075   T const *buf() const { return _v; }
00076
00077 private:
00078   friend class Ostream;
00079   T const *_v;
00080   unsigned long _s;
00081 };
00082 }
00083
00099 template< typename T >
00100 Internal::Buf_cp_out<T> buf_cp_out(T const *v, unsigned long size)
00101 { return Internal::Buf_cp_out<T>(v, size); }
00102
00103
00104 namespace Internal {
00117 template< typename T >
00118 class Buf_cp_in
00119 {
00120 public:
00129   Buf_cp_in(T *v, unsigned long &size) : _v(v), _s(&size) {}
00130
00131   unsigned long &size() const { return *_s; }
00132   T *buf() const { return _v; }
00133
00134 private:
00135   friend class Istream;
00136   T *_v;
00137   unsigned long *_s;
00138 };
00139 }
00140
00158 template< typename T >
00159 Internal::Buf_cp_in<T> buf_cp_in(T *v, unsigned long &size)
00160 { return Internal::Buf_cp_in<T>(v, size); }
00161
00177 template< typename T >
00178 class Str_cp_in
00179 {
00180 public:
00189   Str_cp_in(T *v, unsigned long &size) : _v(v), _s(&size) {}
00190
00191   unsigned long &size() const { return *_s; }
00192   T *buf() const { return _v; }
00193
00194 private:
00195   friend class Istream;
00196   T *_v;
00197   unsigned long *_s;
00198 };
00199
00212 template< typename T >
00213 Str_cp_in<T> str_cp_in(T *v, unsigned long &size)
00214 { return Str_cp_in<T>(v, size); }
00215
00228 template< typename T >
00229 class Msg_ptr
00230 {
00231 private:
00232   T **_p;
00233 public:
00240   explicit Msg_ptr(T *&p) : _p(&p) {}
00241   void set(T *p) const { *_p = p; }
00242 };
```

```
00243
00251 template< typename T >
00252 Msg_ptr<T> msg_ptr(T *&p)
00253 { return Msg_ptr<T>(p); }
00254
00255
00256 namespace Internal {
00270 template< typename T >
00271 class Buf_in
00272 {
00273 public:
00280   Buf_in(T *&v, unsigned long &size) : _v(&v), _s(&size) {}
00281
00282   void set_size(unsigned long s) const { *_s = s; }
00283   T *&buf() const { return *_v; }
00284
00285 private:
00286   friend class Istream;
00287   T **_v;
00288   unsigned long *_s;
00289 };
00290 }
00291
00309 template< typename T >
00310 Internal::Buf_in<T> buf_in(T *&v, unsigned long &size)
00311 { return Internal::Buf_in<T>(v, size); }
00312
00313 namespace Utcb_stream_check
00314 {
00315   static bool check_utcb_data_offset(unsigned sz)
00316   { return sz > sizeof(l4_umword_t) * L4_UTCB_GENERIC_DATA_SIZE; }
00317 }
00318
00319
00334 class Istream
00335 {
00336 public:
00348   Istream(l4_utcb_t *utcb)
00349   : _tag(), _utcb(utcb),
00350     _current_msg(reinterpret_cast<char*>(l4_utcb_mr_u(utcb)->mr)),
00351     _pos(0), _current_buf(0)
00352   {}
00353
00358   void reset()
00359   {
00360     _pos = 0;
00361     _current_buf = 0;
00362     _current_msg = reinterpret_cast<char*>(l4_utcb_mr_u(_utcb)->mr);
00363   }
00364
00368   template< typename T >
00369   bool has_more(unsigned long count = 1)
00370   {
00371     auto const max_bytes = L4_UTCB_GENERIC_DATA_SIZE * sizeof(l4_umword_t);
00372     unsigned apos = cxx::Type_traits<T>::align(_pos);
00373     return (count <= max_bytes / sizeof(T))
00374            && (apos + (sizeof(T) * count)
00375                <= _tag.words() * sizeof(l4_umword_t));
00376   }
00377
00382
00393   template< typename T >
00394   unsigned long get(T *buf, unsigned long elems)
00395   {
00396     if (L4_UNLIKELY(!has_more<T>(elems)))
00397       return 0;
00398
00399     unsigned long size = elems * sizeof(T);
00400     _pos = cxx::Type_traits<T>::align(_pos);
00401
00402     __builtin_memcpy(buf, _current_msg + _pos, size);
00403     _pos += size;
00404     return elems;
00405   }
00406
00407
00413   template< typename T >
00414   void skip(unsigned long elems)
00415   {
00416     if (L4_UNLIKELY(!has_more<T>(elems)))
00417       return;
00418
00419     unsigned long size = elems * sizeof(T);
00420     _pos = cxx::Type_traits<T>::align(_pos);
00421     _pos += size;
00422   }
00423
```

```
00438   template< typename T >
00439   unsigned long get(Msg_ptr<T> const &buf, unsigned long elems = 1)
00440   {
00441     if (L4_UNLIKELY(!has_more<T>(elems)))
00442       return 0;
00443
00444     unsigned long size = elems * sizeof(T);
00445     _pos = cxx::Type_traits<T>::align(_pos);
00446
00447     buf.set(reinterpret_cast<T*>(_current_msg + _pos));
00448     _pos += size;
00449     return elems;
00450   }
00451
00452
00463   template< typename T >
00464   bool get(T &v)
00465   {
00466     if (L4_UNLIKELY(!has_more<T>()))
00467       {
00468         v = T();
00469         return false;
00470       }
00471
00472     _pos = cxx::Type_traits<T>::align(_pos);
00473     v = *(reinterpret_cast<T*>(_current_msg + _pos));
00474     _pos += sizeof(T);
00475     return true;
00476   }
00477
00478
00479   bool get(Ipc::Varg *va)
00480   {
00481     Ipc::Varg::Tag t;
00482     if (!has_more<Ipc::Varg::Tag>())
00483       {
00484         va->tag(0);
00485   return 0;
00486       }
00487     get(t);
00488     va->tag(t);
00489     char const *d;
00490     get(msg_ptr(d), va->length());
00491     va->data(d);
00492
00493     return 1;
00494   }
00495
00505   l4_msgtag_t tag() const { return _tag; }
00506
00507
00517   l4_msgtag_t &tag() { return _tag; }
00518
00520
00525   inline bool put(Rcv_fpage const &);
00526
00531   inline bool put(Small_buf const &);
00532
00533
00538
00548   inline l4_msgtag_t wait(l4_umword_t *src)
00549   { return wait(src, L4_IPC_NEVER); }
00550
00561   inline l4_msgtag_t wait(l4_umword_t *src, l4_timeout_t timeout);
00562
00572   inline l4_msgtag_t receive(l4_cap_idx_t src)
00573   { return receive(src, L4_IPC_NEVER); }
00574   inline l4_msgtag_t receive(l4_cap_idx_t src, l4_timeout_t timeout);
00575
00577
00581   inline l4_utcb_t *utcb() const { return _utcb; }
00582
00583 protected:
00584   l4_msgtag_t _tag;
00585   l4_utcb_t *_utcb;
00586   char *_current_msg;
00587   unsigned _pos;
00588   unsigned char _current_buf;
00589 };
00590
00591 class Istream_copy : public Istream
00592 {
00593 private:
00594   l4_msg_regs_t _mrs;
00595
00596 public:
00597   Istream_copy(Istream const &o) : Istream(o), _mrs(*l4_utcb_mr_u(o.utcb()))
```

```
00598   {
00599     // do some reverse mr to utcb trickery
00600     _utcb = reinterpret_cast<l4_utcb_t *>
00601       (reinterpret_cast<l4_addr_t>(&_mrs)
00602        - reinterpret_cast<l4_addr_t>(l4_utcb_mr_u(nullptr)));
00603     _current_msg = reinterpret_cast<char*>(l4_utcb_mr_u(_utcb)->mr);
00604   }
00605
00606 };
00607
00623 class Ostream
00624 {
00625 public:
00629   Ostream(l4_utcb_t *utcb)
00630   : _tag(), _utcb(utcb),
00631     _current_msg(reinterpret_cast<char *>(l4_utcb_mr_u(_utcb)->mr)),
00632     _pos(0), _current_item(0)
00633   {}
00634
00638   void reset()
00639   {
00640     _pos = 0;
00641     _current_item = 0;
00642     _current_msg = reinterpret_cast<char*>(l4_utcb_mr_u(_utcb)->mr);
00643   }
00644
00652
00659   template< typename T >
00660   bool put(T *buf, unsigned long size)
00661   {
00662     size *= sizeof(T);
00663     _pos = cxx::Type_traits<T>::align(_pos);
00664     if (Utcb_stream_check::check_utcb_data_offset(_pos + size))
00665       return false;
00666
00667     __builtin_memcpy(_current_msg + _pos, buf, size);
00668     _pos += size;
00669     return true;
00670   }
00671
00677   template< typename T >
00678   bool put(T const &v)
00679   {
00680     _pos = cxx::Type_traits<T>::align(_pos);
00681     if (Utcb_stream_check::check_utcb_data_offset(_pos + sizeof(T)))
00682       return false;
00683
00684     *(reinterpret_cast<T*>(_current_msg + _pos)) = v;
00685     _pos += sizeof(T);
00686     return true;
00687   }
00688
00689   int put(Varg const &va)
00690   {
00691     put(va.tag());
00692     put(va.data(), va.length());
00693
00694     return 0;
00695   }
00696
00697   template< typename T >
00698   int put(Varg_t<T> const &va)
00699   { return put(static_cast<Varg const &>(va)); }
00700
00706   l4_msgtag_t tag() const { return _tag; }
00707
00713   l4_msgtag_t &tag() { return _tag; }
00714
00716
00721   inline bool put_snd_item(Snd_fpage const &);
00722
00723
00728
00738   inline l4_msgtag_t send(l4_cap_idx_t dst, long proto = 0, unsigned flags = 0);
00739
00741
00745   inline l4_utcb_t *utcb() const { return _utcb; }
00746 #if 0
00750   unsigned long tell() const
00751   {
00752     unsigned w = l4_bytes_to_mwords(_pos) - _current_item * 2;
00753     _tag = l4_msgtag(0, w, _current_item, 0);
00754   }
00755 #endif
00756 public:
00757   l4_msgtag_t prepare_ipc(long proto = 0, unsigned flags = 0)
00758   {
```

```
00759     unsigned w = l4_bytes_to_mwords(_pos) - _current_item * 2;
00760     return l4_msgtag(proto, w, _current_item, flags);
00761   }
00762
00763   // XXX: this is a hack for <l4/sys/cxx/ipc_server> adaption
00764   void set_ipc_params(l4_msgtag_t tag)
00765   {
00766     _pos = (tag.words() + tag.items() * 2) * sizeof(l4_umword_t);
00767     _current_item = tag.items();
00768   }
00769 protected:
00770   l4_msgtag_t _tag;
00771   l4_utcb_t *_utcb;
00772   char *_current_msg;
00773   unsigned _pos;
00774   unsigned char _current_item;
00775 };
00776
00777
00789 class Iostream : public Istream, public Ostream
00790 {
00791 public:
00792
00801   explicit Iostream(l4_utcb_t *utcb)
00802   : Istream(utcb), Ostream(utcb)
00803   {}
00804
00805   // disambiguate those functions
00806   l4_msgtag_t tag() const { return Istream::tag(); }
00807   l4_msgtag_t &tag() { return Istream::tag(); }
00808   l4_utcb_t *utcb() const { return Istream::utcb(); }
00809
00815   void reset()
00816   {
00817     Istream::reset();
00818     Ostream::reset();
00819   }
00820
00821
00829
00830   using Istream::get;
00831   using Istream::put;
00832   using Ostream::put;
00833
00835
00840
00856   inline l4_msgtag_t call(l4_cap_idx_t dst, l4_timeout_t timeout, long proto = 0);
00857   inline l4_msgtag_t call(l4_cap_idx_t dst, long proto = 0);
00858
00874   inline l4_msgtag_t reply_and_wait(l4_umword_t *src_dst, long proto = 0)
00875   { return reply_and_wait(src_dst, L4_IPC_SEND_TIMEOUT_0, proto); }
00876
00877   inline l4_msgtag_t send_and_wait(l4_cap_idx_t dest, l4_umword_t *src,
00878                                    long proto = 0)
00879   { return send_and_wait(dest, src, L4_IPC_SEND_TIMEOUT_0, proto); }
00880
00897   inline l4_msgtag_t reply_and_wait(l4_umword_t *src_dst,
00898                                     l4_timeout_t timeout, long proto = 0);
00899   inline l4_msgtag_t send_and_wait(l4_cap_idx_t dest, l4_umword_t *src,
00900                                    l4_timeout_t timeout, long proto = 0);
00901   inline l4_msgtag_t reply(l4_timeout_t timeout, long proto = 0);
00902   inline l4_msgtag_t reply(long proto = 0)
00903   { return reply(L4_IPC_SEND_TIMEOUT_0, proto); }
00904
00906 };
00907
00908
00909 inline bool
00910 Ostream::put_snd_item(Snd_fpage const &v)
00911 {
00912   typedef Snd_fpage T;
00913   _pos = cxx::Type_traits<Snd_fpage>::align(_pos);
00914   if (Utcb_stream_check::check_utcb_data_offset(_pos + sizeof(T)))
00915     return false;
00916
00917   *(reinterpret_cast<T*>(_current_msg + _pos)) = v;
00918   _pos += sizeof(T);
00919   ++_current_item;
00920   return true;
00921 }
00922
00923
00924 inline bool
00925 Istream::put(Rcv_fpage const &item)
00926 {
00927   unsigned words = item.forward_mappings() ? 3 : 2;
00928   if (_current_buf >= L4_UTCB_GENERIC_BUFFERS_SIZE - words - 1)
```

```
00929     return false;
00930
00931   l4_utcb_br_u(_utcb)->bdr &= ~L4_BDR_OFFSET_MASK;
00932
00933   l4_umword_t *buf
00934     = reinterpret_cast<l4_umword_t *>(&l4_utcb_br_u(_utcb)->br[_current_buf]);
00935   *buf++ = item.base_x();
00936   *buf++ = item.data();
00937   if (item.forward_mappings())
00938     *buf++ = item.rcv_task();
00939   _current_buf += words;
00940   return true;
00941 }
00942
00943
00944 inline bool
00945 Istream::put(Small_buf const &item)
00946 {
00947   if (_current_buf >= L4_UTCB_GENERIC_BUFFERS_SIZE - 2)
00948     return false;
00949
00950   l4_utcb_br_u(_utcb)->bdr &= ~L4_BDR_OFFSET_MASK;
00951
00952   reinterpret_cast<Small_buf&>(l4_utcb_br_u(_utcb)->br[_current_buf]) = item;
00953   _current_buf += 1;
00954   return true;
00955 }
00956
00957
00958 inline l4_msgtag_t
00959 Ostream::send(l4_cap_idx_t dst, long proto, unsigned flags)
00960 {
00961   l4_msgtag_t tag = prepare_ipc(proto, L4_MSGTAG_FLAGS & flags);
00962   return l4_ipc_send(dst, _utcb, tag, L4_IPC_NEVER);
00963 }
00964
00965 inline l4_msgtag_t
00966 Iostream::call(l4_cap_idx_t dst, l4_timeout_t timeout, long label)
00967 {
00968   l4_msgtag_t tag = prepare_ipc(label);
00969   tag = l4_ipc_call(dst, Ostream::_utcb, tag, timeout);
00970   Istream::tag() = tag;
00971   Istream::_pos = 0;
00972   return tag;
00973 }
00974
00975 inline l4_msgtag_t
00976 Iostream::call(l4_cap_idx_t dst, long label)
00977 { return call(dst, L4_IPC_NEVER, label); }
00978
00979
00980 inline l4_msgtag_t
00981 Iostream::reply_and_wait(l4_umword_t *src_dst, l4_timeout_t timeout, long proto)
00982 {
00983   l4_msgtag_t tag = prepare_ipc(proto);
00984   tag = l4_ipc_reply_and_wait(Ostream::_utcb, tag, src_dst, timeout);
00985   Istream::tag() = tag;
00986   Istream::_pos = 0;
00987   return tag;
00988 }
00989
00990
00991 inline l4_msgtag_t
00992 Iostream::send_and_wait(l4_cap_idx_t dest, l4_umword_t *src,
00993                         l4_timeout_t timeout, long proto)
00994 {
00995   l4_msgtag_t tag = prepare_ipc(proto);
00996   tag = l4_ipc_send_and_wait(dest, Ostream::_utcb, tag, src, timeout);
00997   Istream::tag() = tag;
00998   Istream::_pos = 0;
00999   return tag;
01000 }
01001
01002 inline l4_msgtag_t
01003 Iostream::reply(l4_timeout_t timeout, long proto)
01004 {
01005   l4_msgtag_t tag = prepare_ipc(proto);
01006   tag = l4_ipc_send(L4_INVALID_CAP | L4_SYSF_REPLY, Ostream::_utcb, tag, timeout);
01007   Istream::tag() = tag;
01008   Istream::_pos = 0;
01009   return tag;
01010 }
01011
01012 inline l4_msgtag_t
01013 Istream::wait(l4_umword_t *src, l4_timeout_t timeout)
01014 {
01015   l4_msgtag_t res;
```

```
01016   res = l4_ipc_wait(_utcb, src, timeout);
01017   tag() = res;
01018   _pos = 0;
01019   return res;
01020 }
01021
01022
01023 inline l4_msgtag_t
01024 Istream::receive(l4_cap_idx_t src, l4_timeout_t timeout)
01025 {
01026   l4_msgtag_t res;
01027   res = l4_ipc_receive(src, _utcb, timeout);
01028   tag() = res;
01029   _pos = 0;
01030   return res;
01031 }
01032
01033 } // namespace Ipc
01034 } // namespace L4
01035
01044 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, bool &v) { s.get(v); return s; }
01045 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, int &v) { s.get(v); return s; }
01046 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, long int &v) { s.get(v); return s; }
01047 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, long long int &v) { s.get(v); return s; }
01048 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, unsigned int &v) { s.get(v); return s; }
01049 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, unsigned long int &v) { s.get(v); return s;
      }
01050 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, unsigned long long int &v) { s.get(v);
      return s; }
01051 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, short int &v) { s.get(v); return s; }
01052 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, unsigned short int &v) { s.get(v); return s;
      }
01053 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, char &v) { s.get(v); return s; }
01054 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, unsigned char &v) { s.get(v); return s; }
01055 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, signed char &v) { s.get(v); return s; }
01056 inline L4::Ipc::Istream &operator « (L4::Ipc::Istream &s, L4::Ipc::Rcv_fpage const &v) { s.put(v);
      return s; }
01057 inline L4::Ipc::Istream &operator « (L4::Ipc::Istream &s, L4::Ipc::Small_buf const &v) { s.put(v);
      return s; }
01058 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, L4::Ipc::Snd_fpage &v)
01059 {
01060   l4_umword_t b, d;
01061   s » b » d;
01062   v = L4::Ipc::Snd_fpage(b, d);
01063   return s;
01064 }
01065 inline L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, L4::Ipc::Varg &v)
01066 { s.get(&v); return s; }
01067
01068
01077 inline
01078 L4::Ipc::Istream &operator » (L4::Ipc::Istream &s, l4_msgtag_t &v)
01079 {
01080   v = s.tag();
01081   return s;
01082 }
01083
01101 template< typename T >
01102 inline
01103 L4::Ipc::Istream &operator » (L4::Ipc::Istream &s,
01104                               L4::Ipc::Internal::Buf_in<T> const &v)
01105 {
01106   unsigned long si;
01107   if (s.get(si) && s.has_more<T>(si))
01108     v.set_size(s.get(L4::Ipc::Msg_ptr<T>(v.buf()), si));
01109   else
01110     v.set_size(0);
01111   return s;
01112 }
01113
01128 template< typename T >
01129 inline
01130 L4::Ipc::Istream &operator » (L4::Ipc::Istream &s,
01131                               L4::Ipc::Msg_ptr<T> const &v)
01132 {
01133   s.get(v);
01134   return s;
01135 }
01136
01149 template< typename T >
01150 inline
01151 L4::Ipc::Istream &operator » (L4::Ipc::Istream &s,
01152                               L4::Ipc::Internal::Buf_cp_in<T> const &v)
01153 {
01154   unsigned long sz;
01155   s.get(sz);
01156   v.size() = s.get(v.buf(), cxx::min(v.size(), sz));
```

```
01157   return s;
01158 }
01159
01170 template< typename T >
01171 inline
01172 L4::Ipc::Istream &operator » (L4::Ipc::Istream &s,
01173                               L4::Ipc::Str_cp_in<T> const &v)
01174 {
01175   unsigned long sz;
01176   s.get(sz);
01177   unsigned long rsz = s.get(v.buf(), cxx::min(v.size(), sz));
01178   if (rsz < v.size() && v.buf()[rsz - 1])
01179     ++rsz; // add the zero termination behind the received data
01180
01181   if (rsz != 0)
01182     v.buf()[rsz - 1] = 0;
01183
01184   v.size() = rsz;
01185   return s;
01186 }
01187
01188
01197 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, bool v) { s.put(v); return s; }
01198 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, int v) { s.put(v); return s; }
01199 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, long int v) { s.put(v); return s; }
01200 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, long long int v) { s.put(v); return s; }
01201 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, unsigned int v) { s.put(v); return s; }
01202 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, unsigned long int v) { s.put(v); return s; }
01203 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, unsigned long long int v) { s.put(v); return
      s; }
01204 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, short int v) { s.put(v); return s; }
01205 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, unsigned short int v) { s.put(v); return s;
      }
01206 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, char v) { s.put(v); return s; }
01207 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, unsigned char v) { s.put(v); return s; }
01208 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, signed char v) { s.put(v); return s; }
01209 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, L4::Ipc::Snd_fpage const &v) {
      s.put_snd_item(v); return s; }
01210 template< typename T >
01211 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, L4::Cap<T> const &v)
01212 { s « L4::Ipc::Snd_fpage(v.fpage()); return s; }
01213
01214 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, L4::Ipc::Varg const &v)
01215 { s.put(v); return s; }
01216 template< typename T >
01217 inline L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, L4::Ipc::Varg_t<T> const &v)
01218 { s.put(v); return s; }
01219
01231 inline
01232 L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, l4_msgtag_t const &v)
01233 {
01234   s.tag() = v;
01235   return s;
01236 }
01237
01246 template< typename T >
01247 inline
01248 L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s,
01249                               L4::Ipc::Internal::Buf_cp_out<T> const &v)
01250 {
01251   s.put(v.size());
01252   s.put(v.buf(), v.size());
01253   return s;
01254 }
01255
01268 inline
01269 L4::Ipc::Ostream &operator « (L4::Ipc::Ostream &s, char const *v)
01270 {
01271   unsigned long l = __builtin_strlen(v) + 1;
01272   s.put(l);
01273   s.put(v, l);
01274   return s;
01275 }
01276
01277 namespace L4 { namespace Ipc {
01287 template< typename T >
01288 inline
01289 T read(Istream &s) { T t; s » t; return t; }
01290
01291 } // namespace Ipc
01292 } // namespace L4
```

16.210 ipc_timeout_queue

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Steffen Liebergeld <steffen.liebergeld@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/cxx/hlist>
00010 #include <l4/sys/cxx/ipc_server_loop>
00011
00012 namespace L4 { namespace Ipc_svr {
00013
00018 class Timeout : public cxx::H_list_item
00019 {
00020   friend class Timeout_queue;
00021 public:
00023   Timeout() : _timeout(0) {}
00024
00026   virtual ~Timeout() = 0;
00027
00034   virtual void expired() = 0;
00035
00042   l4_kernel_clock_t timeout() const
00043   { return _timeout; }
00044
00045 private:
00046   l4_kernel_clock_t _timeout;
00047 };
00048
00049 inline Timeout::~Timeout() {}
00050
00055 class Timeout_queue
00056 {
00057 public:
00059   typedef L4::Ipc_svr::Timeout Timeout;
00060
00065   l4_kernel_clock_t next_timeout() const
00066   {
00067     if (auto e = _timeouts.front())
00068       return e->timeout();
00069
00070     return 0;
00071   }
00072
00081   bool timeout_expired(l4_kernel_clock_t now) const
00082   {
00083     l4_kernel_clock_t next = next_timeout();
00084     return (next != 0) && (next <= now);
00085   }
00086
00091   void handle_expired_timeouts(l4_kernel_clock_t now)
00092   {
00093     while (!_timeouts.empty())
00094       {
00095         Queue::Iterator top = _timeouts.begin();
00096         if ((*top)->_timeout > now)
00097           return;
00098
00099         Timeout *t = *top;
00100         top = _timeouts.erase(top);
00101         t->expired();
00102       }
00103   }
00104
00111   void add(Timeout *timeout, l4_kernel_clock_t time)
00112   {
00113     timeout->_timeout = time;
00114     Queue::Iterator i = _timeouts.begin();
00115     while (i != _timeouts.end() && (*i)->timeout() < time)
00116       ++i;
00117
00118     _timeouts.insert_before(timeout, i);
00119   }
00120
00126   void remove(Timeout *timeout)
00127   {
00128     _timeouts.remove(timeout);
00129   }
00130
00131 private:
00132   typedef cxx::H_list<Timeout> Queue;
00133   Queue _timeouts;
00134 };
```

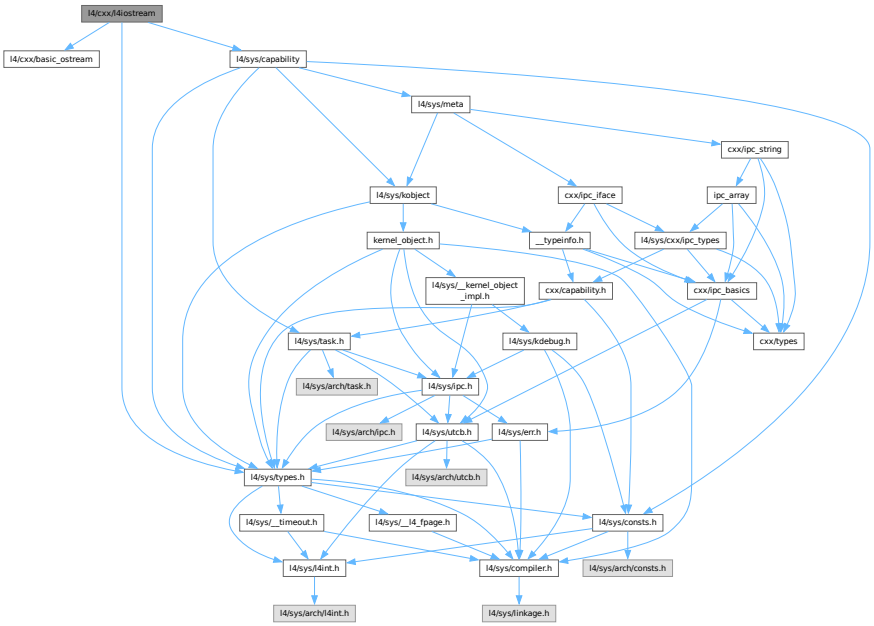
```
00135
00149 template< typename HOOKS, typename BR_MAN = Br_manager_no_buffers >
00150 class Timeout_queue_hooks : public BR_MAN
00151 {
00152   l4_kernel_clock_t _now()
00153   { return static_cast<HOOKS*>(this)->now(); }
00154
00155   unsigned _timeout_br()
00156   { return this->first_free_br(); }
00157
00158 public:
00160   l4_timeout_t timeout()
00161   {
00162     l4_kernel_clock_t t = queue.next_timeout();
00163     if (t)
00164       return l4_timeout(L4_IPC_TIMEOUT_0, l4_timeout_abs(t, _timeout_br()));
00165     return L4_IPC_SEND_TIMEOUT_0;
00166   }
00167
00169   void setup_wait(l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode mode)
00170   {
00171     // we must handle the timer only when called after a possible reply
00172     // otherwise we probably destroy the reply message.
00173     if (mode == L4::Ipc_svr::Reply_separate)
00174       {
00175         l4_kernel_clock_t now = _now();
00176         if (queue.timeout_expired(now))
00177           queue.handle_expired_timeouts(now);
00178       }
00179
00180     BR_MAN::setup_wait(utcb, mode);
00181   }
00182
00184   L4::Ipc_svr::Reply_mode before_reply(l4_msgtag_t, l4_utcb_t *)
00185   {
00186     // split up reply and wait when a timeout has expired
00187     if (queue.timeout_expired(_now()))
00188       return L4::Ipc_svr::Reply_separate;
00189     return L4::Ipc_svr::Reply_compound;
00190   }
00191
00202   int add_timeout(Timeout *timeout, l4_kernel_clock_t time) override
00203   {
00204     queue.add(timeout, time);
00205     return 0;
00206   }
00207
00215   int remove_timeout(Timeout *timeout) override
00216   {
00217     queue.remove(timeout);
00218     return 0;
00219   }
00220
00221   Timeout_queue queue;
00222 };
00223
00224 }}
```

16.211 l4/cxx/l4iostream File Reference

L4 IO stream.

```
#include <l4/cxx/basic_ostream>
#include <l4/sys/types.h>
#include <l4/sys/capability>
```

Include dependency graph for l4iostream:



16.211.1 Detailed Description

L4 IO stream.
Definition in file l4iostream.

16.212 l4iostream

Go to the documentation of this file.

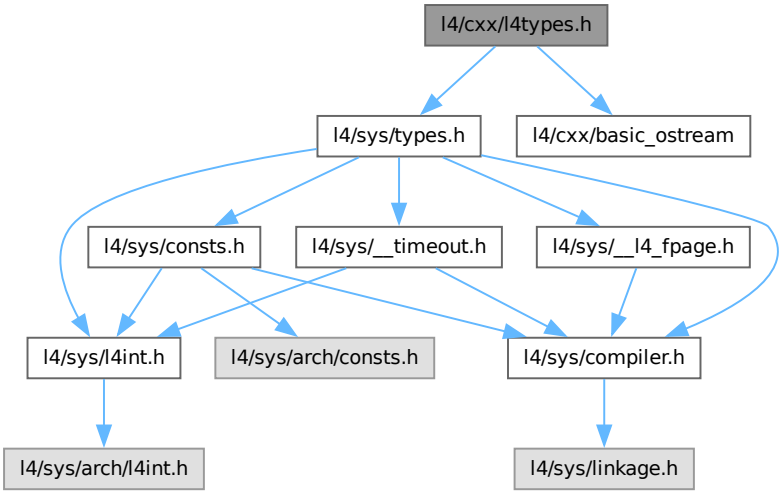
```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2004-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/cxx/basic_ostream>
00016 #include <l4/sys/types.h>
00017 #include <l4/sys/capability>
00018
00019 inline
00020 L4::BasicOStream &operator « (L4::BasicOStream &o, l4_msgtag_t const &tag)
00021 {
00022   L4::IOBackend::Mode m = o.be_mode();
00023   o « "[l=" « L4::dec « tag.label() « "; w=" « tag.words() « "; i="
00024     « tag.items() « "]";
00025   o.be_mode(m);
00026   return o;
00027 }
00028
00029 template<typename T>
00030 inline
00031 L4::BasicOStream &operator « (L4::BasicOStream &o, L4::Cap<T> const &cap)
00032 {
00033   o « "[C:" « L4::n_hex(cap.cap()) « "]";
00034   return o;
00035 }
```

16.213 l4/cxx/l4types.h File Reference

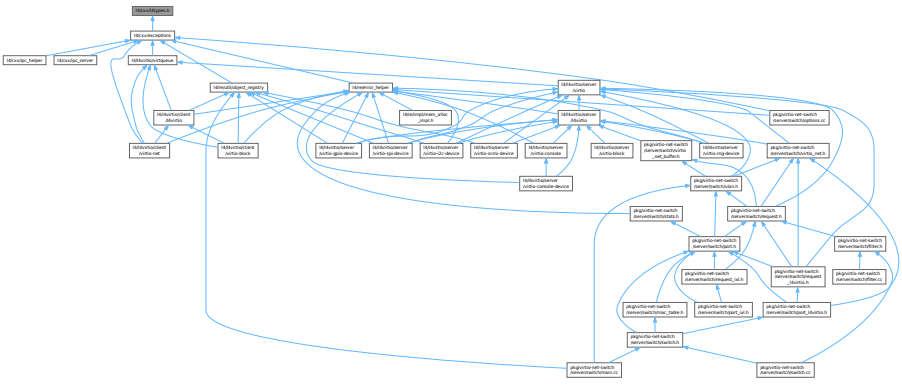
L4 Types.

```
#include <l4/sys/types.h>
#include <l4/cxx/basic_ostream>
```

Include dependency graph for l4types.h:



This graph shows which files directly or indirectly include this file:



16.213.1 Detailed Description

L4 Types.
Definition in file l4types.h.

16.214 l4types.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2004-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
```

```
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/types.h>
00014 #include <l4/cxx/basic_ostream>
```

16.215 list

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/cxx/type_traits>
00012 #include <l4/cxx/std_alloc>
00013 #include <l4/cxx/std_ops>
00014
00015 namespace cxx {
00016 /*
00017  * Classes: List_item, List<D, Alloc>
00018  */
00019
00026 class List_item
00027 {
00028 public:
00034   class Iter
00035   {
00036   public:
00037     Iter(List_item *c, List_item *f) noexcept : _c(c), _f(f) {}
00038     Iter(List_item *f = 0) noexcept : _c(f), _f(f) {}
00039
00040     List_item *operator * () const noexcept { return _c; }
00041     List_item *operator -> () const noexcept { return _c; }
00042     Iter &operator ++ () noexcept
00043     {
00044       if (!_f)
00045   _c = 0;
00046       else
00047         _c = _c->get_next_item();
00048
00049       if (_c == _f)
00050   _c = 0;
00051
00052       return *this;
00053     }
00054
00055     Iter operator ++ (int) noexcept
00056     { Iter o = *this; operator ++ (); return o; }
00057
00058     Iter &operator -- () noexcept
00059     {
00060       if (!_f)
00061   _c = 0;
00062       else
00063         _c = _c->get_prev_item();
00064
00065       if (_c == _f)
00066   _c = 0;
00067
00068       return *this;
00069     }
00070
00071     Iter operator -- (int) noexcept
00072     { Iter o = *this; operator -- (); return o; }
00073
00075     List_item *remove_me() noexcept
00076     {
00077       if (!_c)
00078   return 0;
00079
00080       List_item *l = _c;
00081       operator ++ ();
00082       l->remove_me();
00083
00084       if (_f == l)
00085   _f = _c;
00086
00087       return l;
```

```
00088     }
00089
00090   private:
00091     List_item *_c, *_f;
00092   };
00093
00107   template< typename T, bool Poly = false>
00108   class T_iter : public Iter
00109   {
00110   private:
00111     static bool const P = !Conversion<const T*, const List_item *>::exists
00112       || Poly;
00113
00114     static List_item *cast_to_li(T *i) noexcept
00115     {
00116       if constexpr (P)
00117         return dynamic_cast<List_item*>(i);
00118       else
00119         return i;
00120     }
00121
00122     static T *cast_to_type(List_item *i) noexcept
00123     {
00124       if constexpr (P)
00125         return dynamic_cast<T*>(i);
00126       else
00127         return static_cast<T*>(i);
00128     }
00129
00130   public:
00131
00132     template< typename O >
00133     explicit T_iter(T_iter<O> const &o) noexcept
00134     : Iter(o) { dynamic_cast<T*>(*o); }
00135
00136     //TIter(CListItem *f) : Iter(f) {}
00137     T_iter(T *f = 0) noexcept : Iter(cast_to_li(f)) {}
00138     T_iter(T *c, T *f) noexcept
00139     : Iter(cast_to_li(c), cast_to_li(f))
00140     {}
00141
00142     inline T *operator * () const noexcept
00143     { return cast_to_type(Iter::operator * ()); }
00144     inline T *operator -> () const noexcept
00145     { return operator * (); }
00146
00147     T_iter<T, Poly> operator ++ (int) noexcept
00148     { T_iter<T, Poly> o = *this; Iter::operator ++ (); return o; }
00149     T_iter<T, Poly> operator -- (int) noexcept
00150     { T_iter<T, Poly> o = *this; Iter::operator -- (); return o; }
00151     T_iter<T, Poly> &operator ++ () noexcept
00152     { Iter::operator ++ (); return *this; }
00153     T_iter<T, Poly> &operator -- () noexcept
00154     { Iter::operator -- (); return *this; }
00155     inline T *remove_me() noexcept;
00156   };
00157
00158   List_item() noexcept : _n(this), _p(this) {}
00159
00160 protected:
00161   List_item(List_item const &) noexcept : _n(this), _p(this) {}
00162
00163 public:
00165   List_item *get_prev_item() const noexcept { return _p; }
00166
00168   List_item *get_next_item() const noexcept { return _n; }
00169
00171   void insert_prev_item(List_item *p) noexcept
00172   {
00173     p->_p->_n = this;
00174     List_item *pr = p->_p;
00175     p->_p = _p;
00176     _p->_n = p;
00177     _p = pr;
00178   }
00179
00181   void insert_next_item(List_item *p) noexcept
00182   {
00183     p->_p->_n = _n;
00184     p->_p = this;
00185     _n->_p = p;
00186     _n = p;
00187   }
00188
00190   void remove_me() noexcept
00191   {
00192     if (_p != this)
```

```
00193       {
00194         _p->_n = _n;
00195         _n->_p = _p;
00196       }
00197     _p = _n = this;
00198   }
00199
00208   template< typename C, typename N >
00209   static inline C *push_back(C *head, N *p) noexcept;
00210
00219   template< typename C, typename N >
00220   static inline C *push_front(C *head, N *p) noexcept;
00221
00230   template< typename C, typename N >
00231   static inline C *remove(C *head, N *p) noexcept;
00232
00233 private:
00234   List_item *_n, *_p;
00235 };
00236
00237
00238 /* IMPLEMENTATION -----------------------------------------------------------*/
00239 template< typename C, typename N >
00240 C *List_item::push_back(C *h, N *p) noexcept
00241 {
00242   if (!p)
00243     return h;
00244   if (!h)
00245     return p;
00246   h->insert_prev_item(p);
00247   return h;
00248 }
00249
00250 template< typename C, typename N >
00251 C *List_item::push_front(C *h, N *p) noexcept
00252 {
00253   if (!p)
00254     return h;
00255   if (h)
00256     h->insert_prev_item(p);
00257   return p;
00258 }
00259
00260 template< typename C, typename N >
00261 C *List_item::remove(C *h, N *p) noexcept
00262 {
00263   if (!p)
00264     return h;
00265   if (!h)
00266     return 0;
00267   if (h == p)
00268     {
00269       if (p == p->_n)
00270   h = 0;
00271       else
00272         h = static_cast<C*>(p->_n);
00273     }
00274   p->remove_me();
00275
00276   return h;
00277 }
00278
00279 template< typename T, bool Poly >
00280 inline
00281 T *List_item::T_iter<T, Poly>::remove_me() noexcept
00282 { return cast_to_type(Iter::remove_me()); }
00283
00284
00285 template< typename T >
00286 class T_list_item : public List_item
00287 {
00288 public:
00289   T *next() const { return static_cast<T*>(List_item::get_next_item()); }
00290   T *prev() const { return static_cast<T*>(List_item::get_prev_item()); }
00291 };
00292
00293
00294 template< typename LI >
00295 class L_list
00296 {
00297 private:
00298   LI *_h;
00299
00300 public:
00301
00302   L_list() : _h(0) {}
00303
```

```
00304   void push_front(LI *e) { _h = LI::push_front(_h, e); }
00305   void push_back(LI *e) { _h = LI::push_back(_h, e); }
00306   void insert_before(LI *e, LI *p)
00307   {
00308     p->insert_prev_item(e);
00309     if (_h == p)
00310       _h = e;
00311   }
00312   void insert_after(LI *e, LI *p) { p->insert_next_item(e); }
00313
00314   void remove(LI *e)
00315   { _h = LI::remove(_h, e); }
00316
00317   LI *head() const { return _h; }
00318 };
00319
00325 template< typename D, template<typename A> class Alloc = New_allocator >
00326 class List
00327 {
00328 private:
00329   class E : public List_item
00330   {
00331   public:
00332     E(D const &d) noexcept : data(d) {}
00333     D data;
00334   };
00335
00336 public:
00337   class Node : private E
00338   {};
00339
00340   typedef Alloc<Node> Node_alloc;
00341
00346   class Iter
00347   {
00348   private:
00349     List_item::T_iter<E> _i;
00350
00351   public:
00352     Iter(E *e) noexcept : _i(e) {}
00353
00354     D &operator * () const noexcept { return (*_i)->data; }
00355     D &operator -> () const noexcept { return (*_i)->data; }
00356
00357     Iter operator ++ (int) noexcept
00358     { Iter o = *this; operator ++ (); return o; }
00359     Iter operator -- (int) noexcept
00360     { Iter o = *this; operator -- (); return o; }
00361     Iter &operator ++ () noexcept { ++_i; return *this; }
00362     Iter &operator -- () noexcept { --_i; return *this; }
00363
00365     operator E* () const noexcept { return *_i; }
00366   };
00367
00368   List(Alloc<Node> const &a = Alloc<Node>()) noexcept : _h(0), _l(0), _a(a) {}
00369
00371   void push_back(D const &d) noexcept
00372   {
00373     void *n = _a.alloc();
00374     if (!n) return;
00375     _h = E::push_back(_h, new (n) E(d));
00376     ++_l;
00377   }
00378
00380   void push_front(D const &d) noexcept
00381   {
00382     void *n = _a.alloc();
00383     if (!n) return;
00384     _h = E::push_front(_h, new (n) E(d));
00385     ++_l;
00386   }
00387
00389   void remove(Iter const &i) noexcept
00390   { E *e = i; _h = E::remove(_h, e); --_l; _a.free(e); }
00391
00393   unsigned long size() const noexcept { return _l; }
00394
00396   D const &operator [] (unsigned long idx) const noexcept
00397   { Iter i = _h; for (; idx && *i; ++i, --idx) { } return *i; }
00398
00400   D &operator [] (unsigned long idx) noexcept
00401   { Iter i = _h; for (; idx && *i; ++i, --idx) { } return *i; }
00402
00404   Iter items() noexcept { return Iter(_h); }
00405
00406 private:
00407   E *_h;
```

```
00408   unsigned _l;
00409   Alloc<Node> _a;
00410 };
00411
00412
00413 };
00414
```

16.216 list_alloc

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/cxx/arith>
00013 #include <l4/cxx/minmax>
00014 #include <l4/cxx/type_traits>
00015 #include <l4/sys/consts.h>
00016
00017 #ifdef CXX_LIST_ALLOC_SANITY
00018 #include <l4/cxx/iostream>
00019 #endif
00020
00021 namespace cxx {
00022
00026 class List_alloc
00027 {
00028 private:
00029   friend class List_alloc_sanity_guard;
00030
00031   struct Mem_block
00032   {
00033     Mem_block *next;
00034     unsigned long size;
00035   };
00036
00037   Mem_block *_first;
00038
00039   inline void check_overlap(void *, unsigned long) const;
00040   inline void sanity_check_list(char const *, char const *,
00041                                 bool unmerged) const;
00042   inline void merge(Mem_block *, Mem_block *);
00043
00044 public:
00045
00052   List_alloc() : _first(0) {}
00053
00066   inline void free(void *block, unsigned long size, bool initial_free = false);
00067
00082   inline void *alloc(unsigned long size, unsigned long align,
00083                      unsigned long lower = 0, unsigned long upper = ~0UL);
00084
00105   inline void *alloc_max(unsigned long min, unsigned long *max,
00106                          unsigned long align, unsigned granularity,
00107                          unsigned long lower = 0, unsigned long upper = ~0UL);
00108
00114   inline unsigned long avail() const;
00115
00116   template <typename DBG>
00117   void dump_free_list(DBG &out) const;
00118 };
00119
00120 #if !defined (CXX_LIST_ALLOC_SANITY)
00121 class List_alloc_sanity_guard
00122 {
00123 public:
00124   List_alloc_sanity_guard(List_alloc const *, char const *, bool)
00125   {}
00126
00127 };
00128
00129
00130 void
00131 List_alloc::check_overlap(void *, unsigned long) const
00132 {}
00133
00134 void
```

```
00135 List_alloc::sanity_check_list(char const *, char const *, bool) const
00136 {}
00137
00138 #else
00139
00140 class List_alloc_sanity_guard
00141 {
00142 private:
00143   List_alloc const *a;
00144   char const *func;
00145
00146 public:
00147   List_alloc_sanity_guard(List_alloc const *a, char const *func, bool unmerged)
00148   : a(a), func(func)
00149   { a->sanity_check_list(func, "entry", unmerged); }
00150
00151   ~List_alloc_sanity_guard()
00152   { a->sanity_check_list(func, "exit", false); }
00153 };
00154
00155 void
00156 List_alloc::check_overlap(void *b, unsigned long s) const
00157 {
00158   unsigned long const mb_align = (1UL << arith::Ld<sizeof(Mem_block)>::value) - 1;
00159   if ((unsigned long)b & mb_align)
00160     {
00161       L4::cerr << "List_alloc(FATAL): trying to free unaligned memory: "
00162                << b << " align=" << arith::Ld<sizeof(Mem_block)>::value << "\n";
00163     }
00164
00165   Mem_block const *c = _first;
00166   for (;c ; c = c->next)
00167     {
00168       unsigned long x_s = (unsigned long)b;
00169       unsigned long x_e = x_s + s;
00170       unsigned long b_s = (unsigned long)c;
00171       unsigned long b_e = b_s + c->size;
00172
00173       if ((x_s >= b_s && x_s < b_e)
00174           || (x_e > b_s && x_e <= b_e)
00175           || (b_s >= x_s && b_s < x_e)
00176           || (b_e > x_s && b_e <= x_e))
00177       {
00178         L4::cerr << "List_alloc(FATAL): trying to free memory that "
00179                     "is already free: \n  ["
00180                  << (void*)x_s << '-' << (void*)x_e << ") overlaps ["
00181                  << (void*)b_s << '-' << (void*)b_e << ")\n";
00182       }
00183     }
00184 }
00185
00186 void
00187 List_alloc::sanity_check_list(char const *func, char const *info,
00188                               bool unmerged) const
00189 {
00190   Mem_block const *c = _first;
00191   for (;c ; c = c->next)
00192     {
00193       if (c->next)
00194         {
00195           if (c >= c->next)
00196             {
00197               L4::cerr << "List_alloc(FATAL): " << func << '(' << info
00198                        << "): list order violation\n";
00199             }
00200
00201           unsigned long c_end = reinterpret_cast<unsigned long>(c) + c->size;
00202           unsigned long n_start = reinterpret_cast<unsigned long>(c->next);
00203           if (c_end > n_start || (c_end == n_start && !unmerged))
00204             {
00205               L4::cerr << "List_alloc(FATAL): " << func << '(' << info
00206                        << "): list order violation\n";
00207             }
00208         }
00209     }
00210 }
00211
00212 #endif
00213
00217 void
00218 List_alloc::merge(Mem_block *prev, Mem_block *c)
00219 {
00220   // We allow the list to not be merged in the beginning.
00221   List_alloc_sanity_guard __attribute__((unused)) guard(this, __func__, true);
00222   int iters = 1;
00223   if (prev)
00224     {
```

```
00225       c = prev;
00226       // If we have a predecessor, we might need to merge twice.
00227       iters = 2;
00228     }
00229
00230   while (c && c->next && iters--)
00231     {
00232       unsigned long f_start = reinterpret_cast<unsigned long>(c);
00233       unsigned long f_end   = f_start + c->size;
00234       unsigned long n_start = reinterpret_cast<unsigned long>(c->next);
00235
00236       if (f_end == n_start)
00237         {
00238           c->size += c->next->size;
00239           c->next = c->next->next;
00240           continue;
00241         }
00242
00243       c = c->next;
00244     }
00245 }
00246
00247 void
00248 List_alloc::free(void *block, unsigned long size, bool initial_free)
00249 {
00250   List_alloc_sanity_guard __attribute__((unused)) guard(this, __func__, false);
00251
00252   unsigned long const mb_align = (1UL << arith::Ld<sizeof(Mem_block)>::value) - 1;
00253
00254   if (initial_free)
00255     {
00256       // enforce alignment constraint on initial memory
00257       unsigned long nblock = (reinterpret_cast<unsigned long>(block) + mb_align)
00258                              & ~mb_align;
00259       size = (size - (nblock - reinterpret_cast<unsigned long>(block)))
00260              & ~mb_align;
00261       block = reinterpret_cast<void*>(nblock);
00262     }
00263   else
00264     // blow up size to the minimum aligned size
00265     size = (size + mb_align) & ~mb_align;
00266
00267   check_overlap(block, size);
00268
00269   Mem_block *prev = 0;
00270   Mem_block **c = &_first;
00271   Mem_block *next = 0;
00272
00273   if (*c)
00274     {
00275       while (*c && *c < block)
00276         {
00277           prev = *c;
00278           c = &prev->next;
00279         }
00280
00281       next = *c;
00282     }
00283
00284   *c = reinterpret_cast<Mem_block*>(block);
00285
00286   (*c)->next = next;
00287   (*c)->size = size;
00288
00289   merge(prev, *c);
00290 }
00291
00292 void *
00293 List_alloc::alloc_max(unsigned long min, unsigned long *max, unsigned long align,
00294                       unsigned granularity, unsigned long lower,
00295                       unsigned long upper)
00296 {
00297   List_alloc_sanity_guard __attribute__((unused)) guard(this, __func__, false);
00298
00299   unsigned char const mb_bits = arith::Ld<sizeof(Mem_block)>::value;
00300   unsigned long const mb_align = (1UL << mb_bits) - 1;
00301
00302   // blow minimum up to at least the minimum aligned size of a Mem_block
00303   min = l4_round_size(min, mb_bits);
00304   // truncate maximum to at least the size of a Mem_block
00305   *max = l4_trunc_size(*max, mb_bits);
00306   // truncate maximum size according to granularity
00307   *max = *max & ~(granularity - 1UL);
00308
00309   if (min > *max)
00310     return 0;
00311
```

```
00312   unsigned long almask = align ? (align - 1UL) : 0;
00313
00314   // minimum alignment is given by the size of a Mem_block
00315   if (almask < mb_align)
00316     almask = mb_align;
00317
00318   Mem_block **c = &_first;
00319   Mem_block **fit = 0;
00320   unsigned long max_fit = 0;
00321   unsigned long a_lower = (lower + almask) & ~almask;
00322
00323   for (; *c; c = &(*c)->next)
00324     {
00325       // address of free memory block
00326       unsigned long n_start = reinterpret_cast<unsigned long>(*c);
00327
00328       // block too small, next
00329       // XXX: maybe we can skip this and just do the test below
00330       if ((*c)->size < min)
00331         continue;
00332
00333       // block outside region, next
00334       if (upper < n_start || a_lower > n_start + (*c)->size)
00335         continue;
00336
00337       // aligned start address within the free block
00338       unsigned long a_start = (n_start + almask) & ~almask;
00339
00340       // check if aligned start address is behind the block, next
00341       if (a_start - n_start >= (*c)->size)
00342         continue;
00343
00344       a_start = a_start < a_lower ? a_lower : a_start;
00345
00346       // end address would overflow, next
00347       if (min > ~0UL - a_start)
00348         continue;
00349
00350       // block outside region, next
00351       if (a_start + min - 1UL > upper)
00352         continue;
00353
00354       // remaining size after subtracting the padding for the alignment
00355       unsigned long r_size = (*c)->size - a_start + n_start;
00356
00357       // upper limit can limit maximum size
00358       if (a_start + r_size - 1UL > upper)
00359         r_size = upper - a_start + 1UL;
00360
00361       // round down according to granularity
00362       r_size &= ~(granularity - 1UL);
00363
00364       // block too small
00365       if (r_size < min)
00366         continue;
00367
00368       if (r_size >= *max)
00369         {
00370           fit = c;
00371           max_fit = *max;
00372           break;
00373         }
00374
00375       if (r_size > max_fit)
00376         {
00377           max_fit = r_size;
00378           fit = c;
00379         }
00380     }
00381
00382   if (fit)
00383     {
00384       unsigned long n_start = reinterpret_cast<unsigned long>(*fit);
00385       unsigned long a_lower = (lower + almask) & ~almask;
00386       unsigned long a_start = (n_start + almask) & ~almask;
00387       a_start = a_start < a_lower ? a_lower : a_start;
00388       unsigned long r_size = (*fit)->size - a_start + n_start;
00389
00390       if (a_start > n_start)
00391         {
00392           (*fit)->size -= r_size;
00393           fit = &(*fit)->next;
00394         }
00395       else
00396         *fit = (*fit)->next;
00397
00398       *max = max_fit;
```

```
00399       if (r_size == max_fit)
00400         return reinterpret_cast<void *>(a_start);
00401
00402       Mem_block *m = reinterpret_cast<Mem_block*>(a_start + max_fit);
00403       m->next = *fit;
00404       m->size = r_size - max_fit;
00405       *fit = m;
00406       return reinterpret_cast<void *>(a_start);
00407     }
00408
00409   return 0;
00410 }
00411
00412 void *
00413 List_alloc::alloc(unsigned long size, unsigned long align, unsigned long lower,
00414                   unsigned long upper)
00415 {
00416   List_alloc_sanity_guard __attribute__((unused)) guard(this, __func__, false);
00417
00418   unsigned long const mb_align
00419     = (1UL << arith::Ld<sizeof(Mem_block)>::value) - 1;
00420
00421   // blow up size to the minimum aligned size
00422   size = (size + mb_align) & ~mb_align;
00423
00424   unsigned long almask = align ? (align - 1UL) : 0;
00425
00426   // minimum alignment is given by the size of a Mem_block
00427   if (almask < mb_align)
00428     almask = mb_align;
00429
00430   Mem_block **c = &_first;
00431   unsigned long a_lower = (lower + almask) & ~almask;
00432
00433   for (; *c; c=&(*c)->next)
00434     {
00435       // address of free memory block
00436       unsigned long n_start = reinterpret_cast<unsigned long>(*c);
00437
00438       // block too small, next
00439       // XXX: maybe we can skip this and just do the test below
00440       if ((*c)->size < size)
00441         continue;
00442
00443       // block outside region, next
00444       if (upper < n_start || a_lower > n_start + (*c)->size)
00445         continue;
00446
00447       // aligned start address within the free block
00448       unsigned long a_start = (n_start + almask) & ~almask;
00449
00450       // block too small after alignment, next
00451       if (a_start - n_start >= (*c)->size)
00452         continue;
00453
00454       a_start = a_start < a_lower ? a_lower : a_start;
00455
00456       // end address would overflow, next
00457       if (size > ~0UL - a_start)
00458         continue;
00459
00460       // block outside region, next
00461       if (a_start + size - 1UL > upper)
00462         continue;
00463
00464       // remaining size after subtracting the padding
00465       // for the alignment
00466       unsigned long r_size = (*c)->size - a_start + n_start;
00467
00468       // block too small
00469       if (r_size < size)
00470         continue;
00471
00472       if (a_start > n_start)
00473         {
00474           // have free space before the allocated block
00475           // shrink the block and set c to the next pointer of that
00476           // block
00477           (*c)->size -= r_size;
00478           c = &(*c)->next;
00479         }
00480       else
00481         // drop the block, c remains the next pointer of the
00482         // previous block
00483         *c = (*c)->next;
00484
00485       // allocated the whole remaining space
```

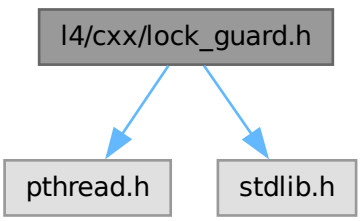
```
00486       if (r_size == size)
00487         return reinterpret_cast<void*>(a_start);
00488
00489       // add a new free block behind the allocated block
00490       Mem_block *m = reinterpret_cast<Mem_block*>(a_start + size);
00491       m->next = *c;
00492       m->size = r_size - size;
00493       *c = m;
00494       return reinterpret_cast<void *>(a_start);
00495     }
00496
00497   return 0;
00498 }
00499
00500 unsigned long
00501 List_alloc::avail() const
00502 {
00503   List_alloc_sanity_guard
00504     __attribute__((unused)) guard(this, __FUNCTION__, false);
00505   Mem_block const *c = _first;
00506   unsigned long a = 0;
00507   while (c)
00508     {
00509       a += c->size;
00510       c = c->next;
00511     }
00512
00513   return a;
00514 }
00515
00516 template <typename DBG>
00517 void
00518 List_alloc::dump_free_list(DBG &out) const
00519 {
00520   Mem_block const *c = _first;
00521   while (c)
00522     {
00523       static constexpr char const *const unitstr[4] =
00524       { "Byte", "KiB", "MiB", "GiB" };
00525
00526       unsigned sz = c->size;
00527       unsigned i;
00528       for (i = 0; i < cxx::array_size(unitstr) && sz > 8 « 10; ++i)
00529         sz »= 10;
00530
00531       out.printf("%12p - %12p (%u %s)\n",
00532                  c, reinterpret_cast<char const *>(c) + c->size - 1, sz, unitstr[i]);
00533
00534       c = c->next;
00535     }
00536 }
00537
00538 }
```

16.217 l4/cxx/lock_guard.h File Reference

Lock guard implementation.

```
#include <pthread.h>
#include <stdlib.h>
```

Include dependency graph for lock_guard.h:



Data Structures

- class L4::Lock_guard

  Basic lock guard implementation that prevents forgotten unlocks on exit paths from a method or a block of code.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.217.1 Detailed Description

Lock guard implementation.
Definition in file lock_guard.h.

16.218 lock_guard.h

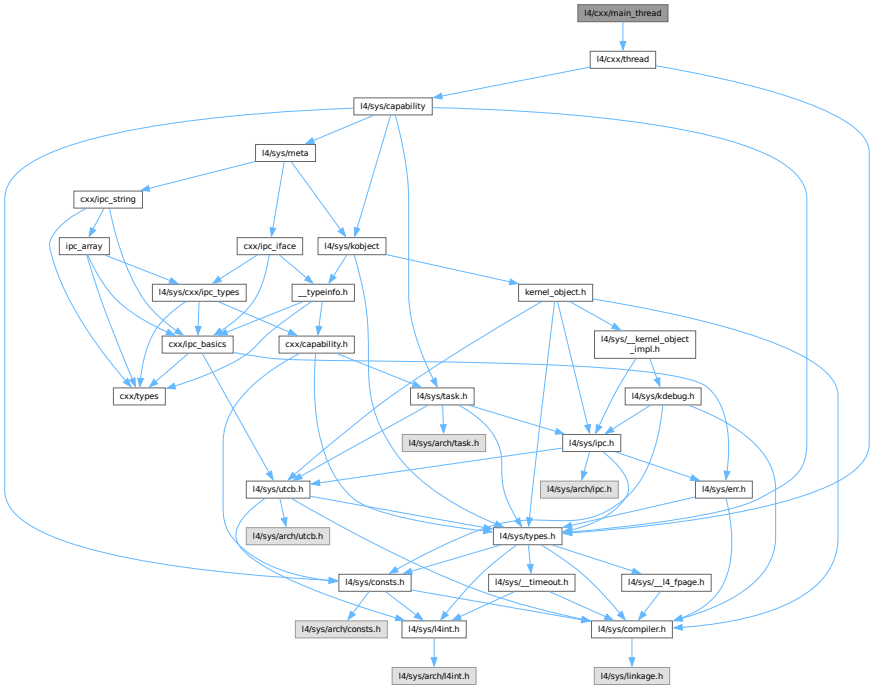
Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2025 Kernkonzept GmbH.
00004  * Author(s): Martin Decky <martin.decky@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00013
00014 #pragma once
00015
00016 #include <pthread.h>
00017 #include <stdlib.h>
00018
00019 namespace L4 {
00020
00044 class Lock_guard
00045 {
00046 public:
00047   Lock_guard() = delete;
00048   Lock_guard(const Lock_guard &) = delete;
00049   Lock_guard &operator=(const Lock_guard &) = delete;
00050
00059   explicit Lock_guard(pthread_mutex_t &lock) : _lock(&lock)
00060   {
00061     _status = pthread_mutex_lock(_lock);
00062   }
00063
00071   Lock_guard(Lock_guard &&guard) : _lock(guard._lock), _status(guard._status)
00072   {
00073     guard.release();
00074   }
00075
00090   Lock_guard &operator=(Lock_guard &&guard)
00091   {
00092     // Unlock the currently associated mutex (if any).
00093     reset();
00094
00095     // Move the state from the other guard.
00096     _lock = guard._lock;
00097     _status = guard._status;
00098
00099     // Release the mutex from the other guard.
00100     guard.release();
00101
00102     return *this;
00103   }
00104
00110   int status() const
00111   {
00112     return _status;
00113   }
00114
00126   ~Lock_guard()
00127   {
00128     reset();
00129   }
00130
00131 private:
```

```
00137   void release()
00138   {
00139     _lock = nullptr;
00140   }
00141
00150   void reset()
00151   {
00152     // No mutex might be associated with this lock guard only if the mutex has
00153     // been moved to a different lock guard.
00154     if (_lock)
00155       {
00156         _status = pthread_mutex_unlock(_lock);
00157         release();
00158       }
00159   }
00160
00161   pthread_mutex_t *_lock;
00162   int _status;
00163 };
00164
00165 } // namespace L4
```

16.219 l4/cxx/main_thread File Reference

Main thread.
`#include <l4/cxx/thread>`
Include dependency graph for main_thread:



Namespaces

- namespace cxx

  Our C++ library.

16.219.1 Detailed Description

Main thread.
Definition in file main_thread.

16.220 main_thread

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2004-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * This file is part of TUD:OS and distributed under the terms of the
00011  * GNU General Public License 2.
00012  * Please see the COPYING-GPL-2 file for details.
00013  *
00014  * As a special exception, you may use this file as part of a free software
00015  * library without restriction.  Specifically, if other files instantiate
00016  * templates or use macros or inline functions from this file, or you compile
00017  * this file and link it with other files to produce an executable, this
00018  * file does not by itself cause the resulting executable to be covered by
00019  * the GNU General Public License.  This exception does not however
00020  * invalidate any other reasons why the executable file might be covered by
00021  * the GNU General Public License.
00022  */
00023
00024 #ifndef L4_CXX_MAIN_THREAD_H__
00025 #define L4_CXX_MAIN_THREAD_H__
00026
00027 #include <l4/cxx/thread>
00028
00029 namespace cxx {
00030   class MainThread : public Thread
00031   {
00032   public:
00033     MainThread() : Thread(true)
00034     {}
00035   };
00036 };
00037
00038 #endif /* L4_CXX_MAIN_THREAD_H__ */
```

16.221 minmax

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "type_traits"
00011
00016 namespace cxx
00017 {
00018   // trivial, used to terminate the variadic recursion
00019   template<typename A>
00020   constexpr A const &
00021   min(A const &a)
00022   { return a; }
00023
00034   template<typename A, typename ...ARGS>
00035   constexpr A const &
00036   min(A const &a1, A const &a2, ARGS const &...a)
00037   {
00038     return min((a1 <= a2) ? a1 : a2, a...);
00039   }
00040
00051   template<typename A, typename ...ARGS>
00052   constexpr A const &
00053   min(cxx::identity_t<A> const &a1,
00054       cxx::identity_t<A> const &a2,
00055       ARGS const &...a)
00056   {
00057     return min<A>((a1 <= a2) ? a1 : a2, a...);
00058   }
00059
00060   // trivial, used to terminate the variadic recursion
00061   template<typename A>
00062   constexpr A const &
00063   max(A const &a)
00064   { return a; }
00065
00076   template<typename A, typename ...ARGS>
```

```
00077   constexpr A const &
00078   max(A const &a1, A const &a2, ARGS const &...a)
00079   { return max((a1 >= a2) ? a1 : a2, a...); }
00080
00091   template<typename A, typename ...ARGS>
00092   constexpr A const &
00093   max(cxx::identity_t<A> const &a1,
00094       cxx::identity_t<A> const &a2,
00095       ARGS const &...a)
00096   {
00097     return max<A>((a1 >= a2) ? a1 : a2, a...);
00098   }
00099
00107   template< typename T1 >
00108   inline
00109   T1 clamp(T1 v, T1 lo, T1 hi)
00110   { return min(hi, max(lo, v)); }
00111 };
```

16.222 numeric

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2025 Kernkonzept GmbH.
00004  * Author(s): Martin Decky <martin.decky@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/cxx/type_traits>
00012
00013 namespace cxx {
00014
00033 template <typename T>
00034 constexpr T gcd(T a, T b)
00035 {
00036   static_assert(Type_traits<T>::is_unsigned, "Type must be unsigned");
00037
00038   while (b != 0)
00039     {
00040       T remainder = a % b;
00041       a = b;
00042       b = remainder;
00043     }
00044
00045   return a;
00046 }
00047
00067 template <typename T>
00068 constexpr T lcm(T a, T b)
00069 {
00070   static_assert(Type_traits<T>::is_unsigned, "Type must be unsigned");
00071
00072   if (a == 0 || b == 0)
00073     return 0;
00074
00075   return (a / gcd(a, b)) * b;
00076 }
00077
00078 }
```

16.223 observer

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/cxx/hlist>
00011
00012 namespace cxx {
00013
00014 class Observer : public H_list_item
00015 {
00016 public:
```

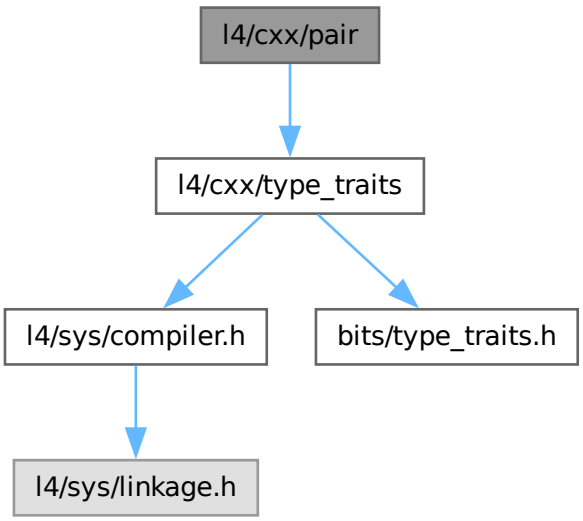
```
00017   virtual void notify() = 0;
00018 };
00019
00020 class Notifier : public H_list<Observer>
00021 {
00022 public:
00023   void notify()
00024   {
00025     for (Iterator i = begin(); i != end(); ++i)
00026       i->notify();
00027   }
00028 };
00029
00030 }
00031
00032
```

16.224 l4/cxx/pair File Reference

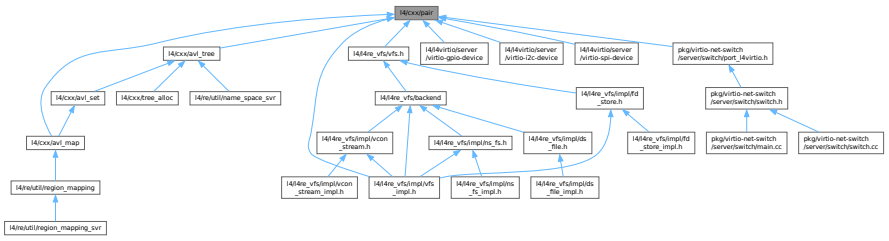
Pair implementation.

`#include <l4/cxx/type_traits>`

Include dependency graph for pair:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct cxx::Pair< First, Second >

Pair of two values.

- class cxx::Pair_first_compare< Cmp, Typ >

  Comparison functor for Pair.

Namespaces

- namespace cxx

  Our C++ library.

16.224.1 Detailed Description

Pair implementation.
Definition in file pair.

16.225 pair

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/cxx/type_traits>
00015
00016 namespace cxx {
00017
00026 template< typename First, typename Second >
00027 struct Pair
00028 {
00030   typedef First First_type;
00032   typedef Second Second_type;
00033
00035   First first;
00037   Second second;
00038
00044   template<typename A1, typename A2>
00045   Pair(A1 &&first, A2 &&second)
00046   : first(cxx::forward<A1>(first)), second(cxx::forward<A2>(second)) {}
00047
00052   template<typename A1>
00053   Pair(A1 &&first)
00054   : first(cxx::forward<A1>(first)), second() {}
00055
00057   Pair() = default;
00058 };
00059
00060 template< typename F, typename S >
00061 Pair<F,S> pair(F const &f, S const &s)
00062 { return cxx::Pair<F,S>(f,s); }
00063
00064
00073 template< typename Cmp, typename Typ >
00074 class Pair_first_compare
00075 {
00076 private:
00077   Cmp const &_cmp;
00078
00079 public:
00084   Pair_first_compare(Cmp const &cmp = Cmp()) : _cmp(cmp) {}
00085
00091   bool operator () (Typ const &l, Typ const &r) const
00092   { return _cmp(l.first,r.first); }
00093 };
00094
00095 }
00096
00097 template< typename OS, typename A, typename B >
00098 inline
00099 OS &operator « (OS &os, cxx::Pair<A,B> const &p)
00100 {
00101   os « p.first « ';' « p.second;
00102   return os;
00103 }
```

00104

16.226 ref_ptr

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include "type_traits"
00012 #include <stddef.h>
00013 #include <l4/sys/compiler.h>
00014
00015 namespace cxx {
00016
00017 template< typename T >
00018 struct Default_ref_counter
00019 {
00020   void h_drop_ref(T *p) noexcept
00021   {
00022     if (p->remove_ref() == 0)
00023       delete p;
00024   }
00025
00026   void h_take_ref(T *p) noexcept
00027   {
00028     p->add_ref();
00029   }
00030 };
00031
00032 struct Ref_ptr_base
00033 {
00034   enum Default_value
00035   { Nil = 0 };
00036 };
00037
00038 template<typename T, template< typename X > class CNT = Default_ref_counter>
00039 class Weak_ptr;
00040
00066 template <
00067   typename T = void,
00068   template< typename X > class CNT = Default_ref_counter
00069 >
00070 class Ref_ptr : public Ref_ptr_base, private CNT<T>
00071 {
00072 private:
00073   typedef decltype(nullptr) Null_type;
00074   typedef Weak_ptr<T, CNT> Wp;
00075
00076 public:
00078   Ref_ptr() noexcept : _p(0) {}
00079
00080   Ref_ptr(Ref_ptr_base::Default_value v)
00081   : _p(reinterpret_cast<T*>(static_cast<unsigned long>(v))) {}
00082
00088   Ref_ptr(Wp const &o) noexcept : _p(o.ptr())
00089   { __take_ref(); }
00090
00092   Ref_ptr(decltype(nullptr) n) noexcept : _p(n) {}
00093
00100   template<typename X>
00101   explicit Ref_ptr(X *o) noexcept : _p(o)
00102   { __take_ref(); }
00103
00114   Ref_ptr(T *o, [[maybe_unused]] bool d) noexcept : _p(o) { }
00115
00121   T *get() const noexcept
00122   {
00123     return _p;
00124   }
00125
00127   T *ptr() const noexcept
00128   {
00129     return _p;
00130   }
00131
00138   T *release() noexcept
00139   {
00140     T *p = _p;
```

```
00141     _p = 0;
00142     return p;
00143   }
00144
00145   ~Ref_ptr() noexcept
00146   { __drop_ref(); }
00147
00148   template<typename OT>
00149   Ref_ptr(Ref_ptr<OT, CNT> const &o) noexcept
00150   {
00151     _p = o.ptr();
00152     __take_ref();
00153   }
00154
00155   Ref_ptr(Ref_ptr<T> const &o) noexcept
00156   {
00157     _p = o._p;
00158     __take_ref();
00159   }
00160
00161   template< typename OT >
00162   void operator = (Ref_ptr<OT> const &o) noexcept
00163   {
00164     __drop_ref();
00165     _p = o.ptr();
00166     __take_ref();
00167   }
00168
00169   void operator = (Ref_ptr<T> const &o) noexcept
00170   {
00171     if (&o == this)
00172       return;
00173
00174     __drop_ref();
00175     _p = o._p;
00176     __take_ref();
00177   }
00178
00179   void operator = (Null_type) noexcept
00180   {
00181     __drop_ref();
00182     _p = 0;
00183   }
00184
00185   template<typename OT>
00186   Ref_ptr(Ref_ptr<OT, CNT> &&o) noexcept
00187   { _p = o.release(); }
00188
00189   Ref_ptr(Ref_ptr<T> &&o) noexcept
00190   { _p = o.release(); }
00191
00192   template< typename OT >
00193   void operator = (Ref_ptr<OT> &&o) noexcept
00194   {
00195     __drop_ref();
00196     _p = o.release();
00197   }
00198
00199   void operator = (Ref_ptr<T> &&o) noexcept
00200   {
00201     if (&o == this)
00202       return;
00203
00204     __drop_ref();
00205     _p = o.release();
00206   }
00207
00208   [[nodiscard]] explicit operator bool () const noexcept { return _p; }
00209
00210   T *operator -> () const noexcept
00211   { return _p; }
00212
00213   [[nodiscard]] bool operator == (Ref_ptr const &o) const noexcept
00214   { return _p == o._p; }
00215
00216   [[nodiscard]] bool operator != (Ref_ptr const &o) const noexcept
00217   { return _p != o._p; }
00218
00219   [[nodiscard]] bool operator < (Ref_ptr const &o) const noexcept
00220   { return _p < o._p; }
00221
00222   [[nodiscard]] bool operator <= (Ref_ptr const &o) const noexcept
00223   { return _p <= o._p; }
00224
00225   [[nodiscard]] bool operator > (Ref_ptr const &o) const noexcept
00226   { return _p > o._p; }
00227
```

```
00228   [[nodiscard]] bool operator >= (Ref_ptr const &o) const noexcept
00229   { return _p >= o._p; }
00230
00231   [[nodiscard]] bool operator == (T const *o) const noexcept
00232   { return _p == o; }
00233
00234   [[nodiscard]] bool operator < (T const *o) const noexcept
00235   { return _p < o; }
00236
00237   [[nodiscard]] bool operator <= (T const *o) const noexcept
00238   { return _p <= o; }
00239
00240   [[nodiscard]] bool operator > (T const *o) const noexcept
00241   { return _p > o; }
00242
00243   [[nodiscard]] bool operator >= (T const *o) const noexcept
00244   { return _p >= o; }
00245
00246 private:
00247   void __drop_ref() noexcept
00248   {
00249     if (_p)
00250       static_cast<CNT<T>*>(this)->h_drop_ref(_p);
00251   }
00252
00253   void __take_ref() noexcept
00254   {
00255     if (_p)
00256       static_cast<CNT<T>*>(this)->h_take_ref(_p);
00257   }
00258
00259   T *_p;
00260 };
00261
00262
00263 template<typename T, template< typename X > class CNT>
00264 class Weak_ptr
00265 {
00266 private:
00267   struct Null_type;
00268   typedef Ref_ptr<T, CNT> Rp;
00269
00270 public:
00271   Weak_ptr() = default;
00272   Weak_ptr(decltype(nullptr)) : _p(nullptr) {}
00273   // backwards 0 ctor
00274   explicit Weak_ptr(int x) noexcept
00275   L4_DEPRECATED("Use initialization from 'nullptr'")
00276   : _p(nullptr)
00277   { if (x != 0) __builtin_trap(); }
00278
00279   Weak_ptr(Rp const &o) noexcept : _p(o.ptr()) {}
00280   explicit Weak_ptr(T *o) noexcept : _p(o) {}
00281
00282   template<typename OT>
00283   Weak_ptr(Weak_ptr<OT, CNT> const &o) noexcept : _p(o.ptr()) {}
00284
00285   Weak_ptr(Weak_ptr<T, CNT> const &o) noexcept : _p(o._p) {}
00286
00287   Weak_ptr<T, CNT> &operator = (const Weak_ptr<T, CNT> &o) = default;
00288
00289   T *get() const noexcept { return _p; }
00290   T *ptr() const noexcept { return _p; }
00291
00292   T *operator -> () const noexcept { return _p; }
00293   operator Null_type const * () const noexcept
00294   { return reinterpret_cast<Null_type const*>(_p); }
00295
00296 private:
00297   T *_p;
00298 };
00299
00300 template<typename OT, typename T> inline
00301 Ref_ptr<OT> ref_ptr_static_cast(Ref_ptr<T> const &o)
00302 { return ref_ptr(static_cast<OT*>(o.ptr())); }
00303
00304 template< typename T >
00305 inline Ref_ptr<T> ref_ptr(T *t)
00306 { return Ref_ptr<T>(t); }
00307
00308 template< typename T >
00309 inline Weak_ptr<T> weak_ptr(T *t)
00310 { return Weak_ptr<T>(t); }
00311
00312
00313 class Ref_obj
00314 {
```

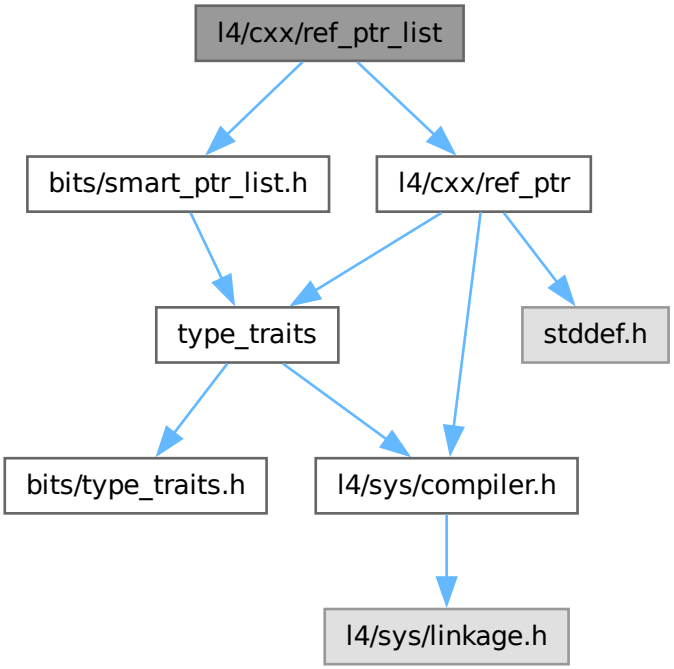
```
00315 private:
00316   mutable int _ref_cnt;
00317
00318 public:
00319   Ref_obj() : _ref_cnt(0)  {}
00320   void add_ref() const noexcept { ++_ref_cnt; }
00321   int remove_ref() const noexcept { return --_ref_cnt; }
00322 };
00323
00324 template< typename T, typename... Args >
00325 Ref_ptr<T>
00326 make_ref_obj(Args &&... args)
00327 { return cxx::Ref_ptr<T>(new T(cxx::forward<Args>(args)...)); }
00328
00329 template<typename T, typename U>
00330 Ref_ptr<T>
00331 dynamic_pointer_cast(Ref_ptr<U> const &p) noexcept
00332 {
00333   // our constructor from a naked pointer increments the counter
00334   return Ref_ptr<T>(dynamic_cast<T *>(p.get()));
00335 }
00336
00337 template<typename T, typename U>
00338 Ref_ptr<T>
00339 static_pointer_cast(Ref_ptr<U> const &p) noexcept
00340 {
00341   // our constructor from a naked pointer increments the counter
00342   return Ref_ptr<T>(static_cast<T *>(p.get()));
00343 }
00344
00345 }
```

16.227 l4/cxx/ref_ptr_list File Reference

Implementation of a list of ref-ptr-managed objects.

```
#include <l4/cxx/ref_ptr>
#include "bits/smart_ptr_list.h"
```

Include dependency graph for ref_ptr_list:



Data Structures

- struct cxx::Ref_obj_list_item< T >

  Item for list linked via cxx::Ref_ptr with default refence counting.

Namespaces

- namespace cxx

  Our C++ library.

Typedefs

- template<typename T>
  using **cxx::Ref_ptr_list_item** = Bits::Smart_ptr_list_item<T, cxx::Ref_ptr<T> >

  Item for list linked with cxx::Ref_ptr.
- template<typename T>
  using **cxx::Ref_ptr_list** = Bits::Smart_ptr_list<Ref_ptr_list_item<T> >

  Single-linked list where elements are connected via a cxx::Ref_ptr.

16.227.1 Detailed Description

Implementation of a list of ref-ptr-managed objects.
Definition in file ref_ptr_list.

16.228 ref_ptr_list

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * Copyright (C) 2018, 2022, 2024 Kernkonzept GmbH.
00008  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/cxx/ref_ptr>
00015
00016 #include "bits/smart_ptr_list.h"
00017
00018 namespace cxx {
00019
00021 template <typename T>
00022 using Ref_ptr_list_item = Bits::Smart_ptr_list_item<T, cxx::Ref_ptr<T> >;
00023
00025 template <typename T>
00026 struct Ref_obj_list_item : public Ref_ptr_list_item<T>, public cxx::Ref_obj {};
00027
00031 template <typename T>
00032 using Ref_ptr_list = Bits::Smart_ptr_list<Ref_ptr_list_item<T> >;
00033
00034 }
```

16.229 result

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002
00003 #pragma once
00004
00005 #include <assert.h>
00006 #include <stdlib.h>
00007
00008 #include "type_traits"
00009 #include "utils"
00010
00011 namespace cxx {
00012
00019 class Error
00020 {
```

```
00021   int _err;
00022
00023 public:
00024   constexpr explicit Error(int err) noexcept : _err(err) {}
00025   constexpr Error(Error const &) noexcept = default;
00026   constexpr Error(Error &&) noexcept = default;
00027
00028   constexpr int error() const noexcept
00029   { return _err; }
00030 };
00031
00038 template <typename T>
00039 class Result
00040 {
00041   // Wrapper providing a placement-new operator. Avoids depending on a global
00042   // placement-new overload (which is not available without <new>).
00043   struct Holder
00044   {
00045     T value;
00046
00047     void *operator new (size_t, void *p) noexcept { return p; }
00048     void operator delete (void *) {}
00049
00050     template<typename... Args>
00051     Holder(Args&&... args)
00052     noexcept(noexcept(T(cxx::forward<Args>(args)...)))
00053     : value(cxx::forward<Args>(args)...) {}
00054   };
00055
00056   union
00057   {
00058     Holder _res;
00059     int _err;
00060   };
00061   bool _has_result;
00062
00063 public:
00070   Result() = delete;
00071
00072   Result(Error err) noexcept
00073   : _err(err.error()), _has_result(false)
00074   {}
00075
00076   template<typename... Args>
00077   explicit Result(in_place_t, Args&&... args)
00078   noexcept(noexcept(T(cxx::forward<Args>(args)...)))
00079   : _res(cxx::forward<Args>(args)...), _has_result(true)
00080   {}
00081
00082   Result(T &&val)
00083   noexcept(noexcept(T(cxx::move(val))))
00084   : _res(cxx::move(val)), _has_result(true)
00085   {}
00086
00087   Result(Result const &o)
00088   noexcept(noexcept(T(o._res.value)))
00089   : _has_result(o._has_result)
00090   {
00091     if (_has_result)
00092       new (&_res) Holder(o._res.value);
00093     else
00094       _err = o._err;
00095   }
00096
00097   Result(Result &&o)
00098   noexcept(noexcept(T(cxx::move(o._res.value))))
00099   : _has_result(o._has_result)
00100   {
00101     if (_has_result)
00102       new (&_res) Holder(cxx::move(o._res.value));
00103     else
00104       _err = o._err;
00105   }
00106
00107   ~Result()
00108   {
00109     if (_has_result)
00110       _res.~Holder();
00111   }
00112
00113   Result &operator=(Result const &o)
00114   noexcept(noexcept(T(o._res.value)))
00115   {
00116     if (_has_result)
00117       _res.~Holder();
00118
00119     _has_result = o._has_result;
```

```
00120     if (_has_result)
00121       new (&_res) Holder(o._res.value);
00122     else
00123       _err = o._err;
00124
00125     return *this;
00126   }
00127
00128   Result &operator=(Result &&o)
00129   {
00130     if (_has_result)
00131       {
00132         if (o._has_result)
00133           _res.value = cxx::move(o._res.value);
00134         else
00135           {
00136             _res.~Holder();
00137             _has_result = false;
00138             _err = o._err;
00139           }
00140       }
00141     else
00142       {
00143         if (o._has_result)
00144           {
00145             new (&_res) Holder(cxx::move(o._res.value));
00146             _has_result = true;
00147           }
00148         else
00149           _err = o._err;
00150       }
00151
00152     return *this;
00153   }
00154
00155   Result &operator=(Error err) noexcept
00156   {
00157     if (_has_result)
00158       _res.~Holder();
00159
00160     _has_result = false;
00161     _err = err.error();
00162
00163     return *this;
00164   }
00165
00166   Result &operator=(T &&val)
00167   {
00168     if (_has_result)
00169       _res.value = cxx::move(val);
00170     else
00171       {
00172         new (&_res) Holder(cxx::move(val));
00173         _has_result = true;
00174       }
00175
00176     return *this;
00177   }
00178
00179   explicit operator bool() const noexcept
00180   { return _has_result; }
00181
00182   int error() const noexcept
00183   { return _has_result ? 0 : _err; }
00184
00185   T const &result() const & noexcept
00186   {
00187     assert(_has_result);
00188     if (!_has_result) [[unlikely]]
00189       abort();
00190
00191     return _res.value;
00192   }
00193
00194   T&& result() && noexcept
00195   {
00196     assert(_has_result);
00197     if (!_has_result) [[unlikely]]
00198       abort();
00199
00200     return cxx::move(_res.value);
00201   }
00202 };
00203
00204 }
```

16.230 slab_alloc

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/cxx/std_alloc>
00013 #include <l4/cxx/hlist>
00014 #include <l4/sys/consts.h>
00015
00016 namespace cxx {
00017
00029 template< int Obj_size, int Slab_size = L4_PAGESIZE,
00030   int Max_free = 2, template<typename A> class Alloc = New_allocator >
00031 class Base_slab
00032 {
00033 private:
00034   struct Free_o
00035   {
00036     Free_o *next;
00037   };
00038
00039 protected:
00040   struct Slab_i;
00041
00042 private:
00043   struct Slab_head : public H_list_item
00044   {
00046     unsigned num_free;
00048     Free_o *free;
00050     Base_slab<Obj_size, Slab_size, Max_free, Alloc> *cache;
00051
00052     inline Slab_head() noexcept : num_free(0), free(0), cache(0)
00053     {}
00054   };
00055
00056   // In an empty or partially filled slab, each free object stores a pointer to
00057   // the next free object. Thus, the size of an object needs to be at least the
00058   // size of a pointer.
00059   static_assert(Obj_size >= sizeof(void *),
00060                 "Object size must be at least the size of a pointer.");
00061   static_assert(Obj_size <= Slab_size - sizeof(Slab_head),
00062                 "Object_size exceeds slab capability.");
00063
00064 public:
00065   enum
00066   {
00068     object_size      = Obj_size,
00070     slab_size        = Slab_size,
00072     objects_per_slab = (Slab_size - sizeof(Slab_head)) / object_size,
00074     max_free_slabs   = Max_free,
00075   };
00076
00077 protected:
00078   struct Slab_store
00079   {
00080     char _o[slab_size - sizeof(Slab_head)];
00081     Free_o *object(unsigned obj) noexcept
00082     { return reinterpret_cast<Free_o*>(_o + object_size * obj); }
00083   };
00084
00086   struct Slab_i : public Slab_store, public Slab_head
00087   {};
00088
00089 public:
00091   typedef Alloc<Slab_i> Slab_alloc;
00092
00093   typedef void Obj_type;
00094
00095 private:
00097   Slab_alloc _alloc;
00099   unsigned _num_free;
00101   unsigned _num_slabs;
00103   H_list<Slab_i> _full_slabs;
00105   H_list<Slab_i> _partial_slabs;
00107   H_list<Slab_i> _empty_slabs;
00108
00110   void add_slab(Slab_i *s) noexcept
00111   {
```

```
00112     s->num_free = objects_per_slab;
00113     s->cache = this;
00114
00115     //L4::cerr « "Slab: " « this « "->add_slab(" « s « ", size="
00116     //  « slab_size « "):" « " f=" « s->object(0) « '\n';
00117
00118     // initialize free list
00119     Free_o *f = s->free = s->object(0);
00120     for (unsigned i = 1; i < objects_per_slab; ++i)
00121       {
00122   f->next = s->object(i);
00123   f = f->next;
00124       }
00125     f->next = 0;
00126
00127     // insert slab into cache's list
00128     _empty_slabs.push_front(s);
00129     ++_num_slabs;
00130     ++_num_free;
00131   }
00132
00134   bool grow() noexcept
00135   {
00136     Slab_i *s = _alloc.alloc();
00137     if (!s)
00138       return false;
00139
00140     new (s, cxx::Nothrow()) Slab_i();
00141
00142     add_slab(s);
00143     return true;
00144   }
00145
00155   void shrink() noexcept
00156   {
00157     if (!_alloc.can_free)
00158       return;
00159
00160     while (!_empty_slabs.empty() && _num_free > max_free_slabs)
00161       {
00162   Slab_i *s = _empty_slabs.front();
00163   _empty_slabs.remove(s);
00164   --_num_free;
00165   --_num_slabs;
00166   _alloc.free(s);
00167       }
00168   }
00169
00170 public:
00171   Base_slab(Slab_alloc const &alloc = Slab_alloc()) noexcept
00172     : _alloc(alloc), _num_free(0), _num_slabs(0), _full_slabs(),
00173       _partial_slabs(), _empty_slabs()
00174   {}
00175
00176   ~Base_slab() noexcept
00177   {
00178     while (!_empty_slabs.empty())
00179       {
00180   Slab_i *o = _empty_slabs.front();
00181   _empty_slabs.remove(o);
00182   _alloc.free(o);
00183       }
00184     while (!_partial_slabs.empty())
00185       {
00186   Slab_i *o = _partial_slabs.front();
00187   _partial_slabs.remove(o);
00188   _alloc.free(o);
00189       }
00190     while (!_full_slabs.empty())
00191       {
00192   Slab_i *o = _full_slabs.front();
00193   _full_slabs.remove(o);
00194   _alloc.free(o);
00195       }
00196   }
00197
00207   void *alloc() noexcept
00208   {
00209     H_list<Slab_i> *free = &_partial_slabs;
00210     if (free->empty())
00211       free = &_empty_slabs;
00212
00213     if (free->empty() && !grow())
00214       return 0;
00215
00216     Slab_i *s = free->front();
00217     Free_o *o = s->free;
```

```
00218     s->free = o->next;
00219
00220     if (free == &_empty_slabs)
00221       {
00222   _empty_slabs.remove(s);
00223         --_num_free;
00224       }
00225
00226     --(s->num_free);
00227
00228     if (!s->free)
00229       {
00230   _partial_slabs.remove(s);
00231         _full_slabs.push_front(s);
00232       }
00233     else if (free == &_empty_slabs)
00234       _partial_slabs.push_front(s);
00235
00236     //L4::cerr « this « "->alloc(): " « o « ", of " « s « '\n';
00237
00238     return o;
00239   }
00240
00246   void free(void *_o) noexcept
00247   {
00248     if (!_o)
00249       return;
00250
00251     unsigned long addr = reinterpret_cast<unsigned long>(_o);
00252
00253     // find out the slab the object is in
00254     addr = (addr / slab_size) * slab_size;
00255     Slab_i *s = reinterpret_cast<Slab_i*>(addr);
00256
00257     if (s->cache != this)
00258       return;
00259
00260     Free_o *o = reinterpret_cast<Free_o*>(_o);
00261
00262     o->next = s->free;
00263     s->free = o;
00264
00265     bool was_full = false;
00266
00267     if (!s->num_free)
00268       {
00269   _full_slabs.remove(s);
00270   was_full = true;
00271       }
00272
00273     ++(s->num_free);
00274
00275     if (s->num_free == objects_per_slab)
00276       {
00277   if (!was_full)
00278     _partial_slabs.remove(s);
00279
00280   _empty_slabs.push_front(s);
00281   ++_num_free;
00282   if (_num_free > max_free_slabs)
00283     shrink();
00284
00285   was_full = false;
00286       }
00287     else if (was_full)
00288       _partial_slabs.push_front(s);
00289
00290     //L4::cerr « this « "->free(" « _o « "): of " « s « '\n';
00291   }
00292
00299   unsigned total_objects() const noexcept
00300   { return _num_slabs * objects_per_slab; }
00301
00308   unsigned free_objects() const noexcept
00309   {
00310     unsigned count = 0;
00311
00312     /* count partial slabs first */
00313     for (typename H_list<Slab_i>::Const_iterator s = _partial_slabs.begin();
00314          s != _partial_slabs.end(); ++s)
00315       count += s->num_free;
00316
00317     /* add empty slabs */
00318     count += _num_free * objects_per_slab;
00319
00320     return count;
00321   }
```

```
00322 };
00323
00333 template<typename Type, int Slab_size = L4_PAGESIZE,
00334   int Max_free = 2, template<typename A> class Alloc = New_allocator >
00335 class Slab : public Base_slab<sizeof(Type), Slab_size, Max_free, Alloc>
00336 {
00337 private:
00338   typedef Base_slab<sizeof(Type), Slab_size, Max_free, Alloc> Base_type;
00339 public:
00340
00341   typedef Type Obj_type;
00342
00343   Slab(typename Base_type::Slab_alloc const &alloc
00344       = typename Base_type::Slab_alloc()) noexcept
00345     : Base_slab<sizeof(Type), Slab_size, Max_free, Alloc>(alloc) {}
00346
00347
00355   Type *alloc() noexcept
00356   {
00357     return reinterpret_cast<Type *>(Base_type::alloc());
00358   }
00359
00366   void free(Type *o) noexcept
00367   { Base_slab<sizeof(Type), Slab_size, Max_free, Alloc>::free(o); }
00368 };
00369
00370
00386 template< int Obj_size, int Slab_size = L4_PAGESIZE,
00387   int Max_free = 2, template<typename A> class Alloc = New_allocator >
00388 class Base_slab_static
00389 {
00390 private:
00391   typedef Base_slab<Obj_size, Slab_size, Max_free, Alloc> _A;
00392   static _A _a;
00393 public:
00394   typedef void Obj_type;
00395   enum
00396   {
00398     object_size      = Obj_size,
00400     slab_size        = Slab_size,
00402     objects_per_slab = _A::objects_per_slab,
00404     max_free_slabs   = Max_free,
00405   };
00406
00412   void *alloc() noexcept { return _a.alloc(); }
00413
00420   void free(void *p) noexcept { _a.free(p); }
00421
00430   unsigned total_objects() const noexcept { return _a.total_objects(); }
00431
00440   unsigned free_objects() const noexcept { return _a.free_objects(); }
00441 };
00442
00443
00444 template< int _O, int _S, int _M, template<typename A> class Alloc >
00445 typename Base_slab_static<_O,_S,_M,Alloc>::_A
00446   Base_slab_static<_O,_S,_M,Alloc>::_a;
00447
00463 template<typename Type, int Slab_size = L4_PAGESIZE,
00464   int Max_free = 2, template<typename A> class Alloc = New_allocator >
00465 class Slab_static
00466 : public Base_slab_static<sizeof(Type), Slab_size, Max_free, Alloc>
00467 {
00468 public:
00469
00470   typedef Type Obj_type;
00478   Type *alloc() noexcept
00479   {
00480     return reinterpret_cast<Type *>(
00481       Base_slab_static<sizeof(Type), Slab_size, Max_free, Alloc>::alloc());
00482   }
00483 };
00484
00485 }
```

16.231 slist

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2011 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
```

```
00008
00009 #pragma once
00010
00011 #include "bits/list_basics.h"
00012
00013 namespace cxx {
00014
00015 class S_list_item
00016 {
00017 public:
00018   S_list_item() : _n(nullptr) {}
00019   // BSS allocation
00020   explicit S_list_item(bool) {}
00021
00022 private:
00023   template<typename T, typename P> friend class S_list;
00024   template<typename T, typename P> friend class S_list_tail;
00025   template<typename T, typename X> friend struct Bits::Basic_list_policy;
00026
00027   S_list_item(S_list_item const &);
00028   void operator = (S_list_item const &);
00029
00030   S_list_item *_n;
00031 };
00032
00039 template< typename T, typename POLICY = Bits::Basic_list_policy< T, S_list_item > >
00040 class S_list : public Bits::Basic_list<POLICY>
00041 {
00042   S_list(S_list const &) = delete;
00043   void operator = (S_list const &) = delete;
00044
00045 private:
00046   typedef typename Bits::Basic_list<POLICY> Base;
00047
00048 public:
00049   typedef typename Base::Iterator Iterator;
00050
00051   S_list(S_list &&o) : Base(static_cast<Base&&>(o)) {}
00052
00053   S_list &operator = (S_list &&o) &
00054   {
00055     if (&o != this)
00056       Base::operator = (static_cast<Base&&>(o));
00057
00058     return *this;
00059   }
00060
00061   // BSS allocation
00062   explicit S_list(bool x) : Base(x) {}
00063
00064   constexpr S_list() : Base() {}
00065
00067   void add(T *e)
00068   {
00069     e->_n = this->_f;
00070     this->_f = e;
00071   }
00072
00073   template< typename CAS >
00074   void add(T *e, CAS const &c)
00075   {
00076     do
00077       {
00078         e->_n = this->_f;
00079       }
00080     while (!c(&this->_f, e->_n, e));
00081   }
00082
00084   void push_front(T *e) { add(e); }
00085
00091   T *pop_front()
00092   {
00093     T *r = this->front();
00094     if (this->_f)
00095       this->_f = this->_f->_n;
00096     return r;
00097   }
00098
00099   void insert(T *e, Iterator const &pred)
00100   {
00101     S_list_item *p = *pred;
00102     e->_n = p->_n;
00103     p->_n = e;
00104   }
00105
00106   static void insert_before(T *e, Iterator const &succ)
00107   {
```

```
00108     S_list_item **x = Base::__get_internal(succ);
00109
00110     e->_n = *x;
00111     *x = e;
00112   }
00113
00114   static void replace(Iterator const &p, T*e)
00115   {
00116     S_list_item **x = Base::__get_internal(p);
00117     e->_n = (*x)->_n;
00118     *x = e;
00119   }
00120
00121   static Iterator erase(Iterator const &e)
00122   {
00123     S_list_item **x = Base::__get_internal(e);
00124     *x = (*x)->_n;
00125     return e;
00126   }
00127
00128 };
00129
00130
00131 template< typename T >
00132 class S_list_bss : public S_list<T>
00133 {
00134 public:
00135   S_list_bss() : S_list<T>(true) {}
00136 };
00137
00138 template< typename T, typename POLICY = Bits::Basic_list_policy< T, S_list_item >  >
00139 class S_list_tail : public S_list<T, POLICY>
00140 {
00141 private:
00142   typedef S_list<T, POLICY> Base;
00143   void add(T *e) = delete;
00144
00145 public:
00146   using Iterator = typename Base::Iterator;
00147   constexpr S_list_tail() : Base(), _tail(&this->_f) {}
00148
00149   S_list_tail(S_list_tail &&t)
00150   : Base(static_cast<Base&&>(t)), _tail(Base::empty() ? &this->_f : t._tail)
00151   {
00152     t._tail = &t._f; // reset the source tail
00153   }
00154
00155   S_list_tail &operator = (S_list_tail &&t) &
00156   {
00157     if (&t != this)
00158       {
00159         Base::operator = (static_cast<Base &&>(t));
00160         // The Basic_list operator= does not clear the tail, so we can use it
00161         _tail = Base::empty() ? &this->_f : t._tail;
00162         t._tail = &t._f; // reset the source tail
00163       }
00164
00165     return *this;
00166   }
00167
00168   void push_front(T *e)
00169   {
00170     if (Base::empty())
00171       _tail = &e->_n;
00172
00173     Base::push_front(e);
00174   }
00175
00176   void push_back(T *e)
00177   {
00178     e->_n = nullptr;
00179     *_tail = e;
00180     _tail = &e->_n;
00181   }
00182
00183   void clear()
00184   {
00185     Base::clear();
00186     _tail = &this->_f;
00187   }
00188
00189   void append(S_list_tail &o)
00190   {
00191     T *x = o.front();
00192     *_tail = x;
00193     if (x)
00194       _tail = o._tail;
```

```
00195     o.clear();
00196   }
00197
00198   T *pop_front()
00199   {
00200     T *t = Base::pop_front();
00201     if (t && Base::empty())
00202       _tail = &this->_f;
00203     return t;
00204   }
00205
00206 private:
00207   static void insert(T *e, Iterator const &pred);
00208   static void insert_before(T *e, Iterator const &succ);
00209   static void replace(Iterator const &p, T*e);
00210   static Iterator erase(Iterator const &e);
00211
00212 private:
00213   S_list_item **_tail;
00214 };
00215
00216 }
```

16.232 static_container

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2012-2013 Technische Universität Dresden.
00004  * Copyright (C) 2016-2017, 2020, 2023-2024 Kernkonzept GmbH.
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/cxx/type_traits>
00012 #include <stddef.h>
00013
00014 namespace cxx {
00015
00016 template< typename T >
00017 class Static_container
00018 {
00019 private:
00020   struct X : T
00021   {
00022     void *operator new (size_t, void *p) noexcept { return p; }
00023     void operator delete (void *) {}
00024     X() = default;
00025     template<typename ...Args>
00026     X(Args && ...a) : T(cxx::forward<Args>(a)...) {}
00027   };
00028
00029 public:
00030   void operator = (Static_container const &) = delete;
00031   Static_container(Static_container const &) = delete;
00032   Static_container() = default;
00033
00034   T *get() { return reinterpret_cast<X*>(_s); }
00035   T *operator -> () { return get(); }
00036   T &operator * () { return *get(); }
00037   operator T* () { return get(); }
00038
00039   void construct()
00040   { new (reinterpret_cast<void*>(_s)) X; }
00041
00042   template< typename ...Args >
00043   void construct(Args && ...args)
00044   { new (reinterpret_cast<void*>(_s)) X(cxx::forward<Args>(args)...); }
00045
00046 private:
00047   char _s[sizeof(X)] __attribute__((aligned(__alignof(X))));
00048 };
00049
00050 }
00051
00052
```

16.233 static_vector

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
```

```
00002
00003 #pragma once
00004
00005 #include "type_traits"
00006
00007 namespace cxx {
00008
00015 template<typename T, typename IDX = unsigned>
00016 class static_vector
00017 {
00018 private:
00019   template<typename X, typename IDX2> friend class static_vector;
00020   T *_v = nullptr;
00021   IDX _l = 0;
00022
00023 public:
00024   typedef T value_type;
00025   typedef IDX index_type;
00026
00027   constexpr static_vector() = default;
00028   constexpr static_vector(value_type *v, index_type length) : _v(v), _l(length) {}
00029
00030   template<typename Z,
00031            typename = enable_if_t<is_same<remove_extent_t<Z>, T>::value»
00032   constexpr static_vector(Z &v) : _v(v), _l(array_size(v))
00033   {}
00034
00036   template<typename X,
00037            typename = enable_if_t<is_convertible_v<X, T»>
00038   static_vector(static_vector<X, IDX> const &o) : _v(o._v), _l(o._l) {}
00039
00040   index_type size() const { return _l; }
00041   bool empty() const { return _l == 0; }
00042
00043   value_type &operator [] (index_type idx) { return _v[idx]; }
00044   value_type const &operator [] (index_type idx) const { return _v[idx]; }
00045
00046   value_type *begin() { return _v; }
00047   value_type *end() { return _v + _l; }
00048   value_type const *begin() const { return _v; }
00049   value_type const *end() const { return _v + _l; }
00050   value_type const *cbegin() const { return _v; }
00051   value_type const *cend() const { return _v + _l; }
00052
00054   index_type index(value_type const *o) const { return o - _v; }
00055   index_type index(value_type const &o) const { return &o - _v; }
00056 };
00057
00058 }
```

16.234 std_alloc

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <stddef.h>
00013 namespace cxx {
00019 class Nothrow {};
00020 }
00021
00028 inline void *operator new (size_t, void *mem, cxx::Nothrow const &) noexcept
00029 { return mem; }
00030
00035 void *operator new (size_t, cxx::Nothrow const &) noexcept;
00036
00042 void operator delete (void *, cxx::Nothrow const &) noexcept;
00043
00044 namespace cxx {
00045
00046
00055 template< typename _Type >
00056 class New_allocator
00057 {
00058 public:
00059   enum { can_free = true };
00060
```

```
00061   New_allocator() noexcept {}
00062   New_allocator(New_allocator const &) noexcept {}
00063
00064   ~New_allocator() noexcept {}
00065
00066   _Type *alloc() noexcept
00067   { return static_cast<_Type*>(::operator new(sizeof (_Type), cxx::Nothrow())); }
00068
00069   void free(_Type *t) noexcept
00070   { ::operator delete(t, cxx::Nothrow()); }
00071 };
00072
00073 }
00074
```

16.235 std_ops

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 namespace cxx {
00013
00017 template< typename Obj >
00018 struct Lt_functor
00019 {
00020   bool operator () (Obj const &l, Obj const &r) const
00021   { return l < r; }
00022 };
00023
00024 };
00025
```

16.236 string

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00012 #pragma once
00013
00014 #include <l4/cxx/minmax>
00015 #include <l4/cxx/basic_ostream>
00016 #include <l4/sys/cxx/limits>
00017 #include <l4/sys/err.h>
00018
00019
00020 namespace cxx {
00021
00032 class String
00033 {
00034 public:
00035
00037   typedef char const *Index;
00038
00040   String(char const *s) noexcept : _start(s), _len(__builtin_strlen(s)) {}
00042   String(char const *s, unsigned long len) noexcept : _start(s), _len(len) {}
00043
00050   String(char const *s, char const *e) noexcept : _start(s), _len(e - s) {}
00051
00053   String() : _start(0), _len(0) {}
00054
00056   Index start() const { return _start; }
00058   Index end() const { return _start + _len; }
00060   int len() const { return _len; }
00061
00063   void start(char const *s) { _start = s; }
00065   void len(unsigned long len) { _len = len; }
00067   bool empty() const { return !_len; }
00068
```

```
00070   String head(Index end) const
00071   {
00072     if (end < _start)
00073       return String();
00074
00075     if (eof(end))
00076       return *this;
00077
00078     return String(_start, end - _start);
00079   }
00080
00082   String head(unsigned long end) const
00083   { return head(start() + end); }
00084
00086   String substr(unsigned long idx, unsigned long len = ~0UL) const
00087   {
00088     if (idx >= _len)
00089       return String(end(), 0UL);
00090
00091     return String(_start + idx, cxx::min(len, _len - idx));
00092   }
00093
00095   String substr(char const *start, unsigned long len = 0) const
00096   {
00097     if (start >= _start && !eof(start))
00098       {
00099   unsigned long nlen = _start + _len - start;
00100   if (len != 0)
00101     nlen = cxx::min(nlen, len);
00102   return String(start, nlen);
00103       }
00104
00105     return String(end(), 0UL);
00106   }
00107
00109   template< typename F >
00110   char const *find_match(F &&match) const
00111   {
00112     String::Index s = _start;
00113     while (1)
00114       {
00115   if (eof(s))
00116     return s;
00117
00118   if (match(*s))
00119     return s;
00120
00121   ++s;
00122       }
00123   }
00124
00126   char const *find(char const *c) const
00127   { return find(c, start());  }
00128
00130   char const *find(int c) const
00131   { return find(c, start());  }
00132
00134   char const *rfind(char const *c) const
00135   {
00136     if (!_len)
00137       return end();
00138
00139     char const *p = end();
00140     --p;
00141     while (p >= _start)
00142       {
00143   if (*p == *c)
00144     return p;
00145   --p;
00146       }
00147     return end();
00148
00149   }
00150
00157   Index starts_with(cxx::String const &c) const
00158   {
00159     unsigned long i;
00160     for (i = 0; i < c._len && i < _len; ++i)
00161       if (_start[i] != c[i])
00162   return 0;
00163     return i == c._len ? start() + i : 0;
00164   }
00165
00167   char const *find(int c, char const *s) const
00168   {
00169     if (s < _start)
00170       return end();
```

```
00171
00172     while (1)
00173       {
00174   if (eof(s))
00175     return s;
00176
00177   if (*s == c)
00178     return s;
00179
00180   ++s;
00181       }
00182   }
00183
00193   char const *find(char const *c, char const *s) const
00194   {
00195     if (s < _start)
00196       return end();
00197
00198     while (1)
00199       {
00200   if (eof(s))
00201     return s;
00202
00203   for (char const *x = c; *x; ++x)
00204     if (*s == *x)
00205       return s;
00206
00207   ++s;
00208       }
00209   }
00210
00212   char const &operator [] (unsigned long idx) const { return _start[idx]; }
00214   char const &operator [] (int idx) const { return _start[idx]; }
00216   char const &operator [] (Index idx) const { return *idx; }
00217
00219   bool eof(char const *s) const { return s >= _start + _len || !*s; }
00220
00229   template<typename INT>
00230   int from_dec(INT *v) const
00231   {
00232     *v = 0;
00233     Index c;
00234     for (c = start(); !eof(c); ++c)
00235       {
00236   unsigned char n;
00237   if (*c >= '0' && *c <= '9')
00238     n = *c - '0';
00239   else
00240     return c - start();
00241
00242         *v *= 10;
00243   *v += n;
00244       }
00245     return c - start();
00246   }
00247
00258   template<typename INT>
00259   int from_hex(INT *v) const
00260   {
00261     *v = 0;
00262     unsigned shift = 0;
00263     Index c;
00264     for (c = start(); !eof(c); ++c)
00265       {
00266   shift += 4;
00267   if (shift > sizeof(INT) * 8)
00268     return -1;
00269   unsigned char n;
00270   if (*c >= '0' && *c <= '9')
00271     n = *c - '0';
00272   else if (*c >= 'A' && *c <= 'F')
00273     n = *c - 'A' + 10;
00274   else if (*c >= 'a' && *c <= 'f')
00275     n = *c - 'a' + 10;
00276   else
00277     return c - start();
00278
00279         *v <<= 4;
00280   *v |= n;
00281       }
00282     return c - start();
00283   }
00284
00308   template<typename INT>
00309   int from_number(INT *v, unsigned base = 0) const
00310   {
00311     // Accumulate in the widest unsigned type. This way the magnitude of the
```

```
00312     // most negative number of a signed INT can be represented too.
00313     typedef unsigned long long Acc;
00314
00315     if (base == 1 || base > 36)
00316       return -L4_EINVAL;
00317
00318     // Value of character `c' in `b', or -1 if it is not a valid digit.
00319     auto to_digit = [](char c, unsigned b) -> int
00320       {
00321         int d;
00322         if (c >= '0' && c <= '9')
00323           d = c - '0';
00324         else if (c >= 'a' && c <= 'z')
00325           d = c - 'a' + 10;
00326         else if (c >= 'A' && c <= 'Z')
00327           d = c - 'A' + 10;
00328         else
00329           return -1;
00330
00331         return d < static_cast<int>(b) ? d : -1;
00332       };
00333
00334     Index i = start();
00335     bool negate = false;
00336     bool have_digits = false;
00337
00338     // skip leading space
00339     while (!eof(i) && (*i == ' ' || *i == '\t'))
00340       ++i;
00341
00342     // optional sign
00343     if (!eof(i) && (*i == '-' || *i == '+'))
00344       {
00345         negate = *i == '-';
00346         ++i;
00347       }
00348
00349     // Optional base prefix. The leading '0' is a valid number of its own, so
00350     // the "0x" prefix is only consumed if a hexadecimal digit follows.
00351     if ((base == 0 || base == 16) && !eof(i) && *i == '0')
00352       {
00353         have_digits = true;
00354         ++i;
00355
00356         if (   !eof(i)     && (*i == 'x' || *i == 'X')
00357             && !eof(i + 1) && to_digit(i[1], 16) >= 0)
00358           {
00359             base = 16;
00360             ++i;
00361           }
00362         else if (base == 0)
00363           base = 8;
00364       }
00365     else if (base == 0)
00366       base = 10;
00367
00368     constexpr INT Max = L4::Types::numeric_limits<INT>::max();
00369     constexpr INT Min = L4::Types::numeric_limits<INT>::min();
00370
00371     // Upper bound of the magnitude. For signed types the negative range is one
00372     // larger than the positive one. Unsigned types wrap around on negation.
00373     Acc const limit = static_cast<Acc>(Max) + ((Min != 0 && negate) ? 1U : 0U);
00374     Acc const lim_div = limit / base;
00375     Acc const lim_mod = limit % base;
00376
00377     // feed the numbers
00378     Acc acc = 0;
00379     while (!eof(i))
00380       {
00381         int d = to_digit(*i, base);
00382         if (d < 0)
00383           break;
00384
00385         if (acc > lim_div || (acc == lim_div && static_cast<Acc>(d) > lim_mod))
00386           return -L4_ERANGE;
00387
00388         acc = acc * base + static_cast<Acc>(d);
00389         have_digits = true;
00390         ++i;
00391       }
00392
00393     if (!have_digits)
00394       return 0;
00395
00396     if (!negate)
00397       *v = static_cast<INT>(acc);
00398     else if (Min != 0 && acc == static_cast<Acc>(Max) + 1U)
```

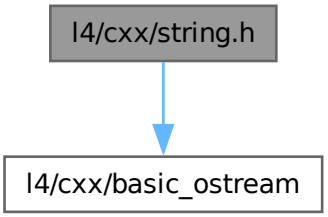
```
00399       *v = Min;
00400     else
00401       *v = static_cast<INT>(-static_cast<INT>(acc));
00402
00403     return i - start();
00404   }
00405
00407   bool operator == (String const &o) const
00408   {
00409     if (len() != o.len())
00410       return false;
00411
00412     for (unsigned long i = 0; i < _len; ++i)
00413       if (_start[i] != o._start[i])
00414   return false;
00415
00416     return true;
00417   }
00418
00420   bool operator != (String const &o) const
00421   { return ! (operator == (o)); }
00422
00423 private:
00424   char const *_start;
00425   unsigned long _len;
00426 };
00427
00428 }
00429
00431 inline
00432 L4::BasicOStream &operator « (L4::BasicOStream &s, cxx::String const &str)
00433 {
00434   s.write(str.start(), str.len());
00435   return s;
00436 }
```

16.237 l4/cxx/string.h File Reference

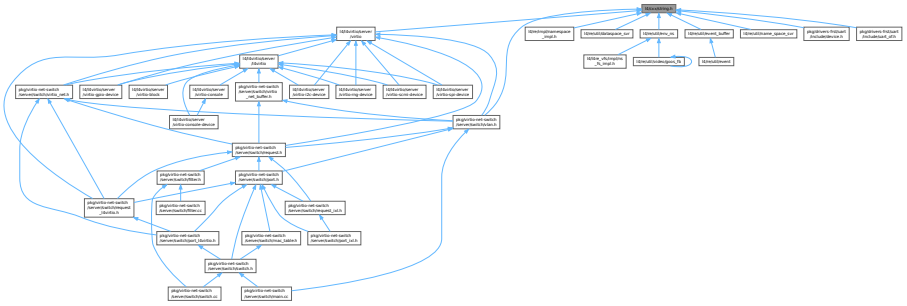
String.

`#include <l4/cxx/basic_ostream>`

Include dependency graph for string.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::String

  A null-terminated string container class.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.237.1 Detailed Description

String.
Definition in file string.h.

16.238 string.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2004-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00007  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/cxx/basic_ostream>
00015
00016 namespace L4 {
00017
00022   class String
00023   {
00024   public:
00025     String(char const *str = "") : _str(str)
00026     {}
00027
00028     unsigned length() const
00029     {
00030       unsigned l;
00031       for (l = 0; _str[l]; l++)
00032         ;
00033       return l;
00034     }
00035
00036     char const *p_str() const { return _str; }
00037
00038   private:
00039     char const *_str;
00040   };
00041 }
00042
00043 inline
00044 L4::BasicOStream &operator « (L4::BasicOStream &o, L4::String const &s)
```

```
00045 {
00046   o « s.p_str();
00047   return o;
00048 }
```

16.239 tree_alloc

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2025 Viktor Reusch
00004  *
00005  * based on the list_alloc by
00006  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00007  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #pragma once
00014
00015 #include <l4/cxx/arith>
00016 #include <l4/cxx/avl_tree>
00017 #include <l4/cxx/iostream>
00018 #include <l4/cxx/minmax>
00019 #include <l4/cxx/type_traits>
00020 #include <l4/sys/consts.h>
00021
00022 namespace cxx
00023 {
00024
00028 class Tree_alloc
00029 {
00030 private:
00031   friend class Tree_alloc_sanity_guard;
00032
00033   struct Mem_block : public Avl_tree_node
00034   {
00035     unsigned long size;
00036
00037     unsigned long addr() { return reinterpret_cast<unsigned long>(this); }
00038     unsigned long end() { return addr() + size; }
00039   };
00040
00041   struct Mem_block_get_key
00042   {
00043     typedef unsigned long Key_type;
00044     static Key_type key_of(Mem_block const *e)
00045     {
00046       return reinterpret_cast<unsigned long>(e);
00047     }
00048   };
00049
00050   Avl_tree<Mem_block, Mem_block_get_key> _tree;
00051
00052   inline void check_overlap(void *, unsigned long) const;
00053   inline void sanity_check_list(char const *, char const *,
00054                                 bool unmerged = true) const;
00055   inline void merge(Mem_block *, Mem_block *);
00056
00057 public:
00070   inline void free(void *block, unsigned long size, bool initial_free = false);
00071
00086   inline void *alloc(unsigned long size, unsigned long align,
00087                      unsigned long lower = 0, unsigned long upper = ~0UL);
00088
00109   inline void *alloc_max(unsigned long min, unsigned long *max,
00110                          unsigned long align, unsigned granularity,
00111                          unsigned long lower = 0, unsigned long upper = ~0UL);
00112
00118   inline unsigned long avail() const;
00119
00120   template<typename DBG>
00121   void dump_free_list(DBG &out) const;
00122 };
00123
00124 #if !defined(CXX_TREE_ALLOC_SANITY)
00125 class Tree_alloc_sanity_guard
00126 {
00127 public:
00128   Tree_alloc_sanity_guard(Tree_alloc const *, char const *, bool = true) {}
00129 };
00130
00131 void
```

```
00132 Tree_alloc::check_overlap(void *, unsigned long) const
00133 {}
00134
00135 void
00136 Tree_alloc::sanity_check_list(char const *, char const *, bool) const
00137 {}
00138
00139 #else
00140
00141 class Tree_alloc_sanity_guard
00142 {
00143 private:
00144   Tree_alloc const *a;
00145   char const *func;
00146
00147 public:
00148   Tree_alloc_sanity_guard(Tree_alloc const *a, char const *func,
00149                           bool unmerged = false)
00150   : a(a), func(func)
00151   {
00152     a->sanity_check_list(func, "entry", unmerged);
00153   }
00154
00155   ~Tree_alloc_sanity_guard() { a->sanity_check_list(func, "exit"); }
00156 };
00157
00158 void
00159 Tree_alloc::check_overlap(void *b, unsigned long s) const
00160 {
00161   unsigned long const mb_align =
00162     (1UL << arith::Ld<sizeof(Mem_block)>::value) - 1;
00163   if (reinterpret_cast<unsigned long>(b) & mb_align)
00164     {
00165       L4::cerr << "Tree_alloc(FATAL): trying to free unaligned memory: " << b
00166                << " align=" << arith::Ld<sizeof(Mem_block)>::value << "\n";
00167     }
00168
00169   for (auto const &c : tree)
00170     {
00171       unsigned long x_s = (unsigned long)b;
00172       unsigned long x_e = x_s + s;
00173       unsigned long b_s = (unsigned long)&c;
00174       unsigned long b_e = b_s + c.size;
00175
00176       if ((x_s >= b_s && x_s < b_e) || (x_e > b_s && x_e <= b_e)
00177           || (b_s >= x_s && b_s < x_e) || (b_e > x_s && b_e <= x_e))
00178         {
00179           L4::cerr << "Tree_alloc(FATAL): trying to free memory that "
00180                       "is already free: \n  ["
00181                    << (void *)x_s << '-' << (void *)x_e << ") overlaps ["
00182                    << (void *)b_s << '-' << (void *)b_e << ")\n";
00183         }
00184     }
00185 }
00186
00187 void
00188 Tree_alloc::sanity_check_list(char const *func, char const *info, bool unmerged) const
00189 {
00190   for (auto c = tree.begin(); c != tree.end(); ++c)
00191     {
00192       auto next = c + 1;
00193
00194       if (next != tree.end())
00195         {
00196           if (c->addr() >= next->addr())
00197             {
00198               L4::cerr << "Tree_alloc(FATAL): " << func << '(' << info
00199                        << "): list order violation\n";
00200             }
00201
00202           auto cmp = +[](unsigned long a, unsigned long b) { return a >= b; };
00203           if (unmerged)
00204             cmp = +[](unsigned long a, unsigned long b) { return a > b; };
00205           if (cmp(c->addr() + c->size, next->addr()))
00206             {
00207               L4::cerr << "Tree_alloc(FATAL): " << func << '(' << info
00208                        << "): list order violation\n";
00209             }
00210         }
00211     }
00212 }
00213
00214 #endif
00215
00216 void
00217 Tree_alloc::free(void *block, unsigned long size, bool initial_free)
00218 {
```

```
00219   [[maybe_unused]] Tree_alloc_sanity_guard guard(this, __func__);
00220
00221   unsigned long const mb_align =
00222     (1UL << arith::Ld<sizeof(Mem_block)>::value) - 1;
00223
00224   if (initial_free)
00225     {
00226       // enforce alignment constraint on initial memory
00227       unsigned long nblock =
00228         (reinterpret_cast<unsigned long>(block) + mb_align) & ~mb_align;
00229       size =
00230         (size - (nblock - reinterpret_cast<unsigned long>(block))) & ~mb_align;
00231       block = reinterpret_cast<void *>(nblock);
00232     }
00233   else
00234     // blow up size to the minimum aligned size
00235     size = (size + mb_align) & ~mb_align;
00236
00237   check_overlap(block, size);
00238
00239   Mem_block *m;
00240   auto addr = reinterpret_cast<unsigned long>(block);
00241   // Extend preceding region if it is adjacent.
00242   auto lower = _tree.last_less_equal_node(addr);
00243   if (lower && lower->end() == addr)
00244     {
00245       lower->size += size;
00246       m = lower;
00247     }
00248   else
00249     {
00250       m = reinterpret_cast<Mem_block *>(block);
00251       m->size = size;
00252       _tree.insert(m);
00253     }
00254
00255   // Merge with following region if it is adjacent.
00256   auto next = _tree.remove(m->end());
00257   if (next)
00258     m->size += next->size;
00259 }
00260
00261 void *
00262 Tree_alloc::alloc_max(unsigned long min, unsigned long *max,
00263                       unsigned long align, unsigned granularity,
00264                       unsigned long lower, unsigned long upper)
00265 {
00266   [[maybe_unused]] Tree_alloc_sanity_guard guard(this, __func__);
00267
00268   unsigned char const mb_bits = arith::Ld<sizeof(Mem_block)>::value;
00269   unsigned long const mb_align = (1UL << mb_bits) - 1;
00270
00271   // blow minimum up to at least the minimum aligned size of a Mem_block
00272   min = l4_round_size(min, mb_bits);
00273   // truncate maximum to at least the size of a Mem_block
00274   *max = l4_trunc_size(*max, mb_bits);
00275   // truncate maximum size according to granularity
00276   *max = *max & ~(granularity - 1UL);
00277
00278   if (min > *max)
00279     return nullptr;
00280
00281   unsigned long almask = align ? (align - 1UL) : 0;
00282
00283   // minimum alignment is given by the size of a Mem_block
00284   if (almask < mb_align)
00285     almask = mb_align;
00286
00287   Mem_block *fit = nullptr;
00288   unsigned long max_fit = 0;
00289   unsigned long a_lower = (lower + almask) & ~almask;
00290
00291   for (auto &c : _tree)
00292     {
00293       // address of free memory block
00294       unsigned long n_start = c.addr();
00295
00296       // block too small, next
00297       // XXX: maybe we can skip this and just do the test below
00298       if (c.size < min)
00299         continue;
00300
00301       // block outside region, next
00302       if (upper < n_start || a_lower > n_start + c.size)
00303         continue;
00304
00305       // aligned start address within the free block
```

```
00306       unsigned long a_start = (n_start + almask) & ~almask;
00307
00308       // check if aligned start address is behind the block, next
00309       if (a_start - n_start >= c.size)
00310         continue;
00311
00312       a_start = a_start < a_lower ? a_lower : a_start;
00313
00314       // end address would overflow, next
00315       if (min > ~0UL - a_start)
00316         continue;
00317
00318       // block outside region, next
00319       if (a_start + min - 1UL > upper)
00320         continue;
00321
00322       // remaining size after subtracting the padding for the alignment
00323       unsigned long r_size = c.size - a_start + n_start;
00324
00325       // upper limit can limit maximum size
00326       if (a_start + r_size - 1UL > upper)
00327         r_size = upper - a_start + 1UL;
00328
00329       // round down according to granularity
00330       r_size &= ~(granularity - 1UL);
00331
00332       // block too small
00333       if (r_size < min)
00334         continue;
00335
00336       if (r_size >= *max)
00337         {
00338           fit = &c;
00339           max_fit = *max;
00340           break;
00341         }
00342
00343       if (r_size > max_fit)
00344         {
00345           max_fit = r_size;
00346           fit = &c;
00347         }
00348     }
00349
00350   if (fit)
00351     {
00352       unsigned long n_start = fit->addr();
00353       unsigned long a_lower = (lower + almask) & ~almask;
00354       unsigned long a_start = (n_start + almask) & ~almask;
00355       a_start = a_start < a_lower ? a_lower : a_start;
00356       unsigned long r_size = fit->size - a_start + n_start;
00357
00358       if (a_start > n_start)
00359         fit->size -= r_size;
00360       else
00361         _tree.remove(fit->addr());
00362
00363       *max = max_fit;
00364       if (r_size == max_fit)
00365         return reinterpret_cast<void *>(a_start);
00366
00367       Mem_block *m = reinterpret_cast<Mem_block *>(a_start + max_fit);
00368       m->size = r_size - max_fit;
00369       _tree.insert(m);
00370       return reinterpret_cast<void *>(a_start);
00371     }
00372
00373   return 0;
00374 }
00375
00376 void *
00377 Tree_alloc::alloc(unsigned long size, unsigned long align, unsigned long lower,
00378                   unsigned long upper)
00379 {
00380   [[maybe_unused]] Tree_alloc_sanity_guard guard(this, __func__);
00381
00382   unsigned long const mb_align =
00383     (1UL << arith::Ld<sizeof(Mem_block)>::value) - 1;
00384
00385   // blow up size to the minimum aligned size
00386   size = (size + mb_align) & ~mb_align;
00387
00388   unsigned long almask = align ? (align - 1UL) : 0;
00389
00390   // minimum alignment is given by the size of a Mem_block
00391   if (almask < mb_align)
00392     almask = mb_align;
```

```
00393
00394   unsigned long a_lower = (lower + almask) & ~almask;
00395
00396   for (auto &c : _tree)
00397     {
00398       // address of free memory block
00399       unsigned long n_start = c.addr();
00400
00401       // block too small, next
00402       // XXX: maybe we can skip this and just do the test below
00403       if (c.size < size)
00404         continue;
00405
00406       // block outside region, next
00407       if (upper < n_start || a_lower > n_start + c.size)
00408         continue;
00409
00410       // aligned start address within the free block
00411       unsigned long a_start = (n_start + almask) & ~almask;
00412
00413       // block too small after alignment, next
00414       if (a_start - n_start >= c.size)
00415         continue;
00416
00417       a_start = a_start < a_lower ? a_lower : a_start;
00418
00419       // end address would overflow, next
00420       if (size > ~0UL - a_start)
00421         continue;
00422
00423       // block outside region, next
00424       if (a_start + size - 1UL > upper)
00425         continue;
00426
00427       // remaining size after subtracting the padding
00428       // for the alignment
00429       unsigned long r_size = c.size - a_start + n_start;
00430
00431       // block too small
00432       if (r_size < size)
00433         continue;
00434
00435       if (a_start > n_start)
00436         // have free space before the allocated block
00437         // shrink the block
00438         c.size -= r_size;
00439       else
00440         // drop the block
00441         _tree.remove(c.addr());
00442
00443       // allocated the whole remaining space
00444       if (r_size == size)
00445         return reinterpret_cast<void *>(a_start);
00446
00447       // add a new free block behind the allocated block
00448       Mem_block *m = reinterpret_cast<Mem_block *>(a_start + size);
00449       m->size = r_size - size;
00450       _tree.insert(m);
00451       return reinterpret_cast<void *>(a_start);
00452     }
00453
00454   return 0;
00455 }
00456
00457 unsigned long
00458 Tree_alloc::avail() const
00459 {
00460   [[maybe_unused]] Tree_alloc_sanity_guard guard(this, __func__);
00461   unsigned long a = 0;
00462   for (auto const &c : _tree)
00463     a += c.size;
00464
00465   return a;
00466 }
00467
00468 template<typename DBG>
00469 void
00470 Tree_alloc::dump_free_list(DBG &out) const
00471 {
00472   for (auto const &c : _tree)
00473     {
00474       static constexpr char const *const unitstr[4] =
00475       { "Byte", "KiB", "MiB", "GiB" };
00476
00477       unsigned sz = c.size;
00478       unsigned i;
00479       for (i = 0; i < cxx::array_size(unitstr) && sz > 8 << 10; ++i)
```

```
00480         sz >>= 10;
00481
00482       out.printf("%12p - %12p (%u %s)\n",
00483                  &c, reinterpret_cast<char const *>(&c) + c.size - 1, sz, unitstr[i]);
00484     }
00485 }
00486
00487 } // namespace cxx
```

16.240 type_list

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 #pragma once
00003
00004 /*
00005  * (c) 2012 Alexander Warg <warg@os.inf.tu-dresden.de>,
00006  *     economic rights: Technische Universität Dresden (Germany)
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010
00011
00012 #include "type_traits"
00013
00014 namespace cxx {
00015
00016 template< typename ...T >
00017 struct type_list;
00018
00019 template<>
00020 struct type_list<>
00021 {
00022   typedef false_type head;
00023   typedef false_type tail;
00024 };
00025
00026 template<typename HEAD, typename ...TAIL>
00027 struct type_list<HEAD, TAIL...>
00028 {
00029   typedef HEAD head;
00030   typedef type_list<TAIL...> tail;
00031 };
00032
00033 template<typename TYPELIST, template <typename T> class PREDICATE>
00034 struct find_type;
00035
00036 template<template <typename T> class PREDICATE>
00037 struct find_type<type_list<>, PREDICATE>
00038 {
00039   typedef false_type type;
00040 };
00041
00042 template<typename TYPELIST, template <typename T> class PREDICATE>
00043 struct find_type
00044 {
00045   typedef typename conditional<PREDICATE<typename TYPELIST::head>::value,
00046                                typename TYPELIST::head,
00047                                typename find_type<typename TYPELIST::tail, PREDICATE>::type>::type
    type;
00048 };
00049
00050 template<typename TYPELIST, template <typename T> class PREDICATE>
00051 using find_type_t = typename find_type<TYPELIST, PREDICATE>::type;
00052
00053 }
```

16.241 type_traits

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002
00003 /*
00004  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00005  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00006  *     economic rights: Technische Universität Dresden (Germany)
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010
00011
00012 #pragma once
00013
```

```
00014 #pragma GCC system_header
00015
00016 #include <l4/sys/compiler.h>
00017 #include "bits/type_traits.h"
00018
00019 namespace cxx {
00020
00021 template< typename T, T V >
00022 struct integral_constant
00023 {
00024   static T const value = V;
00025   typedef T value_type;
00026   typedef integral_constant<T, V> type;
00027 };
00028
00029 typedef integral_constant<bool, true> true_type;
00030 typedef integral_constant<bool, false> false_type;
00031
00032 template<typename...>
00033 using void_t = void;
00034
00035 template< typename T > struct remove_reference;
00036
00037 template< typename T > struct identity { typedef T type; };
00038 template< typename T > using identity_t = typename identity<T>::type;
00039
00040 template< typename T1, typename T2 > struct is_same;
00041
00042 template< typename T > struct remove_const;
00043
00044 template< typename T > struct remove_volatile;
00045
00046 template< typename T > struct remove_cv;
00047
00048 template< typename T > struct remove_pointer;
00049
00050 template< typename T > struct remove_extent;
00051
00052 template< typename T > struct remove_all_extents;
00053
00054
00055
00056 template< typename, typename >
00057 struct is_same : false_type {};
00058
00059 template< typename T >
00060 struct is_same<T, T> : true_type {};
00061
00062 template< typename T1, typename T2 >
00063 inline constexpr bool is_same_v = is_same<T1, T2>::value;
00064
00065 template< typename T >
00066 struct remove_reference { typedef T type; };
00067
00068 template< typename T >
00069 struct remove_reference<T &> { typedef T type; };
00070
00071 template< typename T >
00072 struct remove_reference<T &&> { typedef T type; };
00073
00074 template< typename T >
00075 using remove_reference_t = typename remove_reference<T>::type;
00076
00077 template< typename T > struct remove_const { typedef T type; };
00078 template< typename T > struct remove_const<T const> { typedef T type; };
00079 template< typename T > using remove_const_t = typename remove_const<T>::type;
00080
00081 template< typename T > struct remove_volatile { typedef T type; };
00082 template< typename T > struct remove_volatile<T volatile> { typedef T type; };
00083 template< typename T > using remove_volatile_t = typename remove_volatile<T>::type;
00084
00085 template< typename T >
00086 struct remove_cv { typedef remove_const_t<remove_volatile_t<T» type; };
00087
00088 template< typename T >
00089 using remove_cv_t = typename remove_cv<T>::type;
00090
00091 template<class T>
00092 struct remove_cvref { using type = remove_cv_t<remove_reference_t<T»; };
00093
00094 template< typename T >
00095 using remove_cvref_t = typename remove_cvref<T>::type;
00096
00097 template< typename T, typename >
00098 struct __remove_pointer_h { typedef T type; };
00099
00100 template< typename T, typename I >
```

```
00101 struct __remove_pointer_h<T, I*> { typedef I type; };
00102
00103 template< typename  T >
00104 struct remove_pointer : __remove_pointer_h<T, remove_cv_t<T>> {};
00105
00106 template< typename T >
00107 using remove_pointer_t = typename remove_pointer<T>::type;
00108
00109
00110 template< typename T >
00111 struct remove_extent { typedef T type; };
00112
00113 template< typename T >
00114 struct remove_extent<T[]> { typedef T type; };
00115
00116 template< typename T, unsigned long N >
00117 struct remove_extent<T[N]> { typedef T type; };
00118
00119 template< typename T >
00120 using remove_extent_t = typename remove_extent<T>::type;
00121
00122
00123 template< typename T >
00124 struct remove_all_extents { typedef T type; };
00125
00126 template< typename T >
00127 struct remove_all_extents<T[]> { typedef typename remove_all_extents<T>::type type; };
00128
00129 template< typename T, unsigned long N >
00130 struct remove_all_extents<T[N]> { typedef typename remove_all_extents<T>::type type; };
00131
00132 template< typename T >
00133 using remove_all_extents_t = typename remove_all_extents<T>::type;
00134
00135 template< typename T >
00136 constexpr T &&
00137 forward(cxx::remove_reference_t<T> &t)
00138 { return static_cast<T &&>(t); }
00139
00140 template< typename T >
00141 constexpr T &&
00142 forward(cxx::remove_reference_t<T> &&t)
00143 { return static_cast<T &&>(t); }
00144
00145 template< typename T >
00146 constexpr cxx::remove_reference_t<T> &&
00147 move(T &&t) { return static_cast<cxx::remove_reference_t<T> &&>(t); }
00148
00149 template< bool, typename T = void >
00150 struct enable_if {};
00151
00152 template< typename T >
00153 struct enable_if<true, T> { typedef T type; };
00154
00155 template< bool C, typename T = void >
00156 using enable_if_t = typename enable_if<C, T>::type;
00157
00158 template< typename T >
00159 struct is_const : false_type {};
00160
00161 template< typename T >
00162 struct is_const<T const> : true_type {};
00163
00164 template< typename T >
00165 inline constexpr bool is_const_v = is_const<T>::value;
00166
00167 template< typename T >
00168 struct is_volatile : false_type {};
00169
00170 template< typename T >
00171 struct is_volatile<T volatile> : true_type {};
00172
00173 template< typename T >
00174 inline constexpr bool is_volatile_v = is_volatile<T>::value;
00175
00176 template< typename T >
00177 struct is_pointer : false_type {};
00178
00179 template< typename T >
00180 struct is_pointer<T *> : true_type {};
00181
00182 template< typename T >
00183 inline constexpr bool is_pointer_v = is_pointer<T>::value;
00184
00185 template<class T>
00186 inline constexpr bool is_null_pointer_v = is_same_v<decltype(nullptr), remove_cv_t<T>>;
00187
```

```
00188 template< typename T >
00189 struct is_reference : false_type {};
00190
00191 template< typename T >
00192 struct is_reference<T &> : true_type {};
00193
00194 template< typename T >
00195 struct is_reference<T &&> : true_type {};
00196
00197 template< typename T >
00198 inline constexpr bool is_reference_v = is_reference<T>::value;
00199
00200 template< bool, typename, typename >
00201 struct conditional;
00202
00203 template< bool C, typename T_TRUE, typename T_FALSE >
00204 struct conditional { typedef T_TRUE type; };
00205
00206 template< typename T_TRUE, typename T_FALSE >
00207 struct conditional< false, T_TRUE, T_FALSE > { typedef T_FALSE type; };
00208
00209 template< bool C, typename T_TRUE, typename T_FALSE >
00210 using conditional_t = typename conditional<C, T_TRUE, T_FALSE>::type;
00211
00212 template<typename T>
00213 struct is_enum : integral_constant<bool, __is_enum(T)> {};
00214
00215 template< typename T >
00216 inline constexpr bool is_enum_v = is_enum<T>::value;
00217
00218 template<typename T>
00219 struct is_polymorphic : cxx::integral_constant<bool, __is_polymorphic(T)> {};
00220
00221 template< typename T > struct is_integral : false_type {};
00222
00223 template<> struct is_integral<bool> : true_type {};
00224
00225 template<> struct is_integral<char> : true_type {};
00226 template<> struct is_integral<signed char> : true_type {};
00227 template<> struct is_integral<unsigned char> : true_type {};
00228 template<> struct is_integral<short> : true_type {};
00229 template<> struct is_integral<unsigned short> : true_type {};
00230 template<> struct is_integral<int> : true_type {};
00231 template<> struct is_integral<unsigned int> : true_type {};
00232 template<> struct is_integral<long> : true_type {};
00233 template<> struct is_integral<unsigned long> : true_type {};
00234 template<> struct is_integral<long long> : true_type {};
00235 template<> struct is_integral<unsigned long long> : true_type {};
00236
00237 template< typename T >
00238 inline constexpr bool is_integral_v = is_integral<T>::value;
00239
00240 template< typename T, bool = is_integral_v<T> || is_enum_v<T> >
00241 struct __is_signed_helper : integral_constant<bool, static_cast<bool>(T(-1) < T(0))> {};
00242
00243 template< typename T >
00244 struct __is_signed_helper<T, false> : integral_constant<bool, false> {};
00245
00246 template< typename T >
00247 struct is_signed : __is_signed_helper<T> {};
00248
00249 template< typename T >
00250 inline constexpr bool is_signed_v = is_signed<T>::value;
00251
00252
00253 template< typename >
00254 struct is_array : false_type {};
00255
00256 template< typename T >
00257 struct is_array<T[]> : true_type {};
00258
00259 template< typename T, unsigned long N >
00260 struct is_array<T[N]> : true_type {};
00261
00262 template< typename T >
00263 inline constexpr bool is_array_v = is_array<T>::value;
00264
00265 template< typename T, unsigned N >
00266 constexpr unsigned array_size(T const (&)[N]) { return N; }
00267
00268 template< int SIZE, bool SIGN = false, bool = true > struct int_type_for_size;
00269
00270 template<> struct int_type_for_size<sizeof(char), true, true>
00271 { typedef signed char type; };
00272
00273 template<> struct int_type_for_size<sizeof(char), false, true>
00274 { typedef unsigned char type; };
```

```
00275
00276 template<> struct int_type_for_size<sizeof(short), true, (sizeof(short) > sizeof(char))>
00277 { typedef short type; };
00278
00279 template<> struct int_type_for_size<sizeof(short), false, (sizeof(short) > sizeof(char))>
00280 { typedef unsigned short type; };
00281
00282 template<> struct int_type_for_size<sizeof(int), true, (sizeof(int) > sizeof(short))>
00283 { typedef int type; };
00284
00285 template<> struct int_type_for_size<sizeof(int), false, (sizeof(int) > sizeof(short))>
00286 { typedef unsigned int type; };
00287
00288 template<> struct int_type_for_size<sizeof(long), true, (sizeof(long) > sizeof(int))>
00289 { typedef long type; };
00290
00291 template<> struct int_type_for_size<sizeof(long), false, (sizeof(long) > sizeof(int))>
00292 { typedef unsigned long type; };
00293
00294 template<> struct int_type_for_size<sizeof(long long), true, (sizeof(long long) > sizeof(long))>
00295 { typedef long long type; };
00296
00297 template<> struct int_type_for_size<sizeof(long long), false, (sizeof(long long) > sizeof(long))>
00298 { typedef unsigned long long type; };
00299
00300 template< int SIZE, bool SIGN = false>
00301 using int_type_for_size_t = typename int_type_for_size<SIZE, SIGN>::type;
00302
00303 template< typename T, class Enable = void > struct underlying_type {};
00304
00305 template< typename T >
00306 struct underlying_type<T, typename enable_if<is_enum_v<T>::type >
00307 {
00308   typedef int_type_for_size_t<sizeof(T), is_signed_v<T> type;
00309 };
00310
00311 template< typename T >
00312 using underlying_type_t = typename underlying_type<T>::type;
00313
00314 template< typename T > struct make_signed;
00315 template<> struct make_signed<char>          { typedef signed char type; };
00316 template<> struct make_signed<unsigned char> { typedef signed char type; };
00317 template<> struct make_signed<signed char>   { typedef signed char type; };
00318 template<> struct make_signed<unsigned int>      { typedef signed int type; };
00319 template<> struct make_signed<signed int>        { typedef signed int type; };
00320 template<> struct make_signed<unsigned long int> { typedef signed long int type; };
00321 template<> struct make_signed<signed long int>   { typedef signed long int type; };
00322 template<> struct make_signed<unsigned long long int> { typedef signed long long int type; };
00323 template<> struct make_signed<signed long long int>   { typedef signed long long int type; };
00324 template< typename T > using make_signed_t = typename make_signed<T>::type;
00325
00326 template< typename T > struct make_unsigned;
00327 template<> struct make_unsigned<char>          { typedef unsigned char type; };
00328 template<> struct make_unsigned<unsigned char> { typedef unsigned char type; };
00329 template<> struct make_unsigned<signed char>   { typedef unsigned char type; };
00330 template<> struct make_unsigned<unsigned int>      { typedef unsigned int type; };
00331 template<> struct make_unsigned<signed int>        { typedef unsigned int type; };
00332 template<> struct make_unsigned<unsigned long int> { typedef unsigned long int type; };
00333 template<> struct make_unsigned<signed long int>   { typedef unsigned long int type; };
00334 template<> struct make_unsigned<unsigned long long int> { typedef unsigned long long int type; };
00335 template<> struct make_unsigned<signed long long int>   { typedef unsigned long long int type; };
00336 template< typename T > using make_unsigned_t = typename make_unsigned<T>::type;
00337
00338
00339 template<typename From, typename To>
00340 struct is_convertible
00341 {
00342 private:
00343   struct _true { char x[2]; };
00344   struct _false {};
00345
00346   static _true _helper(To const *);
00347   static _false _helper(...);
00348 public:
00349   enum
00350   {
00351     value = sizeof(_true) == sizeof(_helper(static_cast<From*>(0)))
00352             ? true : false
00353   };
00354
00355   typedef bool value_type;
00356 };
00357
00358 template<typename From, typename To>
00359 inline constexpr bool is_convertible_v = is_convertible<From, To>::value;
00360
00361 template< typename T >
```

```
00362 struct is_empty : integral_constant<bool, __is_empty(T)> {};
00363
00364 template< typename T >
00365 inline constexpr bool is_empty_v = is_empty<T>::value;
00366
00367
00368 #if L4_HAS_BUILTIN(__is_function)
00369   template < typename T >
00370   struct is_function : integral_constant<bool, __is_function(T)> {};
00371 #else
00372   template < typename T >
00373   struct is_function : integral_constant<bool,    !is_reference_v<T>
00374                                                && !is_const_v<const T» {};
00375 #endif
00376
00377 template< typename T >
00378 inline constexpr bool is_function_v = is_function<T>::value;
00379
00380 }
00381
```

16.242 unique_ptr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2013      Technische Universität Dresden.
00004  * Copyright (C) 2014-2017, 2020, 2023-2024 Kernkonzept GmbH.
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include "type_traits"
00012
00013 namespace cxx
00014 {
00015
00016 template< typename T >
00017 struct default_delete
00018 {
00019   default_delete() {}
00020
00021   template< typename U >
00022   default_delete(default_delete<U> const &) {}
00023
00024   void operator () (T *p) const
00025   { delete p; }
00026 };
00027
00028 template< typename T >
00029 struct default_delete<T[]>
00030 {
00031   default_delete() {}
00032
00033   void operator () (T *p)
00034   { delete [] p; }
00035 };
00036
00037 template< typename T, typename C >
00038 struct unique_ptr_index_op {};
00039
00040 template< typename T, typename C >
00041 struct unique_ptr_index_op<T[], C>
00042 {
00043   typedef T &reference;
00044   reference operator [] (int idx) const
00045   { return static_cast<C const *>(this)->get()[idx]; }
00046 };
00047
00048 template< typename T, typename T_Del = default_delete<T> >
00049 class unique_ptr : public unique_ptr_index_op<T, unique_ptr<T, T_Del> >
00050 {
00051 private:
00052   struct _unspec;
00053   typedef _unspec* _unspec_ptr_type;
00054
00055 public:
00056   typedef cxx::remove_extent_t<T> element_type;
00057   typedef element_type *pointer;
00058   typedef element_type &reference;
00059   typedef T_Del deleter_type;
00060
00061   unique_ptr() : _ptr(pointer()) {}
```

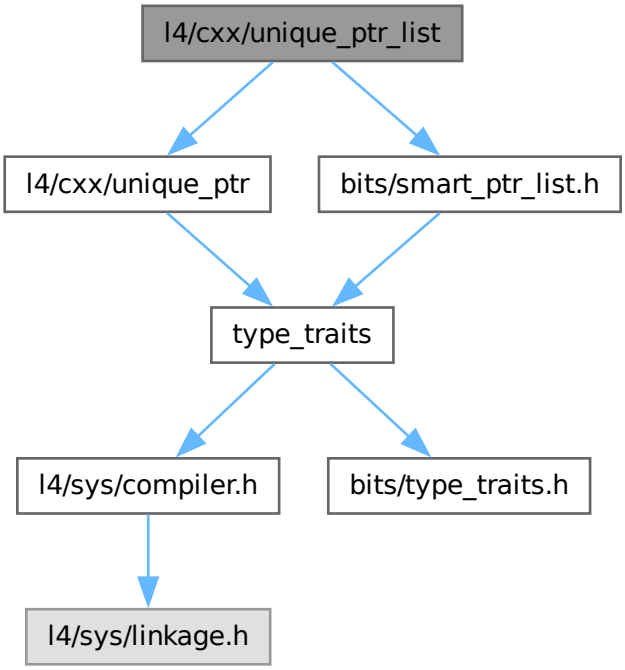
```
00062
00063   explicit unique_ptr(pointer p) : _ptr(p) {}
00064
00065   unique_ptr(unique_ptr &&o) : _ptr(o.release()) {}
00066
00067   ~unique_ptr() { reset(); }
00068
00069   unique_ptr &operator = (unique_ptr &&o)
00070   {
00071     reset(o.release());
00072     return *this;
00073   }
00074
00075   unique_ptr &operator = (_unspec_ptr_type)
00076   {
00077     reset();
00078     return *this;
00079   }
00080
00081   element_type &operator * () const { return *get(); }
00082   pointer operator -> () const { return get(); }
00083
00084   pointer get() const { return _ptr; }
00085
00086   operator _unspec_ptr_type () const
00087   { return reinterpret_cast<_unspec_ptr_type>(get()); }
00088
00089   pointer release()
00090   {
00091     pointer r = _ptr;
00092     _ptr = 0;
00093     return r;
00094   }
00095
00096   void reset(pointer p = pointer())
00097   {
00098     if (p != get())
00099       {
00100         deleter_type()(get());
00101         _ptr = p;
00102       }
00103   }
00104
00105   unique_ptr(unique_ptr const &) = delete;
00106   unique_ptr &operator = (unique_ptr const &) = delete;
00107
00108 private:
00109   pointer _ptr;
00110 };
00111
00112 template< typename T >
00113 unique_ptr<T>
00114 make_unique_ptr(T *p)
00115 { return unique_ptr<T>(p); }
00116
00117 template< typename T >
00118 cxx::enable_if_t<cxx::is_array<T>::value, unique_ptr<T»
00119 make_unique(unsigned long size)
00120 { return cxx::unique_ptr<T>(new cxx::remove_extent_t<T>[size]()); }
00121
00122 template< typename T, typename... Args >
00123 cxx::enable_if_t<!cxx::is_array<T>::value, unique_ptr<T»
00124 make_unique(Args &&... args)
00125 { return cxx::unique_ptr<T>(new T(cxx::forward<Args>(args)...)); }
00126
00127 }
```

16.243 l4/cxx/unique_ptr_list File Reference

Implementation of a list of unique-ptr-managed objects.

```
#include <l4/cxx/unique_ptr>
#include "bits/smart_ptr_list.h"
```

Include dependency graph for unique_ptr_list:



Namespaces

- namespace cxx

  Our C++ library.

Typedefs

- template<typename T>
  using **cxx::Unique_ptr_list_item** = Bits::Smart_ptr_list_item<T, cxx::unique_ptr<T> >

  Item for list linked with cxx::unique_ptr.
- template<typename T>
  using **cxx::Unique_ptr_list** = Bits::Smart_ptr_list<Unique_ptr_list_item<T> >

  Single-linked list where elements are connected with a cxx::unique_ptr.

16.243.1 Detailed Description

Implementation of a list of unique-ptr-managed objects.
Definition in file unique_ptr_list.

16.244 unique_ptr_list

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * Copyright (C) 2018-2019, 2022, 2024 Kernkonzept GmbH.
00008  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00009  *
```

```
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/cxx/unique_ptr>
00015
00016 #include "bits/smart_ptr_list.h"
00017
00018 namespace cxx {
00019
00021 template <typename T>
00022 using Unique_ptr_list_item = Bits::Smart_ptr_list_item<T, cxx::unique_ptr<T> >;
00023
00027 template <typename T>
00028 using Unique_ptr_list = Bits::Smart_ptr_list<Unique_ptr_list_item<T> >;
00029
00030 }
```

16.245 utils

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2013 Technische Universität Dresden.
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 namespace cxx {
00011
00039 template< typename T > inline
00040 T access_once(T const *a)
00041 {
00042 #if 1
00043   __asm__ __volatile__ ( "" : "=m"(*const_cast<T*>(a)));
00044   T tmp = *a;
00045   __asm__ __volatile__ ( "" : "=m"(*const_cast<T*>(a)));
00046   return tmp;
00047 #else
00048   return *static_cast<T const volatile *>(a);
00049 #endif
00050 }
00051
00070 template< typename T, typename VAL > inline
00071 void write_now(T *a, VAL &&val)
00072 {
00073   __asm__ __volatile__ ( "" : "=m"(*a));
00074   *a = val;
00075   __asm__ __volatile__ ( "" : : "m"(*a));
00076 }
00077
00078 struct in_place_t { explicit in_place_t() = default; };
00079
00080 inline constexpr in_place_t in_place {};
00081
00082 }
00083
```

16.246 weak_ref

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2015, 2017, 2024 Kernkonzept GmbH.
00004  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00005  *            Alexander Warg <alexander.warg@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include "hlist"
00012
00013 namespace cxx {
00014
00024 class Weak_ref_base : public H_list_item_t<Weak_ref_base>
00025 {
00026 protected:
00027   Weak_ref_base(void const *ptr = nullptr) : _obj(ptr) {}
00028   void reset_hard() { _obj = nullptr; }
00029   void const *_obj;
```

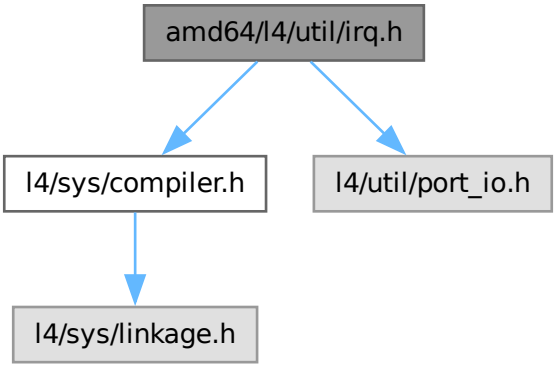
```
00030
00031 public:
00038   struct List : H_list_t<Weak_ref_base>
00039   {
00040     void reset()
00041     {
00042       while (!empty())
00043         pop_front()->reset_hard();
00044     }
00045
00046     ~List()
00047     { reset(); }
00048   };
00049
00050   explicit operator bool () const
00051   { return _obj ? true : false; }
00052 };
00053
00054
00094 template <typename T>
00095 class Weak_ref : public Weak_ref_base
00096 {
00097 public:
00098   T *get() const
00099   { return reinterpret_cast<T*>(const_cast<void *>(_obj)); }
00100
00101   T *reset(T *n)
00102   {
00103     T *r = get();
00104     if (r)
00105       r->remove_weak_ref(this);
00106
00107     _obj = n;
00108     if (n)
00109       n->add_weak_ref(this);
00110
00111     return r;
00112   }
00113
00114   Weak_ref(T *s = nullptr) : Weak_ref_base(s)
00115   {
00116     if (s)
00117       s->add_weak_ref(this);
00118   }
00119
00120   ~Weak_ref() { reset(0); }
00121
00122   void operator = (T *n)
00123   { reset(n); }
00124
00125   Weak_ref(Weak_ref const &o) : Weak_ref_base(o._obj)
00126   {
00127     if (T *x = get())
00128       x->add_weak_ref(this);
00129   }
00130
00131   Weak_ref &operator = (Weak_ref const &o)
00132   {
00133     if (&o == this)
00134       return *this;
00135
00136     reset(o.get());
00137     return *this;
00138   }
00139
00140   T &operator * () const { return get(); }
00141   T *operator -> () const { return get(); }
00142 };
00143
00144 class Weak_ref_obj
00145 {
00146 protected:
00147   template <typename T> friend class Weak_ref;
00148   mutable Weak_ref_base::List weak_references;
00149
00150   void add_weak_ref(Weak_ref_base *ref) const
00151   { weak_references.push_front(ref); }
00152
00153   void remove_weak_ref(Weak_ref_base *ref) const
00154   { weak_references.remove(ref); }
00155 };
00156
00157 }
```

16.247 amd64/l4/util/irq.h File Reference

some PIC and hardware interrupt related functions

```
#include <l4/sys/compiler.h>
#include <l4/util/port_io.h>
```

Include dependency graph for irq.h:



16.247.1 Detailed Description

some PIC and hardware interrupt related functions

Date

2003

Author

Jork Loeser jork.loeser@inf.tu-dresden.de Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file irq.h.

16.248 irq.h

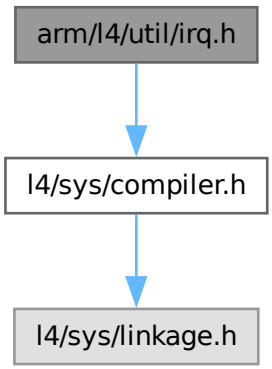
Go to the documentation of this file.

```
00001
00008
00009 /*
00010  * (c) 2003-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #ifndef __L4_IRQ_H__
00016 #define __L4_IRQ_H__
00017
00018 #include <l4/sys/compiler.h>
00019 #include <l4/util/port_io.h>
00020
00021 L4_BEGIN_DECLS
00022
00027
00030 static inline void
00031 l4util_cli (void)
00032 {
00033   __asm__ __volatile__ ("cli" : : : "memory");
00034 }
00035
```

```
00038 static inline void
00039 l4util_sti (void)
00040 {
00041   __asm__ __volatile__ ("sti" : : : "memory");
00042 }
00043
00047 static inline void
00048 l4util_flags_save (l4_umword_t *flags)
00049 {
00050   __asm__ __volatile__ ("pushf ; popq %0 " :"=g" (*flags) : :"memory");
00051 }
00052
00055 static inline void
00056 l4util_flags_restore (l4_umword_t *flags)
00057 {
00058   __asm__ __volatile__ ("pushq %0 ; popf" : :"g" (*flags) : "memory");
00059 }
00061
00062 L4_END_DECLS
00063
00064 #endif
```

16.249 arm/l4/util/irq.h File Reference

ARM specific implementation of irq functions.
`#include <l4/sys/compiler.h>`
Include dependency graph for irq.h:



16.249.1 Detailed Description

ARM specific implementation of irq functions.
Do not use.
Definition in file irq.h.

16.250 irq.h

Go to the documentation of this file.

```
00001
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef __L4UTIL__ARCH_ARCH__IRQ_H__
00015 #define __L4UTIL__ARCH_ARCH__IRQ_H__
```

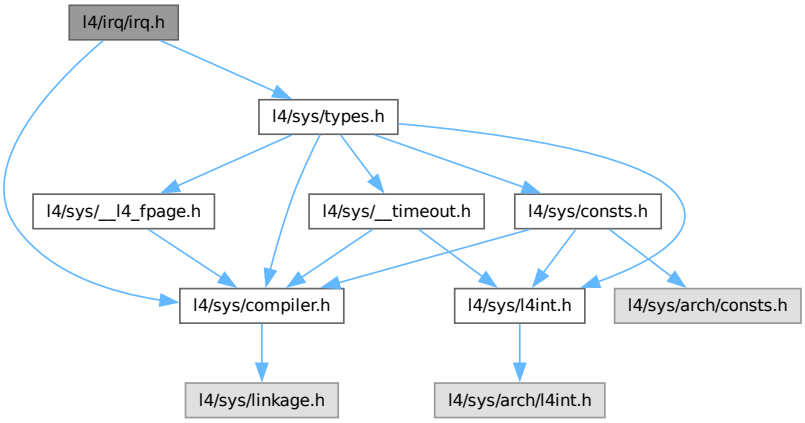
```
00016
00017 #ifdef __GNUC__
00018
00019 #include <l4/sys/compiler.h>
00020
00021 L4_BEGIN_DECLS
00022
00023 L4_INLINE void l4util_cli (void);
00024 L4_INLINE void l4util_sti (void);
00025 L4_INLINE void l4util_flags_save(l4_umword_t *flags);
00026 L4_INLINE void l4util_flags_restore(l4_umword_t *flags);
00027
00028 L4_INLINE
00029 void
00030 l4util_cli(void)
00031 {
00032   extern void __do_not_use_l4util_cli(void);
00033   __do_not_use_l4util_cli();
00034 }
00035
00036
00037 L4_INLINE
00038 void
00039 l4util_sti(void)
00040 {
00041   extern void __do_not_use_l4util_sti(void);
00042   __do_not_use_l4util_sti();
00043 }
00044
00045
00046 L4_INLINE
00047 void
00048 l4util_flags_save(l4_umword_t *flags)
00049 {
00050   (void)flags;
00051   extern void __do_not_use_l4util_flags_save(void);
00052   __do_not_use_l4util_flags_save();
00053 }
00054
00055 L4_INLINE
00056 void
00057 l4util_flags_restore(l4_umword_t *flags)
00058 {
00059   (void)flags;
00060   extern void __do_not_use_l4util_flags_restore(void);
00061   __do_not_use_l4util_flags_restore();
00062 }
00063
00064 L4_END_DECLS
00065
00066 #endif //__GNUC__
00067
00068 #endif /* ! __L4UTIL__ARCH_ARCH__IRQ_H__ */
```

16.251 l4/irq/irq.h File Reference

IRQ handling routines.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
```

Include dependency graph for irq.h:



Functions

- l4irq_t * l4irq_attach (int irqnum)

  Attach/connect to IRQ.
- l4irq_t * l4irq_attach_ft (int irqnum, unsigned mode)

  Attach/connect to IRQ using given type.
- l4irq_t * l4irq_attach_thread (int irqnum, l4_cap_idx_t to_thread)

  Attach/connect to IRQ.
- l4irq_t * l4irq_attach_thread_ft (int irqnum, l4_cap_idx_t to_thread, unsigned mode)

  Attach/connect to IRQ using given type.
- long l4irq_wait (l4irq_t *irq)

  Wait for specified IRQ.
- long l4irq_unmask_and_wait_any (l4irq_t *unmask_irq, l4irq_t **ret_irq)

  Unmask a specific IRQ and wait for any attached IRQ.
- long l4irq_wait_any (l4irq_t **irq)

  Wait for any attached IRQ.
- long l4irq_unmask (l4irq_t *irq)

  Unmask a specific IRQ.
- long l4irq_detach (l4irq_t *irq)

  Detach from IRQ.
- l4irq_t * l4irq_request (int irqnum, void(*isr_handler)(void *), void *isr_data, int irq_thread_prio, unsigned mode)

  Attach asychronous ISR handler to IRQ.
- long l4irq_release (l4irq_t *irq)

  Release asynchronous ISR handler and free resources.
- l4irq_t * l4irq_attach_cap (l4_cap_idx_t irqcap)

  Attach/connect to IRQ.
- l4irq_t * l4irq_attach_cap_ft (l4_cap_idx_t irqcap, unsigned mode)

  Attach/connect to IRQ using given type.
- l4irq_t * l4irq_attach_thread_cap (l4_cap_idx_t irqcap, l4_cap_idx_t to_thread)

  Attach/connect to IRQ.
- l4irq_t * l4irq_attach_thread_cap_ft (l4_cap_idx_t irqcap, l4_cap_idx_t to_thread, unsigned mode)

  Attach/connect to IRQ using given type.

- l4irq_t * l4irq_request_cap (l4_cap_idx_t irqcap, void(*isr_handler)(void *), void *isr_data, int irq_thread_↩ prio, unsigned mode)

  Attach asychronous ISR handler to IRQ.

16.251.1 Detailed Description

IRQ handling routines.
Definition in file irq.h.

16.252 irq.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Henning Schild <hschild@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * This file is part of TUD:OS and distributed under the terms of the
00011  * GNU General Public License 2.
00012  * Please see the COPYING-GPL-2 file for details.
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/compiler.h>
00017 #include <l4/sys/types.h>
00018
00019 __BEGIN_DECLS
00020
00027
00028 struct l4irq_t;
00029 typedef struct l4irq_t l4irq_t;
00030
00041 L4_CV l4irq_t *
00042 l4irq_attach(int irqnum);
00043
00055 L4_CV l4irq_t *
00056 l4irq_attach_ft(int irqnum, unsigned mode);
00057
00068 L4_CV l4irq_t *
00069 l4irq_attach_thread(int irqnum, l4_cap_idx_t to_thread);
00070
00082 L4_CV l4irq_t *
00083 l4irq_attach_thread_ft(int irqnum, l4_cap_idx_t to_thread,
00084                        unsigned mode);
00085
00093 L4_CV long
00094 l4irq_wait(l4irq_t *irq);
00095
00105 L4_CV long
00106 l4irq_unmask_and_wait_any(l4irq_t *unmask_irq, l4irq_t **ret_irq);
00107
00115 L4_CV long
00116 l4irq_wait_any(l4irq_t **irq);
00117
00128 L4_CV long
00129 l4irq_unmask(l4irq_t *irq);
00130
00138 L4_CV long
00139 l4irq_detach(l4irq_t *irq);
00140
00141
00142
00143 /*****************************************************************************/
00152
00165 L4_CV l4irq_t *
00166 l4irq_request(int irqnum, void (*isr_handler)(void *), void *isr_data,
00167               int irq_thread_prio, unsigned mode);
00168
00176 L4_CV long
00177 l4irq_release(l4irq_t *irq);
00178
00179
00180
00181 /*****************************************************************************/
00182 /*****************************************************************************/
00183
00188
00199 L4_CV l4irq_t *
00200 l4irq_attach_cap(l4_cap_idx_t irqcap);
```

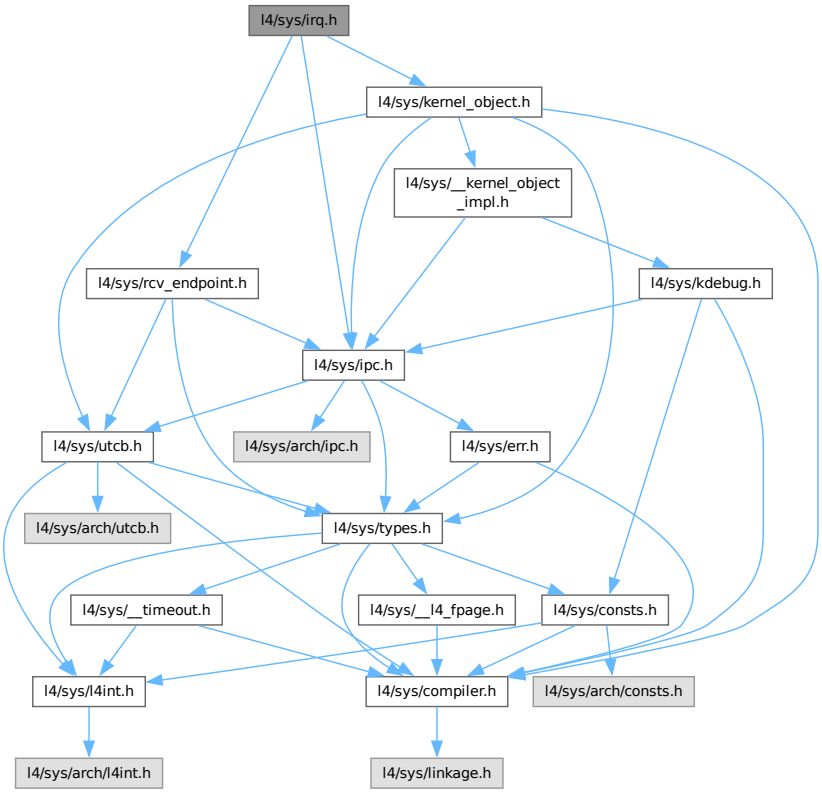
```
00201
00213 L4_CV l4irq_t *
00214 l4irq_attach_cap_ft(l4_cap_idx_t irqcap, unsigned mode);
00215
00226 L4_CV l4irq_t *
00227 l4irq_attach_thread_cap(l4_cap_idx_t irqcap, l4_cap_idx_t to_thread);
00228
00240 L4_CV l4irq_t *
00241 l4irq_attach_thread_cap_ft(l4_cap_idx_t irqcap, l4_cap_idx_t to_thread,
00242                            unsigned mode);
00243
00244 /*****************************************************************************/
00252
00265 L4_CV l4irq_t *
00266 l4irq_request_cap(l4_cap_idx_t irqcap,
00267                   void (*isr_handler)(void *), void *isr_data,
00268                   int irq_thread_prio, unsigned mode);
00269
00270 __END_DECLS
```

16.253 l4/sys/irq.h File Reference

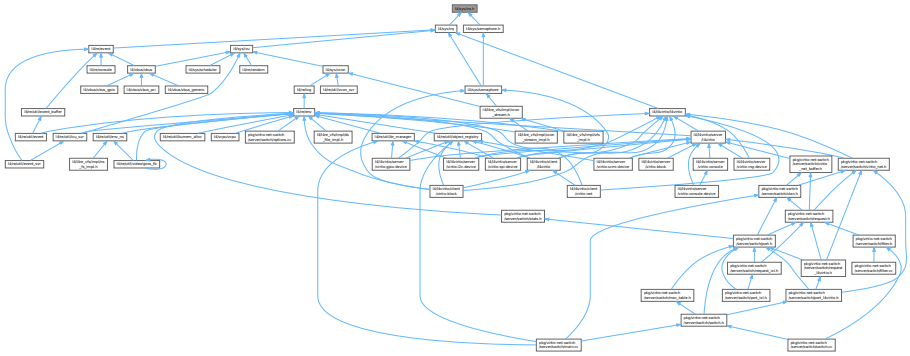
C Irq interface.

```
#include <l4/sys/kernel_object.h>
#include <l4/sys/ipc.h>
#include <l4/sys/rcv_endpoint.h>
```

Include dependency graph for irq.h:



This graph shows which files directly or indirectly include this file:



Functions

- l4_msgtag_t l4_irq_detach (l4_cap_idx_t irq) L4_NOTHROW

  Detach from an interrupt source.
- l4_msgtag_t l4_irq_detach_u (l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Detach from this interrupt.
- l4_msgtag_t l4_irq_bind_vcpu (l4_cap_idx_t irq, l4_cap_idx_t thread, l4_umword_t cfg) L4_NOTHROW

  Bind a thread to this Irq for vCPU interrupt forwarding.
- l4_msgtag_t l4_irq_bind_vcpu_u (l4_cap_idx_t irq, l4_cap_idx_t thread, l4_umword_t cfg, l4_utcb_t *utcb) L4_NOTHROW

  Bind a thread to this Irq for vCPU interrupt forwarding.
- l4_msgtag_t l4_irq_trigger (l4_cap_idx_t irq) L4_NOTHROW

  Trigger an IRQ.
- l4_msgtag_t l4_irq_trigger_u (l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Trigger the object.
- l4_msgtag_t l4_irq_receive (l4_cap_idx_t irq, l4_timeout_t to) L4_NOTHROW

  Unmask and wait for specified IRQ.
- l4_msgtag_t l4_irq_receive_u (l4_cap_idx_t irq, l4_timeout_t timeout, l4_utcb_t *utcb) L4_NOTHROW

  Unmask and wait for this IRQ.
- l4_msgtag_t l4_irq_wait (l4_cap_idx_t irq, l4_umword_t *label, l4_timeout_t to) L4_NOTHROW

  Unmask IRQ and wait for any message.
- l4_msgtag_t l4_irq_wait_u (l4_cap_idx_t irq, l4_umword_t *label, l4_timeout_t timeout, l4_utcb_t *utcb) L4_NOTHROW

  Unmask IRQ and (open) wait for any message.
- l4_msgtag_t l4_irq_unmask (l4_cap_idx_t irq) L4_NOTHROW

  Unmask IRQ.
- l4_msgtag_t l4_irq_unmask_u (l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Unmask this IRQ.

16.253.1 Detailed Description

C Irq interface.
Definition in file irq.h.

16.254 irq.h

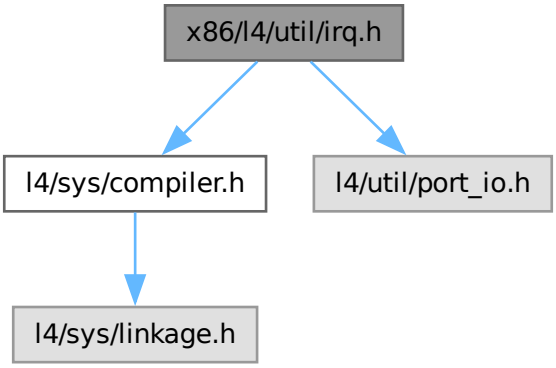
Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/kernel_object.h>
00017 #include <l4/sys/ipc.h>
00018 #include <l4/sys/rcv_endpoint.h>
00019
00046
00062 L4_INLINE l4_msgtag_t
00063 l4_irq_detach(l4_cap_idx_t irq) L4_NOTHROW;
00064
00071 L4_INLINE l4_msgtag_t
00072 l4_irq_detach_u(l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW;
00073
00074
00109 L4_INLINE l4_msgtag_t
00110 l4_irq_bind_vcpu(l4_cap_idx_t irq, l4_cap_idx_t thread,
00111                  l4_umword_t cfg) L4_NOTHROW;
00112
00119 L4_INLINE l4_msgtag_t
00120 l4_irq_bind_vcpu_u(l4_cap_idx_t irq, l4_cap_idx_t thread, l4_umword_t cfg,
00121                    l4_utcb_t *utcb) L4_NOTHROW;
00122
00123
00139 L4_INLINE l4_msgtag_t
00140 l4_irq_trigger(l4_cap_idx_t irq) L4_NOTHROW;
00141
00148 L4_INLINE l4_msgtag_t
00149 l4_irq_trigger_u(l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW;
00150
00160 L4_INLINE l4_msgtag_t
00161 l4_irq_receive(l4_cap_idx_t irq, l4_timeout_t to) L4_NOTHROW;
00162
00169 L4_INLINE l4_msgtag_t
00170 l4_irq_receive_u(l4_cap_idx_t irq, l4_timeout_t timeout, l4_utcb_t *utcb) L4_NOTHROW;
00171
00182 L4_INLINE l4_msgtag_t
00183 l4_irq_wait(l4_cap_idx_t irq, l4_umword_t *label,
00184             l4_timeout_t to) L4_NOTHROW;
00185
00192 L4_INLINE l4_msgtag_t
00193 l4_irq_wait_u(l4_cap_idx_t irq, l4_umword_t *label,
00194               l4_timeout_t timeout, l4_utcb_t *utcb) L4_NOTHROW;
00195
00206 L4_INLINE l4_msgtag_t
00207 l4_irq_unmask(l4_cap_idx_t irq) L4_NOTHROW;
00208
00215 L4_INLINE l4_msgtag_t
00216 l4_irq_unmask_u(l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW;
00217
00221 enum L4_irq_sender_op
00222 {
00223   L4_IRQ_SENDER_OP_RESERVED1 = 0, // Ex ATTACH
00224   L4_IRQ_SENDER_OP_DETACH    = 1,
00225   L4_IRQ_SENDER_OP_BIND_VCPU = 2,
00226 };
00227
00231 enum L4_irq_op
00232 {
00233   L4_IRQ_OP_TRIGGER   = 2,
00234   L4_IRQ_OP_EOI       = 4
00235 };
00236
00237 /*****************************************************************************
00238  * Implementations
00239  */
00240
00241 L4_INLINE l4_msgtag_t
00242 l4_irq_detach_u(l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW
00243 {
00244   l4_utcb_mr_u(utcb)->mr[0] = L4_IRQ_SENDER_OP_DETACH;
00245   return l4_ipc_call(irq, utcb, l4_msgtag(L4_PROTO_IRQ_SENDER, 1, 0, 0),
00246                      L4_IPC_NEVER);
00247 }
00248
```

```
00249 L4_INLINE l4_msgtag_t
00250 l4_irq_bind_vcpu_u(l4_cap_idx_t irq, l4_cap_idx_t thread, l4_umword_t cfg,
00251                    l4_utcb_t *utcb) L4_NOTHROW
00252 {
00253   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00254   m->mr[0] = L4_IRQ_SENDER_OP_BIND_VCPU;
00255   m->mr[1] = cfg;
00256   m->mr[2] = l4_map_obj_control(0, 0);
00257   m->mr[3] = l4_obj_fpage(thread, 0, L4_CAP_FPAGE_RWS).raw;
00258   return l4_ipc_call(irq, utcb, l4_msgtag(L4_PROTO_IRQ_SENDER, 2, 1, 0),
00259                      L4_IPC_NEVER);
00260 }
00261
00262 L4_INLINE l4_msgtag_t
00263 l4_irq_trigger_u(l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW
00264 {
00265   return l4_ipc_send(irq, utcb, l4_msgtag(L4_PROTO_IRQ, 0, 0, 0),
00266                      L4_IPC_BOTH_TIMEOUT_0);
00267 }
00268
00269 L4_INLINE l4_msgtag_t
00270 l4_irq_receive_u(l4_cap_idx_t irq, l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW
00271 {
00272   l4_utcb_mr_u(utcb)->mr[0] = L4_IRQ_OP_EOI;
00273   return l4_ipc_call(irq, utcb, l4_msgtag(L4_PROTO_IRQ, 1, 0, 0), to);
00274 }
00275
00276 L4_INLINE l4_msgtag_t
00277 l4_irq_wait_u(l4_cap_idx_t irq, l4_umword_t *label,
00278             l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW
00279 {
00280   l4_utcb_mr_u(utcb)->mr[0] = L4_IRQ_OP_EOI;
00281   return l4_ipc_send_and_wait(irq, utcb, l4_msgtag(L4_PROTO_IRQ, 1, 0, 0),
00282                               label, to);
00283 }
00284
00285 L4_INLINE l4_msgtag_t
00286 l4_irq_unmask_u(l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW
00287 {
00288   l4_utcb_mr_u(utcb)->mr[0] = L4_IRQ_OP_EOI;
00289   return l4_ipc_send(irq, utcb, l4_msgtag(L4_PROTO_IRQ, 1, 0, 0), L4_IPC_NEVER);
00290 }
00291
00292
00293 L4_INLINE l4_msgtag_t
00294 l4_irq_detach(l4_cap_idx_t irq) L4_NOTHROW
00295 {
00296   return l4_irq_detach_u(irq, l4_utcb());
00297 }
00298
00299 L4_INLINE l4_msgtag_t
00300 l4_irq_bind_vcpu(l4_cap_idx_t irq, l4_cap_idx_t thread,
00301                  l4_umword_t cfg) L4_NOTHROW
00302 {
00303   return l4_irq_bind_vcpu_u(irq, thread, cfg, l4_utcb());
00304 }
00305
00306 L4_INLINE l4_msgtag_t
00307 l4_irq_trigger(l4_cap_idx_t irq) L4_NOTHROW
00308 {
00309   return l4_irq_trigger_u(irq, l4_utcb());
00310 }
00311
00312 L4_INLINE l4_msgtag_t
00313 l4_irq_receive(l4_cap_idx_t irq, l4_timeout_t to) L4_NOTHROW
00314 {
00315   return l4_irq_receive_u(irq, to, l4_utcb());
00316 }
00317
00318 L4_INLINE l4_msgtag_t
00319 l4_irq_wait(l4_cap_idx_t irq, l4_umword_t *label,
00320             l4_timeout_t to) L4_NOTHROW
00321 {
00322   return l4_irq_wait_u(irq, label, to, l4_utcb());
00323 }
00324
00325 L4_INLINE l4_msgtag_t
00326 l4_irq_unmask(l4_cap_idx_t irq) L4_NOTHROW
00327 {
00328   return l4_irq_unmask_u(irq, l4_utcb());
00329 }
00330
```

16.255 x86/l4/util/irq.h File Reference

some PIC and hardware interrupt related functions
`#include <l4/sys/compiler.h>`
`#include <l4/util/port_io.h>`
Include dependency graph for irq.h:



16.255.1 Detailed Description

some PIC and hardware interrupt related functions

Date

2003

Author

Jork Loeser jork.loeser@inf.tu-dresden.de Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file irq.h.

16.256 irq.h

Go to the documentation of this file.

```
00001
00008
00009 /*
00010  * (c) 2003-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #ifndef __L4_IRQ_H__
00016 #define __L4_IRQ_H__
00017
00018 #include <l4/sys/compiler.h>
00019 #include <l4/util/port_io.h>
00020
00021 L4_BEGIN_DECLS
00022
00027
00030 static inline void
00031 l4util_cli (void)
00032 {
00033   __asm__ __volatile__ ("cli" : : : "memory");
00034 }
00035
```

```
00038 static inline void
00039 l4util_sti (void)
00040 {
00041   __asm__ __volatile__ ("sti" : : : "memory");
00042 }
00043
00047 static inline void
00048 l4util_flags_save (l4_umword_t *flags)
00049 {
00050   __asm__ __volatile__ ("pushfl ; popl %0 " :"=g" (*flags) : :"memory");
00051 }
00052
00055 static inline void
00056 l4util_flags_restore (l4_umword_t *flags)
00057 {
00058   __asm__ __volatile__ ("pushl %0 ; popfl" : :"g" (*flags) : "memory");
00059 }
00061
00062 L4_END_DECLS
00063
00064 #endif
```

16.257 backend

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include <l4/l4re_vfs/vfs.h>
00012 #include <l4/crtn/initpriorities.h>
00013
00014 extern "C" void l4re_vfs_select_poll_notify(void);
00015
00016 namespace L4Re { namespace Vfs {
00017
00019 extern L4Re::Vfs::Ops *vfs_ops asm ("l4re_env_posix_vfs_ops");
00020
00021 class Mount_tree;
00022
00030 class Be_file : public File
00031 {
00032 public:
00033   void *operator new (size_t size) noexcept
00034   { return vfs_ops->malloc(size); }
00035
00036   void *operator new (size_t, void *m) noexcept
00037   { return m; }
00038
00039   void operator delete (void *m)
00040   { vfs_ops->free(m); }
00041
00042   // used in close, to unlock all locks of a file (as POSIX says)
00043   int unlock_all_locks() noexcept override
00044   { return 0; }
00045
00046   // for mmap
00047   L4::Cap<L4Re::Dataspace> data_space() noexcept override
00048   { return L4::Cap<L4Re::Dataspace>::Invalid; }
00049
00051   ssize_t readv(const struct iovec*, int) noexcept override
00052   { return -EINVAL; }
00053
00055   ssize_t writev(const struct iovec*, int) noexcept override
00056   { return -EINVAL; }
00057
00059   ssize_t pwritev(const struct iovec*, int, off64_t) noexcept override
00060   { return -EINVAL; }
00061
00063   ssize_t preadv(const struct iovec*, int, off64_t) noexcept override
00064   { return -EINVAL; }
00065
00067   off64_t lseek(off64_t, int) noexcept override
00068   { return -ESPIPE; }
00069
00071   int ftruncate(off64_t) noexcept override
00072   { return -EINVAL; }
00073
00075   int fsync() const noexcept override
```

```
00076   { return -EINVAL; }
00077
00079   int fdatasync() const noexcept override
00080   { return -EINVAL; }
00081
00083   int ioctl(unsigned long, va_list) noexcept override
00084   { return -EINVAL; }
00085
00086   int fstat(struct stat64 *) const noexcept override
00087   { return -EINVAL; }
00088
00090   int fchmod(mode_t) noexcept override
00091   { return -EINVAL; }
00092
00094   int get_status_flags() const noexcept override
00095   { return 0; }
00096
00098   int set_status_flags(long) noexcept override
00099   { return 0; }
00100
00102   int get_lock(struct flock64 *) noexcept override
00103   { return -ENOLCK; }
00104
00106   int set_lock(struct flock64 *, bool) noexcept override
00107   { return -ENOLCK; }
00108
00110   int faccessat(const char *, int, int) noexcept override
00111   { return -ENOTDIR; }
00112
00114   int fchmodat(const char *, mode_t, int) noexcept override
00115   { return -ENOTDIR; }
00116
00118   int utime(const struct utimbuf *) noexcept override
00119   { return -EROFS; }
00120
00122   int utimes(const struct timeval [2]) noexcept override
00123   { return -EROFS; }
00124
00126   int utimensat(const char *, const struct timespec [2], int) noexcept override
00127   { return -EROFS; }
00128
00130   int mkdir(const char *, mode_t) noexcept override
00131   { return -ENOTDIR; }
00132
00134   int unlink(const char *) noexcept override
00135   { return -ENOTDIR; }
00136
00138   int rename(const char *, const char *) noexcept override
00139   { return -ENOTDIR; }
00140
00142   int link(const char *, const char *) noexcept override
00143   { return -ENOTDIR; }
00144
00146   int symlink(const char *, const char *) noexcept override
00147   { return -EPERM; }
00148
00150   int rmdir(const char *) noexcept override
00151   { return -ENOTDIR; }
00152
00154   ssize_t readlink(char *, size_t) override
00155   { return -EINVAL; }
00156
00157   ssize_t getdents(char *, size_t) noexcept override
00158   { return -ENOTDIR; }
00159
00160
00161
00162   // Socket interface
00163   int bind(sockaddr const *, socklen_t) noexcept override
00164   { return -ENOTSOCK; }
00165
00166   int connect(sockaddr const *, socklen_t) noexcept override
00167   { return -ENOTSOCK; }
00168
00169   ssize_t send(void const *, size_t, int) noexcept override
00170   { return -ENOTSOCK; }
00171
00172   ssize_t recv(void *, size_t, int) noexcept override
00173   { return -ENOTSOCK; }
00174
00175   ssize_t sendto(void const *, size_t, int, sockaddr const *, socklen_t) noexcept
00176     override
00177   { return -ENOTSOCK; }
00178
00179   ssize_t recvfrom(void *, size_t, int, sockaddr *, socklen_t *) noexcept override
00180   { return -ENOTSOCK; }
00181
```

```
00182   ssize_t sendmsg(msghdr const *, int) noexcept override
00183   { return -ENOTSOCK; }
00184
00185   ssize_t recvmsg(msghdr *, int) noexcept override
00186   { return -ENOTSOCK; }
00187
00188   int getsockopt(int, int, void *, socklen_t *) noexcept override
00189   { return -ENOTSOCK; }
00190
00191   int setsockopt(int, int, void const *, socklen_t) noexcept override
00192   { return -ENOTSOCK; }
00193
00194   int listen(int) noexcept override
00195   { return -ENOTSOCK; }
00196
00197   int accept(sockaddr *, socklen_t *) noexcept override
00198   { return -ENOTSOCK; }
00199
00200   int shutdown(int) noexcept override
00201   { return -ENOTSOCK; }
00202
00203   int getsockname(sockaddr *, socklen_t *) noexcept override
00204   { return -ENOTSOCK; }
00205
00206   int getpeername(sockaddr *, socklen_t *) noexcept override
00207   { return -ENOTSOCK; }
00208
00217   bool check_ready(Ready_type) noexcept override
00218   { return false; }
00219
00220   ~Be_file() noexcept = 0;
00221
00222 private:
00224   int get_entry(const char *, int, mode_t, cxx::Ref_ptr<File> *) noexcept override
00225   { return -ENOTDIR; }
00226
00227 protected:
00228   const char *get_mount(const char *path, cxx::Ref_ptr<File> *dir) noexcept;
00229 };
00230
00231 inline
00232 Be_file::~Be_file() noexcept {}
00233
00234 class Be_file_pos : public Be_file
00235 {
00236 public:
00237   Be_file_pos() noexcept : Be_file(), _pos(0) {}
00238
00239   virtual off64_t size() const noexcept = 0;
00240
00241   ssize_t readv(const struct iovec *v, int iovcnt) noexcept override
00242   {
00243     ssize_t r = preadv(v, iovcnt, _pos);
00244     if (r > 0)
00245       _pos += r;
00246     return r;
00247   }
00248
00249   ssize_t writev(const struct iovec *v, int iovcnt) noexcept override
00250   {
00251     ssize_t r = pwritev(v, iovcnt, _pos);
00252     if (r > 0)
00253       _pos += r;
00254     return r;
00255   }
00256
00257   ssize_t preadv(const struct iovec *v, int iovcnt, off64_t offset) noexcept override = 0;
00258   ssize_t pwritev(const struct iovec *v, int iovcnt, off64_t offset) noexcept override = 0;
00259
00260   off64_t lseek(off64_t offset, int whence) noexcept override
00261   {
00262     off64_t r;
00263     switch (whence)
00264       {
00265       case SEEK_SET: r = offset; break;
00266       case SEEK_CUR: r = _pos + offset; break;
00267       case SEEK_END: r = size() + offset; break;
00268       default: return -EINVAL;
00269       };
00270
00271     if (r < 0)
00272       return -EINVAL;
00273
00274     _pos = r;
00275     return _pos;
00276   }
00277
```

```
00278   ~Be_file_pos() noexcept = 0;
00279
00280 protected:
00281   off64_t pos() const noexcept { return _pos; }
00282
00283 private:
00284   off64_t _pos;
00285 };
00286
00287 inline Be_file_pos::~Be_file_pos() noexcept {}
00288
00289 class Be_file_stream : public Be_file
00290 {
00291 public:
00292   ssize_t preadv(const struct iovec *v, int iovcnt, off64_t) noexcept override
00293   { return readv(v, iovcnt); }
00294
00295   ssize_t pwritev(const struct iovec *v, int iovcnt, off64_t) noexcept override
00296   { return writev(v, iovcnt); }
00297
00298   ~Be_file_stream() noexcept = 0;
00299
00300 };
00301
00302 inline Be_file_stream::~Be_file_stream() noexcept {}
00303
00310 class Be_file_system : public File_system
00311 {
00312 private:
00313   char const *const _fstype;
00314
00315 public:
00316
00324   explicit Be_file_system(char const *fstype) noexcept
00325   : File_system(), _fstype(fstype)
00326   {
00327     vfs_ops->register_file_system(this);
00328   }
00329
00336   ~Be_file_system() noexcept
00337   {
00338     vfs_ops->unregister_file_system(this);
00339   }
00340
00346   char const *type() const noexcept override { return _fstype; }
00347 };
00348
00349 /* Make sure filesystems can register before the constructor of libmount
00350  * runs */
00351 #define L4RE_VFS_FILE_SYSTEM_ATTRIBUTE \
00352     __attribute__((init_priority(INIT_PRIO_LATE)))
00353
00354 }}
```

16.258 default_ops_impl.h

```
00001 // vi:ft=cpp
00002 /*
00003  * Copyright (C) 2016, 2023-2024 Kernkonzept GmbH.
00004  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #include <l4/cxx/static_container>
00009
00010 namespace {
00011 struct Vfs_init
00012 {
00013   // The Static_containers are used to prevent automatic destruction during
00014   // program shutdown. At least the `vfs' object must never be destructed
00015   // because any later attempt to do any kind of file-descriptor access in
00016   // the program would crash, and we could not be sure that the destructor
00017   // would really be executed after each possible operation using files or file
00018   // descriptors.
00019   cxx::Static_container<Vfs> vfs;
00020
00021   // The Static_containers below are just for providing ordering. The factories
00022   // must be initialized after the `vfs' object.
00023   cxx::Static_container<L4Re::Vfs::File_factory_t<L4Re::Dataspace, L4Re::Core::Ds_file> > ds_file;
00024   cxx::Static_container<L4Re::Vfs::File_factory_t<L4Re::Namespace, L4Re::Core::Ns_dir> > ns_dir;
00025   cxx::Static_container<L4Re::Vfs::File_factory_t<L4::Vcon, L4Re::Core::Vcon_stream> > vcon_stream;
00026
00027   Vfs_init()
00028   {
```

```
00029     vfs.construct();
00030     __rtld_l4re_env_posix_vfs_ops = vfs;
00031     ns_dir.construct();
00032     auto ns_ptr = cxx::ref_ptr(ns_dir.get());
00033     vfs->register_file_factory(ns_ptr);
00034     ns_ptr.release(); // prevent deletion of static object
00035
00036     ds_file.construct();
00037     auto ds_ptr = cxx::ref_ptr(ds_file.get());
00038     vfs->register_file_factory(ds_ptr);
00039     ds_ptr.release(); // prevent deletion of static object
00040
00041     vcon_stream.construct();
00042     auto vcon_ptr = cxx::ref_ptr(vcon_stream.get());
00043     vfs->register_file_factory(vcon_ptr);
00044     vcon_ptr.release(); // prevent deletion of static object
00045   }
00046 };
00047
00048 static Vfs_init __vfs_init __attribute__((init_priority(INIT_PRIO_VFS_INIT)));
00049
00050 };
```

16.259 ds_file.h

```
00001 /*
00002  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/l4re_vfs/backend>
00011
00012 namespace L4Re { namespace Core {
00013
00017 class Ds_file : public L4Re::Vfs::Be_file_pos
00018 {
00019 private:
00020   L4::Cap<L4Re::Dataspace> _ds;
00021   off64_t _size;
00022   char *_addr;
00023
00024   bool _writable;                    // Is this file writable?
00025
00026 public:
00027   explicit Ds_file(L4::Cap<L4Re::Dataspace> ds) noexcept
00028   : Be_file_pos(), _ds(ds), _addr(0)
00029   {
00030     L4Re::Dataspace::Stats ds_stats{};      // Properties of backing dataspace
00031
00032     // Use a single IPC to query backing dataspace for size and permissions
00033     _ds->info(&ds_stats);
00034     _size = ds_stats.size;
00035
00036     // w() returns true if flags has the write permission bit set
00037     _writable = ds_stats.flags.w();
00038   }
00039
00040   L4::Cap<L4Re::Dataspace> data_space() noexcept override { return _ds; }
00041
00042   int fstat(struct stat64 *buf) const noexcept override;
00043
00044   int ioctl(unsigned long, va_list) noexcept override;
00045
00046   off64_t size() const noexcept override { return _size; }
00047
00048   int get_status_flags() const noexcept override
00049   { return O_RDONLY; }
00050
00051   int set_status_flags(long) noexcept override
00052   { return 0; }
00053
00065   bool check_ready(Ready_type rt) noexcept override
00066   {
00067     if (rt == Read)
00068       return true;
00069
00070     if (rt == Write)
00071       return _writable;
00072
00073     return false;
```

```
00074   }
00075
00076   ~Ds_file() noexcept;
00077
00078 private:
00079   ssize_t read_single(const struct iovec*, off64_t) noexcept;
00080   ssize_t preadv(const struct iovec *, int, off64_t) noexcept override;
00081   ssize_t write_single(const struct iovec*, off64_t) noexcept;
00082   ssize_t pwritev(const struct iovec *, int , off64_t) noexcept override;
00083 };
00084
00085
00086 }}
```

16.260 ds_file_impl.h

```
00001 /*
00002  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #include "ds_file.h"
00010
00011 #include <limits.h>
00012 #include <sys/ioctl.h>
00013
00014 #include <l4/re/env>
00015
00016 namespace L4Re { namespace Core {
00017
00018 Ds_file::~Ds_file() noexcept
00019 {
00020   if (_addr)
00021     L4Re::Env::env()->rm()->detach(l4_addr_t(_addr), 0);
00022
00023   L4Re::virt_cap_alloc->release(_ds);
00024 }
00025
00026 int
00027 Ds_file::fstat(struct stat64 *buf) const noexcept
00028 {
00029   static int fake = 0;
00030
00031   memset(buf, 0, sizeof(*buf));
00032   buf->st_size = _size;
00033   buf->st_mode = S_IFREG | 0644;
00034   buf->st_dev = _ds.cap();
00035   buf->st_ino = ++fake;
00036   buf->st_blksize = L4_PAGESIZE;
00037   buf->st_blocks = l4_round_page(_size);
00038   return 0;
00039 }
00040
00041 ssize_t
00042 Ds_file::read_single(const struct iovec *vec, off64_t pos) noexcept
00043 {
00044   // POSIX declares read operations with a length > SSIZE_MAX to not be
00045   // portable, so we do not have to support them. This check also ensures that
00046   // casting the size_t variable vec->iov_len to an ssize_t does not overflow.
00047   if (vec->iov_len > SSIZE_MAX)
00048     return -EINVAL;
00049
00050   off64_t l = vec->iov_len;
00051   if (_size - pos < l)
00052     l = _size - pos;
00053
00054   if (l > 0)
00055     {
00056       Vfs_config::memcpy(vec->iov_base, _addr + pos, l);
00057       return l;
00058     }
00059
00060   return 0;
00061 }
00062
00063 ssize_t
00064 Ds_file::preadv(const struct iovec *vec, int cnt, off64_t offset) noexcept
00065 {
00066   if (cnt < 0 || offset < 0)
00067     return -EINVAL;
00068
```

```
00069   if (!_size)
00070     return 0;
00071
00072   if (!_addr)
00073     {
00074       // Region manager flags and dataspace cap need to be adjusted according
00075       // to file permissions
00076       Rm::Flags rm_flags = Rm::F::Search_addr | Rm::F::R;
00077       L4::Ipc::Cap<L4Re::Dataspace> ds_cap = _ds;
00078       if (_writable)
00079         {
00080           rm_flags |= Rm::F::W;
00081           ds_cap = L4::Ipc::make_cap_rw(_ds);
00082         }
00083
00084       void *file = reinterpret_cast<void*>(L4_PAGESIZE);
00085       long err = L4Re::Env::env()->rm()->attach(&file, _size, rm_flags,
00086                                                 ds_cap, 0);
00087
00088       if (err < 0)
00089         return err;
00090
00091       _addr = static_cast<char *>(file);
00092     }
00093
00094   ssize_t l = 0;
00095
00096   while (cnt > 0)
00097     {
00098       ssize_t r = read_single(vec, offset);
00099
00100       // This check also ensures that casting r to a size_t does not cause
00101       // overflows if r is negative.
00102       if (r < 0)
00103         return (l == 0) ? r : l;
00104
00105       offset += r;
00106       l      += r;
00107
00108       if (static_cast<size_t>(r) < vec->iov_len)
00109         return l;
00110
00111       ++vec;
00112       --cnt;
00113     }
00114   return l;
00115 }
00116
00117 ssize_t
00118 Ds_file::write_single(const struct iovec *vec, off64_t pos) noexcept
00119 {
00120   // POSIX declares write operations with a length > SSIZE_MAX to not be
00121   // portable, so we do not have to support them. This check also ensures that
00122   // casting the size_t variable vec->iov_len to an ssize_t does not overflow.
00123   if (vec->iov_len > SSIZE_MAX)
00124     return -EINVAL;
00125
00126   // The memcpy should never result in invalid memory accesses! Therefore,
00127   // check for overflow, potentially performing a short write.
00128   off64_t l = vec->iov_len;
00129   if (_size - pos < l)
00130     l = _size - pos;
00131
00132   if (l > 0)
00133     {
00134       Vfs_config::memcpy(_addr + pos, vec->iov_base, l);
00135       return l;
00136     }
00137
00138   // The write operation would happen entirely beyond EOF. For now, we cannot
00139   // extend the file, so return an appropriate error code.
00140   return -ENOSPC;
00141 }
00142
00143 ssize_t
00144 Ds_file::pwritev(const struct iovec *vec, int cnt, off64_t offset) noexcept
00145 {
00146   if (cnt < 0 || offset < 0)
00147     return -EINVAL;
00148
00149   if (! _writable)
00150     return -EBADF;
00151
00152   // Create a mapping if none is established yet
00153   if (! _addr)
00154     {
00155       void *file = reinterpret_cast<void*>(L4_PAGESIZE);
```

```
00156       long err = L4Re::Env::env()->rm()->attach(&file, _size,
00157                                                 Rm::F::Search_addr | Rm::F::RW,
00158                                                 L4::Ipc::make_cap_rw(_ds), 0);
00159
00160       if (err < 0)
00161         return err;
00162
00163       _addr = static_cast<char *>(file);
00164     }
00165
00166   // Copy loop, iterating over all I/O vectors
00167   ssize_t l = 0;                          // No. of bytes copied so far
00168   while (cnt > 0)
00169     {
00170       ssize_t r = write_single(vec, offset);
00171
00172       // This check also ensures that casting r to a size_t does not cause
00173       // overflows if r is negative.
00174       if (r < 0)
00175         return (l == 0) ? r : l;
00176
00177       offset += r;
00178       l      += r;
00179
00180       // Check for short writes
00181       if (static_cast<size_t>(r) < vec->iov_len)
00182         return l;
00183
00184       ++vec;
00185       --cnt;
00186     }
00187
00188   return l;
00189 }
00190
00191 int
00192 Ds_file::ioctl(unsigned long v, va_list args) noexcept
00193 {
00194   switch (v)
00195     {
00196     case FIONREAD: // return amount of data still available
00197       int *available = va_arg(args, int *);
00198       *available = _size - pos();
00199       return 0;
00200     };
00201   return -ENOTTY;
00202 }
00203
00204 }}
```

16.261 fd_store.h

```
00001 /*
00002  * (c) 2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/l4re_vfs/vfs.h>
00010
00011 namespace L4Re { namespace Core {
00012
00013 using cxx::Ref_ptr;
00014
00015 class Fd_store
00016 {
00017 public:
00018   enum { MAX_FILES = 50 };
00019
00020   Fd_store() noexcept : _fd_hint(0) {}
00021
00022   int alloc() noexcept;
00023   void free(int fd) noexcept;
00024   bool check_fd(int fd) noexcept;
00025   Ref_ptr<L4Re::Vfs::File> get(int fd) noexcept;
00026   void set(int fd, Ref_ptr<L4Re::Vfs::File> const &f) noexcept;
00027
00028 private:
00029   int _fd_hint;
00030   Ref_ptr<L4Re::Vfs::File> _files[MAX_FILES];
00031 };
00032
```

```
00033 inline
00034 bool
00035 Fd_store::check_fd(int fd) noexcept
00036 {
00037   return fd >= 0 && fd < MAX_FILES;
00038 }
00039
00040 inline
00041 Ref_ptr<L4Re::Vfs::File>
00042 Fd_store::get(int fd) noexcept
00043 {
00044   if (check_fd(fd))
00045     return _files[fd];
00046
00047   return Ref_ptr<>::Nil;
00048 }
00049
00050 inline
00051 void
00052 Fd_store::set(int fd, Ref_ptr<L4Re::Vfs::File> const &f) noexcept
00053 {
00054   _files[fd] = f;
00055 }
00056
00057 }}
```

16.262 fd_store_impl.h

```
00001 /*
00002  * (c) 2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #include "fd_store.h"
00008
00009 namespace L4Re { namespace Core {
00010
00011 int
00012 Fd_store::alloc() noexcept
00013 {
00014   for (int i = _fd_hint; i < MAX_FILES; ++i)
00015     {
00016       if (!_files[i])
00017   {
00018     _fd_hint = i + 1;
00019     return i;
00020   }
00021     }
00022
00023   return -1;
00024 }
00025
00026 void
00027 Fd_store::free(int fd) noexcept
00028 {
00029   _files[fd] = 0;
00030   if (fd < _fd_hint)
00031     _fd_hint = fd;
00032 }
00033
00034 }}
00035
```

16.263 ns_fs.h

```
00001 /*
00002  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/l4re_vfs/backend>
00011 #include <l4/sys/capability>
00012 #include <l4/re/namespace>
00013 #include <l4/re/unique_cap>
00014
00015 namespace L4Re { namespace Core {
```

```
00016
00017 using cxx::Ref_ptr;
00018
00019 class Env_dir : public L4Re::Vfs::Be_file
00020 {
00021 public:
00022   explicit Env_dir(L4Re::Env const *env)
00023   : _env(env), _current_cap_entry(env->initial_caps())
00024   {}
00025
00026   ssize_t readv(const struct iovec*, int) noexcept override { return -EISDIR; }
00027   ssize_t writev(const struct iovec*, int) noexcept override { return -EISDIR; }
00028   ssize_t preadv(const struct iovec*, int, off64_t) noexcept override { return -EISDIR; }
00029   ssize_t pwritev(const struct iovec*, int, off64_t) noexcept override { return -EISDIR; }
00030   int fstat(struct stat64 *) const noexcept override;
00031   int faccessat(const char *path, int mode, int flags) noexcept override;
00032   int get_entry(const char *path, int flags, mode_t mode,
00033                 Ref_ptr<L4Re::Vfs::File> *) noexcept override;
00034   ssize_t getdents(char *, size_t) noexcept override;
00035
00036   ~Env_dir() noexcept {}
00037
00038 private:
00039   int get_ds(const char *path, L4Re::Unique_cap<L4Re::Dataspace> *ds) noexcept;
00040   bool check_type(Env::Cap_entry const *e, long protocol) noexcept;
00041
00042   L4Re::Env const *_env;
00043   Env::Cap_entry const *_current_cap_entry;
00044 };
00045
00046 class Ns_dir : public L4Re::Vfs::Be_file
00047 {
00048 public:
00049   explicit Ns_dir(L4::Cap<L4Re::Namespace> ns)
00050   : _ns(ns), _current_dir_pos(0)
00051   {}
00052
00053   ssize_t readv(const struct iovec*, int) noexcept override { return -EISDIR; }
00054   ssize_t writev(const struct iovec*, int) noexcept override { return -EISDIR; }
00055   ssize_t preadv(const struct iovec*, int, off64_t) noexcept override { return -EISDIR; }
00056   ssize_t pwritev(const struct iovec*, int, off64_t) noexcept override { return -EISDIR; }
00057   int fstat(struct stat64 *) const noexcept override;
00058   int faccessat(const char *path, int mode, int flags) noexcept override;
00059   int get_entry(const char *path, int flags, mode_t mode,
00060                 Ref_ptr<L4Re::Vfs::File> *) noexcept override;
00061   ssize_t getdents(char *, size_t) noexcept override;
00062
00063   ~Ns_dir() noexcept {}
00064
00065 private:
00066   int get_ds(const char *path, L4Re::Unique_cap<L4Re::Dataspace> *ds) noexcept;
00067
00068   L4::Cap<L4Re::Namespace> _ns;
00069   size_t _current_dir_pos;
00070 };
00071
00072 }}
```

16.264 ns_fs_impl.h

```
00001 /*
00002  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #include "ns_fs.h"
00009
00010 #include <l4/re/dataspace>
00011 #include <l4/re/util/env_ns>
00012 #include <l4/re/unique_cap>
00013 #include <dirent.h>
00014
00015 namespace L4Re { namespace Core {
00016
00017 static
00018 Ref_ptr<L4Re::Vfs::File>
00019 cap_to_vfs_object(L4::Cap<void> o, int *err)
00020 {
00021   L4::Cap<L4::Meta> m = L4::cap_reinterpret_cast<L4::Meta>(o);
00022   long proto = 0;
00023   char name_buf[256];
00024   L4::Ipc::String<char> name(sizeof(name_buf), name_buf);
```

```
00025   l4_ret_t r = l4_error(m->interface(0, &proto, &name));
00026   *err = -ENOPROTOOPT;
00027   if (r < 0)
00028     // could not get type of object so bail out
00029     return Ref_ptr<L4Re::Vfs::File>();
00030
00031   *err = -EPROTO;
00032   Ref_ptr<L4Re::Vfs::File_factory> factory;
00033
00034   if (proto != 0)
00035     factory = L4Re::Vfs::vfs_ops->get_file_factory(proto);
00036
00037   if (!factory)
00038     factory = L4Re::Vfs::vfs_ops->get_file_factory(name.data);
00039
00040   if (!factory)
00041     return Ref_ptr<L4Re::Vfs::File>();
00042
00043   *err = -ENOMEM;
00044   return factory->create(o);
00045 }
00046
00047
00048 int
00049 Ns_dir::get_ds(const char *path, L4Re::Unique_cap<L4Re::Dataspace> *ds) noexcept
00050 {
00051   auto file = L4Re::make_unique_cap<L4Re::Dataspace>(L4Re::virt_cap_alloc);
00052
00053   if (!file.is_valid())
00054     return -ENOMEM;
00055
00056   int err = _ns->query(path, file.get());
00057
00058   if (err < 0)
00059     return -ENOENT;
00060
00061   *ds = cxx::move(file);
00062   return err;
00063 }
00064
00065 int
00066 Ns_dir::get_entry(const char *path, int /*flags*/, mode_t /*mode*/,
00067                   Ref_ptr<L4Re::Vfs::File> *f) noexcept
00068 {
00069   if (!*path)
00070     {
00071       *f = cxx::ref_ptr(this);
00072       return 0;
00073     }
00074
00075   L4Re::Unique_cap<Dataspace> file;
00076   int err = get_ds(path, &file);
00077
00078   if (err < 0)
00079     return -ENOENT;
00080
00081   cxx::Ref_ptr<L4Re::Vfs::File> fi = cap_to_vfs_object(file.get(), &err);
00082   if (!fi)
00083     return err;
00084
00085   file.release();
00086   *f = cxx::move(fi);
00087   return 0;
00088 }
00089
00090 int
00091 Ns_dir::faccessat(const char *path, int mode, int /*flags*/) noexcept
00092 {
00093   auto tmpcap = L4Re::make_unique_cap<void>(L4Re::virt_cap_alloc);
00094
00095   if (!tmpcap.is_valid())
00096     return -ENOMEM;
00097
00098   if (_ns->query(path, tmpcap.get()))
00099     return -ENOENT;
00100
00101   if (mode & W_OK)
00102     return -EACCES;
00103
00104   return 0;
00105 }
00106
00107 int
00108 Ns_dir::fstat(struct stat64 *b) const noexcept
00109 {
00110   b->st_dev = 1;
00111   b->st_ino = 1;
```

```
00112   b->st_mode = S_IRWXU | S_IFDIR;
00113   b->st_nlink = 0;
00114   b->st_uid = 0;
00115   b->st_gid = 0;
00116   b->st_rdev = 0;
00117   b->st_size = 0;
00118   b->st_blksize = 0;
00119   b->st_blocks = 0;
00120   b->st_atime = 0;
00121   b->st_mtime = 0;
00122   b->st_ctime = 0;
00123   return 0;
00124 }
00125
00126 ssize_t
00127 Ns_dir::getdents(char *buf, size_t dest_sz) noexcept
00128 {
00129   struct dirent64 *dest = reinterpret_cast<struct dirent64 *>(buf);
00130   ssize_t ret = 0;
00131   l4_addr_t infoaddr;
00132   size_t infosz;
00133
00134   L4Re::Unique_cap<Dataspace> dirinfofile;
00135   int err = get_ds(".dirinfo", &dirinfofile);
00136   if (err)
00137     return 0;
00138
00139   infosz = dirinfofile->size();
00140   if (infosz <= 0)
00141     return 0;
00142
00143   infoaddr = L4_PAGESIZE;
00144   err = L4Re::Env::env()->rm()->attach(&infoaddr, infosz,
00145                                        Rm::F::Search_addr | Rm::F::R,
00146                                        dirinfofile.get(), 0);
00147   if (err < 0)
00148     return 0;
00149
00150   char *p   = reinterpret_cast<char *>(infoaddr) + _current_dir_pos;
00151   char *end = reinterpret_cast<char *>(infoaddr) + infosz;
00152
00153   char *current_dirinfo_entry = p;
00154   while (dest && p < end)
00155     {
00156       // parse lines of dirinfofile
00157       long len = 0;
00158       for (; p < end && *p >= '0' && *p <= '9'; ++p)
00159         {
00160           len *= 10;
00161           len += *p - '0';
00162         }
00163
00164       if (len == 0)
00165         break;
00166
00167       if (p == end)
00168         break;
00169
00170       if (*p != ':')
00171         break;
00172       p++; // skip colon
00173
00174       if (p + len >= end)
00175         break;
00176
00177       unsigned l = len + 1;
00178       if (l > sizeof(dest->d_name))
00179         l = sizeof(dest->d_name);
00180
00181       unsigned n = offsetof (struct dirent64, d_name) + l;
00182       n = (n + sizeof(long) - 1) & ~(sizeof(long) - 1);
00183
00184       if (n > dest_sz)
00185         break;
00186
00187       dest->d_ino = 1;
00188       dest->d_off = 0;
00189       memcpy(dest->d_name, p, l - 1);
00190       dest->d_name[l - 1] = 0;
00191       dest->d_reclen = n;
00192       dest->d_type   = DT_UNKNOWN;
00193       ret += n;
00194       dest_sz -= n;
00195
00196       // next entry
00197       dest = reinterpret_cast<struct dirent64 *>
00198                (reinterpret_cast<unsigned long>(dest) + n);
```

```
00199
00200       // next infodirfile line
00201       p += len;
00202       while (p < end && *p && (*p == '\n' || *p == '\r'))
00203         p++;
00204
00205       current_dirinfo_entry = p;
00206     }
00207
00208   _current_dir_pos = current_dirinfo_entry - reinterpret_cast<char *>(infoaddr);
00209
00210   if (!ret) // hack since we should only reset this at open times
00211     _current_dir_pos = 0;
00212
00213   L4Re::Env::env()->rm()->detach(infoaddr, 0);
00214
00215   return ret;
00216 }
00217
00218 int
00219 Env_dir::get_ds(const char *path, L4Re::Unique_cap<L4Re::Dataspace> *ds) noexcept
00220 {
00221   while (*path == '/')
00222     ++path;
00223   Vfs::Path p(path);
00224   Vfs::Path first = p.strip_first();
00225
00226   if (first.empty())
00227     return -ENOENT;
00228
00229   L4::Cap<L4Re::Namespace>
00230     c = _env->get_cap<L4Re::Namespace>(first.path(), first.length());
00231
00232   if (!c.is_valid())
00233     return -ENOENT;
00234
00235   if (p.empty())
00236     {
00237       *ds = L4Re::Unique_cap<L4Re::Dataspace>(L4::cap_reinterpret_cast<L4Re::Dataspace>(c));
00238       return 0;
00239     }
00240
00241   auto file = L4Re::make_unique_cap<L4Re::Dataspace>(L4Re::virt_cap_alloc);
00242
00243   if (!file.is_valid())
00244     return -ENOMEM;
00245
00246   int err = c->query(p.path(), p.length(), file.get());
00247
00248   if (err < 0)
00249     return -ENOENT;
00250
00251   *ds = cxx::move(file);
00252   return err;
00253 }
00254
00255 int
00256 Env_dir::get_entry(const char *path, int /*flags*/, mode_t /*mode*/,
00257                    Ref_ptr<L4Re::Vfs::File> *f) noexcept
00258 {
00259   if (!*path)
00260     {
00261       *f = cxx::ref_ptr(this);
00262       return 0;
00263     }
00264
00265   L4Re::Unique_cap<Dataspace> file;
00266   int err = get_ds(path, &file);
00267
00268   if (err < 0)
00269     return -ENOENT;
00270
00271   cxx::Ref_ptr<L4Re::Vfs::File> fi = cap_to_vfs_object(file.get(), &err);
00272   if (!fi)
00273     return err;
00274
00275   file.release();
00276   *f = cxx::move(fi);
00277   return 0;
00278 }
00279
00280 int
00281 Env_dir::faccessat(const char *path, int mode, int /*flags*/) noexcept
00282 {
00283   while (*path == '/')
00284     ++path;
00285   Vfs::Path p(path);
```

```
00286   Vfs::Path first = p.strip_first();
00287
00288   if (first.empty())
00289     return -ENOENT;
00290
00291   L4::Cap<L4Re::Namespace>
00292     c = _env->get_cap<L4Re::Namespace>(first.path(), first.length());
00293
00294   if (!c.is_valid())
00295     return -ENOENT;
00296
00297   if (p.empty())
00298     {
00299       if (mode & W_OK)
00300   return -EACCES;
00301
00302       return 0;
00303     }
00304
00305   auto tmpcap = L4Re::make_unique_cap<void>(L4Re::virt_cap_alloc);
00306
00307   if (!tmpcap.is_valid())
00308     return -ENOMEM;
00309
00310   if (c->query(p.path(), p.length(), tmpcap.get()))
00311     return -ENOENT;
00312
00313   if (mode & W_OK)
00314     return -EACCES;
00315
00316   return 0;
00317 }
00318
00319 bool
00320 Env_dir::check_type(Env::Cap_entry const *e, long protocol) noexcept
00321 {
00322   L4::Cap<L4::Meta> m(e->cap);
00323   return m->supports(protocol).label();
00324 }
00325
00326 int
00327 Env_dir::fstat(struct stat64 *b) const noexcept
00328 {
00329   b->st_dev = 1;
00330   b->st_ino = 1;
00331   b->st_mode = S_IRWXU | S_IFDIR;
00332   b->st_nlink = 0;
00333   b->st_uid = 0;
00334   b->st_gid = 0;
00335   b->st_rdev = 0;
00336   b->st_size = 0;
00337   b->st_blksize = 0;
00338   b->st_blocks = 0;
00339   b->st_atime = 0;
00340   b->st_mtime = 0;
00341   b->st_ctime = 0;
00342   return 0;
00343 }
00344
00345 ssize_t
00346 Env_dir::getdents(char *buf, size_t sz) noexcept
00347 {
00348   struct dirent64 *d = reinterpret_cast<struct dirent64 *>(buf);
00349   ssize_t ret = 0;
00350
00351   while (d
00352          && _current_cap_entry
00353          && _current_cap_entry->flags != ~0UL)
00354     {
00355       unsigned l = strlen(_current_cap_entry->name) + 1;
00356       if (l > sizeof(d->d_name))
00357         l = sizeof(d->d_name);
00358
00359       unsigned n = offsetof (struct dirent64, d_name) + l;
00360       n = (n + sizeof(long) - 1) & ~(sizeof(long) - 1);
00361
00362       if (n <= sz)
00363         {
00364           d->d_ino = 1;
00365           d->d_off = 0;
00366           memcpy(d->d_name, _current_cap_entry->name, l);
00367           d->d_name[l - 1] = 0;
00368           d->d_reclen = n;
00369           if (check_type(_current_cap_entry, L4Re::Namespace::Protocol))
00370             d->d_type = DT_DIR;
00371           else if (check_type(_current_cap_entry, L4Re::Dataspace::Protocol))
00372             d->d_type = DT_REG;
```

```
00373           else
00374             d->d_type = DT_UNKNOWN;
00375           ret += n;
00376           sz  -= n;
00377           d    = reinterpret_cast<struct dirent64 *>
00378                    (reinterpret_cast<unsigned long>(d) + n);
00379           _current_cap_entry++;
00380         }
00381       else
00382         return ret;
00383     }
00384
00385   // bit of a hack because we should only (re)set this when opening the dir
00386   if (!ret)
00387     _current_cap_entry = _env->initial_caps();
00388
00389   return ret;
00390 }
00391
00392 }}
```

16.265 vcon_stream.h

```
00001 /*
00002  * (c) 2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/capability>
00010 #include <l4/sys/vcon>
00011 #include <l4/sys/semaphore>
00012
00013 #include <l4/l4re_vfs/backend>
00014
00015 namespace L4Re { namespace Core {
00016
00017 class Vcon_stream : public L4Re::Vfs::Be_file_stream
00018 {
00019 private:
00020   L4::Cap<L4::Vcon> _s;
00021   L4::Cap<L4::Semaphore>  _irq;
00022   unsigned _irq_bound;
00023
00024 public:
00025   explicit Vcon_stream(L4::Cap<L4::Vcon> s) noexcept;
00026
00027   ssize_t readv(const struct iovec*, int iovcnt) noexcept override;
00028   ssize_t writev(const struct iovec*, int iovcnt) noexcept override;
00029   int fstat(struct stat64 *buf) const noexcept override;
00030   int get_status_flags() const noexcept override { return O_RDWR; }
00031   int set_status_flags(long) noexcept override { return 0; }
00032   int ioctl(unsigned long request, va_list args) noexcept override;
00033
00034   ~Vcon_stream() noexcept {}
00035   void operator delete (void *) {}
00036 };
00037
00038 }}
```

16.266 vcon_stream_impl.h

```
00001 /*
00002  * (c) 2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #include <l4/re/env>
00009 #include <l4/sys/factory>
00010 #include <l4/cxx/minmax>
00011
00012 #include "vcon_stream.h"
00013
00014 #include <limits.h>
00015 #include <termios.h>
00016 #include <unistd.h>
00017 #include <sys/ioctl.h>
```

```
00018 #include <sys/ttydefaults.h>
00019
00020 namespace L4Re { namespace Core {
00021 Vcon_stream::Vcon_stream(L4::Cap<L4::Vcon> s) noexcept
00022 : Be_file_stream(),
00023   _s(s), _irq(L4Re::virt_cap_alloc->alloc<L4::Semaphore>()), _irq_bound(false)
00024 {
00025   // [[maybe_unused]] int res =
00026   l4_error(L4Re::Env::env()->factory()->create(_irq));
00027   // (void)res; // handle errors!
00028 }
00029
00030 ssize_t
00031 Vcon_stream::readv(const struct iovec *iovec, int iovcnt) noexcept
00032 {
00033   if (iovcnt < 0)
00034     return -EINVAL;
00035
00036   if (!_irq_bound)
00037     {
00038       bool was_bound = __atomic_exchange_n(&_irq_bound, true, __ATOMIC_SEQ_CST);
00039       if (!was_bound)
00040         if (l4_error(_s->bind(0, _irq)) < 0)
00041           return -EIO;
00042     }
00043
00044   ssize_t bytes = 0;
00045   for (; iovcnt > 0; --iovcnt, ++iovec)
00046     {
00047       size_t len = cxx::min<size_t>(iovec->iov_len, SSIZE_MAX - bytes);
00048       if (len == 0)
00049         continue;
00050
00051       char *buf = static_cast<char *>(iovec->iov_base);
00052
00053       while (1)
00054         {
00055           size_t l = cxx::min<size_t>(L4_VCON_READ_SIZE, len);
00056           int ret = _s->read(buf, l);
00057
00058           if (ret > static_cast<int>(l))
00059             ret = l;
00060
00061           if (ret < 0)
00062             return ret;
00063           else if (ret == 0)
00064             {
00065               if (bytes)
00066                 return bytes;
00067
00068               ret = _s->read(buf, l);
00069               if (ret < 0)
00070                 return ret;
00071               else if (ret == 0)
00072                 {
00073                   _irq->down();
00074                   continue;
00075                 }
00076             }
00077
00078           bytes += ret;
00079           len   -= ret;
00080           buf   += ret;
00081
00082           if (len == 0)
00083             break;
00084         }
00085     }
00086
00087   return bytes;
00088 }
00089
00090 ssize_t
00091 Vcon_stream::writev(const struct iovec *iovec, int iovcnt) noexcept
00092 {
00093   l4_msg_regs_t store;
00094   l4_msg_regs_t *mr = l4_utcb_mr();
00095
00096   if (iovcnt < 0)
00097     return -EINVAL;
00098
00099   Vfs_config::memcpy(&store, mr, sizeof(store));
00100
00101   ssize_t written = 0;
00102   while (iovcnt)
00103     {
00104       size_t sl = cxx::min<size_t>(iovec->iov_len, SSIZE_MAX - written);
```

```
00105       char const *b = static_cast<char const *>(iovec->iov_base);
00106
00107       for (; sl > L4_VCON_WRITE_SIZE
00108            ; sl -= L4_VCON_WRITE_SIZE, b += L4_VCON_WRITE_SIZE,
00109              written += L4_VCON_WRITE_SIZE)
00110         _s->send(b, L4_VCON_WRITE_SIZE);
00111
00112       _s->send(b, sl);
00113
00114       written += sl;
00115
00116       ++iovec;
00117       --iovcnt;
00118     }
00119   Vfs_config::memcpy(mr, &store, sizeof(store));
00120   return written;
00121 }
00122
00123 int
00124 Vcon_stream::fstat(struct stat64 *buf) const noexcept
00125 {
00126   buf->st_size = 0;
00127   buf->st_mode = 0666;
00128   buf->st_dev = _s.cap();
00129   buf->st_ino = 0;
00130   return 0;
00131 }
00132
00133 int
00134 Vcon_stream::ioctl(unsigned long request, va_list args) noexcept
00135 {
00136   switch (request) {
00137     case TCGETS:
00138         {
00139           //vt100_tcgetattr(term, (struct termios *)argp);
00140
00141           struct termios *t = va_arg(args, struct termios *);
00142
00143           l4_vcon_attr_t l4a;
00144           if (!l4_error(_s->get_attr(&l4a)))
00145             {
00146               t->c_iflag = l4a.i_flags;
00147               t->c_oflag = l4a.o_flags; // output flags
00148               t->c_cflag = 0; // control flags
00149               t->c_lflag = l4a.l_flags; // local flags
00150             }
00151           else
00152             t->c_iflag = t->c_oflag = t->c_cflag = t->c_lflag = 0;
00153 #if 0
00154           //t->c_lflag |= ECHO; // if term->echo
00155           t->c_lflag |= ICANON; // if term->term_mode == VT100MODE_COOKED
00156 #endif
00157
00158           t->c_cc[VEOF]     = CEOF;
00159           t->c_cc[VEOL]     = _POSIX_VDISABLE;
00160           t->c_cc[VEOL2]    = _POSIX_VDISABLE;
00161           t->c_cc[VERASE]   = CERASE;
00162           t->c_cc[VWERASE]  = CWERASE;
00163           t->c_cc[VKILL]    = CKILL;
00164           t->c_cc[VREPRINT] = CREPRINT;
00165           t->c_cc[VINTR]    = CINTR;
00166           t->c_cc[VQUIT]    = _POSIX_VDISABLE;
00167           t->c_cc[VSUSP]    = CSUSP;
00168           t->c_cc[VSTART]   = CSTART;
00169           t->c_cc[VSTOP]    = CSTOP;
00170           t->c_cc[VLNEXT]   = CLNEXT;
00171           t->c_cc[VDISCARD] = CDISCARD;
00172           t->c_cc[VMIN]     = CMIN;
00173           t->c_cc[VTIME]    = 0;
00174
00175         }
00176
00177       return 0;
00178
00179     case TCSETS:
00180     case TCSETSW:
00181     case TCSETSF:
00182         {
00183           //vt100_tcsetattr(term, (struct termios *)argp);
00184           struct termios const *t = va_arg(args, struct termios const *);
00185
00186           // XXX: well, we're cheating, get this from the other side!
00187
00188           l4_vcon_attr_t l4a;
00189           l4a.i_flags = t->c_iflag;
00190           l4a.o_flags = t->c_oflag; // output flags
00191           l4a.l_flags = t->c_lflag; // local flags
```

```
00192           _s->set_attr(&l4a);
00193         }
00194       return 0;
00195
00196     default:
00197       break;
00198   };
00199   return -ENOTTY;
00200 }
00201
00202 }}
```

16.267 vfs_impl.h

```
00001 /*
00002  * (c) 2008-2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #include "fd_store.h"
00011 #include "vcon_stream.h"
00012 #include "ns_fs.h"
00013
00014 #include <l4/bid_config.h>
00015 #include <l4/re/env>
00016 #include <l4/re/rm>
00017 #include <l4/re/dataspace>
00018 #include <l4/sys/assert.h>
00019 #include <l4/cxx/hlist>
00020 #include <l4/cxx/pair>
00021 #include <l4/cxx/std_alloc>
00022
00023 #include <l4/l4re_vfs/backend>
00024 #include <l4/re/shared_cap>
00025
00026 #include <unistd.h>
00027 #include <stdarg.h>
00028 #include <errno.h>
00029 #include <sys/uio.h>
00030 #include <sys/mman.h>
00031
00032 #if 0
00033 #include <l4/sys/kdebug.h>
00034 static int debug_mmap = 1;
00035 #define DEBUG_LOG(level, dbg...) do { if (level) dbg } while (0)
00036 #else
00037 #define DEBUG_LOG(level, dbg...) do { } while (0)
00038 #endif
00039
00045 #define USE_BIG_ANON_DS
00046
00047 using L4Re::Rm;
00048
00049 namespace {
00050
00051 using cxx::Ref_ptr;
00052
00053 class Fd_store : public L4Re::Core::Fd_store
00054 {
00055 public:
00056   Fd_store() noexcept;
00057 };
00058
00059 // for internal Vcon_streams we want to have a placement new operator, so
00060 // inherit and add one
00061 class Std_stream : public L4Re::Core::Vcon_stream
00062 {
00063 public:
00064   Std_stream(L4::Cap<L4::Vcon> c) : L4Re::Core::Vcon_stream(c) {}
00065 };
00066
00067 Fd_store::Fd_store() noexcept
00068 {
00069   // use this strange way to prevent deletion of the stdio object
00070   // this depends on Fd_store to being a singleton !!!
00071   static char m[sizeof(Std_stream)] __attribute__((aligned(sizeof(long))));
00072   if (auto log = L4Re::Env::env()->log())
00073     {
00074       Std_stream *s = new (m) Std_stream(log);
00075       set(0, cxx::ref_ptr(s)); // stdin
```

```
00076       set(1, cxx::ref_ptr(s)); // stdout
00077       set(2, cxx::ref_ptr(s)); // stderr
00078
00079       // make sure that we never delete the static io stream thing
00080       s->add_ref();
00081     }
00082 }
00083
00084 class Root_mount_tree : public L4Re::Vfs::Mount_tree
00085 {
00086 public:
00087   Root_mount_tree() : L4Re::Vfs::Mount_tree(0) {}
00088   void operator delete (void *) {}
00089 };
00090
00091 class Vfs : public L4Re::Vfs::Ops
00092 {
00093 private:
00094   bool _early_oom;
00095
00096 public:
00097   Vfs()
00098   : _early_oom(true), _root_mount(), _root(L4Re::Env::env())
00099   {
00100     _root_mount.add_ref();
00101     _root.add_ref();
00102     _root_mount.mount(cxx::ref_ptr(&_root));
00103     _cwd = cxx::ref_ptr(&_root);
00104
00105 #if 0
00106     Ref_ptr<L4Re::Vfs::File> rom;
00107     _root.openat("rom", 0, 0, &rom);
00108
00109     _root_mount.create_tree("lib/foo", rom);
00110
00111     _root.openat("lib", 0, 0, &_cwd);
00112
00113 #endif
00114   }
00115
00116   int alloc_fd(Ref_ptr<L4Re::Vfs::File> const &f) noexcept override;
00117   Ref_ptr<L4Re::Vfs::File> free_fd(int fd) noexcept override;
00118   Ref_ptr<L4Re::Vfs::File> get_root() noexcept override;
00119   Ref_ptr<L4Re::Vfs::File> get_cwd() noexcept override;
00120   void set_cwd(Ref_ptr<L4Re::Vfs::File> const &dir) noexcept override;
00121   Ref_ptr<L4Re::Vfs::File> get_file(int fd) noexcept override;
00122   cxx::Pair<Ref_ptr<L4Re::Vfs::File>, int>
00123     set_fd(int fd, Ref_ptr<L4Re::Vfs::File> const &f = Ref_ptr<>::Nil) noexcept
00124       override;
00125
00126   int mmap2(void *start, size_t len, int prot, int flags, int fd,
00127             off_t offset, void **ptr) noexcept override;
00128
00129   int munmap(void *start, size_t len) noexcept override;
00130   int mprotect(const void *a, size_t sz, int prot) noexcept override;
00131   int msync(void *addr, size_t len, int flags) noexcept override;
00132   int madvise(void *addr, size_t len, int advice) noexcept override;
00133
00134   int register_file_system(L4Re::Vfs::File_system *f) noexcept override;
00135   int unregister_file_system(L4Re::Vfs::File_system *f) noexcept override;
00136   L4Re::Vfs::File_system *get_file_system(char const *fstype) noexcept override;
00137   L4Re::Vfs::File_system_list file_system_list() noexcept override;
00138
00139   int register_file_factory(cxx::Ref_ptr<L4Re::Vfs::File_factory> f) noexcept override;
00140   int unregister_file_factory(cxx::Ref_ptr<L4Re::Vfs::File_factory> f) noexcept override;
00141   Ref_ptr<L4Re::Vfs::File_factory> get_file_factory(int proto) noexcept override;
00142   Ref_ptr<L4Re::Vfs::File_factory> get_file_factory(char const *proto_name) noexcept override;
00143   int mount(char const *path, cxx::Ref_ptr<L4Re::Vfs::File> const &dir) noexcept override;
00144
00145   void operator delete (void *) {}
00146
00147   void *malloc(size_t size) noexcept override { return Vfs_config::malloc(size); }
00148   void free(void *m) noexcept override { Vfs_config::free(m); }
00149
00150 private:
00151   Root_mount_tree _root_mount;
00152   L4Re::Core::Env_dir _root;
00153   Ref_ptr<L4Re::Vfs::File> _cwd;
00154   Fd_store fds;
00155
00156   L4Re::Vfs::File_system *_fs_registry;
00157
00158   struct File_factory_item : cxx::H_list_item_t<File_factory_item>
00159   {
00160     cxx::Ref_ptr<L4Re::Vfs::File_factory> f;
00161     explicit File_factory_item(cxx::Ref_ptr<L4Re::Vfs::File_factory> const &f)
00162     : f(f) {};
```

```
00163
00164     File_factory_item() = default;
00165     File_factory_item(File_factory_item const &) = delete;
00166     File_factory_item &operator = (File_factory_item const &) = delete;
00167   };
00168
00169   cxx::H_list_t<File_factory_item> _file_factories;
00170
00171   void align_mmap_start_and_length(void **start, size_t *length);
00172   int munmap_regions(void *start, size_t len);
00173
00174   L4Re::Vfs::File_system *find_fs_from_type(char const *fstype) noexcept;
00175 };
00176
00177 static inline bool strequal(char const *a, char const *b)
00178 {
00179   for (;*a && *a == *b; ++a, ++b)
00180     ;
00181   return *a == *b;
00182 }
00183
00184 int
00185 Vfs::register_file_system(L4Re::Vfs::File_system *f) noexcept
00186 {
00187   using L4Re::Vfs::File_system;
00188
00189   if (!f)
00190     return -EINVAL;
00191
00192   for (File_system *c = _fs_registry; c; c = c->next())
00193     if (strequal(c->type(), f->type()))
00194       return -EEXIST;
00195
00196   f->next(_fs_registry);
00197   _fs_registry = f;
00198
00199   return 0;
00200 }
00201
00202 int
00203 Vfs::unregister_file_system(L4Re::Vfs::File_system *f) noexcept
00204 {
00205   using L4Re::Vfs::File_system;
00206
00207   if (!f)
00208     return -EINVAL;
00209
00210   File_system **p = &_fs_registry;
00211
00212   for (; *p; p = &(*p)->next())
00213     if (*p == f)
00214       {
00215         *p = f->next();
00216         f->next() = 0;
00217         return 0;
00218       }
00219
00220   return -ENOENT;
00221 }
00222
00223 L4Re::Vfs::File_system *
00224 Vfs::find_fs_from_type(char const *fstype) noexcept
00225 {
00226   L4Re::Vfs::File_system_list fsl(_fs_registry);
00227   for (L4Re::Vfs::File_system_list::Iterator c = fsl.begin();
00228        c != fsl.end(); ++c)
00229     if (strequal(c->type(), fstype))
00230       return *c;
00231   return 0;
00232 }
00233
00234 L4Re::Vfs::File_system_list
00235 Vfs::file_system_list() noexcept
00236 {
00237   return L4Re::Vfs::File_system_list(_fs_registry);
00238 }
00239
00240 L4Re::Vfs::File_system *
00241 Vfs::get_file_system(char const *fstype) noexcept
00242 {
00243   L4Re::Vfs::File_system *fs;
00244   if ((fs = find_fs_from_type(fstype)))
00245     return fs;
00246
00247   // Try to load a file system module dynamically
00248   int res = Vfs_config::load_module(fstype);
00249   if (res < 0)
```

```
00250     return 0;
00251
00252   // Try again
00253   return find_fs_from_type(fstype);
00254 }
00255
00256 int
00257 Vfs::register_file_factory(cxx::Ref_ptr<L4Re::Vfs::File_factory> f) noexcept
00258 {
00259   if (!f)
00260     return -EINVAL;
00261
00262   void *x = this->malloc(sizeof(File_factory_item));
00263   if (!x)
00264     return -ENOMEM;
00265
00266   auto ff = new (x, cxx::Nothrow()) File_factory_item(f);
00267   _file_factories.push_front(ff);
00268   return 0;
00269 }
00270
00271 int
00272 Vfs::unregister_file_factory(cxx::Ref_ptr<L4Re::Vfs::File_factory> f) noexcept
00273 {
00274   for (auto p: _file_factories)
00275     {
00276       if (p->f == f)
00277         {
00278           _file_factories.remove(p);
00279           p->~File_factory_item();
00280           this->free(p);
00281           return 0;
00282         }
00283     }
00284   return -ENOENT;
00285 }
00286
00287 Ref_ptr<L4Re::Vfs::File_factory>
00288 Vfs::get_file_factory(int proto) noexcept
00289 {
00290   for (auto p: _file_factories)
00291     if (p->f->proto() == proto)
00292       return p->f;
00293
00294   return Ref_ptr<L4Re::Vfs::File_factory>();
00295 }
00296
00297 Ref_ptr<L4Re::Vfs::File_factory>
00298 Vfs::get_file_factory(char const *proto_name) noexcept
00299 {
00300   for (auto p: _file_factories)
00301     {
00302       auto n = p->f->proto_name();
00303       if (n)
00304         {
00305           char const *a = n;
00306           char const *b = proto_name;
00307           for (; *a && *b && *a == *b; ++a, ++b)
00308             ;
00309
00310           if ((*a == 0) && (*b == 0))
00311             return p->f;
00312         }
00313     }
00314
00315   return Ref_ptr<L4Re::Vfs::File_factory>();
00316 }
00317
00318 int
00319 Vfs::alloc_fd(Ref_ptr<L4Re::Vfs::File> const &f) noexcept
00320 {
00321   int fd = fds.alloc();
00322   if (fd < 0)
00323     return -EMFILE;
00324
00325   if (f)
00326     fds.set(fd, f);
00327
00328   return fd;
00329 }
00330
00331 Ref_ptr<L4Re::Vfs::File>
00332 Vfs::free_fd(int fd) noexcept
00333 {
00334   Ref_ptr<L4Re::Vfs::File> f = fds.get(fd);
00335
00336   if (!f)
```

```
00337     return Ref_ptr<>::Nil;
00338
00339   fds.free(fd);
00340   return f;
00341 }
00342
00343
00344 Ref_ptr<L4Re::Vfs::File>
00345 Vfs::get_root() noexcept
00346 {
00347   return cxx::ref_ptr(&_root);
00348 }
00349
00350 Ref_ptr<L4Re::Vfs::File>
00351 Vfs::get_cwd() noexcept
00352 {
00353   return _cwd;
00354 }
00355
00356 void
00357 Vfs::set_cwd(Ref_ptr<L4Re::Vfs::File> const &dir) noexcept
00358 {
00359   // FIXME: check for is dir
00360   if (dir)
00361     _cwd = dir;
00362 }
00363
00364 Ref_ptr<L4Re::Vfs::File>
00365 Vfs::get_file(int fd) noexcept
00366 {
00367   return fds.get(fd);
00368 }
00369
00370 cxx::Pair<Ref_ptr<L4Re::Vfs::File>, int>
00371 Vfs::set_fd(int fd, Ref_ptr<L4Re::Vfs::File> const &f) noexcept
00372 {
00373   if (!fds.check_fd(fd))
00374     return cxx::pair(Ref_ptr<L4Re::Vfs::File>(Ref_ptr<>::Nil), EBADF);
00375
00376   Ref_ptr<L4Re::Vfs::File> old = fds.get(fd);
00377   fds.set(fd, f);
00378   return cxx::pair(old, 0);
00379 }
00380
00381
00382 #define GET_FILE_DBG(fd, err) \
00383   Ref_ptr<L4Re::Vfs::File> fi = fds.get(fd); \
00384   if (!fi)                                   \
00385     {                                        \
00386       return -err;                           \
00387     }
00388
00389 #define GET_FILE(fd, err) \
00390   Ref_ptr<L4Re::Vfs::File> fi = fds.get(fd); \
00391   if (!fi)                                   \
00392     return -err;
00393
00394 void
00395 Vfs::align_mmap_start_and_length(void **start, size_t *length)
00396 {
00397   l4_addr_t const s = reinterpret_cast<l4_addr_t>(*start);
00398   size_t const o = s & (L4_PAGESIZE - 1);
00399
00400   *start   = reinterpret_cast<void *>(l4_trunc_page(s));
00401   *length  = l4_round_page(*length + o);
00402 }
00403
00404 int
00405 Vfs::munmap_regions(void *start, size_t len)
00406 {
00407   using namespace L4;
00408   using namespace L4Re;
00409
00410   int err;
00411   Cap<Rm> r = Env::env()->rm();
00412
00413   if (l4_addr_t(start) & (L4_PAGESIZE - 1))
00414     return -EINVAL;
00415
00416   align_mmap_start_and_length(&start, &len);
00417
00418   while (1)
00419     {
00420       DEBUG_LOG(debug_mmap, {
00421                 l4_kd_outstring("DETACH: start = 0x");
00422                 l4_kd_outhex32(l4_addr_t(start));
00423                 l4_kd_outstring(" len = 0x");
```

```
00424                 l4_kd_outhex32(len);
00425                 l4_kd_outstring("\n");
00426       });
00427       err = r->detach(l4_addr_t(start), len, nullptr, This_task);
00428       if (err < 0)
00429         return err;
00430
00431       if (!(err & Rm::Detach_again))
00432         return 0;
00433     }
00434 }
00435
00436 int
00437 Vfs::munmap(void *start, size_t len) L4_NOTHROW
00438 {
00439   using namespace L4;
00440   using namespace L4Re;
00441
00442   int err = 0;
00443   Cap<Rm> r = Env::env()->rm();
00444
00445   // Fields for obtaining a list of areas for the calling process
00446   long area_cnt = -1;           // No. of areas in this process
00447   L4::Ipc::Array_ref<Rm::Area> areas_in_utcb;
00448   bool matches_area = false;        // true if unmap parameters match an area
00449
00450   // First check if there are any areas matching the munmap request. Those
00451   // might have been created by an mmap call using PROT_NONE as protection
00452   // modifier.
00453
00454   area_cnt = r->get_areas((l4_addr_t) start, areas_in_utcb);
00455
00456   // It is enough to check for the very first entry, since get_areas will
00457   // only return areas with a starting address equal or greater to <start>.
00458   // However, we intend to unmap at most the area starting exactly at
00459   // <start>.
00460   if (area_cnt > 0)
00461     {
00462       Rm::Area const &first_area = areas_in_utcb.data[0];
00463       size_t area_size = first_area.end - first_area.start + 1;
00464
00465       // Only free the area if the munmap parameters describe it exactly.
00466       if (first_area.start == (l4_addr_t) start && area_size == len)
00467         {
00468           r->free_area((l4_addr_t) start);
00469           matches_area = true;
00470         }
00471     }
00472
00473   // After clearing possible area reservations from PROT_NONE mappings, clear
00474   // any regions in the address range specified. Note that errors shall be
00475   // suppressed if an area was freed but no regions were found.
00476   err = munmap_regions(start, len);
00477   if (err == -ENOENT && matches_area)
00478     return 0;
00479
00480   return err;
00481 }
00482
00483 int
00484 Vfs::mmap2(void *start, size_t len, int prot, int flags, int fd, off_t page4k_offset,
00485            void **resptr) L4_NOTHROW
00486 {
00487   DEBUG_LOG(debug_mmap, {
00488             l4_kd_outstring("MMAP params: ");
00489             l4_kd_outstring("start = 0x");
00490             l4_kd_outhex32(l4_addr_t(start));
00491             l4_kd_outstring(", len = 0x");
00492             l4_kd_outhex32(len);
00493             l4_kd_outstring(", prot = 0x");
00494             l4_kd_outhex32(prot);
00495             l4_kd_outstring(", flags = 0x");
00496             l4_kd_outhex32(flags);
00497             l4_kd_outstring(", offset = 0x");
00498             l4_kd_outhex32(page4k_offset);
00499             l4_kd_outstring("\n");
00500   });
00501
00502   using namespace L4Re;
00503   off64_t offset = l4_trunc_page(page4k_offset << 12);
00504
00505   if (flags & MAP_FIXED)
00506     if (l4_addr_t(start) & (L4_PAGESIZE - 1))
00507       return -EINVAL;
00508
00509   align_mmap_start_and_length(&start, &len);
00510
```

```
00511   // special code to just reserve an area of the virtual address space
00512   // Same behavior should be exposed when mapping with PROT_NONE. Mind that
00513   // PROT_NONE can only be specified exclusively, since it is defined to 0x0.
00514   if ((flags & 0x1000000) || (prot == PROT_NONE))
00515     {
00516       int err;
00517       L4::Cap<Rm> r = Env::env()->rm();
00518       l4_addr_t area = reinterpret_cast<l4_addr_t>(start);
00519       err = r->reserve_area(&area, len, L4Re::Rm::F::Search_addr);
00520       if (err < 0)
00521         return err;
00522
00523       *resptr = reinterpret_cast<void*>(area);
00524
00525       DEBUG_LOG(debug_mmap, {
00526                 l4_kd_outstring("  MMAP reserved area: 0x");
00527                 l4_kd_outhex32(area);
00528                 l4_kd_outstring("  length= 0x");
00529                 l4_kd_outhex32(len);
00530                 l4_kd_outstring("\n");
00531       });
00532
00533       return 0;
00534     }
00535
00536   L4::Cap<L4Re::Dataspace> ds;
00537   L4Re::Rm::Flags rm_flags(0);
00538   char const *region_name = "[unknown]";
00539   l4_addr_t file_offset = 0;
00540
00541   if (flags & MAP_PRIVATE)
00542     rm_flags |= L4Re::Rm::F::Private;
00543
00544   if (flags & MAP_ANONYMOUS)
00545     {
00546       rm_flags |= L4Re::Rm::F::Anonymous;
00547       offset = 0; // Or should we return EINVAL?
00548       region_name = "[anon]";
00549     }
00550   else
00551     {
00552       Ref_ptr<L4Re::Vfs::File> fi = fds.get(fd);
00553       if (!fi)
00554         return -EBADF;
00555
00556       region_name = fi->path();
00557
00558       ds = fi->data_space();
00559       if (!ds.is_valid())
00560         return -EINVAL;
00561
00562       if (len + offset > l4_round_page(ds->size()))
00563         return -EINVAL;
00564     }
00565
00566
00567   if (!(flags & MAP_FIXED) && start == 0)
00568     start = reinterpret_cast<void*>(L4_PAGESIZE);
00569
00570   char *data = static_cast<char *>(start);
00571   L4::Cap<Rm> r = Env::env()->rm();
00572   l4_addr_t overmap_area = L4_INVALID_ADDR;
00573
00574   int err;
00575   if (flags & MAP_FIXED)
00576     {
00577       overmap_area = l4_addr_t(start);
00578
00579       err = r->reserve_area(&overmap_area, len);
00580       if (err < 0)
00581         overmap_area = L4_INVALID_ADDR;
00582
00583       rm_flags |= Rm::F::In_area;
00584
00585       // Make sure to remove old mappings residing at the respective address
00586       // range. If none exists, we are fine as well, allowing us to ignore
00587       // ENOENT here.
00588       err = munmap_regions(start, len);
00589       if (err && err != -ENOENT)
00590         return err;
00591     }
00592
00593   if (!(flags & MAP_FIXED))
00594     rm_flags |= Rm::F::Search_addr;
00595   if (prot & PROT_READ)
00596     rm_flags |= Rm::F::R;
00597   if (prot & PROT_WRITE)
```

```
00598     rm_flags |= Rm::F::W;
00599   if (prot & PROT_EXEC)
00600     rm_flags |= Rm::F::X;
00601
00602   // Region manager takes a reference to the ds cap...
00603   err = r->attach(&data, len, rm_flags,
00604                   L4::Ipc::make_cap(ds, (prot & PROT_WRITE)
00605                                         ? L4_CAP_FPAGE_RW
00606                                         : L4_CAP_FPAGE_RO),
00607                   offset, L4_PAGESHIFT, L4::Cap<L4::Task>::Invalid,
00608                   region_name, file_offset);
00609
00610   DEBUG_LOG(debug_mmap, {
00611             l4_kd_outstring("  MAPPED: 0x");
00612             l4_kd_outhex32(ds.cap());
00613             l4_kd_outstring("  addr: 0x");
00614             l4_kd_outhex32(l4_addr_t(data));
00615             l4_kd_outstring("  bytes: 0x");
00616             l4_kd_outhex32(len);
00617             l4_kd_outstring("  offset: 0x");
00618             l4_kd_outhex32(offset);
00619             l4_kd_outstring("  err = ");
00620             l4_kd_outdec(err);
00621             l4_kd_outstring("\n");
00622   });
00623
00624
00625   if (overmap_area != L4_INVALID_ADDR)
00626     r->free_area(overmap_area);
00627
00628   if (err < 0)
00629     return err;
00630
00631   l4_assert (!(start && !data));
00632
00633   *resptr = data;
00634
00635   return 0;
00636 }
00637
00638 int
00639 Vfs::mprotect(const void * /* a */, size_t /* sz */, int prot) L4_NOTHROW
00640 {
00641   return (prot & PROT_WRITE) ? -ENOSYS : 0;
00642 }
00643
00644 int
00645 Vfs::msync(void *, size_t, int) L4_NOTHROW
00646 { return 0; }
00647
00648 int
00649 Vfs::madvise(void *, size_t, int) L4_NOTHROW
00650 { return 0; }
00651
00652 }
00653
00654 L4Re::Vfs::Ops *__rtld_l4re_env_posix_vfs_ops;
00655 extern void *l4re_env_posix_vfs_ops __attribute__((alias("__rtld_l4re_env_posix_vfs_ops"),
      visibility("default")));
00656
00657 namespace {
00658   class Real_mount_tree : public L4Re::Vfs::Mount_tree
00659   {
00660   public:
00661     explicit Real_mount_tree(char *n) : Mount_tree(n) {}
00662
00663     void *operator new (size_t size)
00664     { return __rtld_l4re_env_posix_vfs_ops->malloc(size); }
00665
00666     void operator delete (void *mem)
00667     { __rtld_l4re_env_posix_vfs_ops->free(mem); }
00668   };
00669 }
00670
00672 int
00673 Vfs::mount(char const *path, cxx::Ref_ptr<L4Re::Vfs::File> const &dir) noexcept
00674 {
00675   using L4Re::Vfs::File;
00676   using L4Re::Vfs::Mount_tree;
00677   using L4Re::Vfs::Path;
00678
00679   cxx::Ref_ptr<Mount_tree> root = get_root()->mount_tree();
00680   if (!root)
00681     return -EINVAL;
00682
00683   cxx::Ref_ptr<Mount_tree> base;
00684   Path p = root->lookup(Path(path), &base);
```

```
00685
00686   while (!p.empty())
00687     {
00688       Path f = p.strip_first();
00689
00690       if (f.empty())
00691         return -EEXIST;
00692
00693       char *name = __rtld_l4re_env_posix_vfs_ops->strndup(f.path(), f.length());
00694       if (!name)
00695         return -ENOMEM;
00696
00697       auto nt = cxx::make_ref_obj<Real_mount_tree>(name);
00698       if (!nt)
00699         {
00700           __rtld_l4re_env_posix_vfs_ops->free(name);
00701           return -ENOMEM;
00702         }
00703
00704       base->add_child_node(nt);
00705       base = nt;
00706
00707       if (p.empty())
00708         {
00709           nt->mount(dir);
00710           return 0;
00711         }
00712     }
00713
00714   return -EINVAL;
00715 }
00716
00717 #undef DEBUG_LOG
00718 #undef GET_FILE_DBG
00719 #undef GET_FILE
```

16.268 vfs.h

```
00001 /*
00002  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/sys/compiler.h>
00011
00012 #include <unistd.h>
00013 #include <stdarg.h>
00014 #include <fcntl.h>
00015 #include <sys/stat.h>
00016 #include <sys/time.h>
00017 #include <sys/mman.h>
00018 #include <sys/socket.h>
00019 #include <utime.h>
00020 #include <errno.h>
00021
00022 #ifndef AT_FDCWD
00023 # define AT_FDCWD -100
00024 #endif
00025
00026 #ifdef __cplusplus
00027
00028 #include <l4/sys/capability>
00029 #include <l4/re/cap_alloc>
00030 #include <l4/re/dataspace>
00031 #include <l4/cxx/pair>
00032 #include <l4/cxx/ref_ptr>
00033
00034 namespace L4Re {
00038 namespace Vfs {
00039
00040 class Mount_tree;
00041 class File;
00042
00052 class Generic_file
00053 {
00054 public:
00060   enum Ready_type : unsigned
00061   {
00062     Read = 0,
00063     Write,
```

```
00064     Exception
00065   };
00066
00067   virtual ~Generic_file() noexcept = 0;
00068
00080   virtual int unlock_all_locks() noexcept = 0;
00081
00090   virtual int fstat(struct stat64 *buf) const noexcept = 0;
00091
00097   virtual int fchmod(mode_t) noexcept = 0;
00098
00108   virtual int get_status_flags() const noexcept = 0;
00109
00125   virtual int set_status_flags(long flags) noexcept = 0;
00126
00127   virtual int utime(const struct utimbuf *) noexcept = 0;
00128   virtual int utimes(const struct timeval [2]) noexcept = 0;
00129   virtual ssize_t readlink(char *, size_t) = 0;
00130
00146   virtual bool check_ready(Ready_type rt) noexcept = 0;
00147 };
00148
00149 inline
00150 Generic_file::~Generic_file() noexcept
00151 {}
00152
00160 class Directory
00161 {
00162 public:
00163   virtual ~Directory() noexcept = 0;
00164
00178   virtual int faccessat(const char *path, int mode, int flags) noexcept = 0;
00179
00192   virtual int mkdir(const char *path, mode_t mode) noexcept = 0;
00193
00204   virtual int unlink(const char *path) noexcept = 0;
00205
00219   virtual int rename(const char *src_path, const char *dst_path) noexcept = 0;
00220
00234   virtual int link(const char *src_path, const char *dst_path) noexcept = 0;
00235
00248   virtual int symlink(const char *src_path, const char *dst_path) noexcept = 0;
00249
00260   virtual int rmdir(const char *path) noexcept = 0;
00261   virtual int openat(const char *path, int flags, mode_t mode,
00262                      cxx::Ref_ptr<File> *f) noexcept = 0;
00263
00264   virtual ssize_t getdents(char *buf, size_t sizebytes) noexcept = 0;
00265
00266   virtual int fchmodat(const char *pathname,
00267                        mode_t mode, int flags) noexcept = 0;
00268
00269   virtual int utimensat(const char *pathname,
00270                         const struct timespec times[2], int flags) noexcept = 0;
00271
00275   virtual int get_entry(const char *, int, mode_t, cxx::Ref_ptr<File> *) noexcept = 0;
00276 };
00277
00278 inline
00279 Directory::~Directory() noexcept
00280 {}
00281
00287 class Regular_file
00288 {
00289 public:
00290   virtual ~Regular_file() noexcept = 0;
00291
00302   virtual L4::Cap<L4Re::Dataspace> data_space() noexcept = 0;
00303
00313   virtual ssize_t readv(const struct iovec*, int iovcnt) noexcept = 0;
00314
00325   virtual ssize_t writev(const struct iovec*, int iovcnt) noexcept = 0;
00326
00327   virtual ssize_t preadv(const struct iovec *iov, int iovcnt, off64_t offset) noexcept = 0;
00328   virtual ssize_t pwritev(const struct iovec *iov, int iovcnt, off64_t offset) noexcept = 0;
00329
00337   virtual off64_t lseek(off64_t, int) noexcept = 0;
00338
00339
00347   virtual int ftruncate(off64_t pos) noexcept = 0;
00348
00354   virtual int fsync() const noexcept = 0;
00355
00361   virtual int fdatasync() const noexcept = 0;
00362
00372   virtual int get_lock(struct flock64 *lock) noexcept = 0;
00373
```

```
00382   virtual int set_lock(struct flock64 *lock, bool wait) noexcept = 0;
00383 };
00384
00385 inline
00386 Regular_file::~Regular_file() noexcept
00387 {}
00388
00389 class Socket
00390 {
00391 public:
00392   virtual ~Socket() noexcept = 0;
00393   virtual int bind(sockaddr const *, socklen_t) noexcept = 0;
00394   virtual int connect(sockaddr const *, socklen_t) noexcept = 0;
00395   virtual ssize_t send(void const *, size_t, int) noexcept = 0;
00396   virtual ssize_t recv(void *, size_t, int) noexcept = 0;
00397   virtual ssize_t sendto(void const *, size_t, int, sockaddr const *, socklen_t) noexcept = 0;
00398   virtual ssize_t recvfrom(void *, size_t, int, sockaddr *, socklen_t *) noexcept = 0;
00399   virtual ssize_t sendmsg(msghdr const *, int) noexcept = 0;
00400   virtual ssize_t recvmsg(msghdr *, int) noexcept = 0;
00401   virtual int getsockopt(int level, int opt, void *, socklen_t *) noexcept = 0;
00402   virtual int setsockopt(int level, int opt, void const *, socklen_t) noexcept = 0;
00403   virtual int listen(int) noexcept = 0;
00404   virtual int accept(sockaddr *addr, socklen_t *) noexcept = 0;
00405   virtual int shutdown(int) noexcept = 0;
00406
00407   virtual int getsockname(sockaddr *, socklen_t *) noexcept = 0;
00408   virtual int getpeername(sockaddr *, socklen_t *) noexcept = 0;
00409 };
00410
00411 inline
00412 Socket::~Socket() noexcept
00413 {}
00414
00420 class Special_file
00421 {
00422 public:
00423   virtual ~Special_file() noexcept = 0;
00424
00435   virtual int ioctl(unsigned long cmd, va_list args) noexcept = 0;
00436 };
00437
00438 inline
00439 Special_file::~Special_file() noexcept
00440 {}
00441
00455 class File :
00456   public Generic_file,
00457   public Regular_file,
00458   public Directory,
00459   public Special_file,
00460   public Socket
00461 {
00462   friend class Mount_tree;
00463
00464 private:
00465   void operator = (File const &);
00466
00467 protected:
00468   File() noexcept : _ref_cnt(0) {}
00469   File(File const &)
00470   : Generic_file(),Regular_file(), Directory(), Special_file(), _ref_cnt(0)
00471   {}
00472
00473 public:
00474
00475   const char *get_mount(const char *path, cxx::Ref_ptr<File> *dir,
00476                         cxx::Ref_ptr<Mount_tree> *mt = 0) noexcept;
00477
00478   int openat(const char *path, int flags, mode_t mode,
00479              cxx::Ref_ptr<File> *f) noexcept override;
00480
00481   void add_ref() noexcept { ++_ref_cnt; }
00482   int remove_ref() noexcept { return --_ref_cnt; }
00483
00484   virtual ~File() noexcept = 0;
00485
00486   cxx::Ref_ptr<Mount_tree> mount_tree() const noexcept
00487   { return _mount_tree; }
00488
00489   char const *path() const noexcept { return _path; }
00490
00491 private:
00492   int _ref_cnt;
00493   cxx::Ref_ptr<Mount_tree> _mount_tree;
00494   char _path[80] = "";
00495 };
00496
```

```
00497 inline
00498 File::~File() noexcept
00499 {}
00500
00501 class Path
00502 {
00503 private:
00504   char const *_p;
00505   unsigned _l;
00506
00507 public:
00508   Path() noexcept : _p(0), _l(0) {}
00509
00510   explicit Path(char const *p) noexcept : _p(p)
00511   { for (_l = 0; *p; ++p, ++_l) ; }
00512
00513   Path(char const *p, unsigned l) noexcept : _p(p), _l(l)
00514   {}
00515
00516   static bool __is_sep(char s) noexcept;
00517
00518   Path cmp_path(char const *prefix) const noexcept;
00519
00520   struct Invalid_ptr;
00521   operator Invalid_ptr const * () const
00522   { return reinterpret_cast<Invalid_ptr const *>(_p); }
00523
00524   unsigned length() const { return _l; }
00525   char const *path() const { return _p; }
00526
00527   bool empty() const { return _l == 0; }
00528
00529   bool is_sep(unsigned offset) const { return __is_sep(_p[offset]); }
00530
00531   bool strip_sep()
00532   {
00533     bool s = false;
00534     for (; __is_sep(*_p) && _l; ++_p, --_l)
00535       s = true;
00536     return s;
00537   }
00538
00539   Path first() const
00540   {
00541     unsigned i;
00542     for (i = 0; i < _l && !is_sep(i); ++i)
00543       ;
00544
00545     return Path(_p, i);
00546   }
00547
00548   Path strip_first()
00549   {
00550     Path r = first();
00551     _p += r.length();
00552     _l -= r.length();
00553     strip_sep();
00554     return r;
00555   }
00556
00557 };
00558
00559
00566 class Mount_tree
00567 {
00568 public:
00569
00570   explicit Mount_tree(char *n) noexcept;
00571
00572   Path lookup(Path const &path, cxx::Ref_ptr<Mount_tree> *mt,
00573               cxx::Ref_ptr<Mount_tree> *mp = 0) noexcept;
00574
00575   Path find(Path const &p, cxx::Ref_ptr<Mount_tree> *t) noexcept;
00576
00577   cxx::Ref_ptr<File> mount() const
00578   { return _mount; }
00579
00580   void mount(cxx::Ref_ptr<File> const &m)
00581   {
00582     m->_mount_tree = cxx::ref_ptr(this);
00583     _mount = m;
00584   }
00585
00586   static int create_tree(cxx::Ref_ptr<Mount_tree> const &root,
00587                          char const *path,
00588                          cxx::Ref_ptr<File> const &dir) noexcept;
00589
```

```
00590   void add_child_node(cxx::Ref_ptr<Mount_tree> const &cld);
00591
00592   virtual ~Mount_tree() noexcept  = 0;
00593   void operator delete (void *) {}
00594
00595   void add_ref() noexcept { ++_ref_cnt; }
00596   int remove_ref() noexcept { return --_ref_cnt; }
00597
00598 private:
00599   friend class Real_mount_tree;
00600
00601   int _ref_cnt;
00602   char *_name;
00603   cxx::Ref_ptr<Mount_tree> _cld;
00604   cxx::Ref_ptr<Mount_tree> _sib;
00605   cxx::Ref_ptr<File> _mount;
00606 };
00607
00608 inline
00609 Mount_tree::~Mount_tree() noexcept
00610 {}
00611
00612 inline bool
00613 Path::__is_sep(char s) noexcept
00614 { return s == '/'; }
00615
00616 inline Path
00617 Path::cmp_path(char const *n) const noexcept
00618 {
00619   char const *p = _p;
00620   for (; *p && !__is_sep(*p) && *n; ++p, ++n)
00621     if (*p != *n)
00622       return Path();
00623
00624   if (*n || (*p && !__is_sep(*p)))
00625     return Path();
00626
00627   return Path(p, _l - (p - _p));
00628 }
00629
00630 inline
00631 Mount_tree::Mount_tree(char *n) noexcept
00632 : _ref_cnt(0), _name(n)
00633 {}
00634
00635 inline Path
00636 Mount_tree::find(Path const &p, cxx::Ref_ptr<Mount_tree> *t) noexcept
00637 {
00638   if (!_cld)
00639     return Path();
00640
00641   for (cxx::Ref_ptr<Mount_tree> x = _cld; x; x = x->_sib)
00642     {
00643       Path const r = p.cmp_path(x->_name);
00644       if (r)
00645   {
00646     *t = x;
00647     return r;
00648   }
00649     }
00650
00651   return Path();
00652 }
00653
00654 inline Path
00655 Mount_tree::lookup(Path const &path, cxx::Ref_ptr<Mount_tree> *mt,
00656                    cxx::Ref_ptr<Mount_tree> *mp) noexcept
00657 {
00658   cxx::Ref_ptr<Mount_tree> x(this);
00659   Path p = path;
00660
00661   if (p.first().cmp_path("."))
00662     p.strip_first();
00663
00664   Path last_mp = p;
00665
00666   if (mp)
00667     *mp = x;;
00668
00669   while (1)
00670     {
00671       Path r = x->find(p, &x);
00672
00673       if (!r)
00674   {
00675     if (mp)
00676       return last_mp;
```

```
00677
00678     if (mt)
00679       *mt = x;
00680
00681     return p;
00682   }
00683
00684       r.strip_sep();
00685
00686       if (mp && x->_mount)
00687   {
00688     last_mp = r;
00689     *mp = x;
00690   }
00691
00692       if (r.empty())
00693   {
00694     if (mt)
00695       *mt = x;
00696
00697     if (mp)
00698       return last_mp;
00699     else
00700       return r;
00701   }
00702
00703       p = r;
00704     }
00705 }
00706
00707 inline
00708 void
00709 Mount_tree::add_child_node(cxx::Ref_ptr<Mount_tree> const &cld)
00710 {
00711   cld->_sib = _cld;
00712   _cld = cld;
00713 }
00714
00715 inline
00716 const char *
00717 File::get_mount(const char *path, cxx::Ref_ptr<File> *dir,
00718                 cxx::Ref_ptr<Mount_tree> *mt) noexcept
00719 {
00720   if (!_mount_tree)
00721     {
00722       *dir = cxx::ref_ptr(this);
00723       return path;
00724     }
00725
00726   cxx::Ref_ptr<Mount_tree> mp;
00727   Path p = _mount_tree->lookup(Path(path), mt, &mp);
00728   if (mp->mount())
00729     {
00730       *dir = mp->mount();
00731       return p.path();
00732     }
00733   else
00734     {
00735       *dir = cxx::ref_ptr(this);
00736       return path;
00737     }
00738 }
00739
00740 inline int
00741 File::openat(const char *path, int flags, mode_t mode,
00742              cxx::Ref_ptr<File> *f) noexcept
00743 {
00744   cxx::Ref_ptr<File> dir;
00745   cxx::Ref_ptr<Mount_tree> mt;
00746   char const *m_path = get_mount(path, &dir, &mt);
00747
00748   int res = dir->get_entry(m_path, flags, mode, f);
00749
00750   if (res < 0)
00751     return res;
00752
00753   if (!(*f)->_mount_tree && mt)
00754     (*f)->_mount_tree = mt;
00755
00756   // Debugging {
00757   size_t i = 0;
00758   for (; i < sizeof((*f)->_path) - 1 && path[i]; ++i)
00759     (*f)->_path[i] = path[i];
00760   (*f)->_path[i] = '\0';
00761   // } Debugging
00762
00763   return res;
```

```
00764 }
00765
00774 class Mman
00775 {
00776 public:
00778   virtual int mmap2(void *start, size_t len, int prot, int flags, int fd,
00779                     off_t offset, void **ptr) noexcept = 0;
00780
00782   virtual int munmap(void *start, size_t len) noexcept = 0;
00783
00785   virtual int mprotect(const void *a, size_t sz, int prot) noexcept = 0;
00786
00788   virtual int msync(void *addr, size_t len, int flags) noexcept = 0;
00789
00791   virtual int madvise(void *addr, size_t len, int advice) noexcept = 0;
00792
00793   virtual ~Mman() noexcept = 0;
00794 };
00795
00796 inline
00797 Mman::~Mman() noexcept {}
00798
00799 class File_factory
00800 {
00801 private:
00802   int _ref_cnt = 0;
00803   int _proto = 0;
00804   char const *_proto_name = 0;
00805
00806   template<typename T> friend struct cxx::Default_ref_counter;
00807   void add_ref() noexcept { ++_ref_cnt; }
00808   int remove_ref() noexcept { return --_ref_cnt; }
00809
00810 public:
00811   explicit File_factory(int proto) : _proto(proto) {}
00812   explicit File_factory(char const *proto_name) : _proto_name(proto_name) {}
00813   File_factory(int proto, char const *proto_name)
00814   : _proto(proto), _proto_name(proto_name)
00815   {}
00816
00817   File_factory(File_factory const &) = delete;
00818   File_factory &operator = (File_factory const &) = delete;
00819
00820   char const *proto_name() const { return _proto_name; }
00821   int proto() const { return _proto; }
00822
00823   virtual ~File_factory() noexcept = 0;
00824   virtual cxx::Ref_ptr<File> create(L4::Cap<void> file) = 0;
00825 };
00826
00827 inline File_factory::~File_factory() noexcept {}
00828
00829 template<typename IFACE, typename IMPL>
00830 class File_factory_t : public File_factory
00831 {
00832 public:
00833   File_factory_t()
00834   : File_factory(IFACE::Protocol, L4::kobject_typeid<IFACE>()->name())
00835   {}
00836
00837   cxx::Ref_ptr<File> create(L4::Cap<void> file) override
00838   { return cxx::make_ref_obj<IMPL>(L4::cap_cast<IFACE>(file)); }
00839 };
00840
00854 class File_system
00855 {
00856 protected:
00857   File_system *_next;
00858
00859 public:
00860   File_system() noexcept : _next(0) {}
00866   virtual char const *type() const noexcept = 0;
00867
00884   virtual int mount(char const *source, unsigned long mountflags,
00885                     void const *data, cxx::Ref_ptr<File> *dir) noexcept = 0;
00886
00887   virtual ~File_system() noexcept = 0;
00888
00893   File_system *next() const noexcept { return _next; }
00894   File_system *&next() noexcept { return _next; }
00895   void next(File_system *n) noexcept { _next = n; }
00896 };
00897
00898 inline
00899 File_system::~File_system() noexcept
00900 {}
00901
```

```
00902 class File_system_list
00903 {
00904 public:
00905   class Iterator
00906   {
00907   public:
00908     explicit constexpr Iterator(File_system *c = nullptr) : _c(c) {}
00909
00910     Iterator &operator++()
00911     {
00912       if (_c)
00913         _c = _c->next();
00914       return *this;
00915     }
00916
00917     bool operator==(Iterator const &other) const { return _c == other._c; }
00918     bool operator!=(Iterator const &other) const { return _c != other._c; }
00919     File_system *operator*() const { return _c; }
00920     File_system *operator->() const { return _c; }
00921
00922   private:
00923     File_system *_c;
00924   };
00925
00926   File_system_list(File_system *head) : _head(head) {}
00927
00928   constexpr Iterator begin() const
00929   { return Iterator(_head); }
00930
00931   constexpr Iterator end() const
00932   { return Iterator(); }
00933
00934 private:
00935   File_system *_head;
00936 };
00937
00943 class Fs
00944 {
00945 public:
00951   virtual cxx::Ref_ptr<File> get_file(int fd) noexcept = 0;
00952
00954   virtual cxx::Ref_ptr<File> get_root() noexcept = 0;
00955
00957   virtual cxx::Ref_ptr<File> get_cwd() noexcept { return get_root(); }
00958
00960   virtual void set_cwd(cxx::Ref_ptr<File> const &) noexcept {}
00961
00967   virtual int alloc_fd(cxx::Ref_ptr<File> const &f = cxx::Ref_ptr<>::Nil) noexcept = 0;
00968
00979   virtual cxx::Pair<cxx::Ref_ptr<File>, int>
00980     set_fd(int fd, cxx::Ref_ptr<File> const &f = cxx::Ref_ptr<>::Nil) noexcept = 0;
00981
00987   virtual cxx::Ref_ptr<File> free_fd(int fd) noexcept = 0;
00988
00996   virtual int mount(char const *path, cxx::Ref_ptr<File> const &dir) noexcept = 0;
00997
01005   virtual int register_file_system(File_system *f) noexcept = 0;
01006
01014   virtual int unregister_file_system(File_system *f) noexcept = 0;
01015
01023   virtual File_system *get_file_system(char const *fstype) noexcept = 0;
01024
01033   virtual File_system_list file_system_list() noexcept = 0;
01034
01038   int mount(char const *source, char const *target,
01039             char const *fstype, unsigned long mountflags,
01040             void const *data) noexcept;
01041
01042   virtual int register_file_factory(cxx::Ref_ptr<File_factory> f) noexcept = 0;
01043   virtual int unregister_file_factory(cxx::Ref_ptr<File_factory> f) noexcept = 0;
01044   virtual cxx::Ref_ptr<File_factory> get_file_factory(int proto) noexcept = 0;
01045   virtual cxx::Ref_ptr<File_factory> get_file_factory(char const *proto_name) noexcept = 0;
01046
01047   virtual ~Fs() = 0;
01048
01049 private:
01050   int mount_one(char const *source, char const *target,
01051                 File_system *fs, unsigned long mountflags,
01052                 void const *data) noexcept;
01053 };
01054
01055 inline int
01056 Fs::mount_one(char const *source, char const *target,
01057               File_system *fs, unsigned long mountflags,
01058               void const *data) noexcept
01059 {
01060   cxx::Ref_ptr<File> dir;
```

```
01061   int res = fs->mount(source, mountflags, data, &dir);
01062
01063   if (res < 0)
01064     return res;
01065
01066   return mount(target, dir);
01067 }
01068
01069 inline int
01070 Fs::mount(char const *source, char const *target,
01071           char const *fstype, unsigned long mountflags,
01072           void const *data) noexcept
01073 {
01074   if (   fstype[0] == 'a'
01075       && fstype[1] == 'u'
01076       && fstype[2] == 't'
01077       && fstype[3] == 'o'
01078       && fstype[4] == 0)
01079     {
01080       File_system_list fsl = file_system_list();
01081       for (File_system_list::Iterator c = fsl.begin(); c != fsl.end(); ++c)
01082         if (mount_one(source, target, *c, mountflags, data) == 0)
01083           return 0;
01084
01085       return -ENODEV;
01086     }
01087
01088   File_system *fs = get_file_system(fstype);
01089
01090   if (!fs)
01091     return -ENODEV;
01092
01093   return mount_one(source, target, fs, mountflags, data);
01094 }
01095
01096 inline
01097 Fs::~Fs()
01098 {}
01099
01106 class Ops : public Mman, public Fs
01107 {
01108 public:
01109   virtual void *malloc(size_t bytes) noexcept = 0;
01110   virtual void free(void *mem) noexcept = 0;
01111   virtual ~Ops() noexcept = 0;
01112
01113   char *strndup(char const *str, unsigned l) noexcept
01114   {
01115     unsigned len;
01116     for (len = 0; str[len] && len < l; ++len)
01117       ;
01118
01119     if (len == 0)
01120       return nullptr;
01121
01122     ++len;
01123
01124     char *b = static_cast<char *>(this->malloc(len));
01125     if (b == nullptr)
01126       return nullptr;
01127
01128     char *r = b;
01129     for (; len - 1 > 0 && *str; --len, ++b, ++str)
01130       *b = *str;
01131
01132     *b = 0;
01133     return r;
01134   }
01135
01136 };
01137
01138 inline
01139 Ops::~Ops() noexcept
01140 {}
01141
01142 }}
01143
01144 #endif
01145
```

16.269 virtio-net

```
00001 // vi:ft=cpp
00002 /* SPDX-License-Identifier: MIT */
```

```
00003 /*
00004  * Copyright (C) 2022, 2024-2025 Kernkonzept GmbH.
00005  * Author(s): Stephan Gerhold <stephan.gerhold@kernkonzept.com>
00006  */
00007 #pragma once
00008
00009 #include <cstring>
00010 #include <functional>
00011
00012 #include <l4/cxx/exceptions>
00013 #include <l4/cxx/minmax>
00014 #include <l4/re/dataspace>
00015 #include <l4/re/env>
00016 #include <l4/re/error_helper>
00017 #include <l4/re/util/unique_cap>
00018 #include <l4/sys/consts.h>
00019
00020 #include <l4/l4virtio/client/l4virtio>
00021 #include <l4/l4virtio/l4virtio>
00022 #include <l4/l4virtio/virtio_net.h>
00023 #include <l4/l4virtio/virtqueue>
00024
00025 namespace L4virtio { namespace Driver {
00026
00030 class Virtio_net_device : public L4virtio::Driver::Device
00031 {
00032 public:
00037   struct Packet
00038   {
00039     l4virtio_net_header_t hdr;
00040     l4_uint8_t data[1500 + 14]; /* MTU + Ethernet header */
00041   };
00042
00047   int rx_queue_size() const
00048   { return max_queue_size(0); }
00049
00054   int tx_queue_size() const
00055   { return max_queue_size(1); }
00056
00072   void setup_device(L4::Cap<L4virtio::Device> srvcap,
00073                     L4::Cap<L4Re::Dataspace>
00074                       queue_ds = L4::Cap<L4Re::Dataspace>::Invalid,
00075                     L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00076
00077   {
00078     // Contact device.
00079     driver_connect(srvcap, false);
00080
00081     if (_config->device != L4VIRTIO_ID_NET)
00082       L4Re::chksys(-L4_ENODEV, "Device is not a network device.");
00083
00084     if (_config->num_queues < 2)
00085       L4Re::chksys(-L4_EINVAL, "Invalid number of queues reported.");
00086
00087     auto rxqsz = rx_queue_size();
00088     auto txqsz = tx_queue_size();
00089
00090     // Allocate memory for RX/TX queue and RX/TX packet buffers
00091     auto rxqoff = 0;
00092     auto txqoff = l4_round_size(rxqoff + rxqsz * _rxq.total_size(rxqsz),
00093                                 L4virtio::Virtqueue::Desc_align);
00094     auto rxpktoff = l4_round_size(txqoff + txqsz * _txq.total_size(txqsz),
00095                                   L4virtio::Virtqueue::Desc_align);
00096     auto txpktoff = rxpktoff + rxqsz * sizeof(Packet);
00097     auto totalsz = txpktoff + txqsz * sizeof(Packet);
00098
00099     auto *e = L4Re::Env::env();
00100
00101     if (queue_ds)
00102       _queue_ds = L4Re::Util::Unique_cap<L4Re::Dataspace>(queue_ds);
00103     else
00104       {
00105         _queue_ds = L4Re::chkcap(L4Re::Util::make_unique_cap<L4Re::Dataspace>(),
00106                                  "Allocate queue dataspace capability");
00107         L4Re::chksys(e->mem_alloc()->alloc(totalsz, _queue_ds.get(),
00108                                            L4Re::Mem_alloc::Continuous
00109                                            | L4Re::Mem_alloc::Pinned),
00110                      "Allocate memory for virtio structures");
00111       }
00112
00113     L4Re::chksys(e->rm()->attach(&_queue_region, totalsz,
00114                                  L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
00115                                  L4::Ipc::make_cap_rw(_queue_ds.get()), 0,
00116                                  L4_PAGESHIFT),
00117                  "Attach dataspace for virtio structures");
00118
00119     l4_uint64_t devaddr;
```

```
00120     L4Re::chksys(register_ds(_queue_ds.get(), 0, totalsz, &devaddr),
00121                  "Register queue dataspace with device");
00122
00123     _rxq.init_queue(rxqsz, _queue_region.get() + rxqoff, msg_dev);
00124     _txq.init_queue(txqsz, _queue_region.get() + txqoff, msg_dev);
00125
00126     config_queue(0, rxqsz, devaddr + rxqoff,
00127                  devaddr + rxqoff + _rxq.avail_offset(),
00128                  devaddr + rxqoff + _rxq.used_offset());
00129     config_queue(1, txqsz, devaddr + txqoff,
00130                  devaddr + txqoff + _txq.avail_offset(),
00131                  devaddr + txqoff + _txq.used_offset());
00132
00133     _rxpkts = reinterpret_cast<Packet*>(_queue_region.get() + rxpktoff);
00134     _txpkts = reinterpret_cast<Packet*>(_queue_region.get() + txpktoff);
00135
00136     // Prepare descriptors to save work later
00137     for (l4_uint16_t descno = 0; descno < rxqsz; ++descno)
00138       {
00139         auto &desc = _rxq.desc(descno);
00140         desc.addr = L4virtio::Ptr<void>(devaddr + rxpktoff +
00141                                         descno * sizeof(Packet));
00142         desc.len = sizeof(Packet);
00143         desc.flags.write() = 1;
00144       }
00145     for (l4_uint16_t descno = 0; descno < txqsz; ++descno)
00146       {
00147         auto &desc = _txq.desc(descno);
00148         desc.addr = L4virtio::Ptr<void>(devaddr + txpktoff +
00149                                         descno * sizeof(Packet));
00150         desc.len = sizeof(Packet);
00151       }
00152
00153     // Setup notification IRQ
00154     _driver_notification_irq =
00155       L4Re::chkcap(L4Re::Util::make_unique_cap<L4::Irq>(),
00156                    "Allocate notification capability");
00157
00158     L4Re::chksys(l4_error(e->factory()->create(_driver_notification_irq.get())),
00159                  "Create irq for notifications from device");
00160
00161     L4Re::chksys(_device->bind(0, _driver_notification_irq.get()),
00162                  "Bind driver notification interrupt");
00163
00164     // Finish handshake with device
00165     l4virtio_set_feature(_config->driver_features_map,
00166                          L4VIRTIO_FEATURE_VERSION_1);
00167     l4virtio_set_feature(_config->driver_features_map, L4VIRTIO_NET_F_MAC);
00168     driver_acknowledge();
00169   }
00170
00174   l4virtio_net_config_t const &device_config() const
00175   {
00176     return *_config->device_config<l4virtio_net_config_t>();
00177   }
00178
00185   int bind_rx_notification_irq(L4::Cap<L4::Thread> thread, l4_umword_t label)
00186   {
00187     return l4_error(_driver_notification_irq->bind_thread(thread, label));
00188   }
00189
00193   L4::Cap<L4::Irq> get_rx_notification_irq() const
00194   { return _driver_notification_irq.get(); }
00195
00202   Packet &rx_pkt(l4_uint16_t descno)
00203   {
00204     if (descno >= _rxq.num())
00205       throw L4::Bounds_error("Invalid used descriptor number in RX queue");
00206     return _rxpkts[descno];
00207   }
00208
00221   l4_uint16_t poll_rx(l4_uint32_t *len = nullptr)
00222   {
00223     l4_uint16_t descno = _rxq.find_next_used(len);
00224
00225     if (len && descno != Virtqueue::Eoq)
00226       // Ensure that the length provided by the device in wait_for_next_used()
00227       // is not larger than the buffer and subtract the length of the header.
00228       *len = cxx::min(*len - sizeof(_rxpkts[0].hdr), sizeof(_rxpkts[0].data));
00229     return descno;
00230   }
00231
00247   l4_uint16_t wait_rx(l4_uint32_t *len = nullptr)
00248   {
00249     l4_uint16_t descno;
00250     // Wait until used descriptor becomes available.
00251     for (;;)
```

```
00252       {
00253         descno = poll_rx(len);
00254         if (descno != Virtqueue::Eoq)
00255           break;
00256
00257         L4Re::chksys(_driver_notification_irq->receive(), "Wait for RX");
00258       }
00259
00260     return descno;
00261   }
00262
00271   void finish_rx(l4_uint16_t descno)
00272   {
00273     _rxq.free_descriptor(descno, descno);
00274   }
00275
00279   void queue_rx()
00280   {
00281     l4_uint16_t descno;
00282     while ((descno = _rxq.alloc_descriptor()) != Virtqueue::Eoq)
00283       _rxq.enqueue_descriptor(descno);
00284     notify(_rxq);
00285   }
00286
00301   bool tx(std::function<l4_uint32_t(Packet&)> prepare)
00302   {
00303     auto descno = _txq.alloc_descriptor();
00304     if (descno == Virtqueue::Eoq)
00305       {
00306         // Try again after cleaning old descriptors that have already been used
00307         free_used_tx_descriptors();
00308         descno = _txq.alloc_descriptor();
00309         if (descno == Virtqueue::Eoq)
00310           return false;
00311       }
00312
00313     auto &pkt = _txpkts[descno];
00314     auto &desc = _txq.desc(descno);
00315     desc.len = sizeof(pkt.hdr) + prepare(pkt);
00316     send(_txq, descno);
00317     return true;
00318   }
00319
00320 private:
00321   void free_used_tx_descriptors()
00322   {
00323     l4_uint16_t used;
00324     while ((used = _txq.find_next_used()) != Virtqueue::Eoq)
00325       {
00326         if (used >= _txq.num())
00327           throw L4::Bounds_error("Invalid used descriptor number in TX queue");
00328         _txq.free_descriptor(used, used);
00329       }
00330   }
00331
00332 private:
00333   L4Re::Util::Unique_cap<L4Re::Dataspace> _queue_ds;
00334   L4Re::Rm::Unique_region<l4_uint8_t *> _queue_region;
00335   L4Re::Util::Unique_cap<L4::Irq> _driver_notification_irq;
00336   L4virtio::Driver::Virtqueue _rxq, _txq;
00337   Packet *_rxpkts, *_txpkts;
00338 };
00339
00340 } }
```

16.270 l4virtio

```
00001 // vi:ft=cpp
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2015-2020, 2022, 2024 Kernkonzept GmbH.
00005  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *
00007  */
00008 #pragma once
00009
00010 #include <l4/sys/factory>
00011 #include <l4/sys/semaphore>
00012 #include <l4/re/dataspace>
00013 #include <l4/re/env>
00014 #include <l4/re/util/unique_cap>
00015 #include <l4/re/util/object_registry>
00016 #include <l4/re/error_helper>
00017
```

```
00018 #include <l4/util/atomic.h>
00019 #include <l4/util/bitops.h>
00020 #include <l4/l4virtio/l4virtio>
00021 #include <l4/l4virtio/virtqueue>
00022 #include <l4/sys/consts.h>
00023
00024 #include <cstring>
00025
00026 namespace L4virtio { namespace Driver {
00027
00031 class Device
00032 {
00033 public:
00056   void driver_connect(L4::Cap<L4virtio::Device> srvcap, bool manage_notify = true)
00057   {
00058     _device = srvcap;
00059
00060     _next_devaddr = L4_SUPERPAGESIZE;
00061
00062     auto *e = L4Re::Env::env();
00063
00064     // Set up the virtio configuration page.
00065
00066     _config_cap = L4Re::chkcap(L4Re::Util::make_unique_cap<L4Re::Dataspace>(),
00067                                "Allocate config dataspace capability");
00068
00069     l4_addr_t ds_offset;
00070     L4Re::chksys(_device->device_config(_config_cap.get(), &ds_offset),
00071                  "Request virtio config page");
00072
00073     if (ds_offset & ~L4_PAGEMASK)
00074       L4Re::chksys(-L4_EINVAL, "Virtio config page is page aligned.");
00075
00076     L4Re::chksys(e->rm()->attach(&_config, L4_PAGESIZE,
00077                                  L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
00078                                  L4::Ipc::make_cap_rw(_config_cap.get()), ds_offset,
00079                                  L4_PAGESHIFT),
00080                  "Attach config dataspace");
00081
00082     if (memcmp(&_config->magic, "virt", 4) != 0)
00083       L4Re::chksys(-L4_ENODEV, "Device config has wrong magic value");
00084
00085     if (_config->version != 2)
00086       L4Re::chksys(-L4_ENODEV, "Invalid virtio version, must be 2");
00087
00088     _device->set_status(0); // reset
00089     int status = L4VIRTIO_STATUS_ACKNOWLEDGE;
00090     _device->set_status(status);
00091
00092     status |= L4VIRTIO_STATUS_DRIVER;
00093     _device->set_status(status);
00094
00095     if (_config->fail_state())
00096       L4Re::chksys(-L4_EIO, "Device failure during initialisation.");
00097
00098     // Set up the interrupt used to notify the device about events.
00099     // (only supporting one interrupt with index 0 at the moment)
00100
00101     _host_irq = L4Re::chkcap(L4Re::Util::make_unique_cap<L4::Irq>(),
00102                              "Allocate host IRQ capability");
00103
00104     L4Re::chksys(_device->device_notification_irq(0, _host_irq.get()),
00105                  "Request device notification interrupt.");
00106
00107     // Set up the interrupt to get notifications from the device.
00108     // (only supporting one interrupt with index 0 at the moment)
00109     if (manage_notify)
00110       {
00111         _driver_notification =
00112           L4Re::chkcap(L4Re::Util::make_unique_cap<L4::Semaphore>(),
00113                        "Allocate notification capability");
00114
00115         L4Re::chksys(l4_error(e->factory()->create(_driver_notification.get())),
00116                      "Create semaphore for notifications from device");
00117
00118         L4Re::chksys(_device->bind(0, _driver_notification.get()),
00119                      "Bind driver notification interrupt");
00120       }
00121   }
00122
00129   int bind_notification_irq(unsigned index, L4::Cap<L4::Triggerable> irq) const
00130   { return l4_error(_device->bind(index, irq)); }
00131
00133   bool fail_state() const { return _config->fail_state(); }
00134
00145   bool feature_negotiated(unsigned int feat) const
00146   { return l4virtio_get_feature(_config->driver_features_map, feat); }
```

```
00147
00156   int driver_acknowledge()
00157   {
00158     if (!l4virtio_get_feature(_config->dev_features_map,
00159                               L4VIRTIO_FEATURE_VERSION_1))
00160       L4Re::chksys(-L4_ENODEV,
00161                    "Require Virtio 1.0 device; Legacy device not supported.");
00162
00163     _config->driver_features_map[0] &= _config->dev_features_map[0];
00164     _config->driver_features_map[1] &= _config->dev_features_map[1];
00165
00166     _device->set_status(_config->status | L4VIRTIO_STATUS_FEATURES_OK);
00167
00168     if (!(_config->status & L4VIRTIO_STATUS_FEATURES_OK))
00169       L4Re::chksys(-L4_EINVAL, "Negotiation of device features.");
00170
00171     _device->set_status(_config->status | L4VIRTIO_STATUS_DRIVER_OK);
00172
00173     if (_config->fail_state())
00174       return -L4_EIO;
00175
00176     return L4_EOK;
00177   }
00178
00196   int register_ds(L4::Cap<L4Re::Dataspace> ds, l4_umword_t offset,
00197                   l4_umword_t size, l4_uint64_t *devaddr)
00198   {
00199     *devaddr = next_device_address(size);
00200     return _device->register_ds(L4::Ipc::make_cap_rw(ds), *devaddr, offset, size);
00201   }
00202
00212   int config_queue(int num, unsigned size, l4_uint64_t desc_addr,
00213                    l4_uint64_t avail_addr, l4_uint64_t used_addr)
00214   {
00215     auto *queueconf = &_config->queues()[num];
00216     queueconf->num = size;
00217     queueconf->desc_addr = desc_addr;
00218     queueconf->avail_addr = avail_addr;
00219     queueconf->used_addr = used_addr;
00220     queueconf->ready = 1;
00221
00222     return _device->config_queue(num);
00223   }
00224
00230   int max_queue_size(int num) const
00231   {
00232     return _config->queues()[num].num_max;
00233   }
00234
00247   int send_and_wait(Virtqueue &queue, l4_uint16_t descno)
00248   {
00249     send(queue, descno);
00250
00251     // wait for a reply, we assume that no other
00252     // request will get in the way.
00253     auto head = wait_for_next_used(queue);
00254
00255     if (head < 0)
00256       return head;
00257
00258     return (head == descno) ? L4_EOK : -L4_EINVAL;
00259   }
00260
00268   int wait(int index) const
00269   {
00270     if (index != 0)
00271       return -L4_EEXIST;
00272
00273     return l4_error(_driver_notification->down());
00274   }
00275
00291   int wait_for_next_used(Virtqueue &queue, l4_uint32_t *len = nullptr) const
00292   {
00293     while (true)
00294       {
00295         int err = wait(0);
00296
00297         if (err < 0)
00298           return err;
00299
00300         auto head = queue.find_next_used(len);
00301         if (head != Virtqueue::Eoq) // spurious interrupt?
00302           return head;
00303       }
00304   }
00305
00312   void send(Virtqueue &queue, l4_uint16_t descno)
```

```
00313   {
00314     queue.enqueue_descriptor(descno);
00315     notify(queue);
00316   }
00317
00318   void notify(Virtqueue &queue)
00319   {
00320     if (!queue.no_notify_host())
00321       _host_irq->trigger();
00322   }
00323
00324 private:
00335   l4_uint64_t next_device_address(l4_umword_t size)
00336   {
00337     l4_umword_t ret;
00338     size = l4_round_page(size);
00339     do
00340       {
00341         ret = _next_devaddr;
00342         if (l4_umword_t(~0) - ret < size)
00343           L4Re::chksys(-L4_ENOMEM, "Out of device address space.");
00344       }
00345     while (!l4util_cmpxchg(&_next_devaddr, ret, ret + size));
00346
00347     return ret;
00348   }
00349
00350 protected:
00351   L4::Cap<L4virtio::Device> _device;
00352   L4Re::Rm::Unique_region<L4virtio::Device::Config_hdr *> _config;
00353   l4_umword_t _next_devaddr;
00354   L4Re::Util::Unique_cap<L4::Semaphore> _driver_notification;
00355
00356 private:
00357   L4Re::Util::Unique_cap<L4::Irq> _host_irq;
00358   L4Re::Util::Unique_cap<L4Re::Dataspace> _config_cap;
00359 };
00360
00361 } }
```

16.271 l4virtio

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2013-2024 Kernkonzept GmbH.
00005  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00006  *            Matthias Lange <matthias.lange@kernkonzept.com>
00007  *
00008  */
00009 #pragma once
00010
00011 #include "virtio.h"
00012 #include <l4/sys/capability>
00013 #include <l4/sys/cxx/ipc_client>
00014 #include <l4/re/dataspace>
00015 #include <l4/sys/irq>
00016 #include <l4/cxx/utils>
00017
00018 namespace L4virtio {
00039 class Device :
00040   public L4::Kobject_t<Device, L4::Icu, L4VIRTIO_PROTOCOL,
00041                        L4::Type_info::Demand_t<1> >
00042 {
00043 public:
00044   typedef l4virtio_config_queue_t Config_queue;
00045   struct Config_hdr : l4virtio_config_hdr_t
00046   {
00047     Config_queue *queues() const
00048     { return l4virtio_config_queues(this); }
00049
00050     template <typename T>
00051     T *device_config() const
00052     {
00053       return static_cast<T*>(l4virtio_device_config(this));
00054     }
00055
00056     int config_queue(unsigned num, L4::Cap<L4::Triggerable> out_notify,
00057                      L4::Cap<L4::Triggerable> in_notify,
00058                      l4_timeout_s to = L4_IPC_TIMEOUT_NEVER)
00059     {
00060       return send_cmd(L4VIRTIO_CMD_CFG_QUEUE | num,
00061                       out_notify, in_notify, to);
00062     }
```

```
00063
00064     int notify_queue(unsigned num, L4::Cap<L4::Triggerable> out_notify,
00065                      L4::Cap<L4::Triggerable> in_notify,
00066                      l4_timeout_s to = L4_IPC_TIMEOUT_NEVER)
00067     {
00068       return send_cmd(L4VIRTIO_CMD_NOTIFY_QUEUE | num,
00069                       out_notify, in_notify, to);
00070     }
00071
00080     bool fail_state() const
00081     {
00082       auto cfg_status = cxx::access_once(&status);
00083       return cfg_status
00084              & (L4VIRTIO_STATUS_FAILED | L4VIRTIO_STATUS_DEVICE_NEEDS_RESET);
00085     }
00086
00087     int set_status(unsigned new_status, L4::Cap<L4::Triggerable> out_notify,
00088                    L4::Cap<L4::Triggerable> in_notify,
00089                    l4_timeout_s to = L4_IPC_TIMEOUT_NEVER)
00090     {
00091       return send_cmd(L4VIRTIO_CMD_SET_STATUS | new_status,
00092                       out_notify, in_notify, to);
00093     }
00094
00095     int cfg_changed(unsigned reg, L4::Cap<L4::Triggerable> out_notify,
00096                    L4::Cap<L4::Triggerable> in_notify,
00097                    l4_timeout_s to = L4_IPC_TIMEOUT_NEVER)
00098     {
00099       return send_cmd(L4VIRTIO_CMD_CFG_CHANGED | reg,
00100                       out_notify, in_notify, to);
00101     }
00102
00103     int send_cmd(unsigned command, L4::Cap<L4::Triggerable> out_notify,
00104                  L4::Cap<L4::Triggerable> in_notify,
00105                  l4_timeout_s to = L4_IPC_TIMEOUT_NEVER)
00106     {
00107       cxx::write_now(&cmd, command);
00108
00109       if (out_notify)
00110         out_notify->trigger();
00111
00112       auto utcb = l4_utcb();
00113       auto ipc_to = l4_timeout(L4_IPC_TIMEOUT_0, to);
00114
00115       do
00116         {
00117           if (in_notify)
00118             if (l4_ipc_error(l4_ipc_receive(in_notify.cap(), utcb, ipc_to),
00119                              utcb) == L4_IPC_RETIMEOUT)
00120               break;
00121         }
00122       while (cxx::access_once(&cmd));
00123
00124       return cxx::access_once(&cmd) ? -L4_EBUSY : L4_EOK;
00125     }
00126   };
00127
00137   L4_INLINE_RPC_OP(L4VIRTIO_OP_SET_STATUS, long,
00138                    set_status, (unsigned status));
00139
00155   L4_INLINE_RPC_OP(L4VIRTIO_OP_CONFIG_QUEUE, long,
00156                    config_queue, (unsigned queue));
00157
00181   L4_INLINE_RPC_OP(L4VIRTIO_OP_REGISTER_DS, long,
00182                    register_ds, (L4::Ipc::Cap<L4Re::Dataspace> ds_cap,
00183                                  l4_uint64_t base, l4_umword_t offset,
00184                                  l4_umword_t size));
00185
00194   L4_INLINE_RPC_OP(L4VIRTIO_OP_DEVICE_CONFIG, long, device_config,
00195                    (L4::Ipc::Out<L4::Cap<L4Re::Dataspace> > config_ds,
00196                     l4_addr_t *ds_offset));
00197
00216   L4_INLINE_RPC_OP(L4VIRTIO_OP_GET_DEVICE_IRQ, long, device_notification_irq,
00217                    (unsigned index, L4::Ipc::Out<L4::Cap<L4::Triggerable> > irq));
00218
00219
00220   typedef L4::Typeid::Rpcs<set_status_t, config_queue_t, register_ds_t,
00221                            device_config_t, device_notification_irq_t>
00222     Rpcs;
00223 };
00224
00225 }
```

16.272 l4virtio

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2014-2025 Kernkonzept GmbH.
00005  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00006  *            Manuel von Oltersdorff-Kalettka <manuel.kalettka@kernkonzept.com>
00007  *
00008  */
00009 #pragma once
00010
00011 #include <algorithm>
00012 #include <limits.h>
00013 #include <memory>
00014 #include <vector>
00015
00016 #include <l4/re/dataspace>
00017 #include <l4/re/util/debug>
00018 #include <l4/re/env>
00019 #include <l4/re/error_helper>
00020 #include <l4/re/rm>
00021 #include <l4/re/util/cap_alloc>
00022 #include <l4/re/util/shared_cap>
00023 #include <l4/re/util/unique_cap>
00024
00025 #include <l4/sys/types.h>
00026 #include <l4/re/util/meta>
00027
00028 #include <l4/cxx/bitfield>
00029 #include <l4/cxx/utils>
00030 #include <l4/cxx/unique_ptr>
00031
00032 #include <l4/sys/cxx/ipc_legacy>
00033
00034 #include "../l4virtio"
00035 #include "virtio"
00036
00040 namespace L4virtio {
00041 namespace Svr {
00042
00052 class Dev_config
00053 {
00054 public:
00055   typedef Dev_status Status;
00056   typedef Dev_features Features;
00057
00058 private:
00059   typedef L4Re::Rm::Unique_region< l4virtio_config_hdr_t*> Cfg_region;
00060   typedef L4Re::Util::Shared_cap<L4Re::Dataspace> Cfg_cap;
00061
00062   l4_uint32_t _vendor, _device, _qoffset, _nqueues;
00063   l4_uint32_t _host_features[sizeof(l4virtio_config_hdr_t::dev_features_map)
00064                              / sizeof(l4_uint32_t)];
00065   Cfg_cap _ds;
00066   Cfg_region _config;
00067   l4_addr_t _ds_offset = 0;
00068
00069   Status _status{0}; // status shadow, can be trusted by the device model
00070
00071   static l4_uint32_t align(l4_uint32_t x)
00072   { return (x + 0xfU) & ~0xfU; }
00073
00074   static void check_cfg_size(unsigned cfg_size)
00075   {
00076     if (cfg_size > L4_PAGESIZE - 0x100)
00077       L4Re::chksys(-L4_EINVAL,
00078                    "Device configuration fits into the config page");
00079   }
00080
00081   void attach_n_init_cfg(Cfg_cap const &cfg, l4_addr_t offset)
00082   {
00083     L4Re::chksys(L4Re::Env::env()->rm()->attach(&_config, L4_PAGESIZE,
00084                                                 L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
00085                                                 L4::Ipc::make_cap_rw(cfg.get()),
00086                                                 offset),
00087                  "Attach config space to local address space.");
00088
00089     _config->generation = 0;
00090     memset(_config->driver_features_map, 0, sizeof(_config->driver_features_map));
00091     memset(_host_features, 0, sizeof(_host_features));
00092     set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00093     reset_hdr();
00094
00095     _ds = cfg;
00096     _ds_offset = offset;
```

```
00097   }
00098
00099 protected:
00100   void volatile *get_priv_config() const
00101   {
00102     return l4virtio_device_config(_config.get());
00103   }
00104
00105 public:
00106
00119   Dev_config(l4_uint32_t vendor, l4_uint32_t device,
00120              unsigned cfg_size, l4_uint32_t num_queues = 0)
00121   : _vendor(vendor), _device(device),
00122     _qoffset(0x100 + align(cfg_size)),
00123     _nqueues(num_queues)
00124   {
00125     using L4Re::Dataspace;
00126     using L4Re::chkcap;
00127     using L4Re::chksys;
00128
00129     check_cfg_size(cfg_size);
00130
00131     if (sizeof(l4virtio_config_queue_t) * _nqueues + _qoffset > L4_PAGESIZE)
00132       {
00133         // too many queues does not fit into our page
00134         _qoffset = 0;
00135         _nqueues = 0;
00136       }
00137
00138     auto cfg = chkcap(L4Re::Util::make_shared_cap<Dataspace>());
00139     chksys(L4Re::Env::env()->mem_alloc()->alloc(L4_PAGESIZE, cfg.get()));
00140
00141     attach_n_init_cfg(cfg, 0);
00142   }
00143
00155   Dev_config(Cfg_cap const &cfg, l4_addr_t cfg_offset,
00156              l4_uint32_t vendor, l4_uint32_t device,
00157              unsigned cfg_size, l4_uint32_t num_queues = 0)
00158   : _vendor(vendor), _device(device),
00159     _qoffset(0x100 + align(cfg_size)),
00160     _nqueues(num_queues)
00161   {
00162     check_cfg_size(cfg_size);
00163
00164     if (sizeof(l4virtio_config_queue_t) * _nqueues + _qoffset > L4_PAGESIZE)
00165       {
00166         // too many queues does not fit into our page
00167         _qoffset = 0;
00168         _nqueues = 0;
00169       }
00170
00171     attach_n_init_cfg(cfg, cfg_offset);
00172   }
00173
00174   void set_host_feature(unsigned feature)
00175   { l4virtio_set_feature(_host_features, feature); }
00176
00177   void clear_host_feature(unsigned feature)
00178   { l4virtio_clear_feature(_host_features, feature); }
00179
00180   bool get_host_feature(unsigned feature)
00181   { return l4virtio_get_feature(_host_features, feature); }
00182
00183   bool get_guest_feature(unsigned feature)
00184   { return l4virtio_get_feature(_config->driver_features_map, feature); }
00185
00186   l4_uint32_t &host_features(unsigned idx)
00187   { return _host_features[idx]; }
00188
00189   l4_uint32_t host_features(unsigned idx) const
00190   { return _host_features[idx]; }
00191
00198   void set_device_notify_index(unsigned idx)
00199   { _config->cfg_device_notify_index = idx; }
00200
00204   l4_uint32_t num_queues() const
00205   { return _nqueues; }
00206
00218   l4_uint32_t guest_features(unsigned idx) const
00219   { return _config->driver_features_map[idx]; }
00220
00232   l4_uint32_t negotiated_features(unsigned idx) const
00233   { return _config->driver_features_map[idx] & _host_features[idx]; }
00234
00242   Status status() const { return _status; }
00243
00250   l4_uint32_t get_cmd() const
```

```
00251   {
00252     return hdr()->cmd;
00253   }
00254
00261   void reset_cmd()
00262   {
00263     const_cast<l4_uint32_t volatile &>(hdr()->cmd) = 0;
00264   }
00265
00273   void set_status(Status status)
00274   {
00275     _status = status;
00276     const_cast<l4_uint32_t volatile &>(hdr()->status) = status.raw;
00277   }
00278
00285   void add_irq_status(l4_uint32_t status)
00286   {
00287     const_cast<l4_uint32_t volatile &>(hdr()->irq_status) |= status;
00288   }
00289
00296   void set_device_needs_reset()
00297   {
00298     _status.device_needs_reset() = 1;
00299     const_cast<l4_uint32_t volatile &>(hdr()->status) = _status.raw;
00300   }
00301
00306   bool change_queue_config(l4_uint32_t num_queues)
00307   {
00308     if (sizeof(l4virtio_config_queue_t) * num_queues + _qoffset > L4_PAGESIZE)
00309       // too many queues does not fit into our page
00310       return false;
00311
00312     _nqueues = num_queues;
00313     reset_hdr(true);
00314     return true;
00315   }
00316
00323   l4virtio_config_queue_t volatile const *qconfig(unsigned index) const
00324   {
00325     if (L4_UNLIKELY(_qoffset < sizeof (l4virtio_config_hdr_t)))
00326       return 0;
00327
00328     if (L4_UNLIKELY(index >= _nqueues))
00329       return 0;
00330
00331     return reinterpret_cast<l4virtio_config_queue_t const *>
00332       (reinterpret_cast<char *>(_config.get()) + _qoffset) + index;
00333   }
00334
00338   void reset_hdr(bool inc_generation = false) const
00339   {
00340     _config->magic = L4VIRTIO_MAGIC;
00341     _config->version = 2;
00342     _config->device = _device;
00343     _config->vendor = _vendor;
00344     _config->status = 0;
00345     _config->irq_status = 0;
00346     _config->num_queues = _nqueues;
00347     _config->queues_offset = _qoffset;
00348
00349     memcpy(_config->dev_features_map, _host_features,
00350            sizeof(_config->dev_features_map));
00351     wmb();
00352     if (inc_generation)
00353       ++_config->generation;
00354
00355   }
00356
00367   bool reset_queue(unsigned index, unsigned num_max,
00368                    bool inc_generation = false,
00369                    unsigned device_notify_index = 0) const
00370   {
00371     l4virtio_config_queue_t volatile *qc;
00372     // this function is allowed to write to the device config
00373     qc = const_cast<l4virtio_config_queue_t volatile *>(qconfig(index));
00374     if (L4_UNLIKELY(qc == 0))
00375       return false;
00376
00377     qc->num_max = num_max;
00378     qc->num = 0;
00379     qc->ready = 0;
00380     qc->device_notify_index = device_notify_index;
00381     wmb();
00382     if (inc_generation)
00383       ++_config->generation;
00384
00385     return true;
```

```
00386   }
00387
00392   l4virtio_config_hdr_t const volatile *hdr() const
00393   { return _config.get(); }
00394
00399   L4::Cap<L4Re::Dataspace> ds() const { return _ds.get(); }
00400
00405   l4_addr_t ds_offset() const
00406   { return _ds_offset; }
00407 };
00408
00409
00410 template<typename PRIV_CONFIG>
00411 class Dev_config_t : public Dev_config
00412 {
00413 public:
00415   typedef PRIV_CONFIG Priv_config;
00416
00428   Dev_config_t(l4_uint32_t vendor, l4_uint32_t device,
00429                l4_uint32_t num_queues = 0)
00430   : Dev_config(vendor, device, sizeof(PRIV_CONFIG), num_queues)
00431   {}
00432
00443   Dev_config_t(L4Re::Util::Shared_cap<L4Re::Dataspace> const &cfg,
00444                l4_addr_t cfg_offset, l4_uint32_t vendor, l4_uint32_t device,
00445                l4_uint32_t num_queues = 0)
00446   : Dev_config(cfg, cfg_offset, vendor, device, sizeof(PRIV_CONFIG),
00447                num_queues)
00448   {}
00449
00459   Priv_config volatile *priv_config() const
00460   {
00461     return static_cast<Priv_config volatile *>(get_priv_config());
00462   }
00463
00464 };
00465
00466 struct No_custom_data {};
00467
00473 template <typename DATA>
00474 class Driver_mem_region_t : public DATA
00475 {
00476 public:
00477   struct Flags
00478   {
00479     Flags() = default;
00480     explicit Flags(l4_uint32_t raw) : raw(raw) {}
00481
00482     l4_uint32_t raw;
00483     CXX_BITFIELD_MEMBER(0, 0, rw, raw);
00484   };
00485
00486 private:
00488   typedef L4Re::Util::Unique_cap<L4Re::Dataspace> Ds_cap;
00489
00490   l4_uint64_t _drv_base;
00491   l4_uint64_t _trans_offset;
00492   l4_umword_t _size;
00493   Flags       _flags;
00494
00495   Ds_cap      _ds;
00496   l4_addr_t   _ds_offset;
00497
00499   L4Re::Rm::Unique_region<l4_addr_t> _local_base;
00500
00501   template<typename T>
00502   T _local(l4_uint64_t addr) const
00503   {
00504     return reinterpret_cast<T>(addr - _trans_offset);
00505   }
00506
00507 public:
00509   Driver_mem_region_t() : _size(0) {}
00510
00522   Driver_mem_region_t(l4_uint64_t drv_base, l4_umword_t size,
00523                       l4_addr_t offset, Ds_cap &&ds)
00524   : _drv_base(l4_trunc_page(drv_base)), _size(0), _flags(0),
00525     _ds_offset(l4_trunc_page(offset))
00526   {
00527     using L4Re::chksys;
00528     using L4Re::Env;
00529
00530     L4Re::Dataspace::Stats ds_info = L4Re::Dataspace::Stats();
00531     // Sometimes we work with dataspaces that do not implement all dataspace
00532     // methods and return an error instead. An example of such a dataspace is
00533     // io's Vi::System_bus. We detect this case when the info method returns
00534     // -L4_ENOSYS and simply assume the dataspace is good for us.
```

```
00535     long err = ds->info(&ds_info);
00536     if (err >= 0)
00537       {
00538         l4_addr_t ds_size = l4_round_page(ds_info.size);
00539
00540         if (ds_size < L4_PAGESIZE)
00541           chksys(-L4_EINVAL, "DS too small");
00542
00543         if (_ds_offset >= ds_size)
00544           chksys(-L4_ERANGE, "offset larger than DS size");
00545
00546         size = l4_round_page(size);
00547         if (size > ds_size)
00548           chksys(-L4_EINVAL, "size larger than DS size");
00549
00550         if (_ds_offset > ds_size - size)
00551           chksys(-L4_EINVAL, "invalid offset or size");
00552
00553         // overflow check
00554         if ((ULLONG_MAX - size) < _drv_base)
00555           chksys(-L4_EINVAL, "invalid size");
00556
00557         _flags.rw() = (ds_info.flags & L4Re::Dataspace::F::W).raw != 0;
00558       }
00559     else if (err == -L4_ENOSYS)
00560       {
00561         _flags.rw() = true;
00562       }
00563     else
00564       {
00565         chksys(err, "getting data-space infos");
00566       }
00567
00568     auto f = L4Re::Rm::F::Search_addr | L4Re::Rm::F::R;
00569     if (_flags.rw())
00570       f |= L4Re::Rm::F::W;
00571
00572     // use a big alignment to save PT/TLB entries and kernel memory resources!
00573     chksys(Env::env()->rm()->attach(&_local_base, size, f,
00574                                     L4::Ipc::make_cap(ds.get(), _flags.rw()
00575                                                       ? L4_CAP_FPAGE_RW
00576                                                       : L4_CAP_FPAGE_RO),
00577                                     _ds_offset, L4_SUPERPAGESHIFT));
00578
00579     _size = size;
00580     _ds = cxx::move(ds);
00581     _trans_offset = _drv_base - _local_base.get();
00582   }
00583
00585   bool is_writable() const { return _flags.rw(); }
00586
00588   Flags flags() const { return _flags; }
00589
00591   bool empty() const
00592   { return _size == 0; }
00593
00595   l4_uint64_t drv_base() const { return _drv_base; }
00596
00598   l4_addr_t local_base() const { return _local_base.get(); }
00599
00601   l4_umword_t size() const { return _size; }
00602
00604   l4_addr_t ds_offset() const { return _ds_offset; }
00605
00607   L4::Cap<L4Re::Dataspace> ds() const { return _ds.get(); }
00608
00616   bool contains(l4_uint64_t base, l4_umword_t size) const
00617   {
00618     if (base < _drv_base)
00619       return false;
00620
00621     if (base > _drv_base + _size - 1)
00622       return false;
00623
00624     if (size > _size)
00625       return false;
00626
00627     if (base - _drv_base > _size - size)
00628       return false;
00629
00630     return true;
00631   }
00632
00639   template<typename T>
00640   T *local(Ptr<T> p) const
00641   { return _local<T*>(p.get()); }
00642 };
```

```
00643
00644 typedef Driver_mem_region_t<No_custom_data> Driver_mem_region;
00645
00652 template <typename DATA>
00653 class Driver_mem_list_t
00654 {
00655 public:
00656   typedef Driver_mem_region_t<DATA> Mem_region;
00657
00658 private:
00659   cxx::unique_ptr<Mem_region[]> _l;
00660   unsigned _max;
00661   unsigned _free;
00662
00663 public:
00665   typedef L4Re::Util::Unique_cap<L4Re::Dataspace> Ds_cap;
00666
00668   Driver_mem_list_t() : _max(0), _free(0) {}
00669
00674   void init(unsigned max)
00675   {
00676     _l = cxx::make_unique<Driver_mem_region_t<DATA>[]>(max);
00677     _max = max;
00678     _free = 0;
00679   }
00680
00682   bool full() const
00683   { return _free == _max; }
00684
00693   Mem_region const *add(l4_uint64_t drv_base, l4_umword_t size,
00694                         l4_addr_t offset, Ds_cap &&ds)
00695   {
00696     if (full())
00697       L4Re::chksys(-L4_ENOMEM);
00698
00699     _l[_free++] = Mem_region(drv_base, size, offset, cxx::move(ds));
00700     return &_l[_free - 1];
00701   }
00702
00707   void remove(Mem_region const *r)
00708   {
00709     if (r < &_l[0] || r >= &_l[_free])
00710       L4Re::chksys(-L4_ERANGE);
00711
00712     unsigned idx = r - &_l[0];
00713
00714     for (unsigned i = idx; i < _free - 1; ++i)
00715       _l[i] = cxx::move(_l[i + 1]);
00716
00717     _l[--_free] = Mem_region();
00718   }
00719
00727   Mem_region *find(l4_uint64_t base, l4_umword_t size) const
00728   {
00729     return _find(base, size);
00730   }
00731
00741   void load_desc(Virtqueue::Desc const &desc, Request_processor const *p,
00742                  Virtqueue::Desc const **table) const
00743   {
00744     Mem_region const *r = find(desc.addr.get(), desc.len);
00745     if (L4_UNLIKELY(!r))
00746       throw Bad_descriptor(p, Bad_descriptor::Bad_address);
00747
00748     *table = static_cast<Virtqueue::Desc const *>(r->local(desc.addr));
00749   }
00750
00761   void load_desc(Virtqueue::Desc const &desc, Request_processor const *p,
00762                  Mem_region const **data) const
00763   {
00764     Mem_region const *r = find(desc.addr.get(), desc.len);
00765     if (L4_UNLIKELY(!r))
00766       throw Bad_descriptor(p, Bad_descriptor::Bad_address);
00767
00768     *data = r;
00769   }
00770
00787   template<typename ARG>
00788   void load_desc(Virtqueue::Desc const &desc, Request_processor const *p,
00789                  ARG *data) const
00790   {
00791     Mem_region *r = find(desc.addr.get(), desc.len);
00792     if (L4_UNLIKELY(!r))
00793       throw Bad_descriptor(p, Bad_descriptor::Bad_address);
00794
00795     *data = ARG(r, desc, p);
00796   }
```

```
00797
00798   Mem_region       *begin()       { return &_l[0]; }
00799   Mem_region const *begin() const { return &_l[0]; }
00800
00801   Mem_region       *end()       { return &_l[_free]; }
00802   Mem_region const *end() const { return &_l[_free]; }
00803
00804 private:
00805   Mem_region *_find(l4_uint64_t base, l4_umword_t size) const
00806   {
00807     for (unsigned i = 0; i < _free; ++i)
00808       if (_l[i].contains(base, size))
00809         return &_l[i];
00810     return 0;
00811   }
00812
00813
00814 };
00815
00816 typedef Driver_mem_list_t<No_custom_data> Driver_mem_list;
00817
00824 template<typename DATA>
00825 class Device_t
00826 {
00827 public:
00828   typedef Driver_mem_list_t<DATA> Mem_list;
00829
00830 protected:
00831   Mem_list _mem_info;
00832
00833 private:
00834   Dev_config *_device_config;
00835
00836   using Ds_vector = std::vector<L4::Cap<L4Re::Dataspace»;
00838   std::shared_ptr<Ds_vector const> _trusted_ds_caps;
00839
00841   bool _trusted_ds_validation_enabled = false;
00842
00844   L4Re::Util::Dbg _msg_user;
00845
00847   L4Re::Util::Dbg _msg_dev;
00848
00849 public:
00850   L4_RPC_LEGACY_DISPATCH(L4virtio::Device);
00851   template<typename IOS> int virtio_dispatch(unsigned r, IOS &ios)
00852   { return dispatch(r, ios); }
00853
00855   virtual void reset() = 0;
00856
00858   virtual bool check_features()
00859   { return true; }
00860
00862   virtual bool check_queues() = 0;
00863
00865   virtual int reconfig_queue(unsigned idx) = 0;
00866
00868   virtual void cfg_changed(unsigned /* reg */) {};
00869
00871   virtual void register_single_driver_irq()
00872   { L4Re::chksys(-L4_ENOSYS, "Legacy single IRQ interface not implemented."); }
00873
00875   virtual void trigger_driver_config_irq() = 0;
00876
00878   virtual L4::Cap<L4::Irq> device_notify_irq() const
00879   {
00880     L4Re::chksys(-L4_ENOSYS, "Legacy single IRQ interface not implemented.");
00881     return L4::Cap<L4::Irq>();
00882   }
00883
00890   virtual void register_driver_irq(unsigned idx)
00891   {
00892     if (idx != 0)
00893       L4Re::chksys(-L4_ENOSYS, "Multi IRQ interface not implemented.");
00894
00895     register_single_driver_irq();
00896   }
00897
00904   virtual L4::Cap<L4::Irq> device_notify_irq(unsigned idx)
00905   {
00906     if (idx != 0)
00907       L4Re::chksys(-L4_ENOSYS, "Multi IRQ interface not implemented.");
00908
00909     return device_notify_irq();
00910   }
00911
00913   virtual unsigned num_events_supported() const
00914   { return 1; }
```

```
00915
00916   virtual L4::Ipc_svr::Server_iface *server_iface() const = 0;
00917
00918   // Make it possible to react to changes in the list of memory regions
00919   virtual void check_mem_list() {};
00920
00930   Device_t(Dev_config *dev_config,
00931            L4Re::Util::Dbg msg_user = L4Re::Util::Dbg{},
00932            L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00933   : _device_config(dev_config), _msg_user(msg_user), _msg_dev(msg_dev)
00934   {}
00935
00939   Mem_list const *mem_info() const
00940   { return &_mem_info; };
00941
00942   long op_set_status(L4virtio::Device::Rights, unsigned status)
00943   { return _set_status(status); }
00944
00945   long op_config_queue(L4virtio::Device::Rights, unsigned queue)
00946   {
00947     Dev_config::Status status = _device_config->status();
00948     if (status.fail_state() || !status.acked() || !status.driver())
00949       return -L4_EIO;
00950
00951     return reconfig_queue(queue);
00952   }
00953
00954   long op_register_ds(L4virtio::Device::Rights,
00955                       L4::Ipc::Snd_fpage ds_cap_fp, l4_uint64_t ds_base,
00956                       l4_umword_t offset, l4_umword_t sz)
00957   {
00958     _msg_dev
00959       .printf("Registering dataspace from 0x%llx with %lu KiB, offset 0x%lx\n",
00960               ds_base, sz » 10, offset);
00961
00962     _check_n_init_shm(ds_cap_fp, ds_base, sz, offset);
00963
00964     return 0;
00965   }
00966
00967   long op_device_config(L4virtio::Device::Rights,
00968                         L4::Ipc::Cap<L4Re::Dataspace> &config_ds,
00969                         l4_addr_t &ds_offset)
00970   {
00971     _msg_dev
00972       .printf("register client: config DS: %lx\n", _device_config->ds().cap());
00973
00974     config_ds = L4::Ipc::make_cap(_device_config->ds(), L4_CAP_FPAGE_RW);
00975     ds_offset = _device_config->ds_offset();
00976     return 0;
00977   }
00978
00979   long op_device_notification_irq(L4virtio::Device::Rights,
00980                                   unsigned idx,
00981                                   L4::Ipc::Cap<L4::Triggerable> &irq)
00982   {
00983     auto cap = device_notify_irq(idx);
00984
00985     if (!cap.is_valid())
00986       return -L4_EINVAL;
00987
00988     irq = L4::Ipc::make_cap(cap, L4_CAP_FPAGE_RO);
00989     return L4_EOK;
00990   }
00991
00992   int op_bind(L4::Icu::Rights, l4_umword_t idx, L4::Ipc::Snd_fpage irq_cap_fp)
00993   {
00994     if (idx >= num_events_supported())
00995       return -L4_ERANGE;
00996
00997     if (!irq_cap_fp.cap_received())
00998       return -L4_EINVAL;
00999
01000     register_driver_irq(idx);
01001
01002     return L4_EOK;
01003   }
01004
01005   int op_unbind(L4::Icu::Rights, l4_umword_t, L4::Ipc::Snd_fpage)
01006   {
01007     return -L4_ENOSYS;
01008   }
01009
01010   int op_info(L4::Icu::Rights, L4::Icu::_Info &info)
01011   {
01012     info.features = 0;
01013     info.nr_irqs = num_events_supported();
```

```
01014     info.nr_msis = 0;
01015
01016     return L4_EOK;
01017   }
01018
01019   int op_msi_info(L4::Icu::Rights, l4_umword_t, l4_uint64_t, l4_icu_msi_info_t &)
01020   { return -L4_ENOSYS; }
01021
01022   int op_mask(L4::Icu::Rights, l4_umword_t)
01023   { return -L4_ENOSYS; }
01024
01025   int op_unmask(L4::Icu::Rights, l4_umword_t)
01026   { return -L4_ENOREPLY; }
01027
01028   int op_set_mode(L4::Icu::Rights, l4_umword_t, l4_umword_t)
01029   { return -L4_ENOSYS; }
01030
01044   void reset_queue_config(unsigned idx, unsigned num_max,
01045                           bool inc_generation = false,
01046                           unsigned device_notify_index = 0)
01047   {
01048     _device_config->reset_queue(idx, num_max, inc_generation,
01049                                 device_notify_index);
01050   }
01051
01056   void init_mem_info(unsigned num)
01057   {
01058     _mem_info.init(num);
01059   }
01060
01068   void device_error()
01069   {
01070     reset();
01071     _device_config->set_device_needs_reset();
01072
01073     // the device MUST NOT notify the driver before DRIVER_OK.
01074     if (_device_config->status().driver_ok())
01075         trigger_driver_config_irq();
01076   }
01077
01091   bool setup_queue(Virtqueue *q, unsigned qn, unsigned num_max)
01092   {
01093     l4virtio_config_queue_t volatile const *qc;
01094     qc = _device_config->qconfig(qn);
01095     if (L4_UNLIKELY(qc == 0))
01096       return false;
01097
01098     if (!qc->ready)
01099       {
01100         q->disable();
01101         return true;
01102       }
01103
01104     // read to local variables before check
01105     l4_uint32_t num   = qc->num;
01106     l4_uint64_t desc  = qc->desc_addr;
01107     l4_uint64_t avail = qc->avail_addr;
01108     l4_uint64_t used  = qc->used_addr;
01109
01110     if (0)
01111       printf("%p: setup queue: num=0x%x max_num=0x%x desc=0x%llx avail=0x%llx used=0x%llx\n",
01112              this, num, num_max, desc, avail, used);
01113
01114     if (!num || num > num_max)
01115       return false;
01116
01117     // num must be power of two
01118     if (num & (num - 1))
01119       return false;
01120
01121     if (desc & 0xf)
01122       return false;
01123
01124     if (avail & 0x1)
01125       return false;
01126
01127     if (used & 0x3)
01128       return false;
01129
01130     auto const *desc_info = _mem_info.find(desc, Virtqueue::desc_size(num));
01131     if (L4_UNLIKELY(!desc_info))
01132       return false;
01133
01134     auto const *avail_info = _mem_info.find(avail, Virtqueue::avail_size(num));
01135     if (L4_UNLIKELY(!avail_info))
01136       return false;
01137
```

```
01138     auto const *used_info = _mem_info.find(used, Virtqueue::used_size(num));
01139     if (L4_UNLIKELY(!used_info || !used_info->is_writable()))
01140       return false;
01141
01142     _msg_dev
01143       .printf("shm=[%llx-%llx] local=[%lx-%lx] desc=[%llx-%llx] (%p-%p)\n",
01144               desc_info->drv_base(), desc_info->drv_base() + desc_info->size() - 1,
01145               desc_info->local_base(),
01146               desc_info->local_base() + desc_info->size() - 1,
01147               desc, desc + Virtqueue::desc_size(num),
01148               desc_info->local(Ptr<char>(desc)),
01149               desc_info->local(Ptr<char>(desc)) + Virtqueue::desc_size(num));
01150
01151     _msg_dev
01152       .printf("shm=[%llx-%llx] local=[%lx-%lx] avail=[%llx-%llx] (%p-%p)\n",
01153               avail_info->drv_base(), avail_info->drv_base() + avail_info->size() - 1,
01154               avail_info->local_base(),
01155               avail_info->local_base() + avail_info->size() - 1,
01156               avail, avail + Virtqueue::avail_size(num),
01157               avail_info->local(Ptr<char>(avail)),
01158               avail_info->local(Ptr<char>(avail)) + Virtqueue::avail_size(num));
01159
01160     _msg_dev
01161       .printf("shm=[%llx-%llx] local=[%lx-%lx] used=[%llx-%llx] (%p-%p)\n",
01162               used_info->drv_base(), used_info->drv_base() + used_info->size() - 1,
01163               used_info->local_base(),
01164               used_info->local_base() + used_info->size() - 1,
01165               used, used + Virtqueue::used_size(num),
01166               used_info->local(Ptr<char>(used)),
01167               used_info->local(Ptr<char>(used)) + Virtqueue::used_size(num));
01168
01169     q->setup(num, desc_info->local(Ptr<void>(desc)),
01170              avail_info->local(Ptr<void>(avail)),
01171              used_info->local(Ptr<void>(used)), _msg_dev);
01172
01173     _msg_user.printf("New client connection successfully established.\n");
01174
01175     return true;
01176   }
01177
01178   void check_n_init_shm(L4Re::Util::Unique_cap<L4Re::Dataspace> &&shm,
01179                         l4_uint64_t base, l4_umword_t size, l4_addr_t offset)
01180   {
01181     if (_mem_info.full())
01182       L4Re::chksys(-L4_ENOMEM);
01183
01184     auto const *i = _mem_info.add(base, size, offset, cxx::move(shm));
01185     _msg_dev
01186       .printf("PORT[%p]: DMA guest [%llx-%llx]  local [%lx-%lx]  offset %lx\n",
01187               this, i->drv_base(), i->drv_base() + i->size() - 1,
01188               i->local_base(),
01189               i->local_base() + i->size() - 1,
01190               i->ds_offset());
01191   }
01192
01201   bool handle_mem_cmd_write()
01202   {
01203     l4_uint32_t cmd = _device_config->get_cmd();
01204     if (L4_LIKELY(!(cmd & L4VIRTIO_CMD_MASK)))
01205       return false;
01206
01207     switch (cmd & L4VIRTIO_CMD_MASK)
01208       {
01209       case L4VIRTIO_CMD_SET_STATUS:
01210         _set_status(cmd & ~L4VIRTIO_CMD_MASK);
01211         break;
01212
01213       case L4VIRTIO_CMD_CFG_QUEUE:
01214         reconfig_queue(cmd & ~L4VIRTIO_CMD_MASK);
01215         break;
01216
01217       case L4VIRTIO_CMD_CFG_CHANGED:
01218         cfg_changed(cmd & ~L4VIRTIO_CMD_MASK);
01219         break;
01220
01221       default:
01222         // unknown command
01223         break;
01224       }
01225
01226     _device_config->reset_cmd();
01227
01228     return true;
01229   }
01230
01234   void enable_trusted_ds_validation()
01235   {
```

```
01236     _trusted_ds_validation_enabled = true;
01237   }
01238
01244   void
01245   add_trusted_dataspaces(std::shared_ptr<Ds_vector const> ds)
01246   {
01247     _trusted_ds_caps = ds;
01248   }
01249
01250
01251 private:
01263   long validate_ds(L4::Cap<L4Re::Dataspace> ds)
01264   {
01265     if (!_trusted_ds_caps)
01266       return -L4_EINVAL;
01267     if (std::any_of(_trusted_ds_caps->cbegin(), _trusted_ds_caps->cend(),
01268                     [&ds](L4::Cap<L4Re::Dataspace> cap)
01269                       {
01270                         return L4Re::Env::env()->task()
01271                           ->cap_equal(ds, cap).label() == 1;
01272                       }
01273     ))
01274       {
01275         return L4_EOK;
01276       }
01277     return -L4_EINVAL;
01278   }
01279
01280   void _check_n_init_shm(L4::Ipc::Snd_fpage shm_cap_fp,
01281                          l4_uint64_t base, l4_umword_t size, l4_addr_t offset)
01282   {
01283     if (!shm_cap_fp.cap_received())
01284       L4Re::chksys(-L4_EINVAL);
01285
01286     L4Re::Util::Unique_cap<L4Re::Dataspace> ds(
01287         L4Re::chkcap(server_iface()->template rcv_cap<L4Re::Dataspace>(0)));
01288     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
01289
01290     if (_trusted_ds_validation_enabled)
01291       L4Re::chksys(validate_ds(ds.get()), "Validating the dataspace.");
01292
01293     check_n_init_shm(cxx::move(ds), base, size, offset);
01294
01295     check_mem_list();
01296   }
01297
01298   bool check_features_internal()
01299   {
01300     static_assert(sizeof(l4virtio_config_hdr_t::driver_features_map)
01301                     == sizeof(l4virtio_config_hdr_t::dev_features_map),
01302                   "Driver and device feature maps must be of the same size");
01303
01304     // From the Virtio 1.0 specification 6.1 Driver Requirements and 6.2 Device
01305     // Requirements: A driver MUST accept VIRTIO_F_VERSION_1 if it is offered.
01306     // A device MUST offer VIRTIO_F_VERSION_1. A device MAY fail to operate
01307     // further if VIRTIO_F_VERSION_1 is not accepted.
01308     //
01309     // The L4virtio implementation does not support legacy interfaces so we
01310     // fail here if the Virtio 1.0 feature was not accepted.
01311     if (!_device_config->get_guest_feature(L4VIRTIO_FEATURE_VERSION_1))
01312       return false;
01313
01314     for (auto i = 0u;
01315          i < sizeof(l4virtio_config_hdr_t::driver_features_map)
01316                / sizeof(l4virtio_config_hdr_t::driver_features_map[0]);
01317          i++)
01318       {
01319         // Driver must not accept features that were not offered by device
01320         if (_device_config->guest_features(i)
01321             & ~_device_config->host_features(i))
01322           return false;
01323       }
01324     return check_features();
01325   }
01326
01348   void check_and_update_status(Dev_config::Status status)
01349   {
01350     // snapshot of current status
01351     Dev_config::Status current_status = _device_config->status();
01352
01353     // handle reset
01354     if (!status.raw)
01355       {
01356         _device_config->set_status(status);
01357         return;
01358       }
01359
```

```
01360     // Do no further processing in case of driver or device failure. If FAILED
01361     // or DEVICE_NEEDS_RESET are set only these fail_state bits will be set in
01362     // addition to the current status bits already set.
01363     if (current_status.fail_state() || status.fail_state())
01364       {
01365         if (current_status.fail_state() != status.fail_state())
01366           {
01367             current_status.fail_state() =
01368               current_status.fail_state() | status.fail_state();
01369             _device_config->set_status(current_status);
01370           }
01371         return;
01372       }
01373
01374     // Enforce init sequence ACKNOWLEDGE, DRIVER, FEATURES_OK, DRIVER_OK.
01375     // We do not enforce that only one additional new bit is set per call.
01376     if ((!status.acked() && status.driver())
01377         || (!status.driver() && status.features_ok())
01378         || (!status.features_ok() && status.driver_ok()))
01379       {
01380         current_status.device_needs_reset() = 1;
01381         _device_config->set_status(current_status);
01382         return;
01383       }
01384
01385     // only check feature compatibility before DRIVER_OK is set
01386     if (status.features_ok() && !status.driver_ok()
01387           && !check_features_internal())
01388       status.features_ok() = 0;
01389
01390     // Note that if FEATURES_OK and DRIVER_OK are both updated to being set
01391     // at the same time the above check_features_internal() is skipped; this is
01392     // considered undefined behaviour but it is not prevented.
01393     if (status.running() && !check_queues())
01394       {
01395         current_status.device_needs_reset() = 1;
01396         _device_config->set_status(current_status);
01397         return;
01398       }
01399
01400     _device_config->set_status(status);
01401   }
01402
01415   int _set_status(unsigned new_status)
01416   {
01417     if (new_status == 0)
01418       {
01419         _msg_user.printf("Resetting device\n");
01420         reset();
01421         _device_config->reset_hdr(true);
01422       }
01423
01424     Dev_config::Status status(new_status);
01425     check_and_update_status(status);
01426
01427     return 0;
01428   }
01429
01430 };
01431
01432 typedef Device_t<No_custom_data> Device;
01433
01434 } // namespace Svr
01435
01436 }
```

16.273 virtio

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2014-2020, 2023-2025 Kernkonzept GmbH.
00005  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00006  *
00007  */
00008 #pragma once
00009
00010 #include <l4/sys/types.h>
00011 #include <l4/cxx/bitfield>
00012 #include <l4/cxx/minmax>
00013 #include <l4/cxx/utils>
00014
00015 #include <limits.h>
00016 #include <string.h>
```

```
00017 #include <stdio.h>
00018
00019 #include "../virtqueue"
00020
00026 namespace L4virtio {
00027 namespace Svr {
00028
00032 struct Dev_status
00033 {
00034   unsigned char raw;
00035   Dev_status() = default;
00036
00038   explicit Dev_status(l4_uint32_t v) : raw(v) {}
00039
00040   CXX_BITFIELD_MEMBER(0,  0, acked, raw);
00041   CXX_BITFIELD_MEMBER(1,  1, driver, raw);
00042   CXX_BITFIELD_MEMBER(2,  2, driver_ok, raw);
00043   CXX_BITFIELD_MEMBER(3,  3, features_ok, raw);
00044   CXX_BITFIELD_MEMBER(6,  7, fail_state, raw);
00045   CXX_BITFIELD_MEMBER(6,  6, device_needs_reset, raw);
00046   CXX_BITFIELD_MEMBER(7,  7, failed, raw);
00047
00057   bool running() const
00058   {
00059     return (raw == 0xf);
00060   }
00061 };
00062
00066 struct Dev_features
00067 {
00068   l4_uint32_t raw;
00069   Dev_features() = default;
00070
00072   explicit Dev_features(l4_uint32_t v) : raw(v) {}
00073
00074   CXX_BITFIELD_MEMBER(28, 28, ring_indirect_desc, raw);
00075   CXX_BITFIELD_MEMBER(29, 29, ring_event_idx, raw);
00076 };
00077
00078
00087 class Virtqueue : public L4virtio::Virtqueue
00088 {
00089 public:
00093   class Head_desc
00094   {
00095     friend class Virtqueue;
00096   private:
00097     Virtqueue::Desc const *_d;
00098     Head_desc(Virtqueue *r, unsigned i) : _d(r->desc(i)) {}
00099
00100   public:
00102     Head_desc() : _d(0) {}
00103
00105     bool valid() const { return _d; }
00106
00108     explicit operator bool () const
00109     { return valid(); }
00110
00112     Desc const *desc() const
00113     { return _d; }
00114   };
00115
00116   struct Request : Head_desc
00117   {
00118     Virtqueue *ring = nullptr;
00119     Request() = default;
00120   private:
00121     friend class Virtqueue;
00122     Request(Virtqueue *r, unsigned i) : Head_desc(r, i), ring(r) {}
00123   };
00124
00125
00136   Request next_avail()
00137   {
00138     if (L4_LIKELY(_current_avail != _avail->idx))
00139       {
00140         rmb();
00141         unsigned head = _current_avail & _idx_mask;
00142         ++_current_avail;
00143         return Request(this, _avail->ring[head]);
00144       }
00145     return Request();
00146   }
00147
00160   void rewind_avail(Head_desc const &d)
00161   {
00162     unsigned head_idx = d._d - _desc;
```

```
00163     // Calculate the distance between _current_avail and head_idx, taking into
00164     // account that _current_avail might have wrapped around with respect to
00165     // _idx_mask in the meantime.
00166     _current_avail -= (_current_avail - head_idx) & _idx_mask;
00167   }
00168
00175   bool desc_avail() const
00176   {
00177     return _current_avail != _avail->idx;
00178   }
00179
00190   void consumed(Head_desc const &r, l4_uint32_t len = 0)
00191   {
00192     l4_uint16_t i = _used->idx & _idx_mask;
00193     _used->ring[i] = Used_elem(r._d - _desc, len);
00194     wmb();
00195     ++_used->idx;
00196   }
00197
00212   template<typename ITER>
00213   void consumed(ITER const &begin, ITER const &end)
00214   {
00215     l4_uint16_t added = 0;
00216     l4_uint16_t idx = _used->idx;
00217
00218     for (auto elem = begin ; elem != end; ++elem, ++added)
00219       _used->ring[(idx + added) & _idx_mask]
00220         = Used_elem(elem->first._d - _desc, elem->second);
00221
00222     wmb();
00223     _used->idx += added;
00224   }
00225
00239   template<typename QUEUE_OBSERVER>
00240   void finish(Head_desc &d, QUEUE_OBSERVER *o, l4_uint32_t len = 0)
00241   {
00242     consumed(d, len);
00243     o->notify_queue(this);
00244     d._d = 0;
00245   }
00246
00261   template<typename ITER, typename QUEUE_OBSERVER>
00262   void finish(ITER const &begin, ITER const &end, QUEUE_OBSERVER *o)
00263   {
00264     consumed(begin, end);
00265     o->notify_queue(this);
00266   }
00267
00273   void disable_notify()
00274   {
00275     if (L4_LIKELY(ready()))
00276       _used->flags.no_notify() = 1;
00277   }
00278
00284   void enable_notify()
00285   {
00286     if (L4_LIKELY(ready()))
00287       _used->flags.no_notify() = 0;
00288   }
00289
00298   Desc const *desc(unsigned idx) const
00299   { return _desc + idx; }
00300
00301 };
00302
00306 struct Data_buffer
00307 {
00308   char *pos;
00309   l4_uint32_t left;
00310
00311   Data_buffer() = default;
00312
00322   template<typename T>
00323   explicit Data_buffer(T *p)
00324   : pos(reinterpret_cast<char *>(p)), left(sizeof(T))
00325   {}
00326
00336   template<typename T>
00337   void set(T *p)
00338   {
00339     pos = reinterpret_cast<char *>(p);
00340     left = sizeof(T);
00341   }
00342
00354   l4_uint32_t copy_to(Data_buffer *dst, l4_uint32_t max = UINT_MAX)
00355   {
00356     unsigned long bytes = cxx::min(cxx::min(left, dst->left), max);
```

```
00357     memcpy(dst->pos, pos, bytes);
00358     left -= bytes;
00359     pos += bytes;
00360     dst->left -= bytes;
00361     dst->pos += bytes;
00362     return bytes;
00363   }
00364
00375   l4_uint32_t skip(l4_uint32_t bytes)
00376   {
00377     unsigned long b = cxx::min(left, bytes);
00378     left -= b;
00379     pos += b;
00380     return b;
00381   }
00382
00388   bool done() const
00389   { return left == 0; }
00390 };
00391
00392 class Request_processor;
00393
00397 struct Bad_descriptor
00398 {
00400   enum Error
00401   {
00402     Bad_address,
00403     Bad_rights,
00404     Bad_flags,
00405     Bad_next,
00406     Bad_size
00407   };
00408
00410   Request_processor const *proc;
00411
00412   // The error code
00413   Error error;
00414
00421   Bad_descriptor(Request_processor const *proc, Error e)
00422   : proc(proc), error(e)
00423   {}
00424
00430   char const *message() const
00431   {
00432     static char const *const err[] =
00433     {
00434       [Bad_address] = "Descriptor address cannot be translated",
00435       [Bad_rights]  = "Insufficient memory access rights",
00436       [Bad_flags]   = "Invalid descriptor flags",
00437       [Bad_next]    = "The descriptor's `next' index is invalid",
00438       [Bad_size]    = "Invalid size of the memory block"
00439     };
00440
00441     if (error >= (sizeof(err) / sizeof(err[0])) || !err[error])
00442       return "Unknown error";
00443
00444     return err[error];
00445   }
00446 };
00447
00448
00472 class Request_processor
00473 {
00474 private:
00476   Virtqueue::Desc const *_table;
00477
00479   Virtqueue::Desc _current;
00480
00482   l4_uint16_t _num;
00484   l4_uint16_t _left;
00485
00486 public:
00502   template<typename DESC_MAN, typename ...ARGS>
00503   void start(DESC_MAN *dm, Virtqueue *ring, Virtqueue::Head_desc const &request, ARGS... args)
00504   {
00505     _current = cxx::access_once(request.desc());
00506
00507     if (_current.flags.indirect())
00508       {
00509         dm->load_desc(_current, this, &_table);
00510         _num = _current.len / sizeof(Virtqueue::Desc);
00511         if (L4_UNLIKELY(!_num))
00512           throw Bad_descriptor(this, Bad_descriptor::Bad_size);
00513
00514         _current = cxx::access_once(_table);
00515       }
00516     else
```

```
00517       {
00518         _table = ring->desc(0);
00519         _num = ring->num();
00520       }
00521
00522     _left = _num;
00523
00524     dm->load_desc(_current, this, cxx::forward<ARGS>(args)...);
00525   }
00526
00537   template<typename DESC_MAN, typename ...ARGS>
00538   Virtqueue::Request const &start(DESC_MAN *dm, Virtqueue::Request const &request, ARGS... args)
00539   {
00540     start(dm, request.ring, request, cxx::forward<ARGS>(args)...);
00541     return request;
00542   }
00543
00549   Virtqueue::Desc::Flags current_flags() const
00550   { return _current.flags; }
00551
00557   bool has_more() const
00558   { return _current.flags.next(); }
00559
00574   template<typename DESC_MAN, typename ...ARGS>
00575   bool next(DESC_MAN *dm, ARGS... args)
00576   {
00577     if (!_current.flags.next())
00578       return false;
00579
00580     if (L4_UNLIKELY(_current.next >= _num))
00581       throw Bad_descriptor(this, Bad_descriptor::Bad_next);
00582
00583     if (L4_UNLIKELY(_left == 0))
00584       throw Bad_descriptor(this, Bad_descriptor::Bad_next);
00585
00586     --_left;
00587
00588     _current = cxx::access_once(_table + _current.next);
00589
00590     if (0) // we ignore this for performance reasons
00591       if (L4_UNLIKELY(_current.flags.indirect()))
00592         throw Bad_descriptor(this, Bad_descriptor::Bad_flags);
00593
00594     // must throw an exception in case of a bad descriptor
00595     dm->load_desc(_current, this, cxx::forward<ARGS>(args)...);
00596     return true;
00597   }
00598 };
00599
00600 }
00601 }
```

16.274 virtio-block

```
00001 // vi:ft=cpp
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2015-2022, 2024 Kernkonzept GmbH.
00005  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *            Manuel von Oltersdorff-Kalettka <manuel.kalettka@kernkonzept.com>
00007  *
00008  */
00009 #pragma once
00010
00011 #include <l4/sys/factory>
00012 #include <l4/sys/semaphore>
00013 #include <l4/re/dataspace>
00014 #include <l4/re/env>
00015 #include <l4/re/util/unique_cap>
00016 #include <l4/re/util/object_registry>
00017 #include <l4/re/error_helper>
00018
00019 #include <l4/util/atomic.h>
00020 #include <l4/util/bitops.h>
00021 #include <l4/l4virtio/client/l4virtio>
00022 #include <l4/l4virtio/l4virtio>
00023 #include <l4/l4virtio/virtqueue>
00024 #include <l4/l4virtio/virtio_block.h>
00025 #include <l4/sys/consts.h>
00026
00027 #include <cstring>
00028 #include <vector>
00029 #include <functional>
00030
```

```
00031 namespace L4virtio { namespace Driver {
00032
00036 class Block_device : public Device
00037 {
00038 public:
00039   typedef std::function<void(unsigned char)> Callback;
00040
00041 private:
00042   enum { Header_size = sizeof(l4virtio_block_header_t) };
00043
00044   struct Request
00045   {
00046     l4_uint16_t tail;
00047     Callback callback;
00048
00049     Request() : tail(Virtqueue::Eoq), callback(0) {}
00050   };
00051
00052 public:
00056   class Handle
00057   {
00058     friend Block_device;
00059     l4_uint16_t head;
00060
00061     explicit Handle(l4_uint16_t descno) : head(descno) {}
00062
00063   public:
00064     Handle() : head(Virtqueue::Eoq) {}
00065     bool valid() const { return head != Virtqueue::Eoq; }
00066   };
00067
00094   void setup_device(L4::Cap<L4virtio::Device> srvcap, l4_size_t usermem,
00095                     void **userdata, Ptr<void> &user_devaddr,
00096                     L4::Cap<L4Re::Dataspace> qds = L4::Cap<L4Re::Dataspace>(),
00097                     l4_uint32_t fmask0 = -1U, l4_uint32_t fmask1 = -1U,
00098                     L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00099   {
00100     // Contact device.
00101     driver_connect(srvcap);
00102
00103     if (_config->device != L4VIRTIO_ID_BLOCK)
00104       L4Re::chksys(-L4_ENODEV, "Device is not a block device.");
00105
00106     if (_config->num_queues != 1)
00107       L4Re::chksys(-L4_EINVAL, "Invalid number of queues reported.");
00108
00109     // Memory is shared in one large dataspace which contains queues,
00110     // space for header/status and additional user-defined memory.
00111     unsigned queuesz = max_queue_size(0);
00112     l4_size_t totalsz = l4_round_page(usermem);
00113
00114     l4_uint64_t const header_offset =
00115       l4_round_size(_queue.total_size(queuesz),
00116                     l4util_bsr(alignof(l4virtio_block_header_t)));
00117     l4_uint64_t const status_offset = header_offset + queuesz * Header_size;
00118     l4_uint64_t const usermem_offset = l4_round_page(status_offset + queuesz);
00119
00120     // reserve space for one header/status per descriptor
00121     // TODO Should be reduced to 1/3 but this way no freelist is needed.
00122     totalsz += usermem_offset;
00123
00124     auto *e = L4Re::Env::env();
00125     if (!qds.is_valid())
00126       {
00127         _ds = L4Re::chkcap(L4Re::Util::make_unique_cap<L4Re::Dataspace>(),
00128                            "Allocate queue dataspace capability");
00129         L4Re::chksys(e->mem_alloc()->alloc(totalsz, _ds.get(),
00130                                            L4Re::Mem_alloc::Continuous
00131                                              | L4Re::Mem_alloc::Pinned),
00132                      "Allocate memory for virtio structures");
00133         _queue_ds = _ds.get();
00134       }
00135     else
00136       {
00137         if (qds->size() < totalsz)
00138           L4Re::chksys(-L4_EINVAL, "External queue dataspace too small.");
00139         _queue_ds = qds;
00140       }
00141
00142     // Now sort out which region goes where in the dataspace.
00143     L4Re::chksys(e->rm()->attach(&_queue_region, totalsz,
00144                                  L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
00145                                  L4::Ipc::make_cap_rw(_queue_ds), 0,
00146                                  L4_PAGESHIFT),
00147                  "Attach dataspace for virtio structures");
00148
00149     l4_uint64_t devaddr;
```

```
00150     L4Re::chksys(register_ds(_queue_ds, 0, totalsz, &devaddr),
00151                  "Register queue dataspace with device");
00152
00153     _queue.init_queue(queuesz, _queue_region.get(), msg_dev);
00154
00155     config_queue(0, queuesz, devaddr, devaddr + _queue.avail_offset(),
00156                  devaddr + _queue.used_offset());
00157
00158     _header_addr = devaddr + header_offset;
00159     _headers = reinterpret_cast<l4virtio_block_header_t *>(_queue_region.get()
00160                                                            + header_offset);
00161
00162     _status_addr = devaddr + status_offset;
00163     _status = _queue_region.get() + status_offset;
00164
00165     user_devaddr = Ptr<void>(devaddr + usermem_offset);
00166     if (userdata)
00167       *userdata = _queue_region.get() + usermem_offset;
00168
00169     // setup the callback mechanism
00170     _pending.assign(queuesz, Request());
00171
00172     // Finish handshake with device.
00173     _config->driver_features_map[0] = fmask0;
00174     _config->driver_features_map[1] = fmask1;
00175     driver_acknowledge();
00176   }
00177
00181   l4virtio_block_config_t const &device_config() const
00182   {
00183     return *_config->device_config<l4virtio_block_config_t>();
00184   }
00185
00194   Handle start_request(l4_uint64_t sector, l4_uint32_t type,
00195                        Callback callback)
00196   {
00197     l4_uint16_t descno = _queue.alloc_descriptor();
00198     if (descno == Virtqueue::Eoq)
00199       return Handle(Virtqueue::Eoq);
00200
00201     L4virtio::Virtqueue::Desc &desc = _queue.desc(descno);
00202     Request &req = _pending[descno];
00203
00204     // setup the header
00205     l4virtio_block_header_t &head = _headers[descno];
00206     head.type = type;
00207     head.ioprio = 0;
00208     head.sector = sector;
00209
00210     // and put it in the descriptor
00211     desc.addr = Ptr<void>(_header_addr + descno * Header_size);
00212     desc.len = Header_size;
00213     desc.flags.raw = 0; // no write, no indirect
00214
00215     req.tail = descno;
00216     req.callback = callback;
00217
00218     return Handle(descno);
00219   }
00220
00232   int add_block(Handle handle, Ptr<void> addr, l4_uint32_t size)
00233   {
00234     l4_uint16_t descno = _queue.alloc_descriptor();
00235     if (descno == Virtqueue::Eoq)
00236       return -L4_EAGAIN;
00237
00238     Request &req = _pending[handle.head];
00239     L4virtio::Virtqueue::Desc &desc = _queue.desc(descno);
00240     L4virtio::Virtqueue::Desc &prev = _queue.desc(req.tail);
00241
00242     prev.next = descno;
00243     prev.flags.next() = true;
00244
00245     desc.addr = addr;
00246     desc.len = size;
00247     desc.flags.raw = 0;
00248     /* A data buffer is device-writable exactly when the device writes into it:
00249      * read (T_IN) and get-id requests. For write/flush/discard the device
00250      * reads the buffer, so it stays device-readable. Strict virtio transports
00251      * (e.g. a real virtio-blk device) honour this flag; L4virtio device
00252      * backends key off the request type instead. */
00253     auto type = _headers[handle.head].type;
00254     if (type == L4VIRTIO_BLOCK_T_IN || type == L4VIRTIO_BLOCK_T_GET_ID)
00255       desc.flags.write() = true;
00256
00257     req.tail = descno;
00258
```

```
00259     return L4_EOK;
00260   }
00261
00274   int send_request(Handle handle)
00275   {
00276     // add the status bit
00277     auto descno = _queue.alloc_descriptor();
00278     if (descno == Virtqueue::Eoq)
00279       return -L4_EAGAIN;
00280
00281     Request &req = _pending[handle.head];
00282     L4virtio::Virtqueue::Desc &desc = _queue.desc(descno);
00283     L4virtio::Virtqueue::Desc &prev = _queue.desc(req.tail);
00284
00285     prev.next = descno;
00286     prev.flags.next() = true;
00287
00288     desc.addr = Ptr<void>(_status_addr + descno);
00289     desc.len = 1;
00290     desc.flags.raw = 0;
00291     desc.flags.write() = true;
00292
00293     req.tail = descno;
00294
00295     send(_queue, handle.head);
00296
00297     return L4_EOK;
00298   }
00299
00315   int process_request(Handle handle)
00316   {
00317     // add the status bit
00318     auto descno = _queue.alloc_descriptor();
00319     if (descno == Virtqueue::Eoq)
00320       return -L4_EAGAIN;
00321
00322     L4virtio::Virtqueue::Desc &desc = _queue.desc(descno);
00323     L4virtio::Virtqueue::Desc &prev = _queue.desc(_pending[handle.head].tail);
00324
00325     prev.next = descno;
00326     prev.flags.next() = true;
00327
00328     desc.addr = Ptr<void>(_status_addr + descno);
00329     desc.len = 1;
00330     desc.flags.raw = 0;
00331     desc.flags.write() = true;
00332
00333     _pending[handle.head].tail = descno;
00334
00335     int ret = send_and_wait(_queue, handle.head);
00336     unsigned char status = _status[descno];
00337     free_request(handle);
00338
00339     if (ret < 0)
00340       return ret;
00341
00342     switch (status)
00343       {
00344       case L4VIRTIO_BLOCK_S_OK: return L4_EOK;
00345       case L4VIRTIO_BLOCK_S_IOERR: return -L4_EIO;
00346       case L4VIRTIO_BLOCK_S_UNSUPP: return -L4_ENOSYS;
00347       }
00348
00349     return -L4_EINVAL;
00350   }
00351
00352   void free_request(Handle handle)
00353   {
00354     if (handle.head != Virtqueue::Eoq
00355         && _pending[handle.head].tail != Virtqueue::Eoq)
00356       _queue.free_descriptor(handle.head, _pending[handle.head].tail);
00357     _pending[handle.head].tail = Virtqueue::Eoq;
00358   }
00359
00366   void process_used_queue()
00367   {
00368     for (l4_uint16_t descno = _queue.find_next_used();
00369          descno != Virtqueue::Eoq;
00370          descno = _queue.find_next_used()
00371          )
00372       {
00373         if (descno >= _queue.num() || _pending[descno].tail == Virtqueue::Eoq)
00374           L4Re::chksys(-L4_ENOSYS, "Bad descriptor number");
00375
00376         unsigned char status = _status[descno];
00377         free_request(Handle(descno));
00378
```

```
00379         if (_pending[descno].callback)
00380           _pending[descno].callback(status);
00381       }
00382   }
00383
00384 protected:
00385   L4Re::Util::Unique_cap<L4Re::Dataspace> _ds;
00386   L4::Cap<L4Re::Dataspace> _queue_ds;
00387
00388 private:
00389   L4Re::Rm::Unique_region<unsigned char *> _queue_region;
00390   l4virtio_block_header_t *_headers;
00391   unsigned char *_status;
00392   l4_uint64_t _header_addr;
00393   l4_uint64_t _status_addr;
00394   Virtqueue _queue;
00395   std::vector<Request> _pending;
00396 };
00397
00398 } }
```

16.275 virtio-block

```
00001 // vi:ft=cpp
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2017-2021, 2024-2025 Kernkonzept GmbH.
00005  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *
00007  */
00008 #pragma once
00009
00010 #include <l4/cxx/unique_ptr>
00011 #include <l4/re/util/unique_cap>
00012
00013 #include <climits>
00014
00015 #include <l4/l4virtio/virtio.h>
00016 #include <l4/l4virtio/virtio_block.h>
00017 #include <l4/l4virtio/server/l4virtio>
00018 #include <l4/sys/cxx/ipc_epiface>
00019
00020 namespace L4virtio { namespace Svr {
00021
00022 template <typename Ds_data> class Block_dev_base;
00023
00027 template<typename Ds_data>
00028 class Block_request
00029 {
00030   friend class Block_dev_base<Ds_data>;
00031   enum { Header_size = sizeof(l4virtio_block_header_t) };
00032
00033 public:
00034   struct Data_block
00035   {
00037     Driver_mem_region_t<Ds_data> *mem;
00039     void *addr;
00041     l4_uint32_t len;
00042
00043     Data_block() = default;
00044
00045     Data_block(Driver_mem_region_t<Ds_data> *m, Virtqueue::Desc const &desc,
00046                Request_processor const *)
00047     : mem(m), addr(m->local(desc.addr)), len(desc.len)
00048     {}
00049   };
00050
00051
00052
00063   unsigned data_size() const
00064   {
00065     Request_processor rp;
00066     Data_block data;
00067     unsigned total;
00068
00069     try
00070       {
00071         rp.start(_mem_list, _request, &data);
00072
00073         total = data.len;
00074
00075         while (rp.has_more())
00076           {
00077             rp.next(_mem_list, &data);
```

```
00078             total += data.len;
00079           }
00080       }
00081     catch (Bad_descriptor const &e)
00082       {
00083         // need to convert the exception because e contains a raw pointer to rp
00084         throw L4::Runtime_error(-L4_EIO, "bad virtio descriptor");
00085       }
00086
00087     if (total < Header_size + 1)
00088       throw L4::Runtime_error(-L4_EIO, "virtio request too short");
00089
00090     return total - Header_size - 1;
00091   }
00092
00096   bool has_more()
00097   {
00098     // peek into the remaining data
00099     while (_data.len == 0 && _rp.has_more())
00100       _rp.next(_mem_list, &_data);
00101
00102     // there always must be one byte left for status
00103     return (_data.len > 1 || _rp.has_more());
00104   }
00105
00114   Data_block next_block()
00115   {
00116     Data_block out;
00117
00118     if (_data.len == 0)
00119       {
00120         if (!_rp.has_more())
00121           throw L4::Runtime_error(-L4_EEXIST,
00122                                   "No more data blocks in virtio request");
00123
00124         if (_todo_blocks == 0)
00125           throw Bad_descriptor(&_rp, Bad_descriptor::Bad_size);
00126         --_todo_blocks;
00127
00128         _rp.next(_mem_list, &_data);
00129       }
00130
00131     if (_data.len > _max_block_size)
00132       throw Bad_descriptor(&_rp, Bad_descriptor::Bad_size);
00133
00134     out = _data;
00135
00136     if (!_rp.has_more())
00137       {
00138         --(out.len);
00139         _data.len = 1;
00140         _data.addr = static_cast<char *>(_data.addr) + out.len;
00141       }
00142     else
00143       _data.len = 0; // is consumed
00144
00145     return out;
00146   }
00147
00149   l4virtio_block_header_t const &header() const
00150   { return _header; }
00151
00152 private:
00153   Block_request(Virtqueue::Request req, Driver_mem_list_t<Ds_data> *mem_list,
00154                 unsigned max_blocks, l4_uint32_t max_block_size)
00155   : _mem_list(mem_list),
00156     _request(req),
00157     _todo_blocks(max_blocks),
00158     _max_block_size(max_block_size)
00159   {
00160     // read header which should be in the first block
00161     _rp.start(mem_list, _request, &_data);
00162     --_todo_blocks;
00163
00164     if (_data.len < Header_size)
00165       throw Bad_descriptor(&_rp, Bad_descriptor::Bad_size);
00166
00167     _header = *(static_cast<l4virtio_block_header_t *>(_data.addr));
00168
00169     _data.addr = static_cast<char *>(_data.addr) + Header_size;
00170     _data.len -= Header_size;
00171
00172     // if there is no space for status bit we cannot really recover
00173     if (!_rp.has_more() && _data.len == 0)
00174       throw Bad_descriptor(&_rp, Bad_descriptor::Bad_size);
00175   }
00176
```

```
00177   int release_request(Virtqueue *queue, l4_uint8_t status, unsigned sz)
00178   {
00179     // write back status
00180     // If there was an error on the way or the status byte is in its
00181     // own block, fast-forward to the last block.
00182     if (_rp.has_more())
00183       {
00184         try
00185           {
00186             while (_rp.next(_mem_list, &_data) && _todo_blocks > 0)
00187               --_todo_blocks;
00188           }
00189         catch (Bad_descriptor const &)
00190           {
00191             // there was a bad descriptor on the path to the last block
00192             return -L4_EIO;
00193           }
00194
00195         if (_todo_blocks > 0 && _data.len > 0)
00196           *(static_cast<l4_uint8_t *>(_data.addr) + _data.len - 1) = status;
00197         else
00198           return -L4_EIO; // too many data blocks
00199       }
00200     else if (_data.len > 0)
00201       *(static_cast<l4_uint8_t *>(_data.addr)) = status;
00202     else
00203       return -L4_EIO; // no space for final status byte
00204
00205     // now release the head
00206     queue->consumed(_request, sz);
00207
00208     return L4_EOK;
00209   }
00210
00216   Driver_mem_list_t<Ds_data> *_mem_list;
00218   l4virtio_block_header_t _header;
00220   Request_processor _rp;
00222   Data_block _data;
00223
00225   Virtqueue::Request _request;
00227   unsigned _todo_blocks;
00229   l4_uint32_t _max_block_size;
00230 };
00231
00232 struct Block_features : public Dev_config::Features
00233 {
00234   Block_features() = default;
00235   Block_features(l4_uint32_t raw) : Dev_config::Features(raw) {}
00236
00238   CXX_BITFIELD_MEMBER( 1,  1, size_max, raw);
00240   CXX_BITFIELD_MEMBER( 2,  2, seg_max, raw);
00242   CXX_BITFIELD_MEMBER( 4,  4, geometry, raw);
00244   CXX_BITFIELD_MEMBER( 5,  5, ro, raw);
00246   CXX_BITFIELD_MEMBER( 6,  6, blk_size, raw);
00248   CXX_BITFIELD_MEMBER( 9,  9, flush, raw);
00250   CXX_BITFIELD_MEMBER(10, 10, topology, raw);
00252   CXX_BITFIELD_MEMBER(11, 11, config_wce, raw);
00254   CXX_BITFIELD_MEMBER(12, 12, mq, raw);
00256   CXX_BITFIELD_MEMBER(13, 13, discard, raw);
00258   CXX_BITFIELD_MEMBER(14, 14, write_zeroes, raw);
00259 };
00260
00261
00267 template <typename Ds_data>
00268 class Block_dev_base : public L4virtio::Svr::Device_t<Ds_data>
00269 {
00270 private:
00271   L4Re::Util::Unique_cap<L4::Irq> _kick_guest_irq;
00272   Virtqueue _queue;
00273   unsigned _vq_max;
00274   l4_uint32_t _max_block_size = UINT_MAX;
00275   Dev_config_t<l4virtio_block_config_t> _dev_config;
00276
00277 public:
00278   typedef Block_request<Ds_data> Request;
00279
00280 protected:
00281   Block_features negotiated_features() const
00282   { return _dev_config.negotiated_features(0); }
00283
00284   Block_features device_features() const
00285   { return _dev_config.host_features(0); }
00286
00287   void set_device_features(Block_features df)
00288   { _dev_config.host_features(0) = df.raw; }
00289
00299   void set_size_max(l4_uint32_t sz)
```

```
00300   {
00301     _dev_config.priv_config()->size_max = sz;
00302     Block_features df = device_features();
00303     df.size_max() = true;
00304     set_device_features(df);
00305
00306     _max_block_size = sz;
00307   }
00308
00313   void set_seg_max(l4_uint32_t sz)
00314   {
00315     _dev_config.priv_config()->seg_max = sz;
00316     Block_features df = device_features();
00317     df.seg_max() = true;
00318     set_device_features(df);
00319   }
00320
00324   void set_geometry(l4_uint16_t cylinders, l4_uint8_t heads, l4_uint8_t sectors)
00325   {
00326     l4virtio_block_config_t volatile *pc = _dev_config.priv_config();
00327     pc->geometry.cylinders = cylinders;
00328     pc->geometry.heads = heads;
00329     pc->geometry.sectors = sectors;
00330     Block_features df = device_features();
00331     df.geometry() = true;
00332     set_device_features(df);
00333   }
00334
00341   void set_blk_size(l4_uint32_t sz)
00342   {
00343     _dev_config.priv_config()->blk_size = sz;
00344     Block_features df = device_features();
00345     df.blk_size() = true;
00346     set_device_features(df);
00347   }
00348
00357   void set_topology(l4_uint8_t physical_block_exp,
00358                     l4_uint8_t alignment_offset,
00359                     l4_uint16_t min_io_size,
00360                     l4_uint32_t opt_io_size)
00361   {
00362     l4virtio_block_config_t volatile *pc = _dev_config.priv_config();
00363     pc->topology.physical_block_exp = physical_block_exp;
00364     pc->topology.alignment_offset = alignment_offset;
00365     pc->topology.min_io_size = min_io_size;
00366     pc->topology.opt_io_size = opt_io_size;
00367     Block_features df = device_features();
00368     df.topology() = true;
00369     set_device_features(df);
00370   }
00371
00373   void set_flush()
00374   {
00375     Block_features df = device_features();
00376     df.flush() = true;
00377     set_device_features(df);
00378   }
00379
00384   void set_config_wce(l4_uint8_t writeback)
00385   {
00386     l4virtio_block_config_t volatile *pc = _dev_config.priv_config();
00387     pc->writeback = writeback;
00388     Block_features df = device_features();
00389     df.config_wce() = true;
00390     set_device_features(df);
00391   }
00392
00397   l4_uint8_t get_writeback()
00398   {
00399     l4virtio_block_config_t volatile *pc = _dev_config.priv_config();
00400     return pc->writeback;
00401   }
00402
00411   void set_discard(l4_uint32_t max_discard_sectors, l4_uint32_t max_discard_seg,
00412                    l4_uint32_t discard_sector_alignment)
00413   {
00414     l4virtio_block_config_t volatile *pc = _dev_config.priv_config();
00415     pc->max_discard_sectors = max_discard_sectors;
00416     pc->max_discard_seg = max_discard_seg;
00417     pc->discard_sector_alignment = discard_sector_alignment;
00418     Block_features df = device_features();
00419     df.discard() = true;
00420     set_device_features(df);
00421   }
00422
00431   void set_write_zeroes(l4_uint32_t max_write_zeroes_sectors,
00432                         l4_uint32_t max_write_zeroes_seg,
```

```
00433                         l4_uint8_t write_zeroes_may_unmap)
00434   {
00435     l4virtio_block_config_t volatile *pc = _dev_config.priv_config();
00436     pc->max_write_zeroes_sectors = max_write_zeroes_sectors;
00437     pc->max_write_zeroes_seg = max_write_zeroes_seg;
00438     pc->write_zeroes_may_unmap = write_zeroes_may_unmap;
00439     Block_features df = device_features();
00440     df.write_zeroes() = true;
00441     set_device_features(df);
00442   }
00443
00444 public:
00457   Block_dev_base(l4_uint32_t vendor, unsigned queue_size, l4_uint64_t capacity,
00458                  bool read_only, L4Re::Util::Dbg msg_user = L4Re::Util::Dbg{},
00459                  L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00460   : L4virtio::Svr::Device_t<Ds_data>(&_dev_config, msg_user, msg_dev),
00461     _vq_max(queue_size),
00462     _dev_config(vendor, L4VIRTIO_ID_BLOCK, 1)
00463   {
00464     this->reset_queue_config(0, queue_size);
00465
00466     Block_features df(0);
00467     df.ring_indirect_desc() = true;
00468     df.ro() = read_only;
00469     set_device_features(df);
00470
00471     _dev_config.set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00472
00473     _dev_config.priv_config()->capacity = capacity;
00474   }
00475
00479   virtual void reset_device() = 0;
00480
00484   virtual bool queue_stopped() = 0;
00485
00497   void finalize_request(cxx::unique_ptr<Request> req, unsigned sz,
00498                         l4_uint8_t status = L4VIRTIO_BLOCK_S_OK)
00499   {
00500     if (_dev_config.status().fail_state() || !_queue.ready())
00501       return;
00502
00503     if (req->release_request(&_queue, status, sz) < 0)
00504       this->device_error();
00505
00506     if (_queue.no_notify_guest())
00507       return;
00508
00509     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00510     _kick_guest_irq->trigger();
00511
00512     // Request can be dropped here.
00513   }
00514
00515   int reconfig_queue(unsigned idx) override
00516   {
00517     if (idx == 0 && this->setup_queue(&_queue, 0, _vq_max))
00518       return 0;
00519
00520     return -L4_EINVAL;
00521   }
00522
00523   void reset() override
00524   {
00525     _queue.disable();
00526     _dev_config.reset_queue(0, _vq_max);
00527     _dev_config.reset_hdr();
00528     reset_device();
00529   }
00530
00531 protected:
00532   bool check_for_new_requests()
00533   {
00534     if (!_queue.ready() || queue_stopped())
00535       return false;
00536
00537     if (_dev_config.status().fail_state())
00538       return false;
00539
00540     return _queue.desc_avail();
00541   }
00542
00544   cxx::unique_ptr<Request> get_request()
00545   {
00546     cxx::unique_ptr<Request> req;
00547
00548     if (!_queue.ready() || queue_stopped())
00549       return req;
```

```
00550
00551     if (_dev_config.status().fail_state())
00552       return req;
00553
00554     auto r = _queue.next_avail();
00555     if (!r)
00556       return req;
00557
00558     try
00559       {
00560         cxx::unique_ptr<Request> cur{
00561           new Request(r, &(this->_mem_info), _vq_max, _max_block_size)};
00562
00563         req = cxx::move(cur);
00564       }
00565     catch (Bad_descriptor const &e)
00566       {
00567         this->device_error();
00568         return req;
00569       }
00570
00571     return req;
00572   }
00573
00574 private:
00575   void register_single_driver_irq() override
00576   {
00577     _kick_guest_irq = L4Re::Util::Unique_cap<L4::Irq>(
00578       L4Re::chkcap(this->server_iface()->template rcv_cap<L4::Irq>(0)));
00579
00580     L4Re::chksys(this->server_iface()->realloc_rcv_cap(0));
00581   }
00582
00583   void trigger_driver_config_irq() override
00584   {
00585     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00586     _kick_guest_irq->trigger();
00587   }
00588
00589   bool check_queues() override
00590   {
00591     if (!_queue.ready())
00592       {
00593         reset();
00594         return false;
00595       }
00596
00597     return true;
00598   }
00599 };
00600
00601 template <typename Ds_data>
00602 struct Block_dev
00603 : Block_dev_base<Ds_data>,
00604   L4::Epiface_t<Block_dev<Ds_data>, L4virtio::Device>
00605 {
00606 private:
00607   class Irq_object : public L4::Irqep_t<Irq_object>
00608   {
00609   public:
00610     Irq_object(Block_dev<Ds_data> *parent) : _parent(parent) {}
00611
00612     void handle_irq()
00613     {
00614       _parent->kick();
00615     }
00616
00617   private:
00618     Block_dev<Ds_data> *_parent;
00619   };
00620   Irq_object _irq_handler;
00621
00622 protected:
00623   L4::Epiface *irq_iface()
00624   { return &_irq_handler; }
00625
00626 public:
00627   Block_dev(l4_uint32_t vendor, unsigned queue_size, l4_uint64_t capacity,
00628             bool read_only, L4Re::Util::Dbg msg_user = L4Re::Util::Dbg{},
00629             L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00630   : Block_dev_base<Ds_data>(vendor, queue_size, capacity, read_only,
00631                             msg_user, msg_dev),
00632     _irq_handler(this)
00633   {}
00634
00645   L4::Cap<void> register_obj(L4::Registry_iface *registry,
00646                              char const *service = 0)
```

```
00647   {
00648     L4Re::chkcap(registry->register_irq_obj(this->irq_iface()));
00649     L4::Cap<void> ret;
00650     if (service)
00651       ret = registry->register_obj(this, service);
00652     else
00653       ret = registry->register_obj(this);
00654     L4Re::chkcap(ret);
00655
00656     return ret;
00657   }
00658
00659   L4::Cap<void> register_obj(L4::Registry_iface *registry,
00660                              L4::Cap<L4::Rcv_endpoint> ep)
00661   {
00662     L4Re::chkcap(registry->register_irq_obj(this->irq_iface()));
00663
00664     return L4Re::chkcap(registry->register_obj(this, ep));
00665   }
00666
00667   typedef Block_request<Ds_data> Request;
00682   virtual bool process_request(cxx::unique_ptr<Request> &&req) = 0;
00683
00684 protected:
00685   L4::Ipc_svr::Server_iface *server_iface() const override
00686   {
00687     return this->L4::Epiface::server_iface();
00688   }
00689
00690   void kick()
00691   {
00692     for (;;)
00693       {
00694         auto req = this->get_request();
00695         if (!req)
00696           return;
00697         if (!this->process_request(cxx::move(req)))
00698           return;
00699       }
00700   }
00701
00702 private:
00703   L4::Cap<L4::Irq> device_notify_irq() const override
00704   {
00705     return L4::cap_cast<L4::Irq>(_irq_handler.obj_cap());
00706   }
00707 };
00708
00709 } }
```

16.276 virtio-console

```
00001 // vi:ft=cpp
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2019-2024 Kernkonzept GmbH.
00005  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *            Phillip Raffeck <phillip.raffeck@kernkonzept.com>
00007  *            Steffen Liebergeld <steffen.liebergeld@kernkonzept.com>
00008  *            Jan Klötzke <jan.kloetzke@kernkonzept.com>
00009  */
00010 #pragma once
00011
00012 #include <l4/l4virtio/server/l4virtio>
00013 #include <l4/re/error_helper>
00014
00015 namespace L4virtio { namespace Svr { namespace Console {
00016
00018 struct Features : Dev_config::Features
00019 {
00020   Features() = default;
00021   explicit Features(l4_uint32_t raw) : Dev_config::Features(raw) {}
00023   CXX_BITFIELD_MEMBER(0, 0, console_size, raw);
00025   CXX_BITFIELD_MEMBER(1, 1, console_multiport, raw);
00027   CXX_BITFIELD_MEMBER(2, 2, emerg_write, raw);
00028 };
00029
00031 struct Control_message
00032 {
00034   enum Events
00035   {
00037     Device_ready  = 0,
00039     Device_add    = 1,
00041     Device_remove = 2,
```

```
00043     Port_ready    = 3,
00045     Console_port  = 4,
00047     Resize        = 5,
00049     Port_open     = 6,
00051     Port_name     = 7,
00052   };
00053
00054   l4_uint32_t id;
00055   l4_uint16_t event;
00056   l4_uint16_t value;
00057
00058   Control_message() {}
00059   Control_message(l4_uint32_t i, l4_uint16_t e, l4_uint16_t v)
00060   : id(i), event(e), value(v)
00061   {}
00062 };
00063
00065 struct Control_request
00066 {
00068   Control_message *msg;
00070   l4_uint32_t len;
00072   Driver_mem_region *mem;
00073 };
00074
00109 struct Port
00110 {
00114   enum Port_status
00115   {
00117     Port_disabled = 0,
00119     Port_added,
00121     Port_ready,
00123     Port_open,
00125     Port_failed,
00127     Port_num_states,
00128   };
00129
00131   enum { Control_queue_size = 0x10 };
00132
00133   Virtqueue tx;
00134   Virtqueue rx;
00135   Port_status status;
00136   Port_status reported_status;
00137   unsigned vq_max;
00138
00139   Port() : status(Port_disabled), vq_max(Control_queue_size) {}
00140   Port(Port const &) = delete;
00141   Port &operator = (Port const &) = delete;
00142
00143   virtual ~Port() = default;
00144
00146   bool is_open() const
00147   { return status == Port_open; }
00148
00150   virtual void reset()
00151   {
00152     tx.disable();
00153     rx.disable();
00154     status = Port_disabled;
00155     reported_status = Port_disabled;
00156   }
00157
00159   bool queues_ready() const
00160   { return tx.ready() && rx.ready(); }
00161
00163   bool rx_ready() const
00164   { return is_open() && rx.ready(); }
00165
00167   bool tx_ready() const
00168   { return is_open() && tx.ready(); }
00169
00171   struct Transition {
00172     l4_int16_t  event;
00173     l4_uint16_t value;
00174     Port_status next;
00175   };
00176
00196   static constexpr Transition
00197   state_transitions[Port_num_states][Port_num_states] =
00198   {
00199     /*   reported            current     */
00200
00201     /* Port_disabled */ /* Port_disabled */ {{ -1, 0, Port_disabled },
00202                         /* Port_added    */  { Control_message::Device_add, 0,
00203                                                 Port_added },
00204                         /* Port_ready    */  { Control_message::Device_add, 0,
00205                                                 Port_ready },
00206                         /* Port_open     */  { Control_message::Device_add, 0,
```

```
00207                                                 Port_ready },
00208                         /* Port_failed   */  { Control_message::Device_add, 0,
00209                                                 Port_failed }},
00210
00211     /* Port_added    */ /* Port_disabled */ {{ Control_message::Device_remove,
00212                                                 0, Port_disabled },
00213                         /* Port_added    */  { -1, 0, Port_added },
00214                         /* Port_ready    */  { -1, 0, Port_ready },
00215                         /* Port_open     */  { Control_message::Port_open, 1,
00216                                                 Port_open },
00217                         /* Port_failed   */  { -1, 0, Port_failed }},
00218
00219     /* Port_ready    */ /* Port_disabled */ {{ Control_message::Device_remove,
00220                                                 0, Port_disabled },
00221                         /* Port_added    */  { -1, 0, Port_added },
00222                         /* Port_ready    */  { -1, 0, Port_ready },
00223                         /* Port_open     */  { Control_message::Port_open, 1,
00224                                                 Port_open },
00225                         /* Port_failed   */  { -1, 0, Port_failed }},
00226
00227     /* Port_open     */ /* Port_disabled */ {{ Control_message::Port_open, 0,
00228                                                 Port_ready },
00229                         /* Port_added    */  { Control_message::Port_open, 0,
00230                                                 Port_added },
00231                         /* Port_ready    */  { Control_message::Port_open, 0,
00232                                                 Port_ready },
00233                         /* Port_open     */  { -1, 0, Port_open },
00234                         /* Port_failed   */  { Control_message::Port_open, 0,
00235                                                 Port_ready }},
00236
00237     /* Port_failed   */ /* Port_disabled */ {{ Control_message::Device_remove,
00238                                                 0, Port_disabled },
00239                         /* Port_added    */  { -1, 0, Port_added },
00240                         /* Port_ready    */  { -1, 0, Port_ready },
00241                         /* Port_open     */  { Control_message::Port_open, 1,
00242                                                 Port_open },
00243                         /* Port_failed   */  { -1, 0, Port_failed }},
00244   };
00245 };
00246
00269 class Virtio_con : public L4virtio::Svr::Device
00270 {
00271   enum Virtqueue_names
00272   {
00273     Ctrl_rx = 2,
00274     Ctrl_tx = 3,
00275   };
00276
00277   struct Serial_config_space
00278   {
00279     l4_uint16_t cols;
00280     l4_uint16_t rows;
00281     l4_uint32_t max_nr_ports;
00282     l4_uint32_t emerg_wr;
00283   } __attribute__((packed));
00284
00285 public:
00295   explicit Virtio_con(unsigned max_ports, bool enable_multiport)
00296   : L4virtio::Svr::Device(&_dev_config),
00297     _num_ports(enable_multiport ? max_ports : 1),
00298     _dev_config(L4VIRTIO_VENDOR_KK, L4VIRTIO_ID_CONSOLE,
00299                 enable_multiport ? max_ports * 2 + 2 : 2)
00300   {
00301     if (_num_ports < 1)
00302       L4Re::chksys(-L4_EINVAL, "At least one port is required.");
00303
00304     Features hf(0);
00305
00306     hf.console_multiport() = enable_multiport;
00307
00308     _dev_config.host_features(0) = hf.raw;
00309
00310     if (enable_multiport)
00311       _dev_config.priv_config()->max_nr_ports = _num_ports;
00312     _dev_config.reset_hdr();
00313   }
00314
00315   void reset_queue_configs()
00316   {
00317     for (unsigned q = 0; q < _dev_config.num_queues(); ++q)
00318       reset_queue_config(q, max_queue_size(q));
00319   }
00320
00321   int reconfig_queue(unsigned index) override
00322   {
00323     if (index >= _dev_config.num_queues())
00324       return -L4_ERANGE;
```

```
00325
00326     if (setup_queue(get_queue(index), index, max_queue_size(index)))
00327       return 0;
00328
00329     return -L4_EINVAL;
00330   }
00331
00336   bool multiport_enabled() const
00337   {
00338     return _negotiated_features.console_multiport()
00339               && _dev_config.num_queues() > Ctrl_rx;
00340   }
00341
00342   bool ctrl_queue_ready() const
00343   { return _ctrl_port.is_open(); }
00344
00345   bool check_features(void) override
00346   {
00347     _negotiated_features = Features(_dev_config.negotiated_features(0));
00348     return true;
00349   }
00350
00351   bool check_queues() override
00352   {
00353     // NOTE
00354     // The VIRTIO specification states:
00355     // "The port 0 receive and transmit queues always exist"
00356     // The linux driver however does not setup port 0 if the multiport feature
00357     // is negotiated.
00358     // We just go along with the linux driver and do not expect port 0 to be up,
00359     // if the multiport feature is negotiated.
00360
00361     if (multiport_enabled())
00362       // If MULTIPORT was negotiated, ctrl queues should be set up.
00363       return _ctrl_port.queues_ready();
00364
00365     // If MULTIPORT was not negotiated, port 0 should be set up.
00366     port(0)->status = Port::Port_open;
00367     return port(0)->queues_ready();
00368   }
00369
00381   int port_add(unsigned idx)
00382   {
00383     Port *p = port(idx);
00384
00385     if (p->status != Port::Port_disabled)
00386       return -L4_EPERM;
00387
00388     p->status = Port::Port_added;
00389     port_report_status(idx);
00390
00391     return L4_EOK;
00392   }
00393
00405   int port_remove(unsigned idx)
00406   {
00407     Port *p = port(idx);
00408
00409     if (p->status == Port::Port_disabled)
00410       return -L4_EPERM;
00411
00412     p->status = Port::Port_disabled;
00413     port_report_status(idx);
00414
00415     return L4_EOK;
00416   }
00417
00430   int port_open(unsigned idx, bool open)
00431   {
00432     Port *p = port(idx);
00433
00434     if ((open && p->status != Port::Port_ready)
00435         || (!open && p->status != Port::Port_open))
00436       return -L4_EPERM;
00437
00438     p->status = open ? Port::Port_open : Port::Port_ready;
00439     port_report_status(idx);
00440
00441     return L4_EOK;
00442   }
00443
00457   int port_name(unsigned idx, char const *name)
00458   {
00459     Port *p = port(idx);
00460
00461     if (p->status == Port::Port_disabled)
00462       return -L4_EPERM;
```

```
00463
00464     return send_control_message(idx, Control_message::Port_name, 0, name);
00465   }
00466
00489   int send_control_message(l4_uint32_t idx, l4_uint16_t event,
00490                            l4_uint16_t value = 0, const char *name = 0)
00491   {
00492     if (!ctrl_queue_ready())
00493       return  -L4_ENODEV;
00494
00495     Virtqueue *q = &_ctrl_port.rx;
00496     if (!q->ready())
00497       return -L4_ENODEV;
00498
00499     Virtqueue::Request r = q->next_avail();
00500     if (!r)
00501       return -L4_EBUSY;
00502
00503     Request_processor rp;
00504     Control_request req;
00505     rp.start(this, r, &req);
00506
00507     if (req.len < sizeof(Control_message))
00508       return -L4_ENOMEM;
00509
00510     Control_message msg(idx, event, value);
00511
00512     memcpy(req.msg, &msg, sizeof(msg));
00513
00514     if (event == Control_message::Port_name && name)
00515       {
00516         size_t name_len = cxx::min(req.len - sizeof(msg), strlen(name));
00517         memcpy(reinterpret_cast<char*>(req.msg) + sizeof(msg), name, name_len);
00518         q->finish(r, this, sizeof(msg) + name_len);
00519       }
00520     else
00521       q->finish(r, this, sizeof(msg));
00522
00523     return L4_EOK;
00524   }
00525
00538   int handle_control_message()
00539   {
00540     // Report port state transitions if that failed in the past...
00541     if (_report_port_state)
00542       {
00543         _report_port_state = false;
00544
00545         for (unsigned i = 0; i < _num_ports; ++i)
00546           if (!port_report_status(i))
00547             _report_port_state = true;
00548       }
00549
00550     Virtqueue *q = &_ctrl_port.tx;
00551     if (!q->ready())
00552       return -L4_ENODEV;
00553
00554     int ret = L4_EOK;
00555     Virtqueue::Request r;
00556     while ((r = q->next_avail()))
00557       {
00558         Request_processor rp;
00559         Control_request req;
00560
00561         rp.start(this, r, &req);
00562
00563         Control_message msg;
00564         if (req.len < sizeof(msg))
00565           {
00566             // Just ignore malformed input.
00567             q->finish(r, this);
00568             ret = -L4_EINVAL;
00569             continue;
00570           }
00571
00572         memcpy(&msg, req.msg, sizeof(msg));
00573         q->finish(r, this);
00574
00575         if (_ctrl_port.status == Port::Port_disabled)
00576           {
00577             // When the control queue is disabled, only device ready is accepted.
00578             if (msg.event == Control_message::Device_ready)
00579               {
00580                 if (msg.value)
00581                   _ctrl_port.status = Port::Port_open;
00582                 process_device_ready(msg.value);
00583               }
```

```
00584             else
00585               ret = -L4_EIO;
00586
00587             continue;
00588           }
00589
00590         if (!ctrl_queue_ready())
00591           continue;
00592
00593         // Ignore invalid port ids
00594         if (msg.id >= max_ports())
00595           continue;
00596
00597         switch (msg.event)
00598           {
00599           case Control_message::Port_ready:
00600             process_port_ready(msg.id, msg.value);
00601             break;
00602           case Control_message::Port_open:
00603             process_port_open(msg.id, msg.value);
00604             break;
00605           default:
00606             ret = -L4_EINVAL;
00607             break;
00608           }
00609       }
00610
00611     return ret;
00612   }
00613
00615   void load_desc(L4virtio::Virtqueue::Desc const &desc,
00616                  Request_processor const *proc,
00617                  L4virtio::Virtqueue::Desc const **table)
00618   {
00619     this->_mem_info.load_desc(desc, proc, table);
00620   }
00621
00623   void load_desc(L4virtio::Virtqueue::Desc const &desc,
00624                  Request_processor const *proc,
00625                  Control_request *data)
00626   {
00627     auto *region = this->_mem_info.find(desc.addr.get(), desc.len);
00628     if (L4_UNLIKELY(!region))
00629       throw Bad_descriptor(proc, Bad_descriptor::Bad_address);
00630
00631     data->msg = reinterpret_cast<Control_message *>(region->local(desc.addr));
00632     data->len = desc.len;
00633     data->mem = region;
00634   }
00635
00636   void reset() override
00637   {
00638     for (unsigned p = 0; p < _num_ports; ++p)
00639       port(p)->reset();
00640
00641     _ctrl_port.reset();
00642     reset_queue_configs();
00643     _dev_config.reset_hdr();
00644     _negotiated_features = Features(0);
00645     _report_port_state = false;
00646
00647     reset_device();
00648   }
00649
00656   virtual void reset_device() {}
00657
00667   virtual void notify_queue(Virtqueue *queue) = 0;
00668
00676   virtual Port *port(unsigned port) = 0;
00677   virtual Port const *port(unsigned port) const = 0;
00678
00689   virtual void process_device_ready(l4_uint16_t value) = 0;
00690
00702   virtual void process_port_ready(l4_uint32_t id, l4_uint16_t value)
00703   {
00704     Port *p = port(id);
00705
00706     switch (p->status)
00707       {
00708       case Port::Port_added:
00709       case Port::Port_ready:
00710         p->status = value ? Port::Port_ready : Port::Port_failed;
00711         break;
00712       case Port::Port_open:
00713         if (!value)
00714           p->status = Port::Port_failed;
00715         break;
```

```
00716       default:
00717         // invalid state for PORT_READY message
00718         break;
00719       }
00720   }
00721
00732   virtual void process_port_open(l4_uint32_t id, l4_uint16_t value) = 0;
00733
00734   unsigned max_ports() const
00735   { return _num_ports; }
00736
00737 private:
00738   bool is_control_queue(unsigned q) const
00739   { return q == Ctrl_rx || q == Ctrl_tx; }
00740
00741   unsigned queue_to_port(unsigned q) const
00742   { return (q == 0 || q == 1) ? 0 : (q / 2) - 1; }
00743
00752   unsigned max_queue_size(unsigned q) const
00753   {
00754     if (is_control_queue(q))
00755       return _ctrl_port.vq_max;
00756
00757     return port(queue_to_port(q))->vq_max;
00758   }
00759
00768   Virtqueue *get_queue(unsigned q)
00769   {
00770     Port *p;
00771     if (is_control_queue(q))
00772       p = &_ctrl_port;
00773     else
00774       p = port(queue_to_port(q));
00775
00776     if (q & 1)
00777       return &p->tx;
00778     else
00779       return &p->rx;
00780   }
00781
00792   bool port_report_status(unsigned idx)
00793   {
00794     Port *p = port(idx);
00795     while (p->status != p->reported_status)
00796       {
00797         auto const &trans
00798           = Port::state_transitions[p->reported_status][p->status];
00799
00800         if (trans.event >= 0
00801             && send_control_message(idx, trans.event, trans.value) < 0)
00802           {
00803             _report_port_state = true;
00804             return false;
00805           }
00806
00807         p->reported_status = trans.next;
00808       }
00809
00810     return true;
00811   }
00812
00813   unsigned _num_ports;
00814   bool _report_port_state = false;
00815
00816 protected:
00817   Dev_config_t<Serial_config_space> _dev_config;
00818   Port _ctrl_port;
00819   Features _negotiated_features{0};
00820 };
00821
00822 }}} // name space
```

16.277 virtio-console-device

```
00001 // vi:ft=cpp
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2019-2024 Kernkonzept GmbH.
00005  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *            Phillip Raffeck <phillip.raffeck@kernkonzept.com>
00007  *            Steffen Liebergeld <steffen.liebergeld@kernkonzept.com>
00008  *            Jan Klötzke <jan.kloetzke@kernkonzept.com>
00009  */
00010 #pragma once
```

```
00011
00012 #include <l4/cxx/bitmap>
00013 #include <l4/cxx/static_vector>
00014 #include <l4/l4virtio/server/l4virtio>
00015 #include <l4/l4virtio/server/virtio-console>
00016 #include <l4/re/error_helper>
00017
00018 namespace L4virtio { namespace Svr { namespace Console {
00019
00026 struct Device_port : public Port
00027 {
00028   struct Buffer : Data_buffer
00029   {
00030     Buffer() = default;
00031     Buffer(Driver_mem_region const *r,
00032            Virtqueue::Desc const &d,
00033            Request_processor const *)
00034     {
00035       pos = static_cast<char *>(r->local(d.addr));
00036       left = d.len;
00037     }
00038   };
00039
00040   Request_processor rp;
00041   Virtqueue::Request request;
00042   Buffer src;
00043
00044   bool poll_in_req = true;
00045   bool poll_out_req = true;
00046
00047   void reset() override
00048   {
00049     Port::reset();
00050     request = Virtqueue::Request();
00051     poll_in_req = true;
00052     poll_out_req = true;
00053   }
00054 };
00055
00118 class Device
00119 : public Virtio_con
00120 {
00121   class Irq_object : public L4::Irqep_t<Irq_object>
00122   {
00123   public:
00124     Irq_object(Device *parent) : _parent(parent) {}
00125
00126     void handle_irq() { _parent->kick(); }
00127
00128   private:
00129     Device *_parent;
00130   };
00131
00132 protected:
00133   L4::Epiface *irq_iface()
00134   { return &_irq_handler; }
00135
00136 public:
00145   explicit Device(unsigned vq_max)
00146   : Virtio_con(1, false),
00147     _irq_handler(this),
00148     _ports(cxx::make_unique<Device_port[]>(1))
00149   {
00150     _ports[0].vq_max = vq_max;
00151     reset_queue_configs();
00152   }
00153
00163   explicit Device(unsigned vq_max, unsigned ports)
00164   : Virtio_con(ports, true),
00165     _irq_handler(this),
00166     _ports(cxx::make_unique<Device_port[]>(ports))
00167   {
00168     for (unsigned i = 0; i < ports; ++i)
00169       _ports[i].vq_max = vq_max;
00170     reset_queue_configs();
00171   }
00172
00182   explicit Device(cxx::static_vector<unsigned> const &vq_max_nums)
00183   : Virtio_con(vq_max_nums.size(), true),
00184     _irq_handler(this),
00185     _ports(cxx::make_unique<Device_port[]>(max_ports()))
00186   {
00187     for (unsigned i = 0; i < vq_max_nums.size(); ++i)
00188       _ports[i].vq_max = vq_max_nums[i];
00189     reset_queue_configs();
00190   }
00191
```

```
00192   void register_single_driver_irq() override
00193   {
00194     _kick_driver_irq = L4Re::Util::Unique_cap<L4::Irq>(
00195       L4Re::chkcap(server_iface()->rcv_cap<L4::Irq>(0)));
00196     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
00197   }
00198
00199   L4::Cap<L4::Irq> device_notify_irq() const override
00200   { return _irq_handler.obj_cap(); }
00201
00202   void notify_queue(Virtqueue *queue) override
00203   {
00204     if (queue->no_notify_guest())
00205       return;
00206
00207     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00208     _kick_driver_irq->trigger();
00209   }
00210
00214   virtual void rx_data_available(unsigned port) = 0;
00215
00219   virtual void tx_space_available(unsigned port) = 0;
00220
00224   virtual bool queues_stopped()
00225   { return false; }
00226
00227   void trigger_driver_config_irq() override
00228   {
00229     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00230     _kick_driver_irq->trigger();
00231   }
00232
00233   void kick()
00234   {
00235     if (queues_stopped())
00236       return;
00237
00238     // We're not interested in logging any errors, just ignore return value.
00239     handle_control_message();
00240
00241     for (unsigned i = 0; i < max_ports(); ++i)
00242       {
00243         auto &p = _ports[i];
00244         if (p.poll_in_req && p.tx_ready() && p.tx.desc_avail())
00245           {
00246             p.poll_in_req = false;
00247             rx_data_available(i);
00248           }
00249
00250         if (p.poll_out_req && p.rx_ready() && p.rx.desc_avail())
00251           {
00252             p.poll_out_req = false;
00253             tx_space_available(i);
00254           }
00255       }
00256   }
00257
00272   unsigned port_read(char *buf, unsigned len, unsigned port = 0)
00273   {
00274     unsigned total = 0;
00275     Device_port &p = _ports[port];
00276     Virtqueue *q = &p.tx;
00277
00278     Data_buffer dst;
00279     dst.pos = buf;
00280     dst.left = len;
00281
00282     while (dst.left)
00283       {
00284         try
00285           {
00286             // Make sure we have a valid request where we can read data from
00287             if (!p.request.valid())
00288               {
00289                 p.request = p.tx_ready() ? q->next_avail()
00290                                          : Virtqueue::Request();
00291                 if (!p.request.valid())
00292                   break;
00293
00294                 p.rp.start(mem_info(), p.request, &p.src);
00295               }
00296
00297             total += p.src.copy_to(&dst);
00298
00299             // We might have eaten up the current descriptor. Move to the next
00300             // if this is the case. At the end of the descriptor chain we have
00301             // to retire the current request altogether.
```

```
00302             if (!p.src.left)
00303               {
00304                 if (!p.rp.next(mem_info(), &p.src))
00305                   {
00306                     q->finish(p.request, this);
00307                     p.request = Virtqueue::Request();
00308                   }
00309               }
00310           }
00311         catch (Bad_descriptor const &)
00312           {
00313             q->finish(p.request, this);
00314             p.request = Virtqueue::Request();
00315             device_error();
00316             break;
00317           }
00318       }
00319
00320     if (total < len)
00321       p.poll_in_req = true;
00322
00323     return total;
00324   }
00325
00341   unsigned port_write(char const *buf, unsigned len, unsigned port = 0)
00342   {
00343     unsigned total = 0;
00344     Device_port &p = _ports[port];
00345     Virtqueue *q = &p.rx;
00346
00347     Data_buffer src;
00348     src.pos = const_cast<char*>(buf);
00349     src.left = len;
00350
00351     Request_processor rp;
00352     while (src.left)
00353       {
00354         auto r = p.rx_ready() ? q->next_avail() : Virtqueue::Request();
00355         if (!r.valid())
00356           break;
00357
00358         l4_uint32_t chunk = 0;
00359         bool failed = false;
00360         try
00361           {
00362             Device_port::Buffer dst;
00363             rp.start(mem_info(), r, &dst);
00364
00365             for (;;)
00366               {
00367                 chunk += src.copy_to(&dst);
00368                 if (!src.left)
00369                   break;
00370                 if (!rp.next(mem_info(), &dst))
00371                   break;
00372               }
00373           }
00374         catch (Bad_descriptor const &)
00375           {
00376             failed = true;
00377           }
00378
00379         q->finish(r, this, chunk);
00380         total += chunk;
00381
00382         if (failed)
00383           {
00384             device_error();
00385             break;
00386           }
00387       }
00388
00389     if (total < len)
00390       p.poll_out_req = true;
00391
00392     return total;
00393   }
00394
00406   void process_device_ready(l4_uint16_t value) override
00407   {
00408     if (!value)
00409       return;
00410
00411     for (unsigned i = 0; i < max_ports(); ++i)
00412       port_add(i);
00413   }
00414
```

```
00429   void process_port_ready(l4_uint32_t id, l4_uint16_t value) override
00430   {
00431     Virtio_con::process_port_ready(id, value);
00432
00433     Port *p = port(id);
00434     if (p->status == Port::Port_failed)
00435       port_remove(id);
00436     else if (p->status == Port::Port_ready)
00437       port_open(id, true);
00438   }
00439
00450   void process_port_open(l4_uint32_t id, l4_uint16_t value) override
00451   {
00452     static_cast<void>(id);
00453     static_cast<void>(value);
00454   }
00455
00456 protected:
00457   Port* port(unsigned idx) override
00458   {
00459     return &_ports[idx];
00460   }
00461
00462   Port const *port(unsigned idx) const override
00463   {
00464     return &_ports[idx];
00465   }
00466
00467 private:
00468   Irq_object _irq_handler;
00469   cxx::unique_ptr<Device_port[]> _ports;
00470   L4Re::Util::Unique_cap<L4::Irq> _kick_driver_irq;
00471 };
00472
00473 }}} // name space
```

16.278 virtio-gpio-device

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2025 Kernkonzept GmbH.
00004  * Author(s): Christian Pötzsch <christian.poetzsch@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/re/error_helper>
00012 #include <l4/sys/cxx/ipc_epiface>
00013
00014 #include <l4/l4virtio/server/virtio>
00015 #include <l4/l4virtio/server/l4virtio>
00016 #include <l4/l4virtio/l4virtio>
00017
00018 #include <l4/re/error_helper>
00019 #include <l4/re/util/object_registry>
00020 #include <l4/re/util/br_manager>
00021 #include <l4/sys/cxx/ipc_epiface>
00022 #include <l4/cxx/pair>
00023
00024 #include <vector>
00025 #include <memory>
00026
00027 namespace L4virtio {
00028 namespace Svr {
00029
00030 /* GPIO message status types */
00031 enum : l4_uint8_t
00032 {
00033   Gpio_status_ok  = 0x0,
00034   Gpio_status_err = 0x1
00035 };
00036
00037 /* GPIO message types */
00038 enum : l4_uint8_t
00039 {
00040   Gpio_msg_get_line_names = 0x1,
00041   Gpio_msg_get_direction  = 0x2,
00042   Gpio_msg_set_direction  = 0x3,
00043   Gpio_msg_get_value      = 0x4,
00044   Gpio_msg_set_value      = 0x5,
00045   Gpio_msg_set_irq_type   = 0x6
00046 };
```

```
00047
00048 /* GPIO value types */
00049 enum : l4_uint8_t
00050 {
00051   Gpio_low  = 0x0,
00052   Gpio_high = 0x1
00053 };
00054
00055 /* GPIO direction types */
00056 enum : l4_uint8_t
00057 {
00058   Gpio_direction_none = 0x0,
00059   Gpio_direction_out  = 0x1,
00060   Gpio_direction_in   = 0x2
00061 };
00062
00063 /* GPIO interrupt types */
00064 enum : l4_uint8_t
00065 {
00066   Gpio_irq_type_none         = 0x0,
00067   Gpio_irq_type_edge_rising  = 0x1,
00068   Gpio_irq_type_edge_falling = 0x2,
00069   Gpio_irq_type_edge_both    = 0x3,
00070   Gpio_irq_type_level_high   = 0x4,
00071   Gpio_irq_type_level_low    = 0x8
00072 };
00073
00074 /* GPIO interrupt status types */
00075 enum : l4_uint8_t
00076 {
00077   Gpio_irq_status_invalid = 0x0,
00078   Gpio_irq_status_valid   = 0x1
00079 };
00080
00081 struct Gpio_request
00082 {
00083   l4_uint16_t type;
00084   l4_uint16_t gpio;
00085   l4_uint32_t value;
00086 };
00087 static_assert(sizeof(Gpio_request) == 8,
00088               "Gpio_request contains padding bytes.");
00089
00090 struct Gpio_response
00091 {
00092   l4_uint8_t status;
00093   l4_uint8_t value;
00094 };
00095 static_assert(sizeof(Gpio_response) == 2,
00096               "Gpio_response contains padding bytes.");
00097
00098 struct Gpio_irq_request
00099 {
00100   l4_uint16_t gpio;
00101 };
00102 static_assert(sizeof(Gpio_irq_request) == 2,
00103               "Gpio_irq_request contains padding bytes.");
00104
00105 struct Gpio_irq_response
00106 {
00107   l4_uint8_t status;
00108 };
00109 static_assert(sizeof(Gpio_irq_response) == 1,
00110               "Gpio_irq_response contains padding bytes.");
00111
00112 struct Gpio_request_msg
00113 {
00114   struct Gpio_request *in_hdr = nullptr;
00115   struct Gpio_response *out_hdr = nullptr;
00116 };
00117
00118 struct Gpio_irq_request_msg
00119 {
00120   struct Gpio_irq_request *in_hdr = nullptr;
00121   struct Gpio_irq_response *out_hdr = nullptr;
00122 };
00123
00140 template <typename Request_handler,
00141           typename Epiface = L4virtio::Device>
00142 class Virtio_gpio : public L4virtio::Svr::Device,
00143                     public L4::Epiface_t<Virtio_gpio<Request_handler,
00144                                                      Epiface>,
00145                                          Epiface>
00146 {
00147 private:
00148   enum
00149     {
```

```
00150       queue_size = 128,
00151     };
00152
00153 public:
00154   using Gpio_request_handler = Request_handler;
00155
00166   struct Irq_handler
00167   {
00168     Irq_handler(Virtio_gpio *gpio, L4virtio::Svr::Virtqueue *q,
00169                 L4virtio::Svr::Virtqueue::Head_desc const &head,
00170                 l4_uint8_t *status)
00171       : _gpio(gpio), _q(q), _head(head), _status(status)
00172     {}
00173
00174     void handle_irq()
00175     {
00176       *_status = Gpio_irq_status_valid;
00177       _q->finish(_head, _gpio, sizeof(Gpio_irq_response));
00178     }
00179
00180     void cancel()
00181     {
00182       *_status = Gpio_irq_status_invalid;
00183       _q->finish(_head, _gpio, sizeof(Gpio_irq_response));
00184     }
00185
00186   private:
00187     Virtio_gpio *_gpio;
00188     L4virtio::Svr::Virtqueue *_q;
00189     L4virtio::Svr::Virtqueue::Head_desc _head;
00190     l4_uint8_t *_status;
00191   };
00192
00198   struct Host_irq : L4::Irqep_t<Host_irq>
00199   {
00200     explicit Host_irq(Virtio_gpio *gpio)
00201     : L4::Irqep_t<Host_irq>(), _gpio(gpio) {}
00202
00203     void handle_irq()
00204     { _gpio->handle_queue(); }
00205
00206   private:
00207     Virtio_gpio *_gpio;
00208   };
00209
00213   struct Request_processor : L4virtio::Svr::Request_processor
00214   {
00215     Request_processor(L4virtio::Svr::Virtqueue *q, Gpio_request_handler *hndlr,
00216                       Virtio_gpio *gpio)
00217       : _q(q), _req_handler(hndlr), _gpio(gpio), _head(), _req()
00218     {}
00219
00220   protected:
00221     bool init_queue()
00222     {
00223       auto r = _q->next_avail();
00224
00225       if (L4_UNLIKELY(!r))
00226         return false;
00227
00228       _head = start(_gpio->mem_info(), r, &_req);
00229
00230       return true;
00231     }
00232
00240     template <typename T>
00241     T get_request()
00242     {
00243       T req;
00244       req.in_hdr = reinterpret_cast<decltype(T::in_hdr)>(_req.pos);
00245
00246       // Need the next output buffer.
00247       if (!next(_gpio->mem_info(), &_req) || !current_flags().write())
00248         return req;
00249
00250       req.out_hdr = reinterpret_cast<decltype(T::out_hdr)>(_req.pos);
00251
00252       return req;
00253     }
00254
00255     struct Data_buffer : public L4virtio::Svr::Data_buffer
00256     {
00257       Data_buffer()
00258       {
00259         pos = nullptr;
00260         left = 0;
00261       }
```

```
00262       // This constructor is called from within start, so make it available.
00263       Data_buffer(L4virtio::Svr::Driver_mem_region const *r,
00264                   L4virtio::Svr::Virtqueue::Desc const &d,
00265                   L4virtio::Svr::Request_processor const *)
00266       {
00267         pos = static_cast<char *>(r->local(d.addr));
00268         left = d.len;
00269       }
00270
00271     };
00272
00273     L4virtio::Svr::Virtqueue *_q;
00274     Gpio_request_handler *_req_handler;
00275     Virtio_gpio *_gpio;
00276     L4virtio::Svr::Virtqueue::Head_desc _head;
00277     Data_buffer _req;
00278   };
00279
00280   // Handler for the gpio request queue
00281   struct Req_processor : Request_processor
00282   {
00283     using Request_processor::Request_processor;
00284
00285     void handle_request()
00286     {
00287       if (!this->_head)
00288         if (!this->init_queue())
00289           return;
00290
00291       using Consumed_entry =
00292         cxx::Pair<L4virtio::Svr::Virtqueue::Head_desc, l4_uint32_t>;
00293       std::vector<Consumed_entry> consumed;
00294
00295       for (;;)
00296         {
00297           Gpio_request_msg req = this->template get_request<Gpio_request_msg>();
00298           if (!req.in_hdr || !req.out_hdr)
00299             {
00300               this->_gpio->device_error();
00301               break;
00302             }
00303
00304           // default response is error
00305           req.out_hdr->status = Gpio_status_err;
00306           switch (req.in_hdr->type)
00307             {
00308               case Gpio_msg_get_line_names:
00309                 // we don't support this
00310                 break;
00311               case Gpio_msg_get_direction:
00312                 {
00313                   if (this->_req_handler->get_direction(req.in_hdr->gpio,
00314                                                         &req.out_hdr->value))
00315                     req.out_hdr->status = Gpio_status_ok;
00316                   break;
00317                 }
00318               case Gpio_msg_set_direction:
00319                 {
00320                   if (req.in_hdr->value == Gpio_direction_none ||
00321                       req.in_hdr->value == Gpio_direction_out ||
00322                       req.in_hdr->value == Gpio_direction_in)
00323                     {
00324                       if (this->_req_handler->set_direction(req.in_hdr->gpio,
00325                                                             req.in_hdr->value))
00326                         req.out_hdr->status = Gpio_status_ok;
00327                     }
00328                   break;
00329                 }
00330               case Gpio_msg_get_value:
00331                 {
00332                   if (this->_req_handler->get_value(req.in_hdr->gpio,
00333                                                     &req.out_hdr->value))
00334                     req.out_hdr->status = Gpio_status_ok;
00335                   break;
00336                 }
00337               case Gpio_msg_set_value:
00338                 {
00339                   if (req.in_hdr->value == Gpio_low ||
00340                       req.in_hdr->value == Gpio_high)
00341                     {
00342                       if (this->_req_handler->set_value(req.in_hdr->gpio,
00343                                                         req.in_hdr->value))
00344                         req.out_hdr->status = Gpio_status_ok;
00345                     }
00346                   break;
00347                 }
00348               case Gpio_msg_set_irq_type:
```

```
00349                 {
00350                   if (req.in_hdr->value == Gpio_irq_type_none ||
00351                       req.in_hdr->value == Gpio_irq_type_edge_rising ||
00352                       req.in_hdr->value == Gpio_irq_type_edge_falling ||
00353                       req.in_hdr->value == Gpio_irq_type_edge_both ||
00354                       req.in_hdr->value == Gpio_irq_type_level_high ||
00355                       req.in_hdr->value == Gpio_irq_type_level_low)
00356                     {
00357                       if (this->_req_handler->set_irq_type(req.in_hdr->gpio,
00358                                                            req.in_hdr->value))
00359                         req.out_hdr->status = Gpio_status_ok;
00360                     }
00361                   break;
00362                 }
00363             }
00364
00365           // Save the descriptors which are done
00366           consumed.emplace_back(this->_head, sizeof(Gpio_response));
00367
00368           if (!this->init_queue())
00369             break;
00370         }
00371
00372       // Put all finished descriptors back into the used list and notify the
00373       // driver.
00374       this->_q->finish(consumed.begin(), consumed.end(), this->_gpio);
00375
00376       this->_head = Virtqueue::Head_desc();
00377     }
00378   };
00379
00380   // Handler for the gpio event queue
00381   struct Irq_req_processor : Request_processor
00382   {
00383     using Request_processor::Request_processor;
00384
00385     void handle_request()
00386     {
00387       if (!this->_head)
00388         if (!this->init_queue())
00389           return;
00390
00391       for (;;)
00392         {
00393           // There is only one type of message in the event queue. This
00394           // basically arms (unmask) the irq.
00395           Gpio_irq_request_msg req = this->template get_request<Gpio_irq_request_msg>();
00396           if (!req.in_hdr || !req.out_hdr)
00397             {
00398               this->_gpio->device_error();
00399               break;
00400             }
00401
00402           // Save the virtio descriptor for this event in an extra Irq_handler
00403           // object. The descriptor will be returned to the client when the irq
00404           // is triggered or canceled.
00405           this->_req_handler->enable_irq(req.in_hdr->gpio,
00406             std::make_shared<Irq_handler>(this->_gpio,
00407                                           this->_q,
00408                                           this->_head,
00409                                           &req.out_hdr->status));
00410
00411           if (!this->init_queue())
00412             break;
00413         }
00414
00415       this->_head = Virtqueue::Head_desc();
00416     }
00417   };
00418
00419   struct Features : public L4virtio::Svr::Dev_config::Features
00420   {
00421     Features() = default;
00422     Features(l4_uint32_t raw) : L4virtio::Svr::Dev_config::Features(raw) {}
00423
00424     CXX_BITFIELD_MEMBER(0,  0, gpio_f_irq, raw);
00425   };
00426
00427   struct Gpio_config_space
00428   {
00429     l4_uint16_t ngpio;
00430     l4_uint8_t padding[2];
00431     l4_uint32_t gpio_names_size;
00432   };
00433
00434   Virtio_gpio(Gpio_request_handler *hndlr,
00435               L4Re::Util::Object_registry *registry,
```

```
00436               l4_uint16_t ngpio)
00437     : L4virtio::Svr::Device(&_dev_config),
00438       _registry(registry),
00439       _dev_config(L4VIRTIO_VENDOR_KK, L4VIRTIO_ID_GPIO, 2),
00440       _host_irq(this),
00441       _req_processor(&_q[0], hndlr, this),
00442       _irq_req_processor(&_q[1], hndlr, this)
00443   {
00444     init_mem_info(2);
00445
00446     for (size_t i = 0; i < 2; i++)
00447       {
00448         reset_queue_config(i, queue_size);
00449         setup_queue(&_q[i], i, queue_size);
00450       }
00451
00452     registry->register_irq_obj(&_host_irq);
00453
00454     Features hf(0);
00455     hf.ring_indirect_desc() = true;
00456     hf.gpio_f_irq() = true;
00457     _dev_config.host_features(0) = hf.raw;
00458     _dev_config.set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00459
00460     // fill gpio config space
00461     _dev_config.priv_config()->ngpio = ngpio;
00462     _dev_config.priv_config()->gpio_names_size = 0; // not supported
00463
00464     _dev_config.reset_hdr();
00465   }
00466
00467   ~Virtio_gpio()
00468   { _registry->unregister_obj(&_host_irq); }
00469
00470   void notify_queue(L4virtio::Svr::Virtqueue *queue)
00471   {
00472     if (queue->no_notify_guest())
00473       return;
00474
00475     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00476     L4Re::chkipc(_notify_guest_irq->trigger(), "trigger guest irq");
00477   }
00478
00479   void handle_queue()
00480   {
00481     _req_processor.handle_request();
00482     _irq_req_processor.handle_request();
00483   }
00484
00485   void reset() override
00486   {}
00487
00488   bool check_queues() override
00489   { return true; }
00490
00491   int reconfig_queue(unsigned idx) override
00492   {
00493     if (idx >= sizeof(_q) / sizeof(_q[0]))
00494       return -L4_ERANGE;
00495
00496     if (!setup_queue(_q + idx, idx, queue_size))
00497       return -L4_EINVAL;
00498
00499     return L4_EOK;
00500   }
00501
00502   void trigger_driver_config_irq() override
00503   {
00504     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00505     _notify_guest_irq->trigger();
00506   }
00507
00508   L4::Ipc_svr::Server_iface *server_iface() const override
00509   { return L4::Epiface::server_iface(); }
00510
00511   long op_set_status(L4virtio::Device::Rights r, unsigned status)
00512   { return L4virtio::Svr::Device::op_set_status(r, status); }
00513
00514   long op_config_queue(L4virtio::Device::Rights r, unsigned queue)
00515   { return L4virtio::Svr::Device::op_config_queue(r, queue); }
00516
00517   long op_device_config(L4virtio::Device::Rights r,
00518                         L4::Ipc::Cap<L4Re::Dataspace> &config_ds,
00519                         l4_addr_t &ds_offset)
00520   { return L4virtio::Svr::Device::op_device_config(r, config_ds, ds_offset); }
00521
00522   L4::Cap<L4::Irq> device_notify_irq() const override
```

```
00523   { return L4::cap_cast<L4::Irq>(_host_irq.obj_cap()); }
00524
00525   void register_single_driver_irq() override
00526   {
00527     _notify_guest_irq = L4Re::chkcap
00528       (server_iface()->template rcv_cap<L4::Irq>(0));
00529
00530     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
00531   }
00532
00533 private:
00534   L4Re::Util::Object_registry *_registry;
00535   L4virtio::Svr::Dev_config_t<Gpio_config_space> _dev_config;
00536   Host_irq _host_irq;
00537   L4::Cap<L4::Irq> _notify_guest_irq;
00538   L4virtio::Svr::Virtqueue _q[2];
00539   Req_processor _req_processor;
00540   Irq_req_processor _irq_req_processor;
00541 };
00542
00543 } // namespace Svr
00544 } // namespace L4virtio
```

16.279 virtio-i2c-device

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2024-2025 Kernkonzept GmbH.
00004  * Author(s): Martin Kuettler <martin.kuettler@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/re/error_helper>
00012 #include <l4/sys/cxx/ipc_epiface>
00013
00014 #include <l4/l4virtio/server/virtio>
00015 #include <l4/l4virtio/server/l4virtio>
00016 #include <l4/l4virtio/l4virtio>
00017
00018 #include <l4/re/error_helper>
00019 #include <l4/re/util/object_registry>
00020 #include <l4/re/util/br_manager>
00021 #include <l4/sys/cxx/ipc_epiface>
00022
00023 #include <vector>
00024 #include <optional>
00025 #include <l4/cxx/pair>
00026
00027 namespace L4virtio {
00028 namespace Svr {
00029
00030 enum class I2c_transfer_result : l4_uint8_t
00031 {
00032   I2c_msg_ok = 0,
00033   I2c_msg_err = 1
00034 };
00035
00036 struct I2c_request_flags
00037 {
00038   l4_uint32_t raw;
00039
00040   CXX_BITFIELD_MEMBER(0, 0, fail_next, raw);
00041   CXX_BITFIELD_MEMBER(1, 1, m_rd, raw);
00042 };
00043 static_assert(sizeof(I2c_request_flags) == 4,
00044               "I2c_request_flags contains padding bytes.");
00045
00046 struct I2c_out_hdr
00047 {
00048   l4_uint16_t addr;
00049   l4_uint16_t padding;
00050   I2c_request_flags flags;
00051 };
00052 static_assert(sizeof(I2c_out_hdr) == 8, "I2c_out_hdr contains padding bytes.");
00053
00054 struct I2c_in_hdr
00055 {
00056   l4_uint8_t status;
00057 };
00058 static_assert(sizeof(I2c_in_hdr) == 1, "I2c_in_hdr contains padding bytes.");
00059
```

```
00060 struct I2c_req
00061 {
00062   struct I2c_out_hdr out_hdr;
00063   unsigned buf_len;
00064   l4_uint8_t* buf;
00065   struct I2c_in_hdr *in_hdr;
00066   L4virtio::Svr::Virtqueue::Head_desc head;
00067
00068   unsigned write_size;
00069
00070   void set_status(I2c_transfer_result status)
00071   {
00072     in_hdr->status = static_cast<l4_uint8_t>(status);
00073   }
00074 };
00075
00087 template <typename Request_handler,
00088           typename Epiface = L4virtio::Device>
00089 class Virtio_i2c : public L4virtio::Svr::Device,
00090                    public L4::Epiface_t<Virtio_i2c<Request_handler,
00091                                                    Epiface>,
00092                                         Epiface>
00093 {
00094 private:
00095   enum
00096     {
00097       Num_request_queues = 1,
00098       queue_size = 128,
00099     };
00100
00101 public:
00102   using I2c_request_handler = Request_handler;
00103
00109   class Host_irq : public L4::Irqep_t<Host_irq>
00110   {
00111   public:
00112     explicit Host_irq(Virtio_i2c *i2c) : L4::Irqep_t<Host_irq>(), _i2c(i2c) {}
00113
00114     void handle_irq()
00115     {
00116       _i2c->handle_queue();
00117     }
00118
00119   private:
00120     Virtio_i2c *_i2c;
00121   };
00122
00126   class Request_processor : public L4virtio::Svr::Request_processor
00127   {
00128   public:
00129
00130     struct Data_buffer : public L4virtio::Svr::Data_buffer
00131     {
00132       Data_buffer()
00133       {
00134         pos = nullptr;
00135         left = 0;
00136       }
00137       // This constructor is called from within start, so make it available.
00138       Data_buffer(L4virtio::Svr::Driver_mem_region const *r,
00139                   L4virtio::Svr::Virtqueue::Desc const &d,
00140                   L4virtio::Svr::Request_processor const *)
00141       {
00142         pos = static_cast<char *>(r->local(d.addr));
00143         left = d.len;
00144       }
00145
00146     };
00147
00148     Request_processor(L4virtio::Svr::Virtqueue *q, I2c_request_handler *hndlr,
00149                       Virtio_i2c *i2c)
00150       : _q(q), _req_handler(hndlr), _i2c(i2c), _fail_next(false)
00151     {}
00152
00162     I2c_req get_request()
00163     {
00164       I2c_req request;
00165       if (_pending_req.has_value())
00166         {
00167           request = _pending_req.value();
00168           _pending_req.reset();
00169           return request;
00170         }
00171
00172       auto r = _q->next_avail();
00173       if (L4_UNLIKELY(!r))
00174         {
```

```
00175           request.head = Virtqueue::Head_desc();
00176           return request;
00177         }
00178
00179       Data_buffer req;
00180       request.head = start(_i2c->mem_info(), r, &req);
00181       memcpy(&request.out_hdr, req.pos, sizeof(I2c_out_hdr));
00182
00183       // number of bytes to be written in the answer.
00184       request.write_size = sizeof(I2c_in_hdr);
00185       request.buf_len = 0;
00186
00187       // 2nd part: either the optional buffer or the in_hdr
00188       if (next(_i2c->mem_info(), &req))
00189         {
00190
00191           request.buf_len += req.left;
00192           request.buf = reinterpret_cast<l4_uint8_t *>(req.pos);
00193         }
00194
00195       // 3rd part: in_hdr
00196       if (next(_i2c->mem_info(), &req))
00197         {
00198           // 2nd part was indeed a buffer
00199           if (request.out_hdr.flags.m_rd())
00200             request.write_size += request.buf_len;
00201
00202           // actual 3rd part
00203           request.in_hdr = reinterpret_cast<I2c_in_hdr *>(req.pos);
00204         }
00205       else
00206         {
00207           // no 3rd part, 2nd part is in_hdr;
00208           request.in_hdr = reinterpret_cast<I2c_in_hdr *>(request.buf);
00209           request.buf = nullptr;
00210           request.buf_len = 0;
00211         }
00212
00213       return request;
00214     }
00215
00216     void handle_requests()
00217     {
00218       using Consumed_entry =
00219         cxx::Pair<L4virtio::Svr::Virtqueue::Head_desc, l4_uint32_t>;
00220       std::vector<Consumed_entry> consumed;
00221
00222       for (;;)
00223         {
00224           auto r = get_request();
00225           if (!r.head)
00226             break;
00227
00228           if (_fail_next)
00229             {
00230               r.set_status(I2c_transfer_result::I2c_msg_err);
00231               _fail_next = r.out_hdr.flags.fail_next();
00232             }
00233           else
00234             {
00235               std::optional<bool> ok;
00236               l4_uint16_t i2c_addr = r.out_hdr.addr » 1;
00237               if (r.out_hdr.flags.m_rd())
00238                 ok = _req_handler->handle_read(i2c_addr, r.buf, r.buf_len);
00239               else
00240                 ok = _req_handler->handle_write(i2c_addr, r.buf, r.buf_len);
00241               if (ok.has_value())
00242                 {
00243                   if (ok.value())
00244                     {
00245                       r.set_status(I2c_transfer_result::I2c_msg_ok);
00246                       _fail_next = false;
00247                     }
00248                   else
00249                     {
00250                       r.set_status(I2c_transfer_result::I2c_msg_err);
00251                       _fail_next = r.out_hdr.flags.fail_next();
00252                     }
00253                 }
00254               else
00255                 {
00256                   _pending_req = r;
00257                   break;
00258                 }
00259             }
00260           consumed.emplace_back(r.head, r.write_size);
00261         }
```

```
00262
00263       if (!consumed.empty())
00264         _q->finish(consumed.begin(), consumed.end(), _i2c);
00265     }
00266
00267   private:
00268     L4virtio::Svr::Virtqueue *_q;
00269     I2c_request_handler *_req_handler;
00270     Virtio_i2c *_i2c;
00271     bool _fail_next;
00272     std::optional<I2c_req> _pending_req;
00273   };
00274
00275   struct Features : public L4virtio::Svr::Dev_config::Features
00276   {
00277     Features() = default;
00278     Features(l4_uint32_t raw) : L4virtio::Svr::Dev_config::Features(raw) {}
00279
00280     // This feature is mandatory. The driver is requested to abort communication
00281     // if this is not offered.
00282     CXX_BITFIELD_MEMBER(0,  0, zero_length_request, raw);
00283   };
00284
00285   Virtio_i2c(I2c_request_handler *hndlr, L4Re::Util::Object_registry *registry)
00286     : L4virtio::Svr::Device(&_dev_config),
00287       _dev_config(L4VIRTIO_VENDOR_KK, L4VIRTIO_ID_I2C, Num_request_queues),
00288       _req_handler(hndlr),
00289       _host_irq(this),
00290       _request_processor(&_q, hndlr, this)
00291   {
00292     init_mem_info(2);
00293     reset_queue_config(0, queue_size);
00294     setup_queue(&_q, 0, queue_size);
00295     registry->register_irq_obj(&_host_irq);
00296
00297     Features hf(0);
00298     hf.ring_indirect_desc() = true;
00299     hf.zero_length_request() = true;
00300     _dev_config.host_features(0) = hf.raw;
00301     _dev_config.set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00302     _dev_config.reset_hdr();
00303   }
00304
00305   void notify_queue(L4virtio::Svr::Virtqueue *)
00306   {
00307     if (_q.no_notify_guest())
00308       return;
00309
00310     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00311     L4Re::chkipc(_notify_guest_irq->trigger(), "trigger guest irq");
00312   }
00313
00314   void handle_queue()
00315   {
00316     _request_processor.handle_requests();
00317   }
00318
00319   void reset() override
00320   {
00321   }
00322
00323   bool check_queues() override
00324   {
00325     return true;
00326   }
00327
00328   int reconfig_queue(unsigned idx) override
00329   {
00330     if (idx != 0)
00331       return -L4_ERANGE;
00332
00333     if (!setup_queue(&_q, 0, queue_size))
00334       return -L4_EINVAL;
00335
00336     return L4_EOK;
00337   }
00338
00339   void trigger_driver_config_irq() override
00340   {
00341     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00342     _notify_guest_irq->trigger();
00343   }
00344
00345   L4::Ipc_svr::Server_iface *server_iface() const override
00346   {
00347     return L4::Epiface::server_iface();
00348   }
```

```
00349
00350   long op_set_status(L4virtio::Device::Rights r, unsigned status)
00351   {
00352     return L4virtio::Svr::Device::op_set_status(r, status);
00353   }
00354
00355   long op_config_queue(L4virtio::Device::Rights r, unsigned queue)
00356   {
00357     return L4virtio::Svr::Device::op_config_queue(r, queue);
00358   }
00359
00360   long op_device_config(L4virtio::Device::Rights r,
00361                         L4::Ipc::Cap<L4Re::Dataspace> &config_ds,
00362                         l4_addr_t &ds_offset)
00363   {
00364     return L4virtio::Svr::Device::op_device_config(r, config_ds, ds_offset);
00365   }
00366
00367   L4::Cap<L4::Irq> device_notify_irq() const override
00368   {
00369     return L4::cap_cast<L4::Irq>(_host_irq.obj_cap());
00370   }
00371
00372   void register_single_driver_irq() override
00373   {
00374     _notify_guest_irq = L4Re::chkcap
00375       (server_iface()->template rcv_cap<L4::Irq>(0));
00376
00377     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
00378   }
00379
00380
00381 private:
00382   L4virtio::Svr::Dev_config_t<L4virtio::Svr::No_custom_data>_dev_config;
00383   I2c_request_handler *_req_handler;
00384   L4virtio::Svr::Virtqueue _q;
00385   Host_irq _host_irq;
00386   L4::Cap<L4::Irq> _notify_guest_irq;
00387   Request_processor _request_processor;
00388 };
00389
00390 } // namespace Svr
00391 } // namespace L4virtio
```

16.280 virtio-rng-device

```
00001 // vi:ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2024-2025 Kernkonzept GmbH.
00004  * Author(s): Martin Kuettler <martin.kuettler@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/re/error_helper>
00012 #include <l4/sys/cxx/ipc_epiface>
00013
00014 #include <l4/l4virtio/server/virtio>
00015 #include <l4/l4virtio/server/l4virtio>
00016 #include <l4/l4virtio/l4virtio>
00017
00018 namespace L4virtio {
00019 namespace Svr {
00020
00032 template <typename Rnd_state, typename Epiface = L4virtio::Device>
00033 class Virtio_rng : public L4virtio::Svr::Device,
00034                    public L4::Epiface_t<Virtio_rng<Rnd_state, Epiface>, Epiface>
00035 {
00036 private:
00037   enum
00038     {
00039       Num_request_queues = 1,
00040       queue_size = 128,
00041     };
00042
00043 public:
00044   using Random_state = Rnd_state;
00045
00051   class Host_irq : public L4::Irqep_t<Host_irq>
00052   {
00053   public:
00054     explicit Host_irq(Virtio_rng *rng) : L4::Irqep_t<Host_irq>(), _rng(rng) {}
```

```
00055
00056     void handle_irq()
00057     {
00058       _rng->handle_queue();
00059     }
00060
00061   private:
00062     Virtio_rng *_rng;
00063   };
00064
00068   class Request_processor : public L4virtio::Svr::Request_processor
00069   {
00070   public:
00071     struct Data_buffer : public L4virtio::Svr::Data_buffer
00072     {
00073       Data_buffer() = default;
00074       // This constructor is called from within start, so make it available.
00075       Data_buffer(L4virtio::Svr::Driver_mem_region const *r,
00076                   L4virtio::Svr::Virtqueue::Desc const &d,
00077                   L4virtio::Svr::Request_processor const *)
00078       {
00079         pos = static_cast<char *>(r->local(d.addr));
00080         left = d.len;
00081       }
00082     };
00083
00084     Request_processor(L4virtio::Svr::Virtqueue *q, Random_state *rnd,
00085                       Virtio_rng *rng)
00086       : _q(q), _rnd(rnd), _rng(rng), _head() {}
00087
00088     bool init_queue()
00089     {
00090       auto r = _q->next_avail();
00091
00092       if (L4_UNLIKELY(!r))
00093         return false;
00094
00095       _head = start(_rng->mem_info(), r, &_req);
00096
00097       return true;
00098     }
00099
00100     void handle_request()
00101     {
00102       if (!_head)
00103         if (!init_queue())
00104           return;
00105
00106       for (;;)
00107         {
00108           auto const pos = reinterpret_cast<unsigned char *>(_req.pos);
00109           L4Re::chksys(_rnd->get_random(_req.left, pos), "get random");
00110           _q->finish(_head, _rng, _req.left);
00111           if (!init_queue())
00112             break;
00113         }
00114       return;
00115     }
00116
00117   private:
00118     L4virtio::Svr::Virtqueue *_q;
00119     Random_state *_rnd;
00120     Virtio_rng *_rng;
00121     L4virtio::Svr::Virtqueue::Head_desc _head;
00122     Data_buffer _req;
00123   };
00124
00125   Virtio_rng(Random_state *rnd, L4::Registry_iface *registry)
00126     : L4virtio::Svr::Device(&_dev_config),
00127       _dev_config(L4VIRTIO_VENDOR_KK, L4VIRTIO_ID_RNG, Num_request_queues),
00128       _rnd(rnd),
00129       _host_irq(this),
00130       _request_processor(&_q, rnd, this)
00131   {
00132     init_mem_info(2);
00133     reset_queue_config(0, queue_size);
00134     setup_queue(&_q, 0, queue_size);
00135     registry->register_irq_obj(&_host_irq);
00136
00137     L4virtio::Svr::Dev_config::Features hf;
00138     hf.ring_indirect_desc() = true;
00139     _dev_config.host_features(0) = hf.raw;
00140     _dev_config.set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00141     _dev_config.reset_hdr();
00142   }
00143
00144   void notify_queue(L4virtio::Svr::Virtqueue *)
```

```
00145   {
00146     if (_q.no_notify_guest())
00147       return;
00148
00149     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00150     L4Re::chkipc(_notify_guest_irq->trigger(), "trigger guest irq");
00151   }
00152
00153   void handle_queue()
00154   {
00155     _request_processor.handle_request();
00156   }
00157
00158   void reset() override
00159   {
00160   }
00161
00162   bool check_queues() override
00163   {
00164     return true;
00165   }
00166
00167   int reconfig_queue(unsigned idx) override
00168   {
00169     if (idx != 0)
00170       return -L4_ERANGE;
00171
00172     if (!setup_queue(&_q, 0, queue_size))
00173       return -L4_EINVAL;
00174
00175     return L4_EOK;
00176   }
00177
00178   void trigger_driver_config_irq() override
00179   {
00180     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00181     _notify_guest_irq->trigger();
00182   }
00183
00184   L4::Ipc_svr::Server_iface *server_iface() const override
00185   {
00186     return L4::Epiface::server_iface();
00187   }
00188
00189   long op_set_status(L4virtio::Device::Rights r, unsigned status)
00190   {
00191     return L4virtio::Svr::Device::op_set_status(r, status);
00192   }
00193
00194   long op_config_queue(L4virtio::Device::Rights r, unsigned queue)
00195   {
00196     return L4virtio::Svr::Device::op_config_queue(r, queue);
00197   }
00198
00199   long op_device_config(L4virtio::Device::Rights r,
00200                         L4::Ipc::Cap<L4Re::Dataspace> &config_ds,
00201                         l4_addr_t &ds_offset)
00202   {
00203     return L4virtio::Svr::Device::op_device_config(r, config_ds, ds_offset);
00204   }
00205
00206   L4::Cap<L4::Irq> device_notify_irq() const override
00207   {
00208     return L4::cap_cast<L4::Irq>(_host_irq.obj_cap());
00209   }
00210
00211   void register_single_driver_irq() override
00212   {
00213     _notify_guest_irq = L4Re::chkcap
00214       (server_iface()->template rcv_cap<L4::Irq>(0));
00215
00216     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
00217   }
00218
00219
00220 private:
00221   L4virtio::Svr::Dev_config_t<L4virtio::Svr::No_custom_data>_dev_config;
00222   Random_state *_rnd;
00223   L4virtio::Svr::Virtqueue _q;
00224   Host_irq _host_irq;
00225   L4::Cap<L4::Irq> _notify_guest_irq;
00226   Request_processor _request_processor;
00227 };
00228
00229 } // namespace Svr
00230 } // namespace L4virtio
```

16.281 virtio-scmi-device

```
00001 // vi:ft=cpp
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * Copyright (C) 2024 Kernkonzept GmbH.
00005  * Author(s): Christian Pötzsch <christian.poetzsch@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include <l4/cxx/bitmap>
00012 #include <l4/l4virtio/l4virtio>
00013 #include <l4/l4virtio/server/l4virtio>
00014 #include <l4/l4virtio/server/virtio>
00015 #include <l4/re/util/object_registry>
00016
00017 #include <map>
00018 #include <vector>
00019
00020 namespace L4virtio { namespace Svr { namespace Scmi {
00021
00023 enum
00024 {
00025   Version = 0x20000
00026 };
00027
00029 enum
00030 {
00031   Success = 0,
00032   Not_supported = -1,
00033   Invalid_parameters = -2,
00034   Denied = -3,
00035   Not_found = -4,
00036   Out_of_range = -5,
00037   Busy = -6,
00038   Comms_error = -7,
00039   Generic_error = -8,
00040   Hardware_error = -9,
00041   Protocol_error = -10
00042 };
00043
00045 struct Scmi_hdr_t
00046 {
00047   l4_uint32_t hdr_raw = 0;
00048   CXX_BITFIELD_MEMBER(18, 27, token, hdr_raw);
00049   CXX_BITFIELD_MEMBER(10, 17, protocol_id, hdr_raw);
00050   CXX_BITFIELD_MEMBER( 8,  9, message_type, hdr_raw);
00051   CXX_BITFIELD_MEMBER( 0,  7, message_id, hdr_raw);
00052 };
00053
00055 enum
00056 {
00057   Base_protocol = 0x10,
00058   Power_domain_management_protocol = 0x11,
00059   System_power_management_protocol = 0x12,
00060   Performance_domain_management_protocol = 0x13,
00061   Clock_management_protocol = 0x14,
00062   Sensor_management_protocol = 0x15,
00063   Reset_domain_management_protocol = 0x16,
00064   Voltage_domain_management_protocol = 0x17
00065 };
00066
00068 enum
00069 {
00070   Protocol_version = 0x0,
00071   Protocol_attributes = 0x1,
00072   Protocol_message_attributes = 0x2,
00073 };
00074
00076 enum
00077 {
00078   Base_discover_vendor = 0x3,
00079   Base_discover_sub_vendor = 0x4,
00080   Base_discover_implementation_version = 0x5,
00081   Base_discover_list_protocols = 0x6,
00082   Base_discover_agent = 0x7,
00083   Base_notify_errors = 0x8,
00084   Base_set_device_permissions = 0x9,
00085   Base_set_protocol_permissions = 0xa,
00086   Base_reset_agent_configuration = 0xb
00087 };
00088
00090 struct Base_attr_t
00091 {
```

```
00092   l4_uint32_t attr_raw = 0;
00093   CXX_BITFIELD_MEMBER(8, 15, nagents, attr_raw);
00094   CXX_BITFIELD_MEMBER(0,  7, nprots, attr_raw);
00095 };
00096
00098 enum
00099 {
00100   Performance_domain_attributes = 0x3,
00101   Performance_describe_levels = 0x4,
00102   Performance_limits_set = 0x5,
00103   Performance_limits_get = 0x6,
00104   Performance_level_set = 0x7,
00105   Performance_level_get = 0x8,
00106   Performance_notify_limits = 0x9,
00107   Performance_notify_level = 0xa,
00108   Performance_describe_fastchannel = 0xb,
00109 };
00110
00112 struct Performance_attr_t
00113 {
00114   l4_uint32_t attr_raw = 0;
00115   CXX_BITFIELD_MEMBER(16, 16, power, attr_raw);
00116   CXX_BITFIELD_MEMBER( 0, 15, domains, attr_raw);
00117
00118   l4_uint32_t stat_addr_low = 0;
00119   l4_uint32_t stat_addr_high = 0;
00120   l4_uint32_t stat_len = 0;
00121 };
00122
00124 struct Performance_domain_attr_t
00125 {
00126   l4_uint32_t attr_raw = 0;
00127   CXX_BITFIELD_MEMBER(31, 31, set_limits, attr_raw);
00128   CXX_BITFIELD_MEMBER(30, 30, set_perf_level, attr_raw);
00129   CXX_BITFIELD_MEMBER(29, 29, perf_limits_change_notify, attr_raw);
00130   CXX_BITFIELD_MEMBER(28, 28, perf_level_change_notify, attr_raw);
00131   CXX_BITFIELD_MEMBER(27, 27, fast_channel, attr_raw);
00132
00133   l4_uint32_t rate_limit_raw = 0;
00134   CXX_BITFIELD_MEMBER( 0, 19, rate_limit, rate_limit_raw);
00135
00136   l4_uint32_t sustained_freq = 0;
00137   l4_uint32_t sustained_perf_level = 0;
00138   char name[16] = { 0 };
00139 };
00140
00142 struct Performance_describe_levels_n_t
00143 {
00144   l4_uint32_t num_levels_raw = 0;
00145   CXX_BITFIELD_MEMBER(16, 31, nremain_perf_levels, num_levels_raw);
00146   CXX_BITFIELD_MEMBER( 0, 11, nperf_levels, num_levels_raw);
00147 };
00148
00150 struct Performance_describe_level_t
00151 {
00152   l4_uint32_t perf_level = 0;
00153   l4_uint32_t power_cost = 0;
00154   l4_uint16_t trans_latency = 0;
00155   l4_uint16_t res0 = 0;
00156 };
00157
00158 template<typename OBSERV>
00159 struct Queue_worker : Request_processor
00160 {
00161   Queue_worker(OBSERV *o, Virtqueue *queue)
00162   : o(o), q(queue)
00163   {}
00164
00165   bool init_queue()
00166   {
00167     auto r = q->next_avail();
00168
00169     if (L4_UNLIKELY(!r))
00170       return false;
00171
00172     head = start(o->mem_info(), r, &req);
00173
00174     return true;
00175   }
00176
00177   bool next()
00178   { return Request_processor::next(o->mem_info(), &req); }
00179
00180   void finish(l4_uint32_t total)
00181   { q->finish(head, o, total); }
00182
00183   template<typename T>
```

```
00184   l4_ssize_t read(Data_buffer *buf, T *data, l4_size_t s = sizeof(T))
00185   {
00186     buf->pos = reinterpret_cast<char *>(data);
00187     buf->left = s;
00188     l4_size_t chunk = 0;
00189     for (;;)
00190       {
00191         chunk += req.copy_to(buf);
00192         if (req.done() && !next())
00193           break;
00194         if (!buf->left)
00195           break;
00196       }
00197     if (chunk != s)
00198       return -1;
00199     return chunk;
00200   }
00201
00202   template<typename T>
00203   l4_ssize_t write(Data_buffer *buf, T *data, l4_size_t s = sizeof(T))
00204   {
00205     buf->pos = reinterpret_cast<char *>(data);
00206     buf->left = s;
00207     l4_size_t chunk = 0;
00208     for (;;)
00209       {
00210         chunk += buf->copy_to(&req);
00211         if (req.done() && !next())
00212           break;
00213         if (!buf->left)
00214           break;
00215       }
00216     if (chunk != s)
00217       return -1;
00218     return chunk;
00219   }
00220
00221   l4_ssize_t handle_request()
00222   {
00223     if (!q->ready())
00224       return 0;
00225
00226     try
00227       {
00228         if (!head && L4_UNLIKELY(!init_queue()))
00229           return 0;
00230
00231         for (;;)
00232           {
00233             l4_ssize_t total = 0;
00234             l4_ssize_t res = 0;
00235             Scmi_hdr_t hdr;
00236             Data_buffer buf = Data_buffer(&hdr);
00237             if ((res = read(&buf, &hdr)) < 0)
00238               return res;
00239
00240             // Search/execute handler for given protocol
00241             auto proto = o->proto(hdr.protocol_id());
00242             if (proto)
00243               {
00244                 if ((res = proto->handle_request(hdr, buf, this)) < 0)
00245                   return res;
00246                 total += res;
00247               }
00248             else
00249               {
00250                 if ((res = write(&buf, &hdr)) < 0)
00251                   return res;
00252                 total += res;
00253
00254                 l4_int32_t status = Not_supported;
00255                 if ((res = write(&buf, &status)) < 0)
00256                   return res;
00257                 total += res;
00258               }
00259
00260             finish(total);
00261
00262             head = Virtqueue::Head_desc();
00263             if (L4_UNLIKELY(!init_queue()))
00264               return 0;
00265           }
00266       }
00267     catch (L4virtio::Svr::Bad_descriptor const &e)
00268       {
00269         return e.error;
00270       }
```

```
00271     return 0;
00272   }
00273
00274 private:
00275   struct Buffer : Data_buffer
00276   {
00277     Buffer() = default;
00278     Buffer(L4virtio::Svr::Driver_mem_region const *r,
00279            Virtqueue::Desc const &d, Request_processor const *)
00280     {
00281       pos = static_cast<char *>(r->local(d.addr));
00282       left = d.len;
00283     }
00284   };
00285
00287   Virtqueue::Head_desc head;
00288   Buffer req;
00289
00291   OBSERV *o;
00292   Virtqueue *q;
00293 };
00294
00301 template<typename OBSERV>
00302 struct Proto
00303 {
00304   virtual l4_ssize_t handle_request(Scmi_hdr_t &hdr,
00305                                     Data_buffer &buf,
00306                                     Queue_worker<OBSERV> *qw) = 0;
00307 };
00308
00339 class Scmi_dev : public L4virtio::Svr::Device
00340 {
00341   struct Features : L4virtio::Svr::Dev_config::Features
00342   {
00343     Features() = default;
00344     Features(l4_uint32_t raw) : L4virtio::Svr::Dev_config::Features(raw) {}
00345   };
00346
00347   struct Host_irq : public L4::Irqep_t<Host_irq>
00348   {
00349     Scmi_dev *c;
00350     explicit Host_irq(Scmi_dev *c) : c(c) {}
00351     void handle_irq() { c->kick(); }
00352   };
00353
00354   enum
00355   {
00356     Queue_size = 0x10
00357   };
00358
00359 public:
00360   Scmi_dev(L4Re::Util::Object_registry *registry)
00361   : L4virtio::Svr::Device(&_dev_config),
00362    _dev_config(L4VIRTIO_VENDOR_KK, L4VIRTIO_ID_SCMI, 1),
00363    _host_irq(this),
00364    _request_worker(this, &_q[0])
00365   {
00366     init_mem_info(2);
00367
00368     L4Re::chkcap(registry->register_irq_obj(&_host_irq),
00369                  "Register irq object");
00370
00371     Features hf(0);
00372     hf.ring_indirect_desc() = true;
00373
00374     _dev_config.host_features(0) = hf.raw;
00375
00376     _dev_config.set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00377     _dev_config.reset_hdr();
00378
00379     reset();
00380   }
00381
00383   void add_proto(l4_uint32_t id, Proto<Scmi_dev> *proto)
00384   { _protos.insert({id, proto}); }
00385
00386   Proto<Scmi_dev> *proto(l4_uint32_t id) const
00387   {
00388     if (_protos.find(id) != _protos.end())
00389       return _protos.at(id);
00390     return nullptr;
00391   }
00392
00393   void notify_queue(L4virtio::Virtqueue *queue)
00394   {
00395     if (queue->no_notify_guest())
00396       return;
```

```
00397
00398     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00399     _kick_guest_irq->trigger();
00400   }
00401
00402 private:
00403   L4::Cap<L4::Irq> device_notify_irq() const override
00404   { return L4::cap_cast<L4::Irq>(_host_irq.obj_cap()); }
00405
00406   void register_single_driver_irq() override
00407   {
00408     _kick_guest_irq = L4Re::Util::Unique_cap<L4::Irq>(
00409       L4Re::chkcap(server_iface()->template rcv_cap<L4::Irq>(0)));
00410
00411     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
00412   }
00413
00414   void kick()
00415   {
00416     if (_request_worker.handle_request() < 0)
00417       device_error();
00418   }
00419
00420   void reset() override
00421   {
00422     for (Virtqueue &q : _q)
00423       q.disable();
00424
00425     for (l4_uint32_t i = 0; i < _dev_config.num_queues(); i++)
00426       reset_queue_config(i, Queue_size);
00427   }
00428
00429   bool check_queues() override
00430   {
00431     for (Virtqueue &q : _q)
00432       if (!q.ready())
00433         return false;
00434
00435     return true;
00436   }
00437
00438   int reconfig_queue(unsigned idx) override
00439   {
00440     if (idx >= sizeof(_q) / sizeof(_q[0]))
00441       return -L4_ERANGE;
00442
00443     if (!setup_queue(_q + idx, idx, Queue_size))
00444       return -L4_EINVAL;
00445
00446     return L4_EOK;
00447   }
00448
00449   void trigger_driver_config_irq() override
00450   {
00451     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00452     _kick_guest_irq->trigger();
00453   }
00454
00455   L4virtio::Svr::Dev_config_t<L4virtio::Svr::No_custom_data> _dev_config;
00456   Host_irq _host_irq;
00457   L4Re::Util::Unique_cap<L4::Irq> _kick_guest_irq;
00458   Virtqueue _q[1];
00459   Queue_worker<Scmi_dev> _request_worker;
00460   std::map<l4_uint32_t, Proto<Scmi_dev> *> _protos;
00461 };
00462
00468 class Base_proto : public Proto<Scmi_dev>
00469 {
00472   virtual l4_int32_t fill_attr(Base_attr_t *attr) const = 0;
00473
00475   virtual std::vector<l4_uint32_t> prots() const = 0;
00476
00477   l4_ssize_t handle_request(Scmi_hdr_t &hdr, Data_buffer &buf,
00478                             Queue_worker<Scmi_dev> *qw) override
00479   {
00480     l4_ssize_t total = 0;
00481     l4_ssize_t res = 0;
00482     switch (hdr.message_id())
00483       {
00484       case Protocol_version:
00485         {
00486           if ((res = qw->write(&buf, &hdr)) < 0)
00487             return res;
00488           total += res;
00489
00490           struct
00491           {
```

```
00492             l4_int32_t status = Success;
00493             l4_uint32_t version = Version;
00494           } version;
00495           if ((res = qw->write(&buf, &version)) < 0)
00496             return res;
00497           total += res;
00498           break;
00499         }
00500       case Protocol_attributes:
00501         {
00502           if ((res = qw->write(&buf, &hdr)) < 0)
00503             return res;
00504           total += res;
00505
00506           Base_attr_t ba;
00507           l4_int32_t status = fill_attr(&ba);
00508           if ((res = qw->write(&buf, &status)) < 0)
00509             return res;
00510           total += res;
00511           if (status == Success)
00512             {
00513               if ((res = qw->write(&buf, &ba)) < 0)
00514                 return res;
00515               total += res;
00516             }
00517           break;
00518         }
00519       case Protocol_message_attributes:
00520         {
00521           l4_uint32_t msg_id = 0;
00522           if ((res = qw->read(&buf, &msg_id)) < 0)
00523             return res;
00524
00525           if ((res = qw->write(&buf, &hdr)) < 0)
00526             return res;
00527           total += res;
00528
00529           struct
00530           {
00531             l4_int32_t status = Not_found;
00532             l4_uint32_t attr = 0;
00533           } attr;
00534           if (msg_id >= Protocol_version &&
00535               msg_id <= Base_discover_list_protocols)
00536             attr.status = Success;
00537
00538           if ((res = qw->write(&buf, &attr)) < 0)
00539             return res;
00540           total += res;
00541           break;
00542         }
00543       case Base_discover_vendor:
00544         {
00545           if ((res = qw->write(&buf, &hdr)) < 0)
00546             return res;
00547           total += res;
00548
00549           struct
00550           {
00551             l4_int32_t status = Success;
00552             l4_uint8_t vendor_identifier[16] = { "L4Re" };
00553           } vendor;
00554           if ((res = qw->write(&buf, &vendor)) < 0)
00555             return res;
00556           total += res;
00557           break;
00558         }
00559       case Base_discover_sub_vendor:
00560         {
00561           if ((res = qw->write(&buf, &hdr)) < 0)
00562             return res;
00563           total += res;
00564
00565           struct
00566           {
00567             l4_int32_t status = Success;
00568             l4_uint8_t vendor_identifier[16] = { "Scmi" };
00569           } vendor;
00570           if ((res = qw->write(&buf, &vendor)) < 0)
00571             return res;
00572           total += res;
00573           break;
00574         }
00575       case Base_discover_implementation_version:
00576         {
00577           if ((res = qw->write(&buf, &hdr)) < 0)
00578             return res;
```

```
00579           total += res;
00580
00581           struct
00582           {
00583             l4_int32_t status = Success;
00584             l4_uint32_t version = 1;
00585           } version;
00586           if ((res = qw->write(&buf, &version)) < 0)
00587             return res;
00588           total += res;
00589           break;
00590         }
00591       case Base_discover_list_protocols:
00592         {
00593           l4_uint32_t skip = 0;
00594           if ((res = qw->read(&buf, &skip)) < 0)
00595             return res;
00596
00597           if ((res = qw->write(&buf, &hdr)) < 0)
00598             return res;
00599           total += res;
00600
00601           auto p = prots();
00602           struct
00603           {
00604             l4_int32_t status = Success;
00605             l4_uint32_t num;
00606           } proto;
00607           proto.num = p.size();
00608           if ((res = qw->write(&buf, &proto)) < 0)
00609             return res;
00610           total += res;
00611
00612           // Array of uint32 where 4 protos are packed into one uint32. So
00613           // round up to 4 bytes and fill the array byte by byte.
00614           l4_uint8_t parr[(p.size() + 3) / 4 * 4] = { 0 };
00615           for (l4_size_t i = 0; i < p.size(); i++)
00616             parr[i] = p.at(i);
00617
00618           if ((res = qw->write(&buf, parr, sizeof(parr))) < 0)
00619             return res;
00620           total += res;
00621           break;
00622         }
00623       default:
00624         {
00625           if ((res = qw->write(&buf, &hdr)) < 0)
00626             return res;
00627           total += res;
00628
00629           l4_int32_t status = Not_supported;
00630           if ((res = qw->write(&buf, &status)) < 0)
00631             return res;
00632           total += res;
00633           break;
00634         }
00635       }
00636
00637     return total;
00638   }
00639 };
00640
00672 class Perf_proto : public Proto<Scmi_dev>
00673 {
00676   virtual l4_int32_t fill_attr(Performance_attr_t *attr) const = 0;
00677
00680   virtual l4_int32_t fill_domain_attr(l4_uint32_t domain_id,
00681                                       Performance_domain_attr_t *attr) const = 0;
00682
00684   virtual l4_int32_t fill_describe_levels_n(l4_uint32_t domain_id,
00685                                             l4_uint32_t level_idx,
00686                                             Performance_describe_levels_n_t *attr) const = 0;
00687
00690   virtual l4_int32_t fill_describe_levels(l4_uint32_t domain_id,
00691                                           l4_uint32_t level_idx,
00692                                           l4_uint32_t num,
00693                                           Performance_describe_level_t *attr) const = 0;
00694
00696   virtual l4_int32_t level_set(l4_uint32_t domain_id,
00697                                l4_uint32_t perf_level) = 0;
00698
00700   virtual l4_int32_t level_get(l4_uint32_t domain_id,
00701                                l4_uint32_t *perf_level) const = 0;
00702
00703   l4_ssize_t handle_request(Scmi_hdr_t &hdr, Data_buffer &buf,
00704                             Queue_worker<Scmi_dev> *qw) override
00705   {
```

```
00706     l4_ssize_t total = 0;
00707     l4_ssize_t res = 0;
00708     switch (hdr.message_id())
00709       {
00710       case Protocol_version:
00711         {
00712           if ((res = qw->write(&buf, &hdr)) < 0)
00713             return res;
00714           total += res;
00715 
00716           struct
00717           {
00718             l4_int32_t status = Success;
00719             l4_uint32_t version = Version;
00720           } version;
00721           if ((res = qw->write(&buf, &version)) < 0)
00722             return res;
00723           total += res;
00724           break;
00725         }
00726       case Protocol_attributes:
00727         {
00728           if ((res = qw->write(&buf, &hdr)) < 0)
00729             return res;
00730           total += res;
00731 
00732           Performance_attr_t pa;
00733           l4_int32_t status = fill_attr(&pa);
00734           if ((res = qw->write(&buf, &status)) < 0)
00735             return res;
00736           total += res;
00737           if (status == Success)
00738             {
00739               if ((res = qw->write(&buf, &pa)) < 0)
00740                 return res;
00741               total += res;
00742             }
00743           break;
00744         }
00745       case Protocol_message_attributes:
00746         {
00747           l4_uint32_t msg_id = 0;
00748           if ((res = qw->read(&buf, &msg_id)) < 0)
00749             return res;
00750 
00751           if ((res = qw->write(&buf, &hdr)) < 0)
00752             return res;
00753           total += res;
00754 
00755           struct
00756           {
00757             l4_int32_t status = Not_found;
00758 
00759             l4_uint32_t attr_raw = 0;
00760             CXX_BITFIELD_MEMBER(0, 0, fast_channel, attr_raw); // ignored
00761           } attr;
00762           if ((msg_id >= Protocol_version &&
00763                msg_id <= Performance_describe_levels) ||
00764               (msg_id >= Performance_level_set &&
00765                msg_id <= Performance_level_get))
00766             attr.status = Success;
00767 
00768           if ((res = qw->write(&buf, &attr)) < 0)
00769             return res;
00770           total += res;
00771           break;
00772         }
00773       case Performance_domain_attributes:
00774         {
00775           l4_uint32_t domain_id = 0;
00776           if ((res = qw->read(&buf, &domain_id)) < 0)
00777             return res;
00778 
00779           if ((res = qw->write(&buf, &hdr)) < 0)
00780             return res;
00781           total += res;
00782 
00783           Performance_domain_attr_t attr;
00784           l4_int32_t status = fill_domain_attr(domain_id, &attr);
00785           if ((res = qw->write(&buf, &status)) < 0)
00786             return res;
00787           total += res;
00788           if (status == Success)
00789             {
00790               if ((res = qw->write(&buf, &attr)) < 0)
00791                 return res;
00792               total += res;
```

```
00793             }
00794           break;
00795         }
00796       case Performance_describe_levels:
00797         {
00798           struct
00799           {
00800             l4_uint32_t domain_id = 0;
00801             l4_uint32_t level_idx = 0;
00802           } param;
00803           if ((res = qw->read(&buf, &param)) < 0)
00804             return res;
00805
00806           if ((res = qw->write(&buf, &hdr)) < 0)
00807             return res;
00808           total += res;
00809
00810           // First figure out how many levels we support
00811           Performance_describe_levels_n_t attr;
00812           l4_int32_t status = fill_describe_levels_n(param.domain_id, param.level_idx,
00813                                                      &attr);
00814           if (status != Success)
00815             {
00816               // On error bail out early
00817               if ((res = qw->write(&buf, &status)) < 0)
00818                 return res;
00819               total += res;
00820               break;
00821             }
00822
00823           // Now fetch the actual levels
00824           Performance_describe_level_t attr1[attr.nperf_levels().get()];
00825           status = fill_describe_levels(param.domain_id, param.level_idx,
00826                                         attr.nperf_levels(), attr1);
00827           if ((res = qw->write(&buf, &status)) < 0)
00828             return res;
00829           total += res;
00830           if (status == Success)
00831             {
00832               // Write both answers to the client
00833               if ((res = qw->write(&buf, &attr)) < 0)
00834                 return res;
00835               total += res;
00836               if ((res = qw->write(&buf, attr1, sizeof(attr1))) < 0)
00837                 return res;
00838               total += res;
00839             }
00840           break;
00841         }
00842       case Performance_level_set:
00843         {
00844           struct
00845           {
00846             l4_uint32_t domain_id;
00847             l4_uint32_t perf_level;
00848           } param;
00849           if ((res = qw->read(&buf, &param)) < 0)
00850             return res;
00851
00852           if ((res = qw->write(&buf, &hdr)) < 0)
00853             return res;
00854           total += res;
00855
00856           l4_int32_t status = level_set(param.domain_id, param.perf_level);
00857           if ((res = qw->write(&buf, &status)) < 0)
00858             return res;
00859           total += res;
00860           break;
00861         }
00862       case Performance_level_get:
00863         {
00864           l4_uint32_t domain_id = 0;
00865           if ((res = qw->read(&buf, &domain_id)) < 0)
00866             return res;
00867
00868           if ((res = qw->write(&buf, &hdr)) < 0)
00869             return res;
00870           total += res;
00871
00872           l4_uint32_t perf_level;
00873           l4_int32_t status = level_get(domain_id, &perf_level);
00874           if ((res = qw->write(&buf, &status)) < 0)
00875             return res;
00876           total += res;
00877           if (status == Success)
00878             {
00879               if ((res = qw->write(&buf, &perf_level)) < 0)
```

```
00880                 return res;
00881               total += res;
00882             }
00883           break;
00884         }
00885       default:
00886         {
00887           if ((res = qw->write(&buf, &hdr)) < 0)
00888             return res;
00889           total += res;
00890
00891           l4_int32_t status = Not_supported;
00892           if ((res = qw->write(&buf, &status)) < 0)
00893             return res;
00894           total += res;
00895           break;
00896         }
00897       }
00898     return total;
00899   }
00900 };
00901
00902 } /* Scmi */ } /* Svr */ } /* L4virtio */
```

16.282 virtio-spi-device

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2025 Kernkonzept GmbH.
00004  * Author(s): Martin Kuettler <martin.kuettler@kernkonzept.com>
00005  *            Jakub Jermar <jakub.jermar@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/re/error_helper>
00013 #include <l4/sys/cxx/ipc_epiface>
00014
00015 #include <l4/l4virtio/server/virtio>
00016 #include <l4/l4virtio/server/l4virtio>
00017 #include <l4/l4virtio/l4virtio>
00018
00019 #include <l4/re/error_helper>
00020 #include <l4/re/util/object_registry>
00021 #include <l4/re/util/br_manager>
00022 #include <l4/sys/cxx/ipc_epiface>
00023
00024 #include <vector>
00025 #include <l4/cxx/pair>
00026
00027 namespace L4virtio {
00028 namespace Svr {
00029
00030 struct Spi_config
00031 {
00032   l4_uint8_t cs_max_number;
00033   l4_uint8_t cs_change_supported;
00034   l4_uint8_t tx_nbits_supported;
00035   l4_uint8_t rx_nbits_supported;
00036   l4_uint32_t bits_per_word_mask;
00037   l4_uint32_t mode_func_supported;
00038   l4_uint32_t max_freq_hz;
00039   l4_uint32_t max_word_delay_ns;
00040   l4_uint32_t max_cs_setup_ns;
00041   l4_uint32_t max_cs_hold_ns;
00042   l4_uint32_t max_cs_inactive_ns;
00043 };
00044
00045 enum Spi_transfer_result: l4_uint8_t
00046 {
00047   Spi_trans_ok = 0,
00048   Spi_param_err = 1,
00049   Spi_trans_err = 2,
00050 };
00051
00052 struct Spi_transfer_head
00053 {
00054   l4_uint8_t chip_select_id;
00055   l4_uint8_t bits_per_word;
00056   l4_uint8_t cs_change;
00057   l4_uint8_t tx_nbits;
00058   l4_uint8_t rx_nbits;
```

```
00059   l4_uint8_t last_request; // XXX non-standard! aka reserved[0]
00060   l4_uint8_t reserved[2];
00061   l4_uint32_t mode;
00062   l4_uint32_t freq;
00063   l4_uint32_t word_delay_ns;
00064   l4_uint32_t cs_setup_ns;
00065   l4_uint32_t cs_delay_hold_ns;
00066   l4_uint32_t cs_change_delay_inactive_ns;
00067 };
00068 static_assert(sizeof(Spi_transfer_head) == 32,
00069               "Spi_transfer_head contains padding bytes.");
00070
00071 struct Spi_transfer_req
00072 {
00073   struct Spi_transfer_head head;
00074   l4_uint8_t *tx_buf = nullptr;
00075   l4_uint8_t *rx_buf = nullptr;
00076   Spi_transfer_result *result = nullptr;
00077
00078   unsigned tx_size = 0;
00079   unsigned rx_size = 0;
00080
00081   void set_result(Spi_transfer_result res)
00082   {
00083     *result = res;
00084   }
00085 };
00086
00100 template <typename Spi_request_handler, typename Epiface = L4virtio::Device>
00101 class Virtio_spi
00102 : public L4virtio::Svr::Device,
00103   public L4::Epiface_t<Virtio_spi<Spi_request_handler, Epiface>, Epiface>
00104 {
00105 private:
00106   enum
00107     {
00108       Num_request_queues = 1,
00109       Queue_size = 128,
00110     };
00111
00112 public:
00118   class Host_irq : public L4::Irqep_t<Host_irq>
00119   {
00120   public:
00121     explicit Host_irq(Virtio_spi *spi) : L4::Irqep_t<Host_irq>(), _spi(spi) {}
00122
00123     void handle_irq()
00124     {
00125       _spi->handle_queue();
00126     }
00127
00128   private:
00129     Virtio_spi *_spi;
00130   };
00131
00135   class Request_processor : public L4virtio::Svr::Request_processor
00136   {
00137   public:
00138
00139     struct Data_buffer : public L4virtio::Svr::Data_buffer
00140     {
00141       Data_buffer()
00142       {
00143         pos = nullptr;
00144         left = 0;
00145       }
00146       // This constructor is called from within the base start(), so make it
00147       // available.
00148       Data_buffer(L4virtio::Svr::Driver_mem_region const *r,
00149                   L4virtio::Svr::Virtqueue::Desc const &d,
00150                   L4virtio::Svr::Request_processor const *)
00151       {
00152         pos = static_cast<char *>(r->local(d.addr));
00153         left = d.len;
00154       }
00155
00156     };
00157
00158     Request_processor(L4virtio::Svr::Virtqueue *q, Spi_request_handler *hndlr,
00159                       Virtio_spi *spi)
00160       : _q(q), _req_handler(hndlr), _spi(spi), _head(), _req()
00161     {}
00162
00163     bool init_queue()
00164     {
00165       auto r = _q->next_avail();
00166
```

```
00167       if (L4_UNLIKELY(!r))
00168         return false;
00169
00170       _head = start(_spi->mem_info(), r, &_req);
00171
00172       return true;
00173     }
00174
00185     Spi_transfer_req get_request()
00186     {
00187       Spi_transfer_req request;
00188       memcpy(&request.head, _req.pos, sizeof(Spi_transfer_head));
00189
00190       // Check for a TX and/or RX buffer
00191       if (!next(_spi->mem_info(), &_req))
00192         {
00193           L4Re::throw_error(-L4_EIO, "Virtio SPI request too short");
00194         }
00195
00196       if (current_flags().write())
00197         {
00198           // device-writable buffer
00199           request.rx_buf = reinterpret_cast<l4_uint8_t *>(_req.pos);
00200           request.rx_size = _req.left;
00201         }
00202       else
00203         {
00204           request.tx_buf = reinterpret_cast<l4_uint8_t *>(_req.pos);
00205           request.tx_size = _req.left;
00206         }
00207
00208       // Check for an RX buffer or request result buffer
00209       if (!next(_spi->mem_info(), &_req))
00210         {
00211           L4Re::throw_error(-L4_EIO, "Virtio SPI request too short");
00212         }
00213
00214       if (has_more())
00215         {
00216           // This must be the RX buffer
00217           if (request.rx_buf || !current_flags().write())
00218             {
00219               L4Re::throw_error(-L4_EIO, "Bad Virtio SPI request");
00220             }
00221
00222           request.rx_buf = reinterpret_cast<l4_uint8_t *>(_req.pos);
00223           request.rx_size = _req.left;
00224           next(_spi->mem_info(), &_req);
00225         }
00226
00227       request.result = reinterpret_cast<Spi_transfer_result *>(_req.pos);
00228
00229       return request;
00230     }
00231
00232     void handle_request()
00233     {
00234       if (!_head)
00235         if (!init_queue())
00236           return;
00237
00238       using Consumed_entry =
00239         cxx::Pair<L4virtio::Svr::Virtqueue::Head_desc, l4_uint32_t>;
00240       std::vector<Consumed_entry> consumed;
00241
00242       for (;;)
00243         {
00244           auto r = get_request();
00245           Spi_transfer_result res;
00246           if (r.tx_buf && r.rx_buf && (r.tx_size != r.rx_size))
00247             res = Spi_param_err;
00248           else
00249             res =
00250               _req_handler->handle_transfer(r.head, r.tx_buf, r.rx_buf,
00251                                             r.tx_size ? r.tx_size : r.rx_size);
00252           r.set_result(res);
00253
00254           l4_uint32_t written = sizeof(Spi_transfer_result);
00255           if (res == Spi_trans_ok)
00256             written += r.rx_size;
00257
00258           consumed.emplace_back(_head, written);
00259           if (!init_queue())
00260             break;
00261         }
00262
00263       _q->finish(consumed.begin(), consumed.end(), _spi);
```

```
00264
00265       _head = Virtqueue::Head_desc();
00266     }
00267
00268   private:
00269     L4virtio::Svr::Virtqueue *_q;
00270     Spi_request_handler *_req_handler;
00271     Virtio_spi *_spi;
00272     L4virtio::Svr::Virtqueue::Head_desc _head;
00273     Data_buffer _req;
00274   };
00275
00276   Virtio_spi(Spi_request_handler *hndlr, L4Re::Util::Object_registry *registry)
00277     : L4virtio::Svr::Device(&_dev_config),
00278       _dev_config(L4VIRTIO_VENDOR_KK, L4VIRTIO_ID_SPI, Num_request_queues),
00279       _req_handler(hndlr),
00280       _host_irq(this),
00281       _request_processor(&_q, hndlr, this)
00282   {
00283     init_mem_info(2);
00284     reset_queue_config(0, Queue_size);
00285     setup_queue(&_q, 0, Queue_size);
00286     registry->register_irq_obj(&_host_irq);
00287
00288     Spi_config volatile *pc = _dev_config.priv_config();
00289
00290     pc->cs_max_number = hndlr->cs_max_number();
00291     pc->cs_change_supported = 0;
00292     pc->tx_nbits_supported = 0;
00293     pc->rx_nbits_supported = 0;
00294     pc->bits_per_word_mask = 0x80;
00295     pc->mode_func_supported = hndlr->mode_func_supported();
00296     pc->max_freq_hz = 0; // XXX: restrict wrt. controller
00297     pc->max_word_delay_ns = 0;
00298     pc->max_cs_setup_ns = 0;
00299     pc->max_cs_hold_ns = 0;
00300     pc->max_cs_inactive_ns = 0;
00301
00302     L4virtio::Svr::Dev_config::Features hf(0);
00303     _dev_config.host_features(0) = hf.raw;
00304     _dev_config.set_host_feature(L4VIRTIO_FEATURE_VERSION_1);
00305     _dev_config.reset_hdr();
00306   }
00307
00308   void notify_queue(L4virtio::Svr::Virtqueue *)
00309   {
00310     if (_q.no_notify_guest())
00311       return;
00312
00313     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_VRING);
00314     L4Re::chkipc(_notify_guest_irq->trigger(), "trigger guest irq");
00315   }
00316
00317   void handle_queue()
00318   {
00319     _request_processor.handle_request();
00320   }
00321
00322   void reset() override
00323   {
00324   }
00325
00326   bool check_queues() override
00327   {
00328     return true;
00329   }
00330
00331   int reconfig_queue(unsigned idx) override
00332   {
00333     if (idx != 0)
00334       return -L4_ERANGE;
00335
00336     if (!setup_queue(&_q, 0, Queue_size))
00337       return -L4_EINVAL;
00338
00339     return L4_EOK;
00340   }
00341
00342   void trigger_driver_config_irq() override
00343   {
00344     _dev_config.add_irq_status(L4VIRTIO_IRQ_STATUS_CONFIG);
00345     _notify_guest_irq->trigger();
00346   }
00347
00348   L4::Ipc_svr::Server_iface *server_iface() const override
00349   {
00350     return L4::Epiface::server_iface();
```

```
00351   }
00352
00353   long op_set_status(L4virtio::Device::Rights r, unsigned status)
00354   {
00355     return L4virtio::Svr::Device::op_set_status(r, status);
00356   }
00357
00358   long op_config_queue(L4virtio::Device::Rights r, unsigned queue)
00359   {
00360     return L4virtio::Svr::Device::op_config_queue(r, queue);
00361   }
00362
00363   long op_device_config(L4virtio::Device::Rights r,
00364                         L4::Ipc::Cap<L4Re::Dataspace> &config_ds,
00365                         l4_addr_t &ds_offset)
00366   {
00367     return L4virtio::Svr::Device::op_device_config(r, config_ds, ds_offset);
00368   }
00369
00370   L4::Cap<L4::Irq> device_notify_irq() const override
00371   {
00372     return L4::cap_cast<L4::Irq>(_host_irq.obj_cap());
00373   }
00374
00375   void register_single_driver_irq() override
00376   {
00377     _notify_guest_irq =
00378       L4Re::chkcap(server_iface()->template rcv_cap<L4::Irq>(0));
00379
00380     L4Re::chksys(server_iface()->realloc_rcv_cap(0));
00381   }
00382
00383
00384 private:
00385   L4virtio::Svr::Dev_config_t<Spi_config> _dev_config;
00386   Spi_request_handler *_req_handler;
00387   L4virtio::Svr::Virtqueue _q;
00388   Host_irq _host_irq;
00389   L4::Cap<L4::Irq> _notify_guest_irq;
00390   Request_processor _request_processor;
00391 };
00392
00393 } // namespace Svr
00394 } // namespace L4virtio
```

16.283 virtio.h

```
00001 /* SPDX-License-Identifier: MIT */
00002 /*
00003  * Copyright (C) 2013-2022, 2024-2025 Kernkonzept GmbH.
00004  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00005  *            Matthias Lange <matthias.lange@kernkonzept.com>
00006  *
00007  */
00008 #pragma once
00009
00013
00027
00028 #include <l4/sys/compiler.h>
00029 #include <l4/sys/utcb.h>
00030 #include <l4/sys/ipc.h>
00031 #include <l4/sys/types.h>
00032
00034 enum L4_virtio_protocol
00035 {
00036   L4VIRTIO_PROTOCOL = 0,
00037 };
00038
00039 enum L4virtio_magic
00040 {
00041   L4VIRTIO_MAGIC = 0x74726976
00042 };
00043
00044 enum L4virtio_vendor
00045 {
00046   L4VIRTIO_VENDOR_KK = 0x44
00047 };
00048
00052 enum L4_virtio_opcodes
00053 {
00054   L4VIRTIO_OP_SET_STATUS     = 0,
00055   L4VIRTIO_OP_CONFIG_QUEUE   = 1,
00056   L4VIRTIO_OP_REGISTER_DS    = 3,
00057   L4VIRTIO_OP_DEVICE_CONFIG  = 4,
```

```
00058   L4VIRTIO_OP_GET_DEVICE_IRQ = 5,
00059 };
00060
00062 enum L4virtio_device_ids
00063 {
00064   L4VIRTIO_ID_NET           = 1,
00065   L4VIRTIO_ID_BLOCK         = 2,
00066   L4VIRTIO_ID_CONSOLE       = 3,
00067   L4VIRTIO_ID_RNG           = 4,
00068   L4VIRTIO_ID_BALLOON       = 5,
00069   L4VIRTIO_ID_RPMSG         = 7,
00070   L4VIRTIO_ID_SCSI          = 8,
00071   L4VIRTIO_ID_9P            = 9,
00072   L4VIRTIO_ID_RPROC_SERIAL  = 11,
00073   L4VIRTIO_ID_CAIF          = 12,
00074   L4VIRTIO_ID_GPU           = 16,
00075   L4VIRTIO_ID_INPUT         = 18,
00076   L4VIRTIO_ID_VSOCK         = 19,
00077   L4VIRTIO_ID_CRYPTO        = 20,
00078   L4VIRTIO_ID_SOUND         = 25,
00079   L4VIRTIO_ID_FS            = 26,
00080   L4VIRTIO_ID_SCMI          = 32,
00081   L4VIRTIO_ID_I2C           = 34,
00082   L4VIRTIO_ID_WATCHDOG      = 35,
00083   L4VIRTIO_ID_CAN           = 36,
00084   L4VIRTIO_ID_GPIO          = 41,
00085   L4VIRTIO_ID_SPI           = 45,
00086
00087   L4VIRTIO_ID_SOCK          = 0x9999,
00088 };
00089
00091 enum L4virtio_device_status
00092 {
00093   L4VIRTIO_STATUS_ACKNOWLEDGE = 1,
00094   L4VIRTIO_STATUS_DRIVER      = 2,
00095   L4VIRTIO_STATUS_DRIVER_OK   = 4,
00096   L4VIRTIO_STATUS_FEATURES_OK = 8,
00097   L4VIRTIO_STATUS_DEVICE_NEEDS_RESET = 0x40,
00098   L4VIRTIO_STATUS_FAILED      = 0x80
00099 };
00100
00101 enum
00102 {
00103   L4VIRTIO_FEATURES_MAP_WORDS = 6
00104 };
00105
00107 enum L4virtio_feature_bits
00108 {
00110   L4VIRTIO_FEATURE_VERSION_1  = 32,
00112   L4VIRTIO_FEATURE_CMD_CONFIG = 160
00113 };
00114
00119 enum L4_virtio_irq_status
00120 {
00121   L4VIRTIO_IRQ_STATUS_VRING  = 1,
00122   L4VIRTIO_IRQ_STATUS_CONFIG = 2,
00123 };
00124
00128 enum L4_virtio_cmd
00129 {
00130   L4VIRTIO_CMD_NONE         = 0x00000000,
00131   L4VIRTIO_CMD_SET_STATUS   = 0x01000000,
00132   L4VIRTIO_CMD_CFG_QUEUE    = 0x02000000,
00133   L4VIRTIO_CMD_CFG_CHANGED  = 0x04000000,
00134   L4VIRTIO_CMD_NOTIFY_QUEUE = 0x08000000,
00135   L4VIRTIO_CMD_MASK         = 0xff000000,
00136 };
00137
00141 typedef struct l4virtio_config_hdr_t
00142 {
00143   /* Virtio(0x00): device config */
00144   l4_uint32_t magic;
00145   l4_uint32_t version;
00146   l4_uint32_t device;
00147   l4_uint32_t vendor;
00148
00149   /* Virtio(0x10): device features */
00150   l4_uint32_t dev_features;
00151   l4_uint32_t dev_features_sel;
00152   l4_uint32_t _res1[2];
00153
00154   /* Virtio(0x20): driver features */
00155   l4_uint32_t driver_features;
00156   l4_uint32_t driver_features_sel;
00157
00158   /* L4Virtio(0x28): L4 queue */
00159   l4_uint32_t num_queues;
```

```
00160   l4_uint32_t queues_offset;
00161
00162   /* Virtio(0x30): queue status */
00163   l4_uint32_t queue_sel;
00164   l4_uint32_t queue_num_max;
00165   l4_uint32_t queue_num;
00166   l4_uint32_t _res3[2];
00167   l4_uint32_t queue_ready;
00168   l4_uint32_t _res4[2];
00169
00170   /* Virtio(0x50): queue notify */
00171   l4_uint32_t queue_notify;
00172   l4_uint32_t _res5[3];
00173
00174   /* Virtio(0x60): interrupt handling */
00175   l4_uint32_t irq_status;
00176   l4_uint32_t irq_ack;
00177   l4_uint32_t _res6[2];
00178
00179   /* Virtio(0x70): Device status register (read-only). The register must be
00180    * written using l4virtio_set_status(). */
00181   l4_uint32_t status;
00182
00183   /* L4Virtio(0x74): W: Event index to be used for config notifications (device to driver) */
00184   l4_uint32_t cfg_driver_notify_index;
00185   /* L4Virtio(0x78): R: Event index to be used for config notifications (driver to device) */
00186   l4_uint32_t cfg_device_notify_index;
00187
00188   /* L4Virtio(0x7c) L4 specific command register polled by the driver iff supported */
00189   l4_uint32_t cmd;
00190
00191   /* Virtio(0x80): queue descriptors */
00192   l4_uint64_t queue_desc;
00193   l4_uint32_t _res8[2];
00194   l4_uint64_t queue_avail;
00195   l4_uint32_t _res9[2];
00196   l4_uint64_t queue_used;
00197
00198   l4_uint32_t _res10[1];
00199
00200   /* Virtio(0xac): shared memory region */
00201   l4_uint32_t shm_sel;
00202   l4_uint64_t shm_len;
00203   l4_uint64_t shm_base;
00204
00205   /* L4Virtio(0xc0): use the unused space here for device and driver feature bitmaps */
00206   l4_uint32_t dev_features_map[L4VIRTIO_FEATURES_MAP_WORDS];
00207   l4_uint32_t _res11[2];
00208   l4_uint32_t driver_features_map[L4VIRTIO_FEATURES_MAP_WORDS];
00209   l4_uint32_t _res12[1];
00210
00211   /* Virtio(0xfc): config generation */
00212   l4_uint32_t generation;
00213 } l4virtio_config_hdr_t;
00214
00232 typedef struct l4virtio_config_queue_t
00233 {
00235   l4_uint16_t num_max;
00237   l4_uint16_t num;
00238
00240   l4_uint16_t ready;
00241
00243   l4_uint16_t driver_notify_index;
00244
00245   l4_uint64_t desc_addr;
00246   l4_uint64_t avail_addr;
00247   l4_uint64_t used_addr;
00248
00250   l4_uint16_t device_notify_index;
00251 } l4virtio_config_queue_t;
00252
00253 L4_BEGIN_DECLS
00254
00260 L4_INLINE l4virtio_config_queue_t *
00261 l4virtio_config_queues(l4virtio_config_hdr_t const *cfg)
00262 {
00263   return (l4virtio_config_queue_t *)(((l4_addr_t)cfg) + cfg->queues_offset);
00264 }
00265
00271 L4_INLINE void *
00272 l4virtio_device_config(l4virtio_config_hdr_t const *cfg)
00273 {
00274   return (void *)(((l4_addr_t)cfg) + 0x100);
00275 }
00276
00280 L4_INLINE void
00281 l4virtio_set_feature(l4_uint32_t *feature_map, unsigned feat)
```

```
00282 {
00283   unsigned idx = feat / 32;
00284
00285   if (idx < L4VIRTIO_FEATURES_MAP_WORDS)
00286     feature_map[idx] |= 1UL << (feat % 32);
00287 }
00288
00292 L4_INLINE void
00293 l4virtio_clear_feature(l4_uint32_t *feature_map, unsigned feat)
00294 {
00295   unsigned idx = feat / 32;
00296
00297   if (idx < L4VIRTIO_FEATURES_MAP_WORDS)
00298     feature_map[idx] &= ~(1UL << (feat % 32));
00299 }
00300
00304 L4_INLINE unsigned
00305 l4virtio_get_feature(l4_uint32_t *feature_map, unsigned feat)
00306 {
00307   unsigned idx = feat / 32;
00308
00309   if (idx >= L4VIRTIO_FEATURES_MAP_WORDS)
00310     return 0;
00311
00312   return feature_map[idx] & (1UL << (feat % 32));
00313 }
00314
00320 L4_CV int
00321 l4virtio_set_status(l4_cap_idx_t cap, unsigned status) L4_NOTHROW;
00322
00328 L4_CV int
00329 l4virtio_config_queue(l4_cap_idx_t cap, unsigned queue) L4_NOTHROW;
00330
00336 L4_CV int
00337 l4virtio_register_ds(l4_cap_idx_t cap, l4_cap_idx_t ds_cap,
00338                      l4_uint64_t base, l4_umword_t offset,
00339                      l4_umword_t size) L4_NOTHROW;
00340
00346 L4_CV int
00347 l4virtio_device_config_ds(l4_cap_idx_t cap, l4_cap_idx_t config_ds,
00348                           l4_addr_t *ds_offset) L4_NOTHROW;
00349
00355 L4_CV int
00356 l4virtio_device_notification_irq(l4_cap_idx_t cap, unsigned index,
00357                                  l4_cap_idx_t irq) L4_NOTHROW;
00358
00359 L4_END_DECLS
00360
```

16.284 virtio_block.h

```
00001 /* SPDX-License-Identifier: MIT */
00002 /*
00003  * (c) 2014 Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00004  */
00005
00006 #pragma once
00007
00013
00014 #include <l4/sys/types.h>
00015
00019 enum L4virtio_block_operations
00020 {
00021   L4VIRTIO_BLOCK_T_IN      = 0,
00022   L4VIRTIO_BLOCK_T_OUT     = 1,
00023   L4VIRTIO_BLOCK_T_FLUSH   = 4,
00024   L4VIRTIO_BLOCK_T_GET_ID  = 8,
00025   L4VIRTIO_BLOCK_T_DISCARD = 11,
00026   L4VIRTIO_BLOCK_T_WRITE_ZEROES = 13,
00027 };
00028
00032 enum L4virtio_block_status
00033 {
00034   L4VIRTIO_BLOCK_S_OK     = 0,
00035   L4VIRTIO_BLOCK_S_IOERR  = 1,
00036   L4VIRTIO_BLOCK_S_UNSUPP = 2
00037 };
00038
00042 typedef struct l4virtio_block_header_t
00043 {
00044   l4_uint32_t type;
00045   l4_uint32_t ioprio;
00046   l4_uint64_t sector;
00047 } l4virtio_block_header_t;
```

```
00048
00049 enum L4virtio_block_discard_flags_t
00050 {
00051   L4VIRTIO_BLOCK_DISCARD_F_UNMAP    = 0x00000001UL,
00052   L4VIRTIO_BLOCK_DISCARD_F_RESERVED = 0xFFFFFFFEUL,
00053 };
00054
00058 typedef struct l4virtio_block_discard_t
00059 {
00060   l4_uint64_t sector;
00061   l4_uint32_t num_sectors;
00062   l4_uint32_t flags;
00063 } l4virtio_block_discard_t;
00064
00068 typedef struct l4virtio_block_config_t
00069 {
00070   l4_uint64_t capacity;
00071   l4_uint32_t size_max;
00072   l4_uint32_t seg_max;
00073   struct l4virtio_block_config_geometry_t
00074   {
00075     l4_uint16_t cylinders;
00076     l4_uint8_t heads;
00077     l4_uint8_t sectors;
00078   } geometry;
00079   l4_uint32_t blk_size;
00080   struct l4virtio_block_config_topology_t
00081   {
00083     l4_uint8_t physical_block_exp;
00085     l4_uint8_t alignment_offset;
00087     l4_uint16_t min_io_size;
00089     l4_uint32_t opt_io_size;
00090   } topology;
00091   l4_uint8_t writeback;
00092   l4_uint8_t unused0[1];
00093   l4_uint16_t num_queues;
00094   l4_uint32_t max_discard_sectors;
00095   l4_uint32_t max_discard_seg;
00096   l4_uint32_t discard_sector_alignment;
00097   l4_uint32_t max_write_zeroes_sectors;
00098   l4_uint32_t max_write_zeroes_seg;
00099   l4_uint8_t write_zeroes_may_unmap;
00100   l4_uint8_t unused1[3];
00101 } l4virtio_block_config_t;
00102
00104 enum L4virtio_block_feature_bits
00105 {
00106   L4VIRTIO_BLOCK_F_SIZE_MAX = 1,
00107   L4VIRTIO_BLOCK_F_SEG_MAX = 2,
00108   L4VIRTIO_BLOCK_F_GEOMETRY = 4,
00109   L4VIRTIO_BLOCK_F_RO = 5,
00110   L4VIRTIO_BLOCK_F_BLK_SIZE = 6,
00111   L4VIRTIO_BLOCK_F_FLUSH = 9,
00112   L4VIRTIO_BLOCK_F_TOPOLOGY = 10,
00113   L4VIRTIO_BLOCK_F_CONFIG_WCE = 11,
00114   L4VIRTIO_BLOCK_F_DISCARD = 13,
00115   L4VIRTIO_BLOCK_F_WRITE_ZEROES = 14,
00116 };
00117
```

16.285 virtio_input.h

```
00001 /* SPDX-License-Identifier: MIT */
00002 /*
00003  * Copyright (C) 2019, 2022, 2024 Kernkonzept GmbH.
00004  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00005  */
00006 #pragma once
00007
00013
00014 #include <l4/sys/types.h>
00015
00019 enum L4virtio_input_config_select
00020 {
00021   L4VIRTIO_INPUT_CFG_UNSET = 0,
00022   L4VIRTIO_INPUT_CFG_ID_NAME = 1,
00023   L4VIRTIO_INPUT_CFG_ID_SERIAL = 2,
00024   L4VIRTIO_INPUT_CFG_ID_DEVIDS = 3,
00025   L4VIRTIO_INPUT_CFG_PROP_BITS = 0x10,
00026   L4VIRTIO_INPUT_CFG_EV_BITS = 0x11,
00027   L4VIRTIO_INPUT_CFG_ABS_INFO = 0x12
00028 };
00029
00033 typedef struct l4virtio_input_absinfo_t
```

```
00034 {
00035   l4_uint32_t min;
00036   l4_uint32_t max;
00037   l4_uint32_t fuzz;
00038   l4_uint32_t flat;
00039   l4_uint32_t res;
00040 } l4virtio_absinfo_t;
00041
00045 typedef struct l4virtio_input_devids_t
00046 {
00047   l4_uint16_t bustype;
00048   l4_uint16_t vendor;
00049   l4_uint16_t product;
00050   l4_uint16_t version;
00051 } l4virtio_input_devids_t;
00052
00056 typedef struct l4virtio_input_config_t
00057 {
00058   l4_uint8_t    select;
00059   l4_uint8_t    subsel;
00060   l4_uint8_t    size;
00061   l4_uint8_t    reserved[5];
00062   union
00063   {
00064     char string[128];
00065     l4_uint8_t bitmap[128];
00066     struct l4virtio_input_absinfo_t abs;
00067     struct l4virtio_input_devids_t ids;
00068   } u;
00069 } l4virtio_input_config_t;
00070
00074 typedef struct l4virtio_input_event_t
00075 {
00076   l4_uint16_t type;
00077   l4_uint16_t code;
00078   l4_uint32_t value;
00079 } l4virtio_input_event_t;
00080
```

16.286 virtqueue

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /* SPDX-License-Identifier: MIT */
00003 /*
00004  * (c) 2014 Alexander Warg <warg@os.inf.tu-dresden.de>
00005  */
00006
00007 #include <l4/re/util/debug>
00008 #include <l4/sys/types.h>
00009 #include <l4/sys/err.h>
00010 #include <l4/cxx/bitfield>
00011 #include <l4/cxx/exceptions>
00012 #include <cstdint>
00013
00014 #pragma once
00015
00016 namespace L4virtio {
00017
00018 #if defined(__ARM_ARCH) && __ARM_ARCH == 7
00019 static inline void wmb() { asm volatile ("dmb ishst" : : : "memory"); }
00020 static inline void rmb() { asm volatile ("dmb ish"   : : : "memory"); }
00021 static inline void mb()  { asm volatile ("dmb ish"   : : : "memory"); }
00022 #elif defined(__ARM_ARCH) && __ARM_ARCH >= 8
00023 static inline void wmb() { asm volatile ("dmb ishst" : : : "memory"); }
00024 static inline void rmb() { asm volatile ("dmb ishld" : : : "memory"); }
00025 static inline void mb()  { asm volatile ("dmb ish"   : : : "memory"); }
00026 #elif defined(__mips__)
00027 static inline void wmb() { asm volatile ("sync" : : : "memory"); }
00028 static inline void rmb() { asm volatile ("sync" : : : "memory"); }
00029 static inline void mb()  { asm volatile ("sync" : : : "memory"); }
00030 #elif defined(__amd64__) || defined(__i386__) || defined(__i686__)
00031 static inline void wmb() { asm volatile ("sfence" : : : "memory"); }
00032 static inline void rmb() { asm volatile ("lfence" : : : "memory"); }
00033 static inline void mb()  { asm volatile ("mfence" : : : "memory"); }
00034 #elif defined(__riscv)
00035 static inline void wmb() { asm volatile ("fence ow, ow" : : : "memory"); }
00036 static inline void rmb() { asm volatile ("fence ir, ir" : : : "memory"); }
00037 static inline void mb()  { asm volatile ("fence iorw, iorw" : : : "memory"); }
00038 #else
00039 #warning Missing proper memory write barrier
00040 static inline void wmb() { asm volatile ("" : : : "memory"); }
00041 static inline void rmb() { asm volatile ("" : : : "memory"); }
00042 static inline void mb()  { asm volatile ("" : : : "memory"); }
00043 #endif
```

```
00044
00045
00052 template< typename T >
00053 class Ptr
00054 {
00055 public:
00057   enum Invalid_type { Invalid  };
00058
00059   Ptr() = default;
00060
00062   Ptr(Invalid_type) : _p(~0ULL) {}
00063
00065   explicit Ptr(l4_uint64_t vm_addr) : _p(vm_addr) {}
00066
00068   l4_uint64_t get() const { return _p; }
00069
00071   bool is_valid() const { return _p != ~0ULL; }
00072
00073 private:
00074   l4_uint64_t _p;
00075 };
00076
00077
00086 class Virtqueue
00087 {
00088 public:
00092   class Desc
00093   {
00094   public:
00098     struct Flags
00099     {
00100       l4_uint16_t raw;
00101       Flags() = default;
00102
00104       explicit Flags(l4_uint16_t v) : raw(v) {}
00105
00107       CXX_BITFIELD_MEMBER( 0,  0, next, raw);
00109       CXX_BITFIELD_MEMBER( 1,  1, write, raw);
00111       CXX_BITFIELD_MEMBER( 2,  2, indirect, raw);
00112     };
00113
00114     Ptr<void> addr;
00115     l4_uint32_t len;
00116     Flags flags;
00117     l4_uint16_t next;
00118
00126     void dump(unsigned idx, L4Re::Util::Dbg dbg = L4Re::Util::Dbg{}) const
00127     {
00128       dbg.printf("D[%04x]: %08llx (%x) f=%04x n=%04x\n",
00129                  idx, addr.get(), len, flags.raw, next);
00130     }
00131   };
00132
00136   class Avail
00137   {
00138   public:
00142     struct Flags
00143     {
00144       l4_uint16_t raw;
00145       Flags() = default;
00146
00148       explicit Flags(l4_uint16_t v) : raw(v) {}
00149
00151       CXX_BITFIELD_MEMBER( 0,  0, no_irq, raw);
00152     };
00153
00154     Flags flags;
00155     l4_uint16_t idx;
00156     l4_uint16_t ring[];
00157   };
00158
00162   struct Used_elem
00163   {
00164     Used_elem() = default;
00165
00173     Used_elem(l4_uint16_t id, l4_uint32_t len) : id(id), len(len) {}
00174     l4_uint32_t id;
00175     l4_uint32_t len;
00176   };
00177
00181   class Used
00182   {
00183   public:
00187     struct Flags
00188     {
00189       l4_uint16_t raw;
00190       Flags() = default;
```

```
00191
00193       explicit Flags(l4_uint16_t v) : raw(v) {}
00194
00196       CXX_BITFIELD_MEMBER( 0,  0, no_notify, raw);
00197     };
00198
00199     Flags flags;
00200     l4_uint16_t idx;
00201     Used_elem ring[];
00202   };
00203
00204 protected:
00205   Desc *_desc = nullptr;
00206   Avail *_avail = nullptr;
00207   Used *_used = nullptr;
00208
00210   l4_uint16_t _current_avail = 0;
00211
00216   l4_uint16_t _idx_mask = 0;
00217
00221   Virtqueue() = default;
00222
00223   Virtqueue(Virtqueue const &) = delete;
00224   ~Virtqueue() = default;
00225
00226 public:
00232   void disable()
00233   { _desc = 0; }
00234
00238   enum
00239   {
00240     Desc_align  = 4, //< Alignment of the descriptor table.
00241     Avail_align = 1, //< Alignment of the available ring.
00242     Used_align  = 2, //< Alignment of the used ring.
00243   };
00244
00253   static unsigned long total_size(unsigned num)
00254   {
00255     static_assert(Desc_align >= Avail_align,
00256                   "virtqueue alignment assumptions broken");
00257     return l4_round_size(desc_size(num) + avail_size(num), Used_align)
00258            + used_size(num);
00259   }
00260
00269   static unsigned long desc_size(unsigned num)
00270   { return num * 16; }
00271
00277   static unsigned long desc_align()
00278   { return Desc_align; }
00279
00287   static unsigned long avail_size(unsigned num)
00288   { return 2 * num + 6; }
00289
00295   static unsigned long avail_align()
00296   { return Avail_align; }
00297
00306   static unsigned long used_size(unsigned num)
00307   { return 8 * num + 6; }
00308
00314   static unsigned long used_align()
00315   { return Used_align; }
00316
00322   unsigned long total_size() const
00323   {
00324     return (reinterpret_cast<char *>(_used) - reinterpret_cast<char *>(_desc))
00325            + used_size(num());
00326   }
00327
00331   unsigned long avail_offset() const
00332   { return reinterpret_cast<char *>(_avail) - reinterpret_cast<char *>(_desc); }
00333
00337   unsigned long used_offset() const
00338   { return reinterpret_cast<char *>(_used) - reinterpret_cast<char *>(_desc); }
00339
00359   void setup(unsigned num, void *desc, void *avail, void *used,
00360              L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00361   {
00362     if (num == 0 || (num & (num - 1)))
00363       throw L4::Runtime_error(-L4_EINVAL, "Queue size is not a power of two.");
00364     if (num > 0x10000)
00365       throw L4::Runtime_error(-L4_EINVAL, "Queue too large.");
00366
00367     _idx_mask = num - 1;
00368     _desc = static_cast<Desc*>(desc);
00369     _avail = static_cast<Avail*>(avail);
00370     _used = static_cast<Used*>(used);
00371
```

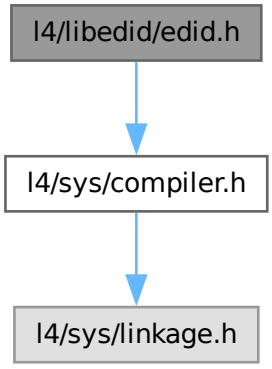
```
00372     _current_avail = 0;
00373
00374     msg_dev.printf("VQ[%p]: num=%d d:%p a:%p u:%p\n",
00375                    this, num, _desc, _avail, _used);
00376   }
00377
00393   void setup_simple(unsigned num, void *ring,
00394                     L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00395   {
00396     l4_addr_t desc = reinterpret_cast<l4_addr_t>(ring);
00397     l4_addr_t avail = l4_round_size(desc + desc_size(num), Avail_align);
00398     void *used = reinterpret_cast<void *>(
00399       l4_round_size(avail + avail_size(num), Used_align));
00400     setup(num, ring, reinterpret_cast<void *>(avail), used, msg_dev);
00401   }
00402
00411   void dump(Desc const *d, L4Re::Util::Dbg dbg = L4Re::Util::Dbg{}) const
00412   { d->dump(d - _desc, dbg); }
00413
00419   bool ready() const
00420   { return L4_LIKELY(_desc != 0); }
00421
00423   unsigned num() const
00424   { return _idx_mask + 1; }
00425
00433   bool no_notify_guest() const
00434   {
00435     mb(); // All queue updates must be visible before the flag can be read!
00436     return _avail->flags.no_irq();
00437   }
00438
00446   bool no_notify_host() const
00447   {
00448     mb(); // All queue updates must be visible before the flag can be read!
00449     return _used->flags.no_notify();
00450   }
00451
00457   void no_notify_host(bool value)
00458   {
00459     _used->flags.no_notify() = value;
00460   }
00461
00470   l4_uint16_t get_avail_idx() const { return _avail->idx; }
00471
00477   l4_uint16_t get_tail_avail_idx() const { return _current_avail; }
00478
00479 };
00480
00481 namespace Driver {
00482
00491 class Virtqueue : public L4virtio::Virtqueue
00492 {
00493 private:
00495   l4_uint16_t _next_free;
00496
00497 public:
00498   enum End_of_queue
00499   {
00500     // Indicates the end of the queue.
00501     Eoq = 0xFFFF
00502   };
00503
00504   Virtqueue() : _next_free(Eoq) {}
00505
00515   void initialize_rings(unsigned num)
00516   {
00517     _used->idx = 0;
00518     _avail->idx = 0;
00519
00520     // setup the freelist
00521     for (l4_uint16_t d = 0; d < num - 1; ++d)
00522       _desc[d].next = d + 1;
00523     _desc[num - 1].next = Eoq;
00524     _next_free = 0;
00525   }
00526
00545   void init_queue(unsigned num, void *desc, void *avail, void *used,
00546                   L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00547   {
00548     setup(num, desc, avail, used, msg_dev);
00549     initialize_rings(num);
00550   }
00551
00563   void init_queue(unsigned num, void *base,
00564                   L4Re::Util::Dbg msg_dev = L4Re::Util::Dbg{2})
00565   {
00566     setup_simple(num, base, msg_dev);
```

```
00567     initialize_rings(num);
00568   }
00569
00570
00585   l4_uint16_t alloc_descriptor()
00586   {
00587     l4_uint16_t idx = _next_free;
00588     if (idx == Eoq)
00589       return Eoq;
00590
00591     _next_free = _desc[idx].next;
00592
00593     return idx;
00594   }
00595
00601   void enqueue_descriptor(l4_uint16_t descno)
00602   {
00603     if (descno > _idx_mask)
00604       throw L4::Bounds_error();
00605
00606     _avail->ring[_avail->idx & _idx_mask] = descno; // _avail->idx expected to wrap
00607     // Make the ring entry visible before publishing the new index, so the
00608     // device never sees an advanced index pointing at a stale entry. Pairs
00609     // with the rmb() on the consuming side.
00610     wmb();
00611     ++_avail->idx;
00612   }
00613
00620   Desc &desc(l4_uint16_t descno)
00621   {
00622     if (descno > _idx_mask)
00623       throw L4::Bounds_error();
00624
00625     return _desc[descno];
00626   }
00627
00639   l4_uint16_t find_next_used(l4_uint32_t *len = nullptr)
00640   {
00641     if (_current_avail == _used->idx)
00642       return Eoq;
00643
00644     // The device writes the used element (id and len) before it advances
00645     // _used->idx. Having observed the new idx above, this barrier ensures
00646     // we read the matching ring entry only afterwards and thus see the
00647     // device's writes, not stale contents. Pairs with the wmb() the device
00648     // side issues before publishing the index.
00649     rmb();
00650     auto elem = _used->ring[_current_avail++ & _idx_mask];
00651
00652     if (len)
00653       *len = elem.len;
00654
00655     return elem.id;
00656   }
00657
00667   void free_descriptor(l4_uint16_t head, l4_uint16_t tail)
00668   {
00669     if (head > _idx_mask || tail > _idx_mask)
00670       throw L4::Bounds_error();
00671
00672     _desc[tail].next = _next_free;
00673     _next_free = head;
00674   }
00675 };
00676
00677 }
00678 } // namespace L4virtio
```

16.287 l4/libedid/edid.h File Reference

```
#include <l4/sys/compiler.h>
```

Include dependency graph for edid.h:



Enumerations

- enum Libedid_consts { Libedid_block_size = 128 }

  EDID constants.

Functions

- int libedid_check_header (const unsigned char *edid)

  Check for valid EDID header.
- int libedid_checksum (const unsigned char *edid)

  Calculates the EDID checksum.
- unsigned libedid_version (const unsigned char *edid)

  Returns the EDID version number.
- unsigned libedid_revision (const unsigned char *edid)

  Returns the EDID revision number.
- void libedid_pnp_id (const unsigned char *edid, unsigned char *id)

  Extracts the display's PnP ID.
- void libedid_prefered_resolution (const unsigned char *edid, unsigned *w, unsigned *h)

  Extract the display's prefered mode.
- unsigned libedid_num_ext_blocks (const unsigned char *edid)

  Get the number of EDID extension blocks.
- unsigned libedid_dump_standard_timings (const unsigned char *edid)

  Dump the standard timings to stdout.
- void libedid_dump (const unsigned char *edid)

  Dump raw EDID data to stdout.

16.288 edid.h

Go to the documentation of this file.

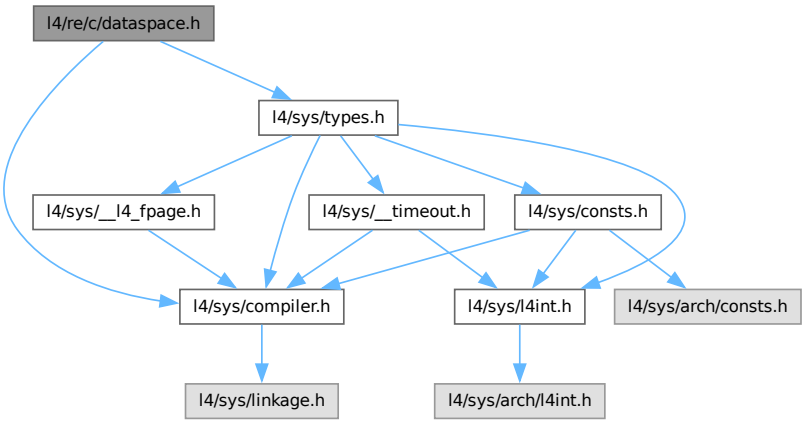
```
00001
00004 /*
00005  * (c) 2014 Matthias Lange <matthias.lange@kernkonzept.com>
00006  *
00007  * This file is part of TUD:OS and distributed under the terms of the
00008  * GNU Lesser General Public License 2.1.
00009  * Please see the COPYING-LGPL-2.1 file for details.
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/compiler.h>
00014
00019
00023 enum Libedid_consts
00024 {
00025   Libedid_block_size = 128,
00026 };
00027
00028 __BEGIN_DECLS
00029
00037 int libedid_check_header(const unsigned char *edid);
00038
00046 int libedid_checksum(const unsigned char *edid);
00047
00055 unsigned libedid_version(const unsigned char *edid);
00056
00064 unsigned libedid_revision(const unsigned char *edid);
00065
00072 void libedid_pnp_id(const unsigned char *edid, unsigned char *id);
00073
00081 void libedid_prefered_resolution(const unsigned char *edid,
00082                                  unsigned *w, unsigned *h);
00083
00091 unsigned libedid_num_ext_blocks(const unsigned char *edid);
00092
00100 unsigned libedid_dump_standard_timings(const unsigned char *edid);
00101
00107 void libedid_dump(const unsigned char *edid);
00108
00110
00111 __END_DECLS
```

16.289 l4/re/c/dataspace.h File Reference

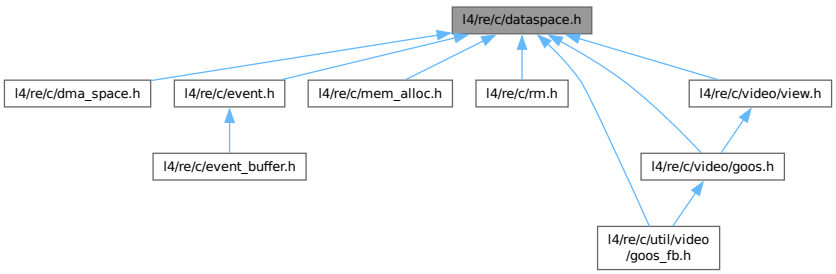
Data space C interface.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
```

Include dependency graph for dataspace.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4re_ds_stats_t

  Information about the data space.

Enumerations

- enum l4re_ds_map_flags { }

  Flags to specify the memory mapping type of a request.

Functions

- l4_ret_t l4re_ds_clear (l4re_ds_t ds, l4re_ds_offset_t offset, l4re_ds_size_t size) L4_NOTHROW

  Clear parts of a dataspace.
- l4_ret_t l4re_ds_allocate (l4re_ds_t ds, l4re_ds_offset_t offset, l4re_ds_size_t size) L4_NOTHROW

  Allocate a range in the dataspace.
- l4_ret_t l4re_ds_copy_in (l4re_ds_t ds, l4re_ds_offset_t dst_offs, l4re_ds_t src, l4re_ds_offset_t src_offs, l4re_ds_size_t size) L4_NOTHROW

  Copy contents from another dataspace.
- l4re_ds_size_t l4re_ds_size (l4re_ds_t ds) L4_NOTHROW

  Get size of a dataspace.
- l4re_ds_flags_t l4re_ds_flags (l4re_ds_t ds) L4_NOTHROW

  Get flags of the dataspace.
- l4_ret_t l4re_ds_info (l4re_ds_t ds, l4re_ds_stats_t *stats) L4_NOTHROW

  Get information on the dataspace.
- l4_ret_t l4re_ds_map_info (l4re_ds_t ds, l4_addr_t *start_addr, l4_addr_t *end_addr) L4_NOTHROW

  Get mapping range of dataspace.

Variables

- L4_BEGIN_DECLS typedef l4_cap_idx_t **l4re_ds_t**

  Dataspace type.

16.289.1 Detailed Description

Data space C interface.
Definition in file dataspace.h.

16.290 dataspace.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00019
00020 #include <l4/sys/compiler.h>
00021 #include <l4/sys/types.h>
00022
00023 L4_BEGIN_DECLS
00024
00029 typedef l4_cap_idx_t l4re_ds_t;
00030 typedef l4_uint64_t l4re_ds_size_t;
00031 typedef l4_uint64_t l4re_ds_offset_t;
00032 typedef l4_uint64_t l4re_ds_map_addr_t;
00033 typedef unsigned long l4re_ds_flags_t;
00034
00039 typedef struct {
00040   l4re_ds_size_t size;
00041   l4re_ds_flags_t flags;
00042 } l4re_ds_stats_t;
00043
00048 enum l4re_ds_map_flags {
00049   L4RE_DS_F_R   = L4_FPAGE_RO,
00050   L4RE_DS_F_W   = L4_FPAGE_W,
00051   L4RE_DS_F_X   = L4_FPAGE_X,
00052   L4RE_DS_F_RW  = L4_FPAGE_RW,
00053   L4RE_DS_F_RX  = L4_FPAGE_RX,
00054   L4RE_DS_F_RWX = L4_FPAGE_RWX,
00055
00056   L4RE_DS_F_RIGHTS_MASK = 0x0f,
00057
00058   L4RE_DS_F_NORMAL        = 0x00,
00059   L4RE_DS_F_CACHEABLE     = L4RE_DS_F_NORMAL,
00060   L4RE_DS_F_BUFFERABLE    = 0x10,
00061   L4RE_DS_F_UNCACHEABLE   = 0x20,
00062   L4RE_DS_F_CACHING_MASK  = 0x30,
00063   L4RE_DS_F_CACHING_SHIFT = 4,
00064 };
00065
00071 L4_CV l4_ret_t
00072 l4re_ds_map(l4re_ds_t ds,
00073             l4re_ds_offset_t offset,
00074             l4re_ds_flags_t flags,
00075             l4re_ds_map_addr_t local_addr,
00076             l4re_ds_map_addr_t min_addr,
00077             l4re_ds_map_addr_t max_addr) L4_NOTHROW;
00078
00084 L4_CV l4_ret_t
00085 l4re_ds_map_region(l4re_ds_t ds,
00086                    l4re_ds_offset_t offset,
00087                    l4re_ds_flags_t flags,
00088                    l4re_ds_map_addr_t min_addr,
00089                    l4re_ds_map_addr_t max_addr) L4_NOTHROW;
00090
00097 L4_CV l4_ret_t
00098 l4re_ds_clear(l4re_ds_t ds, l4re_ds_offset_t offset,
00099               l4re_ds_size_t size) L4_NOTHROW;
00100
00107 L4_CV l4_ret_t
00108 l4re_ds_allocate(l4re_ds_t ds,
00109                  l4re_ds_offset_t offset,
00110                  l4re_ds_size_t size) L4_NOTHROW;
00111
00118 L4_CV l4_ret_t
00119 l4re_ds_copy_in(l4re_ds_t ds, l4re_ds_offset_t dst_offs,
00120                 l4re_ds_t src, l4re_ds_offset_t src_offs,
00121                 l4re_ds_size_t size) L4_NOTHROW;
00122
00129 L4_CV l4re_ds_size_t
00130 l4re_ds_size(l4re_ds_t ds) L4_NOTHROW;
00131
00138 L4_CV l4re_ds_flags_t
00139 l4re_ds_flags(l4re_ds_t ds) L4_NOTHROW;
00140
00147 L4_CV l4_ret_t
00148 l4re_ds_info(l4re_ds_t ds, l4re_ds_stats_t *stats) L4_NOTHROW;
00149
```

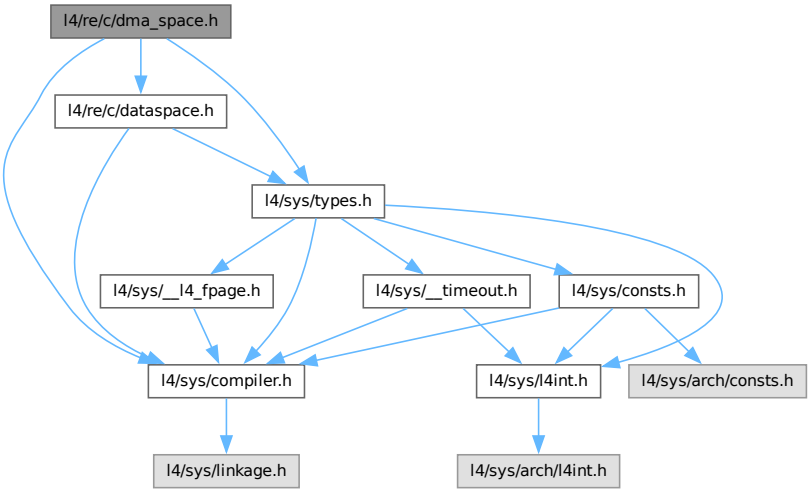
```
00156 L4_CV l4_ret_t
00157 l4re_ds_map_info(l4re_ds_t ds,
00158                  l4_addr_t *start_addr, l4_addr_t *end_addr) L4_NOTHROW;
00159
00160 L4_END_DECLS
```

16.291 l4/re/c/dma_space.h File Reference

DMA space C interface.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/re/c/dataspace.h>
```

Include dependency graph for dma_space.h:



Typedefs

- typedef l4_cap_idx_t l4re_dma_space_t

  DMA space capability type.
- typedef l4_cap_idx_t l4re_dma_space_mgr_t

  DMA space manager capability type.
- typedef l4_uint64_t **l4re_dma_space_dma_addr_t**

  Data type for DMA addresses.
- typedef l4_uint64_t **l4re_dma_space_dma_size_t**

  Data type for DMA sizes.

Enumerations

- enum l4re_dma_space_direction { L4RE_DMA_SPACE_BIDIRECTIONAL , L4RE_DMA_SPACE_TO_DEVICE , L4RE_DMA_SPACE_FROM_DEVICE , L4RE_DMA_SPACE_NONE }

  Direction of the DMA transfers.
- enum l4re_dma_space_attributes { L4RE_DMA_SPACE_SEARCH_ADDR = 1U << 0 , L4RE_DMA_SPACE_PARTIAL_MAP = 1U << 1 , L4RE_DMA_SPACE_RESERVE = 1U << 2 , L4RE_DMA_SPACE_REPLACE = 1U << 3 }

  Attributes used for the memory region.
- enum l4re_dma_space_mgr_space_attribs { L4RE_DMA_SPACE_MGR_IDENTITY_MAP = 1U << 0 }

  Attributes assigned to the DMA space when associated with a specific device.
- enum l4re_dma_space_mgr_block_flags { L4RE_DMA_SPACE_MGR_SEARCH_ADDR = 1U << 0 }

  Attributes used when blocking an area.

Functions

- l4_ret_t l4re_dma_space_map (l4re_dma_space_t dma, l4re_ds_t src, l4re_ds_offset_t offset, l4_size_t *size, unsigned long attrs, enum l4re_dma_space_direction dir, l4re_dma_space_dma_addr_t *dma_addr) L4_NOTHROW

  Map the given part of this data space into the DMA address space.
- l4_ret_t l4re_dma_space_unmap (l4re_dma_space_t dma, l4re_dma_space_dma_addr_t dma_addr, l4_size_t size, unsigned long attrs, enum l4re_dma_space_direction dir) L4_NOTHROW

  Unmap the given part of this data space from the DMA address space.
- l4_ret_t l4re_dma_space_mgr_associate (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, l4_cap_idx_t dma_task, enum l4re_dma_space_mgr_space_attribs attr) L4_NOTHROW

  Associate a (kernel) DMA space for a device to a Dma_space.
- l4_ret_t l4re_dma_space_mgr_associate_phys (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, enum l4re_dma_space_mgr_space_attribs attr) L4_NOTHROW

  Register a Dma_space to use for DMA.
- l4_ret_t l4re_dma_space_mgr_disassociate (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space) L4_NOTHROW
- l4_ret_t l4re_dma_space_mgr_block_area (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, l4re_dma_space_dma_addr_t *addr, l4re_dma_space_dma_size_t size, l4re_dma_space_dma_addr_t max_addr, enum l4re_dma_space_mgr_block_flags flags, unsigned char align) L4_NOTHROW
- l4_ret_t l4re_dma_space_mgr_set_limits (l4re_dma_space_mgr_t dma_mgr, l4re_dma_space_t dma_space, l4re_dma_space_dma_addr_t min_addr, l4re_dma_space_dma_addr_t max_addr) L4_NOTHROW

16.291.1 Detailed Description

DMA space C interface.
Definition in file dma_space.h.

16.291.2 Enumeration Type Documentation

16.291.2.1 l4re_dma_space_attributes

`enum l4re_dma_space_attributes`
Attributes used for the memory region.

See also

Attributes

Enumerator

L4RE_DMA_SPACE_SEARCH_ADDR	Search for suitable address. A spot for the whole mapping is searched, starting from the passed start address. Without this flag, the start address is taken literally. Can be combined with Attribute::Partial_map. If no address remapping is possible (i.e., the Dma_space was associated by Dma_space_mgr::associate_phys()), the flag has no effect. The Dma_space::map() call will always return the physical address.
L4RE_DMA_SPACE_PARTIAL_MAP	Truncate mapping if it does not fit. If there is not enough room after the chosen start address, truncate the mapping instead of failing.

L4RE_DMA_SPACE_RESERVE	Reserve a region instead of mapping pages. If set, the dataspace argument of Dma_space::map() is ignored. Use the Attribute::Replace flag to place dataspace mappings in a reserved region later. The reservation is released with Dma_space::unmap() carrying Unmap↩ _flag::Cancel_reservation. If no address remapping is possible (i.e., the Dma_space was associated by Dma_space_mgr::associate_phys()), Dma_space::map() will always fail with -L4_EPERM if this flag is present.
L4RE_DMA_SPACE_REPLACE	Replace mappings. The pages in the map region are replaced with mappings from the dataspace. Without this flag, existing mappings cause Dma_space::map() to fail. Areas previously claimed by Dma↩ _space_mgr::block_area() are never replaced and still cause Dma↩ _space::map() to fail. If combined with Attribute::Reserve, no dataspace mapping is established. Instead, the reservation reference count is increased. Only after the matching number of Dma_space::unmap(Cancel_reservation) calls, the reservation is released. If no address remapping is possible (i.e., the Dma_space was associated by Dma_space_mgr::associate_phys()), the flag has no effect. The Dma_space::map() call will always return the physical address. Cannot be combined with Attribute::Search_addr or Attribute::↩ Partial_map.

Definition at line 38 of file dma_space.h.

16.291.2.2 l4re_dma_space_direction

enum l4re_dma_space_direction
Direction of the DMA transfers.

Deprecated Ignored by the API. Use function overloads without the direction parameter instead.

Enumerator

L4RE_DMA_SPACE_BIDIRECTIONAL	device reads and writes to the memory
L4RE_DMA_SPACE_TO_DEVICE	device reads the memory
L4RE_DMA_SPACE_FROM_DEVICE	device writes to the memory
L4RE_DMA_SPACE_NONE	device is coherently connected

Definition at line 27 of file dma_space.h.

16.291.2.3 l4re_dma_space_mgr_block_flags

enum l4re_dma_space_mgr_block_flags
Attributes used when blocking an area.

See also

Block_flags

Enumerator

L4RE_DMA_SPACE_MGR_SEARCH_ADDR	Search suitable address. With this flag, the start address is taken as a lower bound. Without the flag, `start` and `size` are taken literally.

Definition at line 58 of file dma_space.h.

16.291.2.4 l4re_dma_space_mgr_space_attribs

`enum l4re_dma_space_mgr_space_attribs`
Attributes assigned to the DMA space when associated with a specific device.

See also

Space_attribs

Enumerator

L4RE_DMA_SPACE_MGR_IDENTITY_MAP	Request identity mappings. This is needed if some devices are not connected to an IOMMU and need physical addresses.

Definition at line 49 of file dma_space.h.

16.292 dma_space.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #pragma once
00011
00017
00018 #include <l4/sys/compiler.h>
00019 #include <l4/sys/types.h>
00020 #include <l4/re/c/dataspace.h>
00021
00022 L4_BEGIN_DECLS
00023
00027 enum l4re_dma_space_direction
00028 {
00029   L4RE_DMA_SPACE_BIDIRECTIONAL,
00030   L4RE_DMA_SPACE_TO_DEVICE,
00031   L4RE_DMA_SPACE_FROM_DEVICE,
00032   L4RE_DMA_SPACE_NONE
00033 };
00034
00038 enum l4re_dma_space_attributes
00039 {
00040   L4RE_DMA_SPACE_SEARCH_ADDR = 1U << 0,
00041   L4RE_DMA_SPACE_PARTIAL_MAP = 1U << 1,
00042   L4RE_DMA_SPACE_RESERVE     = 1U << 2,
00043   L4RE_DMA_SPACE_REPLACE     = 1U << 3,
00044 };
00045
00049 enum l4re_dma_space_mgr_space_attribs
00050 {
00052   L4RE_DMA_SPACE_MGR_IDENTITY_MAP = 1U << 0,
00053 };
00054
00058 enum l4re_dma_space_mgr_block_flags
00059 {
00061   L4RE_DMA_SPACE_MGR_SEARCH_ADDR = 1U << 0,
00062 };
00063
00069 typedef l4_cap_idx_t l4re_dma_space_t;
00070
00076 typedef l4_cap_idx_t l4re_dma_space_mgr_t;
00077
00079 typedef l4_uint64_t l4re_dma_space_dma_addr_t;
00080
```

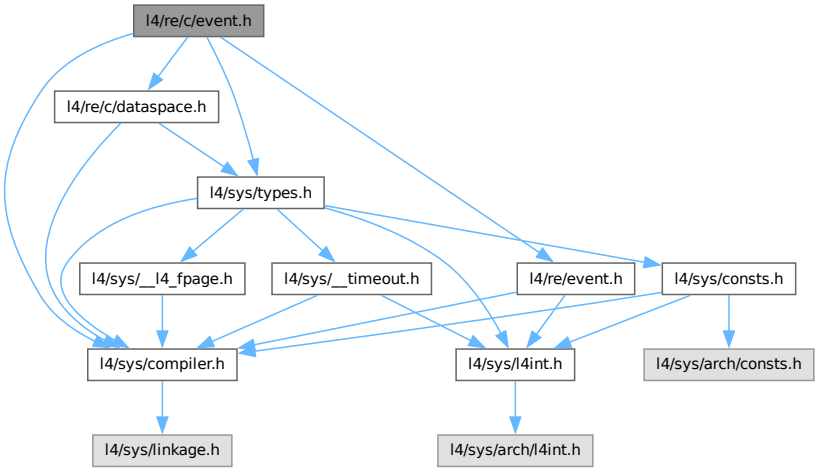
```
00082 typedef l4_uint64_t l4re_dma_space_dma_size_t;
00083
00090 L4_CV l4_ret_t
00091 l4re_dma_space_map(l4re_dma_space_t dma, l4re_ds_t src,
00092                    l4re_ds_offset_t offset,
00093                    l4_size_t * size, unsigned long attrs,
00094                    enum l4re_dma_space_direction dir,
00095                    l4re_dma_space_dma_addr_t *dma_addr) L4_NOTHROW;
00096
00097
00104 L4_CV l4_ret_t
00105 l4re_dma_space_unmap(l4re_dma_space_t dma, l4re_dma_space_dma_addr_t dma_addr,
00106                      l4_size_t size, unsigned long attrs,
00107                      enum l4re_dma_space_direction dir) L4_NOTHROW;
00108
00109
00116 L4_CV l4_ret_t
00117 l4re_dma_space_mgr_associate(l4re_dma_space_mgr_t dma_mgr,
00118                              l4re_dma_space_t dma_space,
00119                              l4_cap_idx_t dma_task,
00120                              enum l4re_dma_space_mgr_space_attribs attr) L4_NOTHROW;
00121
00128 L4_CV l4_ret_t
00129 l4re_dma_space_mgr_associate_phys(l4re_dma_space_mgr_t dma_mgr,
00130                                   l4re_dma_space_t dma_space,
00131                                   enum l4re_dma_space_mgr_space_attribs attr) L4_NOTHROW;
00132
00138 L4_CV l4_ret_t
00139 l4re_dma_space_mgr_disassociate(l4re_dma_space_mgr_t dma_mgr,
00140                                 l4re_dma_space_t dma_space) L4_NOTHROW;
00141
00147 L4_CV l4_ret_t
00148 l4re_dma_space_mgr_block_area(l4re_dma_space_mgr_t dma_mgr,
00149                               l4re_dma_space_t dma_space,
00150                               l4re_dma_space_dma_addr_t *addr,
00151                               l4re_dma_space_dma_size_t size,
00152                               l4re_dma_space_dma_addr_t max_addr,
00153                               enum l4re_dma_space_mgr_block_flags flags,
00154                               unsigned char align) L4_NOTHROW;
00155
00161 L4_CV l4_ret_t
00162 l4re_dma_space_mgr_set_limits(l4re_dma_space_mgr_t dma_mgr,
00163                               l4re_dma_space_t dma_space,
00164                               l4re_dma_space_dma_addr_t min_addr,
00165                               l4re_dma_space_dma_addr_t max_addr) L4_NOTHROW;
00166
00167 L4_END_DECLS
```

16.293 l4/re/c/event.h File Reference

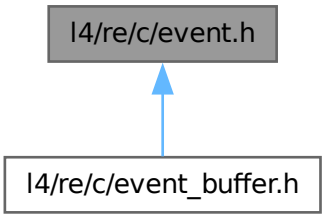
Event C interface.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/re/c/dataspace.h>
#include <l4/re/event.h>
```

Include dependency graph for event.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4re_event_t

  Event structure used in buffer.

Functions

- l4_ret_t l4re_event_get_buffer (const l4_cap_idx_t server, const l4re_ds_t ds) L4_NOTHROW

  Get an event signal buffer.
- l4_ret_t l4re_event_get_num_streams (const l4_cap_idx_t server) L4_NOTHROW

  Get number of streams.
- l4_ret_t l4re_event_get_stream_info (const l4_cap_idx_t server, int idx, l4re_event_stream_info_t *info) L4_NOTHROW

  Get information on a stream.
- l4_ret_t l4re_event_get_stream_info_for_id (const l4_cap_idx_t server, l4_umword_t stream_id, l4re_event_stream_info_t *info) L4_NOTHROW

  Get info for a stream given a stream id.

- l4_ret_t l4re_event_get_axis_info (const l4_cap_idx_t server, l4_umword_t id, unsigned naxes, unsigned const *axis, l4re_event_absinfo_t *info) L4_NOTHROW

  Get Axis information for a stream.

16.293.1 Detailed Description

Event C interface.
Definition in file event.h.

16.294 event.h

Go to the documentation of this file.

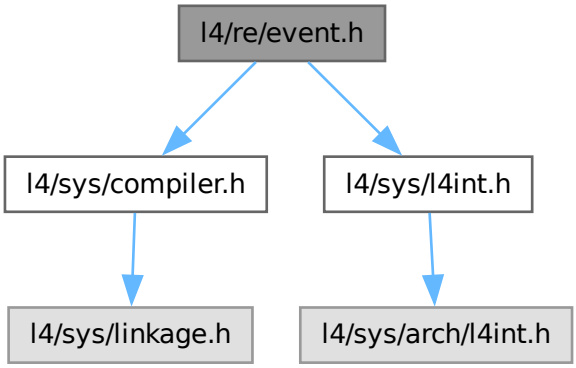
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00019
00020 #include <l4/sys/compiler.h>
00021 #include <l4/sys/types.h>
00022 #include <l4/re/c/dataspace.h>
00023 #include <l4/re/event.h>
00024
00025 L4_BEGIN_DECLS
00026
00030 typedef struct
00031 {
00032   long long time;
00033   unsigned short type;
00034   unsigned short code;
00035   int value;
00036   l4_umword_t stream_id;
00037 } l4re_event_t;
00038
00050 L4_CV l4_ret_t
00051 l4re_event_get_buffer(const l4_cap_idx_t server,
00052                       const l4re_ds_t ds) L4_NOTHROW;
00053
00064 L4_CV l4_ret_t
00065 l4re_event_get_num_streams(const l4_cap_idx_t server) L4_NOTHROW;
00066
00079 L4_CV l4_ret_t
00080 l4re_event_get_stream_info(const l4_cap_idx_t server,
00081                            int idx, l4re_event_stream_info_t *info) L4_NOTHROW;
00082
00095 L4_CV l4_ret_t
00096 l4re_event_get_stream_info_for_id(const l4_cap_idx_t server,
00097                                   l4_umword_t stream_id,
00098                                   l4re_event_stream_info_t *info) L4_NOTHROW;
00099
00115 L4_CV l4_ret_t
00116 l4re_event_get_axis_info(const l4_cap_idx_t server, l4_umword_t id,
00117                          unsigned naxes, unsigned const *axis,
00118                          l4re_event_absinfo_t *info) L4_NOTHROW;
00119
00120 L4_END_DECLS
```

16.295 l4/re/event.h File Reference

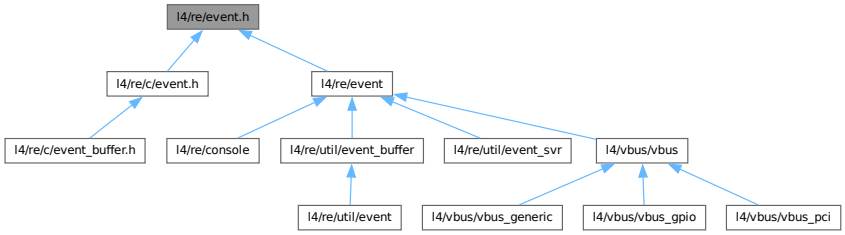
Events.

```
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
```

Include dependency graph for event.h:



This graph shows which files directly or indirectly include this file:



16.295.1 Detailed Description

Events.
Definition in file event.h.

16.296 event.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/compiler.h>
00014 #include <l4/sys/l4int.h>
00015
00016 typedef struct L4_EXPORT_TYPE l4re_event_stream_id_t
00017 {
00018   l4_uint16_t bustype;
00019   l4_uint16_t vendor;
00020   l4_uint16_t product;
00021   l4_uint16_t version;
00022 } l4re_event_stream_id_t;
00023
```

```
00024 typedef struct L4_EXPORT_TYPE l4re_event_absinfo_t
00025 {
00026   l4_int32_t value;
00027   l4_int32_t min;
00028   l4_int32_t max;
00029   l4_int32_t fuzz;
00030   l4_int32_t flat;
00031   l4_int32_t resolution;
00032 } l4re_event_absinfo_t;
00033
00034 enum l4re_event_stream_max_values_t
00035 {
00036   L4RE_EVENT_EV_MAX  = 0x1f,
00037   L4RE_EVENT_KEY_MAX = 0x1ff,
00038   L4RE_EVENT_REL_MAX = 0xf,
00039   L4RE_EVENT_ABS_MAX = 0x3f,
00040   L4RE_EVENT_PROP_MAX = 0x1f,
00041   L4RE_EVENT_SW_MAX   = 0xf, // should be >= L4RE_SW_MAX
00042 };
00043
00044 enum l4re_event_stream_props_t
00045 {
00046   L4RE_EVENT_STREAM_CALIBRATE = 0x001,
00047 };
00048
00049
00050 #define __UNUM_B(x) ((x+1) + sizeof(unsigned long)*8 - 1) / (sizeof(unsigned long)*8)
00051
00052 typedef struct L4_EXPORT_TYPE l4re_event_stream_info_t
00053 {
00054   l4_umword_t stream_id;
00055   char name[32];
00056   char phys[32];
00057   l4re_event_stream_id_t id;
00058
00059   unsigned long propbits[__UNUM_B(L4RE_EVENT_PROP_MAX)];
00060
00061   unsigned long evbits[__UNUM_B(L4RE_EVENT_EV_MAX)];
00062   unsigned long keybits[__UNUM_B(L4RE_EVENT_KEY_MAX)];
00063   unsigned long relbits[__UNUM_B(L4RE_EVENT_REL_MAX)];
00064   unsigned long absbits[__UNUM_B(L4RE_EVENT_ABS_MAX)];
00065   unsigned long swbits[__UNUM_B(L4RE_EVENT_SW_MAX)];
00066
00067 } l4re_event_stream_info_t;
00068
00069 typedef struct L4_EXPORT_TYPE l4re_event_stream_state_t
00070 {
00071   unsigned long keybits[__UNUM_B(L4RE_EVENT_KEY_MAX)];
00072   unsigned long swbits[__UNUM_B(L4RE_EVENT_SW_MAX)];
00073 } l4re_event_stream_state_t;
00074
00075 #undef __UNUM_B
00076
```

16.297 event_buffer.h

```
00001 #pragma once
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #include <l4/sys/compiler.h>
00010 #include <l4/sys/linkage.h>
00011 #include <l4/re/c/event.h>
00012
00013 L4_BEGIN_DECLS
00014
00015 typedef struct l4re_event_buffer_consumer_t
00016 {
00017   unsigned long _obj_buf[8];
00018 } l4re_event_buffer_consumer_t;
00019
00020 L4_CV void
00021 l4re_event_free(l4re_event_t *e) L4_NOTHROW;
00022
00023 L4_CV l4_ret_t
00024 l4re_event_buffer_attach(l4re_event_buffer_consumer_t *evbuf,
00025                          l4re_ds_t ds, l4_cap_idx_t rm) L4_NOTHROW;
00026
00027 L4_CV l4_ret_t
00028 l4re_event_buffer_detach(l4re_event_buffer_consumer_t *evbuf,
```

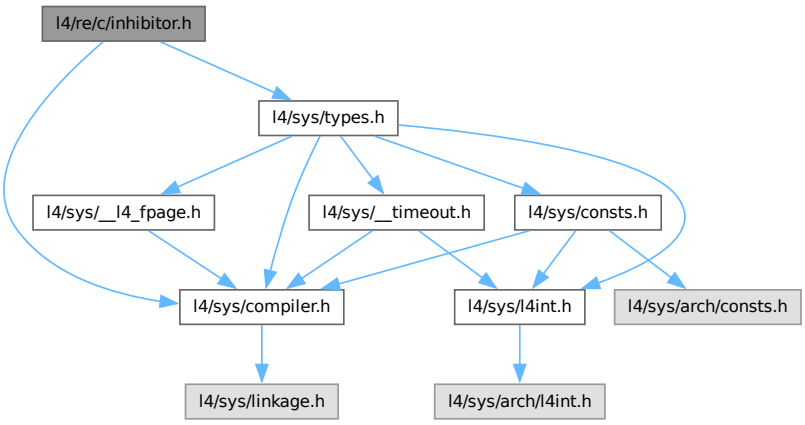
```
00029                           l4_cap_idx_t rm) L4_NOTHROW;
00030
00031 L4_CV l4re_event_t *
00032 l4re_event_buffer_next(l4re_event_buffer_consumer_t *evbuf) L4_NOTHROW;
00033
00034 typedef L4_CV void l4re_event_buffer_cb_t(l4re_event_t *ev, void *data);
00035
00036 L4_CV void
00037 l4re_event_buffer_consumer_foreach_available_event(l4re_event_buffer_consumer_t *evbuf,
00038     void *data, l4re_event_buffer_cb_t *cb);
00039
00040
00041 L4_CV void
00042 l4re_event_buffer_consumer_process(l4re_event_buffer_consumer_t *evbuf,
00043                                    l4_cap_idx_t irq, l4_cap_idx_t thread, void *data,
00044                                    l4re_event_buffer_cb_t *cb);
00045
00046 L4_END_DECLS
```

16.298 l4/re/c/inhibitor.h File Reference

Inhibitor C interface.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
```

Include dependency graph for inhibitor.h:



Functions

- L4_BEGIN_DECLS l4_ret_t l4re_inhibitor_acquire (l4_cap_idx_t cap, l4_umword_t id, char const *reason)

  Acquire an inhibitor lock.
- l4_ret_t l4re_inhibitor_release (l4_cap_idx_t cap, l4_umword_t id)

  Release an inhibitor lock.
- l4_ret_t l4re_inhibitor_next_lock_info (l4_cap_idx_t cap, char *name, unsigned len, l4_mword_t current_id)

  Get information for the next available inhibitor lock.

16.298.1 Detailed Description

Inhibitor C interface.
Definition in file inhibitor.h.

16.298.2 Function Documentation

16.298.2.1 l4re_inhibitor_acquire()

```
L4_BEGIN_DECLS l4_ret_t l4re_inhibitor_acquire (
             l4_cap_idx_t cap,
             l4_umword_t id,
             char const * reason)
```

Acquire an inhibitor lock.

Parameters

cap	Capability for the Inhibitor object (see L4Re::Inhibitor)
id	ID of the inhibitor lock that shall be acquired.
reason	Reason why the inhibitor lock is acquired. (Used for informing the user or debugging.)

Returns

0 for success, <0 on error.

See also

L4Re::Inhibitor::acquire().

References L4_CV, and L4_EXPORT.

16.298.2.2 l4re_inhibitor_next_lock_info()

```
l4_ret_t l4re_inhibitor_next_lock_info (
             l4_cap_idx_t cap,
             char * name,
             unsigned len,
             l4_mword_t current_id)
```

Get information for the next available inhibitor lock.

Parameters

cap	Capability to the Inhibitor object (see L4Re::Inhibitor)
name	A pointer to a buffer for the name of the lock.
len	The length of the available buffer (usually L4Re::Inhibitor::Name_max is used).
current_id	The ID of the last available lock, use -1 to get the first lock.

Return values

>0	The ID of the next available lock if there is one (in this case name shall contain the name of the inhibitor lock).
-L4_ENODEV	if there are no more locks.
<0	Any other negative failure value.

See also

L4Re::Inhibitor::next_lock_info().

References L4_END_DECLS.

16.298.2.3 l4re_inhibitor_release()

```
l4_ret_t l4re_inhibitor_release (
             l4_cap_idx_t cap,
             l4_umword_t id)
```

Release an inhibitor lock.

Parameters

cap	Capability for the Inhibitor object (see L4Re::Inhibitor).
id	ID of inhibitor that shall be released.

Returns

0 for success, <0 on error.

See also

L4Re::Inhibitor::release().

References L4_CV, and L4_EXPORT.

16.299 inhibitor.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2014 Steffen Liebergeld <steffen.liebergeld@kernkonzept.com>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
00013 #include <l4/sys/compiler.h>
00014 #include <l4/sys/types.h>
00015
00016 L4_BEGIN_DECLS
00017
00028 L4_CV l4_ret_t L4_EXPORT
00029 l4re_inhibitor_acquire(l4_cap_idx_t cap, l4_umword_t id,
00030                        char const *reason);
00031
00039 L4_CV l4_ret_t L4_EXPORT
00040 l4re_inhibitor_release(l4_cap_idx_t cap, l4_umword_t id);
00041
00057 L4_CV l4_ret_t L4_EXPORT
00058 l4re_inhibitor_next_lock_info(l4_cap_idx_t cap, char *name,
00059                               unsigned len, l4_mword_t current_id);
00060
00061 L4_END_DECLS
00062
```

16.300 itas.h

```
00001 /*
00002  * (c) 2026 Adam Lackorzynski <adam@l4re.org>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
00008 #include <l4/sys/compiler.h>
00009 #include <l4/re/env.h>
00010
00011 L4_BEGIN_DECLS
00012
00017 L4_CV int
00018 l4re_itas_disable_pf_tramp_srv(l4_cap_idx_t rm) L4_NOTHROW;
00019
00020 L4_CV L4_INLINE int
00021 l4re_itas_disable_pf_tramp(void) L4_NOTHROW
```

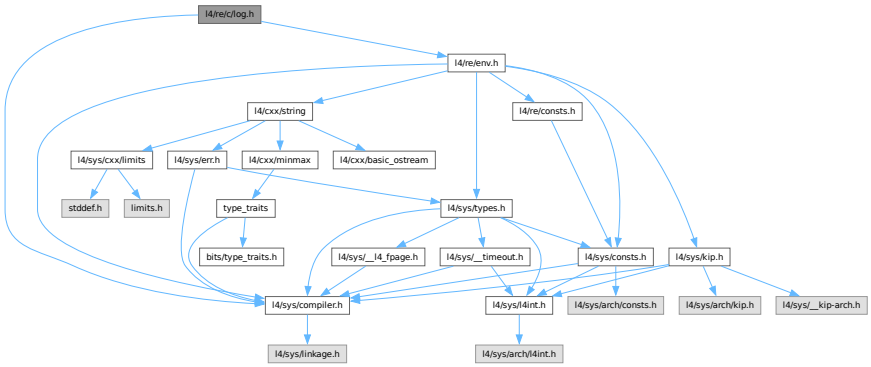
```
00022 {
00023   return l4re_itas_disable_pf_tramp_srv(l4re_global_env->itas);
00024 }
00025
00026 L4_END_DECLS
```

16.301 l4/re/c/log.h File Reference

Log C interface.

```
#include <l4/re/env.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for log.h:



Functions

- L4_BEGIN_DECLS void l4re_log_print (char const ∗string) L4_NOTHROW

  Write a null terminated string to the default log.
- void l4re_log_printn (char const ∗string, int len) L4_NOTHROW

  Write a string of a given length to the default log.
- void l4re_log_print_srv (const l4_cap_idx_t logcap, char const ∗string) L4_NOTHROW

  Write a null terminated string to a log.
- void l4re_log_printn_srv (const l4_cap_idx_t logcap, char const ∗string, int len) L4_NOTHROW

  Write a string of a given length to a log.

16.301.1 Detailed Description

Log C interface.
Definition in file log.h.

16.302 log.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00018
00019 #include <l4/re/env.h>
00020 #include <l4/sys/compiler.h>
00021
00022 L4_BEGIN_DECLS
```

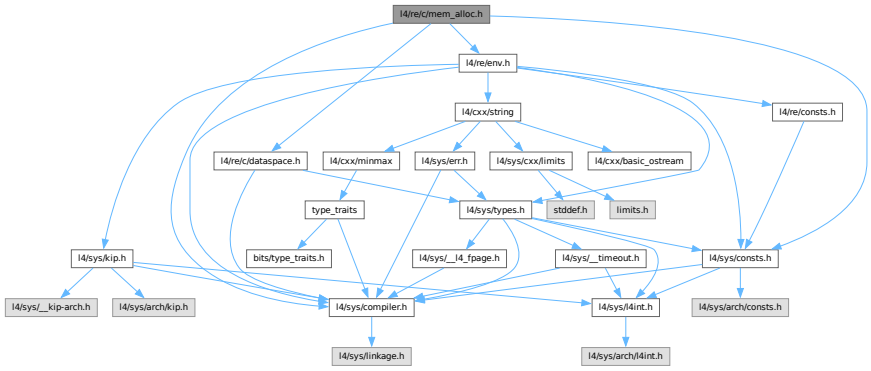
```
00023
00032 L4_CV L4_INLINE void
00033 l4re_log_print(char const *string) L4_NOTHROW;
00034
00044 L4_CV L4_INLINE void
00045 l4re_log_printn(char const *string, int len) L4_NOTHROW;
00046
00047
00048
00049
00059 L4_CV void
00060 l4re_log_print_srv(const l4_cap_idx_t logcap,
00061                    char const *string) L4_NOTHROW;
00062
00073 L4_CV void
00074 l4re_log_printn_srv(const l4_cap_idx_t logcap,
00075                     char const *string, int len) L4_NOTHROW;
00076
00077
00078 /********** Implementations ************************/
00079
00080 L4_CV L4_INLINE void
00081 l4re_log_print(char const *string) L4_NOTHROW
00082 {
00083   l4re_log_print_srv(l4re_global_env->log, string);
00084 }
00085
00086 L4_CV L4_INLINE void
00087 l4re_log_printn(char const *string, int len) L4_NOTHROW
00088 {
00089   l4re_log_printn_srv(l4re_global_env->log, string, len);
00090 }
00091
00092 L4_END_DECLS
```

16.303 l4/re/c/mem_alloc.h File Reference

Memory allocator C interface.

```
#include <l4/re/env.h>
#include <l4/sys/compiler.h>
#include <l4/sys/consts.h>
#include <l4/re/c/dataspace.h>
```

Include dependency graph for mem_alloc.h:



Enumerations

- enum l4re_ma_flags

  Flags for requesting memory at the memory allocator.

Functions

- l4_ret_t l4re_ma_alloc (long size, l4re_ds_t const mem, unsigned long flags) L4_NOTHROW

  Allocate memory.

- l4_ret_t l4re_ma_alloc_align (long size, l4re_ds_t const mem, unsigned long flags, unsigned long align) L4_NOTHROW

  Allocate memory.
- l4_ret_t l4re_ma_alloc_align_srv (l4_cap_idx_t srv, long size, l4re_ds_t const mem, unsigned long flags, unsigned long align) L4_NOTHROW

  Allocate memory.

16.303.1 Detailed Description

Memory allocator C interface.
Definition in file mem_alloc.h.

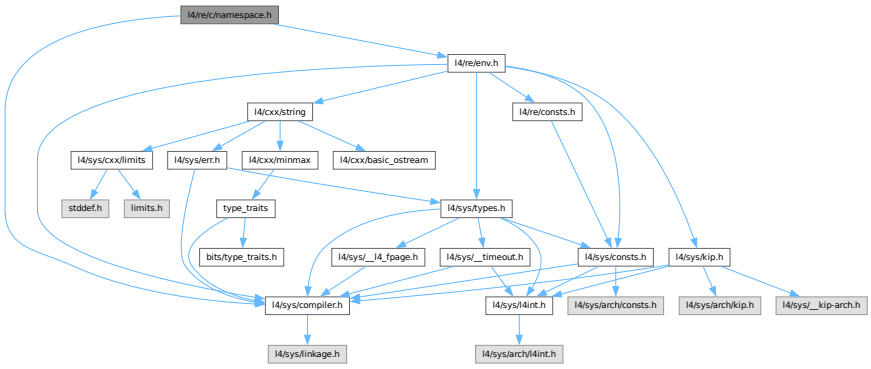
16.304 mem_alloc.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/re/env.h>
00014 #include <l4/sys/compiler.h>
00015 #include <l4/sys/consts.h>
00016
00017 #include <l4/re/c/dataspace.h>
00018
00024
00025 L4_BEGIN_DECLS
00026
00032 enum l4re_ma_flags {
00033   L4RE_MA_CONTINUOUS  = 0x01,
00034   L4RE_MA_PINNED      = 0x02,
00035   L4RE_MA_SUPER_PAGES = 0x04,
00036 };
00037
00038
00069 L4_CV L4_INLINE l4_ret_t
00070 l4re_ma_alloc(long size, l4re_ds_t const mem,
00071               unsigned long flags) L4_NOTHROW;
00072
00106 L4_CV L4_INLINE l4_ret_t
00107 l4re_ma_alloc_align(long size, l4re_ds_t const mem,
00108                     unsigned long flags, unsigned long align) L4_NOTHROW;
00109
00128 L4_CV l4_ret_t
00129 l4re_ma_alloc_align_srv(l4_cap_idx_t srv, long size,
00130                         l4re_ds_t const mem, unsigned long flags,
00131                         unsigned long align) L4_NOTHROW;
00132
00133 /***************** Implementation *****************/
00134
00135 L4_CV L4_INLINE l4_ret_t
00136 l4re_ma_alloc(long size, l4re_ds_t const mem,
00137               unsigned long flags) L4_NOTHROW
00138 {
00139   return l4re_ma_alloc_align_srv(l4re_global_env->mem_alloc, size, mem,
00140                                  flags, 0);
00141 }
00142
00143 L4_CV L4_INLINE l4_ret_t
00144 l4re_ma_alloc_align(long size, l4re_ds_t const mem,
00145                     unsigned long flags, unsigned long align) L4_NOTHROW
00146 {
00147   return l4re_ma_alloc_align_srv(l4re_global_env->mem_alloc, size, mem,
00148                                  flags, align);
00149 }
00150
00151 L4_END_DECLS
```

16.305 l4/re/c/namespace.h File Reference

Namespace functions, C interface.
`#include <l4/re/env.h>`
`#include <l4/sys/compiler.h>`
Include dependency graph for namespace.h:



Enumerations

- enum l4re_ns_register_flags

  Namespace register flags.

Functions

- l4_ret_t l4re_ns_query_to_srv (l4re_namespace_t srv, char const ∗name, l4_cap_idx_t const cap, int timeout) L4_NOTHROW

  Query the name space for the object named by `name`.
- l4_ret_t l4re_ns_query_srv (l4re_namespace_t srv, char const ∗name, l4_cap_idx_t const cap) L4_NOTHROW

  Query the name space for the object named by `name`.
- l4_ret_t l4re_ns_register_obj_srv (l4re_namespace_t srv, char const ∗name, l4_cap_idx_t const obj, unsigned flags) L4_NOTHROW

  Register an object with a name.

Variables

- L4_BEGIN_DECLS typedef l4_cap_idx_t **l4re_namespace_t**

  Namespace type.

16.305.1 Detailed Description

Namespace functions, C interface.
Definition in file namespace.h.

16.306 namespace.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
```

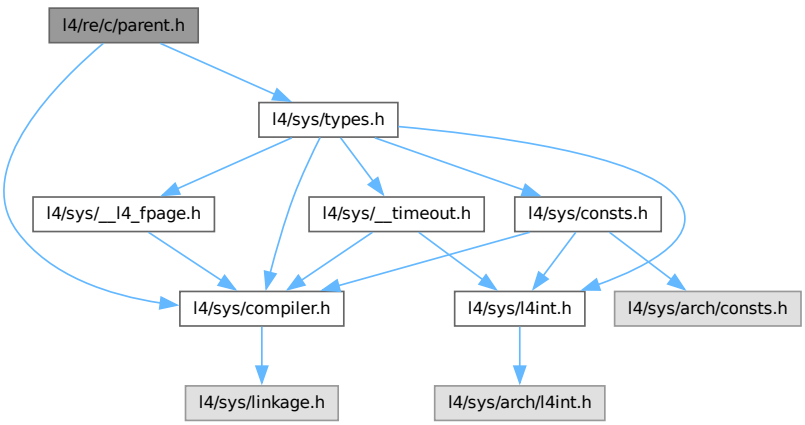
```
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00019
00020 #include <l4/re/env.h>
00021 #include <l4/sys/compiler.h>
00022
00029 enum l4re_ns_register_flags {
00030   L4RE_NS_REGISTER_RO  = L4_FPAGE_RO,
00031   L4RE_NS_REGISTER_DIR = 0x10,
00032   L4RE_NS_REGISTER_RW  = L4_FPAGE_RX,
00033   L4RE_NS_REGISTER_RWS = L4_FPAGE_RWX,
00034   L4RE_NS_REGISTER_S   = L4_FPAGE_W,
00035 };
00036
00037 L4_BEGIN_DECLS
00038
00043 typedef l4_cap_idx_t l4re_namespace_t;
00044
00045
00046
00055 L4_CV l4_ret_t
00056 l4re_ns_query_to_srv(l4re_namespace_t srv, char const *name,
00057                      l4_cap_idx_t const cap, int timeout) L4_NOTHROW;
00058
00075 L4_CV L4_INLINE l4_ret_t
00076 l4re_ns_query_srv(l4re_namespace_t srv, char const *name,
00077                   l4_cap_idx_t const cap) L4_NOTHROW;
00078
00086 L4_CV l4_ret_t
00087 l4re_ns_register_obj_srv(l4re_namespace_t srv, char const *name,
00088                          l4_cap_idx_t const obj, unsigned flags) L4_NOTHROW;
00089
00090
00091
00092 /****** Implementation ***********/
00093
00094 L4_CV L4_INLINE l4_ret_t
00095 l4re_ns_query_srv(l4re_namespace_t srv, char const *name,
00096                   l4_cap_idx_t const cap) L4_NOTHROW
00097 {
00098   return l4re_ns_query_to_srv(srv, name, cap, 40000);
00099 }
00100
00101
00102 L4_END_DECLS
```

16.307 l4/re/c/parent.h File Reference

Parent C interface.

`#include <l4/sys/compiler.h>`
`#include <l4/sys/types.h>`

Include dependency graph for parent.h:



Functions

- L4_BEGIN_DECLS long l4re_parent_signal (l4_cap_idx_t parent, unsigned long sig, unsigned long val)

  Send a signal using the parent protocol.

16.307.1 Detailed Description

Parent C interface.
Definition in file parent.h.

16.307.2 Function Documentation

16.307.2.1 l4re_parent_signal()

```
L4_BEGIN_DECLS long l4re_parent_signal (
             l4_cap_idx_t parent,
             unsigned long sig,
             unsigned long val)
```

Send a signal using the parent protocol.

Parameters

parent	Capability index of parent to send signal to.
sig	Signal to send
val	Value of the signal

Return values

0	Success
<0	IPC error

See also

L4Re::Parent::signal

References L4_END_DECLS.

16.308 parent.h

Go to the documentation of this file.

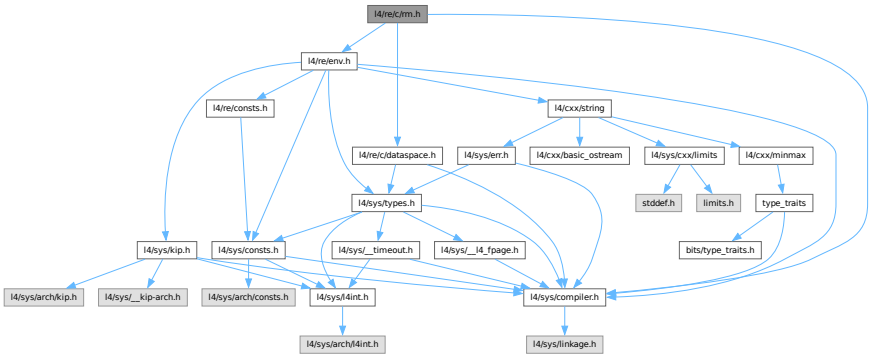
```
00001 /*
00002  * Copyright (C) 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Marcus Haehnel <marcus.haehnel@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012
00013 #pragma once
00014
00019
00020 #include <l4/sys/compiler.h>
00021 #include <l4/sys/types.h>
00022
00023 L4_BEGIN_DECLS
00024
00037 L4_CV long L4_EXPORT
00038 l4re_parent_signal(l4_cap_idx_t parent, unsigned long sig, unsigned long val);
00039
00040 L4_END_DECLS
```

16.309 l4/re/c/rm.h File Reference

Region map interface, C interface.

```
#include <l4/re/env.h>
#include <l4/re/c/dataspace.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for rm.h:



Enumerations

- enum l4re_rm_flags_values {
  L4RE_RM_F_R = L4RE_DS_F_R , **L4RE_RM_F_W** = L4RE_DS_F_W , **L4RE_RM_F_X** = L4RE_DS_F_X , **L4RE_RM_F_RX** = L4RE_DS_F_RX ,
  L4RE_RM_F_RW = L4RE_DS_F_RW , **L4RE_RM_F_RWX** = L4RE_DS_F_RWX , L4RE_RM_F_KERNEL = 0x100 , L4RE_RM_F_DETACH_FREE = 0x200 ,
  L4RE_RM_F_PAGER = 0x400 , L4RE_RM_F_RESERVED = 0x800 , L4RE_RM_CACHING_SHIFT = 4 , L4RE_RM_F_CACHING = L4RE_DS_F_CACHING_MASK ,
  L4RE_RM_REGION_FLAGS = 0xffff , L4RE_RM_F_CACHE_NORMAL = L4RE_DS_F_NORMAL , L4RE_RM_F_CACHE_BUFFERED = L4RE_DS_F_BUFFERABLE , L4RE_RM_F_CACHE_UNCACHED = L4RE_DS_F_UNCACHEABLE ,
  L4RE_RM_F_SEARCH_ADDR = 0x020000 , L4RE_RM_F_IN_AREA = 0x040000 , L4RE_RM_F_EAGER_MAP = 0x080000 , L4RE_RM_F_NO_EAGER_MAP = 0x100000 ,
  L4RE_RM_F_ATTACH_FLAGS = 0x1f0000 }

  Flags for region operations.

Functions

- int l4re_rm_reserve_area (l4_addr_t *start, unsigned long size, l4re_rm_flags_t flags, unsigned char align) L4_NOTHROW

  Reserve the given area in the region map.
- int l4re_rm_free_area (l4_addr_t addr) L4_NOTHROW

  Free an area from the region map.
- int l4re_rm_attach (void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm_offset_t offs, unsigned char align) L4_NOTHROW

  Attach a data space to a region.
- int l4re_rm_attach_w_info (void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm↩_offset_t offs, unsigned char align, char const *name, l4re_ds_offset_t backing_offset) L4_NOTHROW

  Attach a data space to a region.
- int l4re_rm_detach (void *addr) L4_NOTHROW

  Detach and unmap a region from the address space in the current task.
- int l4re_rm_detach_ds (void *addr, l4re_ds_t *ds) L4_NOTHROW

  Detach and unmap a region and return affected dataspace in the current task.

- int l4re_rm_detach_unmap (l4_addr_t addr, l4_cap_idx_t task) L4_NOTHROW

  Detach and unmap in specified task.
- int l4re_rm_detach_ds_unmap (void *addr, l4re_ds_t *ds, l4_cap_idx_t task) L4_NOTHROW

  Detach and unmap in specified task.
- int l4re_rm_find (l4_addr_t *addr, unsigned long *size, l4re_rm_offset_t *offset, l4re_rm_flags_t *flags, l4re_ds_t *m) L4_NOTHROW

  Find a region given an address and size.
- int l4re_rm_get_info (l4_addr_t addr, char *name, unsigned int len, l4re_rm_offset_t *backing_offset) L4_NOTHROW

  Return auxiliary information of a region.
- void l4re_rm_show_lists (void) L4_NOTHROW

  Dump region map internal data structures.
- int l4re_rm_reserve_area_srv (l4_cap_idx_t rm, l4_addr_t *start, unsigned long size, l4re_rm_flags_t flags, unsigned char align) L4_NOTHROW
- int l4re_rm_free_area_srv (l4_cap_idx_t rm, l4_addr_t addr) L4_NOTHROW
- int l4re_rm_attach_srv (l4_cap_idx_t rm, void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm_offset_t offs, unsigned char align) L4_NOTHROW
- int l4re_rm_attach_w_info_srv (l4_cap_idx_t rm, void **start, unsigned long size, l4re_rm_flags_t flags, l4re_ds_t mem, l4re_rm_offset_t offs, unsigned char align, char const *name, l4re_ds_offset_t backing↩_offset) L4_NOTHROW
- int l4re_rm_detach_srv (l4_cap_idx_t rm, l4_addr_t addr, l4re_ds_t *ds, l4_cap_idx_t task) L4_NOTHROW
- int l4re_rm_find_srv (l4_cap_idx_t rm, l4_addr_t *addr, unsigned long *size, l4re_rm_offset_t *offset, l4re↩_rm_flags_t *flags, l4re_ds_t *m) L4_NOTHROW
- int l4re_rm_get_info_srv (l4_cap_idx_t rm, l4_addr_t addr, char *name, unsigned int len, l4re_rm_offset_t *backing_offset) L4_NOTHROW
- void **l4re_rm_show_lists_srv** (l4_cap_idx_t rm) L4_NOTHROW

  Dump region map internal data structures.

16.309.1 Detailed Description

Region map interface, C interface.
Definition in file rm.h.

16.310 rm.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00019
00020 #include <l4/re/env.h>
00021 #include <l4/re/c/dataspace.h>
00022 #include <l4/sys/compiler.h>
00023
00024 L4_BEGIN_DECLS
00025
00030 enum l4re_rm_flags_values {
00031   L4RE_RM_F_R     = L4RE_DS_F_R,
00032   L4RE_RM_F_W     = L4RE_DS_F_W,
00033   L4RE_RM_F_X     = L4RE_DS_F_X,
00034   L4RE_RM_F_RX    = L4RE_DS_F_RX,
00035   L4RE_RM_F_RW    = L4RE_DS_F_RW,
00036   L4RE_RM_F_RWX   = L4RE_DS_F_RWX,
00037
00038   L4RE_RM_F_KERNEL       = 0x100,
00039   L4RE_RM_F_DETACH_FREE  = 0x200,
00040   L4RE_RM_F_PAGER        = 0x400,
00041   L4RE_RM_F_RESERVED     = 0x800,
```

```
00042
00043   L4RE_RM_CACHING_SHIFT    = 4,
00044
00046   L4RE_RM_F_CACHING      = L4RE_DS_F_CACHING_MASK,
00047
00048   L4RE_RM_REGION_FLAGS = 0xffff,
00049
00051   L4RE_RM_F_CACHE_NORMAL   = L4RE_DS_F_NORMAL,
00052
00054   L4RE_RM_F_CACHE_BUFFERED = L4RE_DS_F_BUFFERABLE,
00055
00057   L4RE_RM_F_CACHE_UNCACHED = L4RE_DS_F_UNCACHEABLE,
00058
00059   L4RE_RM_F_SEARCH_ADDR  = 0x020000,
00060   L4RE_RM_F_IN_AREA      = 0x040000,
00061   L4RE_RM_F_EAGER_MAP    = 0x080000,
00062   L4RE_RM_F_NO_EAGER_MAP = 0x100000,
00063   L4RE_RM_F_ATTACH_FLAGS = 0x1f0000,
00064 };
00065
00066 // Temporary
00067 #define __L4RE__DISABLE_TRAMP_PF__AVAILABLE__
00068
00069 typedef l4_uint32_t l4re_rm_flags_t;
00070 typedef l4_uint64_t l4re_rm_offset_t;
00071
00080 L4_CV L4_INLINE int
00081 l4re_rm_reserve_area(l4_addr_t *start, unsigned long size,
00082                      l4re_rm_flags_t flags, unsigned char align) L4_NOTHROW;
00083
00092 L4_CV L4_INLINE int
00093 l4re_rm_free_area(l4_addr_t addr) L4_NOTHROW;
00094
00145 L4_CV L4_INLINE int
00146 l4re_rm_attach(void **start, unsigned long size, l4re_rm_flags_t flags,
00147               l4re_ds_t mem, l4re_rm_offset_t offs,
00148               unsigned char align) L4_NOTHROW;
00149
00203 L4_CV L4_INLINE int
00204 l4re_rm_attach_w_info(void **start, unsigned long size, l4re_rm_flags_t flags,
00205                       l4re_ds_t mem, l4re_rm_offset_t offs,
00206                       unsigned char align,
00207                       char const *name,
00208                       l4re_ds_offset_t backing_offset) L4_NOTHROW;
00209
00210
00228 L4_CV L4_INLINE int
00229 l4re_rm_detach(void *addr) L4_NOTHROW;
00230
00250 L4_CV L4_INLINE int
00251 l4re_rm_detach_ds(void *addr, l4re_ds_t *ds) L4_NOTHROW;
00252
00264 L4_CV L4_INLINE int
00265 l4re_rm_detach_unmap(l4_addr_t addr, l4_cap_idx_t task) L4_NOTHROW;
00266
00281 L4_CV L4_INLINE int
00282 l4re_rm_detach_ds_unmap(void *addr, l4re_ds_t *ds,
00283                         l4_cap_idx_t task) L4_NOTHROW;
00284
00285
00292 L4_CV L4_INLINE int
00293 l4re_rm_find(l4_addr_t *addr, unsigned long *size,
00294              l4re_rm_offset_t *offset,
00295              l4re_rm_flags_t *flags, l4re_ds_t *m) L4_NOTHROW;
00296
00304 L4_CV L4_INLINE int
00305 l4re_rm_get_info(l4_addr_t addr,
00306                  char *name, unsigned int len,
00307                  l4re_rm_offset_t *backing_offset) L4_NOTHROW;
00308
00309
00316 L4_CV L4_INLINE void
00317 l4re_rm_show_lists(void) L4_NOTHROW;
00318
00319
00320 /*
00321  * Variants of functions that also take a capability of the region map
00322  * service.
00323  */
00324
00325
00330 L4_CV int
00331 l4re_rm_reserve_area_srv(l4_cap_idx_t rm, l4_addr_t *start, unsigned long size,
00332                          l4re_rm_flags_t flags, unsigned char align) L4_NOTHROW;
00333
00338 L4_CV int
00339 l4re_rm_free_area_srv(l4_cap_idx_t rm, l4_addr_t addr) L4_NOTHROW;
```

```
00340
00345 L4_CV int
00346 l4re_rm_attach_srv(l4_cap_idx_t rm, void **start, unsigned long size,
00347                    l4re_rm_flags_t flags, l4re_ds_t mem,
00348                    l4re_rm_offset_t offs,
00349                    unsigned char align) L4_NOTHROW;
00350
00355 L4_CV int
00356 l4re_rm_attach_w_info_srv(l4_cap_idx_t rm, void **start, unsigned long size,
00357                           l4re_rm_flags_t flags, l4re_ds_t mem,
00358                           l4re_rm_offset_t offs,
00359                           unsigned char align,
00360                           char const *name,
00361                           l4re_ds_offset_t backing_offset) L4_NOTHROW;
00362
00363
00368 L4_CV int
00369 l4re_rm_detach_srv(l4_cap_idx_t rm, l4_addr_t addr,
00370                    l4re_ds_t *ds, l4_cap_idx_t task) L4_NOTHROW;
00371
00372
00377 L4_CV int
00378 l4re_rm_find_srv(l4_cap_idx_t rm, l4_addr_t *addr,
00379                  unsigned long *size, l4re_rm_offset_t *offset,
00380                  l4re_rm_flags_t *flags, l4re_ds_t *m) L4_NOTHROW;
00381
00382
00387 L4_CV int
00388 l4re_rm_get_info_srv(l4_cap_idx_t rm, l4_addr_t addr,
00389                      char *name, unsigned int len,
00390                      l4re_rm_offset_t *backing_offset) L4_NOTHROW;
00391
00396 L4_CV void
00397 l4re_rm_show_lists_srv(l4_cap_idx_t rm) L4_NOTHROW;
00398
00399
00400 /********** Implementations ***************************/
00401
00402 L4_CV L4_INLINE int
00403 l4re_rm_reserve_area(l4_addr_t *start, unsigned long size,
00404                      l4re_rm_flags_t flags, unsigned char align) L4_NOTHROW
00405 {
00406   return l4re_rm_reserve_area_srv(l4re_global_env->rm, start, size,
00407                                   flags, align);
00408 }
00409
00410 L4_CV L4_INLINE int
00411 l4re_rm_free_area(l4_addr_t addr) L4_NOTHROW
00412 {
00413   return l4re_rm_free_area_srv(l4re_global_env->rm, addr);
00414 }
00415
00416 L4_CV L4_INLINE int
00417 l4re_rm_attach(void **start, unsigned long size, l4re_rm_flags_t flags,
00418                l4re_ds_t mem, l4re_rm_offset_t offs,
00419                unsigned char align) L4_NOTHROW
00420 {
00421   return l4re_rm_attach_srv(l4re_global_env->rm, start, size,
00422                             flags, mem, offs, align);
00423 }
00424
00425 L4_CV L4_INLINE int
00426 l4re_rm_attach_w_info(void **start, unsigned long size, l4re_rm_flags_t flags,
00427                       l4re_ds_t mem, l4re_rm_offset_t offs,
00428                       unsigned char align,
00429                       char const *name,
00430                       l4re_ds_offset_t backing_offset) L4_NOTHROW
00431 {
00432   return l4re_rm_attach_w_info_srv(l4re_global_env->rm, start, size,
00433                                    flags, mem, offs, align,
00434                                    name, backing_offset);
00435 }
00436
00437
00438 L4_CV L4_INLINE int
00439 l4re_rm_detach(void *addr) L4_NOTHROW
00440 {
00441   return l4re_rm_detach_srv(l4re_global_env->rm,
00442                             (l4_addr_t)addr, 0, L4_BASE_TASK_CAP);
00443 }
00444
00445 L4_CV L4_INLINE int
00446 l4re_rm_detach_unmap(l4_addr_t addr, l4_cap_idx_t task) L4_NOTHROW
00447 {
00448   return l4re_rm_detach_srv(l4re_global_env->rm, addr, 0, task);
00449 }
00450
```

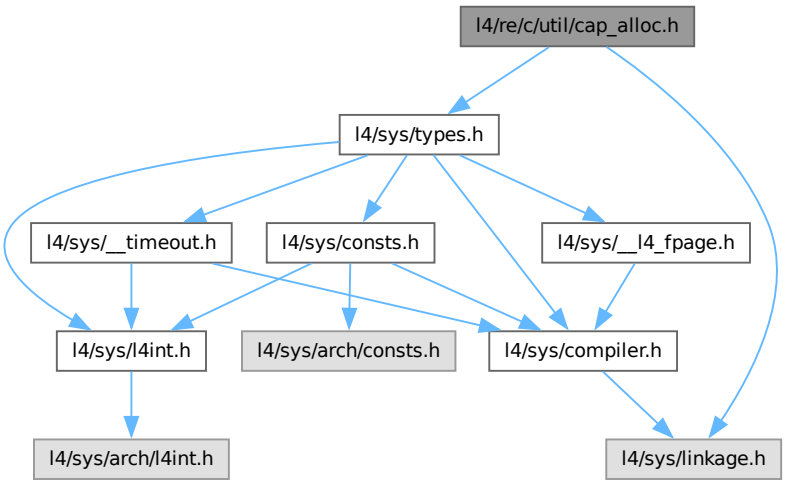
```
00451 L4_CV L4_INLINE int
00452 l4re_rm_detach_ds(void *addr, l4re_ds_t *ds) L4_NOTHROW
00453 {
00454   return l4re_rm_detach_srv(l4re_global_env->rm, (l4_addr_t)addr,
00455                             ds, L4_BASE_TASK_CAP);
00456 }
00457
00458 L4_CV L4_INLINE int
00459 l4re_rm_detach_ds_unmap(void *addr, l4re_ds_t *ds, l4_cap_idx_t task) L4_NOTHROW
00460 {
00461   return l4re_rm_detach_srv(l4re_global_env->rm, (l4_addr_t)addr,
00462                             ds, task);
00463 }
00464
00465 L4_CV L4_INLINE int
00466 l4re_rm_find(l4_addr_t *addr, unsigned long *size,
00467              l4re_rm_offset_t *offset,
00468              l4re_rm_flags_t *flags, l4re_ds_t *m) L4_NOTHROW
00469 {
00470   return l4re_rm_find_srv(l4re_global_env->rm, addr, size, offset, flags, m);
00471 }
00472
00473 L4_CV L4_INLINE void
00474 l4re_rm_show_lists(void) L4_NOTHROW
00475 {
00476   l4re_rm_show_lists_srv(l4re_global_env->rm);
00477 }
00478
00479
00480
00481 L4_CV L4_INLINE int
00482 l4re_rm_get_info(l4_addr_t addr, char *name, unsigned int len,
00483                  l4re_rm_offset_t *backing_offset) L4_NOTHROW
00484 {
00485   return l4re_rm_get_info_srv(l4re_global_env->rm, addr, name, len,
00486                               backing_offset);
00487 }
00488
00489 L4_END_DECLS
```

16.311 l4/re/c/util/cap_alloc.h File Reference

Capability allocator C interface.

```
#include <l4/sys/types.h>
#include <l4/sys/linkage.h>
```

Include dependency graph for cap_alloc.h:



Functions

- L4_BEGIN_DECLS l4_cap_idx_t **l4re_util_cap_alloc** (void) L4_NOTHROW

  Get free capability index at capability allocator.
- void **l4re_util_cap_free** (l4_cap_idx_t cap) L4_NOTHROW

  Return capability index to capability allocator.
- void **l4re_util_cap_free_um** (l4_cap_idx_t cap) L4_NOTHROW

  Return capability index to capability allocator, and unmaps the object.
- long l4re_util_cap_last (void) L4_NOTHROW

  Return last capability index the allocator can return.

16.311.1 Detailed Description

Capability allocator C interface.
Definition in file cap_alloc.h.

16.312 cap_alloc.h

Go to the documentation of this file.

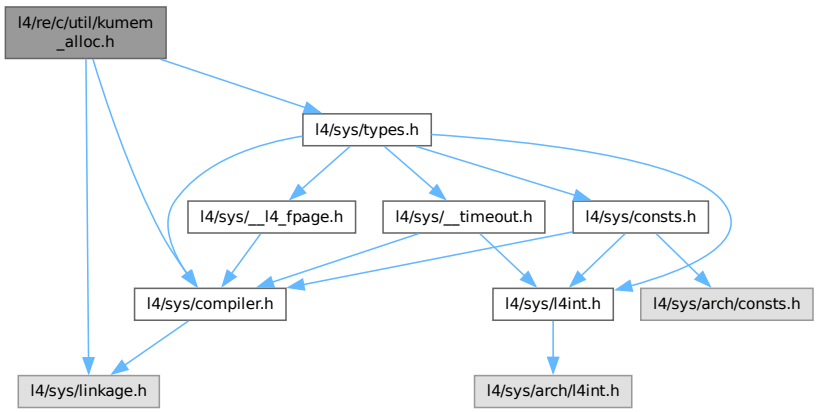
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00019
00020 #include <l4/sys/types.h>
00021 #include <l4/sys/linkage.h>
00022
00023 L4_BEGIN_DECLS
00024
00029 L4_CV l4_cap_idx_t
00030 l4re_util_cap_alloc(void) L4_NOTHROW;
00031
00036 L4_CV void
00037 l4re_util_cap_free(l4_cap_idx_t cap) L4_NOTHROW;
00038
00044 L4_CV void
00045 l4re_util_cap_free_um(l4_cap_idx_t cap) L4_NOTHROW;
00046
00052 L4_CV long
00053 l4re_util_cap_last(void) L4_NOTHROW;
00054
00055 L4_END_DECLS
```

16.313 l4/re/c/util/kumem_alloc.h File Reference

Kumem allocator utility C interface.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/sys/linkage.h>
```

Include dependency graph for kumem_alloc.h:



Functions

- L4_BEGIN_DECLS int l4re_util_kumem_alloc (l4_addr_t *mem, unsigned pages_order, l4_cap_idx_t task, l4_cap_idx_t rm) L4_NOTHROW

  Allocate state area.

16.313.1 Detailed Description

Kumem allocator utility C interface.
Definition in file kumem_alloc.h.

16.313.2 Function Documentation

16.313.2.1 l4re_util_kumem_alloc()

```
L4_BEGIN_DECLS int l4re_util_kumem_alloc (
            l4_addr_t * mem,
            unsigned pages_order,
            l4_cap_idx_t task,
            l4_cap_idx_t rm)
```

Allocate state area.

Parameters

out	*mem*	Pointer to memory that has been allocated.
	pages_order	Size to allocate, in log2 pages.
	task	Task to use for allocation.
	rm	Region manager to use for allocation.

Return values

0	for success
<0	error code on failure

Note

The amount of kernel-user memory that can be allocated at once is limited by the used kernel implementation. The minimum allocatable amount is one page. A portable implementation should not depend on allocations greater than 16KiB to succeed.

Examples

examples/sys/aliens/main.c, and examples/sys/utcb-ipc/main.c.

References L4_END_DECLS, and L4_NOTHROW.

16.314 kumem_alloc.h

Go to the documentation of this file.

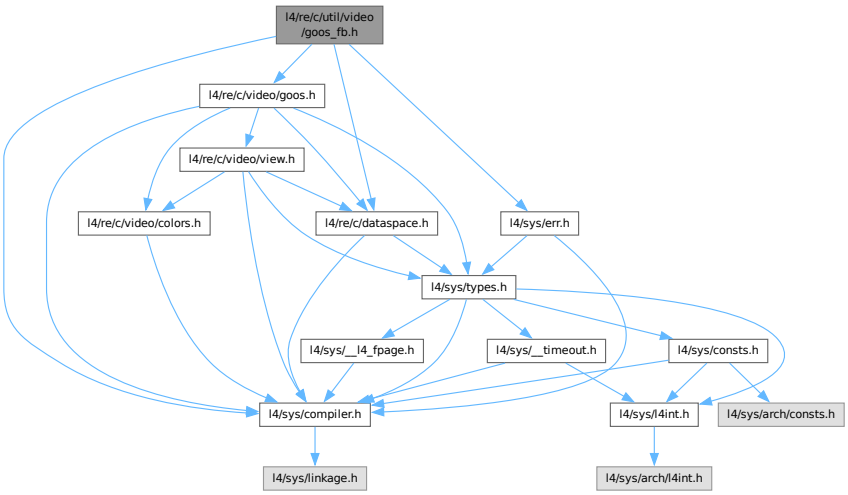
```
00001
00005 /*
00006  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00019
00020 #include <l4/sys/compiler.h>
00021 #include <l4/sys/types.h>
00022 #include <l4/sys/linkage.h>
00023
00024 L4_BEGIN_DECLS
00025
00029 L4_CV int
00030 l4re_util_kumem_alloc(l4_addr_t *mem, unsigned pages_order,
00031                       l4_cap_idx_t task, l4_cap_idx_t rm) L4_NOTHROW;
00032
00033 L4_END_DECLS
```

16.315 l4/re/c/util/video/goos_fb.h File Reference

Framebuffer utility functionality.

```
#include <l4/sys/compiler.h>
#include <l4/re/c/video/goos.h>
#include <l4/sys/err.h>
#include <l4/re/c/dataspace.h>
```

Include dependency graph for goos_fb.h:



16.315.1 Detailed Description

Framebuffer utility functionality.
Definition in file goos_fb.h.

16.316 goos_fb.h

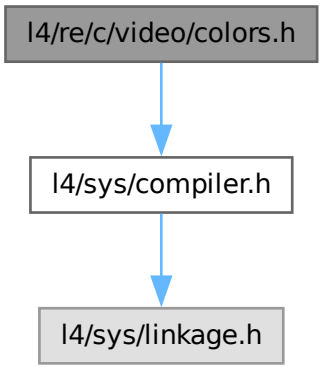
Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/compiler.h>
00014 #include <l4/re/c/video/goos.h>
00015 #include <l4/sys/err.h>
00016 #include <l4/re/c/dataspace.h>
00017
00018 L4_BEGIN_DECLS
00019
00020 typedef struct
00021 {
00022   unsigned long _obj_buf[6];
00023 } l4re_util_video_goos_fb_t;
00024
00025 L4_CV int
00026 l4re_util_video_goos_fb_setup_name(l4re_util_video_goos_fb_t *goosfb,
00027                                    char const *name) L4_NOTHROW;
00028
00029 L4_CV void
00030 l4re_util_video_goos_fb_destroy(l4re_util_video_goos_fb_t *goosfb) L4_NOTHROW;
00031
00032 L4_CV int
00033 l4re_util_video_goos_fb_view_info(l4re_util_video_goos_fb_t *goosfb,
00034                                   l4re_video_view_info_t *info) L4_NOTHROW;
00035
00036 L4_CV void *
00037 l4re_util_video_goos_fb_attach_buffer(l4re_util_video_goos_fb_t *goosfb) L4_NOTHROW;
00038
00039 L4_CV int
00040 l4re_util_video_goos_fb_refresh(l4re_util_video_goos_fb_t *goosfb,
00041                                 int x, int y, int w, int h) L4_NOTHROW;
00042
00043 L4_CV l4re_ds_t
00044 l4re_util_video_goos_fb_buffer(l4re_util_video_goos_fb_t *goosfb) L4_NOTHROW;
00045
00046 L4_CV l4_cap_idx_t
00047 l4re_util_video_goos_fb_goos(l4re_util_video_goos_fb_t *goosfb) L4_NOTHROW;
00048
00049 L4_END_DECLS
```

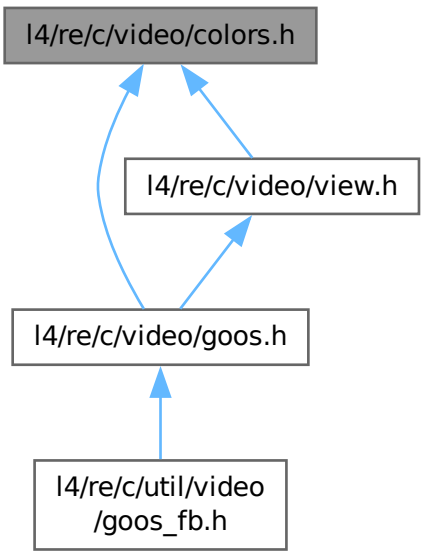
16.317 l4/re/c/video/colors.h File Reference

```
#include <l4/sys/compiler.h>
```

Include dependency graph for colors.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4re_video_color_component_t

  Color component structure.
- struct l4re_video_pixel_info_t

  Pixel_info structure.

Typedefs

- typedef struct l4re_video_color_component_t **l4re_video_color_component_t**

  Color component structure.
- typedef struct l4re_video_pixel_info_t **l4re_video_pixel_info_t**

  Pixel_info structure.

16.317.1 Detailed Description

Note

The C interface of L4Re::Video does *NOT* reflect the full C++ interface on purpose. Use the C++ interface where possible.

Definition in file colors.h.

16.318 colors.h

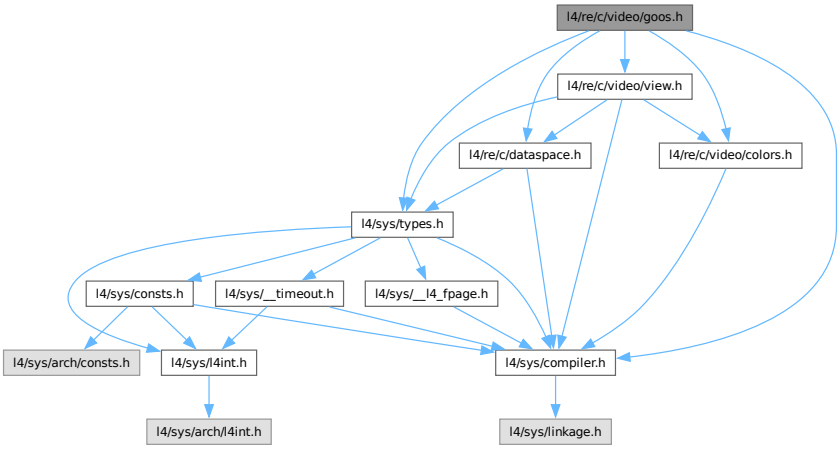
Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/compiler.h>
00015
00020 typedef struct l4re_video_color_component_t
00021 {
00022   unsigned char size;
00023   unsigned char shift;
00024 } __attribute__((packed)) l4re_video_color_component_t;
00025
00030 typedef struct l4re_video_pixel_info_t
00031 {
00032   l4re_video_color_component_t r, g, b, a;
00033   unsigned char bytes_per_pixel;
00034 } l4re_video_pixel_info_t;
00035
00036 L4_BEGIN_DECLS
00037
00038 L4_INLINE L4_CV int
00039 l4re_video_bits_per_pixel(l4re_video_pixel_info_t *p) L4_NOTHROW;
00040
00041 /* ********************************************************** */
00042 /* Implementations */
00043
00044 L4_INLINE L4_CV int
00045 l4re_video_bits_per_pixel(l4re_video_pixel_info_t *p) L4_NOTHROW
00046 {
00047   return p->r.size + p->b.size + p->g.size + p->a.size;
00048 }
00049
00050 L4_END_DECLS
```

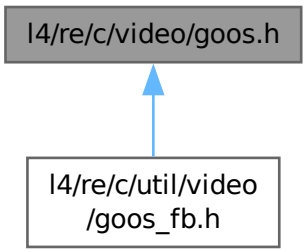
16.319 l4/re/c/video/goos.h File Reference

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/re/c/dataspace.h>
#include <l4/re/c/video/colors.h>
#include <l4/re/c/video/view.h>
```

Include dependency graph for goos.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4re_video_goos_info_t

  Goos information structure.

Typedefs

- typedef l4_cap_idx_t **l4re_video_goos_t**

  Goos object type.

Enumerations

- enum l4re_video_goos_info_flags_t { F_l4re_video_goos_auto_refresh = 0x01 , F_l4re_video_goos_pointer = 0x02 , F_l4re_video_goos_dynamic_views = 0x04 , F_l4re_video_goos_dynamic_buffers = 0x08 }

  Flags of information on the goos.

Functions

- L4_BEGIN_DECLS int l4re_video_goos_info (l4re_video_goos_t goos, l4re_video_goos_info_t *ginfo) L4_NOTHROW

Get information on a goos.

- int l4re_video_goos_refresh (l4re_video_goos_t goos, int x, int y, int w, int h) L4_NOTHROW

  Flush a rectangle of pixels of the goos screen.

- int l4re_video_goos_create_buffer (l4re_video_goos_t goos, unsigned long size, l4_cap_idx_t buffer) L4_NOTHROW

  Create a new buffer (memory buffer) for pixel data.

- int l4re_video_goos_delete_buffer (l4re_video_goos_t goos, unsigned idx) L4_NOTHROW

  Delete a pixel buffer.

- int l4re_video_goos_get_static_buffer (l4re_video_goos_t goos, unsigned idx, l4_cap_idx_t buffer) L4_NOTHROW

  Get the data-space capability of the static pixel buffer.

- int l4re_video_goos_create_view (l4re_video_goos_t goos, l4re_video_view_t *view) L4_NOTHROW

  Create a new view (.

- int l4re_video_goos_delete_view (l4re_video_goos_t goos, l4re_video_view_t *view) L4_NOTHROW

  Delete a view.

- int l4re_video_goos_get_view (l4re_video_goos_t goos, unsigned idx, l4re_video_view_t *view) L4_NOTHROW

  Get a view for the given index.

16.319.1 Detailed Description

Note

The C interface of L4Re::Video does *NOT* reflect the full C++ interface on purpose. Use the C++ where possible.

Definition in file goos.h.

16.320 goos.h

Go to the documentation of this file.

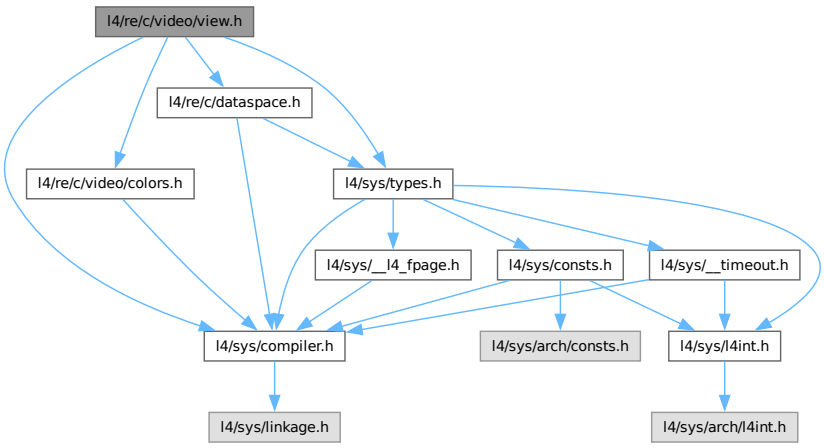
```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/compiler.h>
00015 #include <l4/sys/types.h>
00016 #include <l4/re/c/dataspace.h>
00017 #include <l4/re/c/video/colors.h>
00018 #include <l4/re/c/video/view.h>
00019
00024
00029 enum l4re_video_goos_info_flags_t
00030 {
00031   F_l4re_video_goos_auto_refresh    = 0x01,
00032   F_l4re_video_goos_pointer         = 0x02,
00033   F_l4re_video_goos_dynamic_views   = 0x04,
00034   F_l4re_video_goos_dynamic_buffers = 0x08,
00035 };
00036
00041 typedef struct
00042 {
00043   unsigned long width;
00044   unsigned long height;
00045   unsigned flags;
00046   unsigned num_static_views;
00047   unsigned num_static_buffers;
00048   l4re_video_pixel_info_t pixel_info;
00049 } l4re_video_goos_info_t;
00050
00055 typedef l4_cap_idx_t l4re_video_goos_t;
00056
00057 L4_BEGIN_DECLS
00058
```

```
00070 L4_CV int
00071 l4re_video_goos_info(l4re_video_goos_t goos,
00072                      l4re_video_goos_info_t *ginfo) L4_NOTHROW;
00073
00083 L4_CV int
00084 l4re_video_goos_refresh(l4re_video_goos_t goos, int x, int y, int w,
00085                         int h) L4_NOTHROW;
00086
00098 L4_CV int
00099 l4re_video_goos_create_buffer(l4re_video_goos_t goos, unsigned long size,
00100                               l4_cap_idx_t buffer) L4_NOTHROW;
00101
00109 L4_CV int
00110 l4re_video_goos_delete_buffer(l4re_video_goos_t goos, unsigned idx) L4_NOTHROW;
00111
00123 L4_CV int
00124 l4re_video_goos_get_static_buffer(l4re_video_goos_t goos, unsigned idx,
00125                                   l4_cap_idx_t buffer) L4_NOTHROW;
00126
00133 L4_CV int
00134 l4re_video_goos_create_view(l4re_video_goos_t goos,
00135                             l4re_video_view_t *view) L4_NOTHROW;
00136
00144 L4_CV int
00145 l4re_video_goos_delete_view(l4re_video_goos_t goos,
00146                             l4re_video_view_t *view) L4_NOTHROW;
00147
00148
00160 L4_CV int
00161 l4re_video_goos_get_view(l4re_video_goos_t goos, unsigned idx,
00162                          l4re_video_view_t *view) L4_NOTHROW;
00163
00164 L4_END_DECLS
```

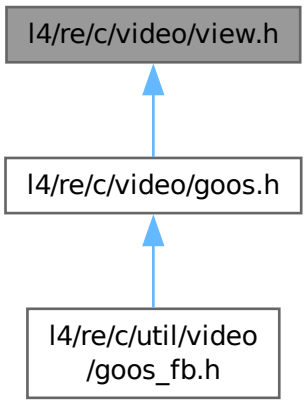
16.321 l4/re/c/video/view.h File Reference

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/re/c/dataspace.h>
#include <l4/re/c/video/colors.h>
```

Include dependency graph for view.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4re_video_view_info_t

  View information structure.
- struct l4re_video_view_t

  C representation of a goos view.

Typedefs

- typedef struct l4re_video_view_info_t **l4re_video_view_info_t**

  View information structure.
- typedef struct l4re_video_view_t l4re_video_view_t

  C representation of a goos view.

Enumerations

- enum l4re_video_view_info_flags_t {
  F_l4re_video_view_none = 0x00 , F_l4re_video_view_set_buffer = 0x01 , F_l4re_video_view_set_buffer_offset = 0x02 , F_l4re_video_view_set_bytes_per_line = 0x04 ,
  F_l4re_video_view_set_pixel = 0x08 , F_l4re_video_view_set_position = 0x10 , F_l4re_video_view_dyn_allocated = 0x20 , F_l4re_video_view_set_background = 0x40 ,
  F_l4re_video_view_set_flags = 0x80 , **F_l4re_video_view_fully_dynamic** , F_l4re_video_view_above = 0x01000 , F_l4re_video_view_flags_mask = 0xff000 }

  Flags of information on a view.

Functions

- L4_BEGIN_DECLS int l4re_video_view_refresh (l4re_video_view_t *view, int x, int y, int w, int h) L4_NOTHROW

  Flush the given rectangle of pixels of the given view.
- int l4re_video_view_get_info (l4re_video_view_t *view, l4re_video_view_info_t *info) L4_NOTHROW

  Retrieve information about the given view.
- int l4re_video_view_set_info (l4re_video_view_t *view, l4re_video_view_info_t *info) L4_NOTHROW

  Set properties of the view.

- int l4re_video_view_set_viewport (l4re_video_view_t *view, int x, int y, int w, int h, unsigned long bofs) L4_NOTHROW

  Set the viewport parameters of a view.
- int l4re_video_view_stack (l4re_video_view_t *view, l4re_video_view_t *pivot, int behind) L4_NOTHROW

  Change the stacking order in the stack of visible views.

16.321.1 Detailed Description

Note

The C interface of L4Re::Video does *NOT* reflect the full C++ interface on purpose. Use the C++ where possible.

Definition in file view.h.

16.322 view.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/compiler.h>
00015 #include <l4/sys/types.h>
00016 #include <l4/re/c/dataspace.h>
00017 #include <l4/re/c/video/colors.h>
00018
00023 enum l4re_video_view_info_flags_t
00024 {
00025   F_l4re_video_view_none               = 0x00,
00026   F_l4re_video_view_set_buffer         = 0x01,
00027   F_l4re_video_view_set_buffer_offset  = 0x02,
00028   F_l4re_video_view_set_bytes_per_line = 0x04,
00029   F_l4re_video_view_set_pixel          = 0x08,
00030   F_l4re_video_view_set_position       = 0x10,
00031   F_l4re_video_view_dyn_allocated      = 0x20,
00032   F_l4re_video_view_set_background     = 0x40,
00033   F_l4re_video_view_set_flags          = 0x80,
00034   F_l4re_video_view_fully_dynamic      =   F_l4re_video_view_set_buffer
00035                                          | F_l4re_video_view_set_buffer_offset
00036                                          | F_l4re_video_view_set_bytes_per_line
00037                                          | F_l4re_video_view_set_pixel
00038                                          | F_l4re_video_view_set_position
00039                                          | F_l4re_video_view_dyn_allocated,
00040
00041   F_l4re_video_view_above      = 0x01000,
00042   F_l4re_video_view_flags_mask = 0xff000,
00043 };
00044
00049 typedef struct l4re_video_view_info_t
00050 {
00051   unsigned               flags;
00052   unsigned               view_index;
00053   unsigned long          xpos, ypos, width, height;
00054   unsigned long          buffer_offset;
00055   unsigned long          bytes_per_line;
00056   l4re_video_pixel_info_t pixel_info;
00057   unsigned               buffer_index;
00058 } l4re_video_view_info_t;
00059
00060
00068 typedef struct l4re_video_view_t
00069 {
00070   l4_cap_idx_t goos;
00071   unsigned idx;
00072 } l4re_video_view_t;
00073
00074
00075 L4_BEGIN_DECLS
00076
00087 L4_CV int
00088 l4re_video_view_refresh(l4re_video_view_t *view, int x, int y, int w,
00089                         int h) L4_NOTHROW;
```

```
00090
00098 L4_CV int
00099 l4re_video_view_get_info(l4re_video_view_t *view,
00100                          l4re_video_view_info_t *info) L4_NOTHROW;
00101
00113 L4_CV int
00114 l4re_video_view_set_info(l4re_video_view_t *view,
00115                          l4re_video_view_info_t *info) L4_NOTHROW;
00116
00133 L4_CV int
00134 l4re_video_view_set_viewport(l4re_video_view_t *view, int x, int y, int w,
00135                              int h, unsigned long bofs) L4_NOTHROW;
00136
00147 L4_CV int
00148 l4re_video_view_stack(l4re_video_view_t *view, l4re_video_view_t *pivot,
00149                       int behind) L4_NOTHROW;
00150
00151 L4_END_DECLS
00152
```

16.323 console

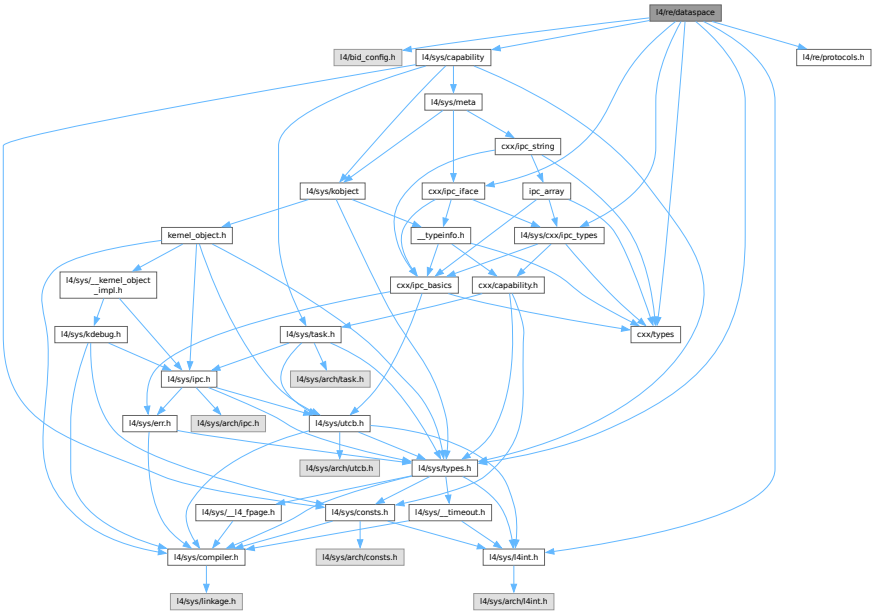
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/re/video/goos>
00013 #include <l4/re/event>
00014
00015 namespace L4Re {
00016
00022
00023
00028 class L4_EXPORT Console :
00029   public L4::Kobject_2t<Console, Video::Goos, Event, L4::PROTO_EMPTY>
00030 {};
00031
00032 }
00033
```

16.324 l4/re/dataspace File Reference

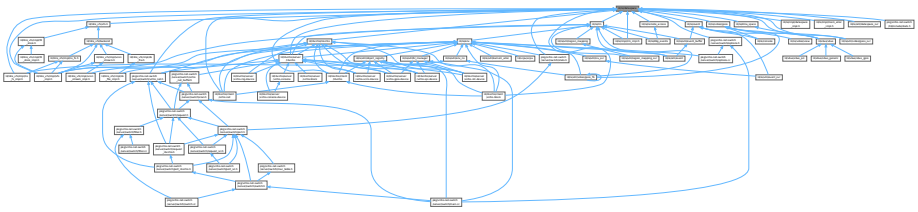
Dataspace interface.

```
#include <l4/bid_config.h>
#include <l4/sys/types.h>
#include <l4/sys/l4int.h>
#include <l4/sys/capability>
#include <l4/re/protocols.h>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/cxx/ipc_iface>
#include <l4/sys/cxx/types>
```

Include dependency graph for dataspace:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Dataspace

  Interface for memory-like objects.
- struct L4Re::Dataspace::F

  Dataspace flags definitions.
- struct L4Re::Dataspace::Stats

  Information about the dataspace.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.324.1 Detailed Description

Dataspace interface.
Definition in file dataspace.

16.325 dataspace

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00011  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  *
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016
00017 #pragma once
00018
00019 #include <l4/bid_config.h>
00020 #include <l4/sys/types.h>
00021 #include <l4/sys/l4int.h>
00022 #include <l4/sys/capability>
00023 #include <l4/re/protocols.h>
00024 #include <l4/sys/cxx/ipc_types>
00025 #include <l4/sys/cxx/ipc_iface>
00026 #include <l4/sys/cxx/types>
00027
00028 namespace L4Re
00029 {
00030
00031   // MISSING:
00032   // * size support in map, mapped size in reply
00033
00050 class L4_EXPORT Dataspace :
00051   public L4::Kobject_t<Dataspace, L4::Kobject, L4RE_PROTO_DATASPACE,
00052                        L4::Type_info::Demand_t<1> >
00053 {
00054 public:
00055
00057   struct F
00058   {
00059     enum
00060     {
00061       Caching_shift = 4,
00062     };
00063
00070     enum Flags
00071     {
00073       R   = L4_FPAGE_RO,
00075       Ro  = L4_FPAGE_RO,
00077       RW  = L4_FPAGE_RW,
00079       W   = L4_FPAGE_W,
00081       X   = L4_FPAGE_X,
00083       RX  = L4_FPAGE_RX,
00085       RWX = L4_FPAGE_RWX,
00087       Rights_mask = 0x0f,
00088
00091       Normal        = 0x00,
00093       Cacheable     = Normal,
00095       Bufferable    = 0x10,
00097       Uncacheable   = 0x20,
00099       Caching_mask  = 0x30,
00100     };
00101
00102     friend void enum_bitops_enable(Flags);
00103   };
00104
00105   struct Flags : L4::Types::Flags_ops_t<Flags>
00106   {
00107     unsigned long raw;
00108
00109     Flags() = default;
00110     explicit constexpr Flags(unsigned long f) : raw(f) {}
00111     constexpr Flags(F::Flags f) : raw(f) {}
00112
00113     constexpr bool r() const { return raw & L4_FPAGE_RO; }
00114     constexpr bool w() const { return raw & L4_FPAGE_W; }
00115     constexpr bool x() const { return raw & L4_FPAGE_X; }
00116
00117     constexpr unsigned long fpage_rights() const
00118     { return raw & 0xf; }
00119   };
00120
00121   typedef l4_uint64_t Size;
00122   typedef l4_uint64_t Offset;
00123   typedef l4_uint64_t Map_addr;
00124
```

```
00128   struct Stats
00129   {
00130     Size size;
00131     Flags flags;
00132   };
00133
00158   l4_ret_t map(Offset offset, Flags flags, Map_addr local_addr,
00159           Map_addr min_addr, Map_addr max_addr,
00160           L4::Cap<L4::Task> dst = L4::Cap<L4::Task>::Invalid) const noexcept;
00161
00189   l4_ret_t map_region(Offset offset, Flags flags,
00190                       Map_addr min_addr, Map_addr max_addr,
00191                       L4::Cap<L4::Task> dst = L4::Cap<L4::Task>::Invalid) const noexcept;
00192
00210   L4_RPC(l4_ret_t, clear, (Offset offset, Size size));
00211
00231   L4_RPC(l4_ret_t, allocate, (Offset offset, Size size));
00232
00251   L4_RPC(l4_ret_t, copy_in, (Offset dst_offs, L4::Ipc::Cap<Dataspace> src,
00252                              Offset src_offs, Size size));
00253
00259   Size size() const noexcept;
00260
00269   Flags flags() const noexcept;
00270
00279   L4_RPC(l4_ret_t, info, (Stats *stats));
00280
00281   L4_RPC_NF(l4_ret_t, map, (Offset offset, Map_addr spot,
00282                             Flags flags, L4::Ipc::Rcv_fpage r,
00283                             L4::Ipc::Snd_fpage &fp));
00284
00304 #ifdef CONFIG_MMU
00305   L4_RPC_NF(long, map_info, (l4_addr_t *start_addr, l4_addr_t *end_addr));
00306   inline long map_info([[maybe_unused]] l4_addr_t *start_addr,
00307                        [[maybe_unused]] l4_addr_t *end_addr)
00308   { return 0; }
00309 #else
00310   L4_RPC(long, map_info, (l4_addr_t *start_addr, l4_addr_t *end_addr));
00311 #endif
00312
00313 private:
00314
00315   l4_ret_t __map(Offset offset, unsigned char *order, Flags flags,
00316                  Map_addr local_addr, L4::Cap<L4::Task> dst) const noexcept;
00317
00318 public:
00319   typedef L4::Typeid::Rpcs<map_t, clear_t, info_t, copy_in_t,
00320                            allocate_t, map_info_t> Rpcs;
00321 };
00322
00323 }
```

16.326 dbg_events

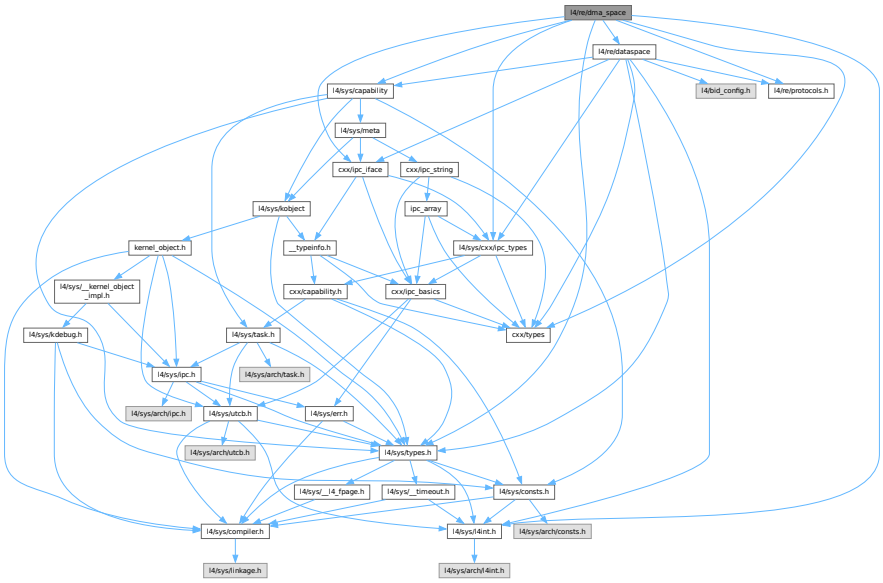
```
00001 // vim:ft=cpp
00002
00003 #pragma once
00004
00005 #include <l4/sys/cxx/ipc_epiface>
00006 #include <l4/sys/utcb.h>
00007 #include <l4/re/remote_access>
00008 #include <l4/re/rm>
00009
00010 namespace L4Re {
00011 struct Dbg_events : L4::Kobject_t<Dbg_events, L4::Kobject, 0,
00012                                   L4::Type_info::Demand_t<2> >
00013 {
00014   L4_INLINE_RPC(int, request_backtrace, (l4_exc_regs_t regs,
00015                                          L4::Ipc::Cap<L4Re::Remote_access> raif,
00016                                          L4::Ipc::Cap<L4Re::Rm> rmif));
00017
00018   typedef L4::Typeid::Rpcs<request_backtrace_t> Rpcs;
00019 };
00020 } // L4Re
```

16.327 l4/re/dma_space File Reference

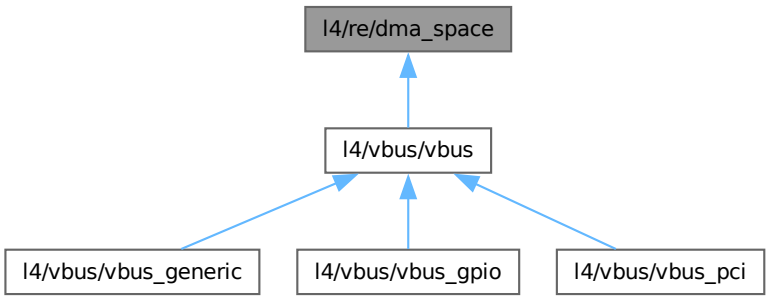
```
#include <l4/sys/types.h>
#include <l4/sys/l4int.h>
#include <l4/sys/capability>
```

```
#include <l4/re/dataspace>
#include <l4/re/protocols.h>
#include <l4/sys/cxx/types>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for dma_space:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Dma_space

  Managed DMA Address Space.
- class L4Re::Dma_space_mgr

  A privileged interface to manage Dma_space associations for the clients.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.328 dma_space

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00006 /*
00007  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015 #include <l4/sys/l4int.h>
00016 #include <l4/sys/capability>
00017 #include <l4/re/dataspace>
00018 #include <l4/re/protocols.h>
00019 #include <l4/sys/cxx/types>
00020 #include <l4/sys/cxx/ipc_types>
00021 #include <l4/sys/cxx/ipc_iface>
00022
00023 namespace L4Re
00024 {
00025
00026
00050 class Dma_space :
00051   public L4::Kobject_0t< Dma_space,
00052                          L4RE_PROTO_DMA_SPACE,
00053                          L4::Type_info::Demand_t<1> >
00054 {
00055 public:
00057   typedef l4_uint64_t Dma_addr;
00058   typedef l4_uint64_t Dma_size;
00059
00066   enum Direction
00067   {
00068     Bidirectional,
00069     To_device,
00070     From_device,
00071     None
00072   };
00073
00078   enum Attribute : unsigned
00079   {
00091     Search_addr = 1U << 0,
00092
00099     Partial_map = 1U << 1,
00100
00113     Reserve = 1U << 2,
00114
00134     Replace = 1U << 3,
00135   };
00136
00137   friend void enum_bitops_enable(Attribute);
00138
00144   using Attributes = L4::Types::Flags_t<Attribute, unsigned>;
00145
00190   l4_ret_t map(L4::Ipc::Cap<L4Re::Dataspace> src,
00191                L4Re::Dataspace::Offset offset,
00192                l4_size_t * size,
00193                Attributes attrs, Direction dir,
00194                Dma_addr *dma_addr)
00195   {
00196     static_cast<void>(dir);
00197
00198     Dma_addr a = 0;
00199     Dma_size sz = *size;
00200
00201     l4_ret_t ret = map(src, offset, &sz, &a, -1, attrs | Search_addr);
00202     if (ret >= 0)
00203       {
00204         *dma_addr = a;
00205         *size = sz;
00206       }
00207
00208     return ret;
00209   }
00210
00260   l4_ret_t map(L4::Ipc::Cap<L4Re::Dataspace> src,
00261                L4Re::Dataspace::Offset offset,
00262                Dma_size *size,
00263                Dma_addr *dma_addr,
00264                Dma_addr dma_max = -1,
00265                Attributes attrs = Search_addr,
00266                unsigned char align = L4_SUPERPAGESHIFT)
```

```
00267   {
00268     return map_t::call(c(), src, offset, size, align, attrs, dma_addr, dma_max);
00269   }
00270
00271   L4_RPC_NF(
00272       l4_ret_t, map, (L4::Ipc::Opt<L4::Ipc::Cap<L4Re::Dataspace>> src,
00273                       L4Re::Dataspace::Offset offset,
00274                       L4::Ipc::In_out<Dma_size *> size, unsigned char align,
00275                       Attributes attrs, L4::Ipc::In_out<Dma_addr *> dma_addr,
00276                       Dma_addr dma_max));
00277
00282   enum Unmap_flag : unsigned
00283   {
00293     Cancel_reservation = 1U << 0,
00294   };
00295
00296   friend void enum_bitops_enable(Unmap_flag);
00297
00303   using Unmap_flags = L4::Types::Flags_t<Unmap_flag, unsigned>;
00304
00326   l4_ret_t unmap(Dma_addr dma_addr, Dma_size size, Attributes attrs,
00327                  Direction dir)
00328   {
00329     static_cast<void>(attrs);
00330     static_cast<void>(dir);
00331     return unmap(dma_addr, size);
00332   }
00333
00358   l4_ret_t unmap(Dma_addr dma_addr, Dma_size size,
00359                  Unmap_flags flags = Unmap_flags())
00360   {
00361     return unmap_t::call(c(), dma_addr, size, flags);
00362   }
00363
00364   L4_RPC_NF(l4_ret_t, unmap, (Dma_addr dma_addr, Dma_size size,
00365                               Unmap_flags flags));
00366
00367   typedef L4::Typeid::Rpcs<map_t, unmap_t> Rpcs;
00368 };
00369
00375 class Dma_space_mgr :
00376   public L4::Kobject_0t< Dma_space_mgr, L4::PROTO_ANY,
00377                          L4::Type_info::Demand_t<2> >
00378 {
00379 public:
00380   using Dma_addr = Dma_space::Dma_addr;
00381   using Dma_size = Dma_space::Dma_size;
00382
00388   enum Space_attrib : unsigned
00389   {
00396     Identity_map = 1U << 0,
00397   };
00398
00399   friend void enum_bitops_enable(Space_attrib);
00400
00402   using Space_attribs = L4::Types::Flags_t<Space_attrib, unsigned>;
00403
00408   enum Block_flag : unsigned
00409   {
00416     Search_addr = 1U << 0,
00417   };
00418
00419   friend void enum_bitops_enable(Block_flag);
00420
00422   using Block_flags = L4::Types::Flags_t<Block_flag, unsigned>;
00423
00451   L4_INLINE_RPC(
00452       l4_ret_t, associate, (L4::Ipc::Cap<Dma_space> dma_space,
00453                             L4::Ipc::Cap<L4::Task> dma_task,
00454                             Space_attribs attr));
00455
00480   L4_INLINE_RPC(
00481       l4_ret_t, associate_phys, (L4::Ipc::Cap<Dma_space> dma_space,
00482                                  Space_attribs attr));
00483
00501   L4_INLINE_RPC(
00502       l4_ret_t, disassociate, (L4::Ipc::Cap<Dma_space> dma_space));
00503
00542   l4_ret_t block_area(L4::Ipc::Cap<Dma_space>     dma_space,
00543                       L4::Ipc::In_out<Dma_addr *> addr,
00544                       Dma_size                    size,
00545                       Dma_addr                    max_addr = -1,
00546                       Block_flags                 flags = Block_flags(),
00547                       unsigned char               align = L4_SUPERPAGESHIFT)
00548   {
00549     return block_area_t::call(c(), dma_space, addr, size, max_addr, flags,
00550                               align);
```

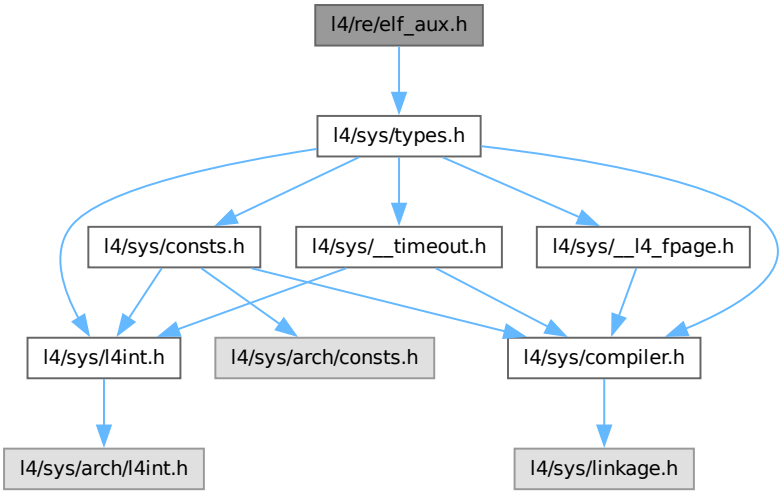
```
00551   }
00552
00553   L4_RPC_NF(
00554       l4_ret_t, block_area, (L4::Ipc::Cap<Dma_space>      dma_space,
00555                              L4::Ipc::In_out<Dma_addr *>  addr,
00556                              Dma_size                     size,
00557                              Dma_addr                     max_addr,
00558                              Block_flags                  flags,
00559                              unsigned char                align));
00560
00590   L4_INLINE_RPC(
00591       l4_ret_t, set_limits, (L4::Ipc::Cap<Dma_space> dma_space,
00592                              Dma_addr min_addr,
00593                              Dma_addr max_addr));
00594
00595
00596   typedef L4::Typeid::Rpcs<associate_t, associate_phys_t, disassociate_t,
00597                            block_area_t, set_limits_t> Rpcs;
00598 };
00599
00600 }
```

16.329 l4/re/elf_aux.h File Reference

Auxiliary information for binaries.

`#include <l4/sys/types.h>`

Include dependency graph for elf_aux.h:



Data Structures

- struct l4re_elf_aux_t

  Generic header for each auxiliary vector element.
- struct l4re_elf_aux_vma_t

  Auxiliary vector element for a reserved virtual memory area.
- struct l4re_elf_aux_mword_t

  Auxiliary vector element for a single unsigned data word.

Macros

- #define L4RE_ELF_AUX_ELEM const __attribute__((used, section(".rol4re_elf_aux"), aligned(sizeof(l4_umword_t))))

  Define an auxiliary vector element.

- #define L4RE_ELF_AUX_ELEM_T(type, id, tag, val...)

  Define an auxiliary vector element.

Typedefs

- typedef struct l4re_elf_aux_t **l4re_elf_aux_t**

  Generic header for each auxiliary vector element.
- typedef struct l4re_elf_aux_vma_t **l4re_elf_aux_vma_t**

  Auxiliary vector element for a reserved virtual memory area.
- typedef struct l4re_elf_aux_mword_t **l4re_elf_aux_mword_t**

  Auxiliary vector element for a single unsigned data word.

Enumerations

- enum {
  L4RE_ELF_AUX_T_NONE = 0 , L4RE_ELF_AUX_T_VMA , L4RE_ELF_AUX_T_STACK_SIZE ,
  L4RE_ELF_AUX_T_STACK_ADDR ,
  L4RE_ELF_AUX_T_KIP_ADDR , L4RE_ELF_AUX_T_EX_REGS_FLAGS }

16.329.1 Detailed Description

Auxiliary information for binaries.
Definition in file elf_aux.h.

16.330 elf_aux.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/types.h>
00014
00015
00028
00041 #define L4RE_ELF_AUX_ELEM const __attribute__((used, section(".rol4re_elf_aux"),
      aligned(sizeof(l4_umword_t))))
00042
00056 #define L4RE_ELF_AUX_ELEM_T(type, id, tag, val...) \
00057   static L4RE_ELF_AUX_ELEM type id = {tag, sizeof(type), val}
00058
00059 enum
00060 {
00064   L4RE_ELF_AUX_T_NONE = 0,
00065
00069   L4RE_ELF_AUX_T_VMA,
00070
00075   L4RE_ELF_AUX_T_STACK_SIZE,
00076
00081   L4RE_ELF_AUX_T_STACK_ADDR,
00082
00087   L4RE_ELF_AUX_T_KIP_ADDR,
00088
00092   L4RE_ELF_AUX_T_EX_REGS_FLAGS,
00093 };
00094
00098 typedef struct l4re_elf_aux_t
00099 {
00100   l4_umword_t type;
00101   l4_umword_t length;
00102 } l4re_elf_aux_t;
00103
00107 typedef struct l4re_elf_aux_vma_t
00108 {
00109   l4_umword_t type;
00110   l4_umword_t length;
```

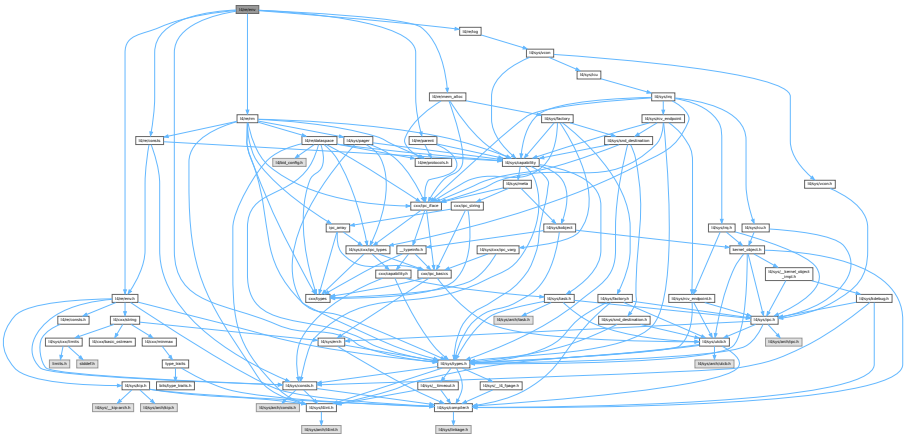
```
00111   l4_umword_t start;
00112   l4_umword_t end;
00113 } l4re_elf_aux_vma_t;
00114
00118 typedef struct l4re_elf_aux_mword_t
00119 {
00120   l4_umword_t type;
00121   l4_umword_t length;
00122   l4_umword_t value;
00123 } l4re_elf_aux_mword_t;
00124
```

16.331 l4/re/env File Reference

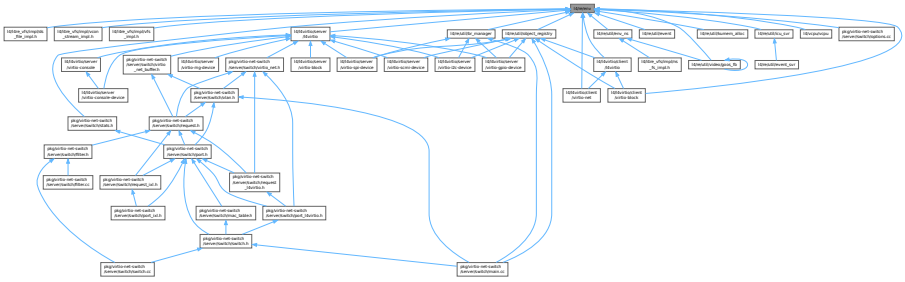
Environment interface.

```
#include <l4/sys/types.h>
#include <l4/re/rm>
#include <l4/re/parent>
#include <l4/re/mem_alloc>
#include <l4/re/log>
#include <l4/re/consts>
#include <l4/re/env.h>
```

Include dependency graph for env:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Env

  C++ interface of the initial environment that is provided to an L4 task.

Namespaces

- namespace L4

L4 low-level kernel interface.

- namespace L4Re

  L4Re C++ Interfaces.

16.331.1 Detailed Description

Environment interface.
Definition in file env.

16.332 env

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #pragma once
00016
00017 #include <l4/sys/types.h>
00018
00019 #include <l4/re/rm>
00020 #include <l4/re/parent>
00021 #include <l4/re/mem_alloc>
00022 #include <l4/re/log>
00023 #include <l4/re/consts>
00024
00025 #include <l4/re/env.h>
00026
00027 namespace L4 {
00028 class Scheduler;
00029 }
00030
00034 namespace L4Re
00035 {
00036   class Itas;
00037   struct Dbg_events;
00038
00078   class L4_EXPORT Env
00079   {
00080   private:
00081     l4re_env_t _env;
00082   public:
00083
00087     typedef l4re_env_cap_entry_t Cap_entry;
00088
00096     static Env const *env() noexcept
00097     { return reinterpret_cast<Env*>(l4re_global_env); }
00098
00103     L4::Cap<Parent> parent() const noexcept
00104     { return L4::Cap<Parent>(_env.parent); }
00109     L4::Cap<Mem_alloc> mem_alloc() const noexcept
00110     { return L4::Cap<Mem_alloc>(_env.mem_alloc); }
00114     L4::Cap<L4::Factory> user_factory() const noexcept
00115     { return L4::Cap<L4::Factory>(_env.mem_alloc); }
00120     L4::Cap<Rm> rm() const noexcept
00121     { return L4::Cap<Rm>(_env.rm); }
00130     L4::Cap<Log> log() const noexcept
00131     { return L4::Cap<Log>(_env.log); }
00136     L4::Cap<L4::Thread> main_thread() const noexcept
00137     { return L4::Cap<L4::Thread>(_env.main_thread); }
00142     L4::Cap<L4::Task> task() const noexcept
00143     { return L4::Cap<L4::Task>(L4RE_THIS_TASK_CAP); }
00148     L4::Cap<L4::Factory> factory() const noexcept
00149     { return L4::Cap<L4::Factory>(_env.factory); }
00158     l4_cap_idx_t first_free_cap() const noexcept
00159     { return _env.first_free_cap; }
00168     l4_umword_t first_free_reply_cap() const noexcept
00169     { return _env.first_free_reply_cap; }
00174     l4_fpage_t utcb_area() const noexcept
00175     { return _env.utcb_area; }
00183     l4_addr_t first_free_utcb() const noexcept
00184     { return _env.first_free_utcb; }
00185
00190     Cap_entry const *initial_caps() const noexcept
```

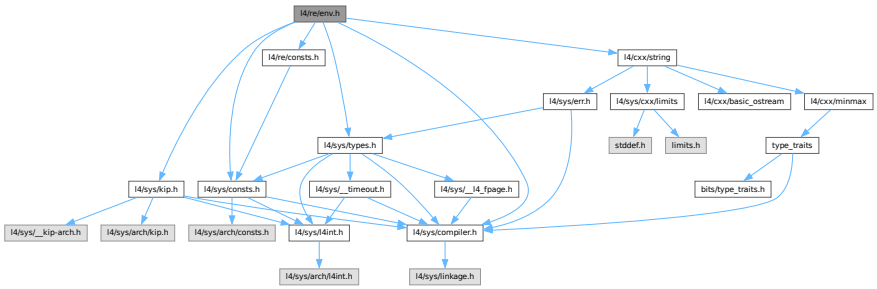
```
00191     { return _env.caps; }
00192
00201     Cap_entry const *get(char const *name, unsigned l) const noexcept
00202     { return l4re_env_get_cap_l(name, l, &_env); }
00203
00212     template< typename T >
00213     L4::Cap<T> get_cap(char const *name, unsigned l) const noexcept
00214     {
00215       if (Cap_entry const *e = get(name, l))
00216   return L4::Cap<T>(e->cap);
00217
00218       return L4::Cap<T>(-L4_ENOENT);
00219     }
00220
00227     template< typename T >
00228     L4::Cap<T> get_cap(char const *name) const noexcept
00229     { return get_cap<T>(name, __builtin_strlen(name)); }
00230
00235     void parent(L4::Cap<Parent> const &c) noexcept
00236     { _env.parent = c.cap(); }
00241     void mem_alloc(L4::Cap<Mem_alloc> const &c) noexcept
00242     { _env.mem_alloc = c.cap(); }
00247     void rm(L4::Cap<Rm> const &c) noexcept
00248     { _env.rm = c.cap(); }
00253     void log(L4::Cap<Log> const &c) noexcept
00254     { _env.log = c.cap(); }
00259     void main_thread(L4::Cap<L4::Thread> const &c) noexcept
00260     { _env.main_thread = c.cap(); }
00265     void factory(L4::Cap<L4::Factory> const &c) noexcept
00266     { _env.factory = c.cap(); }
00273     void first_free_cap(l4_cap_idx_t c) noexcept
00274     { _env.first_free_cap = c; }
00281     void first_free_reply_cap(l4_umword_t c) noexcept
00282     { _env.first_free_reply_cap = c; }
00287     void utcb_area(l4_fpage_t utcbs) noexcept
00288     { _env.utcb_area = utcbs; }
00293     void first_free_utcb(l4_addr_t u) noexcept
00294     { _env.first_free_utcb = u; }
00295
00301     L4::Cap<L4::Scheduler> scheduler() const noexcept
00302     { return L4::Cap<L4::Scheduler>(_env.scheduler); }
00303
00308     void scheduler(L4::Cap<L4::Scheduler> const &c) noexcept
00309     { _env.scheduler = c.cap(); }
00310
00320     L4::Cap<Itas> itas() const noexcept
00321     { return L4::Cap<Itas>(_env.itas); }
00322
00327     void itas(L4::Cap<Itas> const &c) noexcept
00328     { _env.itas = c.cap(); }
00329
00336     L4::Cap<Dbg_events> dbg_events() const noexcept
00337     { return L4::Cap<Dbg_events>(_env.dbg_events); }
00338
00346     void dbg_events(L4::Cap<Dbg_events> const &dbg_events) noexcept
00347     { _env.dbg_events = dbg_events.cap(); }
00348
00353     void initial_caps(Cap_entry *first) noexcept
00354     { _env.caps = first; }
00355   };
00356 };
```

16.333 l4/re/env.h File Reference

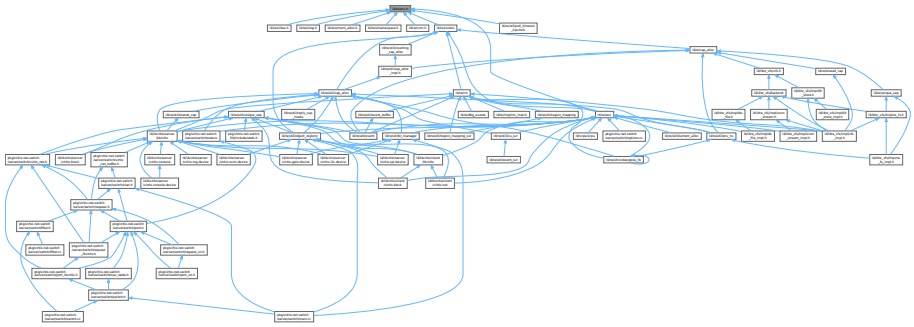
Environment interface.

```
#include <l4/sys/consts.h>
#include <l4/sys/types.h>
#include <l4/sys/kip.h>
#include <l4/sys/compiler.h>
#include <l4/re/consts.h>
#include <l4/cxx/string>
```

Include dependency graph for env.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4re_env_cap_entry_t

  Entry in the L4Re environment array for the named initial objects.
- struct l4re_env_t

  Initial environment data structure.

Typedefs

- typedef struct l4re_env_cap_entry_t **l4re_env_cap_entry_t**

  Entry in the L4Re environment array for the named initial objects.
- typedef struct l4re_env_t l4re_env_t

  Initial environment data structure.

Functions

- l4re_env_t ∗ l4re_env (void) L4_NOTHROW

  Get L4Re initial environment.
- l4_kernel_info_t const ∗ l4re_kip (void) L4_NOTHROW

  Get Kernel Info Page.
- l4_cap_idx_t l4re_env_get_cap (char const ∗name) L4_NOTHROW

  Get the capability index for the object named name.
- l4_cap_idx_t l4re_env_get_cap_e (char const ∗name, l4re_env_t const ∗e) L4_NOTHROW

  Get the capability index for the object named name.
- l4re_env_cap_entry_t const ∗ l4re_env_get_cap_l (char const ∗name, unsigned l, l4re_env_t const ∗e) L4_NOTHROW

  Get the full l4re_env_cap_entry_t for the object named name.

16.333.1 Detailed Description

Environment interface.
Definition in file env.h.

16.333.2 Typedef Documentation

16.333.2.1 l4re_env_t

```
typedef struct l4re_env_t l4re_env_t
```
Initial environment data structure.

See also

Initial environment

16.334 env.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/consts.h>
00015 #include <l4/sys/types.h>
00016 #include <l4/sys/kip.h>
00017 #include <l4/sys/compiler.h>
00018
00019 #include <l4/re/consts.h>
00020
00021 #ifdef __cplusplus
00022 #include <l4/cxx/string>
00023 #endif
00024
00038
00043 typedef struct l4re_env_cap_entry_t
00044 {
00048   l4_cap_idx_t cap;
00049
00054   l4_umword_t flags;
00055
00059   char name[16];
00060 #ifdef __cplusplus
00061
00065   l4re_env_cap_entry_t() L4_NOTHROW : cap(L4_INVALID_CAP), flags(~0UL) {}
00066
00074   l4re_env_cap_entry_t(char const *n, l4_cap_idx_t c, l4_umword_t f = 0) L4_NOTHROW
00075   : cap(c), flags(f)
00076   {
00077     for (unsigned i = 0; n && i < sizeof(name); ++i, ++n)
00078       {
00079         name[i] = *n;
00080   if (!*n)
00081     break;
00082       }
00083   }
00084
00085   static bool is_valid_name(char const *n) L4_NOTHROW
00086   {
00087     for (unsigned i = 0; *n; ++i, ++n)
00088       if (i >= sizeof(name))
00089         return false;
00090
00091     return true;
00092   }
00093
00094   cxx::String get_name() const noexcept
00095   {
00096     unsigned len = 0;
00097     while (len < sizeof(name) && name[len] != '\0')
00098       ++len;
00099
00100     return cxx::String(name, len);
```

```
00101   }
00102
00103   explicit operator bool() const noexcept
00104   { return flags != ~0UL; }
00105 #endif
00106 } l4re_env_cap_entry_t;
00107
00108
00114 typedef struct l4re_env_t
00115 {
00116   l4_cap_idx_t parent;
00117   l4_cap_idx_t rm;
00118   l4_cap_idx_t mem_alloc;
00119   l4_cap_idx_t log;
00120   l4_cap_idx_t main_thread;
00121   l4_cap_idx_t factory;
00122   l4_cap_idx_t scheduler;
00123   l4_cap_idx_t itas;
00124   l4_cap_idx_t dbg_events;
00125   l4_cap_idx_t first_free_cap;
00128   l4_umword_t  first_free_reply_cap;
00131   l4_fpage_t utcb_area;
00132   l4_addr_t first_free_utcb;
00138   l4re_env_cap_entry_t *caps;
00139 } l4re_env_t;
00140
00146 extern l4re_env_t *l4re_global_env;
00147
00148
00154 L4_INLINE l4re_env_t *l4re_env(void) L4_NOTHROW;
00155
00156 /*
00157  * FIXME: this seems to be at the wrong place here
00158  */
00164 L4_INLINE l4_kernel_info_t const *l4re_kip(void) L4_NOTHROW;
00165
00166
00174 L4_INLINE l4_cap_idx_t
00175 l4re_env_get_cap(char const *name) L4_NOTHROW;
00176
00185 L4_INLINE l4_cap_idx_t
00186 l4re_env_get_cap_e(char const *name, l4re_env_t const *e) L4_NOTHROW;
00187
00198 L4_INLINE l4re_env_cap_entry_t const *
00199 l4re_env_get_cap_l(char const *name, unsigned l, l4re_env_t const *e) L4_NOTHROW;
00200
00201 L4_INLINE
00202 l4re_env_t *l4re_env(void) L4_NOTHROW
00203 { return l4re_global_env; }
00204
00205 L4_INLINE
00206 l4_kernel_info_t const *l4re_kip(void) L4_NOTHROW
00207 { return l4_kip(); }
00208
00209 L4_INLINE l4re_env_cap_entry_t const *
00210 l4re_env_get_cap_l(char const *name, unsigned l, l4re_env_t const *e) L4_NOTHROW
00211 {
00212   l4re_env_cap_entry_t const *c = e->caps;
00213   for (; c && c->flags != ~0UL; ++c)
00214     {
00215       unsigned i;
00216       for (i = 0;
00217            i < sizeof(c->name) && i < l && c->name[i] && name[i] && name[i] == c->name[i];
00218            ++i)
00219   ;
00220
00221       if (i == l && (i == sizeof(c->name) || !c->name[i]))
00222   return c;
00223     }
00224   return NULL;
00225 }
00226
00227 L4_INLINE l4_cap_idx_t
00228 l4re_env_get_cap_e(char const *name, l4re_env_t const *e) L4_NOTHROW
00229 {
00230   unsigned l;
00231   l4re_env_cap_entry_t const *r;
00232   for (l = 0; name[l]; ++l) ;
00233   r = l4re_env_get_cap_l(name, l, e);
00234   if (r)
00235     return r->cap;
00236
00237   return L4_INVALID_CAP;
00238 }
00239
00240 L4_INLINE l4_cap_idx_t
00241 l4re_env_get_cap(char const *name) L4_NOTHROW
```

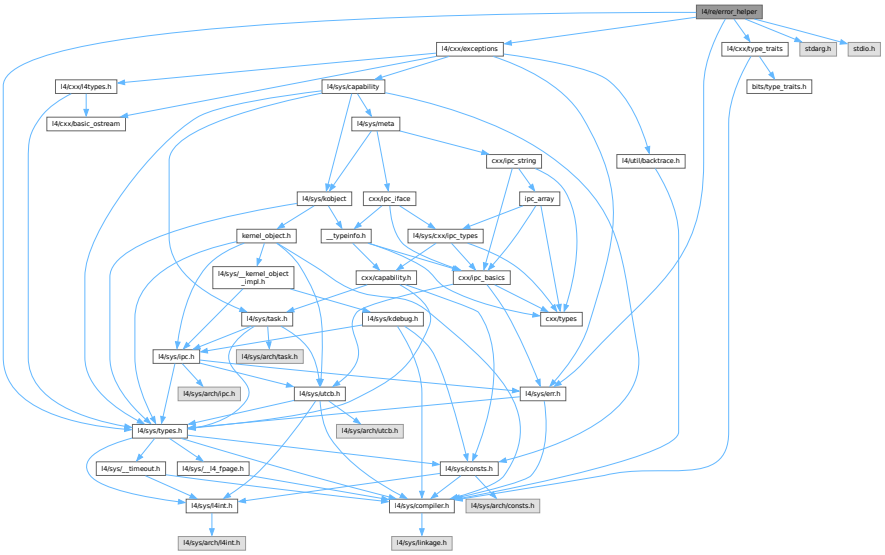
```
00242 { return l4re_env_get_cap_e(name, l4re_env()); }
00243
```

16.335 l4/re/error_helper File Reference

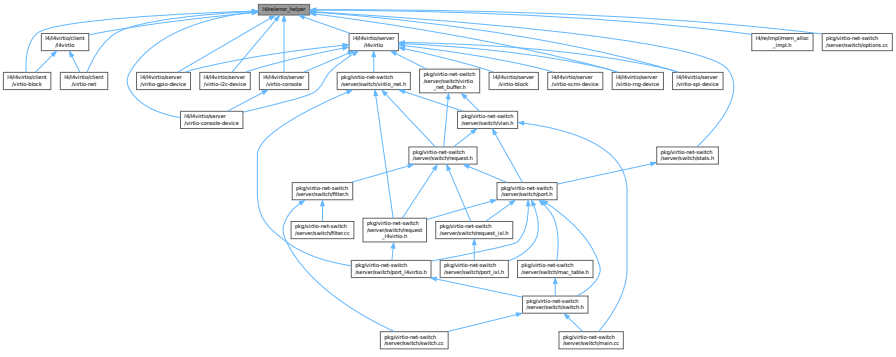
Error helper.

```
#include <l4/sys/types.h>
#include <l4/cxx/exceptions>
#include <l4/cxx/type_traits>
#include <l4/sys/err.h>
#include <stdarg.h>
#include <stdio.h>
```

Include dependency graph for error_helper:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

Functions

- void L4Re::throw_error (long err, char const ∗extra="")

Generate C++ exception.

- l4_ret_t L4Re::chksys (l4_ret_t err, char const *extra="", l4_ret_t ret=0)

  Generate C++ exception on error.
- l4_ret_t L4Re::chksys (l4_msgtag_t const &t, char const *extra="", l4_utcb_t *utcb=l4_utcb(), l4_ret_t ret=0)

  Generate C++ exception on error.
- l4_ret_t L4Re::chksys (l4_msgtag_t const &t, l4_utcb_t *utcb, char const *extra="")

  Generate C++ exception on error.
- template<typename T>
  T L4Re::chkcap (T &&cap, char const *extra="", l4_ret_t err=-L4_ENOMEM)

  Check for valid capability or raise C++ exception.
- l4_msgtag_t L4Re::chkipc (l4_msgtag_t tag, char const *extra="", l4_utcb_t *utcb=l4_utcb())

  Test a message tag for IPC errors.

16.335.1 Detailed Description

Error helper.
Definition in file error_helper.

16.336 error_helper

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/types.h>
00017 #include <l4/cxx/exceptions>
00018 #include <l4/cxx/type_traits>
00019 #include <l4/sys/err.h>
00020
00021 #include <stdarg.h>
00022 #include <stdio.h>
00023
00024 namespace L4Re {
00025
00026 #ifdef __EXCEPTIONS
00027
00037 [[noreturn]] inline void throw_error(long err, char const *extra = "")
00038 {
00039   switch (err)
00040     {
00041     case -L4_ENOENT: throw (L4::Element_not_found(extra));
00042     case -L4_ENOMEM: throw (L4::Out_of_memory(extra));
00043     case -L4_EEXIST: throw (L4::Element_already_exists(extra));
00044     case -L4_ERANGE: throw (L4::Bounds_error(extra));
00045     default: throw (L4::Runtime_error(err, extra));
00046     }
00047 }
00048
00049 [[noreturn]] inline void throw_error_fmt(l4_ret_t err, char const *const fmt, ...)
00050   __attribute__((format(printf, 2, 3)));
00051 [[noreturn]] inline void throw_error_fmt(l4_ret_t err, char const *const fmt, ...)
00052 {
00053   char extra[80];
00054   va_list argp;
00055   va_start(argp, fmt);
00056   vsnprintf(extra, sizeof(extra), fmt, argp);
00057   va_end(argp);
00058   throw_error(err, extra);
00059 }
00060
00071 inline
00072 l4_ret_t chksys(l4_ret_t err, char const *extra = "", l4_ret_t ret = 0)
00073 {
00074   if (L4_UNLIKELY(err < 0))
00075     throw_error(ret ? ret : err, extra);
```

```
00076
00077   return err;
00078 }
00079
00092 inline
00093 l4_ret_t chksys(l4_msgtag_t const &t, char const *extra = "",
00094                 l4_utcb_t *utcb = l4_utcb(), l4_ret_t ret = 0)
00095 {
00096   if (L4_UNLIKELY(t.has_error()))
00097     throw_error(ret ? ret : l4_error_u(t, utcb), extra);
00098   else if (L4_UNLIKELY(t.label() < 0))
00099     throw_error(ret ? ret: t.label(), extra);
00100
00101   return t.label();
00102 }
00103
00115 inline
00116 l4_ret_t chksys(l4_msgtag_t const &t, l4_utcb_t *utcb, char const *extra = "")
00117 { return chksys(t, extra, utcb); }
00118
00119 #if 0
00120 inline
00121 long chksys(l4_ret_t ret, l4_ret_t err, char const *extra = "")
00122 {
00123   if (L4_UNLIKELY(ret < 0))
00124     throw_error(err, extra);
00125
00126   return ret;
00127 }
00128 #endif
00129
00146 template<typename T>
00147 inline
00148 #if __cplusplus >= 201103L
00149 T chkcap(T &&cap, char const *extra = "", l4_ret_t err = -L4_ENOMEM)
00150 #else
00151 T chkcap(T cap, char const *extra = "", l4_ret_t err = -L4_ENOMEM)
00152 #endif
00153 {
00154   if (L4_UNLIKELY(!cap.is_valid()))
00155     throw_error(err ? err : cap.invalid_cap_error(), extra);
00156
00157 #if __cplusplus >= 201103L
00158   return cxx::forward<T>(cap);
00159 #else
00160   return cap;
00161 #endif
00162 }
00163
00178 inline
00179 l4_msgtag_t
00180 chkipc(l4_msgtag_t tag, char const *extra = "",
00181        l4_utcb_t *utcb = l4_utcb())
00182 {
00183   if (L4_UNLIKELY(tag.has_error()))
00184     chksys(l4_error_u(tag, utcb), extra);
00185
00186   return tag;
00187 }
00188 #endif
00189
00190 }
```

16.337 event_enums.h

```
00001 #pragma once
00002
00003 /*
00004  *
00005  *
00006  * Constants for L4Re events ...
00007  */
00008
00009
00010 enum L4Re_events_key
00011 {
00012   L4RE_KEY_RESERVED         = 0,
00013   L4RE_KEY_ESC              = 1,
00014   L4RE_KEY_1                = 2,
00015   L4RE_KEY_2                = 3,
00016   L4RE_KEY_3                = 4,
00017   L4RE_KEY_4                = 5,
00018   L4RE_KEY_5                = 6,
00019   L4RE_KEY_6                = 7,
```

```
00020   L4RE_KEY_7                = 8,
00021   L4RE_KEY_8                = 9,
00022   L4RE_KEY_9                = 10,
00023   L4RE_KEY_0                = 11,
00024   L4RE_KEY_MINUS            = 12,
00025   L4RE_KEY_EQUAL            = 13,
00026   L4RE_KEY_BACKSPACE        = 14,
00027   L4RE_KEY_TAB              = 15,
00028   L4RE_KEY_Q                = 16,
00029   L4RE_KEY_W                = 17,
00030   L4RE_KEY_E                = 18,
00031   L4RE_KEY_R                = 19,
00032   L4RE_KEY_T                = 20,
00033   L4RE_KEY_Y                = 21,
00034   L4RE_KEY_U                = 22,
00035   L4RE_KEY_I                = 23,
00036   L4RE_KEY_O                = 24,
00037   L4RE_KEY_P                = 25,
00038   L4RE_KEY_LEFTBRACE        = 26,
00039   L4RE_KEY_RIGHTBRACE       = 27,
00040   L4RE_KEY_ENTER            = 28,
00041   L4RE_KEY_LEFTCTRL         = 29,
00042   L4RE_KEY_A                = 30,
00043   L4RE_KEY_S                = 31,
00044   L4RE_KEY_D                = 32,
00045   L4RE_KEY_F                = 33,
00046   L4RE_KEY_G                = 34,
00047   L4RE_KEY_H                = 35,
00048   L4RE_KEY_J                = 36,
00049   L4RE_KEY_K                = 37,
00050   L4RE_KEY_L                = 38,
00051   L4RE_KEY_SEMICOLON        = 39,
00052   L4RE_KEY_APOSTROPHE       = 40,
00053   L4RE_KEY_GRAVE            = 41,
00054   L4RE_KEY_LEFTSHIFT        = 42,
00055   L4RE_KEY_BACKSLASH        = 43,
00056   L4RE_KEY_Z                = 44,
00057   L4RE_KEY_X                = 45,
00058   L4RE_KEY_C                = 46,
00059   L4RE_KEY_V                = 47,
00060   L4RE_KEY_B                = 48,
00061   L4RE_KEY_N                = 49,
00062   L4RE_KEY_M                = 50,
00063   L4RE_KEY_COMMA            = 51,
00064   L4RE_KEY_DOT              = 52,
00065   L4RE_KEY_SLASH            = 53,
00066   L4RE_KEY_RIGHTSHIFT       = 54,
00067   L4RE_KEY_KPASTERISK       = 55,
00068   L4RE_KEY_LEFTALT          = 56,
00069   L4RE_KEY_SPACE            = 57,
00070   L4RE_KEY_CAPSLOCK         = 58,
00071   L4RE_KEY_F1               = 59,
00072   L4RE_KEY_F2               = 60,
00073   L4RE_KEY_F3               = 61,
00074   L4RE_KEY_F4               = 62,
00075   L4RE_KEY_F5               = 63,
00076   L4RE_KEY_F6               = 64,
00077   L4RE_KEY_F7               = 65,
00078   L4RE_KEY_F8               = 66,
00079   L4RE_KEY_F9               = 67,
00080   L4RE_KEY_F10              = 68,
00081   L4RE_KEY_NUMLOCK          = 69,
00082   L4RE_KEY_SCROLLLOCK       = 70,
00083   L4RE_KEY_KP7              = 71,
00084   L4RE_KEY_KP8              = 72,
00085   L4RE_KEY_KP9              = 73,
00086   L4RE_KEY_KPMINUS          = 74,
00087   L4RE_KEY_KP4              = 75,
00088   L4RE_KEY_KP5              = 76,
00089   L4RE_KEY_KP6              = 77,
00090   L4RE_KEY_KPPLUS           = 78,
00091   L4RE_KEY_KP1              = 79,
00092   L4RE_KEY_KP2              = 80,
00093   L4RE_KEY_KP3              = 81,
00094   L4RE_KEY_KP0              = 82,
00095   L4RE_KEY_KPDOT            = 83,
00096   L4RE_KEY_ZENKAKUHANKAKU   = 85,
00097   L4RE_KEY_102ND            = 86,
00098   L4RE_KEY_F11              = 87,
00099   L4RE_KEY_F12              = 88,
00100   L4RE_KEY_RO               = 89,
00101   L4RE_KEY_KATAKANA         = 90,
00102   L4RE_KEY_HIRAGANA         = 91,
00103   L4RE_KEY_HENKAN           = 92,
00104   L4RE_KEY_KATAKANAHIRAGANA = 93,
00105   L4RE_KEY_MUHENKAN         = 94,
00106   L4RE_KEY_KPJPCOMMA        = 95,
```

```
00107   L4RE_KEY_KPENTER          = 96,
00108   L4RE_KEY_RIGHTCTRL        = 97,
00109   L4RE_KEY_KPSLASH          = 98,
00110   L4RE_KEY_SYSRQ            = 99,
00111   L4RE_KEY_RIGHTALT         = 100,
00112   L4RE_KEY_LINEFEED         = 101,
00113   L4RE_KEY_HOME             = 102,
00114   L4RE_KEY_UP               = 103,
00115   L4RE_KEY_PAGEUP           = 104,
00116   L4RE_KEY_LEFT             = 105,
00117   L4RE_KEY_RIGHT            = 106,
00118   L4RE_KEY_END              = 107,
00119   L4RE_KEY_DOWN             = 108,
00120   L4RE_KEY_PAGEDOWN         = 109,
00121   L4RE_KEY_INSERT           = 110,
00122   L4RE_KEY_DELETE           = 111,
00123   L4RE_KEY_MACRO            = 112,
00124   L4RE_KEY_MUTE             = 113,
00125   L4RE_KEY_VOLUMEDOWN       = 114,
00126   L4RE_KEY_VOLUMEUP         = 115,
00127   L4RE_KEY_POWER            = 116,
00128   L4RE_KEY_KPEQUAL          = 117,
00129   L4RE_KEY_KPPLUSMINUS      = 118,
00130   L4RE_KEY_PAUSE            = 119,
00131   L4RE_KEY_KPCOMMA          = 121,
00132   L4RE_KEY_HANGEUL          = 122,
00133   L4RE_KEY_HANGUEL          = L4RE_KEY_HANGEUL,
00134   L4RE_KEY_HANJA            = 123,
00135   L4RE_KEY_YEN              = 124,
00136   L4RE_KEY_LEFTMETA         = 125,
00137   L4RE_KEY_RIGHTMETA        = 126,
00138   L4RE_KEY_COMPOSE          = 127,
00139   L4RE_KEY_STOP             = 128,
00140   L4RE_KEY_AGAIN            = 129,
00141   L4RE_KEY_PROPS            = 130,
00142   L4RE_KEY_UNDO             = 131,
00143   L4RE_KEY_FRONT            = 132,
00144   L4RE_KEY_COPY             = 133,
00145   L4RE_KEY_OPEN             = 134,
00146   L4RE_KEY_PASTE            = 135,
00147   L4RE_KEY_FIND             = 136,
00148   L4RE_KEY_CUT              = 137,
00149   L4RE_KEY_HELP             = 138,
00150   L4RE_KEY_MENU             = 139,
00151   L4RE_KEY_CALC             = 140,
00152   L4RE_KEY_SETUP            = 141,
00153   L4RE_KEY_SLEEP            = 142,
00154   L4RE_KEY_WAKEUP           = 143,
00155   L4RE_KEY_FILE             = 144,
00156   L4RE_KEY_SENDFILE         = 145,
00157   L4RE_KEY_DELETEFILE       = 146,
00158   L4RE_KEY_XFER             = 147,
00159   L4RE_KEY_PROG1            = 148,
00160   L4RE_KEY_PROG2            = 149,
00161   L4RE_KEY_WWW              = 150,
00162   L4RE_KEY_MSDOS            = 151,
00163   L4RE_KEY_COFFEE           = 152,
00164   L4RE_KEY_DIRECTION        = 153,
00165   L4RE_KEY_CYCLEWINDOWS     = 154,
00166   L4RE_KEY_MAIL             = 155,
00167   L4RE_KEY_BOOKMARKS        = 156,
00168   L4RE_KEY_COMPUTER         = 157,
00169   L4RE_KEY_BACK             = 158,
00170   L4RE_KEY_FORWARD          = 159,
00171   L4RE_KEY_CLOSECD          = 160,
00172   L4RE_KEY_EJECTCD          = 161,
00173   L4RE_KEY_EJECTCLOSECD     = 162,
00174   L4RE_KEY_NEXTSONG         = 163,
00175   L4RE_KEY_PLAYPAUSE        = 164,
00176   L4RE_KEY_PREVIOUSSONG     = 165,
00177   L4RE_KEY_STOPCD           = 166,
00178   L4RE_KEY_RECORD           = 167,
00179   L4RE_KEY_REWIND           = 168,
00180   L4RE_KEY_PHONE            = 169,
00181   L4RE_KEY_ISO              = 170,
00182   L4RE_KEY_CONFIG           = 171,
00183   L4RE_KEY_HOMEPAGE         = 172,
00184   L4RE_KEY_REFRESH          = 173,
00185   L4RE_KEY_EXIT             = 174,
00186   L4RE_KEY_MOVE             = 175,
00187   L4RE_KEY_EDIT             = 176,
00188   L4RE_KEY_SCROLLUP         = 177,
00189   L4RE_KEY_SCROLLDOWN       = 178,
00190   L4RE_KEY_KPLEFTPAREN      = 179,
00191   L4RE_KEY_KPRIGHTPAREN     = 180,
00192   L4RE_KEY_NEW              = 181,
00193   L4RE_KEY_REDO             = 182,
```

```
00194   L4RE_KEY_F13              = 183,
00195   L4RE_KEY_F14              = 184,
00196   L4RE_KEY_F15              = 185,
00197   L4RE_KEY_F16              = 186,
00198   L4RE_KEY_F17              = 187,
00199   L4RE_KEY_F18              = 188,
00200   L4RE_KEY_F19              = 189,
00201   L4RE_KEY_F20              = 190,
00202   L4RE_KEY_F21              = 191,
00203   L4RE_KEY_F22              = 192,
00204   L4RE_KEY_F23              = 193,
00205   L4RE_KEY_F24              = 194,
00206   L4RE_KEY_PLAYCD           = 200,
00207   L4RE_KEY_PAUSECD          = 201,
00208   L4RE_KEY_PROG3            = 202,
00209   L4RE_KEY_PROG4            = 203,
00210   L4RE_KEY_SUSPEND          = 205,
00211   L4RE_KEY_CLOSE            = 206,
00212   L4RE_KEY_PLAY             = 207,
00213   L4RE_KEY_FASTFORWARD      = 208,
00214   L4RE_KEY_BASSBOOST        = 209,
00215   L4RE_KEY_PRINT            = 210,
00216   L4RE_KEY_HP               = 211,
00217   L4RE_KEY_CAMERA           = 212,
00218   L4RE_KEY_SOUND            = 213,
00219   L4RE_KEY_QUESTION         = 214,
00220   L4RE_KEY_EMAIL            = 215,
00221   L4RE_KEY_CHAT             = 216,
00222   L4RE_KEY_SEARCH           = 217,
00223   L4RE_KEY_CONNECT          = 218,
00224   L4RE_KEY_FINANCE          = 219,
00225   L4RE_KEY_SPORT            = 220,
00226   L4RE_KEY_SHOP             = 221,
00227   L4RE_KEY_ALTERASE         = 222,
00228   L4RE_KEY_CANCEL           = 223,
00229   L4RE_KEY_BRIGHTNESSDOWN   = 224,
00230   L4RE_KEY_BRIGHTNESSUP     = 225,
00231   L4RE_KEY_MEDIA            = 226,
00232   L4RE_KEY_SWITCHVIDEOMODE  = 227,
00233   L4RE_KEY_KBDILLUMTOGGLE   = 228,
00234   L4RE_KEY_KBDILLUMDOWN     = 229,
00235   L4RE_KEY_KBDILLUMUP       = 230,
00236   L4RE_KEY_SEND             = 231,
00237   L4RE_KEY_REPLY            = 232,
00238   L4RE_KEY_FORWARDMAIL      = 233,
00239   L4RE_KEY_SAVE             = 234,
00240   L4RE_KEY_DOCUMENTS        = 235,
00241   L4RE_KEY_UNKNOWN          = 240,
00242   L4RE_KEY_OK               = 0x160,
00243   L4RE_KEY_SELECT           = 0x161,
00244   L4RE_KEY_GOTO             = 0x162,
00245   L4RE_KEY_CLEAR            = 0x163,
00246   L4RE_KEY_POWER2           = 0x164,
00247   L4RE_KEY_OPTION           = 0x165,
00248   L4RE_KEY_INFO             = 0x166,
00249   L4RE_KEY_TIME             = 0x167,
00250   L4RE_KEY_VENDOR           = 0x168,
00251   L4RE_KEY_ARCHIVE          = 0x169,
00252   L4RE_KEY_PROGRAM          = 0x16a,
00253   L4RE_KEY_CHANNEL          = 0x16b,
00254   L4RE_KEY_FAVORITES        = 0x16c,
00255   L4RE_KEY_EPG              = 0x16d,
00256   L4RE_KEY_PVR              = 0x16e,
00257   L4RE_KEY_MHP              = 0x16f,
00258   L4RE_KEY_LANGUAGE         = 0x170,
00259   L4RE_KEY_TITLE            = 0x171,
00260   L4RE_KEY_SUBTITLE         = 0x172,
00261   L4RE_KEY_ANGLE            = 0x173,
00262   L4RE_KEY_ZOOM             = 0x174,
00263   L4RE_KEY_MODE             = 0x175,
00264   L4RE_KEY_KEYBOARD         = 0x176,
00265   L4RE_KEY_SCREEN           = 0x177,
00266   L4RE_KEY_PC               = 0x178,
00267   L4RE_KEY_TV               = 0x179,
00268   L4RE_KEY_TV2              = 0x17a,
00269   L4RE_KEY_VCR              = 0x17b,
00270   L4RE_KEY_VCR2             = 0x17c,
00271   L4RE_KEY_SAT              = 0x17d,
00272   L4RE_KEY_SAT2             = 0x17e,
00273   L4RE_KEY_CD               = 0x17f,
00274   L4RE_KEY_TAPE             = 0x180,
00275   L4RE_KEY_RADIO            = 0x181,
00276   L4RE_KEY_TUNER            = 0x182,
00277   L4RE_KEY_PLAYER           = 0x183,
00278   L4RE_KEY_TEXT             = 0x184,
00279   L4RE_KEY_DVD              = 0x185,
00280   L4RE_KEY_AUX              = 0x186,
```

```
00281   L4RE_KEY_MP3              = 0x187,
00282   L4RE_KEY_AUDIO            = 0x188,
00283   L4RE_KEY_VIDEO            = 0x189,
00284   L4RE_KEY_DIRECTORY        = 0x18a,
00285   L4RE_KEY_LIST             = 0x18b,
00286   L4RE_KEY_MEMO             = 0x18c,
00287   L4RE_KEY_CALENDAR         = 0x18d,
00288   L4RE_KEY_RED              = 0x18e,
00289   L4RE_KEY_GREEN            = 0x18f,
00290   L4RE_KEY_YELLOW           = 0x190,
00291   L4RE_KEY_BLUE             = 0x191,
00292   L4RE_KEY_CHANNELUP        = 0x192,
00293   L4RE_KEY_CHANNELDOWN      = 0x193,
00294   L4RE_KEY_FIRST            = 0x194,
00295   L4RE_KEY_LAST             = 0x195,
00296   L4RE_KEY_AB               = 0x196,
00297   L4RE_KEY_NEXT             = 0x197,
00298   L4RE_KEY_RESTART          = 0x198,
00299   L4RE_KEY_SLOW             = 0x199,
00300   L4RE_KEY_SHUFFLE          = 0x19a,
00301   L4RE_KEY_BREAK            = 0x19b,
00302   L4RE_KEY_PREVIOUS         = 0x19c,
00303   L4RE_KEY_DIGITS           = 0x19d,
00304   L4RE_KEY_TEEN             = 0x19e,
00305   L4RE_KEY_TWEN             = 0x19f,
00306   L4RE_KEY_DEL_EOL          = 0x1c0,
00307   L4RE_KEY_DEL_EOS          = 0x1c1,
00308   L4RE_KEY_INS_LINE         = 0x1c2,
00309   L4RE_KEY_DEL_LINE         = 0x1c3,
00310   L4RE_KEY_FN               = 0x1d0,
00311   L4RE_KEY_FN_ESC           = 0x1d1,
00312   L4RE_KEY_FN_F1            = 0x1d2,
00313   L4RE_KEY_FN_F2            = 0x1d3,
00314   L4RE_KEY_FN_F3            = 0x1d4,
00315   L4RE_KEY_FN_F4            = 0x1d5,
00316   L4RE_KEY_FN_F5            = 0x1d6,
00317   L4RE_KEY_FN_F6            = 0x1d7,
00318   L4RE_KEY_FN_F7            = 0x1d8,
00319   L4RE_KEY_FN_F8            = 0x1d9,
00320   L4RE_KEY_FN_F9            = 0x1da,
00321   L4RE_KEY_FN_F10           = 0x1db,
00322   L4RE_KEY_FN_F11           = 0x1dc,
00323   L4RE_KEY_FN_F12           = 0x1dd,
00324   L4RE_KEY_FN_1             = 0x1de,
00325   L4RE_KEY_FN_2             = 0x1df,
00326   L4RE_KEY_FN_D             = 0x1e0,
00327   L4RE_KEY_FN_E             = 0x1e1,
00328   L4RE_KEY_FN_F             = 0x1e2,
00329   L4RE_KEY_FN_S             = 0x1e3,
00330   L4RE_KEY_FN_B             = 0x1e4,
00331   L4RE_KEY_MAX              = 0x1ff,
00332 };
00333
00334 enum L4Re_events_rel
00335 {
00336   L4RE_REL_X      = 0x00,
00337   L4RE_REL_Y      = 0x01,
00338   L4RE_REL_Z      = 0x02,
00339   L4RE_REL_RX     = 0x03,
00340   L4RE_REL_RY     = 0x04,
00341   L4RE_REL_RZ     = 0x05,
00342   L4RE_REL_HWHEEL = 0x06,
00343   L4RE_REL_DIAL   = 0x07,
00344   L4RE_REL_WHEEL  = 0x08,
00345   L4RE_REL_MISC   = 0x09,
00346   L4RE_REL_MAX    = 0x0f,
00347 };
00348
00349 enum L4Re_events_snd
00350 {
00351   L4RE_SND_CLICK = 0x00,
00352   L4RE_SND_BELL  = 0x01,
00353   L4RE_SND_TONE  = 0x02,
00354   L4RE_SND_MAX   = 0x07,
00355 };
00356
00357 enum L4Re_events_rep
00358 {
00359   L4RE_REP_DELAY  = 0x00,
00360   L4RE_REP_PERIOD = 0x01,
00361   L4RE_REP_MAX    = 0x01,
00362 };
00363
00364 enum L4Re_events_led
00365 {
00366   L4RE_LED_NUML     = 0x00,
00367   L4RE_LED_CAPSL    = 0x01,
```

```
00368   L4RE_LED_SCROLLL  = 0x02,
00369   L4RE_LED_COMPOSE  = 0x03,
00370   L4RE_LED_KANA     = 0x04,
00371   L4RE_LED_SLEEP    = 0x05,
00372   L4RE_LED_SUSPEND  = 0x06,
00373   L4RE_LED_MUTE     = 0x07,
00374   L4RE_LED_MISC     = 0x08,
00375   L4RE_LED_MAIL     = 0x09,
00376   L4RE_LED_CHARGING = 0x0a,
00377   L4RE_LED_MAX      = 0x0f,
00378 };
00379
00380 enum L4Re_events_btn
00381 {
00382   L4RE_BTN_MISC           = 0x100,
00383   L4RE_BTN_0              = 0x100,
00384   L4RE_BTN_1              = 0x101,
00385   L4RE_BTN_2              = 0x102,
00386   L4RE_BTN_3              = 0x103,
00387   L4RE_BTN_4              = 0x104,
00388   L4RE_BTN_5              = 0x105,
00389   L4RE_BTN_6              = 0x106,
00390   L4RE_BTN_7              = 0x107,
00391   L4RE_BTN_8              = 0x108,
00392   L4RE_BTN_9              = 0x109,
00393   L4RE_BTN_MOUSE          = 0x110,
00394   L4RE_BTN_LEFT           = 0x110,
00395   L4RE_BTN_RIGHT          = 0x111,
00396   L4RE_BTN_MIDDLE         = 0x112,
00397   L4RE_BTN_SIDE           = 0x113,
00398   L4RE_BTN_EXTRA          = 0x114,
00399   L4RE_BTN_FORWARD        = 0x115,
00400   L4RE_BTN_BACK           = 0x116,
00401   L4RE_BTN_TASK           = 0x117,
00402   L4RE_BTN_JOYSTICK       = 0x120,
00403   L4RE_BTN_TRIGGER        = 0x120,
00404   L4RE_BTN_THUMB          = 0x121,
00405   L4RE_BTN_THUMB2         = 0x122,
00406   L4RE_BTN_TOP            = 0x123,
00407   L4RE_BTN_TOP2           = 0x124,
00408   L4RE_BTN_PINKIE         = 0x125,
00409   L4RE_BTN_BASE           = 0x126,
00410   L4RE_BTN_BASE2          = 0x127,
00411   L4RE_BTN_BASE3          = 0x128,
00412   L4RE_BTN_BASE4          = 0x129,
00413   L4RE_BTN_BASE5          = 0x12a,
00414   L4RE_BTN_BASE6          = 0x12b,
00415   L4RE_BTN_DEAD           = 0x12f,
00416   L4RE_BTN_GAMEPAD        = 0x130,
00417   L4RE_BTN_A              = 0x130,
00418   L4RE_BTN_B              = 0x131,
00419   L4RE_BTN_C              = 0x132,
00420   L4RE_BTN_X              = 0x133,
00421   L4RE_BTN_Y              = 0x134,
00422   L4RE_BTN_Z              = 0x135,
00423   L4RE_BTN_TL             = 0x136,
00424   L4RE_BTN_TR             = 0x137,
00425   L4RE_BTN_TL2            = 0x138,
00426   L4RE_BTN_TR2            = 0x139,
00427   L4RE_BTN_SELECT         = 0x13a,
00428   L4RE_BTN_START          = 0x13b,
00429   L4RE_BTN_MODE           = 0x13c,
00430   L4RE_BTN_THUMBL         = 0x13d,
00431   L4RE_BTN_THUMBR         = 0x13e,
00432   L4RE_BTN_DIGI           = 0x140,
00433   L4RE_BTN_TOOL_PEN       = 0x140,
00434   L4RE_BTN_TOOL_RUBBER    = 0x141,
00435   L4RE_BTN_TOOL_BRUSH     = 0x142,
00436   L4RE_BTN_TOOL_PENCIL    = 0x143,
00437   L4RE_BTN_TOOL_AIRBRUSH  = 0x144,
00438   L4RE_BTN_TOOL_FINGER    = 0x145,
00439   L4RE_BTN_TOOL_MOUSE     = 0x146,
00440   L4RE_BTN_TOOL_LENS      = 0x147,
00441   L4RE_BTN_TOUCH          = 0x14a,
00442   L4RE_BTN_STYLUS         = 0x14b,
00443   L4RE_BTN_STYLUS2        = 0x14c,
00444   L4RE_BTN_TOOL_DOUBLETAP = 0x14d,
00445   L4RE_BTN_TOOL_TRIPLETAP = 0x14e,
00446   L4RE_BTN_WHEEL          = 0x150,
00447   L4RE_BTN_GEAR_DOWN      = 0x150,
00448   L4RE_BTN_GEAR_UP        = 0x151,
00449 };
00450
00451 enum L4Re_events_sw
00452 {
00453   L4RE_SW_0   = 0x00,
00454   L4RE_SW_1   = 0x01,
```

```
00455   L4RE_SW_2   = 0x02,
00456   L4RE_SW_3   = 0x03,
00457   L4RE_SW_4   = 0x04,
00458   L4RE_SW_5   = 0x05,
00459   L4RE_SW_6   = 0x06,
00460   L4RE_SW_7   = 0x07,
00461   L4RE_SW_MAX = 0x0f,
00462 };
00463
00464 enum L4Re_events_ev
00465 {
00466   L4RE_EV_SYN       = 0x00,
00467   L4RE_EV_KEY       = 0x01,
00468   L4RE_EV_REL       = 0x02,
00469   L4RE_EV_ABS       = 0x03,
00470   L4RE_EV_MSC       = 0x04,
00471   L4RE_EV_SW        = 0x05,
00472   L4RE_EV_LED       = 0x11,
00473   L4RE_EV_SND       = 0x12,
00474   L4RE_EV_REP       = 0x14,
00475   L4RE_EV_FF        = 0x15,
00476   L4RE_EV_PWR       = 0x16,
00477   L4RE_EV_FF_STATUS = 0x17,
00478   L4RE_EV_WINDOW    = 0x18,
00479   L4RE_EV_PM        = 0x1e, // power management signals
00480   L4RE_EV_MAX       = 0x1f,
00481 };
00482
00483 enum L4Re_events_syn
00484 {
00485   L4RE_SYN_REPORT    = 0,
00486   L4RE_SYN_CONFIG    = 1,
00487   L4RE_SYN_MT_REPORT = 2,
00488
00489   L4RE_SYN_STREAM_CFG    = 0x80,
00490 };
00491
00492 enum L4Re_stream_cfg
00493 {
00494   L4RE_SYN_STREAM_NEW   = 0,
00495   L4RE_SYN_STREAM_CLOSE = 1,
00496 };
00497
00498 enum L4Re_events_abs
00499 {
00500   L4RE_ABS_X              = 0x00,
00501   L4RE_ABS_Y              = 0x01,
00502   L4RE_ABS_Z              = 0x02,
00503   L4RE_ABS_RX             = 0x03,
00504   L4RE_ABS_RY             = 0x04,
00505   L4RE_ABS_RZ             = 0x05,
00506   L4RE_ABS_THROTTLE       = 0x06,
00507   L4RE_ABS_RUDDER         = 0x07,
00508   L4RE_ABS_WHEEL          = 0x08,
00509   L4RE_ABS_GAS            = 0x09,
00510   L4RE_ABS_BRAKE          = 0x0a,
00511   L4RE_ABS_HAT0X          = 0x10,
00512   L4RE_ABS_HAT0Y          = 0x11,
00513   L4RE_ABS_HAT1X          = 0x12,
00514   L4RE_ABS_HAT1Y          = 0x13,
00515   L4RE_ABS_HAT2X          = 0x14,
00516   L4RE_ABS_HAT2Y          = 0x15,
00517   L4RE_ABS_HAT3X          = 0x16,
00518   L4RE_ABS_HAT3Y          = 0x17,
00519   L4RE_ABS_PRESSURE       = 0x18,
00520   L4RE_ABS_DISTANCE       = 0x19,
00521   L4RE_ABS_TILT_X         = 0x1a,
00522   L4RE_ABS_TILT_Y         = 0x1b,
00523   L4RE_ABS_TOOL_WIDTH     = 0x1c,
00524   L4RE_ABS_VOLUME         = 0x20,
00525   L4RE_ABS_MISC           = 0x28,
00526   L4RE_ABS_MT_TOUCH_MAJOR = 0x30,
00527   L4RE_ABS_MT_TOUCH_MINOR = 0x31,
00528   L4RE_ABS_MT_WIDTH_MAJOR = 0x32,
00529   L4RE_ABS_MT_WIDTH_MINOR = 0x33,
00530   L4RE_ABS_MT_ORIENTATION = 0x34,
00531   L4RE_ABS_MT_POSITION_X  = 0x35,
00532   L4RE_ABS_MT_POSITION_Y  = 0x36,
00533   L4RE_ABS_MT_TOOL_TYPE   = 0x37,
00534   L4RE_ABS_MT_BLOB_ID     = 0x38,
00535   L4RE_ABS_MT_TRACKING_ID = 0x39,
00536   L4RE_ABS_MT_PRESSURE    = 0x3a,
00537   L4RE_ABS_MT_DISTANCE    = 0x3b,
00538
00539   L4RE_ABS_MAX            = 0x3f,
00540 };
00541
```

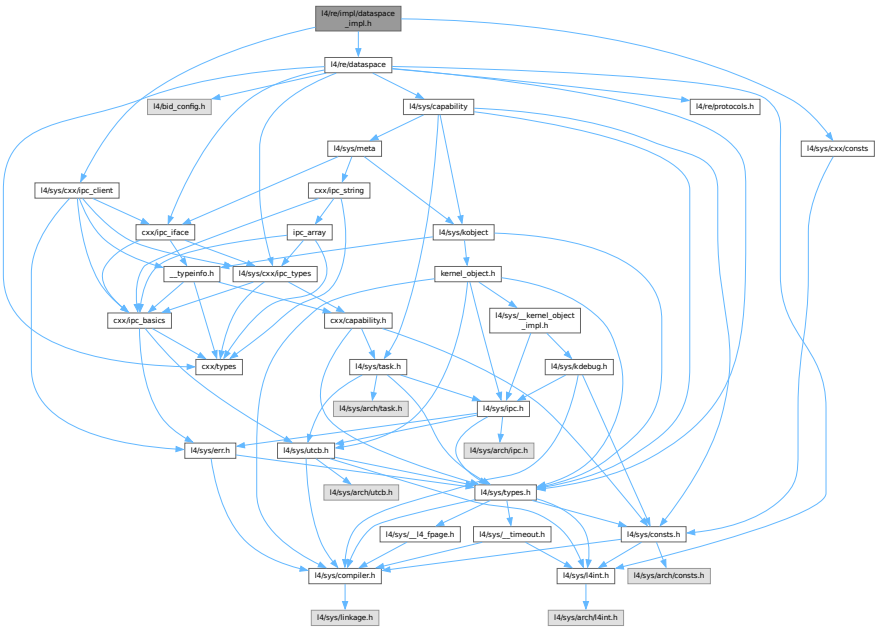
```
00542 enum L4Re_events_msc
00543 {
00544   L4RE_MSC_SERIAL    = 0x00,
00545   L4RE_MSC_PULSELED  = 0x01,
00546   L4RE_MSC_GESTURE   = 0x02,
00547   L4RE_MSC_RAW       = 0x03,
00548   L4RE_MSC_SCAN      = 0x04,
00549   L4RE_MSC_MAX       = 0x07,
00550 };
00551
00552 enum L4Re_events_properties
00553 {
00554   L4RE_EVENT_PROP_POINTER    = 0x00,
00555   L4RE_EVENT_PROP_DIRECT     = 0x01,
00556   L4RE_EVENT_PROP_BUTTONPAD  = 0x02,
00557   L4RE_EVENT_PROP_SEMI_MT    = 0x03,
00558   //L4RE_EVENT_PROP_MAX        = 0x1f
00559 };
```

16.338 l4/re/impl/dataspace_impl.h File Reference

Dataspace client stub implementation.

```
#include <l4/re/dataspace>
#include <l4/sys/cxx/ipc_client>
#include <l4/sys/cxx/consts>
```

Include dependency graph for dataspace_impl.h:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.338.1 Detailed Description

Dataspace client stub implementation.
Definition in file dataspace_impl.h.

16.339 dataspace_impl.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #include <l4/re/dataspace>
00014 #include <l4/sys/cxx/ipc_client>
00015 #include <l4/sys/cxx/consts>
00016
00017 L4_RPC_DEF(L4Re::Dataspace::clear);
00018 L4_RPC_DEF(L4Re::Dataspace::allocate);
00019 L4_RPC_DEF(L4Re::Dataspace::copy_in);
00020 L4_RPC_DEF(L4Re::Dataspace::info);
00021 L4_RPC_DEF(L4Re::Dataspace::map_info);
00022
00023 namespace L4Re {
00024
00025 l4_ret_t
00026 Dataspace::__map(Dataspace::Offset offset, unsigned char *order,
00027                  Dataspace::Flags flags,
00028                  Dataspace::Map_addr local_addr,
00029                  L4::Cap<L4::Task> dst) const noexcept
00030 {
00031   Map_addr spot = local_addr & ~(~0ULL << l4_umword_t(*order));
00032   Map_addr base = local_addr & (~0ULL << l4_umword_t(*order));
00033   L4::Ipc::Rcv_fpage r = L4::Ipc::Rcv_fpage::mem(base, *order, 0, dst);
00034
00035   L4::Ipc::Snd_fpage fp;
00036   l4_ret_t err = map_t::call(c(), offset, spot, flags, r, fp, l4_utcb());
00037   if (L4_UNLIKELY(err < 0))
00038     return err;
00039
00040   *order = fp.rcv_order();
00041   return err;
00042 }
00043
00044 l4_ret_t
00045 Dataspace::map_region(Dataspace::Offset offset, Dataspace::Flags flags,
00046                       Dataspace::Map_addr min_addr,
00047                       Dataspace::Map_addr max_addr,
00048                       L4::Cap<L4::Task> dst) const noexcept
00049 {
00050   min_addr   = L4::trunc_page(min_addr);
00051   max_addr   = L4::round_page(max_addr);
00052   unsigned char order = L4_LOG2_PAGESIZE;
00053
00054   l4_ret_t err = 0;
00055
00056   while (min_addr < max_addr)
00057     {
00058       unsigned char order_mapped;
00059       order_mapped = order
00060         = L4::max_order(order, min_addr, min_addr, max_addr, min_addr);
00061
00062       err = __map(offset, &order_mapped, flags, min_addr, dst);
00063       if (L4_UNLIKELY(err < 0))
00064         return err;
00065
00066       if (order > order_mapped)
00067         order = order_mapped;
00068
00069       min_addr += Map_addr(1) << order;
00070       offset   += Map_addr(1) << order;
00071
00072       if (min_addr >= max_addr)
00073         return 0;
00074
00075       while (min_addr != L4::trunc_order(min_addr, order)
00076              || max_addr < L4::round_order(min_addr + 1, order))
00077         --order;
00078     }
00079
00080   return 0;
00081 }
00082
00083 l4_ret_t
00084 Dataspace::map(Dataspace::Offset offset, Dataspace::Flags flags,
00085                Dataspace::Map_addr local_addr,
00086                Dataspace::Map_addr min_addr,
```

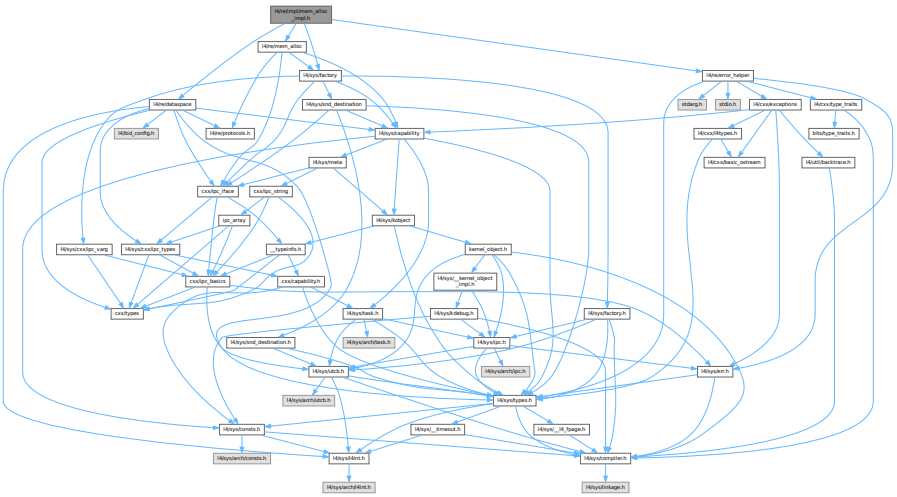
```
00087                Dataspace::Map_addr max_addr,
00088                L4::Cap<L4::Task> dst) const noexcept
00089 {
00090   min_addr   = L4::trunc_page(min_addr);
00091   max_addr   = L4::round_page(max_addr);
00092   local_addr = L4::trunc_page(local_addr);
00093   unsigned char order
00094     = L4::max_order(L4_LOG2_PAGESIZE, local_addr, min_addr, max_addr, local_addr);
00095
00096   return __map(offset, &order, flags, local_addr, dst);
00097 }
00098
00099 Dataspace::Size
00100 Dataspace::size() const noexcept
00101 {
00102   Stats stats = Stats();
00103
00104   int err = info(&stats);
00105   if (err < 0)
00106     return 0;
00107
00108   return stats.size;
00109 }
00110
00111 Dataspace::Flags
00112 Dataspace::flags() const noexcept
00113 {
00114   Stats stats = Stats();
00115
00116   int err = info(&stats);
00117   if (err < 0)
00118     return Flags(0);
00119
00120   return stats.flags;
00121 }
00122
00123 };
```

16.340 l4/re/impl/mem_alloc_impl.h File Reference

Memory allocator client stub implementation.

```
#include <l4/re/mem_alloc>
#include <l4/re/dataspace>
#include <l4/re/error_helper>
#include <l4/sys/factory>
```

Include dependency graph for mem_alloc_impl.h:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.340.1 Detailed Description

Memory allocator client stub implementation.
Definition in file mem_alloc_impl.h.

16.341 mem_alloc_impl.h

Go to the documentation of this file.

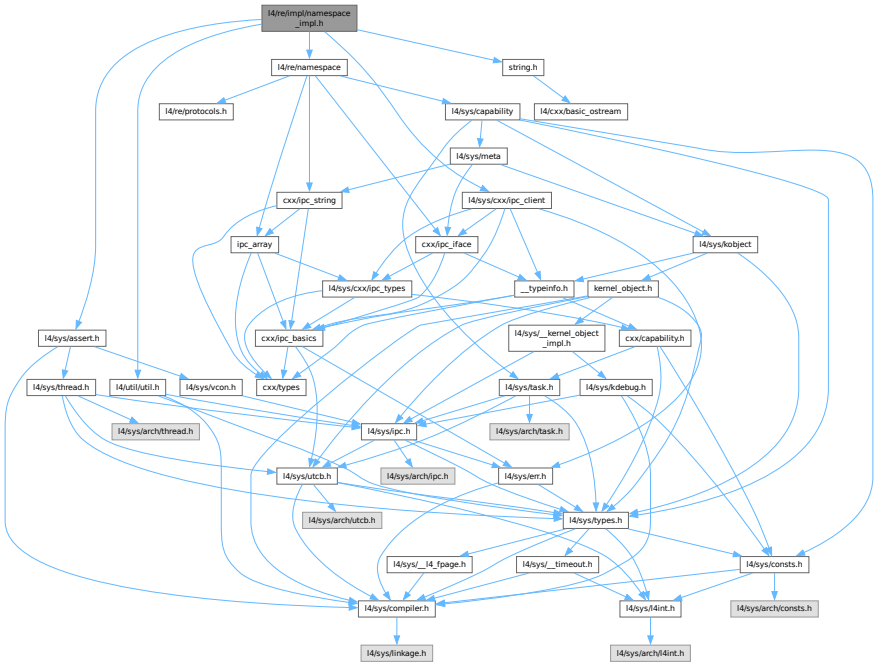
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #include <l4/re/mem_alloc>
00013 #include <l4/re/dataspace>
00014 #include <l4/re/error_helper>
00015
00016 #include <l4/sys/factory>
00017
00018
00019 namespace L4Re
00020 {
00021
00022 l4_ret_t
00023 Mem_alloc::alloc(long size, L4::Cap<Dataspace> mem, unsigned long flags,
00024                  unsigned long align, l4_addr_t paddr,
00025                  char const *type) const noexcept
00026 {
00027   L4::Cap<L4::Factory> f(cap());
00028   auto call = f->create(mem, L4Re::Dataspace::Protocol);
00029   call « l4_mword_t(size)
00030        « l4_umword_t(flags)
00031        « l4_umword_t(align);
00032   if (flags & Fixed_paddr)
00033     call « l4_umword_t(paddr);
00034   if (type)
00035     {
00036       // We have to prepend 'type='.
00037       static constexpr unsigned Prefix_len = 5;
00038       char type_buf[32]; // assuming that type length is limited
00039       auto len = __builtin_strlen(type);
00040       if (len > sizeof(type_buf) - Prefix_len - 1)
00041         return -L4_EINVAL; // name too long
00042       __builtin_memcpy(type_buf, "type=", Prefix_len);
00043       __builtin_memcpy(&type_buf[Prefix_len], type, len);
00044       type_buf[Prefix_len + len] = '\0';
00045
00046       call « type_buf;
00047     }
00048
00049   return l4_error(call);
00050 }
00051
00052 };
```

16.342 l4/re/impl/namespace_impl.h File Reference

Namespace client stub implementation.

```
#include <l4/re/namespace>
#include <l4/util/util.h>
#include <l4/sys/cxx/ipc_client>
#include <l4/sys/assert.h>
#include <string.h>
```

Include dependency graph for namespace_impl.h:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.342.1 Detailed Description

Namespace client stub implementation.
Definition in file namespace_impl.h.

16.343 namespace_impl.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #include <l4/re/namespace>
00013
00014 #include <l4/util/util.h>
00015 #include <l4/sys/cxx/ipc_client>
00016 #include <l4/sys/assert.h>
00017
00018 #include <string.h>
00019
00020 L4_RPC_DEF(L4Re::Namespace::query);
00021 L4_RPC_DEF(L4Re::Namespace::register_obj);
00022 L4_RPC_DEF(L4Re::Namespace::unlink);
00023
00024 namespace L4Re {
00025
00026 l4_ret_t
00027 Namespace::_query(char const *name, unsigned len,
00028                   L4::Cap<void> const &target,
00029                   l4_umword_t *local_id, bool iterate) const noexcept
00030 {
```

```
00031   l4_assert(target.is_valid());
00032
00033   L4::Cap<Namespace> ns = c();
00034   L4::Ipc::Array<char const, unsigned long> _name(len, name);
00035
00036   while (_name.length > 0)
00037     {
00038       L4::Ipc::Snd_fpage cap;
00039       L4::Opcode dummy;
00040       int err = query_t::call(ns, _name,
00041                               L4::Ipc::Small_buf(target.cap(),
00042                                                  local_id
00043                                                    ? L4_RCV_ITEM_LOCAL_ID
00044                                                    : 0),
00045                               cap, dummy, _name);
00046       if (err < 0)
00047         return err;
00048
00049       bool const partly = err & Partly_resolved;
00050       if (cap.id_received())
00051         {
00052           *local_id = cap.data();
00053           return _name.length;
00054         }
00055
00056       if (partly && iterate)
00057         ns = L4::cap_cast<Namespace>(target);
00058       else
00059         return err;
00060     }
00061
00062   return _name.length;
00063 }
00064
00065 l4_ret_t
00066 Namespace::query(char const *name, unsigned len, L4::Cap<void> const &target,
00067                  int timeout, l4_umword_t *local_id, bool iterate) const noexcept
00068 {
00069   if (L4_UNLIKELY(len == 0))
00070     return -L4_EINVAL;
00071
00072   if (L4_UNLIKELY(timeout < 0))
00073     return -L4_EINVAL;
00074
00075   l4_ret_t ret;
00076   long rem = timeout;
00077   long to = 0;
00078
00079   if (rem)
00080     to = 10;
00081
00082   do
00083     {
00084       ret = _query(name, len, target, local_id, iterate);
00085
00086       if (ret >= 0)
00087         return ret;
00088
00089       if (L4_UNLIKELY(ret != -L4_EAGAIN))
00090         return ret;
00091
00092       if (rem == to)
00093         return ret;
00094
00095       l4_sleep(to);
00096
00097       if (rem > 0)
00098         {
00099           rem -= to;
00100           if (rem < 0)
00101             {
00102               to = rem = 0;
00103               continue; // one final try
00104             }
00105         }
00106
00107       if (to < 100)
00108         to += to;
00109     }
00110   while (486);
00111 }
00112
00113 l4_ret_t
00114 Namespace::query(char const *name, L4::Cap<void> const &target,
00115                  int timeout, l4_umword_t *local_id,
00116                  bool iterate) const noexcept
00117 {
```

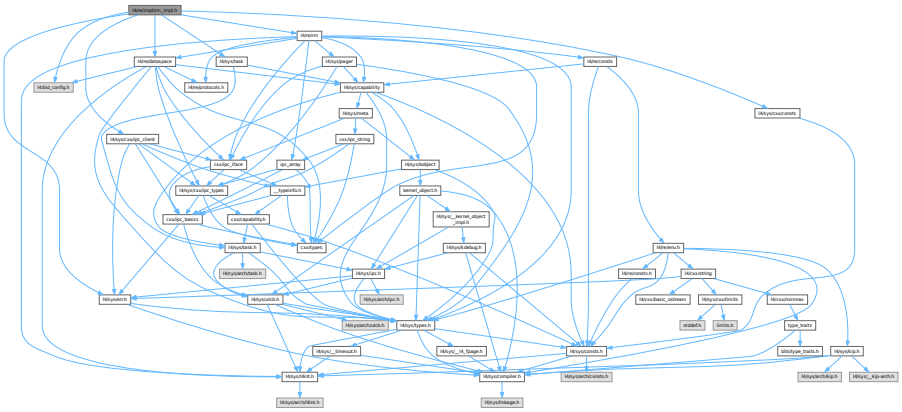
```
00118   return query(name, __builtin_strlen(name), target,
00119                timeout, local_id, iterate);
00120 }
00121
00122 }
```

16.344 l4/re/impl/rm_impl.h File Reference

Region map client stub implementation.

```
#include <l4/bid_config.h>
#include <l4/re/rm>
#include <l4/re/dataspace>
#include <l4/sys/cxx/consts>
#include <l4/sys/cxx/ipc_client>
#include <l4/sys/task>
#include <l4/sys/err.h>
```

Include dependency graph for rm_impl.h:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.344.1 Detailed Description

Region map client stub implementation.
Definition in file rm_impl.h.

16.345 rm_impl.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #include <l4/bid_config.h>
00014 #include <l4/re/rm>
00015 #include <l4/re/dataspace>
00016
00017 #include <l4/sys/cxx/consts>
00018 #include <l4/sys/cxx/ipc_client>
00019
00020 #include <l4/sys/task>
```

```
00021 #include <l4/sys/err.h>
00022
00023 L4_RPC_DEF(L4Re::Rm::reserve_area);
00024 L4_RPC_DEF(L4Re::Rm::free_area);
00025 L4_RPC_DEF(L4Re::Rm::attach);
00026 L4_RPC_DEF(L4Re::Rm::detach);
00027 L4_RPC_DEF(L4Re::Rm::get_regions);
00028 L4_RPC_DEF(L4Re::Rm::get_areas);
00029 L4_RPC_DEF(L4Re::Rm::find);
00030 L4_RPC_DEF(L4Re::Rm::get_info);
00031 L4_RPC_DEF(L4Re::Rm::add_rescue_jump);
00032 L4_RPC_DEF(L4Re::Rm::remove_rescue_jump);
00033
00034 namespace L4Re
00035 {
00036
00037 l4_ret_t
00038 Rm::attach(l4_addr_t *start, unsigned long size, Rm::Flags flags,
00039            L4::Ipc::Cap<Dataspace> mem, Rm::Offset offs,
00040            unsigned char align, L4::Cap<L4::Task> const task,
00041            char const *name, Rm::Offset backing_offset) const noexcept
00042 {
00043   if ((flags & F::Rights_mask) == Flags(0)
00044       || (flags & (F::Reserved | F::Kernel)))
00045     mem = L4::Ipc::Cap<L4Re::Dataspace>();
00046
00047   char const n = '\0';
00048   l4_ret_t e = attach_t::call(c(), start, size, flags, mem, offs, align,
00049                               mem.cap().cap(), name ? name : &n, backing_offset);
00050   if (e < 0)
00051     return e;
00052
00053 #ifdef CONFIG_MMU
00054   if ((flags & (F::Eager_map | F::No_eager_map)) == F::Eager_map)
00055 #else
00056   if (!(flags & F::No_eager_map) && mem.is_valid())
00057 #endif
00058     page_in(*start, size, flags.region_flags() & F::RWX, task);
00059
00060   return 0;
00061 }
00062
00063 l4_ret_t
00064 Rm::detach(l4_addr_t start, unsigned long size, L4::Cap<Dataspace> *mem,
00065            L4::Cap<L4::Task> task, unsigned flags) const noexcept
00066 {
00067   l4_addr_t rstart = 0, rsize = 0;
00068   l4_cap_idx_t mem_cap = L4_INVALID_CAP;
00069   l4_ret_t e = detach_t::call(c(), start, size, flags, rstart, rsize, mem_cap);
00070   if (L4_UNLIKELY(e < 0))
00071     return e;
00072
00073   if (mem)
00074     *mem = L4::Cap<L4Re::Dataspace>(mem_cap);
00075
00076   if (e & Unmapped_range)
00077     // Hide Unmapped_range bit. Some callers incorrectly treat anything except
00078     // zero as failure.
00079     return e & ~Unmapped_range;
00080
00081   if (!task.is_valid())
00082     return e;
00083
00084   rsize = l4_round_page(rsize);
00085   unsigned order = L4_LOG2_PAGESIZE;
00086   unsigned long sz = (1UL << order);
00087   for (unsigned long p = rstart; rsize; p += sz, rsize -= sz)
00088     {
00089       while (sz > rsize)
00090         {
00091           --order;
00092           sz >>= 1;
00093         }
00094
00095       for (;;)
00096         {
00097           unsigned long m = sz << 1;
00098           if (m > rsize)
00099             break;
00100
00101           if (p & (m - 1))
00102             break;
00103
00104           ++order;
00105           sz <<= 1;
00106         }
00107
```

```
00108       task->unmap(l4_fpage(p, order, L4_FPAGE_RWX),
00109                   L4_FP_ALL_SPACES);
00110     }
00111
00112   return e;
00113 }
00114
00115 l4_ret_t
00116 Rm::page_in(l4_addr_t start, unsigned long size, Rm::Region_flags rights,
00117             L4::Cap<L4::Task> dst) const noexcept
00118 {
00119   if (rights & ~F::RWX)
00120     return -L4_EINVAL;
00121
00122   if (size == 0 || !(rights & F::R))
00123     return 0;
00124
00125   if (start + size - 1 < start)
00126     return -L4_EINVAL;
00127
00128   auto rwin = L4::Ipc::Rcv_fpage::mem(0, L4_WHOLE_ADDRESS_SPACE, 0, dst);
00129
00130   l4_addr_t min_addr  = L4::trunc_page(start);
00131   l4_addr_t max_addr  = L4::round_page(start + size) - 1;
00132
00133   while (min_addr < max_addr)
00134     {
00135       L4::Ipc::Snd_fpage fp;
00136       page_in_fn helper = nullptr;
00137       l4_ret_t ret = page_in_t::call(c(), min_addr, max_addr, rights, rwin, fp,
00138                                      &helper);
00139       if (ret != 0)
00140         return ret;
00141
00142       // ITAS, which is in the same task, will let us jump to the handler. That
00143       // way, the thread itself will do the work. The helper is supposed to
00144       // handle the full range...
00145       if (helper)
00146         {
00147           // The ITAS only pages the current task. Trying to page for a foreign
00148           // task is not supported.
00149           if (dst)
00150             return -L4_EINVAL;
00151
00152           return helper(min_addr, max_addr, rights);
00153         }
00154
00155       min_addr += l4_addr_t{1} << fp.rcv_order();
00156     }
00157
00158   return 0;
00159 }
00160
00161 }
```

16.346 inhibitor

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Steffen Liebergeld <steffen.liebergeld@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/capability>
00010 #include <l4/sys/cxx/ipc_iface>
00011 #include <l4/sys/cxx/ipc_string>
00012 #include <l4/re/protocols.h>
00013
00014 namespace L4Re {
00015
00038 class Inhibitor :
00039   public L4::Kobject_t<Inhibitor, L4::Kobject, L4RE_PROTO_INHIBITOR>
00040 {
00041 public:
00042   enum
00043   {
00044     Name_max = 20
00045   };
00046
00057   L4_INLINE_RPC(l4_ret_t, acquire, (l4_umword_t id, L4::Ipc::String<> reason));
00058
00067   L4_INLINE_RPC(l4_ret_t, release, (l4_umword_t id));
```

```
00068
00084   l4_ret_t next_lock_info(char *name, unsigned len, l4_mword_t current_id = -1,
00085                           l4_utcb_t *utcb = l4_utcb())
00086   {
00087     L4::Ipc::String<char> name_buf(len , name);
00088     l4_ret_t r = next_lock_info_t::call(c(), &current_id, name_buf, utcb);
00089     if (r < 0)
00090       return r;
00091
00092     return current_id;
00093   }
00094
00095   L4_INLINE_RPC_NF(l4_ret_t, next_lock_info, (L4::Ipc::In_out<l4_mword_t *> current_id,
00096                                               L4::Ipc::String<char> &name));
00097
00098   typedef L4::Typeid::Rpcs<acquire_t, release_t, next_lock_info_t> Rpcs;
00099 };
00100
00101 }
```

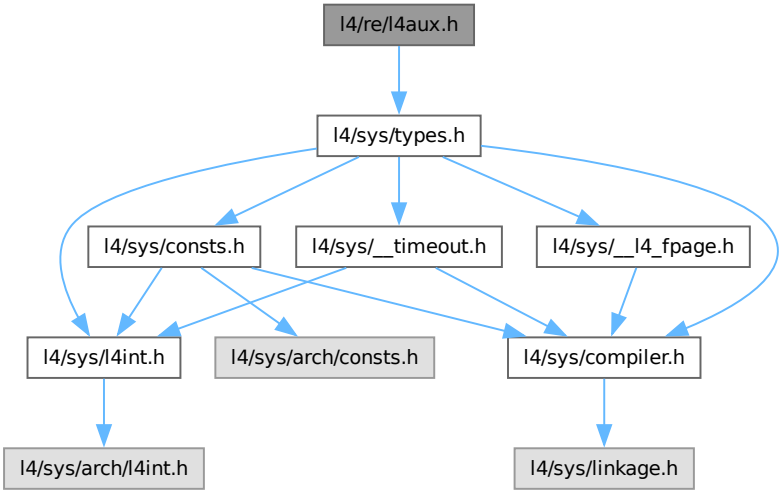
16.347 itas

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2025 Kernkonzept GmbH.
00004  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00009 #pragma once
00010
00011 #include <l4/sys/cxx/ipc_iface>
00012 #include <l4/sys/cxx/ipc_types>
00013 #include <l4/sys/cxx/types>
00014 #include <l4/sys/l4int.h>
00015 #include <l4/sys/thread>
00016 #include <l4/sys/types.h>
00017
00018 #include <signal.h>
00019 #include <sys/time.h>
00020
00021 namespace L4Re
00022 {
00023
00030 class L4_EXPORT Itas :
00031   public L4::Kobject_t<Itas, L4::Kobject,
00032                        L4RE_PROTO_ITAS,
00033                        L4::Type_info::Demand_t<2> >
00034 {
00035 public:
00048   L4_INLINE_RPC(l4_ret_t, register_thread, (L4::Ipc::Cap<L4::Thread> parent,
00049                                             L4::Ipc::Cap<L4::Thread> thread_cap,
00050                                             l4_addr_t thread_utcb));
00051
00060   L4_INLINE_RPC(l4_ret_t, unregister_thread, (L4::Ipc::Cap<L4::Thread> thread));
00061
00073   L4_INLINE_RPC(l4_ret_t, disable_pf_tramp, ());
00074
00075   // sigaction.sa_flags is usually `unsigned long', except for MIPS...
00076   enum : unsigned
00077   {
00078     Ignore_sigaction = ~0U
00079   };
00080
00092   L4_INLINE_RPC(l4_ret_t, sigaction, (int signum,
00093                                       const struct sigaction *act,
00094                                       struct sigaction *oldact));
00095
00108   L4_INLINE_RPC(l4_ret_t, sigaltstack, (L4::Ipc::Cap<L4::Thread> thread,
00109                                         const struct sigaltstack *ss,
00110                                         struct sigaltstack *oss));
00111
00126   L4_INLINE_RPC(l4_ret_t, sigprocmask, (L4::Ipc::Cap<L4::Thread> thread,
00127                                         int how, sigset_t const *set,
00128                                         sigset_t *oldset));
00129
00139   L4_INLINE_RPC(l4_ret_t, sigpending, (L4::Ipc::Cap<L4::Thread> thread,
00140                                        sigset_t *set));
00141
00151   L4_INLINE_RPC(l4_ret_t, setitimer, (int which,
00152                                       const struct itimerval *new_value,
00153                                       struct itimerval *old_value));
00154
```

```
00163   L4_INLINE_RPC(l4_ret_t, getitimer, (int which, struct itimerval *curr_value));
00164
00171   L4_INLINE_RPC(l4_ret_t, raise, (L4::Ipc::Cap<L4::Thread> thread, int sig));
00172
00173   typedef L4::Typeid::Rpcs<
00174     register_thread_t, unregister_thread_t, disable_pf_tramp_t, sigaction_t,
00175     sigaltstack_t, sigprocmask_t, sigpending_t, setitimer_t, getitimer_t,
00176     raise_t
00177   > Rpcs;
00178 };
00179
00180 }
```

16.348 l4/re/l4aux.h File Reference

Auxiliary definitions.
`#include <l4/sys/types.h>`
Include dependency graph for l4aux.h:



Data Structures

- struct l4re_aux_t

  Auxiliary descriptor.

Typedefs

- typedef struct l4re_aux_t **l4re_aux_t**

  Auxiliary descriptor.

Enumerations

- enum l4re_aux_ldr_flags_t

  Flags for program loading.

16.348.1 Detailed Description

Auxiliary definitions.
Definition in file l4aux.h.

16.349 l4aux.h

Go to the documentation of this file.

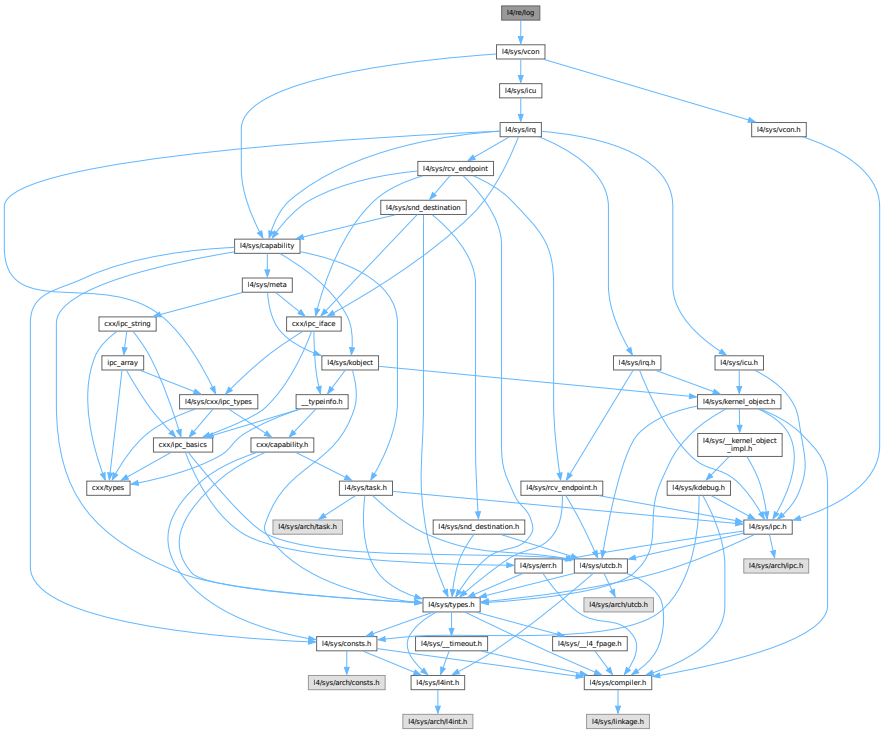
```
00001 #pragma once
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #include <l4/sys/types.h>
00016
00022
00028 enum l4re_aux_ldr_flags_t
00029 {
00030   L4RE_AUX_LDR_FLAG_EAGER_MAP    = 0x1,
00031   L4RE_AUX_LDR_FLAG_ALL_SEGS_COW = 0x2,
00032   L4RE_AUX_LDR_FLAG_PINNED_SEGS  = 0x4,
00033 };
00034
00040 typedef struct l4re_aux_t
00041 {
00042   char const *    binary;
00043   l4_cap_idx_t    kip_ds;
00044   l4_umword_t     dbg_lvl;
00045   l4_umword_t     ldr_flags;
00046   l4_addr_t       ldr_base;
00047 } l4re_aux_t;
00048
```

16.350 l4/re/log File Reference

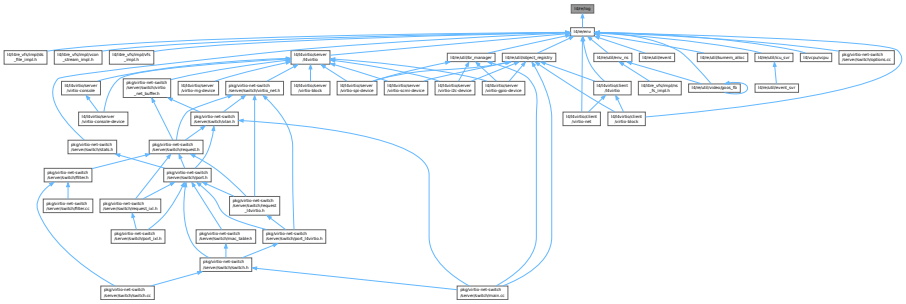
Log interface.

`#include <l4/sys/vcon>`

Include dependency graph for log:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Log

  Log interface class.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.350.1 Detailed Description

Log interface.
Definition in file log.

16.351 log

Go to the documentation of this file.

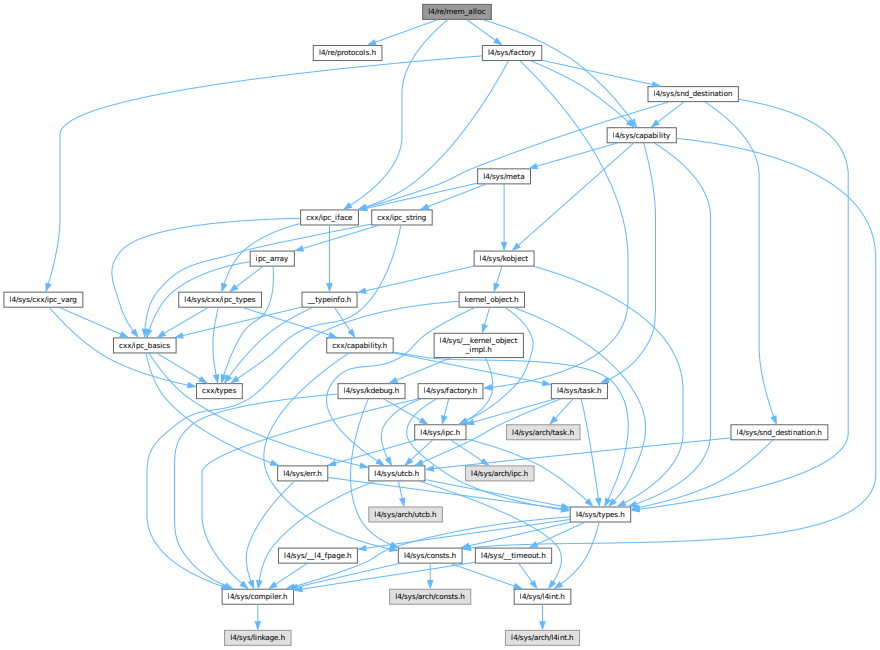
```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/vcon>
00017
00018 namespace L4Re {
00019
00033 class L4_EXPORT Log : public L4::Kobject_t<Log, L4::Vcon, L4::PROTO_EMPTY>
00034 {
00035 public:
00036
00043   void printn(char const *string, unsigned len) const noexcept;
00044
00050   void print(char const *string) const noexcept;
00051 };
00052 }
```

16.352 l4/re/mem_alloc File Reference

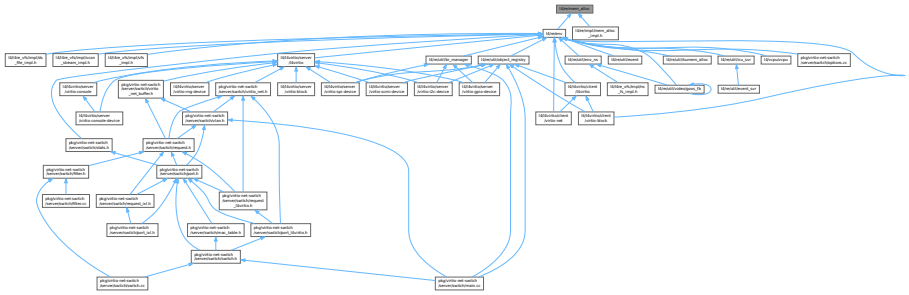
Memory allocator interface.

```
#include <l4/re/protocols.h>
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_iface>
```

`#include <l4/sys/factory>`
Include dependency graph for mem_alloc:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Mem_alloc

  Memory allocation interface.
- struct L4Re::Mem_alloc::Stats

  Statistics about memory-allocator.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.352.1 Detailed Description

Memory allocator interface.
Definition in file mem_alloc.

16.353 mem_alloc

Go to the documentation of this file.

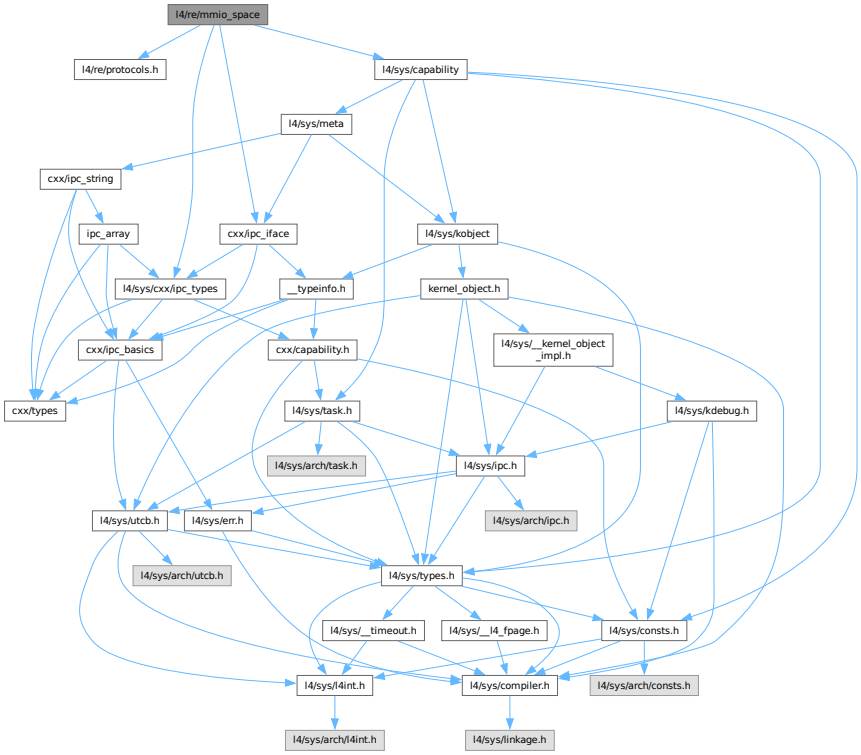
```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * Copyright (C) 2014-2016, 2019, 2021, 2024-2025 Kernkonzept GmbH.
00009  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00010  */
00011 /*
00012  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00013  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00014  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00015  *     economic rights: Technische Universität Dresden (Germany)
00016  *
00017  * License: see LICENSE.spdx (in this directory or the directories above)
00018  */
00019 #pragma once
00020
00021 #include <l4/re/protocols.h>
00022 #include <l4/sys/capability>
00023 #include <l4/sys/cxx/ipc_iface>
00024 #include <l4/sys/factory>
00025
00026 namespace L4Re {
00027 class Dataspace;
00028
00029 // MISSING:
00030 // * alignment constraints
00031 // * shall we support superpages in noncont memory?
00032
00052 class L4_EXPORT Mem_alloc :
00053   public L4::Kobject_t<Mem_alloc, L4::Factory, L4RE_PROTO_MEM_ALLOC>
00054 {
00055 public:
00062   enum Mem_alloc_flags : unsigned long
00063   {
00064     Continuous    = 0x01,
00065     Pinned        = 0x02,
00066     Super_pages   = 0x04,
00067     Fixed_paddr   = 0x08,
00069
00070     Dma_mask_bits    = 0x3f0,
00071     Invert_dma_mask = 0x400,
00072   };
00073
00080   static L4_INLINE L4_CONSTEXPR unsigned Dma_mask(unsigned bits)
00081   {
00082     if (L4_UNLIKELY(bits > 64))
00083       return 0;
00084
00085     if (L4_UNLIKELY(bits == 0))
00086       bits = 1; // prevent overflow below
00087
00088     // Implemented as (64 - bits) « 4 for backwards compatibility.
00089     return (64 - bits) « 4;
00090   }
00091
00095   struct Stats
00096   {
00104     l4_size_t quota;
00105
00115     l4_size_t quota_used;
00116
00123     l4_size_t mem_limit;
00124
00137     l4_size_t mem_used;
00138
00147     l4_size_t mem_free;
00148   };
00149
00184   l4_ret_t alloc(long size, L4::Cap<Dataspace> mem, unsigned long flags = 0,
00185                  unsigned long align = 0, l4_addr_t paddr = 0,
00186                  char const *type = nullptr) const noexcept;
00187
00196   L4_INLINE_RPC(long, info, (Stats &stats));
00197
00198   typedef L4::Typeid::Rpcs<info_t> Rpcs;
00199 };
00200
00201 };
```

16.354 l4/re/mmio_space File Reference

Interface definition to emit MMIO-like accesses via IPC.

```
#include <l4/re/protocols.h>
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for mmio_space:



Data Structures

- struct L4Re::Mmio_space

  Interface for memory-like address space accessible via IPC.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.354.1 Detailed Description

Interface definition to emit MMIO-like accesses via IPC.
Definition in file mmio_space.

16.355 mmio_space

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00003 /*
00004  * Copyright (C) 2017-2018, 2022, 2024 Kernkonzept GmbH.
```

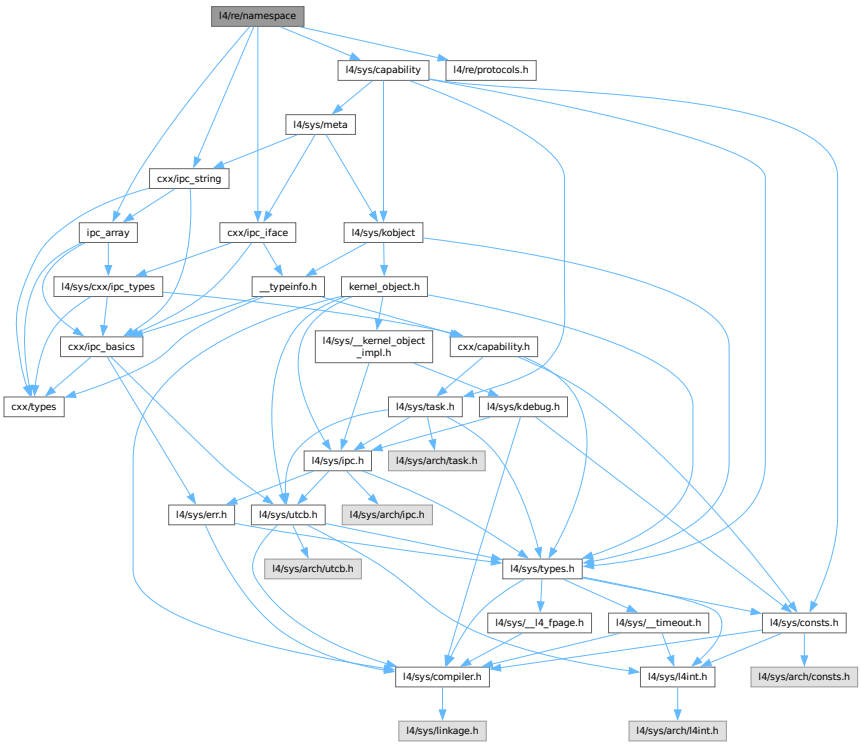
```
00005  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00013 #pragma once
00014
00015 #include <l4/re/protocols.h>
00016 #include <l4/sys/capability>
00017 #include <l4/sys/cxx/ipc_types>
00018 #include <l4/sys/cxx/ipc_iface>
00019
00020 namespace L4Re
00021 {
00022
00045 struct L4_EXPORT Mmio_space
00046 : public L4::Kobject_t<Mmio_space, L4::Kobject, L4RE_PROTO_MMIO_SPACE>
00047 {
00049   enum Access_width
00050   {
00051     Wd_8bit = 0,
00052     Wd_16bit = 1,
00053     Wd_32bit = 2,
00054     Wd_64bit = 3
00055   };
00056
00058   typedef l4_uint64_t Addr;
00059
00074   L4_INLINE_RPC(l4_ret_t, mmio_read, (Addr addr, char width, l4_uint64_t *value));
00075
00090   L4_INLINE_RPC(l4_ret_t, mmio_write, (Addr addr, char width, l4_uint64_t value));
00091
00092   typedef L4::Typeid::Rpcs<mmio_read_t, mmio_write_t> Rpcs;
00093 };
00094
00095 }
```

16.356 l4/re/namespace File Reference

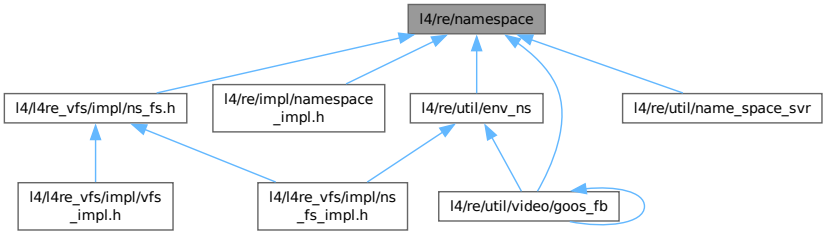
Namespace interface.

```
#include <l4/sys/capability>
#include <l4/re/protocols.h>
#include <l4/sys/cxx/ipc_iface>
#include <l4/sys/cxx/ipc_array>
#include <l4/sys/cxx/ipc_string>
```

Include dependency graph for namespace:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Namespace

  Name-space interface.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.356.1 Detailed Description

Namespace interface.
Definition in file namespace.

16.357 namespace

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #pragma once
00016
00017 #include <l4/sys/capability>
00018 #include <l4/re/protocols.h>
00019 #include <l4/sys/cxx/ipc_iface>
00020 #include <l4/sys/cxx/ipc_array>
00021 #include <l4/sys/cxx/ipc_string>
00022
00023 namespace L4Re {
00024
00049 class L4_EXPORT Namespace :
00050   public L4::Kobject_t<Namespace, L4::Kobject, L4RE_PROTO_NAMESPACE,
00051                        L4::Type_info::Demand_t<1> >
00052 {
00053 public:
00057   enum Register_flags
00058   {
00059     Ro         = L4_CAP_FPAGE_RO,
00060     Rw         = L4_CAP_FPAGE_RW,
00061     Rs         = L4_CAP_FPAGE_RS,
00062     Rws        = L4_CAP_FPAGE_RWS,
00063     Strong     = L4_CAP_FPAGE_S,
00064     Trusted    = 0x008,
00065
00066     Cap_flags = Ro | Rw | Strong | Trusted,
00067
00068     Link       = 0x100,
00069     Overwrite = 0x200,
00070   };
00071
00077   enum Query_result_flags
00078   {
00079     Partly_resolved = 0x020,
00080   };
00081
00083   enum Query_timeout
00084   {
00085     To_default      = 3600000,
00086     To_non_blocking = 0,
00087   };
00088
00089   L4_RPC_NF(
00090       l4_ret_t, query, (L4::Ipc::Array_ref<char const, unsigned long> name,
00091                         L4::Ipc::Small_buf cap,
00092                         L4::Ipc::Snd_fpage &snd_cap,
00093                         L4::Ipc::Opt<L4::Opcode &> dummy,
00094                         L4::Ipc::Opt<
00095                           L4::Ipc::Array_ref<char const, unsigned long> &> out_name));
00096
00122   l4_ret_t query(char const *name, L4::Cap<void> const &cap,
00123                  int timeout = To_default,
00124                  l4_umword_t *local_id = 0, bool iterate = true) const noexcept;
00125
00135   l4_ret_t query(char const *name, unsigned len, L4::Cap<void> const &cap,
00136                  int timeout = To_default,
00137                  l4_umword_t *local_id = 0, bool iterate = true) const noexcept;
00138
00139   L4_RPC_NF(l4_ret_t, register_obj, (unsigned flags,
00140                                      L4::Ipc::Array<char const, unsigned long> name,
00141                                      L4::Ipc::Opt< L4::Ipc::Cap<void> > obj),
00142             L4::Ipc::Call_t<L4_CAP_FPAGE_W>);
00143
00167   l4_ret_t register_obj(char const *name, L4::Ipc::Cap<void> obj,
00168                         unsigned flags = Rw) const noexcept
00169   {
00170     return register_obj_t::call(c(), flags,
00171                                 L4::Ipc::Array<char const, unsigned long>(
00172                                   __builtin_strlen(name), name),
00173                                 obj);
00174   }
00175
00176   L4_RPC_NF_OP(3, // backward compatibility opcode
00177                l4_ret_t, unlink, (L4::Ipc::Array<char const, unsigned long> name),
```

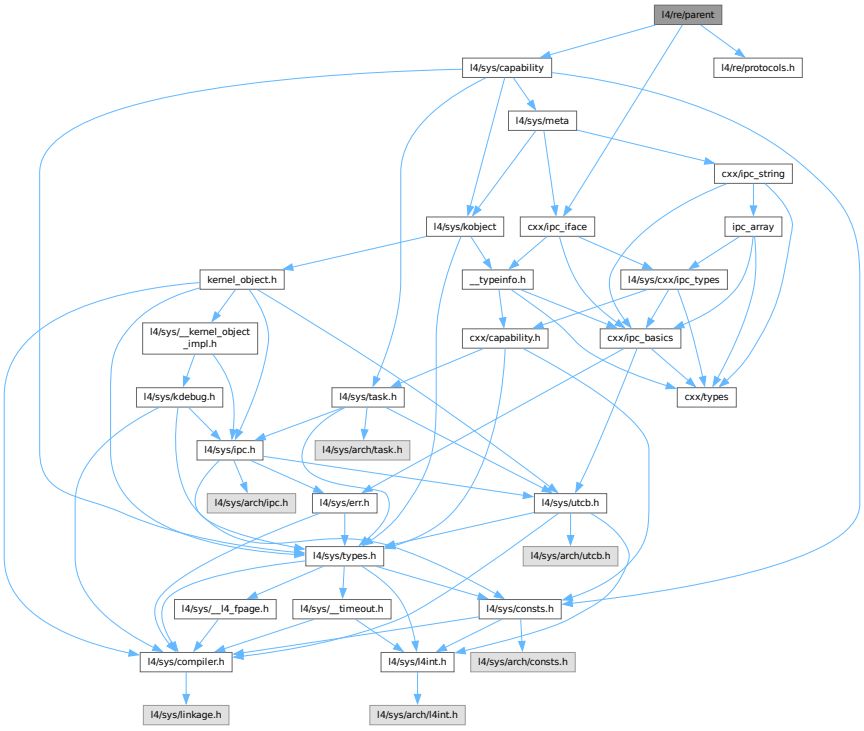
```
00178               L4::Ipc::Call_t<L4_CAP_FPAGE_W>);
00179
00194   l4_ret_t unlink(char const* name)
00195   {
00196     return unlink_t::call(c(), L4::Ipc::Array<char const, unsigned long>(
00197                                  __builtin_strlen(name), name));
00198   }
00199
00200   typedef L4::Typeid::Rpcs<query_t, register_obj_t, unlink_t> Rpcs;
00201
00202 private:
00203   l4_ret_t _query(char const *name, unsigned len,
00204                   L4::Cap<void> const &target, l4_umword_t *local_id,
00205                   bool iterate) const noexcept;
00206
00207 };
00208
00209 };
```

16.358 l4/re/parent File Reference

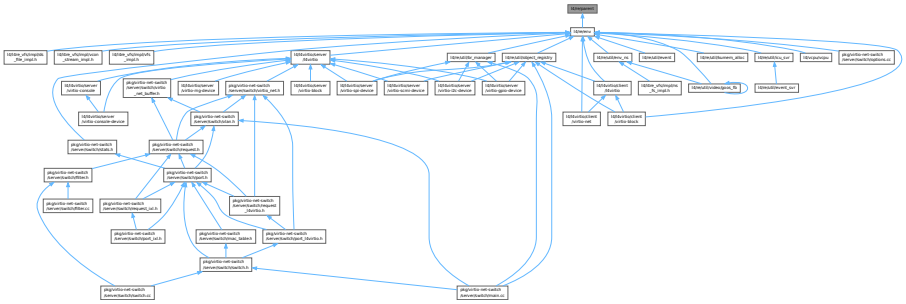
Parent interface.

```
#include <l4/sys/capability>
#include <l4/re/protocols.h>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for parent:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Parent

  Parent interface.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.358.1 Detailed Description

Parent interface.
Definition in file parent.

16.359 parent

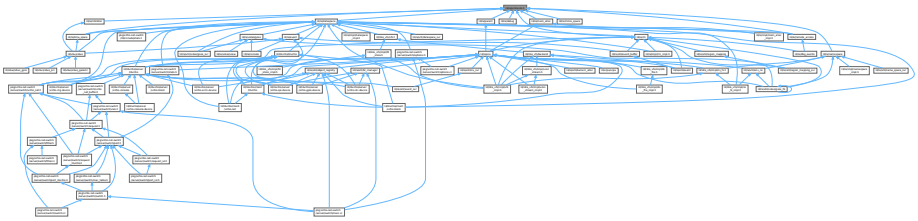
Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/capability>
00017 #include <l4/re/protocols.h>
00018 #include <l4/sys/cxx/ipc_iface>
00019
00020 namespace L4Re {
00021
00034
00042 class L4_EXPORT Parent :
00043   public L4::Kobject_t<Parent, L4::Kobject, L4RE_PROTO_PARENT>
00044 {
00045 public:
00061   L4_INLINE_RPC(l4_ret_t, signal, (unsigned long sig, unsigned long val));
00062   typedef L4::Typeid::Rpcs<signal_t> Rpcs;
00063 };
00064 };
00065
```

16.360 l4/re/protocols.h File Reference

L4Re Protocol Constants (C version).

This graph shows which files directly or indirectly include this file:



Enumerations

- enum L4re_protocols {
  L4RE_PROTO_DATASPACE = 0x4000 , L4RE_PROTO_NAMESPACE , L4RE_PROTO_PARENT ,
  L4RE_PROTO_GOOS ,
  L4RE_PROTO_RSVD_1 , L4RE_PROTO_RM , L4RE_PROTO_EVENT , L4RE_PROTO_INHIBITOR ,
  L4RE_PROTO_DMA_SPACE , L4RE_PROTO_MMIO_SPACE , L4RE_PROTO_ITAS , L4RE_PROTO_MEM_ALLOC
  ,
  L4RE_PROTO_REMOTE_ACCESS , L4RE_PROTO_DEBUG = ~0x7fffL }

  Common L4Re Protocol Constants.

16.360.1 Detailed Description

L4Re Protocol Constants (C version).
Definition in file protocols.h.

16.361 protocols.h

Go to the documentation of this file.

```
00001
00005
00006 /*
00007  * (c) 2015 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00019
00024 enum L4re_protocols
00025 {
00026   L4RE_PROTO_DATASPACE = 0x4000,
00027   L4RE_PROTO_NAMESPACE,
00028   L4RE_PROTO_PARENT,
00029   L4RE_PROTO_GOOS,
00030   L4RE_PROTO_RSVD_1,
00031   L4RE_PROTO_RM,
00032   L4RE_PROTO_EVENT,
00033   L4RE_PROTO_INHIBITOR,
00034   L4RE_PROTO_DMA_SPACE,
00035   L4RE_PROTO_MMIO_SPACE,
00036   L4RE_PROTO_ITAS,
00037   L4RE_PROTO_MEM_ALLOC,
00038   L4RE_PROTO_REMOTE_ACCESS,
00039
00040   L4RE_PROTO_DEBUG = ~0x7fffL
00041 };
00042
```

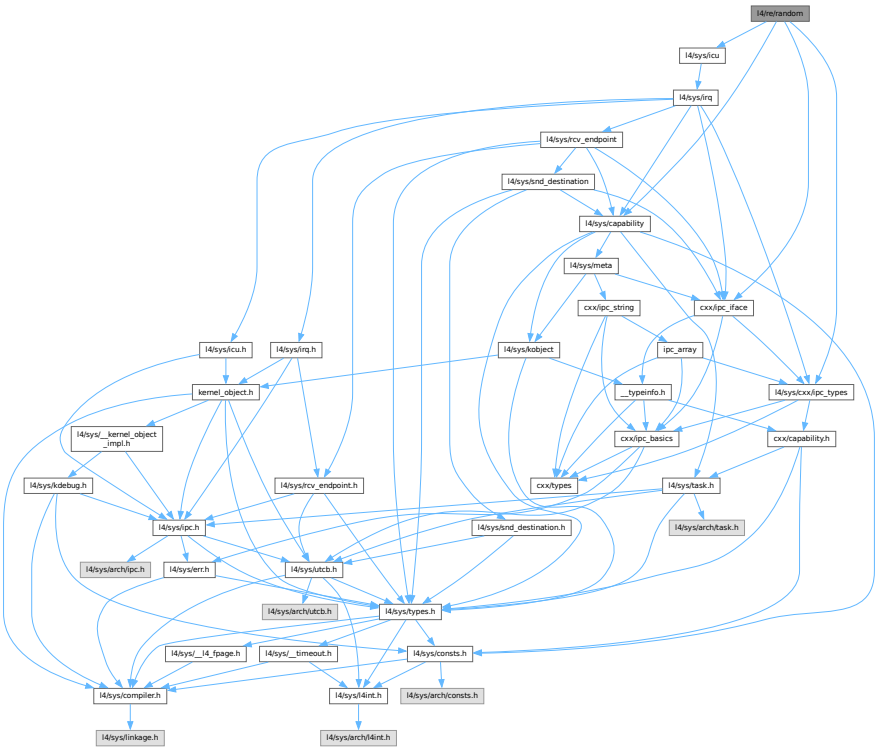
16.362 l4/re/random File Reference

Random number generator interface definition.

```
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_types>
```

```
#include <l4/sys/cxx/ipc_iface>
#include <l4/sys/icu>
```

Include dependency graph for random:



Data Structures

- struct L4Re::Random

  Low-bandwidth interface for random number generators.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.362.1 Detailed Description

Random number generator interface definition.
Definition in file random.

16.363 random

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2019-2020, 2022, 2024 Kernkonzept GmbH.
00004  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012 #pragma once
00013
00014 #include <l4/sys/capability>
00015 #include <l4/sys/cxx/ipc_types>
00016 #include <l4/sys/cxx/ipc_iface>
```

```
00017 #include <l4/sys/icu>
00018
00019 namespace L4Re
00020 {
00021
00033 struct L4_EXPORT Random
00034 : public L4::Kobject_t<Random, L4::Icu>
00035 {
00060   L4_INLINE_RPC(long, get_random, (l4_size_t size,
00061                                    L4::Ipc::Array<char, unsigned long> *buffer));
00062
00063   typedef L4::Typeid::Rpcs<get_random_t> Rpcs;
00064 };
00065
00066 } // namespace
```

16.364 remote_access

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2025 Adam Lackorzynski <adam@l4re.org>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/re/protocols.h>
00011 #include <l4/re/dataspace>
00012 #include <l4/sys/cxx/ipc_iface>
00013 #include <l4/sys/cxx/ipc_types>
00014 #include <l4/sys/cxx/types>
00015 #include <l4/sys/l4int.h>
00016
00017 namespace L4Re
00018 {
00019
00020 struct L4_EXPORT Remote_access
00021 : public L4::Kobject_t<Remote_access, Dataspace, L4RE_PROTO_REMOTE_ACCESS>
00022 {
00023   enum Access_width
00024   {
00025     Wd_8bit  = 0,
00026     Wd_16bit = 1,
00027     Wd_32bit = 2,
00028     Wd_64bit = 3
00029   };
00030
00031   L4_INLINE_RPC(long, read_mem,  (l4_addr_t addr, char width, l4_uint64_t *value));
00032   L4_INLINE_RPC(long, write_mem, (l4_addr_t addr, char width, l4_uint64_t value));
00033
00034   //L4_INLINE_RPC(long, get_regs, (unsigned TBD_THREAD_ID, l4_exc_regs_t *regs));
00035   //L4_INLINE_RPC(long, set_regs, (unsigned TBD_THREAD_ID, l4_exc_regs_t regs));
00036
00037   // !!! sizeof(l4_fpu_regs_t) > sizeof(utcb)
00038   //L4_INLINE_RPC(long, get_fpu_regs, (l4_fpu_regs_t *regs));
00039   //L4_INLINE_RPC(long, set_fpu_regs, (l4_fpu_regs_t regs));
00040
00041   L4_INLINE_RPC(long, terminate, (int exit_code), L4::Ipc::Send_only);
00042
00043   typedef L4::Typeid::Rpcs<read_mem_t, write_mem_t, terminate_t> Rpcs;
00044 };
00045
00046 }
```

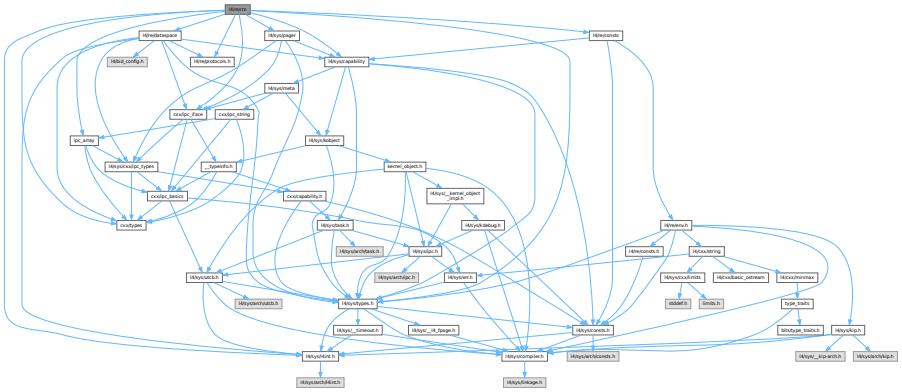
16.365 l4/re/rm File Reference

Region mapper interface.

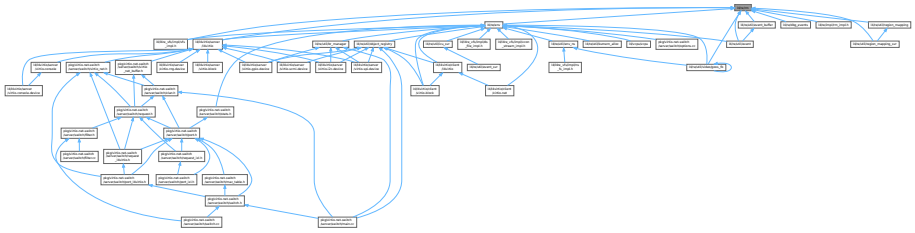
```
#include <l4/sys/types.h>
#include <l4/sys/l4int.h>
#include <l4/sys/capability>
#include <l4/re/protocols.h>
#include <l4/sys/pager>
#include <l4/sys/cxx/ipc_iface>
#include <l4/sys/cxx/ipc_array>
#include <l4/sys/cxx/types>
```

```
#include <l4/re/consts>
#include <l4/re/dataspace>
```

Include dependency graph for rm:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Rm

  Region map.
- struct L4Re::Rm::F

  Rm flags definitions.
- class L4Re::Rm::Unique_region< T >

  Unique region.
- struct L4Re::Rm::Region

  A region is a range of virtual addresses which is backed by content.
- struct L4Re::Rm::Area

  An area is a range of virtual addresses which is reserved, see L4Re::Rm::reserve_area().

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.365.1 Detailed Description

Region mapper interface.
Definition in file rm.

16.366 rm

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00011  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  *
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016 #pragma once
00017
00018 #include <l4/sys/types.h>
00019 #include <l4/sys/l4int.h>
00020 #include <l4/sys/capability>
00021 #include <l4/re/protocols.h>
00022 #include <l4/sys/pager>
00023 #include <l4/sys/cxx/ipc_iface>
00024 #include <l4/sys/cxx/ipc_array>
00025 #include <l4/sys/cxx/types>
00026 #include <l4/re/consts>
00027 #include <l4/re/dataspace>
00028
00029 namespace L4Re {
00030
00073
00081 class L4_EXPORT Rm :
00082   public L4::Kobject_t<Rm, L4::Pager, L4RE_PROTO_RM,
00083                        L4::Type_info::Demand_t<1> >
00084 {
00085 public:
00086   typedef L4Re::Dataspace::Offset Offset;
00087
00089   enum Detach_result
00090   {
00091     Detached_ds  = 0,
00092     Kept_ds      = 1,
00093     Split_ds     = 2,
00094     Detach_result_mask = 3,
00095
00096     Detach_again = 4,
00097
00098     Unmapped_range = 8,
00099   };
00100
00102   enum Region_flag_shifts
00103   {
00105     Caching_shift    = Dataspace::F::Caching_shift,
00106   };
00107
00109   struct F
00110   {
00112     enum Attach_flags : l4_uint32_t
00113     {
00115       Search_addr  =  0x20000,
00117       In_area      =  0x40000,
00119       Eager_map    =  0x80000,
00121       No_eager_map = 0x100000,
00122
00124       Attach_mask  = 0x1f0000,
00125     };
00126
00127     friend void enum_bitops_enable(Attach_flags);
00128
00130     enum Region_flags : l4_uint16_t
00131     {
00133       Rights_mask = 0x0f,
00135       R         = Dataspace::F::R,
00137       W         = Dataspace::F::W,
00139       X         = Dataspace::F::X,
00141       RW        = Dataspace::F::RW,
00143       RX        = Dataspace::F::RX,
00145       RWX       = Dataspace::F::RWX,
00146
00148       Kernel      = 0x100,
00151       Pager       = 0x400,
00153       Reserved    = 0x800,
00156       Private     = 0x1000,
00160       Anonymous   = 0x2000,
00161
00162
00164       Caching_mask   = Dataspace::F::Caching_mask,
```

```
00167       Cache_normal   = Dataspace::F::Normal,
00169       Cache_buffered = Dataspace::F::Bufferable,
00171       Cache_uncached = Dataspace::F::Uncacheable,
00172
00174       Ds_map_mask    = 0xff,
00175
00177       Region_flags_mask = 0xffff,
00178     };
00179
00180     friend void enum_bitops_enable(Region_flags);
00181
00182     friend constexpr Dataspace::Flags map_flags(Region_flags rf)
00183     { return Dataspace::Flags(static_cast<l4_uint16_t>(rf) & Ds_map_mask); }
00184
00185     struct Flags : L4::Types::Flags_ops_t<Flags>
00186     {
00187       l4_uint32_t raw;
00188
00189       Flags() = default;
00190       explicit constexpr Flags(l4_uint32_t f) : raw(f) {}
00191       constexpr Flags(Attach_flags af) : raw(static_cast<l4_uint32_t>(af)) {}
00192       constexpr Flags(Region_flags rf) : raw(static_cast<l4_uint32_t>(rf)) {}
00193
00194       constexpr Dataspace::Flags map_flags() const
00195       { return Dataspace::Flags(raw & Ds_map_mask); }
00196
00197       constexpr Region_flags region_flags() const
00198       { return Region_flags(raw & Region_flags_mask); }
00199
00200       constexpr Attach_flags attach_flags() const
00201       { return Attach_flags(raw & Attach_mask); }
00202
00203       constexpr bool r() const { return raw & L4_FPAGE_RO; }
00204       constexpr bool w() const { return raw & L4_FPAGE_W; }
00205       constexpr bool x() const { return raw & L4_FPAGE_X; }
00206
00207       constexpr unsigned cap_rights() const
00208       { return w() ? L4_CAP_FPAGE_RW : L4_CAP_FPAGE_RO; }
00209     };
00210
00211     friend constexpr Flags operator | (Region_flags l, Attach_flags r)
00212     { return Flags(l) | Flags(r); }
00213
00214     friend constexpr Flags operator | (Attach_flags l, Region_flags r)
00215     { return Flags(l) | Flags(r); }
00216   };
00217
00218   using Attach_flags = F::Attach_flags;
00219   using Region_flags = F::Region_flags;
00220   using Flags = F::Flags;
00221
00223   enum Detach_flags
00224   {
00234     Detach_exact   = 1,
00235
00245     Detach_overlap = 2,
00246   };
00247
00275   l4_ret_t reserve_area(l4_addr_t *start, unsigned long size,
00276                         Flags flags = Flags(0),
00277                         unsigned char align = L4_PAGESHIFT) const noexcept
00278   { return reserve_area_t::call(c(), start, size, flags, align); }
00279
00280   L4_RPC_NF(l4_ret_t, reserve_area, (L4::Ipc::In_out<l4_addr_t *> start,
00281                                      unsigned long size,
00282                                      Flags flags,
00283                                      unsigned char align));
00284
00303   template<typename T>
00304   l4_ret_t reserve_area(T **start, unsigned long size,
00305                         Flags flags = Flags(0),
00306                         unsigned char align = L4_PAGESHIFT) const noexcept
00307   {
00308     return reserve_area_t::call(c(), reinterpret_cast<l4_addr_t*>(start), size,
00309                                 flags, align);
00310   }
00311
00325   L4_RPC(l4_ret_t, free_area, (l4_addr_t addr));
00326
00327   L4_RPC_NF(l4_ret_t, attach, (L4::Ipc::In_out<l4_addr_t *> start,
00328                                unsigned long size, Flags flags,
00329                                L4::Ipc::Opt<L4::Ipc::Cap<Dataspace>> mem,
00330                                Offset offs, unsigned char align,
00331                                L4::Ipc::Opt<l4_cap_idx_t> client_cap,
00332                                L4::Ipc::String<> name, Offset backing_offset));
00333
00334   L4_RPC_NF(l4_ret_t, detach, (l4_addr_t addr, unsigned long size, unsigned flags,
```

```
00335                               l4_addr_t &start, l4_addr_t &rsize,
00336                               l4_cap_idx_t &mem_cap));
00337
00393   l4_ret_t attach(l4_addr_t *start, unsigned long size, Flags flags,
00394                   L4::Ipc::Cap<Dataspace> mem, Offset offs = 0,
00395                   unsigned char align = L4_PAGESHIFT,
00396                   L4::Cap<L4::Task> const task
00397                   = L4::Cap<L4::Task>::Invalid,
00398                   char const *name = nullptr,
00399                   Offset backing_offset = 0) const noexcept;
00400
00404   template<typename T>
00405   l4_ret_t attach(T **start, unsigned long size, Flags flags,
00406                   L4::Ipc::Cap<Dataspace> mem, Offset offs = 0,
00407                   unsigned char align = L4_PAGESHIFT,
00408                   L4::Cap<L4::Task> const task
00409                   = L4::Cap<L4::Task>::Invalid,
00410                   char const *name = nullptr,
00411                   Offset backing_offset = 0) const noexcept
00412   {
00413     union X { l4_addr_t a; T* t; };
00414     X *x = reinterpret_cast<X*>(start);
00415     return attach(&x->a, size, flags, mem, offs, align, task,
00416                   name, backing_offset);
00417   }
00418
00419 #if __cplusplus >= 201103L
00430   template<typename T>
00431   class Unique_region
00432   {
00433   private:
00434     T _addr;
00435     L4::Cap<Rm> _rm;
00436
00437   public:
00438     Unique_region(Unique_region const &) = delete;
00439     Unique_region &operator = (Unique_region const &) = delete;
00440
00444     Unique_region() noexcept
00445     : _addr(0), _rm(L4::Cap<Rm>::Invalid) {}
00446
00452     explicit Unique_region(T addr) noexcept
00453     : _addr(addr), _rm(L4::Cap<Rm>::Invalid) {}
00454
00461     Unique_region(T addr, L4::Cap<Rm> const &rm) noexcept
00462     : _addr(addr), _rm(rm) {}
00463
00469     Unique_region(Unique_region &&o) noexcept : _addr(o.get()), _rm(o._rm)
00470     { o.release(); }
00471
00477     Unique_region &operator = (Unique_region &&o) noexcept
00478     {
00479       if (&o != this)
00480         {
00481           if (_rm.is_valid())
00482             _rm->detach(reinterpret_cast<l4_addr_t>(_addr), 0);
00483           _rm = o._rm;
00484           _addr = o.release();
00485         }
00486       return *this;
00487     }
00488
00494     ~Unique_region() noexcept
00495     {
00496       if (_rm.is_valid())
00497         _rm->detach(reinterpret_cast<l4_addr_t>(_addr), 0);
00498     }
00499
00505     T get() const noexcept
00506     { return _addr; }
00507
00513     T release() noexcept
00514     {
00515       _rm = L4::Cap<Rm>::Invalid;
00516       return _addr;
00517     }
00518
00525     void reset(T addr, L4::Cap<Rm> const &rm) noexcept
00526     {
00527       if (_rm.is_valid())
00528         _rm->detach(l4_addr_t(_addr), 0);
00529
00530       _rm = rm;
00531       _addr = addr;
00532     }
00533
00537     void reset() noexcept
```

```
00538     { reset(0, L4::Cap<Rm>::Invalid); }
00539
00545     bool is_valid() const noexcept
00546     { return _rm.is_valid(); }
00547
00549     T operator * () const noexcept { return _addr; }
00550
00552     T operator -> () const noexcept { return _addr; }
00553
00554     explicit operator bool() const noexcept
00555     { return is_valid(); }
00556   };
00557
00558   template<typename T>
00559   l4_ret_t attach(Unique_region<T> *start, unsigned long size, Flags flags,
00560                   L4::Ipc::Cap<Dataspace> mem, Offset offs = 0,
00561                   unsigned char align = L4_PAGESHIFT,
00562                   L4::Cap<L4::Task> const task
00563                   = L4::Cap<L4::Task>::Invalid,
00564                   char const *name = nullptr,
00565                   Offset backing_offset = 0) const noexcept
00566   {
00567     l4_addr_t addr = reinterpret_cast<l4_addr_t>(start->get());
00568
00569     long res = attach(&addr, size, flags, mem, offs, align, task,
00570                       name, backing_offset);
00571     if (res < 0)
00572       return res;
00573
00574     start->reset(reinterpret_cast<T>(addr), L4::Cap<Rm>(cap()));
00575     return res;
00576   }
00577 #endif
00578
00596   l4_ret_t detach(l4_addr_t addr, L4::Cap<Dataspace> *mem,
00597                   L4::Cap<L4::Task> const &task = This_task) const noexcept;
00598
00602   l4_ret_t detach(void *addr, L4::Cap<Dataspace> *mem,
00603                   L4::Cap<L4::Task> const &task = This_task) const noexcept;
00604
00624   l4_ret_t detach(l4_addr_t start, unsigned long size, L4::Cap<Dataspace> *mem,
00625                   L4::Cap<L4::Task> const &task = This_task) const noexcept;
00626
00680   l4_ret_t find(l4_addr_t *addr, unsigned long *size, Offset *offset,
00681                 L4Re::Rm::Flags *flags, L4::Cap<Dataspace> *m) noexcept
00682   {
00683     l4_cap_idx_t ds_idx;
00684     l4_ret_t ret = find_t::call(c(), addr, size, flags, offset, &ds_idx);
00685     if (ret >= 0)
00686       *m = L4::Cap<Dataspace>(ds_idx);
00687     return ret;
00688   }
00689
00690   L4_RPC_NF(l4_ret_t, find, (L4::Ipc::In_out<l4_addr_t *> addr,
00691                              L4::Ipc::In_out<unsigned long *> size,
00692                              L4Re::Rm::Flags *flags, Offset *offset,
00693                              l4_cap_idx_t *m));
00694
00700   struct Region
00701   {
00702     l4_addr_t start;
00703     l4_addr_t end;
00704     F::Region_flags flags;
00705   };
00706
00713   struct Area
00714   {
00715     l4_addr_t start;
00716     l4_addr_t end;
00717     F::Region_flags flags;
00718   };
00719
00734   L4_RPC(l4_ret_t, get_regions, (l4_addr_t start, L4::Ipc::Array_ref<Region> &regions));
00735
00750   L4_RPC(long, get_areas, (l4_addr_t start, L4::Ipc::Array_ref<Area> &areas));
00751
00765   L4_RPC(l4_ret_t, get_info, (l4_addr_t addr, L4::Ipc::String<char> &name,
00766                               Offset &backing_offset));
00767
00789   L4_RPC(l4_ret_t, add_rescue_jump, (l4_addr_t pc_begin, l4_addr_t pc_end,
00790                                      l4_addr_t rescue_pc));
00791
00803   L4_RPC(l4_ret_t, remove_rescue_jump, (l4_addr_t pc));
00804
00805   l4_ret_t detach(l4_addr_t start, unsigned long size, L4::Cap<Dataspace> *mem,
00806                   L4::Cap<L4::Task> task, unsigned flags) const noexcept;
00807
```

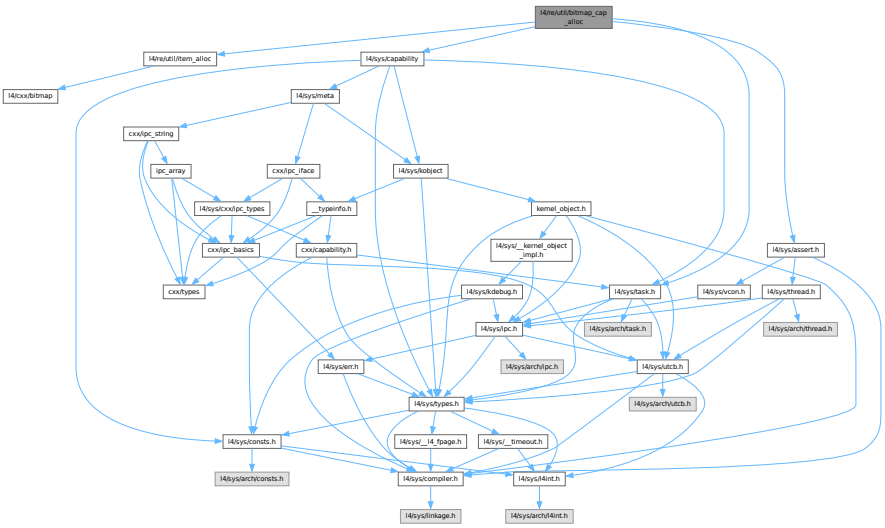
```
00808
00837   l4_ret_t page_in(l4_addr_t start, unsigned long size, Region_flags rights,
00838                    L4::Cap<L4::Task> dst = L4::Cap<L4::Task>::Invalid) const noexcept;
00839
00856   typedef l4_ret_t (*page_in_fn)(l4_addr_t min_addr, l4_addr_t max_addr,
00857                                  Region_flags rights);
00858
00882   L4_RPC_NF(l4_ret_t, page_in, (l4_addr_t min_addr, l4_addr_t max_addr,
00883                                 Region_flags rights, L4::Ipc::Rcv_fpage rwin,
00884                                 L4::Ipc::Snd_fpage &fp, page_in_fn *helper));
00885
00886
00887   typedef L4::Typeid::Rpcs<attach_t, detach_t, find_t,
00888                            reserve_area_t, free_area_t,
00889                            get_regions_t, get_areas_t,
00890                            get_info_t, add_rescue_jump_t,
00891                            remove_rescue_jump_t, page_in_t> Rpcs;
00892 };
00893
00894 inline l4_ret_t
00895 Rm::detach(l4_addr_t addr, L4::Cap<Dataspace> *mem,
00896            L4::Cap<L4::Task> const &task) const noexcept
00897 {  return detach(addr, 1, mem, task, Detach_overlap); }
00898
00899 inline l4_ret_t
00900 Rm::detach(void *addr, L4::Cap<Dataspace> *mem,
00901            L4::Cap<L4::Task> const &task) const noexcept
00902 {
00903   return detach(reinterpret_cast<l4_addr_t>(addr), 1, mem, task,
00904                 Detach_overlap);
00905 }
00906
00907 inline l4_ret_t
00908 Rm::detach(l4_addr_t addr, unsigned long size, L4::Cap<Dataspace> *mem,
00909            L4::Cap<L4::Task> const &task) const noexcept
00910 {  return detach(addr, size, mem, task, Detach_exact); }
00911
00912 };
```

16.367 l4/re/util/bitmap_cap_alloc File Reference

Bitmap capability allocator.

```
#include <l4/re/util/item_alloc>
#include <l4/sys/assert.h>
#include <l4/sys/capability>
#include <l4/sys/task.h>
```

Include dependency graph for bitmap_cap_alloc:



Data Structures

- class L4Re::Util::Cap_alloc_base

  Capability allocator.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

16.367.1 Detailed Description

Bitmap capability allocator.
Definition in file bitmap_cap_alloc.

16.368 bitmap_cap_alloc

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #pragma once
00016
00017 #include <l4/re/util/item_alloc>
00018 #include <l4/sys/assert.h>
00019 #include <l4/sys/capability>
00020 #include <l4/sys/task.h>
00021
00022 namespace L4Re { namespace Util {
00023
00028 class Cap_alloc_base
00029 {
00030 private:
00031   long _bias;
00032   Item_alloc_base _items;
00033
00034 public:
00035   template <unsigned COUNT>
00036   struct Storage
00037   {
00038     typename Bitmap_base::Word<COUNT>::Type _bits[Bitmap_base::Word<COUNT>::Size];
00039   };
00040
00041   enum State { Free = 0, Allocated, Unknown };
00042   Cap_alloc_base(long max, void *mem, long bias = 0, void * = 0)
00043     noexcept : _bias(bias), _items(max, mem) {}
00044
00045   L4::Cap<void> alloc() noexcept
00046   {
00047     long cap = _items.alloc();
00048     if (cap < 0)
00049       return L4::Cap<void>::Invalid;
00050
00051     return L4::Cap<void>((cap + _bias) « L4_CAP_SHIFT);
00052   }
00053
00054   long hint() const { return _items.hint(); }
00055
00059   template< typename T >
00060   L4::Cap<T> alloc() noexcept
00061   { return L4::Cap<T>(alloc().cap()); }
00062
00063   State is_allocated(L4::Cap<void> c) const noexcept
00064   {
00065     long idx = (c.cap() » L4_CAP_SHIFT);
00066
00067     if (idx < _bias)
```

```
00068       return Unknown;
00069
00070     idx -= _bias;
00071     if (idx >= _items.size())
00072       return Unknown;
00073
00074     return _items.is_allocated(idx) ? Allocated : Free;
00075   }
00076
00080   template< typename T>
00081   void free(L4::Cap<T> const &cap, l4_cap_idx_t task = L4_INVALID_CAP,
00082             l4_umword_t unmap_flags = L4_FP_ALL_SPACES) noexcept
00083   {
00084     long idx = (cap.cap() » L4_CAP_SHIFT);
00085     if (idx < _bias)
00086       return;
00087
00088     idx -= _bias;
00089     if (idx >= _items.size())
00090       return;
00091
00092     l4_assert(_items.is_allocated(idx));
00093
00094     if (l4_is_valid_cap(task))
00095       l4_task_unmap(task, cap.fpage(), unmap_flags | 2);
00096
00097     _items.free(idx);
00098   }
00099
00100   // since we have no counters assume counter always > 0
00101   void take(L4::Cap<void>) noexcept {}
00102   bool release(L4::Cap<void>, l4_cap_idx_t /*task*/ = L4_BASE_TASK_CAP,
00103                unsigned /*unmap_flags*/ = L4_FP_ALL_SPACES) noexcept
00104   { return false; }
00105
00106   long last() noexcept
00107   {
00108     return _items.size() + _bias - 1;
00109   }
00110 };
00111
00112 template< long Size >
00113 class Cap_alloc : public Cap_alloc_base
00114 {
00115 private:
00116   typename Bitmap_base::Word<Size>::Type _bits[Bitmap_base::Word<Size>::Size];
00117
00118 public:
00119   explicit Cap_alloc(long bias = 0) noexcept
00120     : Cap_alloc_base(Size, _bits, bias) {}
00121
00122 };
00123
00124 }
00125 }
```

16.369 br_manager

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/re/env>
00011 #include <l4/re/util/cap_alloc>
00012 #include <l4/sys/cxx/ipc_server_loop>
00013 #include <l4/cxx/ipc_timeout_queue>
00014 #include <l4/cxx/minmax>
00015 #include <l4/sys/assert.h>
00016
00017 namespace L4Re { namespace Util {
00018
00027 class Br_manager : public L4::Ipc_svr::Server_iface,
00028                    private L4::Ipc_svr::Server_iface::Mem_window::Allocator
00029 {
00030 private:
00031   enum { _ports = 0 };
00032   enum { Brs_per_timeout = sizeof(l4_kernel_clock_t) / sizeof(l4_umword_t) };
00033
00034   void dispose(l4_fpage_t fp) noexcept override
```

```
00035   {
00036     auto *env = L4Re::Env::env();
00037
00038     env->task()->unmap(fp, L4_FP_ALL_SPACES);
00039     env->rm()->free_area(l4_fpage_memaddr(fp));
00040   }
00041
00042 public:
00044   Br_manager()
00045   {
00046     _brs[0] = 0; // obj caps terminating entry
00047     _brs[1] = 0; // mem terminating entry
00048   }
00049
00050   Br_manager(Br_manager const &) = delete;
00051   Br_manager &operator = (Br_manager const &) = delete;
00052
00053   Br_manager(Br_manager &&) = delete;
00054   Br_manager &operator = (Br_manager &&) = delete;
00055
00056   ~Br_manager()
00057   {
00058     // Slots for received capabilities are placed at the beginning of the
00059     // (shadowed) buffer registers. Free those.
00060     for (unsigned i = 0; i < _caps; ++i)
00061       cap_alloc.free(L4::Cap<void>(_brs[i] & L4_CAP_MASK), L4RE_THIS_TASK_CAP);
00062
00063     if (l4_is_fpage_valid(_mem_fp))
00064       dispose(_mem_fp);
00065   }
00066
00067   /*
00068    * This implementation dynamically manages assignment of buffer registers for
00069    * the necessary amount of receive buffers allocated by all calls to this
00070    * function.
00071    */
00072   int alloc_buffer_demand(Demand const &d) override
00073   {
00074     using L4::Ipc::Small_buf;
00075
00076     // IO port receive windows currently not supported
00077     if (d.ports)
00078       return -L4_EINVAL;
00079
00080     // Take extra buffers for a possible timeout and for two zero terminators
00081     // (caps + mem).
00082     if (   cxx::max(d.caps, _caps)              + 1 // obj BRs + terminator
00083         + (cxx::max(d.mem, _mem_order) ? 2 : 0) + 1 // mem BRs + terminator
00084         + Brs_per_timeout                           // timeout BR(s)
00085         > L4_UTCB_GENERIC_BUFFERS_SIZE)
00086       return -L4_ERANGE;
00087
00088     if (d.caps > _caps)
00089       {
00090         while (_caps < d.caps)
00091           {
00092             L4::Cap<void> cap = cap_alloc.alloc();
00093             if (!cap)
00094               return -L4_ENOMEM;
00095
00096             reinterpret_cast<Small_buf&>(_brs[_caps])
00097               = Small_buf(cap.cap(), _cap_flags);
00098             ++_caps;
00099           }
00100         _brs[_caps] = 0;
00101       }
00102
00103     if (d.mem > _mem_order)
00104       {
00105         l4_addr_t start = 0;
00106         int err = L4Re::Env::env()->rm()
00107           ->reserve_area(&start, 1UL << d.mem,
00108                          L4Re::Rm::F::Search_addr | L4Re::Rm::F::Reserved,
00109                          d.mem);
00110         if (err < 0)
00111           return -L4_ENOMEM;
00112
00113         if (l4_is_fpage_valid(_mem_fp))
00114           dispose(_mem_fp);
00115
00116         _mem_order = d.mem;
00117         _mem_fp = l4_fpage(start, _mem_order, L4_FPAGE_RWX);
00118       }
00119
00120     // Memory receive window is in BRs after object caps...
00121     if (l4_is_fpage_valid(_mem_fp))
00122       {
```

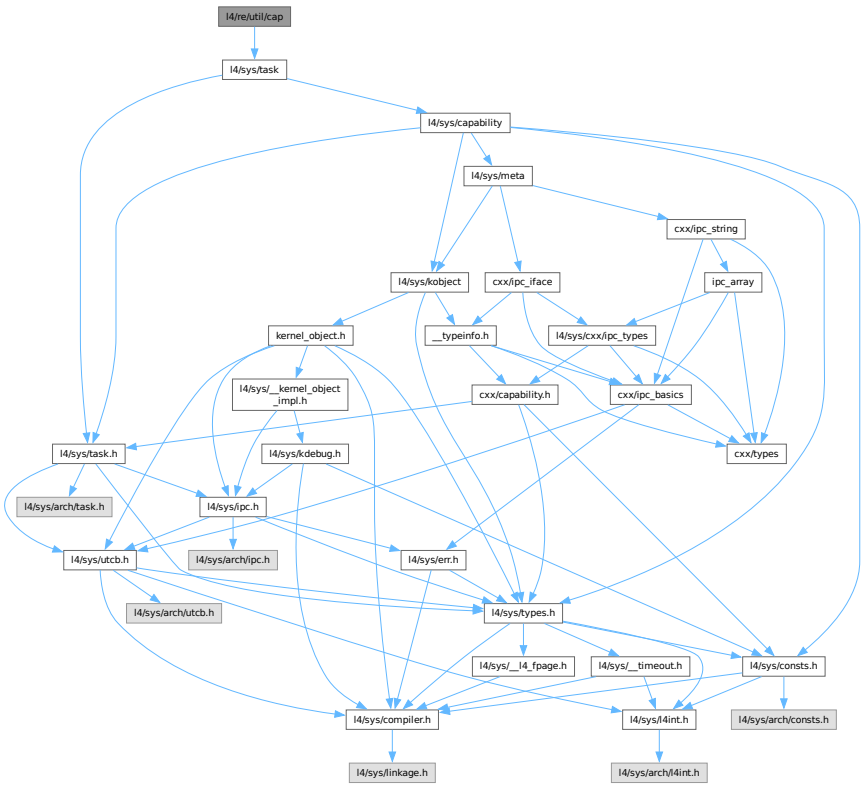
```
00123         L4::Ipc::Rcv_fpage rcv_fpage(_mem_fp);
00124         _brs[_caps + 1] = rcv_fpage.base_x();
00125         _brs[_caps + 2] = rcv_fpage.data();
00126         _brs[_caps + 3] = 0;
00127         _used_brs = _caps + 4;
00128       }
00129     else
00130       {
00131         _brs[_caps + 1] = 0;
00132         _used_brs = _caps + 2;
00133       }
00134
00135     return L4_EOK;
00136   }
00137
00138
00139   L4::Cap<void> get_rcv_cap(int i) const override
00140   {
00141     if (i < 0 || i >= _caps)
00142       return L4::Cap<void>::Invalid;
00143
00144     return L4::Cap<void>(_brs[i] & L4_CAP_MASK);
00145   }
00146
00147   int realloc_rcv_cap(int i) override
00148   {
00149     using L4::Ipc::Small_buf;
00150
00151     if (i < 0 || i >= _caps)
00152       return -L4_EINVAL;
00153
00154     L4::Cap<void> cap = cap_alloc.alloc();
00155     if (!cap)
00156       return -L4_ENOMEM;
00157
00158     reinterpret_cast<Small_buf&>(_brs[i])
00159       = Small_buf(cap.cap(), _cap_flags);
00160
00161     return L4_EOK;
00162   }
00163
00164   cxx::Result<L4::Ipc_svr::Server_iface::Mem_window>
00165   get_rcv_mem() noexcept override
00166   {
00167     if (!_mem_order)
00168       return cxx::Error(-L4_EINVAL);
00169
00170     l4_addr_t start = 0;
00171     int err = L4Re::Env::env()->rm()
00172       ->reserve_area(&start, 1UL << _mem_order,
00173                      L4Re::Rm::F::Search_addr | L4Re::Rm::F::Reserved,
00174                      _mem_order);
00175     if (err < 0)
00176       {
00177         // There might be pages mapped there already. Unmap them because the
00178         // caller cannot get hold of them any more.
00179         L4Re::Env::env()->task()->unmap(_mem_fp, L4_FP_ALL_SPACES);
00180         return cxx::Error(-L4_ENOMEM);
00181       }
00182
00183     l4_fpage_t ret = _mem_fp;
00184
00185     _mem_fp = l4_fpage(start, _mem_order, L4_FPAGE_RWX);
00186     L4::Ipc::Rcv_fpage rcv_fpage(_mem_fp);
00187     _brs[_caps + 1] = rcv_fpage.base_x();
00188     _brs[_caps + 2] = rcv_fpage.data();
00189
00190     return L4::Ipc_svr::Server_iface::Mem_window(ret, this);
00191   }
00192
00200   void set_rcv_cap_flags(unsigned long flags)
00201   {
00202     l4_assert(_caps == 0);
00203
00204     _cap_flags = flags;
00205   }
00206
00208   int add_timeout(L4::Ipc_svr::Timeout *, l4_kernel_clock_t) override
00209   { return -L4_ENOSYS; }
00210
00212   int remove_timeout(L4::Ipc_svr::Timeout *) override
00213   { return -L4_ENOSYS; }
00214
00216   void setup_wait(l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)
00217   {
00218     l4_buf_regs_t *br = l4_utcb_br_u(utcb);
00219     br->bdr = l4_bdr(_caps + 1, 0, 0, 0);
```

```
00220     for (unsigned i = 0; i < _used_brs; ++i)
00221       br->br[i] = _brs[i];
00222   }
00223
00224 protected:
00226   unsigned first_free_br() const
00227   {
00228     // The last BR (64-bit) or the last two BRs (32-bit); this is constant.
00229     return L4_UTCB_GENERIC_BUFFERS_SIZE - Brs_per_timeout;
00230     // We could also do the following dynamic approach:
00231     // return _caps + _mem + _ports + 1
00232   }
00233
00234 private:
00235   unsigned char _caps = 0;
00236   unsigned char _mem_order = 0;
00237   unsigned char _used_brs = 2;  // always at least two terminating entries
00238   unsigned long _cap_flags = L4_RCV_ITEM_LOCAL_ID;
00239   l4_fpage_t _mem_fp = l4_fpage_invalid();
00240
00241   l4_umword_t _brs[L4_UTCB_GENERIC_BUFFERS_SIZE];
00242 };
00243
00250 struct Br_manager_hooks
00251 : L4::Ipc_svr::Ignore_errors,
00252   L4::Ipc_svr::Default_timeout,
00253   L4::Ipc_svr::Compound_reply,
00254   Br_manager
00255 {};
00256
00264 struct Br_manager_timeout_hooks :
00265   public L4::Ipc_svr::Timeout_queue_hooks<Br_manager_timeout_hooks, Br_manager>,
00266   public L4::Ipc_svr::Ignore_errors
00267 {
00268 public:
00269   static l4_kernel_clock_t now()
00270   { return l4_kip_clock(l4re_kip()); }
00271 };
00272
00273 }}
00274
```

16.370 l4/re/util/cap File Reference

Capability utility functions.

`#include <l4/sys/task>`
Include dependency graph for cap:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

16.370.1 Detailed Description

Capability utility functions.
Definition in file cap.

16.371 cap

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/task>
00017
00018 namespace L4Re { namespace Util {
00019
```

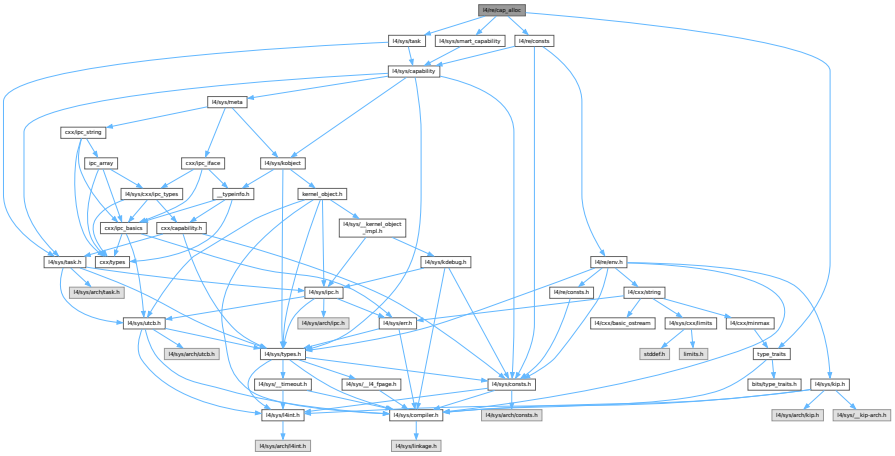
```
00027 L4_CV static inline l4_msgtag_t cap_release(L4::Cap<void> cap)
00028 {
00029   return l4_task_unmap(L4_BASE_TASK_CAP,
00030                        l4_obj_fpage(cap.cap(), 0, L4_FPAGE_RWX),
00031            L4_FP_ALL_SPACES);
00032 }
00033
00034 }}
```

16.372 l4/re/cap_alloc File Reference

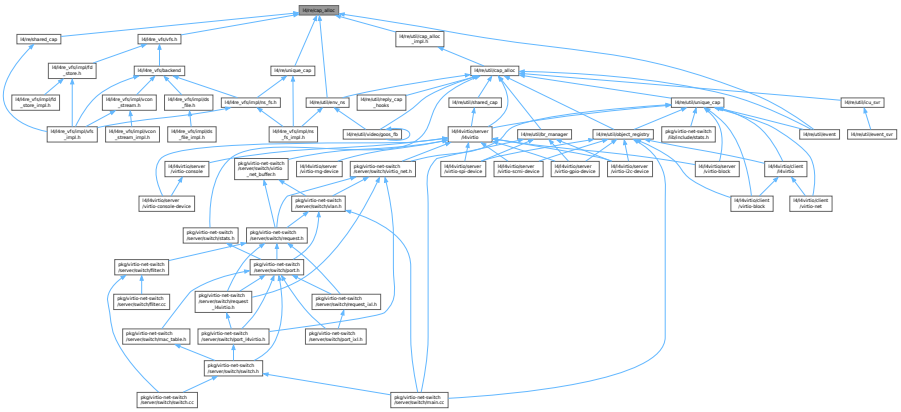
Abstract capability-allocator interface.

```
#include <l4/sys/task>
#include <l4/sys/smart_capability>
#include <l4/re/consts>
#include <l4/cxx/type_traits>
```

Include dependency graph for cap_alloc:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Cap_alloc

  Capability allocator interface.

- class L4Re::Smart_cap_auto< Unmap_flags >

  Helper for Unique_cap and Unique_del_cap.

- class L4Re::Smart_count_cap< Unmap_flags >

  Helper for Ref_cap and Ref_del_cap.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.372.1 Detailed Description

Abstract capability-allocator interface.
Definition in file cap_alloc.

16.373 cap_alloc

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/task>
00017 #include <l4/sys/smart_capability>
00018 #include <l4/re/consts>
00019 #include <l4/cxx/type_traits>
00020
00021 namespace L4Re {
00022
00030 class Cap_alloc
00031 {
00032 public:
00033   constexpr Cap_alloc() = default;
00034
00035   // Attention: do *not* define a destructor. We must keep the class trivially
00036   // destructible so that no global destructor is created for
00037   // L4Re::Util::cap_alloc.
00038   // virtual ~Cap_alloc() = default;
00039
00040   Cap_alloc(Cap_alloc const &) = delete;
00041   Cap_alloc &operator = (Cap_alloc const &) = delete;
00042
00047   virtual L4::Cap<void> alloc() noexcept = 0;
00048   virtual void take(L4::Cap<void> cap) noexcept = 0;
00049
00054   template< typename T >
00055   L4::Cap<T> alloc() noexcept
00056   { return L4::cap_cast<T>(alloc()); }
00057
00064   virtual void free(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
00065                     unsigned unmap_flags = L4_FP_ALL_SPACES) noexcept = 0;
00066   virtual bool release(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
00067                     unsigned unmap_flags = L4_FP_ALL_SPACES) noexcept = 0;
00068 };
00069
00070 template<typename ALLOC>
00071 struct Cap_alloc_t : ALLOC, L4Re::Cap_alloc
00072 {
00073   template<typename ...ARGS>
00074   Cap_alloc_t(ARGS &&...args) : ALLOC(cxx::forward<ARGS>(args)...) {}
00075
00076   L4::Cap<void> alloc() noexcept override { return ALLOC::alloc(); }
00077   void take(L4::Cap<void> cap) noexcept override { ALLOC::take(cap); }
00078
00079   template <typename T>
00080   L4::Cap<T> alloc() noexcept
00081   {
00082     return L4::cap_cast<T>(alloc());
00083   }
00084
00085   void free(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
00086             unsigned unmap_flags = L4_FP_ALL_SPACES) noexcept override
00087   { ALLOC::free(cap, task, unmap_flags); }
```

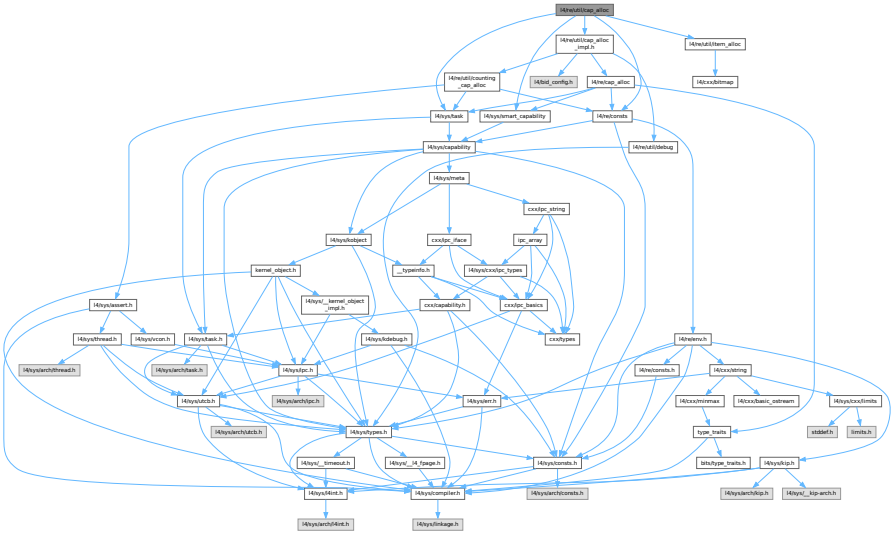
```
00088
00089   bool release(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
00090                unsigned unmap_flags = L4_FP_ALL_SPACES) noexcept override
00091   { return ALLOC::release(cap, task, unmap_flags); }
00092
00093   void operator delete(void *) {}
00094 };
00095
00096 extern Cap_alloc *virt_cap_alloc;
00097
00102 template< unsigned long Unmap_flags = L4_FP_ALL_SPACES >
00103 class Smart_cap_auto
00104 {
00105 private:
00106   Cap_alloc *_ca;
00107
00108 public:
00109   Smart_cap_auto() : _ca(0) {}
00110   Smart_cap_auto(Cap_alloc *ca) : _ca(ca) {}
00111
00112   void free(L4::Cap_base &c)
00113   {
00114     if (c.is_valid() && _ca)
00115       _ca->free(L4::Cap<void>(c.cap()), This_task, Unmap_flags);
00116
00117     invalidate(c);
00118   }
00119
00120   static void invalidate(L4::Cap_base &c)
00121   {
00122     if (c.is_valid())
00123       c.invalidate();
00124   }
00125
00126 };
00127
00131 template< unsigned long Unmap_flags = L4_FP_ALL_SPACES >
00132 class Smart_count_cap
00133 {
00134 private:
00135   Cap_alloc *_ca;
00136
00137 public:
00138   Smart_count_cap() : _ca(nullptr) {}
00139   Smart_count_cap(Cap_alloc *ca) : _ca(ca) {}
00144   void free(L4::Cap_base &c) noexcept
00145   {
00146     if (c.is_valid())
00147       {
00148         if (_ca && _ca->release(L4::Cap<void>(c.cap()), This_task, Unmap_flags))
00149           c.invalidate();
00150       }
00151   }
00152
00156   static void invalidate(L4::Cap_base &c) noexcept
00157   {
00158     if (c.is_valid())
00159       c.invalidate();
00160   }
00161
00165   L4::Cap_base copy(L4::Cap_base const &src)
00166   {
00167     if (_ca && src.is_valid())
00168       _ca->take(L4::Cap<void>(src.cap()));
00169     return src;
00170   }
00171 };
00173
00174 }
```

16.374 l4/re/util/cap_alloc File Reference

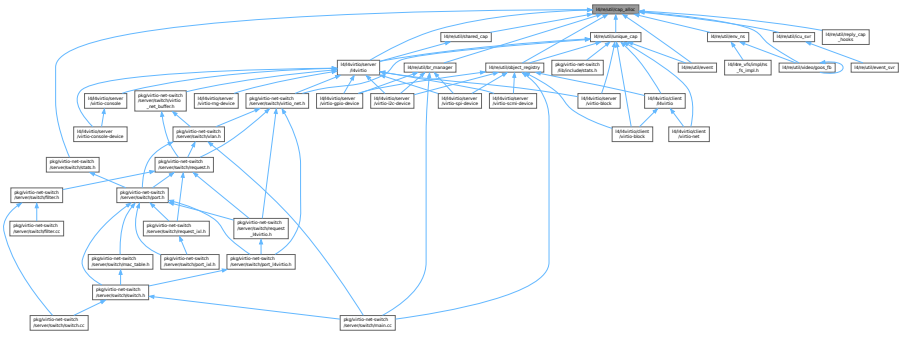
Capability allocator.

```
#include <l4/re/util/cap_alloc_impl.h>
#include <l4/re/util/item_alloc>
#include <l4/sys/smart_capability>
#include <l4/sys/task>
#include <l4/re/consts>
```

Include dependency graph for cap_alloc:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Util::Smart_cap_auto< Unmap_flags >

  Helper for Unique_cap and Unique_del_cap.
- class L4Re::Util::Smart_count_cap< Unmap_flags >

  Helper for Ref_cap and Ref_del_cap.
- struct L4Re::Util::Ref_cap< T >

  Automatic capability that implements automatic free and unmap of the capability slot.
- struct L4Re::Util::Ref_del_cap< T >

  Automatic capability that implements automatic free and unmap+delete of the capability slot.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

Functions

- template<typename T>
  Ref_cap< T >::Cap L4Re::Util::make_ref_cap ()

  Allocate a capability slot and wrap it in a Ref_cap.
- template<typename T>
  Ref_del_cap< T >::Cap L4Re::Util::make_ref_del_cap ()

  Allocate a capability slot and wrap it in a Ref_del_cap.

Variables

- _Cap_alloc L4Re::Util::cap_alloc

  Capability allocator.
- Def_reply_cap_alloc L4Re::Util::reply_cap_alloc

  Reply capability allocator.

16.374.1 Detailed Description

Capability allocator.
Definition in file cap_alloc.

16.375 cap_alloc

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #pragma once
00016
00017 #include <l4/re/util/cap_alloc_impl.h>
00018 #include <l4/re/util/item_alloc>
00019 #include <l4/sys/smart_capability>
00020 #include <l4/sys/task>
00021 #include <l4/re/consts>
00022
00023 namespace L4Re { namespace Util {
00024
00030
00031 template<unsigned Num_caps>
00032 class Reply_cap_alloc final : public L4::Reply_cap_alloc
00033 {
00034 public:
00035   static constexpr unsigned Capacity = Num_caps;
00036
00037   explicit Reply_cap_alloc(unsigned bias) noexcept
00038   : _bias(bias)
00039   {}
00040
00041   L4::Reply_cap alloc() noexcept override
00042   {
00043     if (long slot = _alloc.alloc(); slot >= 0) [[likely]]
00044       {
00045         auto idx = (static_cast<l4_cap_idx_t>(slot) + _bias) << L4_CAP_SHIFT;
00046         return L4::Reply_cap(L4::Reply_cap_idx(idx), this);
00047       }
00048     else
00049       return L4::Reply_cap();
00050   }
00051
00052 protected:
00053   void free(L4::Reply_cap_idx cap) noexcept override
00054   { _alloc.free((cap.cap() >> L4_CAP_SHIFT) - _bias); }
00055
00056 private:
00057   unsigned _bias;
00058   Item_alloc<Capacity> _alloc;
```

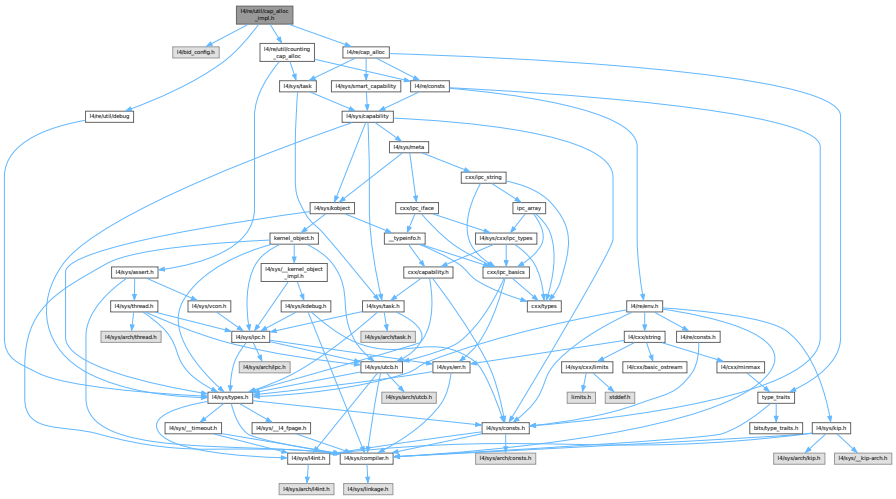
```
00059 };
00060
00061 using Def_reply_cap_alloc = Reply_cap_alloc<CONFIG_L4RE_CAP_DFL_ALLOCATOR_MAX>;
00062
00073 extern _Cap_alloc cap_alloc;
00074
00081 extern Def_reply_cap_alloc reply_cap_alloc;
00082
00086 template< unsigned long Unmap_flags = L4_FP_ALL_SPACES >
00087 class Smart_cap_auto
00088 {
00089 public:
00093   static void free(L4::Cap_base &c)
00094   {
00095     if (c.is_valid())
00096       {
00097         cap_alloc.free(L4::Cap<void>(c.cap()), This_task, Unmap_flags);
00098         c.invalidate();
00099       }
00100   }
00101
00105   static void invalidate(L4::Cap_base &c)
00106   {
00107     if (c.is_valid())
00108       c.invalidate();
00109   }
00110
00111 };
00112
00113
00117 template< unsigned long Unmap_flags = L4_FP_ALL_SPACES >
00118 class Smart_count_cap
00119 {
00120 public:
00125   static void free(L4::Cap_base &c) noexcept
00126   {
00127     if (c.is_valid())
00128       {
00129         if (cap_alloc.release(L4::Cap<void>(c.cap()), This_task, Unmap_flags))
00130     c.invalidate();
00131       }
00132   }
00133
00137   static void invalidate(L4::Cap_base &c) noexcept
00138   {
00139     if (c.is_valid())
00140       c.invalidate();
00141   }
00142
00146   static L4::Cap_base copy(L4::Cap_base const &src)
00147   {
00148     cap_alloc.take(L4::Cap<void>(src.cap()));
00149     return src;
00150   }
00151 };
00152
00153
00183 template< typename T >
00184 struct Ref_cap
00185 {
00186   typedef L4::Smart_cap<T, Smart_count_cap<L4_FP_ALL_SPACES> > Cap;
00187 };
00188
00224 template< typename T >
00225 struct Ref_del_cap
00226 {
00227   typedef L4::Smart_cap<T, Smart_count_cap<L4_FP_DELETE_OBJ> > Cap;
00228 };
00229
00235 template< typename T >
00236 typename Ref_cap<T>::Cap
00237 make_ref_cap() { return typename Ref_cap<T>::Cap(cap_alloc.alloc<T>()); }
00238
00244 template< typename T >
00245 typename Ref_del_cap<T>::Cap
00246 make_ref_del_cap()
00247 { return typename Ref_del_cap<T>::Cap(cap_alloc.alloc<T>()); }
00248
00250
00251 }}
00252
```

16.376 l4/re/util/cap_alloc_impl.h File Reference

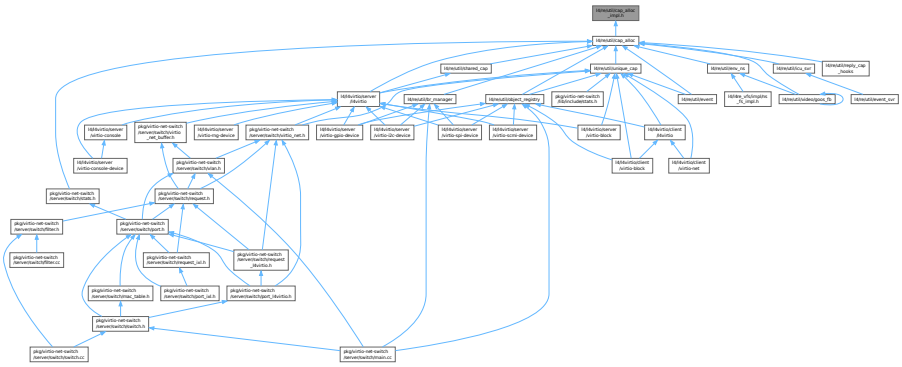
Capability allocator implementation.

```
#include <l4/bid_config.h>
#include <l4/re/cap_alloc>
#include <l4/re/util/counting_cap_alloc>
#include <l4/re/util/debug>
```

Include dependency graph for cap_alloc_impl.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Util::_Cap_alloc

  Adapter to expose the cap allocator implementation as L4Re::Cap_alloc compatible class.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

16.376.1 Detailed Description

Capability allocator implementation.
Definition in file cap_alloc_impl.h.

16.377 cap_alloc_impl.h

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/bid_config.h>
00017 #include <l4/re/cap_alloc>
00018
00019 #if defined(CONFIG_L4RE_BITMAP_CAP_ALLOC)
00020
00021 #include <l4/re/util/bitmap_cap_alloc>
00022
00023 namespace L4Re { namespace Util {
00024
00025 using _Cap_alloc_impl = Cap_alloc_base;
00026
00027 }}
00028
00029 #elif defined(CONFIG_L4RE_COUNTING_CAP_ALLOC)
00030
00031 #include <l4/re/util/counting_cap_alloc>
00032 #include <l4/re/util/debug>
00033
00034 namespace L4Re { namespace Util {
00035
00036 // RISC-V does not natively support subword atomics, such as __atomic_load_1.
00037 // The RISC-V gcc developers have decided to emulate these via libatomic, which
00038 // is automatically linked against.
00039 #if defined(__GCC_HAVE_SYNC_COMPARE_AND_SWAP_1) || defined(ARCH_arm) || defined(ARCH_riscv)
00040 using _Cap_alloc_impl
00041   = Counting_cap_alloc<L4Re::Util::Counter_atomic<unsigned char>,
00042                        L4Re::Util::Dbg>;
00043 #elif defined(ARCH_sparc)
00044 using _Cap_alloc_impl
00045   = Counting_cap_alloc<L4Re::Util::Counter<unsigned char>,
00046                        L4Re::Util::Dbg>;
00047 #warning "Thread-safe capability allocator not available!"
00048 #else
00049 #error "Unsupported platform"
00050 #endif
00051
00052 }}
00053
00054 #else
00055 #error "No supported capability allocator selected"
00056 #endif
00057
00058 namespace L4Re { namespace Util {
00059
00066 class _Cap_alloc final : public L4Re::Cap_alloc, private _Cap_alloc_impl
00067 {
00068 public:
00069   template <unsigned COUNT>
00070   using Storage = _Cap_alloc_impl::Storage<COUNT>;
00071
00072   using _Cap_alloc_impl::_Cap_alloc_impl; // Expose underlying constructor
00073   void operator delete(void *) {} // Prevent global operator delete reference
00074
00075   L4::Cap<void> alloc() noexcept override
00076   { return _Cap_alloc_impl::alloc(); }
00077
00078   template< typename T >
00079   L4::Cap<T> alloc() noexcept
00080   { return L4::cap_cast<T>(alloc()); }
00081
00082   void take(L4::Cap<void> cap) noexcept override
00083   { _Cap_alloc_impl::take(cap); }
00084
00085   void free(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
```

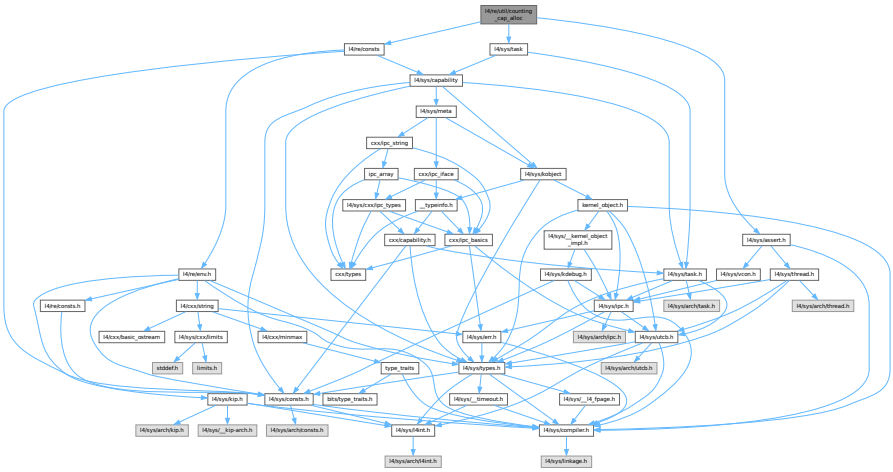
```
00086             unsigned unmap_flags = L4_FP_ALL_SPACES) noexcept override
00087   { _Cap_alloc_impl::free(cap, task, unmap_flags); }
00088
00089   bool release(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
00090                unsigned unmap_flags= L4_FP_ALL_SPACES) noexcept override
00091   { return _Cap_alloc_impl::release(cap, task, unmap_flags); }
00092
00093   using _Cap_alloc_impl::last;
00094 };
00095
00096 }}
```

16.378 l4/re/util/counting_cap_alloc File Reference

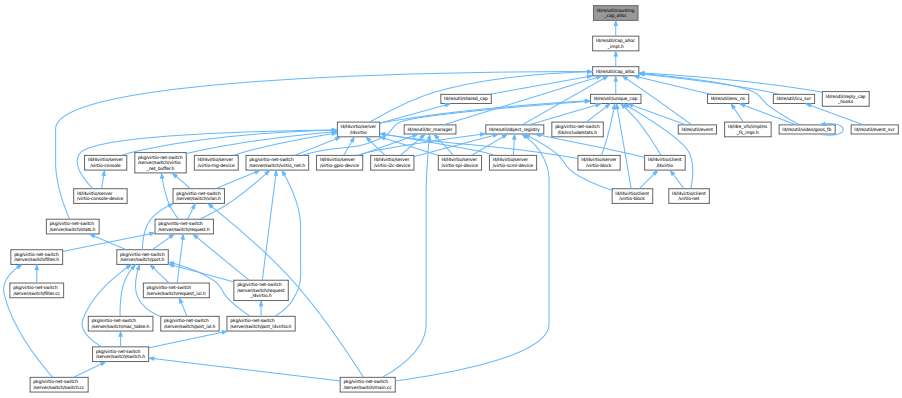
Reference-counting capability allocator.

```
#include <l4/sys/task>
#include <l4/sys/assert.h>
#include <l4/re/consts>
```

Include dependency graph for counting_cap_alloc:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct L4Re::Util::Counter< COUNTER >

  Counter for *Counting_cap_alloc* with variable data width.
- struct L4Re::Util::Counter_atomic< COUNTER >

  Thread safe version of counter for Counting_cap_alloc.

- class L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >

  Internal reference-counting cap allocator.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

16.378.1 Detailed Description

Reference-counting capability allocator.
Definition in file counting_cap_alloc.

16.379 counting_cap_alloc

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #pragma once
00014
00015 #include <l4/sys/task>
00016 #include <l4/sys/assert.h>
00017 #include <l4/re/consts>
00018
00019 namespace L4Re { namespace Util {
00020
00026 template< typename COUNTER = unsigned char >
00027 struct Counter
00028 {
00029   typedef COUNTER Type;
00030   Type _cnt;
00031
00032   static Type nil() { return 0; }
00033   static Type unused() { return 0; }
00034
00035   void free() { _cnt = 0; }
00036   bool is_free() const { return _cnt == 0; }
00037   bool is_saturated() const { return static_cast<Type>(_cnt + 1) == 0; }
00038
00050   bool inc()
00051   {
00052     if (is_saturated())
00053       return true; // no change and no warning
00054     ++_cnt;
00055     if (is_saturated())
00056       return false; // warn caller that counter is now saturated
00057     else
00058       return true; // success
00059   }
00060
00067   Type dec()
00068   {
00069     if (is_saturated())
00070       return _cnt; // no change
00071     else
00072       return --_cnt; // success
00073   }
00074
00075   bool try_alloc()
00076   {
00077     if (_cnt == 0)
00078       {
00079         _cnt = 1;
00080         return true;
00081       }
00082     return false;
00083   }
00084 };
```

```
00085
00097 template< typename COUNTER = unsigned char >
00098 struct Counter_atomic
00099 {
00100   typedef COUNTER Type;
00101   Type _cnt;
00102
00103   static Type nil() { return 0; }
00104   static Type unused() { return 1; }
00105
00106   bool is_free() const { return __atomic_load_n(&_cnt, __ATOMIC_RELAXED) == 0; }
00107   static bool is_saturated(Type cnt) { return static_cast<Type>(cnt + 1) == 0; }
00108
00109   bool try_alloc()
00110   {
00111     Type expected = nil();
00112     // Use "acquire" memory ordering. Any operations tied to the capability slot
00113     // must only be observable after the slot has been occupied.
00114     return __atomic_compare_exchange_n(&_cnt, &expected, 2, false,
00115                                        __ATOMIC_ACQUIRE, __ATOMIC_RELAXED);
00116   }
00117
00121   bool inc()
00122   {
00123     Type old_cnt = __atomic_load_n(&_cnt, __ATOMIC_RELAXED);
00124     Type new_cnt;
00125     do
00126       {
00127         if (is_saturated(old_cnt))
00128           return true; // no change and no warning
00129         new_cnt = old_cnt + 1;
00130       }
00131     while (!__atomic_compare_exchange_n(&_cnt, &old_cnt, new_cnt, false,
00132                                         __ATOMIC_RELAXED, __ATOMIC_RELAXED));
00133     if (is_saturated(new_cnt))
00134       return false; // warn caller that counter is now saturated
00135     else
00136       return true; // success
00137   }
00138
00142   Type dec()
00143   {
00144     Type old_cnt = __atomic_load_n(&_cnt, __ATOMIC_RELAXED);
00145     Type new_cnt;
00146     do
00147       {
00148         if (is_saturated(old_cnt))
00149           return old_cnt; // no change
00150         new_cnt = old_cnt - 1;
00151       }
00152     while (!__atomic_compare_exchange_n(&_cnt, &old_cnt, new_cnt, false,
00153                                         __ATOMIC_RELAXED, __ATOMIC_RELAXED));
00154     return new_cnt; // success
00155   }
00156
00157   void free()
00158   {
00159     // Use "release" memory ordering to make sure that any operations tied to
00160     // the capability slot are observable by other threads before the slot can
00161     // be reused.
00162     __atomic_store_n(&_cnt, 0, __ATOMIC_RELEASE);
00163   }
00164 };
00165
00190 template <typename COUNTERTYPE, typename Dbg>
00191 class Counting_cap_alloc
00192 {
00193 private:
00194   void operator = (Counting_cap_alloc const &) { }
00195   typedef COUNTERTYPE Counter;
00196
00197   COUNTERTYPE *_items;
00198   long _free_hint;
00199   long _bias;
00200   long _capacity;
00201   Dbg *_dbg;
00202
00203 public:
00204
00205   template <unsigned COUNT>
00206   struct Storage
00207   {
00208     COUNTERTYPE _buf[COUNT];
00209     typedef COUNTERTYPE Buf_type[COUNT];
00210     enum { Size = COUNT };
00211   };
00212
```

```
00213   Counting_cap_alloc(long capacity, void *m, long bias, Dbg *dbg) noexcept
00214   : _items((Counter*)m), _free_hint(0), _bias(bias), _capacity(capacity),
00215     _dbg(dbg)
00216   {}
00217
00218 protected:
00224   Counting_cap_alloc() noexcept
00225   : _items(0), _free_hint(0), _bias(0), _capacity(0)
00226   {}
00227
00242   void setup(void *m, long capacity, long bias, Dbg *dbg) noexcept
00243   {
00244     _items = static_cast<Counter*>(m);
00245     _capacity = capacity;
00246     _bias = bias;
00247     _dbg = dbg;
00248   }
00249
00250 public:
00257   L4::Cap<void> alloc() noexcept
00258   {
00259     long free_hint = __atomic_load_n(&_free_hint, __ATOMIC_RELAXED);
00260
00261     for (long i = free_hint; i < _capacity; ++i)
00262       if (_items[i].try_alloc())
00263         {
00264           _free_hint = i + 1;
00265           return L4::Cap<void>((i + _bias) « L4_CAP_SHIFT);
00266         }
00267
00268     // _free_hint is not necessarily correct in case of multi-threading! Make
00269     // sure we don't miss any potentially free slots.
00270     for (long i = 0; i < free_hint && i < _capacity; ++i)
00271       if (_items[i].try_alloc())
00272         {
00273           _free_hint = i + 1;
00274           return L4::Cap<void>((i + _bias) « L4_CAP_SHIFT);
00275         }
00276
00277     return L4::Cap<void>::Invalid;
00278   }
00279
00281   template <typename T>
00282   L4::Cap<T> alloc() noexcept
00283   {
00284     return L4::cap_cast<T>(alloc());
00285   }
00286
00287
00296   void take(L4::Cap<void> cap) noexcept
00297   {
00298     long c;
00299     if (!range_check_and_get_idx(cap, &c))
00300       return;
00301
00302     if (!L4_UNLIKELY(_items[c].inc()))
00303       _dbg->printf("Warning: Reference counter of cap 0x%lx now saturated!\n",
00304                    cap.cap() » L4_CAP_SHIFT);
00305   }
00306
00307
00321   bool free(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
00322             unsigned unmap_flags = L4_FP_ALL_SPACES) noexcept
00323   {
00324     long c;
00325     if (!range_check_and_get_idx(cap, &c))
00326       return false;
00327
00328     l4_assert(!_items[c].is_free());
00329
00330     if (l4_is_valid_cap(task))
00331       l4_task_unmap(task, cap.fpage(), unmap_flags);
00332
00333     if (c < _free_hint)
00334       _free_hint = c;
00335
00336     _items[c].free();
00337
00338     return true;
00339   }
00340
00359   bool release(L4::Cap<void> cap, l4_cap_idx_t task = L4_BASE_TASK_CAP,
00360                unsigned unmap_flags = L4_FP_ALL_SPACES) noexcept
00361   {
00362     long c;
00363     if (!range_check_and_get_idx(cap, &c))
00364       return false;
```

```
00365
00366     l4_assert(!_items[c].is_free());
00367
00368     if (_items[c].dec() == Counter::unused())
00369       {
00370         if (task != L4_INVALID_CAP)
00371           l4_task_unmap(task, cap.fpage(), unmap_flags);
00372
00373         if (c < _free_hint)
00374           _free_hint = c;
00375
00376         // Let others allocate this slot only after the l4_task_unmap() has
00377         // finished.
00378         _items[c].free();
00379
00380         return true;
00381       }
00382     return false;
00383   }
00384
00388   long last() noexcept
00389   {
00390     return _capacity + _bias - 1;
00391   }
00392
00393 private:
00394   bool range_check_and_get_idx(L4::Cap<void> cap, long *c)
00395   {
00396     *c = cap.cap() » L4_CAP_SHIFT;
00397     if (*c < _bias)
00398       return false;
00399
00400     *c -= _bias;
00401
00402     return *c < _capacity;
00403   }
00404 };
00405
00406 }}
```

16.380 dataspace_svr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00005  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00006  *     economic rights: Technische Universität Dresden (Germany)
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #pragma once
00011
00012 #include <string.h>
00013 #include <stdio.h>
00014 #include <stddef.h>
00015 #include <l4/bid_config.h>
00016 #include <l4/sys/types.h>
00017 #include <l4/cxx/minmax>
00018 #include <l4/re/dataspace>
00019 #include <l4/sys/cxx/ipc_legacy>
00020
00021 namespace L4Re { namespace Util {
00022
00029 class Dataspace_svr
00030 {
00031 public:
00032   L4_RPC_LEGACY_DISPATCH(L4Re::Dataspace);
00033
00034   typedef L4::Ipc::Snd_fpage::Map_type Map_type;
00035   typedef L4::Ipc::Snd_fpage::Cacheopt Cache_type;
00036
00037   Dataspace_svr() noexcept
00038   : _ds_start(0), _ds_size(0), _map_flags(L4::Ipc::Snd_fpage::Map),
00039     _cache_flags(L4::Ipc::Snd_fpage::Cached)
00040   {}
00041
00042   virtual ~Dataspace_svr() noexcept {}
00043
00057   l4_ret_t map(Dataspace::Offset offset,
00058                Dataspace::Map_addr local_addr,
00059                Dataspace::Flags flags,
00060                Dataspace::Map_addr min_addr,
00061                Dataspace::Map_addr max_addr,
```

```
00062                L4::Ipc::Snd_fpage &memory)
00063   {
00064     memory = L4::Ipc::Snd_fpage();
00065
00066     offset     = l4_trunc_page(offset);
00067     local_addr = l4_trunc_page(local_addr);
00068
00069     if (!check_limit(offset))
00070       {
00071 #if 0
00072         printf("limit failed: off=%lx sz=%lx\n", offset, size());
00073 #endif
00074         return -L4_ERANGE;
00075       }
00076
00077     min_addr = l4_trunc_page(min_addr);
00078     max_addr = l4_round_page(max_addr);
00079
00080     l4_addr_t addr = _ds_start + offset;
00081     unsigned char order = L4_PAGESHIFT;
00082
00083     while (order < 30 /* limit to 1GB flexpage */)
00084       {
00085         l4_addr_t map_base = l4_trunc_size(addr, order + 1);
00086         if (map_base < _ds_start)
00087           break;
00088
00089         if (map_base + (1UL << (order + 1)) -1 > (_ds_start + round_size() - 1))
00090           break;
00091
00092         map_base = l4_trunc_size(local_addr, order + 1);
00093         if (map_base < min_addr)
00094           break;
00095
00096         if (map_base + (1UL << (order + 1)) -1 > max_addr -1)
00097           break;
00098
00099         l4_addr_t mask = ~(~0UL << (order + 1));
00100         if (local_addr == ~0UL || ((addr ^ local_addr) & mask))
00101           break;
00102
00103         ++order;
00104       }
00105
00106     l4_addr_t map_base = l4_trunc_size(addr, order);
00107
00108     Dataspace::Map_addr b = map_base;
00109     unsigned send_order = order;
00110     l4_ret_t err = map_hook(offset /*map_base - _ds_start*/, order, flags,
00111                             &b, &send_order);
00112     if (err < 0)
00113       return err;
00114
00115     l4_fpage_t fpage = l4_fpage(b, send_order, flags.fpage_rights());
00116
00117     memory = L4::Ipc::Snd_fpage(fpage, local_addr, _map_flags, _cache_flags);
00118
00119     return L4_EOK;
00120   }
00121
00136   virtual l4_ret_t map_hook([[maybe_unused]] Dataspace::Offset offs,
00137                             [[maybe_unused]] unsigned order,
00138                             [[maybe_unused]] Dataspace::Flags flags,
00139                             [[maybe_unused]] Dataspace::Map_addr *base,
00140                             [[maybe_unused]] unsigned *send_order)
00141   {
00142     return 0;
00143   }
00144
00150   virtual void take() noexcept
00151   {}
00152
00160   virtual unsigned long release() noexcept
00161   { return 0; }
00162
00175   virtual l4_ret_t copy([[maybe_unused]] l4_addr_t dst_offs,
00176                         [[maybe_unused]] l4_umword_t src_id,
00177                         [[maybe_unused]] l4_addr_t src_offs,
00178                         [[maybe_unused]] unsigned long size) noexcept
00179   {
00180     return -L4_ENODEV;
00181   }
00182
00192   virtual l4_ret_t clear(unsigned long offs, unsigned long size) const noexcept
00193   {
00194     if (!check_limit(offs))
00195       return -L4_ERANGE;
```

```
00196
00197     size = cxx::min(size, round_size() - offs);
00198     memset(reinterpret_cast<void *>(_ds_start + offs), 0, size);
00199     return 0;
00200   }
00201
00213   virtual l4_ret_t allocate([[maybe_unused]] l4_addr_t offset,
00214                             [[maybe_unused]] l4_size_t size,
00215                             [[maybe_unused]] unsigned access) noexcept
00216   {
00217     return -L4_ENODEV;
00218   }
00219
00225   virtual unsigned long page_shift() const noexcept
00226   { return L4_LOG2_PAGESIZE; }
00227
00233   virtual bool is_static() const noexcept
00234   { return true; }
00235
00248   virtual l4_ret_t map_info([[maybe_unused]] l4_addr_t &start_addr,
00249                             [[maybe_unused]] l4_addr_t &end_addr) noexcept
00250   { return -L4_EPERM; }
00251
00252
00253   l4_ret_t op_map(L4Re::Dataspace::Rights rights,
00254                   L4Re::Dataspace::Offset offset,
00255                   L4Re::Dataspace::Map_addr spot,
00256                   L4Re::Dataspace::Flags flags,
00257                   L4::Ipc::Snd_fpage &fp)
00258   {
00259     auto rf = map_flags(rights);
00260     if (!rf.w() && flags.w())
00261       return -L4_EPERM;
00262
00263     return map(offset, spot, flags & rf, 0, ~0, fp);
00264   }
00265
00266   l4_ret_t op_allocate(L4Re::Dataspace::Rights rights,
00267                        L4Re::Dataspace::Offset offset,
00268                        L4Re::Dataspace::Size size)
00269   { return allocate(offset, size, rights & 3); }
00270
00271   l4_ret_t op_copy_in(L4Re::Dataspace::Rights rights,
00272                       L4Re::Dataspace::Offset dst_offs,
00273                       L4::Ipc::Snd_fpage const &src_cap,
00274                       L4Re::Dataspace::Offset src_offs,
00275                       L4Re::Dataspace::Size sz)
00276   {
00277     if (!src_cap.id_received())
00278       return -L4_EINVAL;
00279
00280     if (!(rights & L4_CAP_FPAGE_W))
00281       return -L4_EACCESS;
00282
00283     if (sz == 0)
00284       return L4_EOK;
00285
00286     return copy(dst_offs, src_cap.data(), src_offs, sz);
00287   }
00288
00289   l4_ret_t op_info(L4Re::Dataspace::Rights rights, L4Re::Dataspace::Stats &s)
00290   {
00291     s.size = size();
00292     // only return writable if really writable
00293     s.flags = Dataspace::Flags(0);
00294     if (map_flags(rights).w())
00295       s.flags |= Dataspace::F::W;
00296     return L4_EOK;
00297   }
00298
00299   l4_ret_t op_clear(L4Re::Dataspace::Rights rights,
00300                     L4Re::Dataspace::Offset offset,
00301                     L4Re::Dataspace::Size size)
00302   {
00303     if (!map_flags(rights).w())
00304       return -L4_EACCESS;
00305
00306     return clear(offset, size);
00307   }
00308
00309   l4_ret_t op_map_info(L4Re::Dataspace::Rights,
00310                        [[maybe_unused]] l4_addr_t &start_addr,
00311                        [[maybe_unused]] l4_addr_t &end_addr)
00312   {
00313 #ifdef CONFIG_MMU
00314     return 0;
00315 #else
```

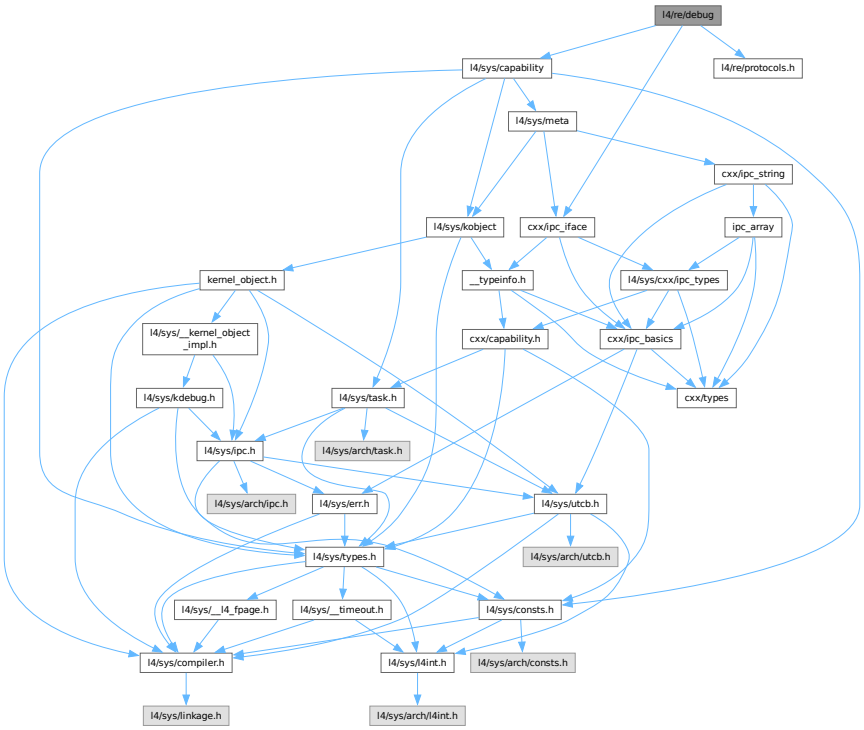
```
00316     return map_info(start_addr, end_addr);
00317 #endif
00318   }
00319
00320 protected:
00321   unsigned long size() const noexcept
00322   { return _ds_size; }
00323   unsigned long map_flags() const noexcept
00324   { return _map_flags; }
00325   unsigned long page_size() const noexcept
00326   { return 1UL << page_shift(); }
00327   unsigned long round_size() const noexcept
00328   { return l4_round_size(size(), page_shift()); }
00329   bool check_limit(l4_addr_t offset) const noexcept
00330   { return offset < round_size(); }
00331
00332   L4Re::Dataspace::Flags
00333   map_flags(L4Re::Dataspace::Rights rights = L4_CAP_FPAGE_W) const noexcept
00334   {
00335     auto f = (_rw_flags & L4Re::Dataspace::Flags(0x0f)) | L4Re::Dataspace::F::Caching_mask;
00336     if (!(rights & L4_CAP_FPAGE_W))
00337       f -= L4Re::Dataspace::F::W;
00338
00339     return f;
00340   }
00341
00342 protected:
00343   void size(unsigned long size) noexcept { _ds_size = size; }
00344
00345   l4_addr_t _ds_start;
00346   l4_size_t _ds_size;
00347   Map_type _map_flags;
00348   Cache_type _cache_flags;
00349   L4Re::Dataspace::Flags _rw_flags;
00350 };
00351
00352 }}
```

16.381 l4/re/debug File Reference

Debug interface.

```
#include <l4/sys/capability>
#include <l4/re/protocols.h>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for debug:



Data Structures

- class L4Re::Debug_obj

  Debug interface.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.381.1 Detailed Description

Debug interface.
Definition in file debug.

16.382 debug

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/capability>
00016 #include <l4/re/protocols.h>
00017 #include <l4/sys/cxx/ipc_iface>
00018
00019 namespace L4Re {
```

```
00033
00040 class L4_EXPORT Debug_obj :
00041   public L4::Kobject_t<Debug_obj, L4::Kobject, L4RE_PROTO_DEBUG>
00042 {
00043 public:
00044
00056   L4_INLINE_RPC(l4_ret_t, debug, (unsigned long function));
00057   typedef L4::Typeid::Rpc_nocode<debug_t> Rpcs;
00058 };
00059
00060 template<typename BASE>
00061 class Debug_obj_t :
00062   public L4::Kobject_2t<Debug_obj_t<BASE>, BASE, Debug_obj, L4::PROTO_EMPTY>
00063 {
00064   typedef L4::Typeid::Rpcs<> Rpcs;
00065 };
00066 }
```

16.383 debug

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/types.h>
00017
00018 namespace L4Re { namespace Util {
00019 class Err
00020 {
00021 public:
00022   enum Level
00023   {
00024     Normal = 0,
00025     Fatal,
00026   };
00027
00028   static char const *const levels[];
00029
00030   void tag() const
00031   { cprintf("%s: %s", _component, levels[_l]); }
00032
00033   int printf(char const *fmt, ...) const
00034     __attribute__((format(printf,2,3)));
00035
00036   int cprintf(char const *fmt, ...) const
00037     __attribute__((format(printf,2,3)));
00038
00039   constexpr Err(Level l, char const *component) : _l(l), _component(component)
00040   {}
00041
00042 private:
00043   Level _l;
00044   char const *_component;
00045 };
00046
00047
00048 class Dbg
00049 {
00050 private:
00051   void tag() const;
00052
00053 #ifndef NDEBUG
00054
00055   unsigned long _m;
00056   char const *const _component;
00057   char const *const _subsys;
00058
00059 # ifndef __clang__
00060
00061   int printf_impl(char const *fmt, ...) const
00062     __attribute__((format(printf, 2, 3)));
00063
00064   int cprintf_impl(char const *fmt, ...) const
00065     __attribute__((format(printf, 2, 3)));
00066
00067 # endif
00068
00069 public:
```

```
00070   static unsigned long level;
00071
00072   static void set_level(unsigned long l) { level = l; }
00073
00074   bool is_active() const { return _m & level; }
00075
00076 # ifdef __clang__
00077
00078   int printf(char const *fmt, ...) const
00079     __attribute__((format(printf, 2, 3)));
00080
00081   int cprintf(char const *fmt, ...) const
00082     __attribute__((format(printf, 2, 3)));
00083
00084 # else
00085
00086   int __attribute__((always_inline, format(printf, 2, 3)))
00087   printf(char const *fmt, ...) const
00088   {
00089     if (!(level & _m))
00090       return 0;
00091
00092     return printf_impl(fmt, __builtin_va_arg_pack());
00093   }
00094
00095   int __attribute__((always_inline, format(printf, 2, 3)))
00096   cprintf(char const *fmt, ...) const
00097   {
00098     if (!(level & _m))
00099       return 0;
00100
00101     return cprintf_impl(fmt, __builtin_va_arg_pack());
00102   }
00103
00104 # endif
00105
00106   explicit constexpr
00107   Dbg() : _m(1), _component(nullptr), _subsys(nullptr)
00108   {}
00109
00110   explicit constexpr
00111   Dbg(unsigned long mask) : _m(mask), _component(nullptr), _subsys(nullptr)
00112   {}
00113
00114   explicit constexpr
00115   Dbg(unsigned long mask, char const *comp, char const *subs)
00116   : _m(mask), _component(comp), _subsys(subs)
00117   {}
00118
00119 #else
00120
00121 public:
00122   static void set_level(unsigned long) {}
00123   bool is_active() const { return false; }
00124
00125   int printf(char const * /*fmt*/, ...) const
00126     __attribute__((format(printf, 2, 3)))
00127   { return 0; }
00128
00129   int cprintf(char const * /*fmt*/, ...) const
00130     __attribute__((format(printf, 2, 3)))
00131   { return 0; }
00132
00133   explicit constexpr
00134   Dbg() {}
00135
00136   explicit constexpr
00137   Dbg(unsigned long) {}
00138
00139   explicit constexpr
00140   Dbg(unsigned long, char const *, char const *) {}
00141
00142 #endif
00143
00144 };
00145
00146 }}
00147
```

16.384 env_ns

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002
00003 #pragma once
```

```
00004
00005 #include <l4/re/cap_alloc>
00006 #include <l4/re/util/cap_alloc>
00007 #include <l4/re/namespace>
00008 #include <l4/re/env>
00009 #include <string.h>
00010
00011 namespace L4Re { namespace Util {
00012
00013 class Env_ns
00014 {
00015 private:
00016   L4Re::Cap_alloc *_ca;
00017   Env const *_env;
00018
00019 public:
00020   explicit Env_ns(Env const *env = Env::env(),
00021                   L4Re::Cap_alloc *ca = &L4Re::Util::cap_alloc)
00022   : _ca(ca), _env(env) {}
00023
00024   L4::Cap<void>
00025   query(char const *name, unsigned len, int timeout = Namespace::To_default,
00026         l4_umword_t *local_id = 0, bool iterate = true) const noexcept
00027   {
00028     typedef Env::Cap_entry Cap_entry;
00029
00030     // Skip possible first slash
00031     if (len && name[0] == '/')
00032       {
00033         ++name;
00034         --len;
00035       }
00036
00037     char const *n = name;
00038     for (; len && *n != '/'; ++n, --len) // Count first path element
00039       ;
00040
00041     Cap_entry const *e = _env->get(name, n - name);
00042     if (!e)
00043       return L4::Cap<void>(-L4_ENOENT);
00044
00045     if (len > 0 && *n == '/')
00046       {
00047   L4::Cap<L4Re::Namespace> ns(e->cap);
00048   L4::Cap<void> cap = _ca->alloc<void>();
00049
00050   if (!cap.is_valid())
00051     return L4::Cap<void>(-L4_ENOMEM);
00052
00053   long r = ns->query(n + 1, len - 1, cap, timeout, local_id, iterate);
00054   if (r >= 0)
00055     return cap;
00056
00057   _ca->free(cap);
00058
00059   return L4::Cap<void>(r);
00060       }
00061
00062     return L4::Cap<void>(e->cap);
00063   }
00064
00065   L4::Cap<void>
00066   query(char const *name, int timeout = Namespace::To_default,
00067         l4_umword_t *local_id = 0, bool iterate = true) const noexcept
00068   { return query(name, __builtin_strlen(name), timeout, local_id, iterate); }
00069
00070   template<typename T >
00071   L4::Cap<T>
00072   query(char const *name, int timeout = Namespace::To_default,
00073         l4_umword_t *local_id = 0, bool iterate = true) const noexcept
00074   {
00075     return L4::cap_cast<T>(query(name, __builtin_strlen(name),
00076                                  timeout, local_id, iterate));
00077   }
00078 };
00079
00080 }}
```

16.385 event

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
```

```
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/sys/capability>
00013 #include <l4/sys/irq>
00014 #include <l4/sys/cxx/ipc_iface>
00015 #include <l4/sys/cxx/ipc_array>
00016 #include <l4/re/dataspace>
00017 #include <l4/re/event.h>
00018
00019 namespace L4Re {
00020
00039
00040 typedef l4re_event_stream_id_t Event_stream_id;
00041 typedef l4re_event_absinfo_t Event_absinfo;
00042
00043 class L4_EXPORT Event_stream_bitmap_h
00044 {
00045 protected:
00046   static unsigned __get_idx(unsigned idx)
00047   { return idx / (sizeof(unsigned long)*8); }
00048
00049   static unsigned long __get_mask(unsigned idx)
00050   { return 1ul << (idx % (sizeof(unsigned long)*8)); }
00051
00052   static bool __get_bit(unsigned long const *bm, unsigned max, unsigned idx)
00053   {
00054     if (idx <= max)
00055       return bm[__get_idx(idx)] & __get_mask(idx);
00056     return false;
00057   }
00058
00059   static void __set_bit(unsigned long *bm, unsigned max, unsigned idx, bool v)
00060   {
00061     if (idx > max)
00062       return;
00063
00064     if (v)
00065       bm[__get_idx(idx)] |= __get_mask(idx);
00066     else
00067       bm[__get_idx(idx)] &= ~__get_mask(idx);
00068   }
00069 };
00070
00071 class L4_EXPORT Event_stream_info
00072 : public l4re_event_stream_info_t,
00073   private Event_stream_bitmap_h
00074 {
00075 public:
00076   bool get_propbit(unsigned idx) const
00077   { return __get_bit(propbits, L4RE_EVENT_PROP_MAX, idx); }
00078
00079   void set_propbit(unsigned idx, bool v)
00080   { __set_bit(propbits, L4RE_EVENT_PROP_MAX, idx, v); }
00081
00082   bool get_evbit(unsigned idx) const
00083   { return __get_bit(evbits, L4RE_EVENT_EV_MAX, idx); }
00084
00085   void set_evbit(unsigned idx, bool v)
00086   { __set_bit(evbits, L4RE_EVENT_EV_MAX, idx, v); }
00087
00088   bool get_keybit(unsigned idx) const
00089   { return __get_bit(keybits, L4RE_EVENT_KEY_MAX, idx); }
00090
00091   void set_keybit(unsigned idx, bool v)
00092   { __set_bit(keybits, L4RE_EVENT_KEY_MAX, idx, v); }
00093
00094   bool get_relbit(unsigned idx) const
00095   { return __get_bit(relbits, L4RE_EVENT_REL_MAX, idx); }
00096
00097   void set_relbit(unsigned idx, bool v)
00098   { __set_bit(relbits, L4RE_EVENT_REL_MAX, idx, v); }
00099
00100   bool get_absbit(unsigned idx) const
00101   { return __get_bit(absbits, L4RE_EVENT_ABS_MAX, idx); }
00102
00103   void set_absbit(unsigned idx, bool v)
00104   { __set_bit(absbits, L4RE_EVENT_ABS_MAX, idx, v); }
00105
00106   bool get_swbit(unsigned idx) const
00107   { return __get_bit(swbits, L4RE_EVENT_SW_MAX, idx); }
00108
00109   void set_swbit(unsigned idx, bool v)
```

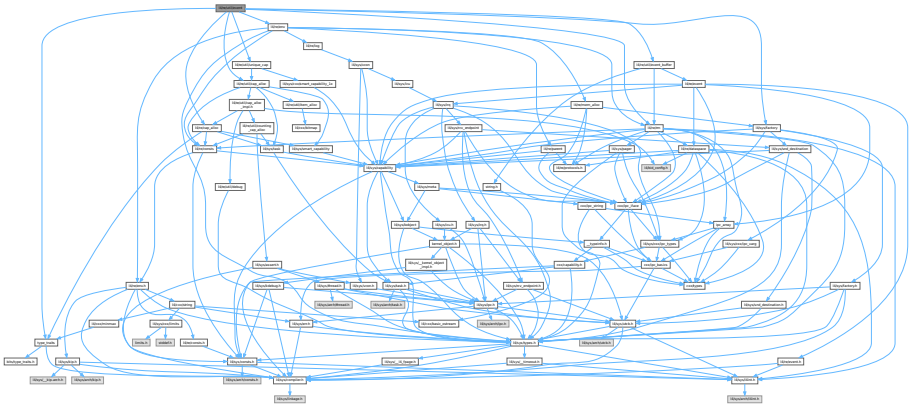
```
00110   { __set_bit(swbits, L4RE_EVENT_SW_MAX, idx, v); }
00111 };
00112
00113 class L4_EXPORT Event_stream_state
00114 : public l4re_event_stream_state_t,
00115   private Event_stream_bitmap_h
00116 {
00117 public:
00118   bool get_keybit(unsigned idx) const
00119   { return __get_bit(keybits, L4RE_EVENT_KEY_MAX, idx); }
00120
00121   void set_keybit(unsigned idx, bool v)
00122   { __set_bit(keybits, L4RE_EVENT_KEY_MAX, idx, v); }
00123
00124   bool get_swbit(unsigned idx) const
00125   { return __get_bit(swbits, L4RE_EVENT_SW_MAX, idx); }
00126
00127   void set_swbit(unsigned idx, bool v)
00128   { __set_bit(swbits, L4RE_EVENT_SW_MAX, idx, v); }
00129 };
00130
00137 class L4_EXPORT Event :
00138   public L4::Kobject_t<Event, L4::Icu, L4RE_PROTO_EVENT>
00139 {
00140 public:
00149   L4_RPC(l4_ret_t, get_buffer, (L4::Ipc::Out<L4::Cap<Dataspace>> ds));
00150
00157   L4_RPC(l4_ret_t, get_num_streams, ());
00158
00170   L4_RPC(l4_ret_t, get_stream_info, (int idx, Event_stream_info *info));
00171
00181   L4_RPC(l4_ret_t, get_stream_info_for_id, (l4_umword_t stream_id, Event_stream_info *info));
00182
00194   L4_RPC_NF(l4_ret_t, get_axis_info, (l4_umword_t stream_id,
00195                                       L4::Ipc::Array<unsigned const,
00196                                       unsigned long> axes,
00197                                       L4::Ipc::Array<Event_absinfo,
00198                                       unsigned long> &info));
00199
00200   l4_ret_t get_axis_info(l4_umword_t stream_id, unsigned naxes,
00201                          unsigned const *axis, Event_absinfo *info) const noexcept
00202   {
00203     L4::Ipc::Array<Event_absinfo, unsigned long> i(naxes, info);
00204     return get_axis_info_t::call(c(), stream_id,
00205         L4::Ipc::Array<unsigned const, unsigned long>(naxes, axis), i);
00206   }
00207
00217   L4_RPC(l4_ret_t, get_stream_state_for_id, (l4_umword_t stream_id,
00218                                              Event_stream_state *state));
00219
00220   typedef L4::Typeid::Rpcs<
00221     get_buffer_t,
00222     get_num_streams_t,
00223     get_stream_info_t,
00224     get_stream_info_for_id_t,
00225     get_axis_info_t,
00226     get_stream_state_for_id_t
00227   > Rpcs;
00228 };
00229
00234 struct L4_EXPORT Default_event_payload
00235 {
00236   unsigned short type;
00237   unsigned short code;
00238   int value;
00239   l4_umword_t stream_id;
00240 };
00241
00242
00247 template< typename PAYLOAD = Default_event_payload >
00248 class L4_EXPORT Event_buffer_t
00249 {
00250 public:
00251
00255   struct Event
00256   {
00257     long long time;
00258     PAYLOAD payload;
00259
00263     void free() noexcept { l4_mb(); time = 0; }
00264   };
00265
00266 private:
00267   Event *_current;
00268   Event *_begin;
00269   Event const *_end;
00270
```

```
00271   void inc() noexcept
00272   {
00273     ++_current;
00274     if (_current == _end)
00275       _current = _begin;
00276   }
00277
00278 public:
00279
00280   Event_buffer_t() : _current(0), _begin(0), _end(0) {}
00281
00282   void reset()
00283   {
00284     for (Event *i = _begin; i != _end; ++i)
00285       i->time = 0;
00286     _current = _begin;
00287   }
00288
00295   Event_buffer_t(void *buffer, l4_addr_t size)
00296   : _current(static_cast<Event*>(buffer)), _begin(_current),
00297     _end(_begin + size / sizeof(Event))
00298   { reset(); }
00299
00305   Event *next() noexcept
00306   {
00307     Event *c = _current;
00308     if (c->time)
00309       {
00310         inc();
00311         return c;
00312       }
00313     return 0;
00314   }
00315
00322   bool put(Event const &ev) noexcept
00323   {
00324     Event *c = _current;
00325     if (c->time)
00326       return false;
00327
00328     inc();
00329     c->payload = ev.payload;
00330     l4_wmb();
00331     c->time = ev.time;
00332     return true;
00333   }
00334 };
00335
00336 typedef Event_buffer_t<Default_event_payload> Event_buffer;
00337
00338 }
```

16.386 l4/re/util/event File Reference

```
#include <l4/re/cap_alloc>
#include <l4/re/util/cap_alloc>
#include <l4/re/util/unique_cap>
#include <l4/re/env>
#include <l4/re/rm>
#include <l4/re/util/event_buffer>
#include <l4/sys/factory>
#include <l4/cxx/type_traits>
```

Include dependency graph for event:



Data Structures

- class L4Re::Util::Event_t< PAYLOAD >

  Convenience wrapper for getting access to an event object.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

16.387 event

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/re/cap_alloc>
00015 #include <l4/re/util/cap_alloc>
00016 #include <l4/re/util/unique_cap>
00017 #include <l4/re/env>
00018 #include <l4/re/rm>
00019 #include <l4/re/util/event_buffer>
00020 #include <l4/sys/factory>
00021 #include <l4/cxx/type_traits>
00022
00023 namespace L4Re { namespace Util {
00024
00031 template< typename PAYLOAD >
00032 class Event_t
00033 {
00034 public:
00038   enum Mode
00039   {
00040     Mode_irq,
00041     Mode_polling,
00042   };
00043
00058   template<typename IRQ_TYPE>
00059   int init(L4::Cap<L4Re::Event> event,
00060            L4Re::Env const *env = L4Re::Env::env(),
00061            L4Re::Cap_alloc *ca = &L4Re::Util::cap_alloc)
00062   {
00063     Unique_cap<L4Re::Dataspace> ev_ds(ca->alloc<L4Re::Dataspace>());
```

```
00064     if (!ev_ds.is_valid())
00065       return -L4_ENOMEM;
00066
00067     int r;
00068
00069     Unique_del_cap<IRQ_TYPE> ev_irq(ca->alloc<IRQ_TYPE>());
00070     if (!ev_irq.is_valid())
00071       return -L4_ENOMEM;
00072
00073     if ((r = l4_error(env->factory()->create(ev_irq.get()))))
00074       return r;
00075
00076     if ((r = l4_error(event->bind(0, ev_irq.get()))))
00077       return r;
00078
00079     if ((r = event->get_buffer(ev_ds.get())))
00080       return r;
00081
00082     long sz = ev_ds->size();
00083     if (sz < 0)
00084       return sz;
00085
00086     Rm::Unique_region<void*> buf;
00087
00088     if ((r = env->rm()->attach(&buf, sz,
00089                                L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
00090                                L4::Ipc::make_cap_rw(ev_ds.get()))))
00091       return r;
00092
00093     _ev_buffer = L4Re::Event_buffer_t<PAYLOAD>(buf.get(), sz);
00094     _ev_ds     = cxx::move(ev_ds);
00095     _ev_irq    = cxx::move(ev_irq);
00096     _buf       = cxx::move(buf);
00097
00098     return 0;
00099   }
00100
00112   int init_poll(L4::Cap<L4Re::Event> event,
00113                 L4Re::Env const *env = L4Re::Env::env(),
00114                 L4Re::Cap_alloc *ca = &L4Re::Util::cap_alloc)
00115   {
00116     Unique_cap<L4Re::Dataspace> ev_ds(ca->alloc<L4Re::Dataspace>());
00117     if (!ev_ds.is_valid())
00118       return -L4_ENOMEM;
00119
00120     int r;
00121
00122     if ((r = event->get_buffer(ev_ds.get())))
00123       return r;
00124
00125     long sz = ev_ds->size();
00126     if (sz < 0)
00127       return sz;
00128
00129     Rm::Unique_region<void*> buf;
00130
00131     if ((r = env->rm()->attach(&buf, sz,
00132                                L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
00133                                L4::Ipc::make_cap_rw(ev_ds.get()))))
00134       return r;
00135
00136     _ev_buffer = L4Re::Event_buffer_t<PAYLOAD>(buf.get(), sz);
00137     _ev_ds     = cxx::move(ev_ds);
00138     _buf       = cxx::move(buf);
00139
00140     return 0;
00141   }
00142
00148   L4Re::Event_buffer_t<PAYLOAD> &buffer() { return _ev_buffer; }
00149
00155   L4::Cap<L4::Triggerable> irq() const { return _ev_irq.get(); }
00156
00157 private:
00158   Unique_cap<L4Re::Dataspace> _ev_ds;
00159   Unique_del_cap<L4::Triggerable> _ev_irq;
00160   L4Re::Event_buffer_t<PAYLOAD> _ev_buffer;
00161   Rm::Unique_region<void*> _buf;
00162 };
00163
00164 typedef Event_t<Default_event_payload> Event;
00165
00166 }}
```

16.388 event_buffer

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/re/event>
00013 #include <l4/re/rm>
00014
00015 #include <string.h>
00016
00017 namespace L4Re { namespace Util {
00018
00023 template< typename PAYLOAD >
00024 class Event_buffer_t : public L4Re::Event_buffer_t<PAYLOAD>
00025 {
00026 private:
00027   void *_buf;
00028 public:
00034   void *buf() const noexcept { return _buf; }
00035
00044   long attach(L4::Cap<L4Re::Dataspace> ds, L4::Cap<L4Re::Rm> rm) noexcept
00045   {
00046     l4_addr_t sz = ds->size();
00047     _buf = 0;
00048
00049     long r = rm->attach(&_buf, sz,
00050                         L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
00051                         L4::Ipc::make_cap_rw(ds));
00052     if (r < 0)
00053       return r;
00054
00055     *static_cast<L4Re::Event_buffer_t<PAYLOAD> *>(this)
00056       = L4Re::Event_buffer_t<PAYLOAD>(_buf, sz);
00057     return 0;
00058   }
00059
00067   long detach(L4::Cap<L4Re::Rm> rm) noexcept
00068   {
00069     L4::Cap<L4Re::Dataspace> ds;
00070     if (_buf)
00071       return rm->detach(_buf, &ds);
00072     return 0;
00073   }
00074
00075 };
00076
00081 template< typename PAYLOAD >
00082 class Event_buffer_consumer_t : public Event_buffer_t<PAYLOAD>
00083 {
00084 public:
00085
00092   template< typename CB, typename D >
00093   void foreach_available_event(CB const &cb, D data = D())
00094   {
00095     typename Event_buffer_t<PAYLOAD>::Event *e;
00096     while ((e = Event_buffer_t<PAYLOAD>::next()))
00097       {
00098         cb(e, data);
00099         e->free();
00100       }
00101   }
00102
00113   template< typename CB, typename D >
00114   void process(L4::Cap<L4::Irq> irq,
00115                L4::Cap<L4::Thread> thread,
00116                CB const &cb, D data = D())
00117   {
00118
00119     if (l4_error(irq->bind_thread(thread, 0)))
00120       return;
00121
00122     while (1)
00123       {
00124         long r;
00125         r = l4_ipc_error(l4_irq_receive(irq.cap(), L4_IPC_NEVER),
00126                          l4_utcb());
00127         if (r)
00128           continue;
```

```
00129
00130         foreach_available_event(cb, data);
00131       }
00132   }
00133 };
00134
00135 typedef Event_buffer_t<Default_event_payload> Event_buffer;
00136 typedef Event_buffer_consumer_t<Default_event_payload> Event_buffer_consumer;
00137
00138 }}
```

16.389 event_svr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/re/event_enums.h>
00013 #include <l4/re/event>
00014 #include <l4/re/util/icu_svr>
00015 #include <l4/cxx/minmax>
00016
00017 #include <l4/sys/cxx/ipc_legacy>
00018
00019 namespace L4Re { namespace Util {
00020
00026 template< typename SVR >
00027 class Event_svr : public Icu_cap_array_svr<SVR>
00028 {
00029 private:
00030   typedef Icu_cap_array_svr<SVR> Icu_svr;
00031
00032 protected:
00033   L4::Cap<L4Re::Dataspace> _ds;
00034   typename Icu_svr::Irq _irq;
00035
00036 public:
00037   Event_svr() : Icu_svr(1, &_irq) {}
00038
00039   L4_RPC_LEGACY_DISPATCH(L4Re::Event);
00040   L4_RPC_LEGACY_USING(Icu_svr);
00041
00043   l4_ret_t op_get_buffer(L4Re::Event::Rights, L4::Ipc::Cap<L4Re::Dataspace> &ds)
00044   {
00045     static_cast<SVR*>(this)->reset_event_buffer();
00046     ds = L4::Ipc::Cap<L4Re::Dataspace>(_ds, L4_CAP_FPAGE_RW);
00047     return 0;
00048   }
00049
00050   l4_ret_t op_get_num_streams(L4Re::Event::Rights)
00051   { return static_cast<SVR*>(this)->get_num_streams(); }
00052
00053   l4_ret_t op_get_stream_info(L4Re::Event::Rights, int idx, Event_stream_info &info)
00054   { return static_cast<SVR*>(this)->get_stream_info(idx, &info); }
00055
00056   l4_ret_t op_get_stream_info_for_id(L4Re::Event::Rights, l4_umword_t id,
00057                                      Event_stream_info &info)
00058   { return static_cast<SVR*>(this)->get_stream_info_for_id(id, &info); }
00059
00060   l4_ret_t op_get_axis_info(L4Re::Event::Rights, l4_umword_t id,
00061                             L4::Ipc::Array_in_buf<unsigned, unsigned long> const &axes,
00062                             L4::Ipc::Array_ref<Event_absinfo, unsigned long> &info)
00063   {
00064     unsigned naxes = cxx::min<unsigned>(L4RE_ABS_MAX, axes.length);
00065
00066     info.length = 0;
00067
00068     Event_absinfo _info[L4RE_ABS_MAX];
00069     int r = static_cast<SVR*>(this)->get_axis_info(id, naxes, axes.data, _info);
00070     if (r < 0)
00071       return r;
00072
00073     for (unsigned i = 0; i < naxes; ++i)
00074       info.data[i] = _info[i];
00075
00076     info.length = naxes;
00077     return r;
```

```
00078   }
00079
00080   l4_ret_t op_get_stream_state_for_id(L4Re::Event::Rights, l4_umword_t stream_id,
00081                                      Event_stream_state &state)
00082   { return static_cast<SVR*>(this)->get_stream_state_for_id(stream_id, &state); }
00083
00084   int get_num_streams() const { return 0; }
00085   int get_stream_info(int, L4Re::Event_stream_info *)
00086   { return -L4_EINVAL; }
00087   int get_stream_info_for_id(l4_umword_t, L4Re::Event_stream_info *)
00088   { return -L4_EINVAL; }
00089   int get_axis_info(l4_umword_t, unsigned /*naxes*/, unsigned const * /*axes*/,
00090                     L4Re::Event_absinfo *)
00091   { return -L4_EINVAL; }
00092   int get_stream_state_for_id(l4_umword_t, L4Re::Event_stream_state *)
00093   { return -L4_EINVAL; }
00094 };
00095
00096 }}
```

16.390 icu_svr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2009-2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010
00011 #include <l4/sys/types.h>
00012
00013 #include <l4/sys/icu>
00014 #include <l4/sys/task>
00015 #include <l4/re/env>
00016 #include <l4/re/util/cap_alloc>
00017 #include <l4/sys/cxx/ipc_legacy>
00018
00019 namespace L4Re { namespace Util {
00020
00021 template< typename ICU >
00022 class Icu_svr
00023 {
00024 private:
00025   ICU const *this_icu() const { return static_cast<ICU const *>(this); }
00026   ICU *this_icu() { return static_cast<ICU*>(this); }
00027
00028 public:
00029   L4_RPC_LEGACY_DISPATCH(L4::Icu);
00030
00031   l4_ret_t op_bind(L4::Icu::Rights, l4_umword_t irqnum,
00032                    L4::Ipc::Snd_fpage irq_fp);
00033   l4_ret_t op_unbind(L4::Icu::Rights, l4_umword_t irqnum,
00034                      L4::Ipc::Snd_fpage irq_fp);
00035   l4_ret_t op_info(L4::Icu::Rights, L4::Icu::_Info &info);
00036   l4_ret_t op_msi_info(L4::Icu::Rights, l4_umword_t irqnum,
00037                        l4_uint64_t source, l4_icu_msi_info_t &info);
00038   l4_ret_t op_mask(L4::Icu::Rights, l4_umword_t irqnum);
00039   l4_ret_t op_unmask(L4::Icu::Rights, l4_umword_t irqnum);
00040   l4_ret_t op_set_mode(L4::Icu::Rights, l4_umword_t, l4_umword_t)
00041   { return 0; }
00042 };
00043
00044 template<typename ICU> inline
00045 l4_ret_t
00046 Icu_svr<ICU>::op_bind(L4::Icu::Rights, l4_umword_t irqnum,
00047                       L4::Ipc::Snd_fpage irq_fp)
00048 {
00049   typename ICU::Irq *irq = this_icu()->icu_get_irq(irqnum);
00050   if (!irq)
00051     return -L4_EINVAL;
00052
00053   return irq->bind(this_icu(), irq_fp);
00054 }
00055
00056 template<typename ICU> inline
00057 l4_ret_t
00058 Icu_svr<ICU>::op_unbind(L4::Icu::Rights, l4_umword_t irqnum,
00059                         L4::Ipc::Snd_fpage irq_fp)
00060 {
00061   typename ICU::Irq *irq = this_icu()->icu_get_irq(irqnum);
00062   if (!irq)
```

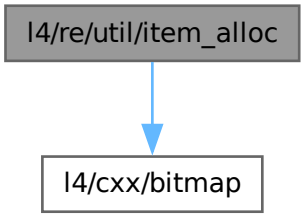
```
00063     return -L4_EINVAL;
00064
00065   return irq->unbind(this_icu(), irq_fp);
00066 }
00067
00068 template<typename ICU> inline
00069 l4_ret_t
00070 Icu_svr<ICU>::op_info(L4::Icu::Rights, L4::Icu::_Info &info)
00071 {
00072   l4_icu_info_t i;
00073   this_icu()->icu_get_info(&i);
00074   info.features = i.features;
00075   info.nr_irqs = i.nr_irqs;
00076   info.nr_msis = i.nr_msis;
00077   return 0;
00078 }
00079
00080 template<typename ICU> inline
00081 l4_ret_t
00082 Icu_svr<ICU>::op_msi_info(L4::Icu::Rights, l4_umword_t irqnum,
00083                           l4_uint64_t source, l4_icu_msi_info_t &info)
00084 {
00085   typename ICU::Irq *irq = this_icu()->icu_get_irq(irqnum);
00086   if (!irq)
00087     return -L4_EINVAL;
00088   return irq->msi_info(source, &info);
00089 }
00090
00091 template<typename ICU> inline
00092 l4_ret_t
00093 Icu_svr<ICU>::op_mask(L4::Icu::Rights, l4_umword_t irqnum)
00094 {
00095   typename ICU::Irq *irq = this_icu()->icu_get_irq(irqnum);
00096   if (irq)
00097     irq->mask(true);
00098   return -L4_ENOREPLY;
00099 }
00100
00101 template<typename ICU> inline
00102 l4_ret_t
00103 Icu_svr<ICU>::op_unmask(L4::Icu::Rights, l4_umword_t irqnum)
00104 {
00105   typename ICU::Irq *irq = this_icu()->icu_get_irq(irqnum);
00106   if (irq)
00107     irq->mask(false);
00108   return -L4_ENOREPLY;
00109 }
00110
00111
00112 template< typename ICU >
00113 class Icu_cap_array_svr : public Icu_svr<ICU>
00114 {
00115 protected:
00116   static void free_irq_cap(L4::Cap<L4::Irq> &cap)
00117   {
00118     if (cap)
00119       {
00120         L4Re::Util::cap_alloc.free(cap);
00121         cap.invalidate();
00122       }
00123   }
00124
00125 public:
00126   class Irq
00127   {
00128     public:
00129     Irq() {}
00130     ~Irq() { ICU::free_irq_cap(_cap); }
00131
00132     void trigger() const
00133     {
00134       if (_cap)
00135         _cap->trigger();
00136     }
00137
00138     l4_ret_t bind(ICU *, L4::Ipc::Snd_fpage const &irq_fp);
00139     l4_ret_t unbind(ICU *, L4::Ipc::Snd_fpage const &irq_fp);
00140     void mask(bool /*mask*/) const
00141     { }
00142
00143     l4_ret_t msi_info(l4_uint64_t, l4_icu_msi_info_t *) const
00144     { return -L4_EINVAL; }
00145
00146     L4::Cap<L4::Irq> cap() const { return _cap; }
00147
00148   private:
00149     L4::Cap<L4::Irq> _cap;
```

```
00150   };
00151
00152 private:
00153   Irq *_irqs;
00154   unsigned _nr_irqs;
00155
00156 public:
00157
00158   Icu_cap_array_svr(unsigned nr_irqs, Irq *irqs)
00159   : _irqs(irqs), _nr_irqs(nr_irqs)
00160   {}
00161
00162   Irq *icu_get_irq(l4_umword_t irqnum)
00163   {
00164     if (irqnum >= _nr_irqs)
00165       return 0;
00166
00167     return _irqs + irqnum;
00168   }
00169
00170   void icu_get_info(l4_icu_info_t *inf)
00171   {
00172     inf->features = 0;
00173     inf->nr_irqs = _nr_irqs;
00174     inf->nr_msis = 0;
00175   }
00176 };
00177
00178 template< typename ICU >
00179 l4_ret_t
00180 Icu_cap_array_svr<ICU>::Irq::bind(ICU *cfb, L4::Ipc::Snd_fpage const &irq_fp)
00181 {
00182   if (!irq_fp.cap_received())
00183     return -L4_EINVAL;
00184
00185   L4::Cap<L4::Irq> irq = cfb->server_iface()->template rcv_cap<L4::Irq>(0);
00186   if (!irq)
00187     return -L4_EINVAL;
00188
00189   int r = cfb->server_iface()->realloc_rcv_cap(0);
00190   if (r < 0)
00191     return r;
00192
00193   ICU::free_irq_cap(_cap);
00194   _cap = irq;
00195   return 0;
00196 }
00197
00198 template< typename ICU >
00199 l4_ret_t
00200 Icu_cap_array_svr<ICU>::Irq::unbind(ICU *, L4::Ipc::Snd_fpage const &/*irq_fp*/)
00201 {
00202   ICU::free_irq_cap(_cap);
00203   _cap = L4::Cap<L4::Irq>::Invalid;
00204   return 0;
00205 }
00206
00207
00208 }}
```

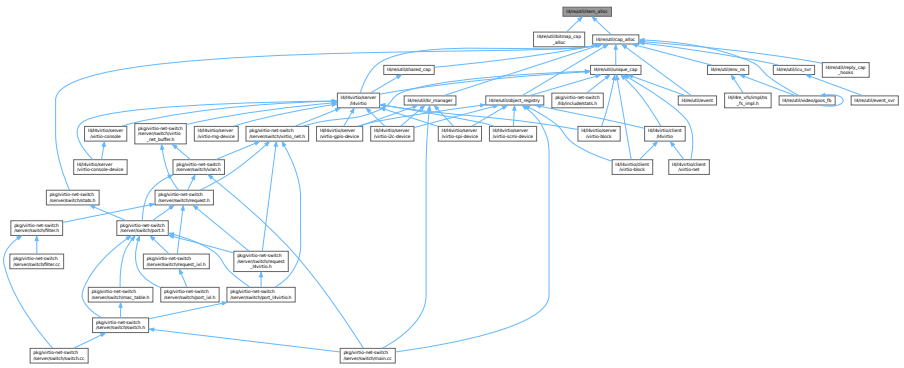
16.391 l4/re/util/item_alloc File Reference

Item allocator.

`#include <l4/cxx/bitmap>`
Include dependency graph for item_alloc:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4Re::Util::Item_alloc_base

  Item allocator.
- class L4Re::Util::Bitmap_base

  Basic bitmap abstraction.
- class L4Re::Util::Bitmap< BITS >

  A static bitmap.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

16.391.1 Detailed Description

Item allocator.
Definition in file item_alloc.

16.392 item_alloc

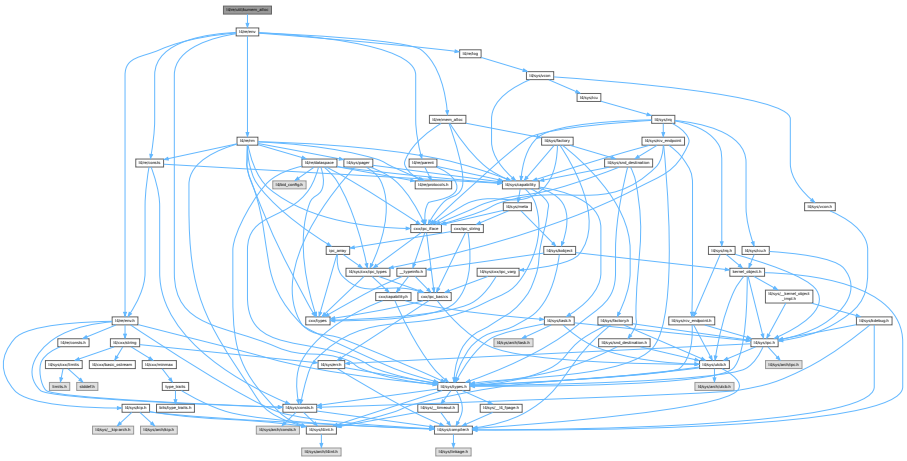
Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #pragma once
00016
00017 #include <l4/cxx/bitmap>
00018
00019 namespace L4Re { namespace Util {
00020
00021 using cxx::Bitmap_base;
00022 using cxx::Bitmap;
00023
00027 class Item_alloc_base
00028 {
00029 private:
00030   long _capacity;
00031   long _free_hint;
00032   Bitmap_base _bits;
00033
00034   void hint(long hint)
00035   { __atomic_store_n(&_free_hint, hint, __ATOMIC_RELAXED); }
00036
00037 public:
00038   bool is_allocated(long item) const noexcept
00039   { return _bits[item]; }
00040
00041   long hint() const { return __atomic_load_n(&_free_hint, __ATOMIC_RELAXED); }
00042
00043   bool alloc(long item) noexcept
00044   {
00045     return !_bits.atomic_get_and_set(item);
00046   }
00047
00048   void free(long item) noexcept
00049   {
00050     if (item < hint())
00051       hint(item);
00052
00053     _bits.atomic_clear_bit(item);
00054   }
00055
00056   Item_alloc_base(long size, void *mem) noexcept
00057     : _capacity(size), _free_hint(0), _bits(mem)
00058   {}
00059
00060   long alloc() noexcept
00061   {
00062     long free_hint = hint();
00063
00064     for (long i = free_hint; i < _capacity; ++i)
00065       if (alloc(i))
00066         {
00067           hint(i + 1);
00068           return i;
00069         }
00070
00071     // _free_hint is not necessarily correct in case of multi-threading! Make
00072     // sure we don't miss any potentially free slots.
00073     for (long i = 0; i < free_hint && i < _capacity; ++i)
00074       if (alloc(i))
00075         {
00076           hint(i + 1);
00077           return i;
00078         }
00079
00080     return -1;
00081   }
00082
00083   long size() const noexcept
00084   {
00085     return _capacity;
00086   }
00087 };
00088
00089 template< long Bits >
00090 class Item_alloc : public Item_alloc_base
```

```
00091 {
00092 private:
00093   typename Bitmap_base::Word<Bits>::Type _bits[Bitmap_base::Word<Bits>::Size];
00094
00095 public:
00096   Item_alloc() noexcept : Item_alloc_base(Bits, _bits) {}
00097 };
00098
00099 }}
```

16.393 l4/re/util/kumem_alloc File Reference

Kumem allocator helper.
`#include <l4/re/env>`
Include dependency graph for kumem_alloc:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

Functions

- int L4Re::Util::kumem_alloc (l4_addr_t *mem, unsigned pages_order, L4::Cap< L4::Task > task=L4Re::Env::env() ->task(), L4::Cap< L4Re::Rm > rm=L4Re::Env::env() ->rm()) noexcept

  Allocate state area.

16.393.1 Detailed Description

Kumem allocator helper.
Definition in file kumem_alloc.

16.394 kumem_alloc

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
```

```
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #pragma once
00016
00017 #include <l4/re/env>
00018
00019 namespace L4Re { namespace Util {
00020
00026
00044 int
00045 kumem_alloc(l4_addr_t *mem, unsigned pages_order,
00046             L4::Cap<L4::Task> task = L4Re::Env::env()->task(),
00047             L4::Cap<L4Re::Rm> rm = L4Re::Env::env()->rm()) noexcept;
00048
00050 }}
```

16.395 name_space_svr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include <l4/cxx/avl_tree>
00012 #include <l4/cxx/std_ops>
00013 #include <l4/sys/cxx/ipc_epiface>
00014 #include <l4/cxx/string>
00015 #include <l4/re/util/debug>
00016
00017 #include <l4/sys/capability>
00018 #include <l4/re/namespace>
00019
00020 #include <stddef.h>
00021 #include <string.h>
00022
00023 namespace L4Re { namespace Util { namespace Names {
00024
00028 class Name : public cxx::String
00029 {
00030 public:
00031
00032   Name(const char *name = "") : String(name, __builtin_strlen(name)) {}
00033   Name(const char *name, unsigned long len) : String(name, len) {}
00034   Name(cxx::String const &n) : String(n) {}
00035   char const *name() const { return start(); }
00036   bool operator < (Name const &r) const
00037   {
00038     unsigned long l = cxx::min(len(), r.len());
00039     int v = memcmp(start(), r.start(), l);
00040     return v < 0 || (v == 0 && len() < r.len());
00041   }
00042 };
00043
00044
00048 class Obj
00049 {
00050 protected:
00051   unsigned _f;
00052   union
00053   {
00054     l4_cap_idx_t _cap;
00055     L4::Epiface *_obj;
00056   };
00057
00058
00059 public:
00060   enum Flags
00061   {
00062     F_rw        = L4Re::Namespace::Rw,
00063     F_strong    = L4Re::Namespace::Strong,
00064
00065     F_trusted   = L4Re::Namespace::Trusted,
00066
00067     F_rights_mask = F_rw | F_strong | F_trusted,
00068
00069     F_cap        = 0x100,
00070     F_local      = 0x200,
00071     F_replacable = 0x400,
```

```
00072     F_base_mask  = 0xf00,
00073   };
00074
00075
00076   unsigned flags() const { return _f; }
00077   void restrict_flags(unsigned max_rights)
00078   { _f &= (~F_rights_mask | (max_rights & F_rights_mask)); }
00079
00080   bool is_rw() const { return (_f & F_rw) == F_rw; }
00081   bool is_strong() const { return _f & F_strong; }
00082
00083   bool is_valid() const { return _f & F_cap; }
00084   bool is_complete() const { return is_valid(); }
00085   bool is_local() const { return _f & F_local; }
00086   bool is_replacable() const { return _f & F_replacable; }
00087   bool is_trusted() const { return _f & F_trusted; }
00088
00089   L4::Epiface *obj() const { if (is_local()) return _obj; return 0; }
00090   L4::Cap<void> cap() const
00091   {
00092     if (!is_local())
00093       return L4::Cap<void>(_cap);
00094     if (!_obj)
00095       return L4::Cap<void>::Invalid;
00096     return _obj->obj_cap();
00097   }
00098
00099
00100   void set(Obj const &o, unsigned flags)
00101   {
00102     *this = o;
00103     restrict_flags(flags);
00104   }
00105
00106   explicit Obj(unsigned flags = 0)
00107   : _f(flags), _cap(L4_INVALID_CAP)
00108   {}
00109
00110   Obj(unsigned f, L4::Cap<void> const &cap)
00111   : _f((f & ~F_base_mask) | F_cap), _cap(cap.cap())
00112   {}
00113
00114   Obj(unsigned f, L4::Epiface *o)
00115   : _f((f & ~F_base_mask) | F_cap | F_local), _obj(o)
00116   {}
00117
00118   void reset(unsigned flags)
00119   {
00120     _f = (_f & F_replacable) | (flags & ~(F_cap | F_local));
00121     _cap = L4_INVALID_CAP;
00122   }
00123
00124
00125 };
00126
00127
00131 class Entry : public cxx::Avl_tree_node
00132 {
00133 private:
00134   friend class Name_space;
00135   Name _n;
00136   Obj  _o;
00137
00138   bool _dynamic;
00139
00140 public:
00141   Entry(Name const &n, Obj const &o, bool dynamic = false)
00142   : _n(n), _o(o), _dynamic(dynamic) {}
00143
00144   Name const &name() const { return _n; }
00145   Obj const *obj() const { return &_o; }
00146   Obj *obj() { return &_o; }
00147   void obj(Obj const &o) { _o = o; }
00148
00149   bool is_placeholder() const
00150   { return !obj()->is_complete(); }
00151
00152   bool is_dynamic() const { return _dynamic; }
00153
00154   void set(Obj const &o)
00155   {
00156     obj()->set(o, obj()->flags());
00157   }
00158
00159 private:
00160   void * operator new (size_t s);
00161   void operator delete(void *b);
```

```
00162
00163 };
00164
00165 struct Names_get_key
00166 {
00167   typedef Name Key_type;
00168   static Key_type const &key_of(Entry const *e)
00169   { return e->name(); }
00170 };
00171
00172
00180 class Name_space
00181 {
00182   friend class Entry;
00183
00184 private:
00185   typedef cxx::Avl_tree<Entry, Names_get_key> Tree;
00186   Tree _tree;
00187
00188 protected:
00189   L4Re::Util::Dbg const &_dbg;
00190   L4Re::Util::Err const &_err;
00191
00192 public:
00193
00194   typedef Tree::Const_iterator Const_iterator;
00195
00196   Const_iterator begin() const { return _tree.begin(); }
00197   Const_iterator end() const { return _tree.end(); }
00198
00199   Name_space(L4Re::Util::Dbg const &dbg, L4Re::Util::Err const &err)
00200   : _dbg(dbg), _err(err)
00201   {}
00202
00206   virtual ~Name_space() {}
00207
00208   Entry *find(Name const &name) const  { return _tree.find_node(name); }
00209   Entry *remove(Name const &name) { return _tree.remove(name); }
00210   Entry *find_iter(Name const &pname) const
00211   {
00212     Name name = pname;
00213     _dbg.printf("resolve '%.*s': ", name.len(), name.start());
00214     Name_space const *ns = this;
00215     while (ns)
00216       {
00217         cxx::String::Index sep = name.find("/");
00218         cxx::String part;
00219         if (!name.eof(sep))
00220           part = name.head(sep);
00221         else
00222           part = name;
00223
00224         _dbg.cprintf(" '%.*s'", part.len(), part.start());
00225         Entry *o = ns->find(Name(part.start(), part.len()));
00226
00227         if (!o)
00228           {
00229             _dbg.cprintf(": resolution failed: '%.*s' remaining\n",
00230                          name.len(), name.start());
00231             return 0;
00232           }
00233
00234         auto const *obj = o->obj()->obj();
00235         ns = dynamic_cast<Name_space const *>(obj);
00236         if (ns)
00237           {
00238             if (!name.eof(sep))
00239               {
00240                 name = name.substr(sep + 1);
00241                 continue;
00242               }
00243           }
00244
00245         _dbg.cprintf(": found object: %p (%s)\n",
00246                      obj, obj ? typeid(*obj).name() : "");
00247
00248         return o;
00249       }
00250
00251     return 0;
00252   }
00253
00254   bool insert(Entry *e)  { return _tree.insert(e).second; }
00255
00256   void dump(bool rec = false, int indent = 0) const;
00257
00258 protected:
```

```
00259   // server support ---------------------------------------------
00272   virtual Entry *alloc_dynamic_entry(Name const &n, unsigned flags) = 0;
00273
00279   virtual void free_dynamic_entry(Entry *e) = 0;
00280
00303   virtual l4_ret_t get_epiface(l4_umword_t data, bool is_local, L4::Epiface **lo) = 0;
00304
00317   virtual l4_ret_t copy_receive_cap(L4::Cap<void> *cap) = 0;
00318
00327   virtual void free_capability(L4::Cap<void> cap) = 0;
00328
00337   virtual void free_epiface(L4::Epiface *epiface) = 0;
00338
00339   l4_ret_t insert_entry(Name const &name, unsigned flags, Entry **e)
00340   {
00341     Entry *n = find(name);
00342     if (n && n->obj()->is_valid())
00343       {
00344         if (!(flags & L4Re::Namespace::Overwrite)
00345             && n->obj()->cap().validate(L4_BASE_TASK_CAP).label() > 0)
00346           return -L4_EEXIST;
00347
00348         if (!n->is_dynamic() && !n->obj()->is_replacable())
00349           return -L4_EEXIST;
00350
00351         if (n->obj()->is_local())
00352           free_epiface(n->obj()->obj());
00353         else
00354           free_capability(n->obj()->cap());
00355
00356         if (n->is_dynamic())
00357           {
00358             remove(n->name());
00359             free_dynamic_entry(n);
00360             n = 0;
00361           }
00362         else
00363           n->obj()->reset(Obj::F_rw);
00364       }
00365
00366     flags &= L4Re::Namespace::Cap_flags;
00367     if (!n)
00368       {
00369         if (!(n = alloc_dynamic_entry(name, flags)))
00370           return -L4_ENOMEM;
00371         else
00372           {
00373             if (!insert(n))
00374               {
00375                 free_dynamic_entry(n);
00376                 return -L4_EEXIST;
00377               }
00378           }
00379       }
00380
00381     *e = n;
00382     return 0;
00383   }
00384
00385 public:
00386   // server interface ------------------------------------------
00387   l4_ret_t op_query(L4Re::Namespace::Rights,
00388                     L4::Ipc::Array_in_buf<char, unsigned long> const &name,
00389                     L4::Ipc::Snd_fpage &snd_cap, L4::Ipc::Opt<L4::Opcode> &dummy,
00390                     L4::Ipc::Opt<L4::Ipc::Array_ref<char, unsigned long> > &out_name)
00391   {
00392 #if 1
00393     _dbg.printf("query: [%ld] '%.*s'\n", name.length,
00394                 static_cast<int>(name.length), name.data);
00395 #endif
00396
00397     char const *sep
00398       = static_cast<char const*>(memchr(name.data, '/', name.length));
00399     unsigned long part;
00400     if (sep)
00401       part = sep - name.data;
00402     else
00403       part = name.length;
00404
00405     Entry *n = find(Name(name.data, part));
00406     if (!n)
00407       return -L4_ENOENT;
00408     else if (!n->obj()->is_valid())
00409       return -L4_EAGAIN;
00410     else
00411       {
00412         if (n->obj()->cap().validate(L4_BASE_TASK_CAP).label() <= 0)
```

```
00413           {
00414             if (n->obj()->is_local())
00415               free_epiface(n->obj()->obj());
00416             else
00417               free_capability(n->obj()->cap());
00418
00419             if (n->is_dynamic())
00420               {
00421                 remove(n->name());
00422                 free_dynamic_entry(n);
00423               }
00424             return -L4_ENOENT;
00425           }
00426
00427         // make picky clients happy
00428         dummy.set_valid();
00429         // prevent warning about writing uninitialized data in IPC framework
00430         dummy = 0;
00431
00432         l4_ret_t result = 0;
00433
00434         out_name.set_valid();
00435         if (part < name.length)
00436           {
00437             result |= L4Re::Namespace::Partly_resolved;
00438             memcpy(out_name->data, name.data + part + 1, name.length - part - 1);
00439             out_name->length = name.length - part - 1;
00440           }
00441         else
00442           out_name->length = 0;
00443
00444         unsigned flags = L4_CAP_FPAGE_R;
00445         if (n->obj()->is_rw())     flags |= L4_CAP_FPAGE_W;
00446         if (n->obj()->is_strong()) flags |= L4_CAP_FPAGE_S;
00447
00448         snd_cap = L4::Ipc::Snd_fpage(n->obj()->cap(), flags);
00449         _dbg.printf(" result = %x flgs=%x strg=%d\n",
00450                     result, flags, static_cast<int>(n->obj()->is_strong()));
00451         return result;
00452       }
00453   }
00454
00455   l4_ret_t op_register_obj(L4Re::Namespace::Rights, unsigned flags,
00456                            L4::Ipc::Array_in_buf<char, unsigned long> const &name,
00457                            L4::Ipc::Snd_fpage &cap)
00458   {
00459     if (name.length == 0 || memchr(name.data, '/', name.length))
00460         return -L4_EINVAL;
00461
00462     L4::Cap<void> reg_cap(L4_INVALID_CAP);
00463     L4::Epiface *src_o = 0;
00464
00465     // Did we receive something we have handed out ourselves? If yes,
00466     // register the object under the given name but do not allocate
00467     // anything more.
00468     if (cap.id_received() || cap.local_id_received())
00469       {
00470         if (l4_ret_t ret = get_epiface(cap.data(), cap.local_id_received(), &src_o))
00471           return ret;
00472
00473         // Make sure rights are restricted to the mapped rights.
00474         flags &= (cap.data() & 0x3UL) | ~0x3UL;
00475       }
00476     else if (cap.cap_received())
00477       {
00478         if (l4_ret_t ret = copy_receive_cap(&reg_cap))
00479           return ret;
00480       }
00481     else if (!cap.is_valid())
00482       {
00483         reg_cap = L4::Cap<void>::Invalid;
00484       }
00485     else
00486       return -L4_EINVAL;
00487
00488     // got a valid entry to register
00489     _dbg.printf("register: '%.*s' flags=%x\n", static_cast<int>(name.length),
00490                 name.data, flags);
00491
00492     Name _name(name.data, name.length);
00493
00494     Entry *n;
00495     if (l4_ret_t r = insert_entry(_name, flags, &n))
00496       {
00497         if (cap.cap_received())
00498           free_capability(reg_cap);
00499         if (src_o)
```

```
00500           free_epiface(src_o);
00501
00502         return r;
00503       }
00504
00505     if (src_o)
00506       n->set(Names::Obj(flags & L4Re::Namespace::Cap_flags, src_o));
00507     else if (reg_cap.is_valid())
00508       n->set(Names::Obj(flags & L4Re::Namespace::Cap_flags, reg_cap));
00509
00510     return 0;
00511   }
00512
00513   l4_ret_t op_unlink(L4Re::Namespace::Rights,
00514                      L4::Ipc::Array_in_buf<char, unsigned long> const &name)
00515
00516   {
00517 #if 1
00518     _dbg.printf("unlink: [%ld] '%.*s'\n", name.length,
00519                 static_cast<int>(name.length), name.data);
00520 #endif
00521
00522     char const *sep
00523       = static_cast<char const*>(memchr(name.data, '/', name.length));
00524     unsigned long part;
00525     if (sep)
00526       part = sep - name.data;
00527     else
00528       part = name.length;
00529
00530     Entry *n = find(Name(name.data, part));
00531     if (!n || !n->obj()->is_valid())
00532       return -L4_ENOENT;
00533
00534     if (!n->is_dynamic())
00535       return -L4_EACCESS;
00536
00537     if (n->obj()->is_local())
00538       free_epiface(n->obj()->obj());
00539     else
00540       free_capability(n->obj()->cap());
00541
00542     remove(n->name());
00543     free_dynamic_entry(n);
00544
00545     return 0;
00546   }
00547 };
00548
00549 }}}
00550
```

16.396 object_registry

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/re/util/cap_alloc>
00013 #include <l4/re/util/unique_cap>
00014 #include <l4/re/consts>
00015 #include <l4/re/env>
00016
00017 #include <l4/sys/cxx/ipc_server_loop>
00018 #include <l4/sys/factory>
00019 #include <l4/sys/task>
00020 #include <l4/sys/thread>
00021 #include <l4/sys/ipc_gate>
00022
00023 #include <l4/cxx/exceptions>
00024
00025 namespace L4Re { namespace Util {
00026
00041 class Object_registry :
00042   public L4::Basic_registry,
00043   public L4::Registry_iface
00044 {
```

```
00049   struct Null_handler : L4::Epiface_t<Null_handler, L4::Kobject>
00050   {};
00051
00052 protected:
00053   L4::Cap<L4::Thread> _server;
00054   L4::Cap<L4::Factory> _factory;
00055   L4::Ipc_svr::Server_iface *_sif;
00056
00057 private:
00058   Null_handler _null_handler;
00059
00060 public:
00066   explicit
00067   Object_registry(L4::Ipc_svr::Server_iface *sif)
00068   : _server(L4Re::Env::env()->main_thread()),
00069     _factory(L4Re::Env::env()->factory()),
00070     _sif(sif)
00071   {}
00072
00081   Object_registry(L4::Ipc_svr::Server_iface *sif,
00082                   L4::Cap<L4::Thread> server,
00083                   L4::Cap<L4::Factory> factory)
00084   : _server(server), _factory(factory), _sif(sif)
00085   {}
00086
00087 private:
00088   typedef L4::Ipc_svr::Server_iface Server_iface;
00089   typedef Server_iface::Demand Demand;
00090
00091   L4::Cap<L4::Rcv_endpoint>
00092   _register_ep(L4::Epiface *o, L4::Cap<L4::Rcv_endpoint> ep,
00093                Demand const &demand)
00094   {
00095     int err = _sif->alloc_buffer_demand(demand);
00096     if (err < 0)
00097       return L4::Cap<L4::Rcv_endpoint>(err | L4_INVALID_CAP_BIT);
00098
00099     err = o->set_server(_sif, ep);
00100     if (err < 0)
00101       return L4::Cap<L4::Rcv_endpoint>(err | L4_INVALID_CAP_BIT);
00102
00103     l4_umword_t id = l4_umword_t(o);
00104     err = l4_error(ep->bind_thread(_server, id));
00105     if (err < 0)
00106       return L4::Cap<L4::Rcv_endpoint>(err | L4_INVALID_CAP_BIT);
00107
00108     return ep;
00109   }
00110
00111   L4::Cap<void> _register_ep(L4::Epiface *o, char const *service,
00112                              Demand const &demand)
00113   {
00114     L4::Cap<L4::Rcv_endpoint> cap = L4Re::Env::env()->get_cap<L4::Rcv_endpoint>(service);
00115     if (!cap.is_valid())
00116       return cap;
00117
00118     return _register_ep(o, cap, demand);
00119   }
00120
00121   L4::Cap<void> _register_gate(L4::Epiface *o, Demand const &demand)
00122   {
00123     int err = _sif->alloc_buffer_demand(demand);
00124     if (err < 0)
00125       return L4::Cap<void>(err | L4_INVALID_CAP_BIT);
00126
00127    auto cap = L4Re::Util::make_unique_cap<L4::Kobject>();
00128
00129     if (!cap.is_valid())
00130       return cap.get();
00131
00132     l4_umword_t id = l4_umword_t(o);
00133     err = l4_error(_factory->create_gate(cap.get(), _server, id));
00134     if (err < 0)
00135       return L4::Cap<void>(err | L4_INVALID_CAP_BIT);
00136
00137     err = o->set_server(_sif, cap.get(), true);
00138     if (err < 0)
00139       return L4::Cap<void>(err | L4_INVALID_CAP_BIT);
00140
00141     return cap.release();
00142   }
00143
00144   L4::Cap<L4::Irq> _register_irq(L4::Epiface *o,
00145                                  Demand const &demand)
00146   {
00147     int err = _sif->alloc_buffer_demand(demand);
00148     if (err < 0)
```

```
00149       return L4::Cap<L4::Irq>(err | L4_INVALID_CAP_BIT);
00150
00151     auto cap = L4Re::Util::make_unique_cap<L4::Irq>();
00152
00153     if (!cap.is_valid())
00154       return cap.get();
00155
00156     l4_umword_t id = l4_umword_t(o);
00157     err = l4_error(_factory->create(cap.get()));
00158     if (err < 0)
00159       return L4::Cap<L4::Irq>(err | L4_INVALID_CAP_BIT);
00160
00161     err = o->set_server(_sif, cap.get(), true);
00162     if (err < 0)
00163       return L4::Cap<L4::Irq>(err | L4_INVALID_CAP_BIT);
00164
00165     err = l4_error(cap->bind_thread(_server, id));
00166     if (err < 0)
00167       return L4::Cap<L4::Irq>(err | L4_INVALID_CAP_BIT);
00168
00169     return cap.release();
00170   }
00171
00172   static Demand _get_buffer_demand(L4::Epiface *o)
00173   { return o->get_buffer_demand(); }
00174
00175   template<typename T>
00176   static Demand _get_buffer_demand(T *,
00177       typename L4::Kobject_typeid<typename T::Interface>::Demand
00178         d = typename L4::Kobject_typeid<typename T::Interface>::Demand())
00179   { return d; }
00180
00181 public:
00194   L4::Cap<void> register_obj(L4::Epiface *o, char const *service) override
00195   {
00196     return _register_ep(o, service, _get_buffer_demand(o));
00197   }
00198
00211   L4::Cap<void> register_obj(L4::Epiface *o) override
00212   {
00213     return _register_gate(o, _get_buffer_demand(o));
00214   }
00215
00227   L4::Cap<L4::Irq> register_irq_obj(L4::Epiface *o) override
00228   {
00229     return _register_irq(o, _get_buffer_demand(o));
00230   }
00231
00245   L4::Cap<L4::Rcv_endpoint>
00246   register_obj(L4::Epiface *o, L4::Cap<L4::Rcv_endpoint> ep) override
00247   {
00248     return _register_ep(o, ep, _get_buffer_demand(o));
00249   }
00250
00251
00262   void unregister_obj(L4::Epiface *o, bool unmap = true) override
00263   {
00264     L4::Epiface::Stored_cap c;
00265
00266     if (!o || !o->obj_cap().is_valid())
00267       return;
00268
00269     c = o->obj_cap();
00270
00271     if (unmap)
00272       L4::Cap<L4::Task>(L4Re::This_task)->unmap(c.fpage(), L4_FP_ALL_SPACES);
00273
00274     // make sure unhandled ipc ends up with the null handler
00275     L4::Thread::Modify_senders todo;
00276     todo.add(~3UL, reinterpret_cast<l4_umword_t>(o),
00277              ~0UL, reinterpret_cast<l4_umword_t>
00278                    (static_cast<L4::Epiface *>(&_null_handler)));
00279     _server->modify_senders(todo);
00280
00281     // we use bit 4 to indicate an internally allocated cap
00282     if (c.managed())
00283       cap_alloc.free(c, L4_INVALID_CAP);
00284
00285     o->set_server(0, L4::Cap<void>::Invalid);
00286   }
00287 };
00288
00292 template< typename LOOP_HOOKS = L4::Ipc_svr::Default_loop_hooks >
00293 class Registry_server : public L4::Server<LOOP_HOOKS>
00294 {
00295 private:
00296   typedef L4::Server<LOOP_HOOKS> Base;
```

```
00297   Object_registry _registry;
00298
00299 public:
00305   Registry_server() : _registry(this)
00306   {}
00307
00317   Registry_server(l4_utcb_t *, L4::Cap<L4::Thread> server,
00318                   L4::Cap<L4::Factory> factory) L4_DEPRECATED("Omit UTCB pointer argument")
00319   : _registry(this, server, factory)
00320   {}
00321
00328   Registry_server(L4::Cap<L4::Thread> server,
00329                   L4::Cap<L4::Factory> factory)
00330   : _registry(this, server, factory)
00331   {}
00332
00334   Object_registry const *registry() const { return &_registry; }
00336   Object_registry *registry() { return &_registry; }
00337
00344   void L4_NORETURN loop(l4_utcb_t *utcb = l4_utcb())
00345   { Base::template loop<L4::Runtime_error, Object_registry &>(_registry, utcb); }
00346
00355   template <typename Printer>
00356   void L4_NORETURN loop_dbg(Printer printer, l4_utcb_t *utcb = l4_utcb())
00357   {
00358     Base::template loop_dbg<L4::Runtime_error, Object_registry &, Printer>
00359       (_registry, printer, utcb);
00360   }
00361 };
00362 }}
```

16.397 poll_timeout_kipclock

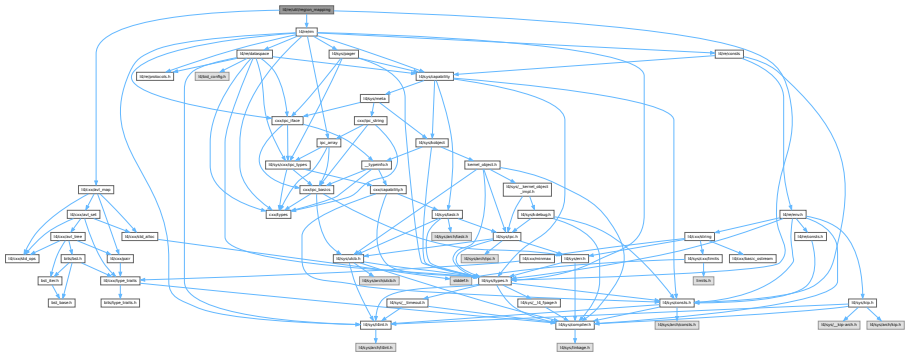
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2012 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/kip.h>
00010 #include <l4/re/env.h>
00011
00012 namespace L4 {
00013
00035 class Poll_timeout_kipclock
00036 {
00037 public:
00042   Poll_timeout_kipclock(unsigned poll_time_us)
00043   {
00044     set(poll_time_us);
00045   }
00046
00051   void set(unsigned poll_time_us)
00052   {
00053     _timeout = l4_kip_clock(l4re_kip()) + poll_time_us;
00054     _last_check = true;
00055   }
00056
00065   bool test(bool expression = true)
00066   {
00067     if (!expression)
00068       return false;
00069
00070     return _last_check = l4_kip_clock(l4re_kip()) < _timeout;
00071   }
00072
00077   bool timed_out() const { return !_last_check; }
00078
00079 private:
00080   l4_cpu_time_t _timeout;
00081   bool _last_check;
00082 };
00083 }
```

16.398 l4/re/util/region_mapping File Reference

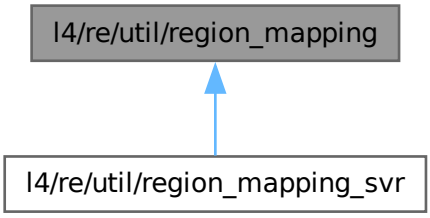
Region handling.

```
#include <l4/cxx/avl_map>
#include <l4/sys/types.h>
#include <l4/re/rm>
```

Include dependency graph for region_mapping:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

16.398.1 Detailed Description

Region handling.
Definition in file region_mapping.

16.399 region_mapping

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
```

```
00014  */
00015
00016 #pragma once
00017
00018 #include <l4/cxx/avl_map>
00019 #include <l4/sys/types.h>
00020 #include <l4/re/rm>
00021
00022 namespace L4Re { namespace Util {
00023
00024 class Region
00025 {
00026 private:
00027   l4_addr_t _start, _end;
00028 #ifdef CONFIG_L4RE_REGION_INFO
00029   char _dbg_name[40]; // Not a 0-terminating string
00030   unsigned char _dbg_name_len = 0;
00031   static_assert(sizeof(_dbg_name) < 256);
00032   Rm::Offset _dbg_backing_offset = 0;
00033 #endif
00034
00035 public:
00036   Region() noexcept : _start(~0UL), _end(~0UL) {}
00037   Region(l4_addr_t addr) noexcept : _start(addr), _end(addr) {}
00038   Region(l4_addr_t start, l4_addr_t end) noexcept
00039     : _start(start), _end(end) {}
00040   Region(l4_addr_t start, l4_addr_t end,
00041          char const *name, unsigned name_len,
00042          Rm::Offset backing_offset) noexcept
00043     : _start(start), _end(end)
00044   {
00045 #ifdef CONFIG_L4RE_REGION_INFO
00046     _dbg_name_len = name_len > sizeof(_dbg_name)
00047                     ? sizeof(_dbg_name) : name_len;
00048     for (unsigned i = 0; i < _dbg_name_len; ++i)
00049       _dbg_name[i] = name[i];
00050
00051     _dbg_backing_offset = backing_offset;
00052 #else
00053     (void)name;
00054     (void)name_len;
00055     (void)backing_offset;
00056 #endif
00057  }
00058   l4_addr_t start() const noexcept { return _start; }
00059   l4_addr_t end() const noexcept { return _end; }
00060   unsigned long size() const noexcept { return end() - start() + 1; }
00061   bool invalid() const noexcept { return _start == ~0UL && _end == ~0UL; }
00062   bool operator < (Region const &o) const noexcept
00063   { return end() < o.start(); }
00064   bool contains(Region const &o) const noexcept
00065   { return o.start() >= start() && o.end() <= end(); }
00066   bool operator == (Region const &o) const noexcept
00067   { return o.start() == start() && o.end() == end(); }
00068   ~Region() noexcept {}
00069
00070 #ifdef CONFIG_L4RE_REGION_INFO
00071   char const *name() const { return _dbg_name; }
00072   unsigned char name_len() const { return _dbg_name_len; }
00073   Rm::Offset backing_offset() const { return _dbg_backing_offset; }
00074 #else
00075   char const *name() const { return "N/A"; }
00076   unsigned char name_len() const { return 3; }
00077   Rm::Offset backing_offset() const { return 0; }
00078 #endif
00079 };
00080
00081
00082 template< typename Hdlr, template<typename T> class Alloc >
00083 class Region_map
00084 {
00085 protected:
00086   typedef cxx::Avl_map<Region, Hdlr, cxx::Lt_functor, Alloc> Tree;
00087   typedef cxx::Avl_map<Region, l4_addr_t, cxx::Lt_functor, Alloc> Rescue_tree;
00088
00089   Tree _rm;
00090   Tree _am;
00091   Rescue_tree _rescue_map;
00092
00093 private:
00094   l4_addr_t _start;
00095   l4_addr_t _end;
00096
00097 protected:
00098   void set_limits(l4_addr_t start, l4_addr_t end) noexcept
00099   {
00100     _start = start;
```

```
00101     _end = end;
00102   }
00103
00104 public:
00105   typedef typename Tree::Item_type  Item;
00106   typedef typename Tree::Node       Node;
00107   typedef typename Tree::Key_type   Key_type;
00108   typedef Hdlr Region_handler;
00109
00110   typedef typename Tree::Iterator Iterator;
00111   typedef typename Tree::Const_iterator Const_iterator;
00112   typedef typename Tree::Rev_iterator Rev_iterator;
00113   typedef typename Tree::Const_rev_iterator Const_rev_iterator;
00114
00115   Iterator begin() noexcept { return _rm.begin(); }
00116   Const_iterator begin() const noexcept { return _rm.begin(); }
00117   Iterator end() noexcept { return _rm.end(); }
00118   Const_iterator end() const noexcept { return _rm.end(); }
00119
00120   Iterator area_begin() noexcept { return _am.begin(); }
00121   Const_iterator area_begin() const noexcept { return _am.begin(); }
00122   Iterator area_end() noexcept { return _am.end(); }
00123   Const_iterator area_end() const noexcept { return _am.end(); }
00124   Node area_find(Key_type const &c) const noexcept { return _am.find_node(c); }
00125
00126   l4_addr_t min_addr() const noexcept { return _start; }
00127   l4_addr_t max_addr() const noexcept { return _end; }
00128
00129   Region_map(l4_addr_t start, l4_addr_t end) noexcept : _start(start), _end(end) {}
00130
00131   Node find(Key_type const &key) const noexcept
00132   {
00133     Node n = _rm.find_node(key);
00134     if (!n)
00135       return Node();
00136
00137     // 'find' should find any region overlapping with the searched one, the
00138     // caller should check for further requirements
00139     if (0)
00140       if (!n->first.contains(key))
00141         return Node();
00142
00143     return n;
00144   }
00145
00146   Node lower_bound(Key_type const &key) const noexcept
00147   {
00148     Node n = _rm.lower_bound_node(key);
00149     return n;
00150   }
00151
00152   Node lower_bound_area(Key_type const &key) const noexcept
00153   {
00154     Node n = _am.lower_bound_node(key);
00155     return n;
00156   }
00157
00158   bool add_area(Region const &region, L4Re::Rm::F::Region_flags region_flags)
00159   {
00160     using DS = typename Hdlr::Dataspace;
00161     return _am.insert(region, Hdlr(DS(), 0, 0, region_flags)).second == 0;
00162   }
00163
00164   l4_addr_t attach_area(l4_addr_t addr, unsigned long size,
00165                         L4Re::Rm::Flags flags = L4Re::Rm::Flags(0),
00166                         unsigned char align = L4_PAGESHIFT) noexcept
00167   {
00168     Region c;
00169
00170     if (flags & L4Re::Rm::F::Search_addr)
00171       {
00172         if (addr < min_addr())
00173           addr = min_addr();
00174       }
00175     else
00176       {
00177         c = Region(addr, addr + size - 1);
00178         if (_am.find_node(c))
00179           return L4_INVALID_ADDR;
00180
00181         // Regions cannot be placed in reserved areas. We explicitly allow the
00182         // reverse: place areas over regions that are already present.
00183         if ((flags & L4Re::Rm::F::Reserved) && _rm.find_node(c))
00184           return L4_INVALID_ADDR;
00185       }
00186
00187     while (flags & L4Re::Rm::F::Search_addr)
```

```
00188       {
00189         if (addr > max_addr() || (max_addr() - addr) < (size - 1))
00190           return L4_INVALID_ADDR;
00191
00192         addr = find_free(addr, max_addr(), size, align, flags);
00193         if (addr == L4_INVALID_ADDR)
00194           return L4_INVALID_ADDR;
00195
00196         c = Region(addr, addr + size - 1);
00197         Node r = _am.find_node(c);
00198         if (!r)
00199           break;
00200
00201         if (r->first.end() >= max_addr())
00202           return L4_INVALID_ADDR;
00203
00204         addr = r->first.end() + 1;
00205       }
00206
00207     if (add_area(c, flags.region_flags()))
00208       return addr;
00209
00210     return L4_INVALID_ADDR;
00211   }
00212
00213   bool detach_area(l4_addr_t addr) noexcept
00214   {
00215     if (_am.remove(addr))
00216       return false;
00217
00218     return true;
00219   }
00220
00221   bool add_region(Region const &region, Hdlr const &hdlr)
00222   {
00223     auto [it, res] = _rm.insert(region, hdlr);
00224     if (res != 0)
00225       return false;
00226
00227     if (!it->second.attached(region.start(), region.end()))
00228       {
00229         _rm.erase(it->first);
00230         return false;
00231       }
00232
00233     return true;
00234   }
00235
00236   void *attach(void *addr, unsigned long size, Hdlr const &hdlr,
00237                L4Re::Rm::Flags attach_flags = L4Re::Rm::Flags(0),
00238                unsigned char align = L4_PAGESHIFT,
00239                char const *name = nullptr, unsigned name_len = 0,
00240                L4Re::Rm::Offset backing_offset = 0) noexcept
00241   {
00242     l4_addr_t beg, end;
00243     int err = hdlr.map_info(&beg, &end);
00244     if (err > 0)
00245       {
00246         // Mapping address determined by underlying dataspace. Make sure we
00247         // prevent any additional alignment. We already know the place!
00248         end = beg + size - 1U;
00249         align = L4_PAGESHIFT;
00250
00251         // In case of exact mappings, the supplied address must match because
00252         // we cannot remap.
00253         if (!(attach_flags & L4Re::Rm::F::Search_addr)
00254             && reinterpret_cast<l4_addr_t>(addr) != beg)
00255           return L4_INVALID_PTR;
00256
00257         // When searching for a suitable address, the start must cover the
00258         // dataspace beginning to "find" the right spot.
00259         if ((attach_flags & L4Re::Rm::F::Search_addr)
00260             && reinterpret_cast<l4_addr_t>(addr) > beg)
00261           return L4_INVALID_PTR;
00262       }
00263     else if (err == 0)
00264       {
00265         beg = reinterpret_cast<l4_addr_t>(addr);
00266         end = max_addr();
00267       }
00268     else if (err < 0)
00269       return L4_INVALID_PTR;
00270
00271     if (attach_flags & L4Re::Rm::F::In_area)
00272       {
00273         Node r = _am.find_node(Region(beg, beg + size - 1));
00274         if (!r || (r->second.flags() & L4Re::Rm::F::Reserved))
```

```
00275           return L4_INVALID_PTR;
00276
00277         end = r->first.end();
00278       }
00279
00280     if (attach_flags & L4Re::Rm::F::Search_addr)
00281       {
00282         beg = find_free(beg, end, size, align, attach_flags);
00283         if (beg == L4_INVALID_ADDR)
00284           return L4_INVALID_PTR;
00285       }
00286
00287     if (!(attach_flags & (L4Re::Rm::F::Search_addr | L4Re::Rm::F::In_area))
00288         && _am.find_node(Region(beg, beg + size - 1)))
00289       return L4_INVALID_PTR;
00290
00291     if (beg < min_addr() || beg + size - 1 > end)
00292       return L4_INVALID_PTR;
00293
00294     if (add_region(Region(beg, beg + size - 1, name, name_len, backing_offset),
00295                    hdlr))
00296       return reinterpret_cast<void*>(beg);
00297
00298     return L4_INVALID_PTR;
00299   }
00300
00301   int detach(void *addr, unsigned long sz, unsigned flags,
00302              Region *reg, Hdlr *hdlr) noexcept
00303   {
00304     l4_addr_t a = reinterpret_cast<l4_addr_t>(addr);
00305     Region dr(a, a + sz - 1);
00306     Region res(~0UL, 0);
00307
00308     Node r = find(dr);
00309     if (!r)
00310       return -L4_ENOENT;
00311
00312     Region g = r->first;
00313     Hdlr const &h = r->second;
00314
00315     if (flags & L4Re::Rm::Detach_overlap || dr.contains(g))
00316       {
00317         // Successful removal of the AVL tree item also frees the node.
00318         Hdlr h_copy = h;
00319
00320         if (_rm.remove(g))
00321           return -L4_ENOENT;
00322
00323         if (h_copy.flags() & (L4Re::Rm::F::Anonymous | L4Re::Rm::F::Private))
00324           h_copy.free(0, g.size());
00325
00326         int ret = Rm::Detached_ds;
00327         if (h_copy.detached(g.start(), g.end()))
00328           ret |= Rm::Unmapped_range;
00329
00330         if (hdlr)
00331           *hdlr = h_copy;
00332         if (reg)
00333           *reg = g;
00334
00335         if (find(dr))
00336           ret |= Rm::Detach_again;
00337
00338         return ret;
00339       }
00340     else if (dr.start() <= g.start())
00341       {
00342         // Move the start of a region.
00343
00344         if (h.flags() & (L4Re::Rm::F::Anonymous | L4Re::Rm::F::Private))
00345           h.free(0, dr.end() + 1 - g.start());
00346
00347         int ret = Rm::Kept_ds;
00348         if (h.detached(g.start(), dr.end()))
00349           ret |= Rm::Unmapped_range;
00350
00351         unsigned long sz = dr.end() + 1 - g.start();
00352         Item &cn = const_cast<Item &>(*r);
00353         cn.first = Region(dr.end() + 1, g.end(), g.name(), g.name_len(),
00354                           g.backing_offset() + sz);
00355         cn.second = cn.second + sz;
00356         if (hdlr)
00357           *hdlr = Hdlr();
00358         if (reg)
00359           *reg = Region(g.start(), dr.end());
00360
00361         if (find(dr))
```

```
00362           ret |= Rm::Detach_again;
00363
00364         return ret;
00365       }
00366     else if (dr.end() >= g.end())
00367       {
00368         // Move the end of a region.
00369
00370         if (h.flags() & (L4Re::Rm::F::Anonymous | L4Re::Rm::F::Private))
00371           h.free(dr.start() - g.start(), g.end() + 1 - dr.start());
00372
00373         int ret = Rm::Kept_ds;
00374         if (h.detached(dr.start(), g.end()))
00375           ret |= Rm::Unmapped_range;
00376
00377         Item &cn = const_cast<Item &>(*r);
00378         cn.first = Region(g.start(), dr.start() - 1, g.name(), g.name_len(),
00379                           g.backing_offset());
00380         if (hdlr)
00381           *hdlr = Hdlr();
00382         if (reg)
00383           *reg = Region(dr.start(), g.end());
00384
00385         if (find(dr))
00386           ret |= Rm::Detach_again;
00387
00388         return ret;
00389       }
00390     else if (g.contains(dr))
00391       {
00392         // Split a single region that contains the new region.
00393
00394         if (h.flags() & (L4Re::Rm::F::Anonymous | L4Re::Rm::F::Private))
00395           h.free(dr.start() - g.start(), dr.size());
00396
00397         int ret = Rm::Split_ds;
00398         if (h.detached(dr.start(), dr.end()))
00399           ret |= Rm::Unmapped_range;
00400
00401         // First move the end off the existing region before the new one.
00402         Item &cn = const_cast<Item &>(*r);
00403         cn.first = Region(g.start(), dr.start()-1, g.name(), g.name_len(),
00404                           g.backing_offset());
00405
00406         int err;
00407
00408         // Insert a second region for the remaining tail of
00409         // the old existing region.
00410         auto tail_sz = dr.end() + 1 - g.start();
00411         err = _rm.insert(Region(dr.end() + 1, g.end(), g.name(), g.name_len(),
00412                                 g.backing_offset() + tail_sz),
00413                          h + tail_sz).second;
00414
00415         if (err)
00416           return err;
00417
00418         if (hdlr)
00419           *hdlr = h;
00420         if (reg)
00421           *reg = dr;
00422
00423         return ret;
00424       }
00425
00426     return -L4_ENOENT;
00427   }
00428
00429   l4_addr_t find_free(l4_addr_t start, l4_addr_t end, l4_addr_t size,
00430                       unsigned char align, L4Re::Rm::Flags attach_flags) const noexcept;
00431
00440   l4_ret_t add_rescue_jump(l4_addr_t pc_begin, l4_addr_t pc_end,
00441                            l4_addr_t rescue_pc) noexcept
00442   {
00443     if (pc_begin >= pc_end)
00444       return -L4_EINVAL;
00445
00446     Region key(pc_begin, pc_end - 1);
00447     if (_rescue_map.find_node(key))
00448       return -L4_EEXIST;
00449     if (_rescue_map.insert(key, rescue_pc).second)
00450       return -L4_ENOMEM;
00451
00452     return L4_EOK;
00453   }
00454
00462   l4_addr_t find_rescue_jump(l4_addr_t pc) const noexcept
00463   {
```

```
00464     auto n = _rescue_map.find_node(Region(pc));
00465     if (!n)
00466       return 0;
00467     return n->second;
00468   }
00469
00478   l4_ret_t remove_rescue_jump(l4_addr_t pc) noexcept
00479   {
00480     if (_rescue_map.remove(Region(pc)))
00481       return -L4_ENOENT;
00482     return L4_EOK;
00483   }
00484
00485   l4_ret_t page_in(l4_addr_t min_addr, l4_addr_t max_addr,
00486                    L4Re::Rm::Region_flags rights,
00487                    typename Hdlr::Map_result *map_res)
00488   {
00489     // We'll try to map one flexpage...
00490     if (auto r = find(Region(min_addr)))
00491       {
00492         if (r->second.flags() & (L4Re::Rm::F::Kernel | L4Re::Rm::F::Reserved))
00493           return -L4_ENODEV;
00494
00495         l4_addr_t start = min_addr;
00496         l4_addr_t end = cxx::min(max_addr, r->first.end());
00497         L4Re::Rm::Region_flags r_flags = r->second.flags();
00498
00499         // Cannot request more rights than with what the region was attached in
00500         // the first place.
00501         if ((r_flags & rights) != rights)
00502           return -L4_EACCESS;
00503
00504         return r->second.page_in(r->first, start, end, rights, map_res);
00505       }
00506     else
00507       return -L4_ENOENT;
00508   }
00509 };
00510
00511 template<typename Hdlr, template<typename T> class Alloc>
00512 l4_addr_t
00513 Region_map<Hdlr, Alloc>::find_free(l4_addr_t start, l4_addr_t end,
00514     unsigned long size, unsigned char align, L4Re::Rm::Flags attach_flags) const noexcept
00515 {
00516   l4_addr_t addr = start;
00517
00518   if (addr == ~0UL || addr < min_addr() || addr >= end)
00519     addr = min_addr();
00520
00521   addr = l4_round_size(addr, align);
00522   Node r;
00523
00524   for (;;)
00525     {
00526       if (addr > 0 && addr - 1 > end - size)
00527         return L4_INVALID_ADDR;
00528
00529       Region c(addr, addr + size - 1);
00530       r = _rm.find_node(c);
00531
00532       if (!r)
00533         {
00534           if (!(attach_flags & L4Re::Rm::F::In_area) && (r = _am.find_node(c)))
00535             {
00536               if (r->first.end() > end - size)
00537                 return L4_INVALID_ADDR;
00538
00539               addr = l4_round_size(r->first.end() + 1, align);
00540               continue;
00541             }
00542
00543           break;
00544         }
00545       else if (r->first.end() > end - size)
00546         return L4_INVALID_ADDR;
00547
00548       addr = l4_round_size(r->first.end() + 1, align);
00549     }
00550
00551   if (!r)
00552     return addr;
00553
00554   return L4_INVALID_ADDR;
00555 }
00556
00557 }}
```

16.400 region_mapping_svr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00007 /*
00008  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015 #include <l4/re/rm>
00016 #include <l4/re/util/region_mapping>
00017
00018 namespace L4Re { namespace Util {
00019
00020 template<typename DERIVED, typename Dbg>
00021 struct Rm_server
00022 {
00023 private:
00024   DERIVED *rm() { return static_cast<DERIVED*>(this); }
00025   DERIVED const *rm() const { return static_cast<DERIVED const *>(this); }
00026
00027 public:
00028
00032   l4_ret_t op_attach(L4Re::Rm::Rights, l4_addr_t &_start,
00033                      unsigned long size, Rm::Flags flags,
00034                      L4::Ipc::Snd_fpage ds_cap, L4Re::Rm::Offset offs,
00035                      unsigned char align, l4_cap_idx_t client_cap_idx,
00036                      L4::Ipc::String<> name, L4Re::Rm::Offset backing_offset)
00037   {
00038     typename DERIVED::Dataspace ds;
00039
00040     constexpr auto Known_flags =
00041       // Attach_flags
00042         Rm::F::Search_addr | Rm::F::In_area | Rm::F::Eager_map
00043       | Rm::F::No_eager_map
00044       // Region_flags
00045       | Rm::F::RWX | Rm::F::Kernel | Rm::F::Pager
00046       | Rm::F::Reserved | Rm::F::Private | Rm::F::Anonymous
00047       | Rm::F::Caching_mask;
00048
00049     if (flags & ~Known_flags)
00050       return -L4_EINVAL;
00051
00052     if (!(flags & (Rm::F::Reserved | Rm::F::Kernel | Rm::F::Anonymous)))
00053       {
00054         if (l4_ret_t r = rm()->validate_ds(ds_cap, flags.region_flags(), &ds))
00055           return r;
00056       }
00057
00058     if (size == 0)
00059       return -L4_EINVAL;
00060
00061     constexpr unsigned Max_align = sizeof(l4_addr_t) * 8 - 1;
00062     if (flags & Rm::F::Search_addr && (   align < L4_PAGESHIFT
00063                                        || align > Max_align))
00064       return -L4_EINVAL;
00065
00066     size  = l4_round_page(size);
00067     l4_addr_t start = l4_trunc_page(_start);
00068     if (size == 0 || start + size - 1 < start)
00069       return -L4_EINVAL;
00070
00071     Rm::Region_flags r_flags = flags.region_flags();
00072     Rm::Attach_flags a_flags = flags.attach_flags();
00073
00074     typename DERIVED::Region_handler handler(ds, client_cap_idx, offs, r_flags);
00075     if (int err = handler.init(rm(), size); err < 0)
00076       return err;
00077
00078     start = l4_addr_t(rm()->attach(reinterpret_cast<void*>(start), size,
00079                                    handler, a_flags, align,
00080                                    name.data,
00081                                    // L4::Ipc::String includes terminating '\0'
00082                                    name.length ? name.length - 1 : 0,
00083                                    backing_offset));
00084
00085     if (start == L4_INVALID_ADDR)
00086       return -L4_EADDRNOTAVAIL;
00087
00088     _start = start;
00089     return L4_EOK;
00090   }
00091
00095   l4_ret_t op_free_area(L4Re::Rm::Rights, l4_addr_t start)
```

```
00096   {
00097     if (!rm()->detach_area(start))
00098       return -L4_ENOENT;
00099
00100     return L4_EOK;
00101   }
00102
00106   l4_ret_t op_find(L4Re::Rm::Rights, l4_addr_t &addr, unsigned long &size,
00107                L4Re::Rm::Flags &flags, L4Re::Rm::Offset &offset,
00108                l4_cap_idx_t &m)
00109   {
00110     if (!DERIVED::Have_find)
00111       return -L4_EPERM;
00112
00113     if (size == 0)
00114       return -L4_EINVAL;
00115
00116     Rm::Flags flag_area { 0 };
00117
00118     typename DERIVED::Node r = rm()->find(Region(addr, addr + size -1));
00119     if (!r)
00120       {
00121         r = rm()->area_find(Region(addr, addr + size - 1));
00122         if (!r)
00123           return -L4_ENOENT;
00124         flag_area = Rm::F::In_area;
00125       }
00126
00127     addr = r->first.start();
00128     size = r->first.end() + 1 - addr;
00129
00130     flags = r->second.flags() | flag_area;
00131     offset = r->second.offset();
00132     m = r->second.client_cap_idx();
00133     return L4_EOK;
00134   }
00135
00139   l4_ret_t op_detach(L4Re::Rm::Rights, l4_addr_t addr,
00140                      unsigned long size, unsigned flags,
00141                      l4_addr_t &start, l4_addr_t &rsize,
00142                      l4_cap_idx_t &mem_cap)
00143   {
00144     start = rsize = 0;
00145     mem_cap = L4_INVALID_CAP;
00146
00147     constexpr unsigned Known_flags =   Rm::Detach_exact | Rm::Detach_overlap;
00148     if (flags & ~Known_flags)
00149       return -L4_EINVAL;
00150
00151     if (size == 0)
00152       return -L4_EINVAL;
00153
00154     l4_addr_t aligned_addr = l4_trunc_page(addr);
00155     size = l4_round_page(addr - aligned_addr + size);
00156     if (size == 0 || aligned_addr + size - 1 < aligned_addr)
00157       return -L4_EINVAL;
00158
00159     Region r;
00160     typename DERIVED::Region_handler h;
00161     int err = rm()->detach(reinterpret_cast<void*>(aligned_addr), size, flags,
00162                            &r, &h);
00163     if (err < 0)
00164       return err;
00165
00166     if (r.invalid())
00167       return -L4_ENOENT;
00168
00169     start = r.start();
00170     rsize = r.size();
00171     mem_cap = h.client_cap_idx();
00172     return err;
00173   }
00174
00178   l4_ret_t op_reserve_area(L4Re::Rm::Rights, l4_addr_t &start, unsigned long size,
00179                            L4Re::Rm::Flags flags, unsigned char align)
00180   {
00181     constexpr auto Known_flags =   Rm::F::Search_addr | Rm::F::Kernel
00182                                  | Rm::F::Reserved;
00183     if (flags & ~Known_flags)
00184       return -L4_EINVAL;
00185
00186     if (size == 0 || start + size - 1 < start)
00187       return -L4_EINVAL;
00188
00189     constexpr unsigned Max_align = sizeof(l4_addr_t) * 8 - 1;
00190     if (flags & Rm::F::Search_addr && align > Max_align)
00191       return -L4_EINVAL;
```

```
00192
00193     start = rm()->attach_area(start, size, flags, align);
00194     if (start == L4_INVALID_ADDR)
00195       return -L4_EADDRNOTAVAIL;
00196
00197     return L4_EOK;
00198   }
00199
00203   l4_ret_t op_get_regions(L4Re::Rm::Rights, l4_addr_t addr,
00204                           L4::Ipc::Array_ref<L4Re::Rm::Region> &regions)
00205   {
00206     typename DERIVED::Node r;
00207     unsigned limit = regions.length;
00208
00209     regions.length = 0;
00210     while ((r = rm()->lower_bound(Region(addr))))
00211       {
00212         Rm::Region &x = regions.data[regions.length];
00213         x.start  = r->first.start();
00214         x.end    = r->first.end();
00215         x.flags  = r->second.flags();
00216
00217         if (++regions.length >= limit)
00218           break;
00219
00220         if (x.end >= rm()->max_addr())
00221           break;
00222         addr = x.end + 1;
00223       }
00224
00225     return regions.length;
00226   }
00227
00231   l4_ret_t op_get_areas(L4Re::Rm::Rights, l4_addr_t addr,
00232                         L4::Ipc::Array_ref<L4Re::Rm::Area> &areas)
00233   {
00234     typename DERIVED::Node r;
00235     unsigned limit = areas.length;
00236
00237     areas.length = 0;
00238     while ((r = rm()->lower_bound_area(Region(addr))))
00239       {
00240         Rm::Area &x = areas.data[areas.length];
00241         x.start  = r->first.start();
00242         x.end    = r->first.end();
00243         x.flags  = r->second.flags();
00244
00245         if (++areas.length >= limit)
00246           break;
00247
00248         if (x.end >= rm()->max_addr())
00249           break;
00250
00251         addr = x.end + 1;
00252       }
00253
00254     return areas.length;
00255   }
00256
00260   l4_ret_t op_add_rescue_jump(L4Re::Rm::Rights, l4_addr_t pc_begin,
00261                               l4_addr_t pc_end, l4_addr_t rescue_pc)
00262   {
00263     return rm()->add_rescue_jump(pc_begin, pc_end, rescue_pc);
00264   }
00265
00269   l4_ret_t op_remove_rescue_jump(L4Re::Rm::Rights, l4_addr_t pc)
00270   {
00271     return rm()->remove_rescue_jump(pc);
00272   }
00273
00277   l4_ret_t op_page_in(L4Re::Rm::Rights, l4_addr_t min_addr, l4_addr_t max_addr,
00278                       L4Re::Rm::Region_flags rights, L4::Ipc::Snd_fpage &fp,
00279                       L4Re::Rm::page_in_fn &helper)
00280   {
00281     // Start and end address are inclusive. They must be page aligned.
00282     if (   l4_trunc_page(min_addr)     != min_addr
00283         || l4_trunc_page(max_addr + 1) != max_addr + 1)
00284       return -L4_EINVAL;
00285
00286     // The default implementation assumes it is executed in a dedicated thread.
00287     helper = nullptr;
00288
00289     typename DERIVED::Region_handler::Map_result map_res;
00290     l4_ret_t res = rm()->page_in(min_addr, max_addr, rights, &map_res);
00291     if (res >= 0)
00292       pager_set_result(&fp, map_res);
00293
```

```
00294     return res;
00295   }
00296
00297 private:
00298   static void pager_set_result(L4::Ipc::Opt<L4::Ipc::Snd_fpage> *fp,
00299                                L4::Ipc::Snd_fpage const &f)
00300   { *fp = f;  }
00301
00302   static void pager_set_result(L4::Ipc::Snd_fpage *fp,
00303                                L4::Ipc::Snd_fpage const &f)
00304   { *fp = f; }
00305
00306   static void pager_set_result(L4::Ipc::Opt<L4::Ipc::Snd_fpage> *, ...)
00307   {}
00308
00309 public:
00310
00314   l4_ret_t op_io_page_fault(L4::Io_pager::Rights, l4_fpage_t, l4_umword_t,
00315                             L4::Ipc::Opt<L4::Ipc::Snd_fpage> &)
00316   {
00317     // generate exception
00318     return -L4_ENOMEM;
00319   }
00320
00321   l4_ret_t op_page_fault(L4::Pager::Rights, l4_umword_t addr, l4_umword_t pc,
00322                          L4::Ipc::Opt<L4::Ipc::Snd_fpage> &fp)
00323   {
00324     Dbg(Dbg::Server).printf("page fault: %lx pc=%lx\n", addr, pc);
00325
00326     bool need_w = addr & 2;
00327     bool need_x = addr & 4;
00328
00329     typename DERIVED::Node n = rm()->find(addr);
00330
00331     if (!n)
00332       {
00333         Dbg(Dbg::Warn, "rm").printf("unhandled %s page fault at 0x%lx pc=0x%lx\n",
00334                                     need_w ? "write" :
00335                                     need_x ? "instruction" : "read", addr, pc);
00336         // generate exception
00337         return -L4_ENOMEM;
00338       }
00339
00340     if (!(n->second.flags() & L4Re::Rm::F::W) && need_w)
00341       {
00342         Dbg(Dbg::Warn, "rm").printf("write page fault in readonly region at 0x%lx pc=0x%lx\n",
00343                                     addr, pc);
00344         // generate exception
00345         return -L4_EACCESS;
00346       }
00347
00348     if (!(n->second.flags() & L4Re::Rm::F::X) && need_x)
00349       {
00350         Dbg(Dbg::Warn, "rm").printf("instruction page fault in non-exec region at 0x%lx pc=0x%lx\n",
00351                                     addr, pc);
00352         // generate exception
00353         return -L4_EACCESS;
00354       }
00355
00356     // This check is optional but avoids doing a map operation that will not
00357     // work. We shall never get here from a page-fault but only from
00358     // artificial page handling.
00359     if (n->second.flags() & (L4Re::Rm::F::Kernel | L4Re::Rm::F::Reserved))
00360       {
00361         Dbg(Dbg::Warn, "rm").printf("page fault handling in kernel-memory provided region or reserved
      region at 0x%lx pc=0x%lx\n",
00362                                     addr, pc);
00363         // generate exception
00364         return -L4_ENODEV;
00365       }
00366
00367     typename DERIVED::Region_handler::Map_result map_res;
00368     if (int err = n->second.map(addr, n->first, need_w, &map_res))
00369       {
00370         Dbg(Dbg::Warn, "rm").printf("mapping for page fault failed with error %d at 0x%lx pc=0x%lx\n",
00371                                     err, addr, pc);
00372         // generate exception
00373         return -L4_ENOMEM;
00374       }
00375
00376     pager_set_result(&fp, map_res);
00377     return L4_EOK;
00378   }
00379
00380   long op_get_info(L4Re::Rm::Rights, l4_addr_t addr,
00381                    L4::Ipc::String<char> &name, L4Re::Rm::Offset &backing_offset)
00382   {
```

```
00383 #ifdef CONFIG_L4RE_REGION_INFO
00384     typename DERIVED::Node r = rm()->find(Region(addr));
00385     if (!r)
00386       return -L4_ENOENT;
00387     backing_offset = r->first.backing_offset();
00388     unsigned long i;
00389     char const *src = r->first.name();
00390     unsigned src_len = r->first.name_len();
00391     for (i = 0; i < src_len && i < name.length - 1; ++i)
00392       name.data[i] = src[i];
00393     name.length = i + 1;
00394     name.data[i] = '\0';
00395     return L4_EOK;
00396 #else
00397     (void)addr;
00398     (void)name;
00399     (void)backing_offset;
00400     return -L4_ENOSYS;
00401 #endif
00402   }
00403 };
00404
00405 }}
```

16.401 reply_cap_hooks

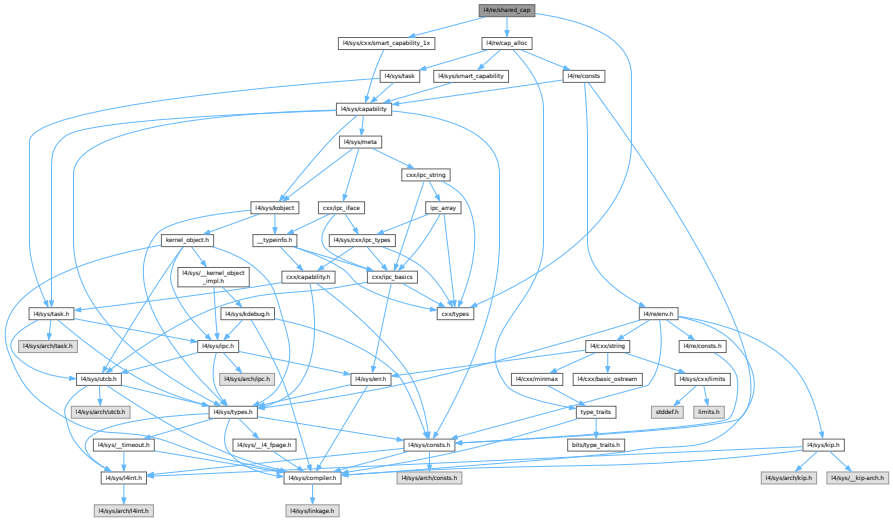
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002
00003 #pragma once
00004
00005 #include <l4/cxx/result>
00006 #include <l4/re/util/cap_alloc>
00007
00008 namespace L4Re { namespace Util {
00009
00010 template<typename HOOKS>
00011 class Reply_cap_hooks : public HOOKS
00012 {
00013 public:
00014   // Implement L4::Ipc_svr::Server_iface
00015   cxx::Result<L4::Reply_cap> take_reply_cap() noexcept override
00016   {
00017     auto next = reply_cap_alloc.alloc();
00018     if (!next)
00019       return cxx::Error(-L4_ENOMEM);
00020
00021     auto ret = cxx::move(_reply_cap);
00022     _reply_cap = cxx::move(next);
00023     return ret;
00024   }
00025
00026 protected:
00027   // Required interface for L4::Ipc_svr::Server
00028   L4::Reply_cap_idx setup_reply_cap() const noexcept
00029   { return _reply_cap.get(); }
00030
00031 private:
00032   L4::Reply_cap _reply_cap{reply_cap_alloc.alloc()};
00033 };
00034
00035 }}
```

16.402 l4/re/shared_cap File Reference

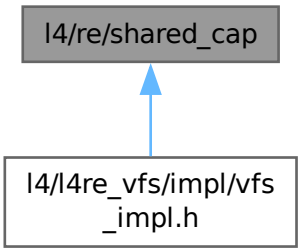
Shared_cap / Shared_del_cap.

```
#include <l4/re/cap_alloc>
#include <l4/sys/cxx/smart_capability_1x>
#include <l4/sys/cxx/types>
```

Include dependency graph for shared_cap:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

Typedefs

- template<typename T>
  using L4Re::Shared_cap = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_ALL_SPACES>>

  Shared capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using L4Re::Shared_del_cap = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_DELETE_OBJ>>

  Shared capability that implements automatic free and unmap+delete of the capability slot.

Functions

- template<typename T>
  Shared_cap< T > L4Re::make_shared_cap (L4Re::Cap_alloc *ca)

Allocate a capability slot and wrap it in a Shared_cap.

- template<typename T, typename U>
  Shared_cap< T > L4Re::shared_cap_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > L4Re::shared_cap_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > L4Re::shared_cap_reinterpret_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > L4Re::shared_cap_reinterpret_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > L4Re::shared_cap_dynamic_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a dynamic cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > L4Re::shared_cap_dynamic_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by an dynamic cast from another shared capability with move semantics.
- template<typename T>
  Shared_del_cap< T > L4Re::make_shared_del_cap (L4Re::Cap_alloc *ca)

  Allocate a capability slot and wrap it in a Shared_del_cap.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::shared_del_cap_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::shared_del_cap_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::shared_del_cap_reinterpret_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::shared_del_cap_reinterpret_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::shared_del_cap_dynamic_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by a dynamic cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::shared_del_cap_dynamic_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an dynamic cast from another shared capability with move semantics.

16.402.1 Detailed Description

Shared_cap / Shared_del_cap.
Definition in file shared_cap.

16.403 shared_cap

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2018 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
```

```
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/re/cap_alloc>
00015 #include <l4/sys/cxx/smart_capability_lx>
00016 #include <l4/sys/cxx/types>
00017
00018 namespace L4Re {
00019
00033 template< typename T >
00034 using Shared_cap
00035   = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_ALL_SPACES>>;
00037 template< typename T >
00038 using shared_cap [[deprecated("Use L4Re::Shared_cap.")]]
00039   = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_ALL_SPACES>>;
00040
00050 template< typename T >
00051 Shared_cap<T>
00052 make_shared_cap(L4Re::Cap_alloc *ca)
00053 { return Shared_cap<T>(ca->alloc<T>(), ca); }
00054
00067 template<typename T, typename U>
00068 Shared_cap<T> shared_cap_cast(Shared_cap<U> const &from) noexcept
00069 {
00070   auto to = L4::cap_cast<T>(from.get());
00071   return Shared_cap<T>(from, to);
00072 }
00073
00086 template<typename T, typename U>
00087 Shared_cap<T> shared_cap_cast(Shared_cap<U> &&from) noexcept
00088 {
00089   auto to = L4::cap_cast<T>(from.get());
00090   return Shared_cap<T>(L4::Types::move(from), to);
00091 }
00092
00103 template<typename T, typename U>
00104 Shared_cap<T> shared_cap_reinterpret_cast(Shared_cap<U> const &from) noexcept
00105 {
00106   auto to = L4::cap_reinterpret_cast<T>(from.get());
00107   return Shared_cap<T>(from, to);
00108 }
00109
00122 template<typename T, typename U>
00123 Shared_cap<T> shared_cap_reinterpret_cast(Shared_cap<U> &&from) noexcept
00124 {
00125   auto to = L4::cap_reinterpret_cast<T>(from.get());
00126   return Shared_cap<T>(L4::Types::move(from), to);
00127 }
00128
00139 template<typename T, typename U>
00140 Shared_cap<T> shared_cap_dynamic_cast(Shared_cap<U> const &from) noexcept
00141 {
00142   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00143     return Shared_cap<T>(from, to);
00144   else
00145     return Shared_cap<T>();
00146 }
00147
00160 template<typename T, typename U>
00161 Shared_cap<T> shared_cap_dynamic_cast(Shared_cap<U> &&from) noexcept
00162 {
00163   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00164     return Shared_cap<T>(L4::Types::move(from), to);
00165   else
00166     return Shared_cap<T>();
00167 }
00168
00185 template< typename T >
00186 using Shared_del_cap
00187   = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_DELETE_OBJ>>;
00189 template<typename T>
00190 using shared_del_cap [[deprecated("Use L4Re::Shared_del_cap.")]]
00191   = L4::Detail::Shared_cap_impl<T, L4Re::Smart_count_cap<L4_FP_DELETE_OBJ>>;
00192
00202 template< typename T >
00203 Shared_del_cap<T>
00204 make_shared_del_cap(L4Re::Cap_alloc *ca)
00205 { return Shared_del_cap<T>(ca->alloc<T>(), ca); }
00206
00219 template<typename T, typename U>
00220 Shared_del_cap<T> shared_del_cap_cast(Shared_del_cap<U> const &from) noexcept
00221 {
00222   auto to = L4::cap_cast<T>(from.get());
00223   return Shared_del_cap<T>(from, to);
00224 }
00225
```

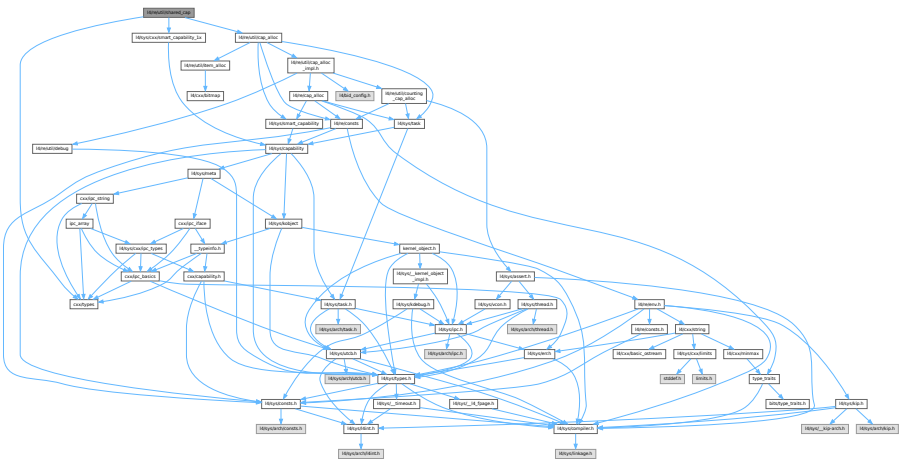
```
00238 template<typename T, typename U>
00239 Shared_del_cap<T> shared_del_cap_cast(Shared_del_cap<U> &&from) noexcept
00240 {
00241   auto to = L4::cap_cast<T>(from.get());
00242   return Shared_del_cap<T>(L4::Types::move(from), to);
00243 }
00244
00255 template<typename T, typename U>
00256 Shared_del_cap<T>
00257 shared_del_cap_reinterpret_cast(Shared_del_cap<U> const &from) noexcept
00258 {
00259   auto to = L4::cap_reinterpret_cast<T>(from.get());
00260   return Shared_del_cap<T>(from, to);
00261 }
00262
00275 template<typename T, typename U>
00276 Shared_del_cap<T>
00277 shared_del_cap_reinterpret_cast(Shared_del_cap<U> &&from) noexcept
00278 {
00279   auto to = L4::cap_reinterpret_cast<T>(from.get());
00280   return Shared_del_cap<T>(L4::Types::move(from), to);
00281 }
00282
00293 template<typename T, typename U>
00294 Shared_del_cap<T>
00295 shared_del_cap_dynamic_cast(Shared_del_cap<U> const &from) noexcept
00296 {
00297   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00298     return Shared_del_cap<T>(from, to);
00299   else
00300     return Shared_del_cap<T>();
00301 }
00302
00315 template<typename T, typename U>
00316 Shared_del_cap<T>
00317 shared_del_cap_dynamic_cast(Shared_del_cap<U> &&from) noexcept
00318 {
00319   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00320     return Shared_del_cap<T>(L4::Types::move(from), to);
00321   else
00322     return Shared_del_cap<T>();
00323 }
00324
00325 } // namespace L4Re
```

16.404 l4/re/util/shared_cap File Reference

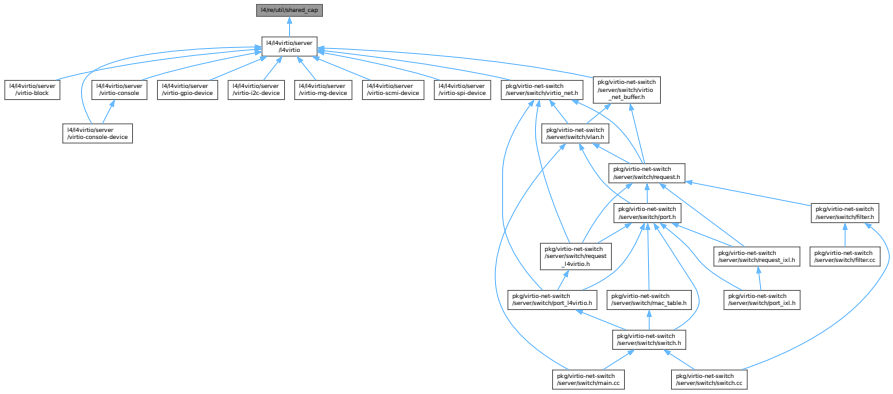
Shared_cap / Shared_del_cap.

```
#include <l4/re/util/cap_alloc>
#include <l4/sys/cxx/smart_capability_1x>
#include <l4/sys/cxx/types>
```

Include dependency graph for shared_cap:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

Typedefs

- template<typename T>
  using L4Re::Util::Shared_cap = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_ALL_SPACES>>

  Shared capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using L4Re::Util::Shared_del_cap = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_DELETE_OBJ>>

  Shared capability that implements automatic free and unmap+delete of the capability slot.

Functions

- template<typename T>
  Shared_cap< T > L4Re::Util::make_shared_cap ()

  Allocate a capability slot and wrap it in a Shared_cap.
- template<typename T, typename U>
  Shared_cap< T > L4Re::Util::shared_cap_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > L4Re::Util::shared_cap_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > L4Re::Util::shared_cap_reinterpret_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > L4Re::Util::shared_cap_reinterpret_cast (Shared_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_cap< T > L4Re::Util::shared_cap_dynamic_cast (Shared_cap< U > const &from) noexcept

  Create a new shared capability by a dynamic cast from another shared capability.
- template<typename T, typename U>
  Shared_cap< T > L4Re::Util::shared_cap_dynamic_cast (Shared_cap< U > &&from) noexcept

Create a new shared capability by an dynamic cast from another shared capability with move semantics.

- template<typename T>
  Shared_del_cap< T > L4Re::Util::make_shared_del_cap ()

  Allocate a capability slot and wrap it in a Shared_del_cap.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::Util::shared_del_cap_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by an explicit cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::Util::shared_del_cap_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an explicit cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::Util::shared_del_cap_reinterpret_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::Util::shared_del_cap_reinterpret_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by a reinterpret cast from another shared capability with move semantics.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::Util::shared_del_cap_dynamic_cast (Shared_del_cap< U > const &from) noexcept

  Create a new shared capability by a dynamic cast from another shared capability.
- template<typename T, typename U>
  Shared_del_cap< T > L4Re::Util::shared_del_cap_dynamic_cast (Shared_del_cap< U > &&from) noexcept

  Create a new shared capability by an dynamic cast from another shared capability with move semantics.

16.404.1 Detailed Description

Shared_cap / Shared_del_cap.
Definition in file shared_cap.

16.405 shared_cap

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2017 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/re/util/cap_alloc>
00015 #include <l4/sys/cxx/smart_capability_1x>
00016 #include <l4/sys/cxx/types>
00017
00018 namespace L4Re { namespace Util {
00019
00048 template< typename T >
00049 using Shared_cap
00050   = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_ALL_SPACES>>;
00052 template< typename T >
00053 using shared_cap [[deprecated("Use L4Re::Util::Shared_cap.")]]
00054   = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_ALL_SPACES>>;
00055
00061 template< typename T >
00062 Shared_cap<T>
00063 make_shared_cap()
00064 { return Shared_cap<T>(cap_alloc.alloc<T>()); }
00065
00078 template<typename T, typename U>
00079 Shared_cap<T> shared_cap_cast(Shared_cap<U> const &from) noexcept
00080 {
```

```
00081   auto to = L4::cap_cast<T>(from.get());
00082   return Shared_cap<T>(from, to);
00083 }
00084
00097 template<typename T, typename U>
00098 Shared_cap<T> shared_cap_cast(Shared_cap<U> &&from) noexcept
00099 {
00100   auto to = L4::cap_cast<T>(from.get());
00101   return Shared_cap<T>(L4::Types::move(from), to);
00102 }
00103
00114 template<typename T, typename U>
00115 Shared_cap<T> shared_cap_reinterpret_cast(Shared_cap<U> const &from) noexcept
00116 {
00117   auto to = L4::cap_reinterpret_cast<T>(from.get());
00118   return Shared_cap<T>(from, to);
00119 }
00120
00133 template<typename T, typename U>
00134 Shared_cap<T> shared_cap_reinterpret_cast(Shared_cap<U> &&from) noexcept
00135 {
00136   auto to = L4::cap_reinterpret_cast<T>(from.get());
00137   return Shared_cap<T>(L4::Types::move(from), to);
00138 }
00139
00150 template<typename T, typename U>
00151 Shared_cap<T> shared_cap_dynamic_cast(Shared_cap<U> const &from) noexcept
00152 {
00153   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00154     return Shared_cap<T>(from, to);
00155   else
00156     return Shared_cap<T>();
00157 }
00158
00171 template<typename T, typename U>
00172 Shared_cap<T> shared_cap_dynamic_cast(Shared_cap<U> &&from) noexcept
00173 {
00174   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00175     return Shared_cap<T>(L4::Types::move(from), to);
00176   else
00177     return Shared_cap<T>();
00178 }
00179
00214 template< typename T >
00215 using Shared_del_cap
00216   = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_DELETE_OBJ>>;
00218 template< typename T >
00219 using shared_del_cap [[deprecated("Use L4Re::Util::Shared_del_cap.")]]
00220   = L4::Detail::Shared_cap_impl<T, L4Re::Util::Smart_count_cap<L4_FP_DELETE_OBJ>>;
00221
00227 template< typename T >
00228 Shared_del_cap<T>
00229 make_shared_del_cap()
00230 { return Shared_del_cap<T>(cap_alloc.alloc<T>()); }
00231
00244 template<typename T, typename U>
00245 Shared_del_cap<T> shared_del_cap_cast(Shared_del_cap<U> const &from) noexcept
00246 {
00247   auto to = L4::cap_cast<T>(from.get());
00248   return Shared_del_cap<T>(from, to);
00249 }
00250
00263 template<typename T, typename U>
00264 Shared_del_cap<T> shared_del_cap_cast(Shared_del_cap<U> &&from) noexcept
00265 {
00266   auto to = L4::cap_cast<T>(from.get());
00267   return Shared_del_cap<T>(L4::Types::move(from), to);
00268 }
00269
00280 template<typename T, typename U>
00281 Shared_del_cap<T>
00282 shared_del_cap_reinterpret_cast(Shared_del_cap<U> const &from) noexcept
00283 {
00284   auto to = L4::cap_reinterpret_cast<T>(from.get());
00285   return Shared_del_cap<T>(from, to);
00286 }
00287
00300 template<typename T, typename U>
00301 Shared_del_cap<T>
00302 shared_del_cap_reinterpret_cast(Shared_del_cap<U> &&from) noexcept
00303 {
00304   auto to = L4::cap_reinterpret_cast<T>(from.get());
00305   return Shared_del_cap<T>(L4::Types::move(from), to);
00306 }
00307
00318 template<typename T, typename U>
00319 Shared_del_cap<T>
```

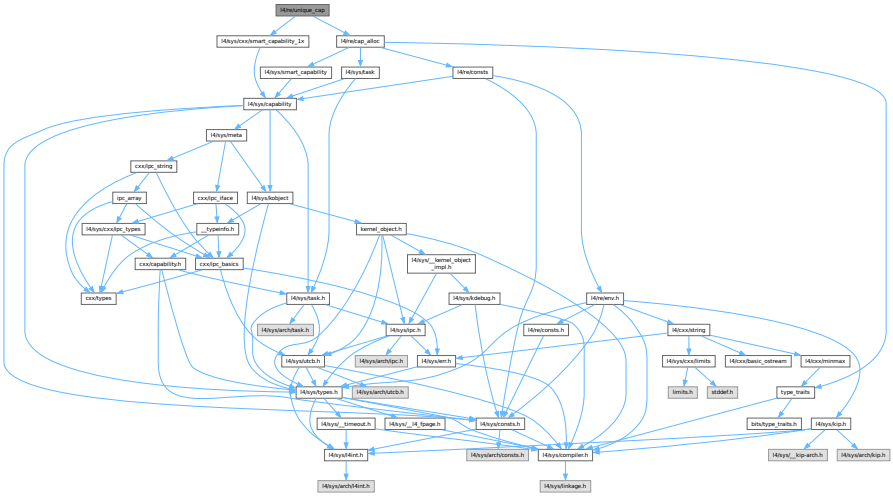
```
00320 shared_del_cap_dynamic_cast(Shared_del_cap<U> const &from) noexcept
00321 {
00322   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00323     return Shared_del_cap<T>(from, to);
00324   else
00325     return Shared_del_cap<T>();
00326 }
00327
00340 template<typename T, typename U>
00341 Shared_del_cap<T>
00342 shared_del_cap_dynamic_cast(Shared_del_cap<U> &&from) noexcept
00343 {
00344   if (auto to = L4::cap_dynamic_cast<T>(from.get()))
00345     return Shared_del_cap<T>(L4::Types::move(from), to);
00346   else
00347     return Shared_del_cap<T>();
00348 }
00349
00350 }} // namespace L4Re::Util
00351
```

16.406 l4/re/unique_cap File Reference

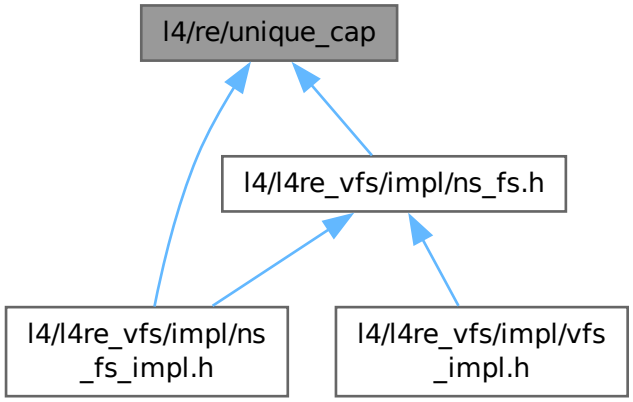
Unique_cap / Unique_del_cap.

```
#include <l4/re/cap_alloc>
#include <l4/sys/cxx/smart_capability_1x>
```

Include dependency graph for unique_cap:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

Typedefs

- template<typename T>
  using L4Re::Unique_cap = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_ALL_SPACES>>

  Unique capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using L4Re::Unique_del_cap = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_DELETE_OBJ>>

  Unique capability that implements automatic free and unmap+delete of the capability slot.

Functions

- template<typename T>
  Unique_cap< T > L4Re::make_unique_cap (L4Re::Cap_alloc *ca)

  Allocate a capability slot and wrap it in an Unique_cap.
- template<typename T>
  Unique_del_cap< T > L4Re::make_unique_del_cap (L4Re::Cap_alloc *ca)

  Allocate a capability slot and wrap it in an Unique_del_cap.

16.406.1 Detailed Description

Unique_cap / Unique_del_cap.
Definition in file unique_cap.

16.407 unique_cap

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2017 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
```

```
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/re/cap_alloc>
00015 #include <l4/sys/cxx/smart_capability_1x>
00016
00017 namespace L4Re {
00018
00030 template< typename T >
00031 using Unique_cap
00032   = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_ALL_SPACES>>;
00034 template< typename T >
00035 using unique_cap [[deprecated("Use L4Re::Unique_cap.")]]
00036   = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_ALL_SPACES>>;
00037
00047 template< typename T >
00048 Unique_cap<T>
00049 make_unique_cap(L4Re::Cap_alloc *ca)
00050 { return Unique_cap<T>(ca->alloc<T>(), ca); }
00051
00065 template< typename T >
00066 using Unique_del_cap
00067   = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_DELETE_OBJ>>;
00069 template<typename T>
00070 using unique_del_cap [[deprecated("Use L4Re::Unique_del_cap.")]]
00071   = L4::Detail::Unique_cap_impl<T, L4Re::Smart_cap_auto<L4_FP_DELETE_OBJ>>;
00072
00082 template< typename T >
00083 Unique_del_cap<T>
00084 make_unique_del_cap(L4Re::Cap_alloc *ca)
00085 { return Unique_del_cap<T>(ca->alloc<T>(), ca); }
00086
00087 }
```

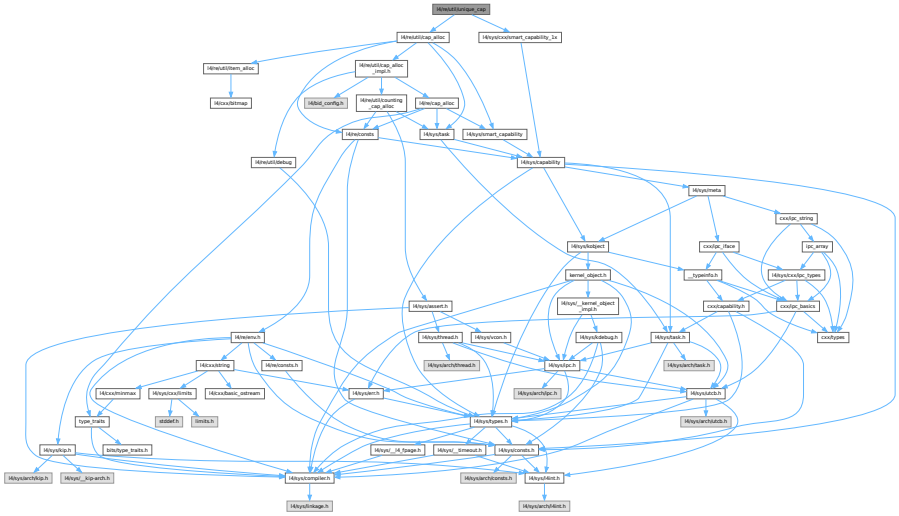
16.408 l4/re/util/unique_cap File Reference

Unique_cap / Unique_del_cap.

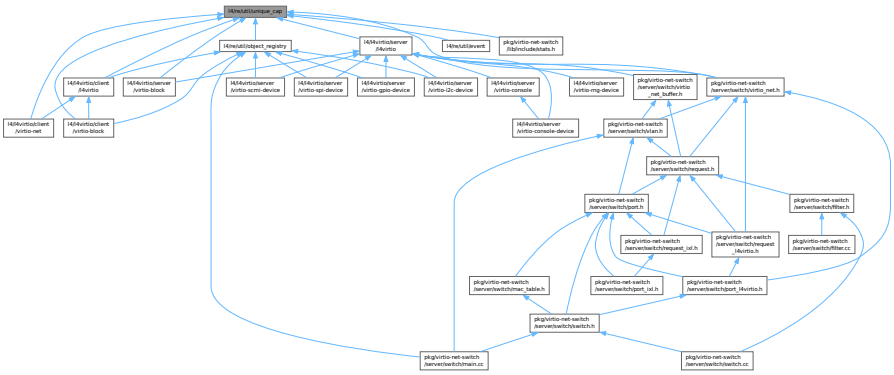
`#include <l4/re/util/cap_alloc>`

`#include <l4/sys/cxx/smart_capability_1x>`

Include dependency graph for unique_cap:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.
- namespace L4Re::Util

  Documentation of the L4 Runtime Environment utility functionality in C++.

Typedefs

- template<typename T>
  using L4Re::Util::Unique_cap = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_ALL_SPACES>>

  Unique capability that implements automatic free and unmap of the capability slot.
- template<typename T>
  using L4Re::Util::Unique_del_cap = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_DELETE_OBJ>>

  Unique capability that implements automatic free and unmap+delete of the capability slot.

Functions

- template<typename T>
  Unique_cap< T > L4Re::Util::make_unique_cap ()

  Allocate a capability slot and wrap it in an Unique_cap.
- template<typename T>
  Unique_del_cap< T > L4Re::Util::make_unique_del_cap ()

  Allocate a capability slot and wrap it in an Unique_del_cap.

16.408.1 Detailed Description

Unique_cap / Unique_del_cap.
Definition in file unique_cap.

16.409 unique_cap

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2017 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
```

```
00014 #include <l4/re/util/cap_alloc>
00015 #include <l4/sys/cxx/smart_capability_lx>
00016
00017 namespace L4Re { namespace Util {
00018
00042 template< typename T >
00043 using Unique_cap
00044   = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_ALL_SPACES>>;
00046 template< typename T >
00047 using unique_cap [[deprecated("Use L4Re::Util::Unique_cap.")]]
00048   = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_ALL_SPACES>>;
00049
00055 template< typename T >
00056 Unique_cap<T>
00057 make_unique_cap()
00058 { return Unique_cap<T>(cap_alloc.alloc<T>()); }
00059
00087 template< typename T >
00088 using Unique_del_cap
00089   = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_DELETE_OBJ>>;
00091 template< typename T >
00092 using unique_del_cap [[deprecated("Use L4Re::Util::Unique_del_cap.")]]
00093   = L4::Detail::Unique_cap_impl<T, L4Re::Util::Smart_cap_auto<L4_FP_DELETE_OBJ>>;
00094
00100 template< typename T >
00101 Unique_del_cap<T>
00102 make_unique_del_cap()
00103 { return Unique_del_cap<T>(cap_alloc.alloc<T>()); }
00104
00105 }}
00106
```

16.410 vcon_svr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2011 Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00005  *               Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00006  *     economic rights: Technische Universität Dresden (Germany)
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #pragma once
00011
00012 #include <l4/sys/types.h>
00013 #include <l4/sys/vcon>
00014 #include <l4/sys/cxx/ipc_legacy>
00015 #include <l4/cxx/minmax>
00016
00017 namespace L4Re { namespace Util {
00018
00035 template< typename SVR >
00036 class Vcon_svr
00037 {
00038 public:
00039   L4_RPC_LEGACY_DISPATCH(L4::Vcon);
00040
00041   l4_msgtag_t op_dispatch(l4_utcb_t *utcb, l4_msgtag_t tag, L4::Vcon::Rights)
00042   {
00043     l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00044     L4::Opcode op = m->mr[0] & 0xFFFF;
00045
00046     switch (op)
00047       {
00048       case L4_VCON_WRITE_OP:
00049         if (tag.words() < 3)
00050           return l4_msgtag(-L4_ENOREPLY, 0, 0, 0);
00051
00052         this_vcon()->vcon_write(reinterpret_cast<char const *>(&m->mr[2]),
00053                                 m->mr[1]);
00054         return l4_msgtag(-L4_ENOREPLY, 0, 0, 0);
00055
00056       case L4_VCON_SET_ATTR_OP:
00057         {
00058           if (tag.words() < 4)
00059             return l4_msgtag(-L4_EINVAL, 0, 0, 0);
00060
00061           auto attr = reinterpret_cast<l4_vcon_attr_t const *>(&m->mr[1]);
00062           return l4_msgtag(this_vcon()->vcon_set_attr(attr), 0, 0, 0);
00063         }
00064       case L4_VCON_GET_ATTR_OP:
00065         {
00066           auto attr = reinterpret_cast<l4_vcon_attr_t *>(&m->mr[1]);
```

```
00067           return l4_msgtag(this_vcon()->vcon_get_attr(attr), 4, 0, 0);
00068         }
00069       case L4_VCON_READ_OP:
00070         break;
00071
00072       default:
00073         return l4_msgtag(-L4_ENOSYS, 0, 0, 0);
00074       }
00075
00076     unsigned const max_size = L4_VCON_READ_SIZE;
00077     char buf[max_size];
00078
00079     unsigned size = cxx::min<unsigned>(m->mr[0] » 16, max_size);
00080
00081     // Hmm, could we avoid the double copy here?
00082     l4_umword_t v = this_vcon()->vcon_read(buf, size);
00083     unsigned bytes = v & L4_VCON_READ_SIZE_MASK;
00084
00085     if (bytes <= size)
00086       v |= L4_VCON_READ_STAT_DONE;
00087     else
00088       // In case of size == max_size, the returned bytes value is greater than
00089       // the buffer.
00090       bytes = size;
00091
00092     m->mr[0] = v;
00093     __builtin_memcpy(&m->mr[1], buf, bytes);
00094
00095     return l4_msgtag(0, l4_bytes_to_mwords(bytes) + 1, 0, 0);
00096   }
00097
00098   unsigned vcon_read(char *buf, unsigned size) noexcept;
00099   void vcon_write(const char *buf, unsigned size) noexcept;
00100   int vcon_set_attr(l4_vcon_attr_t const *) noexcept
00101   { return -L4_EOK; }
00102   int vcon_get_attr(l4_vcon_attr_t *attr) noexcept
00103   {
00104     attr->l_flags = attr->o_flags = attr->i_flags = 0;
00105     return -L4_EOK;
00106   }
00107
00108 private:
00109   SVR const *this_vcon() const { return static_cast<SVR const *>(this); }
00110   SVR *this_vcon() { return static_cast<SVR *>(this); }
00111 };
00112
00113 }}
```

16.411 goos_fb

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include <l4/re/env>
00012 #include <l4/re/namespace>
00013 #include <l4/re/rm>
00014 #include <l4/re/util/cap_alloc>
00015 #include <l4/re/util/env_ns>
00016 #include <l4/re/util/video/goos_fb>
00017 #include <l4/re/video/goos>
00018
00019 namespace L4Re { namespace Util { namespace Video {
00020
00021 class Goos_fb
00022 {
00023 private:
00024   L4::Cap<L4Re::Video::Goos> _goos;
00025   L4Re::Video::View _view;
00026   L4::Cap<L4Re::Dataspace> _buffer;
00027
00028   enum Flags
00029   {
00030     F_dyn_buffer = 0x01,
00031     F_dyn_view   = 0x02,
00032     F_dyn_goos   = 0x04,
00033   };
00034   unsigned _flags;
```

```
00035
00036   unsigned _buffer_index;
00037
00038 private:
00039   long init()
00040   {
00041     using namespace L4Re::Video;
00042
00043     Goos::Info gi;
00044     long ret = _goos->info(&gi);
00045     if (ret < 0)
00046       return ret;
00047
00048     if (gi.has_dynamic_views())
00049       {
00050         ret = _goos->create_view(&_view);
00051         if (ret < 0)
00052           return ret;
00053
00054         _flags |= F_dyn_view;
00055       }
00056     else // we just assume view 0 to be our's and ignore other possible views
00057       _view = _goos->view(0);
00058
00059     View::Info vi;
00060     ret = _view.info(&vi);
00061     if (ret < 0)
00062       return ret;
00063
00064     _buffer = cap_alloc.alloc<L4Re::Dataspace>();
00065     if (!_buffer)
00066       return -L4_ENOMEM;
00067
00068     if (vi.has_static_buffer())
00069       {
00070         ret = _goos->get_static_buffer(vi.buffer_index, _buffer);
00071         if (ret < 0)
00072           return ret;
00073       }
00074     else
00075       {
00076         unsigned long buffer_sz = gi.pixel_info.bytes_per_pixel() * gi.width
00077                                                                   * gi.height;
00078         ret = _goos->create_buffer(buffer_sz, _buffer);
00079         if (ret < 0)
00080           return ret;
00081
00082         _buffer_index = static_cast<unsigned>(ret);
00083         _flags |= F_dyn_buffer;
00084
00085         // use the allocated buffer, at offset 0
00086         vi.buffer_index = _buffer_index;
00087         vi.buffer_offset = 0;
00088         vi.pixel_info = gi.pixel_info;
00089         vi.bytes_per_line = gi.width * gi.pixel_info.bytes_per_pixel();
00090
00091         // we want a fullscreen view
00092         vi.xpos = 0;
00093         vi.ypos = 0;
00094         vi.width = gi.width;
00095         vi.height = gi.height;
00096
00097         ret = _view.set_info(vi);
00098         if (ret < 0)
00099           return ret;
00100
00101         ret = _view.push_top();
00102         if (ret < 0)
00103           return ret;
00104       }
00105
00106     return 0;
00107   }
00108
00109   Goos_fb(Goos_fb const &);
00110   void operator = (Goos_fb const &);
00111
00112 public:
00113   Goos_fb()
00114   : _goos(L4_INVALID_CAP), _buffer(L4_INVALID_CAP), _flags(0), _buffer_index(0)
00115   {}
00116
00117   long init(L4::Cap<L4Re::Video::Goos> goos)
00118   {
00119     _goos = goos;
00120     return init();
00121   }
```

```
00122
00123   long init(char const *name)
00124   {
00125     Env_ns ns;
00126     _goos = ns.query<L4Re::Video::Goos>(name);
00127     if (!_goos)
00128       return _goos.cap();
00129
00130     _flags |= F_dyn_goos;
00131
00132     return init();
00133   }
00134
00135   ~Goos_fb()
00136   {
00137     if (!_goos.is_valid())
00138       return;
00139
00140     if (_flags & F_dyn_view)
00141       _goos->delete_view(_view);
00142
00143     if (_flags & F_dyn_buffer)
00144       _goos->delete_buffer(_buffer_index);
00145
00146     if (_buffer.is_valid())
00147       cap_alloc.free(_buffer);
00148
00149     if (_flags & F_dyn_goos)
00150       cap_alloc.free(_goos);
00151   }
00152
00153   int view_info(L4Re::Video::View::Info *info)
00154   { return _view.info(info); }
00155
00156   L4Re::Video::View const *view() const { return &_view; }
00157   L4Re::Video::View *view() { return &_view; }
00158
00159   L4::Cap<L4Re::Dataspace> buffer() const { return _buffer; }
00160   void *attach_buffer()
00161   {
00162     void *fb_addr = 0;
00163     if (!_goos)
00164       return nullptr;
00165
00166     long ret = L4Re::Env::env()->rm()
00167         ->attach(&fb_addr, _buffer->size(),
00168                  L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW, _buffer,
00169                  0, L4_SUPERPAGESHIFT);
00170     if (ret < 0)
00171       return nullptr;
00172
00173     return fb_addr;
00174   }
00175
00176   int refresh(int x, int y, int w, int h)
00177   { return _view.refresh(x, y, w, h); }
00178
00179   L4::Cap<L4Re::Video::Goos> goos() const { return _goos; }
00180 };
00181 }}}
```

16.412 goos_svr

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/re/dataspace>
00013 #include <l4/re/video/goos>
00014
00015 #include <l4/sys/capability>
00016 #include <l4/sys/cxx/ipc_legacy>
00017
00018 namespace L4Re { namespace Util { namespace Video {
00019
00024 class Goos_svr
00025 {
```

```
00026   typedef L4Re::Video::Goos::Rights Rights;
00027 protected:
00029   L4::Cap<L4Re::Dataspace> _fb_ds;
00031   L4Re::Video::Goos::Info _screen_info;
00033   L4Re::Video::View::Info _view_info;
00034
00035 public:
00036   L4_RPC_LEGACY_DISPATCH(L4Re::Video::Goos);
00041   L4::Cap<L4Re::Dataspace> get_fb() const { return _fb_ds; }
00042
00047   L4Re::Video::Goos::Info const *screen_info() const { return &_screen_info; }
00048
00053   L4Re::Video::View::Info const *view_info() const { return &_view_info; }
00054
00065   virtual int refresh(int x, int y, int w, int h)
00066   { (void)x; (void)y; (void)w; (void)h; return -L4_ENOSYS; }
00067
00068
00077   void init_infos()
00078   {
00079     using L4Re::Video::View;
00080
00081     _view_info.flags = View::F_none;
00082
00083     _view_info.view_index = 0;
00084     _view_info.xpos = 0;
00085     _view_info.ypos = 0;
00086     _view_info.width = _screen_info.width;
00087     _view_info.height = _screen_info.height;
00088     _view_info.pixel_info = _screen_info.pixel_info;
00089     _view_info.buffer_index = 0;
00090   }
00091
00095   virtual ~Goos_svr() {}
00096
00097   l4_ret_t op_view_info(Rights, unsigned idx, L4Re::Video::View::Info &info)
00098   {
00099     if (idx != 0)
00100       return -L4_ERANGE;
00101
00102     info = _view_info;
00103     return L4_EOK;
00104   }
00105
00106   l4_ret_t op_info(Rights, L4Re::Video::Goos::Info &info)
00107   {
00108     info = _screen_info;
00109     return L4_EOK;
00110   }
00111
00112   l4_ret_t op_get_static_buffer(Rights, unsigned idx,
00113                                 L4::Ipc::Cap<L4Re::Dataspace> &ds)
00114   {
00115     if (idx != 0)
00116       return -L4_ERANGE;
00117
00118     ds = L4::Ipc::Cap<L4Re::Dataspace>(_fb_ds, L4_CAP_FPAGE_RW);
00119     return L4_EOK;
00120   }
00121
00122   l4_ret_t op_refresh(Rights, int x, int y, int w, int h)
00123   { return refresh(x, y, w, h); }
00124
00125   l4_ret_t op_view_refresh(Rights, unsigned idx, int x, int y, int w, int h)
00126   {
00127     if (idx != 0)
00128       return -L4_ERANGE;
00129
00130     return refresh(x, y, w, h);
00131   }
00132
00133   l4_ret_t op_set_view_info(Rights, unsigned, L4Re::Video::View::Info)
00134   { return -L4_ENOSYS; }
00135
00136   l4_ret_t op_view_stack(Rights, unsigned, unsigned, bool)
00137   { return -L4_ENOSYS; }
00138
00139   l4_ret_t op_delete_view(Rights, unsigned)
00140   { return -L4_ENOSYS; }
00141
00142   l4_ret_t op_create_view(Rights)
00143   { return -L4_ENOSYS; }
00144
00145   l4_ret_t op_create_buffer(Rights, unsigned long,
00146                             L4::Ipc::Cap<L4Re::Dataspace> &)
00147   { return -L4_ENOSYS; }
00148
```

```
00149   l4_ret_t op_delete_buffer(Rights, unsigned)
00150   { return -L4_ENOSYS; }
00151 };
00152
00153
00154 }}}
```

16.413 colors

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/sys/compiler.h>
00013 #include <l4/cxx/minmax>
00014
00015 namespace L4Re { namespace Video {
00016
00021 class L4_EXPORT Color_component
00022 {
00023 private:
00024   unsigned char _bits;
00025   unsigned char _shift;
00026
00027 public:
00029   Color_component() : _bits(0), _shift(0) {}
00030
00036   Color_component(unsigned char bits, unsigned char shift)
00037   : _bits(bits), _shift(shift) {}
00038
00043   unsigned char size() const { return _bits; }
00044
00049   unsigned char shift() const { return _shift; }
00050
00055   bool operator == (Color_component const &o) const
00056   { return _shift == o._shift && _bits == o._bits; }
00057
00063   int get(unsigned long v) const
00064   {
00065     return ((v » _shift) & ~(~0UL « _bits)) « (16UL - _bits);
00066   }
00067
00073   long unsigned set(int v) const
00074   { return (static_cast<unsigned long>(v) » (16UL - _bits)) « _shift; }
00075
00080   template< typename OUT >
00081   void dump(OUT &s) const
00082   {
00083     s.printf("%d(%d)", static_cast<int>(size()), static_cast<int>(shift()));
00084   }
00085 } __attribute__((packed));
00086
00094 class L4_EXPORT Pixel_info
00095 {
00096 private:
00097   Color_component _r, _g, _b, _a;
00098   unsigned char _bpp;
00099
00100 public:
00105   Color_component const &r() const { return _r; }
00106
00111   Color_component const &g() const { return _g; }
00112
00117   Color_component const &b() const { return _b; }
00118
00123   Color_component const &a() const { return _a; }
00124
00131   Color_component const padding() const
00132   {
00133     unsigned char top_bit = cxx::max<unsigned char>(_r.size() + _r.shift(),
00134                                                     _g.size() + _g.shift());
00135     top_bit = cxx::max<unsigned char>(top_bit, _b.size() + _b.shift());
00136     top_bit = cxx::max<unsigned char>(top_bit, _a.size() + _a.shift());
00137
00138     unsigned char bits = _bpp * 8;
00139
00140     if (top_bit < bits)
```

```
00141       return Color_component(bits - top_bit, top_bit);
00142
00143     return Color_component(0, 0);
00144   }
00145
00150   unsigned char bytes_per_pixel() const { return _bpp; }
00151
00156   unsigned char bits_per_pixel() const
00157   { return _r.size() + _g.size() + _b.size() + _a.size(); }
00158
00163   bool has_alpha() const { return _a.size() > 0; }
00164
00169   void r(Color_component const &c) { _r = c; }
00170
00175   void g(Color_component const &c) { _g = c; }
00176
00181   void b(Color_component const &c) { _b = c; }
00182
00187   void a(Color_component const &c) { _a = c; }
00188
00193   void bytes_per_pixel(unsigned char bpp) { _bpp = bpp; }
00194
00198   Pixel_info() : _bpp(0) {};
00199
00212   Pixel_info(unsigned char bpp, char r, char rs, char g, char gs,
00213              char b, char bs, char a = 0, char as = 0)
00214   : _r(r, rs), _g(g, gs), _b(b, bs), _a(a, as), _bpp(bpp)
00215   {}
00216
00223   template<typename VBI>
00224   explicit Pixel_info(VBI const *vbi)
00225   : _r(vbi->red_mask_size, vbi->red_field_position),
00226     _g(vbi->green_mask_size, vbi->green_field_position),
00227     _b(vbi->blue_mask_size, vbi->blue_field_position),
00228     _bpp((vbi->bits_per_pixel + 7) / 8)
00229   {}
00230
00236   bool operator == (Pixel_info const &o) const
00237   {
00238     return _r == o._r && _g == o._g && _b == o._b && _a == o._a && _bpp == o._bpp;
00239   }
00240
00245   template< typename OUT >
00246   void dump(OUT &s) const
00247   {
00248     s.printf("RGBA(%d):%d(%d):%d(%d):%d(%d):%d(%d)",
00249              static_cast<int>(bytes_per_pixel()),
00250              static_cast<int>(r().size()), static_cast<int>(r().shift()),
00251              static_cast<int>(g().size()), static_cast<int>(g().shift()),
00252              static_cast<int>(b().size()), static_cast<int>(b().shift()),
00253              static_cast<int>(a().size()), static_cast<int>(a().shift()));
00254   }
00255 };
00256
00257
00258 }}
00259
00260
```

16.414 goos

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include <l4/sys/capability>
00012 #include <l4/re/dataspace>
00013 #include <l4/re/video/colors>
00014 #include <l4/sys/cxx/ipc_iface>
00015
00016 namespace L4Re { namespace Video {
00017
00026 class L4_EXPORT Goos;
00027
00039 class L4_EXPORT View
00040 {
00041 private:
00042   friend class Goos;
```

```
00043
00044   L4::Cap<Goos> _goos;
00045   unsigned _view_idx;
00046
00047   View(l4_cap_idx_t goos, unsigned idx)
00048   : _goos(goos), _view_idx(_goos.is_valid() ? idx : ~0U) {}
00049
00050   unsigned view_index() const noexcept
00051   { return _goos.is_valid() ? _view_idx : ~0U; }
00052
00053 public:
00054   View() : _goos(L4::Cap<Goos>::Invalid), _view_idx(~0U) {}
00055
00059   enum Flags
00060   {
00061     F_none               = 0x00,
00062     F_set_buffer         = 0x01,
00063     F_set_buffer_offset  = 0x02,
00064     F_set_bytes_per_line = 0x04,
00065     F_set_pixel          = 0x08,
00066     F_set_position       = 0x10,
00067     F_dyn_allocated      = 0x20,
00068     F_set_background     = 0x40,
00069     F_set_flags          = 0x80,
00070
00072     F_fully_dynamic      =   F_set_buffer | F_set_buffer_offset | F_set_bytes_per_line
00073                            | F_set_pixel | F_set_position | F_dyn_allocated,
00074   };
00075
00082   enum V_flags
00083   {
00084     F_above              = 0x1000,
00085     F_flags_mask         = 0xff000,
00086   };
00087
00091   struct Info
00092   {
00093     unsigned flags               = 0;
00094     unsigned view_index          = 0;
00095
00096     unsigned long xpos           = 0;
00097     unsigned long ypos           = 0;
00098     unsigned long width          = 0;
00099     unsigned long height         = 0;
00100     unsigned long buffer_offset  = 0;
00101     unsigned long bytes_per_line = 0;
00102     Pixel_info pixel_info;
00103     unsigned buffer_index        = 0;
00104
00106     bool has_static_buffer() const { return !(flags & F_set_buffer); }
00108     bool has_static_buffer_offset() const { return !(flags & F_set_buffer_offset); }
00109
00111     bool has_set_buffer() const { return flags & F_set_buffer; }
00113     bool has_set_buffer_offset() const { return flags & F_set_buffer_offset; }
00115     bool has_set_bytes_per_line() const { return flags & F_set_bytes_per_line; }
00117     bool has_set_pixel() const { return flags & F_set_pixel; }
00119     bool has_set_position() const { return flags & F_set_position; }
00120
00122     template< typename OUT >
00123     void dump(OUT &s) const
00124     {
00125       s.printf("View::Info:\n"
00126                "  flags: %x\n"
00127                "  size:  %ldx%ld\n"
00128                "  pos:   %ldx%ld\n"
00129                "  bytes_per_line: %ld\n"
00130                "  buffer_offset:  %lx\n"
00131                "  ",
00132                flags, width, height, xpos, ypos,
00133                bytes_per_line, buffer_offset);
00134       pixel_info.dump(s);
00135       s.printf("\n");
00136     }
00137   };
00138
00146   int info(Info *info) const noexcept;
00147
00158   int set_info(Info const &info) const noexcept;
00159
00171   int set_viewport(int scr_x, int scr_y, int w, int h, unsigned long buf_offset) const noexcept;
00172
00182   int stack(View const &pivot, bool behind = true) const noexcept;
00183
00185   int push_top() const noexcept
00186   { return stack(View(), true); }
00187
00189   int push_bottom() const noexcept
```

```
00190   { return stack(View(), false); }
00191
00202   int refresh(int x, int y, int w, int h) const noexcept;
00203
00205   bool valid() const { return _goos.is_valid(); }
00206 };
00207
00208
00223 class L4_EXPORT Goos :
00224   public L4::Kobject_t<Goos, L4::Kobject, L4RE_PROTO_GOOS>
00225 {
00226 public:
00228   enum Flags
00229   {
00230     F_auto_refresh    = 0x01,
00231     F_pointer         = 0x02,
00232     F_dynamic_views   = 0x04,
00233     F_dynamic_buffers = 0x08,
00234   };
00235
00237   struct Info
00238   {
00239     unsigned long width;
00240     unsigned long height;
00241     unsigned flags;
00242     unsigned num_static_views;
00243     unsigned num_static_buffers;
00244     Pixel_info pixel_info;
00245
00248     bool auto_refresh() const { return flags & F_auto_refresh; }
00250     bool has_pointer() const { return flags & F_pointer; }
00252     bool has_dynamic_views() const { return flags & F_dynamic_views; }
00254     bool has_dynamic_buffers() const { return flags & F_dynamic_buffers; }
00255
00256     Info()
00257     : width(0), height(0), flags(0), num_static_views(0),
00258       num_static_buffers(0) {}
00259   };
00260
00268   L4_INLINE_RPC(l4_ret_t, info, (Info *info));
00269
00278   L4_RPC(l4_ret_t, get_static_buffer, (unsigned idx,
00279                                        L4::Ipc::Out<L4::Cap<L4Re::Dataspace> > rbuf));
00280
00289   L4_RPC(l4_ret_t, create_buffer, (unsigned long size,
00290                                    L4::Ipc::Out<L4::Cap<L4Re::Dataspace> > rbuf));
00291
00299   L4_INLINE_RPC(l4_ret_t, delete_buffer, (unsigned idx));
00300
00301   // Use a wrapper for this RPC as we encapsulate the View
00302   L4_INLINE_RPC_NF(l4_ret_t, create_view, ());
00303
00312   l4_ret_t create_view(View *view, l4_utcb_t *utcb = l4_utcb()) const noexcept
00313   {
00314     l4_ret_t r = create_view_t::call(c(), utcb);
00315     if (r < 0)
00316       return r;
00317     *view = View(cap(), r);
00318     return r;
00319   }
00320
00321   // Use a wrapper as Views are encapsulated
00322   L4_INLINE_RPC_NF(l4_ret_t, delete_view, (unsigned index));
00323
00332   l4_ret_t delete_view(View const &v, l4_utcb_t *utcb = l4_utcb()) const noexcept
00333   {
00334     return delete_view_t::call(c(), v._view_idx, utcb);
00335   }
00336
00342   View view(unsigned index) const noexcept;
00343
00347   L4_INLINE_RPC(l4_ret_t, refresh, (int x, int y, int w, int h));
00348
00349   // those are used by the View
00350   L4_INLINE_RPC(l4_ret_t, view_info, (unsigned index, View::Info *info));
00351   L4_INLINE_RPC(l4_ret_t, set_view_info, (unsigned index, View::Info const &info));
00352   L4_INLINE_RPC(l4_ret_t, view_stack, (unsigned index, unsigned pivot, bool behind));
00353   L4_INLINE_RPC(l4_ret_t, view_refresh, (unsigned index, int x, int y, int w, int h));
00354
00355   typedef L4::Typeid::Rpcs<
00356     info_t, get_static_buffer_t, create_buffer_t, create_view_t, delete_buffer_t,
00357     delete_view_t, view_info_t, set_view_info_t, view_stack_t, view_refresh_t,
00358     refresh_t
00359   > Rpcs;
00360 };
00361
00362 inline View
```

```
00363 Goos::view(unsigned index) const noexcept
00364 { return View(cap(), index); }
00365
00366 inline int
00367 View::info(Info *info) const noexcept
00368 { return _goos->view_info(_view_idx, info); }
00369
00370 inline int
00371 View::set_info(Info const &info) const noexcept
00372 { return _goos->set_view_info(_view_idx, info); }
00373
00374 inline int
00375 View::stack(View const &pivot, bool behind) const noexcept
00376 { return _goos->view_stack(_view_idx, pivot._view_idx, behind); }
00377
00378 inline int
00379 View::refresh(int x, int y, int w, int h) const noexcept
00380 { return _goos->view_refresh(_view_idx, x, y, w, h); }
00381
00382 inline int
00383 View::set_viewport(int scr_x, int scr_y, int w, int h,
00384                    unsigned long buf_offset) const noexcept
00385 {
00386   Info i;
00387   i.flags = F_set_buffer_offset | F_set_position;
00388   i.buffer_offset = buf_offset;
00389   i.buffer_index = 0;
00390   i.view_index = 0;
00391   i.bytes_per_line = 0;
00392   i.pixel_info = Pixel_info();
00393   i.xpos = scr_x;
00394   i.ypos = scr_y;
00395   i.width = w;
00396   i.height = h;
00397   return set_info(i);
00398 }
00399
00400 }}
```

16.415 l4/re/video/goos-sys.h File Reference

Goos protocol definition.

Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

Enumerations

- enum L4Re::Video::Goos_::Opcodes

  Frame buffer communication-protocol opcodes.

16.415.1 Detailed Description

Goos protocol definition.
Definition in file goos-sys.h.

16.416 goos-sys.h

Go to the documentation of this file.

```
00001 #pragma once
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 namespace L4Re { namespace Video {
00016   namespace Goos_
```

```
00017   {
00023     enum Opcodes
00024     {
00025       Info, Get_buffer, Create_buffer, Create_view,
00026       Delete_buffer, Delete_view,
00027       View_info, View_set_info, View_stack, View_refresh,
00028       Screen_refresh
00029     };
00030   };
00031 }}
```

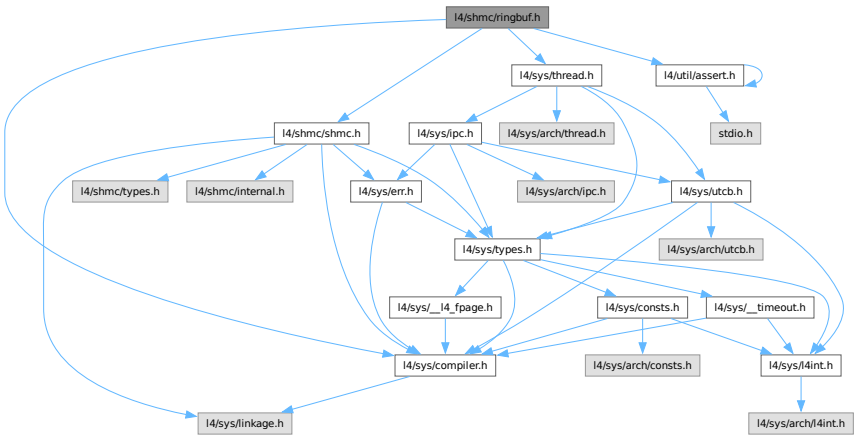
16.417 view

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00004  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include <l4/re/video/goos>
00012
```

16.418 l4/shmc/ringbuf.h File Reference

```
#include <l4/shmc/shmc.h>
#include <l4/util/assert.h>
#include <l4/sys/compiler.h>
#include <l4/sys/thread.h>
```

Include dependency graph for ringbuf.h:



Data Structures

- struct l4shmc_ringbuf_head_t

  Head field of a ring buffer.
- struct l4shmc_ringbuf_t

  Ring buffer.

Macros

- #define L4SHMC_RINGBUF_HEAD(ringbuf)

  Get ring buffer head pointer.

- #define L4SHMC_RINGBUF_DATA(ringbuf)

  Get ring buffer data pointer.
- #define L4SHMC_RINGBUF_DATA_SIZE(ringbuf)

  Get size of data area.

Functions

- int l4shmc_rb_init_buffer (l4shmc_ringbuf_t *buf, l4shmc_area_t *area, char const *chunk_name, char const *signal_name, unsigned size)

  Initialize a ring buffer by creating an SHMC chunk and the corresponding signals.
- void l4shmc_rb_deinit_buffer (l4shmc_ringbuf_t *buf)

  De-init a ring buffer.
- int l4shmc_rb_attach_sender (l4shmc_ringbuf_t *buf, char const *signal_name, l4_cap_idx_t owner)

  Attach to sender signal of a ring buffer.
- char * l4shmc_rb_sender_alloc_packet (l4shmc_ringbuf_head_t *head, unsigned psize)

  Allocate a packet of a given size within the ring buffer.
- void l4shmc_rb_sender_put_data (l4shmc_ringbuf_t *buf, char *addr, char *data, unsigned dsize)

  Copy data into a previously allocated packet.
- int l4shmc_rb_sender_next_copy_in (l4shmc_ringbuf_t *buf, char *data, unsigned size, int block_if_necessary)

  Copy in packet from an external data source.
- void l4shmc_rb_sender_commit_packet (l4shmc_ringbuf_t *buf)

  Tell the consumer that new data is available.
- int l4shmc_rb_init_receiver (l4shmc_ringbuf_t *buf, l4shmc_area_t *area, char const *chunk_name, char const *signal_name)

  Initialize receive buffer.
- void l4shmc_rb_attach_receiver (l4shmc_ringbuf_t *buf, l4_cap_idx_t owner)

  Attach to receiver signal of a ring buffer.
- int l4shmc_rb_receiver_wait_for_data (l4shmc_ringbuf_t *buf, int blocking)

  Check if (and optionally block until) new data is ready.
- int l4shmc_rb_receiver_copy_out (l4shmc_ringbuf_head_t *head, char *target, unsigned *tsize)

  Copy data out of the buffer.
- void l4shmc_rb_receiver_notify_done (l4shmc_ringbuf_t *buf)

  Notify producer that space is available.
- int l4shmc_rb_receiver_read_next_size (l4shmc_ringbuf_head_t *head)

  Have a look at the ring buffer and see which size the next packet to be read has.

16.418.1 Function Documentation

16.418.1.1 l4shmc_rb_attach_receiver()

```
void l4shmc_rb_attach_receiver (
            l4shmc_ringbuf_t * buf,
            l4_cap_idx_t owner)
```

Attach to receiver signal of a ring buffer.
Attach owner to the receiver-side signal of a ring buffer, which is triggered whenever new data has been produced. This is split from initialization, because you may not know the owner cap when initializing the buffer.

Parameters

buf	pointer to ring buffer struct
owner	owner thread

References L4_CV.

16.418.1.2 l4shmc_rb_attach_sender()

```
int l4shmc_rb_attach_sender (
             l4shmc_ringbuf_t * buf,
             char const * signal_name,
             l4_cap_idx_t owner)
```

Attach to sender signal of a ring buffer.
Attach owner to the sender-side signal of a ring buffer, which is triggered whenever new space has been freed in the buffer for the sender to write to.
This is split from initialization, because you may not know the owner cap when initializing the buffer.

Parameters

buf	pointer to ring buffer struct
signal_name	signal base name
owner	owner thread

Returns

0 on success, error otherwise

References L4_CV.

16.418.1.3 l4shmc_rb_deinit_buffer()

```
void l4shmc_rb_deinit_buffer (
             l4shmc_ringbuf_t * buf)
```

De-init a ring buffer.

Parameters

buf	pointer to ring buffer struct

References L4_CV.

16.418.1.4 l4shmc_rb_init_buffer()

```
int l4shmc_rb_init_buffer (
             l4shmc_ringbuf_t * buf,
             l4shmc_area_t * area,
             char const * chunk_name,
             char const * signal_name,
             unsigned size)
```

Initialize a ring buffer by creating an SHMC chunk and the corresponding signals.
This needs to be done by one of the participating parties when setting up communication channel.

Precondition

area has been attached using l4shmc_attach().

Parameters

buf	pointer to ring buffer struct
area	pointer to SHMC area
chunk_name	name of SHMC chunk to create in area

signal_name	base name for SHMC signals to create
size	chunk size

Returns

0 on success, error otherwise

References L4_CV.

16.418.1.5 l4shmc_rb_init_receiver()

```
int l4shmc_rb_init_receiver (
              l4shmc_ringbuf_t * buf,
              l4shmc_area_t * area,
              char const * chunk_name,
              char const * signal_name)
```

Initialize receive buffer.

Initialize the receiver-side of a ring buffer. This requires the underlying SHMC chunk and the corresponding signals to be valid already (read: to be initialized by the sender).

Precondition

chunk & signals have been created and initialized by the sender side

Parameters

buf	pointer to ring buffer struct
area	pointer to SHMC area
chunk_name	name of SHMC chunk to create in area
signal_name	base name for SHMC signals to create

Returns

0 on success, error otherwise

References L4_CV.

16.418.1.6 l4shmc_rb_receiver_copy_out()

```
int l4shmc_rb_receiver_copy_out (
              l4shmc_ringbuf_head_t * head,
              char * target,
              unsigned * tsize)
```

Copy data out of the buffer.

Parameters

	head	ring buffer head pointer
	target	valid target buffer
in, out	*tsize*	size of target buffer (must be >= packet size!); contains the real data size

Returns

0 on success, negative error otherwise

References L4_CV.

16.418.1.7 l4shmc_rb_receiver_notify_done()

```
void l4shmc_rb_receiver_notify_done (
            l4shmc_ringbuf_t * buf)
```

Notify producer that space is available.

Parameters

buf	pointer to ring buffer struct

References L4_CV.

16.418.1.8 l4shmc_rb_receiver_read_next_size()

```
int l4shmc_rb_receiver_read_next_size (
            l4shmc_ringbuf_head_t * head)
```

Have a look at the ring buffer and see which size the next packet to be read has.
Does not modify anything.

Returns

size of next buffer or -1 if no data available

References L4_CV, and L4_END_DECLS.

16.418.1.9 l4shmc_rb_receiver_wait_for_data()

```
int l4shmc_rb_receiver_wait_for_data (
            l4shmc_ringbuf_t * buf,
            int blocking)
```

Check if (and optionally block until) new data is ready.

Parameters

buf	pointer to ring buffer struct
blocking	block if data is not available immediately

Returns immediately, if data is available.

Returns

0 success, data available, != 0 otherwise

References L4_CV.

16.418.1.10 l4shmc_rb_sender_alloc_packet()

```
char * l4shmc_rb_sender_alloc_packet (
            l4shmc_ringbuf_head_t * head,
            unsigned psize)
```

Allocate a packet of a given size within the ring buffer.
This packet may wrap around at the end of the buffer. Users need to be aware of that.

Parameters

head	ring buffer head pointer
psize	packet size

Returns

valid address on success

Return values

NULL	if not enough space available

References L4_CV.

16.418.1.11 l4shmc_rb_sender_commit_packet()

```
void l4shmc_rb_sender_commit_packet (
             l4shmc_ringbuf_t * buf)
```

Tell the consumer that new data is available.

Parameters

buf	pointer to ring buffer struct

References L4_CV.

16.418.1.12 l4shmc_rb_sender_next_copy_in()

```
int l4shmc_rb_sender_next_copy_in (
             l4shmc_ringbuf_t * buf,
             char * data,
             unsigned size,
             int block_if_necessary)
```

Copy in packet from an external data source.
This is the function you'll want to use. Just pass it a buffer pointer and let the lib do the work.

Parameters

buf	pointer to ring buffer struct
data	valid buffer
size	data size
block_if_necessary	bool: block if buffer currently full

Return values

0	on success
-L4_ENOMEM	if block == false and no space available

References L4_CV.

16.418.1.13 l4shmc_rb_sender_put_data()

```
void l4shmc_rb_sender_put_data (
             l4shmc_ringbuf_t * buf,
             char * addr,
             char * data,
             unsigned dsize)
```

Copy data into a previously allocated packet.
This function is wrap-around aware.

Parameters

buf	pointer to ring buffer struct
addr	valid destination (allocate with alloc_packet())
data	data source
dsize	data size

References L4_CV.

16.419 ringbuf.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2010 Björn Döbel <doebel@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  * This file is part of TUD:OS and distributed under the terms of the
00005  * GNU Lesser General Public License 2.1.
00006  * Please see the COPYING-LGPL-2.1 file for details.
00007  */
00008
00012 #pragma once
00013
00014 #include <l4/shmc/shmc.h>
00015 #include <l4/util/assert.h>
00016 #include <l4/sys/compiler.h>
00017 #include <l4/sys/thread.h>
00018
00019 L4_BEGIN_DECLS
00020
00035
00046
00047 /*
00048  * Turn on ringbuf poisoning. This will add magic values to the ringbuf
00049  * header as well as each packet header and check that these values are
00050  * valid all the time.
00051  */
00052 #define L4SHMC_RINGBUF_POISONING 1
00053
00059 typedef struct
00060 {
00061   volatile l4_uint32_t lock;
00062   unsigned data_size;
00063 #if L4SHMC_RINGBUF_POISONING
00064   char     magic1;
00065 #endif
00066   unsigned next_read;
00067   unsigned next_write;
00068 #if L4SHMC_RINGBUF_POISONING
00069   char     magic2;
00070 #endif
00071   unsigned bytes_filled;
00072   unsigned sender_waits;
00073 #if L4SHMC_RINGBUF_POISONING
00074   char     magic3;
00075 #endif
00076   char data[];
00077 } l4shmc_ringbuf_head_t;
00078
00079
00085 typedef struct
00086 {
00087   l4shmc_area_t   *_area;
00088   l4_cap_idx_t     _owner;
00089   l4shmc_chunk_t   _chunk;
00090   unsigned         _size;
00091   char            *_chunkname;
00092   char            *_signame;
00093   l4shmc_ringbuf_head_t  *_addr;
00094   l4shmc_signal_t  _signal_full;
00095   l4shmc_signal_t  _signal_empty;
00096 } l4shmc_ringbuf_t;
00097
00098
```

```
00105 #define L4SHMC_RINGBUF_HEAD(ringbuf)       ((l4shmc_ringbuf_head_t*)((ringbuf)->_addr))
00106
00107
00114 #define L4SHMC_RINGBUF_DATA(ringbuf)       (L4SHMC_RINGBUF_HEAD(ringbuf)->data)
00115
00116
00123 #define L4SHMC_RINGBUF_DATA_SIZE(ringbuf)  ((ringbuf)->_size - sizeof(l4shmc_ringbuf_head_t))
00124
00125 enum lock_content
00126 {
00127   lock_cont_min = 4,
00128   locked        = 5,
00129   unlocked      = 6,
00130   lock_cont_max = 7,
00131 };
00132
00133 static L4_CV inline void l4shmc_rb_lock(l4shmc_ringbuf_head_t *head)
00134 {
00135   ASSERT_NOT_NULL(head);
00136   ASSERT_ASSERT(head->lock > lock_cont_min);
00137   ASSERT_ASSERT(head->lock < lock_cont_max);
00138
00139   while (!l4util_cmpxchg32(&head->lock, unlocked, locked))
00140     l4_thread_yield();
00141 }
00142
00143
00144 static L4_CV inline void l4shmc_rb_unlock(l4shmc_ringbuf_head_t *head)
00145 {
00146   ASSERT_NOT_NULL(head);
00147   ASSERT_ASSERT(head->lock > lock_cont_min);
00148   ASSERT_ASSERT(head->lock < lock_cont_max);
00149
00150   head->lock = unlocked;
00151 }
00152
00153 /******************
00154  * Initialization *
00155  ******************/
00156
00173 L4_CV int  l4shmc_rb_init_buffer(l4shmc_ringbuf_t *buf, l4shmc_area_t *area,
00174                                  char const *chunk_name,
00175                                  char const *signal_name, unsigned size);
00176
00182 L4_CV void l4shmc_rb_deinit_buffer(l4shmc_ringbuf_t *buf);
00183
00184
00185
00186 /***************************
00187  *    RINGBUF SENDER       *
00188  ***************************/
00189
00206 L4_CV int l4shmc_rb_attach_sender(l4shmc_ringbuf_t *buf, char const *signal_name,
00207                                   l4_cap_idx_t owner);
00208
00209
00222 L4_CV char *l4shmc_rb_sender_alloc_packet(l4shmc_ringbuf_head_t *head,
00223                                          unsigned psize);
00224
00225
00236 L4_CV void l4shmc_rb_sender_put_data(l4shmc_ringbuf_t *buf, char *addr,
00237                                     char *data, unsigned dsize);
00238
00239
00254 L4_CV int  l4shmc_rb_sender_next_copy_in(l4shmc_ringbuf_t *buf, char *data,
00255                                          unsigned size, int block_if_necessary);
00256
00257
00263 L4_CV void l4shmc_rb_sender_commit_packet(l4shmc_ringbuf_t *buf);
00264
00265
00266 /***************************
00267  *    RINGBUF RECEIVER     *
00268  ***************************/
00269
00286 L4_CV int  l4shmc_rb_init_receiver(l4shmc_ringbuf_t *buf, l4shmc_area_t *area,
00287                                    char const *chunk_name,
00288                                    char const *signal_name);
00289
00290
00303 L4_CV void l4shmc_rb_attach_receiver(l4shmc_ringbuf_t *buf, l4_cap_idx_t owner);
00304
00305
00316 L4_CV int l4shmc_rb_receiver_wait_for_data(l4shmc_ringbuf_t *buf, int blocking);
00317
00318
00328 L4_CV int  l4shmc_rb_receiver_copy_out(l4shmc_ringbuf_head_t *head, char *target,
```

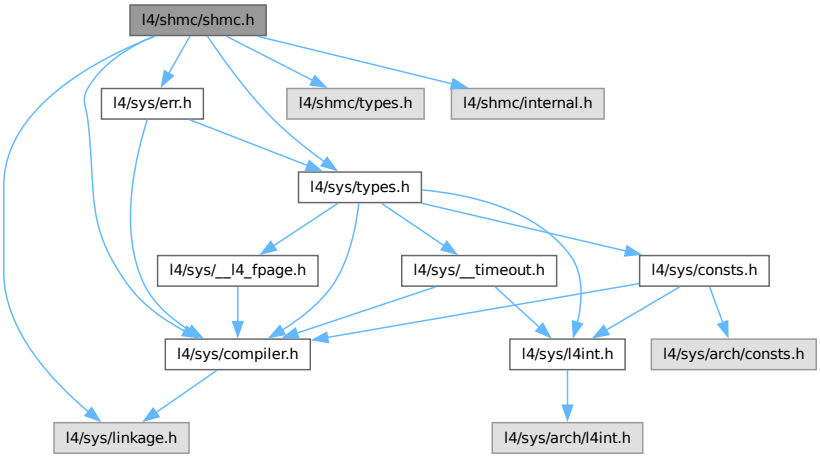
```
00329                                       unsigned *tsize);
00330
00331
00337 L4_CV void l4shmc_rb_receiver_notify_done(l4shmc_ringbuf_t *buf);
00338
00339
00346 L4_CV int l4shmc_rb_receiver_read_next_size(l4shmc_ringbuf_head_t *head);
00347
00348 L4_END_DECLS
```

16.420 l4/shmc/shmc.h File Reference

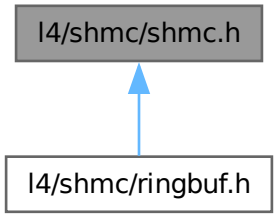
Shared memory library header file.

```
#include <l4/sys/compiler.h>
#include <l4/sys/linkage.h>
#include <l4/sys/types.h>
#include <l4/sys/err.h>
#include <l4/shmc/types.h>
#include <l4/shmc/internal.h>
```

Include dependency graph for shmc.h:



This graph shows which files directly or indirectly include this file:



Functions

- L4_BEGIN_DECLS long l4shmc_create (char const *shmc_name)

Create a shared memory area.

- long l4shmc_attach (char const *shmc_name, l4shmc_area_t *shmarea)

  Attach to a shared memory area.
- long l4shmc_get_client_nr (l4shmc_area_t const *shmarea)

  Determine the client number of the shared memory region.
- long l4shmc_mark_client_initialized (l4shmc_area_t *shmarea)

  Mark this shared memory client as 'initialized'.
- long l4shmc_get_initialized_clients (l4shmc_area_t *shmarea, l4_umword_t *bitmask)

  Fetch the `_clients_init_done` bitmask of the shared memory area.
- long l4shmc_add_chunk (l4shmc_area_t *shmarea, char const *chunk_name, l4_umword_t chunk_capacity, l4shmc_chunk_t *chunk)

  Add a chunk in the shared memory area.
- long l4shmc_add_signal (l4shmc_area_t *shmarea, char const *signal_name, l4shmc_signal_t *signal)

  Add a signal for the shared memory area.
- long l4shmc_trigger (l4shmc_signal_t *signal)

  Trigger a signal.
- long l4shmc_chunk_try_to_take (l4shmc_chunk_t *chunk)

  Try to mark chunk busy.
- long l4shmc_chunk_try_to_take_for_writing (l4shmc_chunk_t *chunk)

  Try to mark chunk busy writing.
- long l4shmc_chunk_try_to_take_for_overwriting (l4shmc_chunk_t *chunk)

  Try to mark the chunk busy writing after it was ready for reading.
- long l4shmc_chunk_try_to_take_for_reading (l4shmc_chunk_t *chunk)

  Try to mark chunk busy reading.
- long l4shmc_chunk_ready (l4shmc_chunk_t *chunk, l4_umword_t size)

  Mark chunk as filled (ready).
- long l4shmc_chunk_ready_sig (l4shmc_chunk_t *chunk, l4_umword_t size)

  Mark chunk as filled (ready) and signal consumer.
- long l4shmc_get_chunk (l4shmc_area_t *shmarea, char const *chunk_name, l4shmc_chunk_t *chunk)

  Get chunk out of shared memory area.
- long l4shmc_get_chunk_to (l4shmc_area_t *shmarea, char const *chunk_name, l4_umword_t timeout_ms, l4shmc_chunk_t *chunk)

  Get chunk out of shared memory area, with timeout.
- long l4shmc_iterate_chunk (l4shmc_area_t const *shmarea, char const **chunk_name, long offs)

  Iterate over names of all existing chunks.
- long l4shmc_attach_signal (l4shmc_area_t *shmarea, char const *signal_name, l4_cap_idx_t thread, l4shmc_signal_t *signal)

  Attach to signal.
- long l4shmc_get_signal (l4shmc_area_t *shmarea, char const *signal_name, l4shmc_signal_t *signal)

  Get signal object from the shared memory area.
- long l4shmc_enable_signal (l4shmc_signal_t *signal)

  Enable a signal.
- long l4shmc_enable_chunk (l4shmc_chunk_t *chunk)

  Enable a signal connected with a chunk.
- long l4shmc_wait_any (l4shmc_signal_t **retsignal)

  Wait on any signal.
- long l4shmc_wait_any_try (l4shmc_signal_t **retsignal)

  Check whether any waited signal has an event pending.
- long l4shmc_wait_any_to (l4_timeout_t timeout, l4shmc_signal_t **retsignal)

  Wait for any signal with timeout.
- long l4shmc_wait_signal (l4shmc_signal_t *signal)

Wait on a specific signal.

- long l4shmc_wait_signal_to (l4shmc_signal_t *signal, l4_timeout_t timeout)

  Wait on a specific signal, with timeout.
- long l4shmc_wait_signal_try (l4shmc_signal_t *signal)

  Check whether a specific signal has an event pending.
- long l4shmc_wait_chunk (l4shmc_chunk_t *chunk)

  Wait on a specific chunk.
- long l4shmc_wait_chunk_to (l4shmc_chunk_t *chunk, l4_timeout_t timeout)

  Check whether a specific chunk has an event pending, with timeout.
- long l4shmc_wait_chunk_try (l4shmc_chunk_t *chunk)

  Check whether a specific chunk has an event pending.
- long l4shmc_chunk_consumed (l4shmc_chunk_t *chunk)

  Mark a chunk as free.
- long l4shmc_connect_chunk_signal (l4shmc_chunk_t *chunk, l4shmc_signal_t *signal)

  Connect a signal with a chunk.
- long l4shmc_is_chunk_ready (l4shmc_chunk_t const *chunk)

  Check whether data is available.
- long l4shmc_is_chunk_clear (l4shmc_chunk_t const *chunk)

  Check whether chunk is free.
- void * l4shmc_chunk_ptr (l4shmc_chunk_t const *chunk)

  Get data pointer to chunk.
- long l4shmc_chunk_size (l4shmc_chunk_t const *chunk)

  Get current size of a chunk.
- long l4shmc_chunk_capacity (l4shmc_chunk_t const *chunk)

  Get capacity of a chunk.
- l4shmc_signal_t * l4shmc_chunk_signal (l4shmc_chunk_t const *chunk)

  Get the registered signal of a chunk.
- l4_cap_idx_t l4shmc_signal_cap (l4shmc_signal_t const *signal)

  Get the signal capability of a signal.
- long l4shmc_check_magic (l4shmc_chunk_t const *chunk)

  Check magic value of a chunk.
- long l4shmc_area_size (l4shmc_area_t const *shmarea)

  Get size of shared memory area.
- long l4shmc_area_size_free (l4shmc_area_t const *shmarea)

  Get free size of shared memory area.
- long l4shmc_area_overhead (void)

  Get memory overhead per area that is not available for chunks.
- long l4shmc_chunk_overhead (void)

  Get memory overhead required in addition to the chunk capacity for adding one chunk.

16.420.1 Detailed Description

Shared memory library header file.
Definition in file shmc.h.

16.421 shmc.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * This file is part of TUD:OS and distributed under the terms of the
00010  * GNU Lesser General Public License 2.1.
00011  * Please see the COPYING-LGPL-2.1 file for details.
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/compiler.h>
00016 #include <l4/sys/linkage.h>
00017 #include <l4/sys/types.h>
00018 #include <l4/sys/err.h>
00019
00069
00070 #define __INCLUDED_FROM_L4SHMC_H__
00071 #include <l4/shmc/types.h>
00072
00073 L4_BEGIN_DECLS
00074
00087 L4_CV long
00088 l4shmc_create(char const *shmc_name);
00089
00111 L4_CV long
00112 l4shmc_attach(char const *shmc_name, l4shmc_area_t *shmarea);
00113
00122 L4_CV long
00123 l4shmc_get_client_nr(l4shmc_area_t const *shmarea);
00124
00137 L4_CV long
00138 l4shmc_mark_client_initialized(l4shmc_area_t *shmarea);
00139
00152 L4_CV long
00153 l4shmc_get_initialized_clients(l4shmc_area_t *shmarea, l4_umword_t *bitmask);
00154
00167 L4_CV long
00168 l4shmc_add_chunk(l4shmc_area_t *shmarea, char const *chunk_name,
00169                  l4_umword_t chunk_capacity, l4shmc_chunk_t *chunk);
00170
00182 L4_CV long
00183 l4shmc_add_signal(l4shmc_area_t *shmarea, char const *signal_name,
00184                   l4shmc_signal_t *signal);
00185
00195 L4_CV L4_INLINE long
00196 l4shmc_trigger(l4shmc_signal_t *signal);
00197
00207 L4_CV L4_INLINE long
00208 l4shmc_chunk_try_to_take(l4shmc_chunk_t *chunk);
00209
00221 L4_CV L4_INLINE long
00222 l4shmc_chunk_try_to_take_for_writing(l4shmc_chunk_t *chunk);
00223
00238 L4_CV L4_INLINE long
00239 l4shmc_chunk_try_to_take_for_overwriting(l4shmc_chunk_t *chunk);
00240
00250 L4_CV L4_INLINE long
00251 l4shmc_chunk_try_to_take_for_reading(l4shmc_chunk_t *chunk);
00252
00263 L4_CV L4_INLINE long
00264 l4shmc_chunk_ready(l4shmc_chunk_t *chunk, l4_umword_t size);
00265
00276 L4_CV L4_INLINE long
00277 l4shmc_chunk_ready_sig(l4shmc_chunk_t *chunk, l4_umword_t size);
00278
00290 L4_CV L4_INLINE long
00291 l4shmc_get_chunk(l4shmc_area_t *shmarea, char const *chunk_name,
00292                  l4shmc_chunk_t *chunk);
00293
00307 L4_CV long
00308 l4shmc_get_chunk_to(l4shmc_area_t *shmarea, char const *chunk_name,
00309                     l4_umword_t timeout_ms, l4shmc_chunk_t *chunk);
00310
00324 L4_CV long
00325 l4shmc_iterate_chunk(l4shmc_area_t const *shmarea, char const **chunk_name,
00326                      long offs);
00327
00340 L4_CV long
00341 l4shmc_attach_signal(l4shmc_area_t *shmarea, char const *signal_name,
00342                      l4_cap_idx_t thread, l4shmc_signal_t *signal);
00343
00344
```

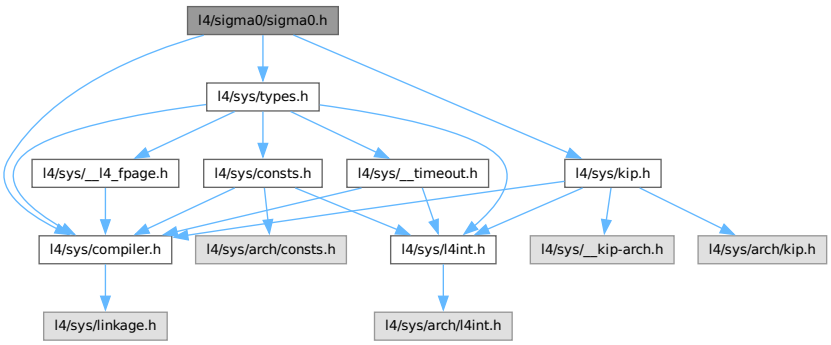
```
00356 L4_CV long
00357 l4shmc_get_signal(l4shmc_area_t *shmarea, char const *signal_name,
00358                   l4shmc_signal_t *signal);
00359
00373 L4_CV long
00374 l4shmc_enable_signal(l4shmc_signal_t *signal);
00375
00389 L4_CV long
00390 l4shmc_enable_chunk(l4shmc_chunk_t *chunk);
00391
00401 L4_CV L4_INLINE long
00402 l4shmc_wait_any(l4shmc_signal_t **retsignal);
00403
00417 L4_CV L4_INLINE long
00418 l4shmc_wait_any_try(l4shmc_signal_t **retsignal);
00419
00434 L4_CV long
00435 l4shmc_wait_any_to(l4_timeout_t timeout, l4shmc_signal_t **retsignal);
00436
00446 L4_CV L4_INLINE long
00447 l4shmc_wait_signal(l4shmc_signal_t *signal);
00448
00459 L4_CV long
00460 l4shmc_wait_signal_to(l4shmc_signal_t *signal, l4_timeout_t timeout);
00461
00475 L4_CV L4_INLINE long
00476 l4shmc_wait_signal_try(l4shmc_signal_t *signal);
00477
00487 L4_CV L4_INLINE long
00488 l4shmc_wait_chunk(l4shmc_chunk_t *chunk);
00489
00504 L4_CV long
00505 l4shmc_wait_chunk_to(l4shmc_chunk_t *chunk, l4_timeout_t timeout);
00506
00520 L4_CV L4_INLINE long
00521 l4shmc_wait_chunk_try(l4shmc_chunk_t *chunk);
00522
00532 L4_CV L4_INLINE long
00533 l4shmc_chunk_consumed(l4shmc_chunk_t *chunk);
00534
00545 L4_CV long
00546 l4shmc_connect_chunk_signal(l4shmc_chunk_t *chunk, l4shmc_signal_t *signal);
00547
00557 L4_CV L4_INLINE long
00558 l4shmc_is_chunk_ready(l4shmc_chunk_t const *chunk);
00559
00569 L4_CV L4_INLINE long
00570 l4shmc_is_chunk_clear(l4shmc_chunk_t const *chunk);
00571
00580 L4_CV L4_INLINE void *
00581 l4shmc_chunk_ptr(l4shmc_chunk_t const *chunk);
00582
00591 L4_CV L4_INLINE long
00592 l4shmc_chunk_size(l4shmc_chunk_t const *chunk);
00593
00602 L4_CV L4_INLINE long
00603 l4shmc_chunk_capacity(l4shmc_chunk_t const *chunk);
00604
00614 L4_CV L4_INLINE l4shmc_signal_t *
00615 l4shmc_chunk_signal(l4shmc_chunk_t const *chunk);
00616
00625 L4_CV L4_INLINE l4_cap_idx_t
00626 l4shmc_signal_cap(l4shmc_signal_t const *signal);
00627
00637 L4_CV L4_INLINE long
00638 l4shmc_check_magic(l4shmc_chunk_t const *chunk);
00639
00649 L4_CV long
00650 l4shmc_area_size(l4shmc_area_t const *shmarea);
00651
00661 L4_CV long
00662 l4shmc_area_size_free(l4shmc_area_t const *shmarea);
00663
00670 L4_CV long
00671 l4shmc_area_overhead(void);
00672
00680 L4_CV long
00681 l4shmc_chunk_overhead(void);
00682
00683 #include <l4/shmc/internal.h>
00684
00685 L4_END_DECLS
```

16.422 l4/sigma0/sigma0.h File Reference

Sigma0 interface.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/sys/kip.h>
```

Include dependency graph for sigma0.h:



Macros

- #define **SIGMA0_REQ_MAGIC** ~0xFFUL

  Request magic.
- #define **SIGMA0_REQ_MASK** ~0xFFUL

  Request mask.
- #define **SIGMA0_REQ_ID_MASK** 0xF0

  ID mask.
- #define **SIGMA0_REQ_ID_FPAGE_RAM** 0x60

  RAM.
- #define **SIGMA0_REQ_ID_FPAGE_IOMEM** 0x70

  I/O memory.
- #define **SIGMA0_REQ_ID_FPAGE_IOMEM_CACHED** 0x80

  Cached I/O memory.
- #define **SIGMA0_REQ_ID_FPAGE_ANY** 0x90

  Any.
- #define **SIGMA0_REQ_ID_KIP** 0xA0

  KIP.
- #define **SIGMA0_REQ_ID_DEBUG_DUMP** 0xC0

  Debug dump.
- #define **SIGMA0_REQ_ID_COV** 0xE0

  Trigger cov dump.
- #define **SIGMA0_IS_MAGIC_REQ**(d1)

  Check if magic.
- #define **SIGMA0_REQ**(x)

  Construct.
- #define **SIGMA0_REQ_FPAGE_RAM** (SIGMA0_REQ(FPAGE_RAM))

  RAM.
- #define **SIGMA0_REQ_FPAGE_IOMEM** (SIGMA0_REQ(FPAGE_IOMEM))

  I/O memory.

- #define **SIGMA0_REQ_FPAGE_IOMEM_CACHED** (SIGMA0_REQ(FPAGE_IOMEM_CACHED))

  Cache I/O memory.
- #define **SIGMA0_REQ_FPAGE_ANY** (SIGMA0_REQ(FPAGE_ANY))

  Any.
- #define **SIGMA0_REQ_KIP** (SIGMA0_REQ(KIP))

  KIP.
- #define **SIGMA0_REQ_DEBUG_DUMP** (SIGMA0_REQ(DEBUG_DUMP))

  Debug dump.
- #define **SIGMA0_REQ_COV** (SIGMA0_REQ(COV))

  Cov.

Enumerations

- enum l4sigma0_return_flags_t {
  L4SIGMA0_OK , L4SIGMA0_NOTALIGNED , L4SIGMA0_IPCERROR , L4SIGMA0_NOFPAGE ,
  L4SIGMA0_4 , **L4SIGMA0_5** , L4SIGMA0_SMALLERFPAGE }

  Return flags of libsigma0 functions.

Functions

- L4_BEGIN_DECLS l4_kernel_info_t ∗ l4sigma0_map_kip (l4_cap_idx_t sigma0, void ∗addr, unsigned log2↩
  _size)

  Map the kernel info page from sigma0 to addr.
- int l4sigma0_map_mem (l4_cap_idx_t sigma0, l4_addr_t phys, l4_addr_t virt, l4_addr_t size)

  Request a memory mapping from sigma0.
- int l4sigma0_map_iomem (l4_cap_idx_t sigma0, l4_addr_t phys, l4_addr_t virt, l4_addr_t size, int cached)

  Request IO memory from sigma0.
- int l4sigma0_map_anypage (l4_cap_idx_t sigma0, l4_addr_t map_area, unsigned log2_map_size, l4_addr_t ∗base, unsigned sz)

  Request an arbitrary free page of RAM.
- void l4sigma0_debug_dump (l4_cap_idx_t sigma0)

  Request sigma0 to dump internal debug information.
- char const ∗ l4sigma0_map_errstr (int err)

  Get user readable error messages for the return codes.

16.422.1 Detailed Description

Sigma0 interface.
Definition in file sigma0.h.

16.423 sigma0.h

Go to the documentation of this file.

```
00001
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef __L4_SIGMA0_SIGMA0_H
00015 #define __L4_SIGMA0_SIGMA0_H
00016
00024
00025 #include <l4/sys/compiler.h>
00026 #include <l4/sys/types.h>
00027 #include <l4/sys/kip.h>
00028
00035 #undef SIGMA0_REQ_MAGIC
```

```
00036 #undef SIGMA0_REQ_MASK
00037
00038 # define SIGMA0_REQ_MAGIC   ~0xFFUL
00039 # define SIGMA0_REQ_MASK    ~0xFFUL
00040
00041 /* Starting with 0x60 allows to detect components which still use the old
00042  * constants (0x00 ... 0x50) */
00043 #define SIGMA0_REQ_ID_MASK      0xF0
00044 #define SIGMA0_REQ_ID_FPAGE_RAM     0x60
00045 #define SIGMA0_REQ_ID_FPAGE_IOMEM   0x70
00046 #define SIGMA0_REQ_ID_FPAGE_IOMEM_CACHED  0x80
00047 #define SIGMA0_REQ_ID_FPAGE_ANY     0x90
00048 #define SIGMA0_REQ_ID_KIP     0xA0
00049 #define SIGMA0_REQ_ID_DEBUG_DUMP    0xC0
00050 #define SIGMA0_REQ_ID_COV     0xE0
00051
00052 #define SIGMA0_IS_MAGIC_REQ(d1) \
00053   ((d1 & SIGMA0_REQ_MASK) == SIGMA0_REQ_MAGIC)
00054
00055 #define SIGMA0_REQ(x) \
00056   (SIGMA0_REQ_MAGIC + SIGMA0_REQ_ID_ ## x)
00057
00058 /* Use these constants in your code! */
00059 #define SIGMA0_REQ_FPAGE_RAM            (SIGMA0_REQ(FPAGE_RAM))
00060 #define SIGMA0_REQ_FPAGE_IOMEM          (SIGMA0_REQ(FPAGE_IOMEM))
00061 #define SIGMA0_REQ_FPAGE_IOMEM_CACHED   (SIGMA0_REQ(FPAGE_IOMEM_CACHED))
00062 #define SIGMA0_REQ_FPAGE_ANY            (SIGMA0_REQ(FPAGE_ANY))
00063 #define SIGMA0_REQ_KIP                  (SIGMA0_REQ(KIP))
00064 #define SIGMA0_REQ_DEBUG_DUMP           (SIGMA0_REQ(DEBUG_DUMP))
00065 #define SIGMA0_REQ_COV                  (SIGMA0_REQ(COV))
00067
00072
00076 enum l4sigma0_return_flags_t {
00077   L4SIGMA0_OK,
00078   L4SIGMA0_NOTALIGNED,
00079   L4SIGMA0_IPCERROR,
00080   L4SIGMA0_NOFPAGE,
00081   L4SIGMA0_4,
00082   L4SIGMA0_5,
00083   L4SIGMA0_SMALLERFPAGE,
00084 };
00085
00086 L4_BEGIN_DECLS
00087
00100 L4_CV l4_kernel_info_t *
00101 l4sigma0_map_kip(l4_cap_idx_t sigma0, void *addr, unsigned log2_size);
00102
00132 L4_CV int l4sigma0_map_mem(l4_cap_idx_t sigma0,
00133                            l4_addr_t phys, l4_addr_t virt, l4_addr_t size);
00134
00157 L4_CV int l4sigma0_map_iomem(l4_cap_idx_t sigma0, l4_addr_t phys,
00158                              l4_addr_t virt, l4_addr_t size, int cached);
00183 L4_CV int l4sigma0_map_anypage(l4_cap_idx_t sigma0, l4_addr_t map_area,
00184                                unsigned log2_map_size, l4_addr_t *base,
00185                                unsigned sz);
00186
00195 L4_CV void l4sigma0_debug_dump(l4_cap_idx_t sigma0);
00196
00204 L4_INLINE char const *l4sigma0_map_errstr(int err);
00205
00206 L4_CV void l4sigma0_print_cov_data(l4_cap_idx_t pager);
00207
00209
00210
00211 /* Implementations */
00212
00213 L4_INLINE char const *l4sigma0_map_errstr(int err)
00214 {
00215   switch (err)
00216     {
00217     case  0: return "No error";
00218     case -1: return "Phys, virt or size not aligned";
00219     case -2: return "IPC error";
00220     case -3: return "No fpage received";
00221 #ifndef SIGMA0_REQ_MAGIC
00222     case -4: return "Bad physical address (old protocol only)";
00223 #endif
00224     case -6: return "Superpage requested but smaller flexpage received";
00225     case -7: return "Cannot map I/O memory cacheable (old protocol only)";
00226     default: return "Unknown error";
00227     }
00228 }
00229
00230
00231 L4_END_DECLS
00232
00233 #endif /* ! __L4_SIGMA0_SIGMA0_H */
```

16.424 __kernel_object_impl.h

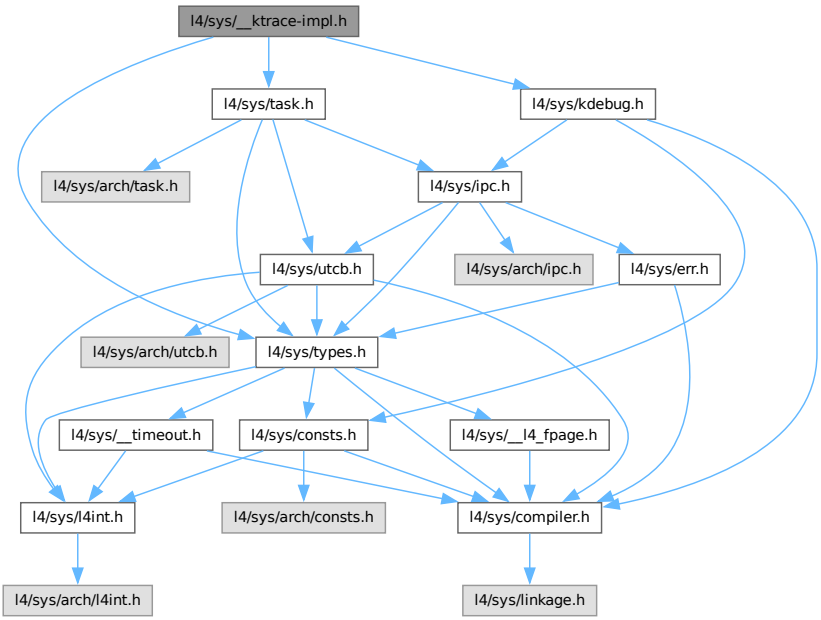
```
00001
00006 #pragma once
00007
00008 #include <l4/sys/ipc.h>
00009 #include <l4/sys/kdebug.h>
00010
00011 L4_INLINE l4_msgtag_t
00012 l4_invoke_debugger(l4_cap_idx_t obj, l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW
00013 {
00014   l4_msgtag_t t2;
00015   unsigned const words = l4_msgtag_words(tag);
00016   l4_msg_regs_t *mr = l4_utcb_mr_u(utcb);
00017
00018   if (l4_is_invalid_cap(obj))
00019     return l4_msgtag(-L4_EINVAL, 0, 0, 0);
00020
00021   if (words + 2 > L4_UTCB_GENERIC_DATA_SIZE)
00022     return l4_msgtag(-L4_EMSGTOOLONG, 0, 0, 0);
00023
00024   mr->mr[0] += L4_KDEBUG_GROUP_KOBJ;
00025   mr->mr[words]     = L4_ITEM_MAP;
00026   mr->mr[words + 1] = l4_obj_fpage(obj, 0, L4_CAP_FPAGE_RWS).raw;
00027   t2 = l4_msgtag(L4_PROTO_DEBUGGER, words, 1, l4_msgtag_flags(tag));
00028
00029   return l4_ipc_call(L4_BASE_DEBUGGER_CAP, utcb, t2, L4_IPC_NEVER);
00030 }
00031
```

16.425 l4/sys/__ktrace-impl.h File Reference

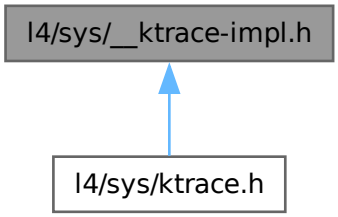
L4 kernel event tracing.

```
#include <l4/sys/types.h>
#include <l4/sys/kdebug.h>
#include <l4/sys/task.h>
```

Include dependency graph for __ktrace-impl.h:



This graph shows which files directly or indirectly include this file:



Functions

- l4_msgtag_t fiasco_tbuf_validate (void)

  Validate the kernel base debugger capability.
- l4_umword_t fiasco_tbuf_log (const char *text)

  Create new trace-buffer entry with describing <text>.
- l4_umword_t fiasco_tbuf_log_3val (const char *text, l4_umword_t v1, l4_umword_t v2, l4_umword_t v3)

  Create new trace-buffer entry with describing <text> and three additional values.
- void **fiasco_tbuf_clear** (void)

  Clear trace-buffer.
- void **fiasco_tbuf_dump** (void)

  Dump trace-buffer to kernel console.
- l4_umword_t fiasco_tbuf_log_binary (const unsigned char *data)

  Create new trace-buffer entry with binary data.
- l4_msgtag_t fiasco_tbuf_map_status (l4_fpage_t *ku_mem)

  Map kernel trace-buffer status page.
- l4_msgtag_t fiasco_tbuf_map_slots (l4_fpage_t *ku_mem)

  Map kernel trace-buffer slots.

16.425.1 Detailed Description

L4 kernel event tracing.
Definition in file __ktrace-impl.h.

16.426 __ktrace-impl.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/types.h>
00017 #include <l4/sys/kdebug.h>
00018 #include <l4/sys/task.h>
00019
00020 /*****************************************************************************
```

```
00021  *** Implementation
00022  ***************************************************************************/
00023
00024 L4_INLINE l4_msgtag_t
00025 fiasco_tbuf_validate(void)
00026 { return l4_task_cap_valid(L4_BASE_TASK_CAP, L4_BASE_DEBUGGER_CAP); }
00027
00028 L4_INLINE l4_umword_t
00029 fiasco_tbuf_log(const char *text)
00030 {
00031   enum { TBUF_LOG = L4_KDEBUG_GROUP_TRACE + 0x01 };
00032   return l4_error(__l4_kdebug_text(TBUF_LOG, text, __builtin_strlen(text)));
00033 }
00034
00035 L4_INLINE l4_umword_t
00036 fiasco_tbuf_log_3val(const char *text, l4_umword_t v1, l4_umword_t v2,
00037                      l4_umword_t v3)
00038 {
00039   enum { TBUF_LOG_3VAL = L4_KDEBUG_GROUP_TRACE + 0x04 };
00040   return l4_error(__l4_kdebug_3_text(TBUF_LOG_3VAL, text,
00041                                      __builtin_strlen(text), v1, v2, v3));
00042 }
00043
00044 L4_INLINE void
00045 fiasco_tbuf_clear(void)
00046 {
00047   enum { TBUF_CLEAR = L4_KDEBUG_GROUP_TRACE + 0x02 };
00048   __l4_kdebug_op(TBUF_CLEAR);
00049 }
00050
00051 L4_INLINE void
00052 fiasco_tbuf_dump(void)
00053 {
00054   enum { TBUF_DUMP = L4_KDEBUG_GROUP_TRACE + 0x03 };
00055   __l4_kdebug_op(TBUF_DUMP);
00056 }
00057
00058 L4_INLINE l4_umword_t
00059 fiasco_tbuf_log_binary(const unsigned char *data)
00060 {
00061   enum { TBUF_LOG_BIN = L4_KDEBUG_GROUP_TRACE + 0x08 };
00062   return l4_error(__l4_kdebug_text(TBUF_LOG_BIN, (const char *)data, 24));
00063 }
00064
00065 L4_INLINE l4_msgtag_t
00066 fiasco_tbuf_map_status(l4_fpage_t *ku_mem)
00067 {
00068   enum { TBUF_MAP_STATUS = L4_KDEBUG_GROUP_TRACE + 0x10 };
00069
00070   l4_utcb_t *utcb = l4_utcb();
00071   l4_msg_regs_t *mr = l4_utcb_mr_u(utcb);
00072   l4_msgtag_t ret;
00073
00074   mr->mr[0] = TBUF_MAP_STATUS;
00075   mr->mr[1] = ku_mem->raw;
00076   ret = l4_ipc_call(L4_BASE_DEBUGGER_CAP, utcb,
00077                     l4_msgtag(L4_PROTO_DEBUGGER, 2, 0, 0), L4_IPC_NEVER);
00078   if (!l4_msgtag_has_error(ret))
00079     ku_mem->raw = mr->mr[0];
00080
00081   return ret;
00082 }
00083
00084 L4_INLINE l4_msgtag_t
00085 fiasco_tbuf_map_slots(l4_fpage_t *ku_mem)
00086 {
00087   enum { TBUF_MAP_SLOTS = L4_KDEBUG_GROUP_TRACE + 0x11 };
00088
00089   l4_utcb_t *utcb = l4_utcb();
00090   l4_msg_regs_t *mr = l4_utcb_mr_u(utcb);
00091   l4_msgtag_t ret;
00092
00093   mr->mr[0] = TBUF_MAP_SLOTS;
00094   mr->mr[1] = ku_mem->raw;
00095   ret = l4_ipc_call(L4_BASE_DEBUGGER_CAP, utcb,
00096                     l4_msgtag(L4_PROTO_DEBUGGER, 2, 0, 0), L4_IPC_NEVER);
00097   if (!l4_msgtag_has_error(ret))
00098     ku_mem->raw = mr->mr[0];
00099
00100   return ret;
00101 }
```

16.427 __l4_fpage.h

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00010  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #pragma once
00016
00017 #include <l4/sys/compiler.h>
00018
00043
00048 enum L4_fpage_consts
00049 {
00050   L4_FPAGE_RIGHTS_SHIFT = 0,
00051   L4_FPAGE_TYPE_SHIFT   = 4,
00052   L4_FPAGE_SIZE_SHIFT   = 6,
00053   L4_FPAGE_ADDR_SHIFT   = 12,
00054
00055   L4_FPAGE_RIGHTS_BITS = 4,
00056   L4_FPAGE_TYPE_BITS   = 2,
00057   L4_FPAGE_SIZE_BITS   = 6,
00058   L4_FPAGE_ADDR_BITS   = L4_MWORD_BITS - L4_FPAGE_ADDR_SHIFT,
00059
00061   L4_FPAGE_RIGHTS_MASK  = ((1UL << L4_FPAGE_RIGHTS_BITS) - 1)
00062                           << L4_FPAGE_RIGHTS_SHIFT,
00063   L4_FPAGE_TYPE_MASK    = ((1UL << L4_FPAGE_TYPE_BITS)   - 1)
00064                           << L4_FPAGE_TYPE_SHIFT,
00065   L4_FPAGE_SIZE_MASK    = ((1UL << L4_FPAGE_SIZE_BITS)   - 1)
00066                           << L4_FPAGE_SIZE_SHIFT,
00067   L4_FPAGE_ADDR_MASK    = ~0UL << L4_FPAGE_ADDR_SHIFT,
00069   L4_FPAGE_RIGHTS_ALL   = L4_FPAGE_RIGHTS_MASK,
00070 };
00071
00076 typedef union {
00077   l4_umword_t fpage;
00078   l4_umword_t raw;
00079 } l4_fpage_t;
00080
00084 enum
00085 {
00092   L4_WHOLE_ADDRESS_SPACE = 63
00093 };
00094
00099 typedef struct {
00100   l4_umword_t snd_base;
00101   l4_fpage_t fpage;
00102 } l4_snd_fpage_t;
00103
00104
00118 enum L4_fpage_rights
00119 {
00120   L4_FPAGE_X     = 1,
00121   L4_FPAGE_W     = 2,
00122   L4_FPAGE_RO    = 4,
00123   L4_FPAGE_RW    = L4_FPAGE_RO | L4_FPAGE_W,
00124   L4_FPAGE_RX    = L4_FPAGE_RO | L4_FPAGE_X,
00125   L4_FPAGE_RWX   = L4_FPAGE_RW | L4_FPAGE_X,
00126 };
00127
00148 enum L4_cap_fpage_rights
00149 {
00157   L4_CAP_FPAGE_W     = 0x1,
00169   L4_CAP_FPAGE_S     = 0x2,
00175   L4_CAP_FPAGE_R     = 0x4,
00176   L4_CAP_FPAGE_RO    = 0x4,
00185   L4_CAP_FPAGE_D     = 0x8,
00192   L4_CAP_FPAGE_RW    = L4_CAP_FPAGE_R | L4_CAP_FPAGE_W,
00199   L4_CAP_FPAGE_RS    = L4_CAP_FPAGE_R | L4_CAP_FPAGE_S,
00206   L4_CAP_FPAGE_RWS   = L4_CAP_FPAGE_RW | L4_CAP_FPAGE_S,
00212   L4_CAP_FPAGE_RWSD  = L4_CAP_FPAGE_RWS | L4_CAP_FPAGE_D,
00218   L4_CAP_FPAGE_RWD   = L4_CAP_FPAGE_RW | L4_CAP_FPAGE_D,
00224   L4_CAP_FPAGE_RSD   = L4_CAP_FPAGE_RS | L4_CAP_FPAGE_D,
00225 };
00226
00230 enum L4_fpage_type
00231 {
00232   L4_FPAGE_SPECIAL = 0,
00235   L4_FPAGE_MEMORY  = 1,
00236   L4_FPAGE_IO      = 2,
00237   L4_FPAGE_OBJ     = 3,
```

```
00238 };
00239
00243 enum L4_fpage_control
00244 {
00247   L4_FPAGE_CONTROL_OFFSET_SHIFT = 12,
00250   L4_FPAGE_CONTROL_MASK = ~0UL « L4_FPAGE_CONTROL_OFFSET_SHIFT,
00251 };
00252
00264
00266 #define L4_FPAGE_C_REF_CNT      0x00
00267
00269 #define L4_FPAGE_C_NO_REF_CNT   0x10
00270
00272 #define L4_FPAGE_C_OBJ_RIGHT1   0x20
00273
00275 #define L4_FPAGE_C_OBJ_RIGHT2   0x40
00276
00278 #define L4_FPAGE_C_OBJ_RIGHT3   0x80
00279
00281 #define L4_FPAGE_C_OBJ_RIGHTS   0xe0
00282
00288 #define L4_FPAGE_C_IPCGATE_SVR L4_FPAGE_C_OBJ_RIGHT1
00289
00291
00292
00303 enum l4_fpage_cacheability_opt_t
00304 {
00307   L4_FPAGE_CACHE_OPT    = 0x1,
00308
00311   L4_FPAGE_CACHEABLE    = 0x3,
00312
00315   L4_FPAGE_BUFFERABLE   = 0x5,
00316
00319   L4_FPAGE_UNCACHEABLE = 0x1
00320 };
00321
00322
00326 enum
00327 {
00331   L4_WHOLE_IOADDRESS_SPACE  = 16,
00332
00334   L4_IOPORT_MAX             = (1L « L4_WHOLE_IOADDRESS_SPACE)
00335 };
00336
00337
00338
00353 L4_INLINE L4_CONSTEXPR l4_fpage_t
00354 l4_fpage(l4_addr_t address, unsigned int order, unsigned char rights) L4_NOTHROW;
00355
00367 L4_INLINE L4_CONSTEXPR l4_fpage_t
00368 l4_fpage_all(void) L4_NOTHROW;
00369
00376 L4_INLINE L4_CONSTEXPR l4_fpage_t
00377 l4_fpage_invalid(void) L4_NOTHROW;
00378
00379
00390 L4_INLINE L4_CONSTEXPR l4_fpage_t
00391 l4_iofpage(unsigned long port, unsigned int order) L4_NOTHROW;
00392
00393
00406 L4_INLINE L4_CONSTEXPR l4_fpage_t
00407 l4_obj_fpage(l4_cap_idx_t obj, unsigned int order, unsigned char rights) L4_NOTHROW;
00408
00418 L4_INLINE L4_CONSTEXPR int
00419 l4_is_fpage_writable(l4_fpage_t fp) L4_NOTHROW;
00420
00421
00452
00468 L4_INLINE L4_CONSTEXPR l4_umword_t
00469 l4_map_control(l4_umword_t spot, unsigned char cache, unsigned grant) L4_NOTHROW;
00470
00484 L4_INLINE L4_CONSTEXPR l4_umword_t
00485 l4_map_obj_control(l4_umword_t spot, unsigned grant) L4_NOTHROW;
00486
00495 L4_INLINE L4_CONSTEXPR unsigned
00496 l4_fpage_rights(l4_fpage_t f) L4_NOTHROW;
00497
00506 L4_INLINE L4_CONSTEXPR unsigned
00507 l4_fpage_type(l4_fpage_t f) L4_NOTHROW;
00508
00521 L4_INLINE L4_CONSTEXPR unsigned
00522 l4_fpage_size(l4_fpage_t f) L4_NOTHROW;
00523
00534 L4_INLINE L4_CONSTEXPR unsigned
00535 l4_fpage_order(l4_fpage_t f) L4_NOTHROW;
00536
00547 L4_INLINE L4_CONSTEXPR unsigned long
```

```
00548 l4_fpage_page(l4_fpage_t f) L4_NOTHROW;
00549
00563 L4_INLINE L4_CONSTEXPR l4_addr_t
00564 l4_fpage_memaddr(l4_fpage_t f) L4_NOTHROW;
00565
00579 L4_INLINE L4_CONSTEXPR l4_cap_idx_t
00580 l4_fpage_obj(l4_fpage_t f) L4_NOTHROW;
00581
00595 L4_INLINE L4_CONSTEXPR unsigned long
00596 l4_fpage_ioport(l4_fpage_t f) L4_NOTHROW;
00597
00607 L4_INLINE L4_CONSTEXPR l4_fpage_t
00608 l4_fpage_set_rights(l4_fpage_t src, unsigned char new_rights) L4_NOTHROW;
00609
00621 L4_INLINE L4_CONSTEXPR int
00622 l4_fpage_contains(l4_fpage_t fpage, l4_addr_t addr, unsigned order) L4_NOTHROW;
00623
00640 L4_INLINE L4_CONSTEXPR unsigned char
00641 l4_fpage_max_order(unsigned char order, l4_addr_t addr,
00642                    l4_addr_t min_addr, l4_addr_t max_addr,
00643                    l4_addr_t hotspot L4_DEFAULT_PARAM(0));
00644
00654 L4_INLINE L4_CONSTEXPR int
00655 l4_is_fpage_valid(l4_fpage_t fp) L4_NOTHROW;
00656
00657 /*****************************************************************************
00658  * Implementations
00659  *****************************************************************************/
00660
00661 L4_INLINE L4_CONSTEXPR unsigned
00662 l4_fpage_rights(l4_fpage_t f) L4_NOTHROW
00663 {
00664   return (f.raw & L4_FPAGE_RIGHTS_MASK) » L4_FPAGE_RIGHTS_SHIFT;
00665 }
00666
00667 L4_INLINE L4_CONSTEXPR unsigned
00668 l4_fpage_type(l4_fpage_t f) L4_NOTHROW
00669 {
00670   return (f.raw & L4_FPAGE_TYPE_MASK) » L4_FPAGE_TYPE_SHIFT;
00671 }
00672
00673 L4_INLINE L4_CONSTEXPR unsigned
00674 l4_fpage_size(l4_fpage_t f) L4_NOTHROW
00675 {
00676   return (f.raw & L4_FPAGE_SIZE_MASK) » L4_FPAGE_SIZE_SHIFT;
00677 }
00678
00679 L4_INLINE L4_CONSTEXPR unsigned
00680 l4_fpage_order(l4_fpage_t f) L4_NOTHROW
00681 {
00682   return (f.raw & L4_FPAGE_SIZE_MASK) » L4_FPAGE_SIZE_SHIFT;
00683 }
00684
00685 L4_INLINE L4_CONSTEXPR unsigned long
00686 l4_fpage_page(l4_fpage_t f) L4_NOTHROW
00687 {
00688   return (f.raw & L4_FPAGE_ADDR_MASK) » L4_FPAGE_ADDR_SHIFT;
00689 }
00690
00691 L4_INLINE L4_CONSTEXPR unsigned long
00692 l4_fpage_ioport(l4_fpage_t f) L4_NOTHROW
00693 {
00694   return (f.raw & L4_FPAGE_ADDR_MASK) » L4_FPAGE_ADDR_SHIFT;
00695 }
00696
00697 L4_INLINE L4_CONSTEXPR l4_addr_t
00698 l4_fpage_memaddr(l4_fpage_t f) L4_NOTHROW
00699 {
00700   return f.raw & L4_FPAGE_ADDR_MASK;
00701 }
00702
00703 L4_INLINE L4_CONSTEXPR l4_cap_idx_t
00704 l4_fpage_obj(l4_fpage_t f) L4_NOTHROW
00705 {
00706   return f.raw & L4_FPAGE_ADDR_MASK;
00707 }
00708
00710 L4_INLINE L4_CONSTEXPR l4_fpage_t
00711 __l4_fpage_generic(unsigned long address, unsigned int type,
00712                    unsigned int order, unsigned char rights) L4_NOTHROW;
00713
00714 L4_INLINE L4_CONSTEXPR l4_fpage_t
00715 __l4_fpage_generic(unsigned long address, unsigned int type,
00716                    unsigned int order, unsigned char rights) L4_NOTHROW
00717 {
00718   l4_fpage_t t =
00719     {
```

```
00720             ((rights  « L4_FPAGE_RIGHTS_SHIFT) & L4_FPAGE_RIGHTS_MASK)
00721           | ((type    « L4_FPAGE_TYPE_SHIFT)   & L4_FPAGE_TYPE_MASK)
00722     | ((order   « L4_FPAGE_SIZE_SHIFT)   & L4_FPAGE_SIZE_MASK)
00723     | ((address                        )   & L4_FPAGE_ADDR_MASK)
00724     };
00725   return t;
00726 }
00727
00728 L4_INLINE L4_CONSTEXPR l4_fpage_t
00729 l4_fpage_set_rights(l4_fpage_t src, unsigned char new_rights) L4_NOTHROW
00730 {
00731   l4_fpage_t f =
00732     {
00733       ((L4_FPAGE_TYPE_MASK | L4_FPAGE_SIZE_MASK | L4_FPAGE_ADDR_MASK) & src.raw)
00734       | ((new_rights « L4_FPAGE_RIGHTS_SHIFT) & L4_FPAGE_RIGHTS_MASK)
00735     };
00736   return f;
00737 }
00738
00739 L4_INLINE L4_CONSTEXPR l4_fpage_t
00740 l4_fpage(l4_addr_t address, unsigned int order, unsigned char rights) L4_NOTHROW
00741 {
00742   return __l4_fpage_generic(address, L4_FPAGE_MEMORY, order, rights);
00743 }
00744
00745 L4_INLINE L4_CONSTEXPR l4_fpage_t
00746 l4_iofpage(unsigned long port, unsigned int order) L4_NOTHROW
00747 {
00748   return __l4_fpage_generic(port « L4_FPAGE_ADDR_SHIFT, L4_FPAGE_IO, order, L4_FPAGE_RW);
00749 }
00750
00751 L4_INLINE L4_CONSTEXPR l4_fpage_t
00752 l4_obj_fpage(l4_cap_idx_t obj, unsigned int order, unsigned char rights) L4_NOTHROW
00753 {
00754   static_assert((unsigned long)L4_CAP_SHIFT >= L4_FPAGE_ADDR_SHIFT,
00755                 "Capability index does not fit into fpage.");
00756   return __l4_fpage_generic(obj, L4_FPAGE_OBJ, order, rights);
00757 }
00758
00759 L4_INLINE L4_CONSTEXPR l4_fpage_t
00760 l4_fpage_all(void) L4_NOTHROW
00761 {
00762   return __l4_fpage_generic(0, L4_FPAGE_SPECIAL, L4_WHOLE_ADDRESS_SPACE, 0);
00763 }
00764
00765 L4_INLINE L4_CONSTEXPR l4_fpage_t
00766 l4_fpage_invalid(void) L4_NOTHROW
00767 {
00768   return __l4_fpage_generic(0, L4_FPAGE_SPECIAL, 0, 0);
00769 }
00770
00771
00772 L4_INLINE L4_CONSTEXPR int
00773 l4_is_fpage_writable(l4_fpage_t fp) L4_NOTHROW
00774 {
00775   return l4_fpage_rights(fp) & L4_FPAGE_W;
00776 }
00777
00778 L4_INLINE L4_CONSTEXPR l4_umword_t
00779 l4_map_control(l4_umword_t snd_base, unsigned char cache, unsigned grant) L4_NOTHROW
00780 {
00781   return (snd_base & L4_FPAGE_CONTROL_MASK)
00782          | ((l4_umword_t)cache « 4) | L4_ITEM_MAP | grant;
00783 }
00784
00785 L4_INLINE L4_CONSTEXPR l4_umword_t
00786 l4_map_obj_control(l4_umword_t snd_base, unsigned grant) L4_NOTHROW
00787 {
00788   return l4_map_control(snd_base, 0, grant);
00789 }
00790
00791 L4_INLINE L4_CONSTEXPR int
00792 l4_fpage_contains(l4_fpage_t fpage, l4_addr_t addr, unsigned log2size) L4_NOTHROW
00793 {
00794   l4_addr_t fa = l4_fpage_memaddr(fpage);
00795   return (fa <= addr)
00796          && (fa + (1UL « l4_fpage_order(fpage)) >= addr + (1UL « log2size));
00797 }
00798
00799 L4_INLINE L4_CONSTEXPR unsigned char
00800 l4_fpage_max_order(unsigned char order, l4_addr_t addr,
00801                    l4_addr_t min_addr, l4_addr_t max_addr,
00802                    l4_addr_t hotspot)
00803 {
00804   while (order < 30 /* limit to 1GB flexpages */)
00805     {
00806       l4_addr_t mask = ~(~0UL « (order + 1));
```

```
00807       l4_addr_t base = l4_trunc_size(addr, order + 1);
00808       if (base < min_addr)
00809         return order;
00810
00811       if (base + (1UL << (order + 1)) - 1 > max_addr - 1)
00812         return order;
00813
00814       if (hotspot == ~0UL || ((addr ^ hotspot) & mask))
00815         break;
00816
00817       ++order;
00818     }
00819
00820   return order;
00821 }
00822
00823 L4_INLINE L4_CONSTEXPR int
00824 l4_is_fpage_valid(l4_fpage_t fp) L4_NOTHROW
00825 {
00826   return l4_fpage_type(fp) != L4_FPAGE_SPECIAL || l4_fpage_order(fp) != 0;
00827 }
```

16.428 __platform_control-arm.h

```
00001 /*
00002  * Copyright (C) 2024 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/types.h>
00010
00011
00029 L4_INLINE l4_msgtag_t
00030 l4_platform_ctl_set_task_asid(l4_cap_idx_t pfc,
00031                               l4_cap_idx_t task,
00032                               l4_umword_t asid) L4_NOTHROW;
00033
00034
00038 L4_INLINE l4_msgtag_t
00039 l4_platform_ctl_set_task_asid_u(l4_cap_idx_t pfc,
00040                                 l4_cap_idx_t task,
00041                                 l4_umword_t asid,
00042                                 l4_utcb_t *utcb) L4_NOTHROW;
00043
00044 /* IMPLEMENTATION ----------------------------------------------------------*/
00045
00046 L4_INLINE l4_msgtag_t
00047 l4_platform_ctl_set_task_asid_u(l4_cap_idx_t pfc,
00048                                 l4_cap_idx_t task,
00049                                 l4_umword_t asid,
00050                                 l4_utcb_t *utcb) L4_NOTHROW
00051 {
00052   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00053   v->mr[0] = L4_PLATFORM_CTL_SET_TASK_ASID_OP;
00054   v->mr[1] = asid;
00055   v->mr[2] = l4_map_obj_control(0,0);
00056   v->mr[3] = l4_obj_fpage(task, 0, L4_CAP_FPAGE_RWS).raw;
00057   return l4_ipc_call(pfc, utcb, l4_msgtag(L4_PROTO_PLATFORM_CTL, 2, 1, 0),
00058                      L4_IPC_NEVER);
00059 }
00060
00061 L4_INLINE l4_msgtag_t
00062 l4_platform_ctl_set_task_asid(l4_cap_idx_t pfc,
00063                               l4_cap_idx_t task,
00064                               l4_umword_t asid) L4_NOTHROW
00065 {
00066   return l4_platform_ctl_set_task_asid_u(pfc, task, asid, l4_utcb());
00067 }
```

16.429 __task-arm.h

```
00001 /*
00002  * (c) 2018 Adam Lackorzynski <adam@l4re.org>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
```

```
00008 #include <l4/sys/types.h>
00009
00013 L4_INLINE l4_msgtag_t
00014 l4_task_vgicc_map_u(l4_cap_idx_t task, l4_fpage_t vgicc_fpage,
00015                     l4_utcb_t *u) L4_NOTHROW;
00016
00028 L4_INLINE l4_msgtag_t
00029 l4_task_vgicc_map(l4_cap_idx_t task, l4_fpage_t vgicc_fpage) L4_NOTHROW;
00030
00031 /* IMPLEMENTATION ----------------------------------------------------------*/
00032
00033 #include <l4/sys/ipc.h>
00034
00035 L4_INLINE l4_msgtag_t
00036 l4_task_vgicc_map_u(l4_cap_idx_t task, l4_fpage_t vgicc_fpage,
00037                     l4_utcb_t *u) L4_NOTHROW
00038 {
00039   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00040   v->mr[0] = L4_TASK_MAP_VGICC_ARM_OP;
00041   v->mr[1] = vgicc_fpage.raw;
00042   return l4_ipc_call(task, u, l4_msgtag(L4_PROTO_TASK, 2, 0, 0), L4_IPC_NEVER);
00043 }
00044
00045 L4_INLINE l4_msgtag_t
00046 l4_task_vgicc_map(l4_cap_idx_t task, l4_fpage_t vgicc_fpage) L4_NOTHROW
00047 {
00048   return l4_task_vgicc_map_u(task, vgicc_fpage, l4_utcb());
00049 }
```

16.430 __timeout.h

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef L4_SYS_TIMEOUT_H__
00015 #define L4_SYS_TIMEOUT_H__
00016
00017 #include <l4/sys/l4int.h>
00018 #include <l4/sys/compiler.h>
00019
00025
00040 typedef struct l4_timeout_s {
00041   l4_uint16_t t;
00042 } __attribute__((packed)) l4_timeout_s;
00043
00044
00052 typedef union l4_timeout_t
00053 {
00054   l4_uint32_t raw;
00055   struct
00056   {
00057 #ifdef __BIG_ENDIAN__
00058     l4_timeout_s snd;
00059     l4_timeout_s rcv;
00060 #else
00061     l4_timeout_s rcv;
00062     l4_timeout_s snd;
00063 #endif
00064   } p;
00065 } l4_timeout_t;
00066
00067
00073 #define L4_IPC_TIMEOUT_0 ((l4_timeout_s){0x0400})
00074 #define L4_IPC_TIMEOUT_NEVER ((l4_timeout_s){0})
00075 #define L4_IPC_NEVER_INITIALIZER {0}
00076 #define L4_IPC_NEVER ((l4_timeout_t){0})
00077 #define L4_IPC_RECV_TIMEOUT_0 ((l4_timeout_t){0x00000400})
00078 #define L4_IPC_SEND_TIMEOUT_0 ((l4_timeout_t){0x04000000})
00079 #define L4_IPC_BOTH_TIMEOUT_0 ((l4_timeout_t){0x04000400})
00080
00085 #define L4_TIMEOUT_US_NEVER (~0ULL)
00086
00091 #define L4_TIMEOUT_US_MAX   ((1ULL << 41) - 1)
00092
00094
00104 L4_CONSTEXPR L4_INLINE
00105 l4_timeout_s l4_timeout_rel(unsigned man, unsigned exp) L4_NOTHROW;
00106
```

```
00107
00117 L4_CONSTEXPR L4_INLINE
00118 l4_timeout_t l4_ipc_timeout(unsigned snd_man, unsigned snd_exp,
00119                              unsigned rcv_man, unsigned rcv_exp) L4_NOTHROW;
00120
00130 L4_CONSTEXPR L4_INLINE
00131 l4_timeout_t l4_timeout(l4_timeout_s snd, l4_timeout_s rcv) L4_NOTHROW;
00132
00140 L4_CONSTEXPR L4_INLINE
00141 void l4_snd_timeout(l4_timeout_s snd, l4_timeout_t *to) L4_NOTHROW;
00142
00150 L4_CONSTEXPR L4_INLINE
00151 void l4_rcv_timeout(l4_timeout_s rcv, l4_timeout_t *to) L4_NOTHROW;
00152
00161 L4_CONSTEXPR L4_INLINE
00162 l4_kernel_clock_t l4_timeout_rel_get(l4_timeout_s to) L4_NOTHROW;
00163
00164
00173 L4_CONSTEXPR L4_INLINE
00174 unsigned l4_timeout_is_absolute(l4_timeout_s to) L4_NOTHROW;
00175
00185 L4_CONSTEXPR L4_INLINE
00186 l4_kernel_clock_t l4_timeout_get(l4_kernel_clock_t cur, l4_timeout_s to) L4_NOTHROW;
00187
00199 L4_CONSTEXPR L4_INLINE
00200 l4_timeout_s l4_timeout_from_us(l4_uint64_t us) L4_NOTHROW;
00201
00202 /*
00203  * Implementation
00204  */
00205
00206 L4_CONSTEXPR L4_INLINE
00207 l4_timeout_t l4_ipc_timeout(unsigned snd_man, unsigned snd_exp,
00208                              unsigned rcv_man, unsigned rcv_exp) L4_NOTHROW
00209 {
00210   l4_uint16_t snd = (snd_man & 0x3ff) | ((snd_exp « 10) & 0x7c00);
00211   l4_uint16_t rcv = (rcv_man & 0x3ff) | ((rcv_exp « 10) & 0x7c00);
00212   return l4_timeout((l4_timeout_s){snd}, (l4_timeout_s){rcv});
00213 }
00214
00215
00216 L4_CONSTEXPR L4_INLINE
00217 l4_timeout_t l4_timeout(l4_timeout_s snd, l4_timeout_s rcv) L4_NOTHROW
00218 {
00219   return (l4_timeout_t){ ((l4_uint32_t){snd.t} « 16) | rcv.t };
00220 }
00221
00222
00223 L4_CONSTEXPR L4_INLINE
00224 void l4_snd_timeout(l4_timeout_s snd, l4_timeout_t *to) L4_NOTHROW
00225 {
00226   to->p.snd = snd;
00227 }
00228
00229
00230 L4_CONSTEXPR L4_INLINE
00231 void l4_rcv_timeout(l4_timeout_s rcv, l4_timeout_t *to) L4_NOTHROW
00232 {
00233   to->p.rcv = rcv;
00234 }
00235
00236
00237 L4_CONSTEXPR L4_INLINE
00238 l4_timeout_s l4_timeout_rel(unsigned man, unsigned exp) L4_NOTHROW
00239 {
00240   return (l4_timeout_s){(l4_uint16_t)((man & 0x3ff) | ((exp « 10) & 0x7c00))};
00241 }
00242
00243
00244 L4_CONSTEXPR L4_INLINE
00245 l4_kernel_clock_t l4_timeout_rel_get(l4_timeout_s to) L4_NOTHROW
00246 {
00247   if (to.t == 0)
00248     return ~0ULL;
00249   return (l4_kernel_clock_t)(to.t & 0x3ff) « ((to.t » 10) & 0x1f);
00250 }
00251
00252
00253 L4_CONSTEXPR L4_INLINE
00254 unsigned l4_timeout_is_absolute(l4_timeout_s to) L4_NOTHROW
00255 {
00256   return to.t & 0x8000;
00257 }
00258
00259
00260 L4_CONSTEXPR L4_INLINE
00261 l4_kernel_clock_t l4_timeout_get(l4_kernel_clock_t cur, l4_timeout_s to) L4_NOTHROW
```

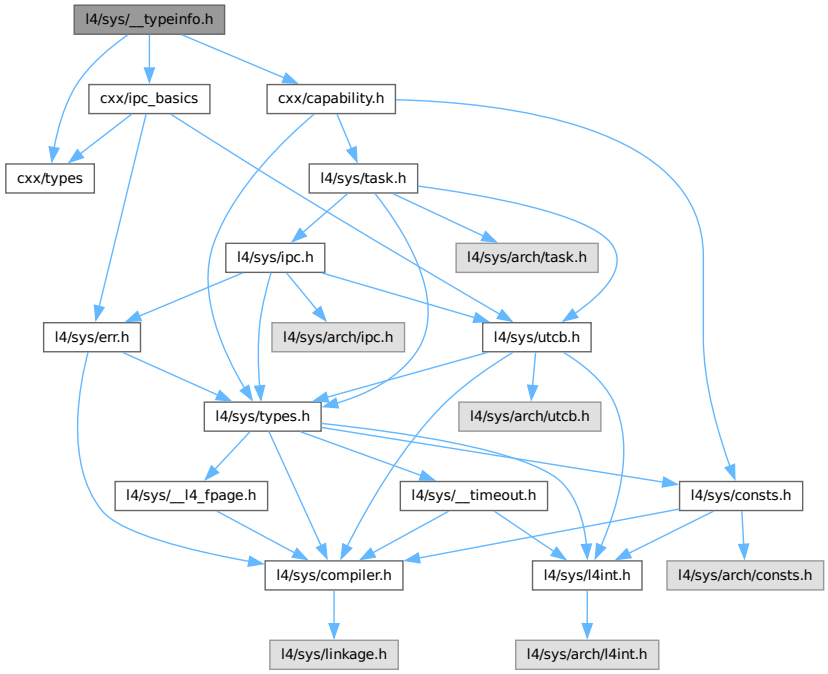
```
00262 {
00263   if (l4_timeout_is_absolute(to))
00264     return 0; /* We cannot retrieve the value ... */
00265   else
00266     return cur + l4_timeout_rel_get(to);
00267 }
00268
00269 L4_CONSTEXPR L4_INLINE
00270 l4_timeout_s l4_timeout_from_us(l4_uint64_t us) L4_NOTHROW
00271 {
00272   if (us == 0)
00273     return L4_IPC_TIMEOUT_0;
00274   else if (us == L4_TIMEOUT_US_NEVER || us > L4_TIMEOUT_US_MAX)
00275     return L4_IPC_TIMEOUT_NEVER;
00276   else
00277     {
00278       /* Here it is certain that at least one bit in 'us' is set. */
00279
00280       enum { m_max = 0x3ff, e_max = 0x1f, }; // max values also serve as mask
00281
00282       l4_uint16_t m = 0; // initialization required by constexpr, optimized away
00283       l4_uint16_t v = 0; // initialization required by constexpr, optimized away
00284       int e = (63 - __builtin_clzll(us)) - 9;
00285       if (e < 0)
00286         e = 0;
00287
00288       /* Here it is certain that '0 <= e <= 31' and '1 <= 2^e <= 2^31':
00289        * L4_TIMEOUT_US_MAX = 2^41-1 = 0x000001ffffffffff => e = 31.
00290        * Note: 2^41-1 (0x000001ffffffffff) > 1023*2^31 (0x00001ff800000000). */
00291
00292       /* Round up to next aligned timeout value to not return too early. */
00293       m = (us + ((1ULL << e) - 1)) >> e;
00294       /* Bounds check */
00295       if (m > m_max)
00296         {
00297           if (e < e_max)
00298             {
00299               ++e;
00300               m >>= 1;
00301             }
00302           else
00303             m = m_max;
00304         }
00305
00306       /* Here it is certain that '1 <= m <= 1023. Consider the following cases:
00307        *  o    1 <= us <= 1023: e = 0; 2^e = 1;   1 <= us/1 <= 1023
00308        *  o 1024 <= us <= 2047: e = 1; 2^e = 2; 512 <= us/2 <= 1023
00309        *  o 2048 <= us <= 4095: e = 2; 2^e = 4; 512 <= us/4 <= 1023
00310        *  ...
00311        *  o 2^31 <= us <= 2^32-1: e = 22;       512 <= us/2^22 <= 1023
00312        *  o 2^40 <= us <= 2^41-1: e = 31;       512 <= us/2^31 <= 1023
00313        *
00314        * Dividing by (1<<e) ensures that for all us < 2^41: m < 2^10.
00315        *
00316        * Maximum possible timeout using this format: L4_TIMEOUT_US_MAX = 2^41-1:
00317        *  e = 31, m = 1023 => 2'196'875'771'904 us = 610h 14m 35s.
00318        */
00319
00320       /* Without introducing 'v' we had to type-cast the expression to
00321        * l4_uint16_t. This cannot be avoided by declaring m and e_pow_10 as
00322        * l4_uint16_t due to C++ integer promotion. */
00323       v = (e << 10) | m;
00324       return (l4_timeout_s){v};
00325     }
00326 }
00327
00328 #endif
```

16.431 l4/sys/__typeinfo.h File Reference

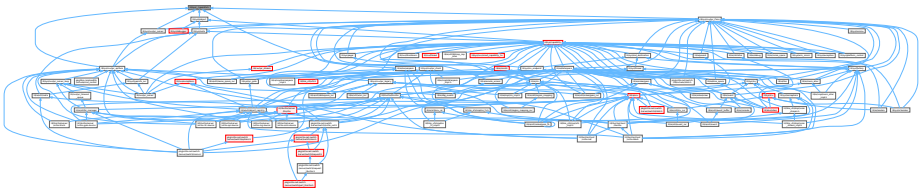
Type information handling.

```
#include "cxx/types"
#include "cxx/ipc_basics"
#include "cxx/capability.h"
```

Include dependency graph for __typeinfo.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct L4::Typeid::P_dispatch< LIST >

  Use for protocol based dispatch stage.
- struct L4::Typeid::Detail::Rpcs_end

  Internal end-of-list marker.
- struct L4::Typeid::Detail::_Rpcs< OPCODE, O, X >

  Empty list of RPCs.
- struct L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >

  Non-empty list of RPCs.
- struct L4::Typeid::Detail::_Rpcs< OPCODE, O, R, X... >::Rpc< Y >

  Find the given RPC in the list.
- struct L4::Typeid::Detail::_Rpcs< OPCODE, O, Default_op< R > >::Rpc< Y >

  Find the given RPC in the list.
- struct L4::Typeid::Raw_ipc< CLASS >

  RPCs list for passing raw incoming IPC to the server object.
- struct L4::Typeid::Rpcs< RPCS >

  Standard list of RPCs of an interface.

- struct L4::Typeid::Rpcs_code< OPCODE_TYPE >

  List of RPCs of an interface using a special opcode type.
- struct L4::Typeid::Rpcs_code< OPCODE_TYPE >::F< RPCS >
- struct L4::Typeid::Rpc_nocode< OPERATION >

  List of RPCs of an interface using a single operation without an opcode.
- struct L4::Typeid::Rpcs_sys< ARG >

  List of RPCs typically used for kernel interfaces.
- struct L4::Type_info

  Dynamic Type Information for L4Re Interfaces.
- class L4::Type_info::Demand

  Data type for expressing the needed receive buffers at the server-side of an interface.
- struct L4::Type_info::Demand_t< CAPS, FLAGS, MEM, PORTS >

  Template type statically describing demand of receive buffers.
- struct L4::Type_info::Demand_union_t< D1, D2 >

  Template type statically describing the combination of two Demand object.
- struct L4::Kobject_typeid< T >

  Meta object for handling access to type information of Kobjects.
- struct L4::Kobject_typeid< void >

  Minimalistic ID for `void` interface.
- class L4::Kobject_t< Derived, Base, PROTO, S_DEMAND >

  Helper class to create an L4Re interface class that is derived from a single base class.
- class L4::Kobject_2t< Derived, Base1, Base2, PROTO, S_DEMAND >

  Helper class to create an L4Re interface class that is derived from two base classes (see `L4::Kobject_t`).
- struct L4::Kobject_3t< Derived, Base1, Base2, Base3, PROTO, S_DEMAND >

  Helper class to create an L4Re interface class that is derived from three base classes (see `L4::Kobject_t`).
- struct L4::Proto_t< P >

  Data type for defining protocol numbers.

Namespaces

- namespace L4

  L4 low-level kernel interface.
- namespace L4::Typeid

  Definition of interface data-type helpers.

Typedefs

- typedef int **L4::Opcode**

  Data type for RPC opcodes.

Enumerations

- enum : l4_proto_t { L4::PROTO_ANY = 0 , L4::PROTO_EMPTY = -19 }

Functions

- template<typename T>
  Type_info const * L4::kobject_typeid () noexcept

  Get the L4::Type_info for the L4Re interface given in `T`.

16.431.1 Detailed Description

Type information handling.
Definition in file __typeinfo.h.

16.432 __typeinfo.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * Copyright (C) 2014-2017, 2019, 2022-2025 Kernkonzept GmbH.
00007  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00008  */
00009 /*
00010  * (c) 2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #pragma once
00016 #pragma GCC system_header
00017
00018 #include "cxx/types"
00019 #include "cxx/ipc_basics"
00020 #include "cxx/capability.h"
00021
00022 #if defined(__GXX_RTTI) && !defined(L4_NO_RTTI)
00023 #  include <typeinfo>
00024    typedef std::type_info const *L4_std_type_info_ptr;
00025 #  define L4_KOBJECT_META_RTTI(type) (&typeid(type))
00026    inline char const *L4_kobject_type_name(L4_std_type_info_ptr n) noexcept
00027    { return n ? n->name() : 0; }
00028 #else
00029    typedef void const *L4_std_type_info_ptr;
00030 #  define L4_KOBJECT_META_RTTI(type) (0)
00031    inline char const *L4_kobject_type_name(L4_std_type_info_ptr) noexcept
00032    { return 0; }
00033 #endif
00034
00035 namespace L4 {
00036   typedef int Opcode;
00037 // internal max helpers
00038 namespace __I {
00039   // internal max of A nd B helper
00040   template< unsigned char A, unsigned char B>
00041   struct Max { enum { Res = A > B ? A : B }; };
00042 } // namespace __I
00043
00044 enum : l4_proto_t
00045 {
00047   PROTO_ANY   = 0,
00049   PROTO_EMPTY = -19,
00050 };
00051
00058
00066 namespace Typeid {
00071
00072     using namespace L4::Types;
00073
00074   /*********************/
00082   template<l4_proto_t P, typename T>
00083   struct Iface
00084   {
00085     typedef Iface type;
00086     typedef T iface_type;
00087     enum { Proto = P };
00088   };
00089
00090
00091   /*********************/
00097   struct Iface_list_end
00098   {
00099     typedef Iface_list_end type;
00100     static bool contains(l4_proto_t) noexcept { return false; }
00101   };
00102
00103
00111   template<typename I, typename N = Iface_list_end>
00112   struct Iface_list
00113   {
00114     typedef Iface_list<I, N> type;
00115
00116     typedef typename I::iface_type iface_type;
00117     typedef N Next;
00118
00119     enum { Proto = I::Proto };
00120
00121     static bool contains(l4_proto_t proto) noexcept
00122     { return (proto == Proto) || Next::contains(proto); }
00123   };
00124
```

```
00125 // do not insert PROTO_EMPTY interfaces
00126 template<typename I, typename N>
00127 struct Iface_list<Iface<PROTO_EMPTY, I>, N> : N {};
00128
00129 // do not insert 'void' type interfaces
00130 template<l4_proto_t P, typename N>
00131 struct Iface_list<Iface<P, void>, N> : N {};
00132
00133
00134 /*********************/
00135 /*
00136  * \internal
00137  * Test if an interface I is in list L
00138  * \tparam I  Interface for lookup
00139  * \tparam L  Iface_list for search
00140  */
00141 template< typename I, typename L >
00142 struct _In_list;
00143
00144 template< typename I >
00145 struct _In_list<I, Iface_list_end> : False {};
00146
00147 template< typename I, typename N >
00148 struct _In_list<I, Iface_list<I, N> > : True {};
00149
00150 template< typename I, typename I2, typename N >
00151 struct _In_list<I, Iface_list<I2, N> > : _In_list<I, typename N::type> {};
00152
00153 template<typename I, typename L>
00154 struct In_list : _In_list<typename I::type, typename L::type> {};
00155
00156
00157 /************/
00158 /*
00159  * \internal
00160  * Add Helper: add I to interface list L if ADD is true
00161  * \ingroup l4_cxx_ipc_internal
00162  */
00163 template< bool ADD, typename I, typename L>
00164 struct _Iface_list_add;
00165
00166 template< typename I, typename L>
00167 struct _Iface_list_add<false, I, L> : L {};
00168
00169 template< typename I, typename L>
00170 struct _Iface_list_add<true, I, L> : Iface_list<I, L> {};
00171
00172 /*
00173  * \internal
00174  * Add Helper: add I to interface list L if not already in L.
00175  * \ingroup l4_cxx_ipc_internal
00176  */
00177 template< typename I, typename L >
00178 struct Iface_list_add :
00179   _Iface_list_add<
00180     !In_list<I, typename L::type>::value, I, typename L::type>
00181 {};
00182
00183 /************/
00184 /*
00185  * \internal
00186  * Helper: checking for a conflict between I2 and I2.
00187  * A conflict means I1 and I2 have the same protocol ID but a different
00188  * iface_type.
00189  */
00190 template< typename I1, typename I2 >
00191 struct __Iface_conflict : Bool<I1::Proto != PROTO_EMPTY && I1::Proto == I2::Proto> {};
00192
00193 template< typename I >
00194 struct __Iface_conflict<I, I> : False {};
00195
00196 /*
00197  * \internal
00198  * Helper: checking for a conflict between I and any interface in LIST.
00199  */
00200 template< typename I, typename LIST >
00201 struct _Iface_conflict;
00202
00203 template< typename I >
00204 struct _Iface_conflict<I, Iface_list_end> : False {};
00205
00206 template< typename I, typename I2, typename LIST >
00207 struct _Iface_conflict<I, Iface_list<I2, LIST> > :
00208   Bool<__Iface_conflict<I, I2>::value || _Iface_conflict<I, typename LIST::type>::value>
00209 {};
00210
00215 template< typename I, typename LIST >
```

```
00216   struct Iface_conflict : _Iface_conflict<typename I::type, typename LIST::type> {};
00217
00218   /**************/
00219   /*
00220    * \internal
00221    * Helper: merge two interface lists
00222    */
00223   template< typename L1, typename L2 >
00224   struct _Merge_list;
00225
00226   template< typename L >
00227   struct _Merge_list<Iface_list_end, L> : L {};
00228
00229   template< typename I, typename L1, typename L2 >
00230   struct _Merge_list<Iface_list<I, L1>, L2> :
00231     _Merge_list<typename L1::type, typename Iface_list_add<I, L2>::type> {};
00232
00233   template<typename L1, typename L2>
00234   struct Merge_list : _Merge_list<typename L1::type, typename L2::type> {};
00235
00236   /**************/
00237   /*
00238    * \internal
00239    * check for conflicts among all interfaces in L1 with any interfaces in L2.
00240    */
00241   template< typename L1, typename L2 >
00242   struct _Conflict;
00243
00244   template< typename L >
00245   struct _Conflict<Iface_list_end, L> : False {};
00246
00247   template< typename I, typename L1, typename L2 >
00248   struct _Conflict<Iface_list<I, L1>, L2> :
00249     Bool<Iface_conflict<I, typename L2::type>::value
00250           || _Conflict<typename L1::type, typename L2::type>::value> {};
00251
00252   template< typename L1, typename L2 >
00253   struct Conflict : _Conflict<typename L1::type, typename L2::type> {};
00254
00255   // to be removed ---------------------------------------
00256   // p_dispatch code -- for legacy dispatch ------------------------------
00257   /**********************/
00258   /*
00259    * \internal
00260    * helper: Dispatch helper for calling server-side p_dispatch() functions.
00261    */
00262   template<typename LIST>
00263   struct _P_dispatch;
00264
00265   // No matching dispatcher found
00266   template<>
00267   struct _P_dispatch<Iface_list_end>
00268   {
00269     template< typename THIS, typename A1, typename A2 >
00270     static int f(THIS *, l4_proto_t, A1, A2 &) noexcept
00271     { return -L4_EBADPROTO; }
00272   };
00273
00274
00275   // call matching p_dispatch() function
00276   template< typename I, typename LIST >
00277   struct _P_dispatch<Iface_list<I, LIST> >
00278   {
00279     // special handling for the meta protocol, to avoid 'using' murx
00280     template< typename THIS, typename A1, typename A2 >
00281     static int _f(THIS self, A1, A2 &a2, True::type)
00282     {
00283       return self->dispatch_meta_request(a2);
00284     }
00285
00286     // normal p_dispatch() dispatching
00287     template< typename THIS, typename A1, typename A2 >
00288     static int _f(THIS self, A1 a1, A2 &a2, False::type)
00289     {
00290       return self->p_dispatch(reinterpret_cast<typename I::iface_type *>(0),
00291                               a1, a2);
00292     }
00293
00294     // dispatch function with switch for meta protocol
00295     template< typename THIS, typename A1, typename A2 >
00296     static int f(THIS *self, l4_proto_t proto, A1 a1, A2 &a2)
00297     {
00298       if (I::Proto == proto)
00299         return _f(self, a1, a2,
00300                   Bool<I::Proto == static_cast<l4_proto_t>(L4_PROTO_META)>());
00301
00302       return _P_dispatch<typename LIST::type>::f(self, proto, a1, a2);
```

```
00303     }
00304   };
00305
00307   template<typename LIST>
00308   struct P_dispatch : _P_dispatch<typename LIST::type> {};
00309   // end: p_dispatch ----------------------------------------------------
00310   // end: to be removed -------------------------------------
00311
00312   template<typename RPC> struct Default_op;
00313
00314   namespace Detail {
00315
00317   struct Rpcs_end
00318   {
00319     typedef void opcode_type;
00320     typedef Rpcs_end rpc;
00321     typedef Rpcs_end type;
00322   };
00323
00325   template<typename O1, typename O2, typename RPCS>
00326   struct _Rpc : _Rpc<typename RPCS::next::rpc, O2, typename RPCS::next>::type {};
00328
00329   template<typename O1, typename O2>
00330   struct _Rpc<O1, O2, Rpcs_end> {};
00331
00332   template<typename OP, typename RPCS>
00333   struct _Rpc<OP, OP, RPCS> : RPCS
00334   {
00335     typedef _Rpc type;
00336   };
00337
00338   template<typename OP, typename RPCS>
00339   struct Rpc : _Rpc<typename RPCS::rpc, OP, RPCS> {};
00340
00341   template<typename T, unsigned CODE>
00342   struct _Get_opcode
00343   {
00344     template<bool, typename> struct Invalid_opcode {};
00345     template<typename X> struct Invalid_opcode<true, X>;
00346
00347   private:
00348     template<typename U, U> struct _chk;
00349     template<typename U> static l4_proto_t _opc(_chk<int, U::Opcode> *);
00350     template<typename U> static char _opc(...);
00351
00352     template<unsigned SZ, typename U>
00353     struct _Opc { enum { value = CODE }; };
00354
00355     template<typename U>
00356     struct _Opc<sizeof(l4_proto_t), U> { enum { value = U::Opcode }; };
00357
00358   public:
00359     enum { value = _Opc<sizeof(_opc<T>(0)), T>::value };
00360     Invalid_opcode<(value < CODE), T> invalid_opcode;
00361   };
00362
00364   template<typename OPCODE, unsigned O, typename ...X>
00365   struct _Rpcs : Rpcs_end {};
00366
00368   template<typename OPCODE, unsigned O, typename R, typename ...X>
00369   struct _Rpcs<OPCODE, O, R, X...>
00370   {
00372     typedef _Rpcs type;
00374     typedef OPCODE opcode_type;
00376     typedef R rpc;
00378     typedef typename _Rpcs<OPCODE, _Get_opcode<R, O>::value + 1, X...>::type next;
00380     enum { Opcode = _Get_opcode<R, O>::value };
00382     template<typename Y> struct Rpc : Typeid::Detail::Rpc<Y, _Rpcs> {};
00383   };
00384
00385   template<typename OPCODE, unsigned O, typename R>
00386   struct _Rpcs<OPCODE, O, Default_op<R> >
00387   {
00389     typedef _Rpcs type;
00391     typedef void opcode_type;
00393     typedef R rpc;
00395     typedef Rpcs_end next;
00397     enum { Opcode = -99 };
00399     template<typename Y> struct Rpc : Typeid::Detail::Rpc<Y, _Rpcs> {};
00400   };
00401
00402   } // namespace Detail
00403
00411   template<typename CLASS>
00412   struct Raw_ipc
00413   {
00414     typedef Raw_ipc type;
```

```
00415     typedef Detail::Rpcs_end next;
00416     typedef void opcode_type;
00417   };
00418
00427   template<typename ...RPCS>
00428   struct Rpcs : Detail::_Rpcs<L4::Opcode, 0, RPCS...> {};
00429
00438   template<typename OPCODE_TYPE>
00439   struct Rpcs_code
00440   {
00444     template<typename ...RPCS>
00445     struct F : Detail::_Rpcs<OPCODE_TYPE, 0, RPCS...> {};
00446   };
00447
00453   template<typename OPERATION>
00454   struct Rpc_nocode : Detail::_Rpcs<void, 0, OPERATION> {};
00455
00464   template<typename ...ARG>
00465   struct Rpcs_sys : Detail::_Rpcs<l4_umword_t, 0, ARG...> {};
00466
00467   template<typename CLASS>
00468   struct Rights
00469   {
00470     unsigned rights;
00471     Rights(unsigned rights) noexcept : rights(rights) {}
00472     unsigned operator & (unsigned rhs) const noexcept { return rights & rhs; }
00473   };
00474
00475 } // namespace Typeid
00476
00499 struct L4_EXPORT Type_info
00500 {
00506   class L4_EXPORT Demand
00507   {
00508   private:
00510     static unsigned char max(unsigned char a, unsigned char b) noexcept
00511     { return a > b ? a : b; }
00512
00513   public:
00514     unsigned char caps;
00515     unsigned char flags;
00516     unsigned char mem;
00517     unsigned char ports;
00518
00526     explicit
00527     Demand(unsigned char caps = 0, unsigned char flags = 0,
00528            unsigned char mem = 0,  unsigned char ports = 0) noexcept
00529     : caps(caps), flags(flags), mem(mem), ports(ports) {}
00530
00532     bool no_demand() const noexcept
00533     { return caps == 0 && mem == 0 && ports == 0 && flags == 0; }
00534
00536     Demand operator | (Demand const &rhs) const noexcept
00537     {
00538       return Demand(max(caps, rhs.caps), flags | rhs.flags,
00539                     max(mem, rhs.mem), max(ports, rhs.ports));
00540     }
00541   };
00542
00551   template<unsigned char CAPS = 0, unsigned char FLAGS = 0,
00552            unsigned char MEM  = 0, unsigned char PORTS = 0>
00553   struct Demand_t : Demand
00554   {
00555     enum
00556     {
00557       Caps  = CAPS,
00558       Flags = FLAGS,
00559       Mem   = MEM,
00560       Ports = PORTS
00561     };
00562     Demand_t() noexcept : Demand(CAPS, FLAGS, MEM, PORTS) {}
00563   };
00564
00572   template<typename D1, typename D2>
00573   struct Demand_union_t : Demand_t<__I::Max<D1::Caps,  D2::Caps>::Res,
00574                                    D1::Flags | D2::Flags,
00575                                    __I::Max<D1::Mem,   D2::Mem>::Res,
00576                                    __I::Max<D1::Ports, D2::Ports>::Res>
00577   {};
00578
00579   L4_std_type_info_ptr _type;
00580   Type_info const *const *_bases;
00581   unsigned _num_bases;
00582   l4_proto_t _proto;
00583
00584   L4_std_type_info_ptr type() const noexcept { return _type; }
00585   Type_info const *base(unsigned idx) const noexcept { return _bases[idx]; }
```

```
00586   unsigned num_bases() const noexcept { return _num_bases; }
00587   l4_proto_t proto() const noexcept { return _proto; }
00588   char const *name() const noexcept { return L4_kobject_type_name(type()); }
00589   bool has_proto(l4_proto_t proto) const noexcept
00590   {
00591     if (_proto && _proto == proto)
00592       return true;
00593
00594     if (!proto)
00595       return false;
00596
00597     for (unsigned i = 0; i < _num_bases; ++i)
00598       if (base(i)->has_proto(proto))
00599         return true;
00600
00601     return false;
00602   }
00603 };
00604
00610 template<typename T> struct Kobject_typeid
00611 {
00622   typedef typename T::__Kobject_typeid::Demand Demand;
00623   typedef typename T::__Iface::iface_type Iface;
00624   typedef typename T::__Iface_list Iface_list;
00625
00630   static Type_info const *id() noexcept { return &T::__Kobject_typeid::_m; }
00631
00639   static Type_info::Demand demand() noexcept
00640   { return T::__Kobject_typeid::Demand(); }
00641
00642   // to be removed ---------------------------------------
00643   // p_dispatch ------------------------------------------------------------
00659   template<typename THIS, typename A1, typename A2>
00660   static int proto_dispatch(THIS *self, l4_proto_t proto, A1 a1, A2 &a2)
00661   { return Typeid::P_dispatch<typename T::__Iface_list>::f(self, proto, a1, a2);  }
00662   // p_dispatch ------------------------------------------------------------
00663   // end: to be removed ----------------------------------------
00664 };
00665
00667 template<> struct Kobject_typeid<void>
00668 {
00669   typedef Type_info::Demand_t<> Demand;
00670 };
00671
00680 template<typename T>
00681 inline
00682 Type_info const *kobject_typeid() noexcept
00683 { return Kobject_typeid<T>::id(); }
00684
00689 #define L4____GEN_TI(t...)                                              \
00690 Type_info const t::__Kobject_typeid::_m =                               \
00691 {                                                                       \
00692   L4_KOBJECT_META_RTTI(Derived),                                        \
00693   &t::__Kobject_typeid::_b[0],                                          \
00694   sizeof(t::__Kobject_typeid::_b) / sizeof(t::__Kobject_typeid::_b[0]),  \
00695   PROTO                                                                 \
00696 }
00697
00702 #define L4____GEN_TI_MEMBERS(BASE_DEMAND...)                            \
00703 private:                                                                \
00704   template< typename T > friend struct Kobject_typeid;                  \
00705 protected:                                                              \
00706   struct __Kobject_typeid {                                             \
00707     typedef Type_info::Demand_union_t<S_DEMAND, BASE_DEMAND> Demand;     \
00708     static Type_info const *const _b[];                                 \
00709     static Type_info const _m;                                          \
00710   };                                                                    \
00711 public:                                                                 \
00712   static l4_proto_t const Protocol = PROTO;                               \
00713   typedef L4::Typeid::Rights<Class> Rights;
00714
00743 template<
00744   typename Derived,
00745   typename Base,
00746   l4_proto_t PROTO = PROTO_ANY,
00747   typename S_DEMAND = Type_info::Demand_t<>
00748 >
00749 class Kobject_t : public Base
00750 {
00751 protected:
00753   typedef Derived Class;
00755   typedef Typeid::Iface<PROTO, Derived> __Iface;
00757   typedef Typeid::Merge_list<
00758     Typeid::Iface_list<__Iface>, typename Base::__Iface_list
00759   > __Iface_list;
00760
00762   static void __check_protocols__() noexcept
```

```
00763   {
00764     typedef Typeid::Iface_conflict<__Iface, typename Base::__Iface_list> Base_conflict;
00765     static_assert(!Base_conflict::value, "ambiguous protocol ID: protocol also used by Base");
00766   }
00767
00769   L4::Cap<Class> c() const noexcept { return L4::Cap<Class>(this->cap()); }
00770
00771   // Generate the remaining type information
00772   L4____GEN_TI_MEMBERS(typename Base::__Kobject_typeid::Demand)
00773 };
00774
00775
00777 template< typename Derived, typename Base, l4_proto_t PROTO, typename S_DEMAND>
00778 Type_info const *const
00779 Kobject_t<Derived, Base, PROTO, S_DEMAND>::
00780   __Kobject_typeid::_b[] = { &Base::__Kobject_typeid::_m };
00782
00787 template< typename Derived, typename Base, l4_proto_t PROTO, typename S_DEMAND>
00788 L4____GEN_TI(Kobject_t<Derived, Base, PROTO, S_DEMAND>);
00789
00790
00820 template<
00821   typename Derived,
00822   typename Base1,
00823   typename Base2,
00824   l4_proto_t PROTO = PROTO_ANY,
00825   typename S_DEMAND = Type_info::Demand_t<>
00826 >
00827 class Kobject_2t : public Base1, public Base2
00828 {
00829 protected:
00831   typedef Derived Class;
00833   typedef Typeid::Iface<PROTO, Derived> __Iface;
00835   typedef Typeid::Merge_list<
00836     Typeid::Iface_list<__Iface>,
00837     Typeid::Merge_list<
00838       typename Base1::__Iface_list,
00839       typename Base2::__Iface_list
00840     >
00841   > __Iface_list;
00842
00844   static void __check_protocols__() noexcept
00845   {
00846     typedef typename Base1::__Iface_list Base1_proto_list;
00847     typedef typename Base2::__Iface_list Base2_proto_list;
00848
00849     typedef Typeid::Iface_conflict<__Iface, Base1_proto_list> Base1_conflict;
00850     typedef Typeid::Iface_conflict<__Iface, Base2_proto_list> Base2_conflict;
00851     static_assert(!Base1_conflict::value, "ambiguous protocol ID, also in Base1");
00852     static_assert(!Base2_conflict::value, "ambiguous protocol ID, also in Base2");
00853
00854     typedef Typeid::Conflict<Base1_proto_list, Base2_proto_list> Bases_conflict;
00855     static_assert(!Bases_conflict::value, "ambiguous protocol IDs in base classes");
00856   }
00857
00858   // disambiguate cap()
00859   l4_cap_idx_t cap() const noexcept
00860   { return Base1::cap(); }
00861
00863   L4::Cap<Class> c() const noexcept { return L4::Cap<Class>(this->cap()); }
00864
00865   L4____GEN_TI_MEMBERS(Type_info::Demand_union_t<
00866     typename Base1::__Kobject_typeid::Demand,
00867     typename Base2::__Kobject_typeid::Demand>
00868   )
00869
00870 public:
00871   // Provide non-ambiguous conversion to Kobject
00872   operator Kobject const & () const noexcept
00873   { return *static_cast<Base1 const *>(this); }
00874
00875   // Provide non-ambiguous access of dec_refcnt()
00876   l4_msgtag_t dec_refcnt(l4_mword_t diff, l4_utcb_t *utcb = l4_utcb())
00877     noexcept(noexcept(static_cast<Base1*>(nullptr)->dec_refcnt(diff, utcb)))
00878   { return Base1::dec_refcnt(diff, utcb); }
00879 };
00880
00881
00883 template< typename Derived, typename Base1, typename Base2,
00884           l4_proto_t PROTO, typename S_DEMAND >
00885 Type_info const *const
00886 Kobject_2t<Derived, Base1, Base2, PROTO, S_DEMAND>::__Kobject_typeid::_b[] =
00887 {
00888   &Base1::__Kobject_typeid::_m,
00889   &Base2::__Kobject_typeid::_m
00890 };
00892
```

```
00897 template< typename Derived, typename Base1, typename Base2,
00898           l4_proto_t PROTO, typename S_DEMAND >
00899 L4____GEN_TI(Kobject_2t<Derived, Base1, Base2, PROTO, S_DEMAND>);
00900
00901
00902
00922 template<
00923   typename Derived,
00924   typename Base1,
00925   typename Base2,
00926   typename Base3,
00927   l4_proto_t PROTO = PROTO_ANY,
00928   typename S_DEMAND = Type_info::Demand_t<>
00929 >
00930 struct Kobject_3t : Base1, Base2, Base3
00931 {
00932 protected:
00934   typedef Derived Class;
00936   typedef Typeid::Iface<PROTO, Derived> __Iface;
00938   typedef Typeid::Merge_list<
00939     Typeid::Iface_list<__Iface>,
00940     Typeid::Merge_list<
00941       typename Base1::__Iface_list,
00942       Typeid::Merge_list<
00943         typename Base2::__Iface_list,
00944         typename Base3::__Iface_list
00945       >
00946     >
00947   > __Iface_list;
00948
00950   static void __check_protocols__() noexcept
00951   {
00952     typedef typename Base1::__Iface_list Base1_proto_list;
00953     typedef typename Base2::__Iface_list Base2_proto_list;
00954     typedef typename Base3::__Iface_list Base3_proto_list;
00955
00956     typedef Typeid::Iface_conflict<__Iface, Base1_proto_list> Base1_conflict;
00957     typedef Typeid::Iface_conflict<__Iface, Base2_proto_list> Base2_conflict;
00958     typedef Typeid::Iface_conflict<__Iface, Base3_proto_list> Base3_conflict;
00959
00960     static_assert(!Base1_conflict::value, "ambiguous protocol ID, also in Base1");
00961     static_assert(!Base2_conflict::value, "ambiguous protocol ID, also in Base2");
00962     static_assert(!Base3_conflict::value, "ambiguous protocol ID, also in Base3");
00963
00964     typedef Typeid::Conflict<Base1_proto_list, Base2_proto_list> Conflict_bases12;
00965     typedef Typeid::Conflict<Base1_proto_list, Base3_proto_list> Conflict_bases13;
00966     typedef Typeid::Conflict<Base2_proto_list, Base3_proto_list> Conflict_bases23;
00967
00968     static_assert(!Conflict_bases12::value, "ambiguous protocol IDs in base classes: Base1 and
      Base2");
00969     static_assert(!Conflict_bases13::value, "ambiguous protocol IDs in base classes: Base1 and
      Base3");
00970     static_assert(!Conflict_bases23::value, "ambiguous protocol IDs in base classes: Base2 and
      Base3");
00971   }
00972
00973   // disambiguate cap()
00974   l4_cap_idx_t cap() const noexcept
00975   { return Base1::cap(); }
00976
00978   L4::Cap<Class> c() const noexcept { return L4::Cap<Class>(this->cap()); }
00979
00980   L4____GEN_TI_MEMBERS(Type_info::Demand_union_t<Type_info::Demand_union_t<
00981     typename Base1::__Kobject_typeid::Demand,
00982     typename Base2::__Kobject_typeid::Demand>,
00983     typename Base3::__Kobject_typeid::Demand>
00984   )
00985
00986 public:
00987   // Provide non-ambiguous conversion to Kobject
00988   operator Kobject const & () const noexcept
00989   { return *static_cast<Base1 const *>(this); }
00990
00991   // Provide non-ambiguous access of dec_refcnt()
00992   l4_msgtag_t dec_refcnt(l4_mword_t diff, l4_utcb_t *utcb = l4_utcb())
00993     noexcept(noexcept(static_cast<Base1*>(nullptr)->dec_refcnt(diff, utcb)))
00994   { return Base1::dec_refcnt(diff, utcb); }
00995 };
00996
00997
00999 template< typename Derived, typename Base1, typename Base2, typename Base3,
01000           l4_proto_t PROTO, typename S_DEMAND >
01001 Type_info const *const
01002 Kobject_3t<Derived, Base1, Base2, Base3, PROTO, S_DEMAND>::__Kobject_typeid::_b[] =
01003 {
01004   &Base1::__Kobject_typeid::_m,
01005   &Base2::__Kobject_typeid::_m,
```

```
01006   &Base3::__Kobject_typeid::_m
01007 };
01009
01014 template< typename Derived, typename Base1, typename Base2, typename Base3,
01015           l4_proto_t PROTO, typename S_DEMAND >
01016 L4____GEN_TI(Kobject_3t<Derived, Base1, Base2, Base3, PROTO, S_DEMAND>);
01017
01018 }
01019
01020 #if __cplusplus >= 201103L
01021
01022 namespace L4 {
01023
01030 template< typename ...T >
01031 struct Kobject_demand;
01032
01033 template<>
01034 struct Kobject_demand<> : Type_info::Demand_t<> {};
01035
01036 template<typename T>
01037 struct Kobject_demand<T> : Kobject_typeid<T>::Demand {};
01038
01039 template<typename T1, typename ...T2>
01040 struct Kobject_demand<T1, T2...> :
01041   Type_info::Demand_union_t<typename Kobject_typeid<T1>::Demand,
01042                             Kobject_demand<T2...> >
01043 {};
01044
01045 namespace Typeid_xx {
01046
01047   template<typename ...LISTS>
01048   struct Merge_list;
01049
01050   template<typename L>
01051   struct Merge_list<L> : L {};
01052
01053   template<typename L1, typename L2>
01054   struct Merge_list<L1, L2> : Typeid::Merge_list<L1, L2> {};
01055
01056   template<typename L1, typename L2, typename ...LISTS>
01057   struct Merge_list<L1, L2, LISTS...> :
01058     Merge_list<typename Typeid::Merge_list<L1, L2>::type, LISTS...> {};
01059
01060   template< typename I, typename ...LIST >
01061   struct Iface_conflict;
01062
01063   template< typename I >
01064   struct Iface_conflict<I> : Typeid::False {};
01065
01066   template< typename I, typename L, typename ...LIST >
01067   struct Iface_conflict<I, L, LIST...> :
01068     Typeid::Bool<Typeid::Iface_conflict<typename I::type, typename L::type>::value
01069                  || Iface_conflict<I, LIST...>::value>
01070   {};
01071
01072   template< typename ...LIST >
01073   struct Conflict;
01074
01075   template< typename L >
01076   struct Conflict<L> : Typeid::False {};
01077
01078   template< typename L1, typename L2, typename ...LIST >
01079   struct Conflict<L1, L2, LIST...> :
01080     Typeid::Bool<Typeid::Conflict<typename L1::type, typename L2::type>::value
01081                  || Conflict<L1, LIST...>::value
01082                  || Conflict<L2, LIST...>::value>
01083   {};
01084
01085   template< typename T >
01086   struct Is_demand
01087   {
01088     static l4_proto_t test(Type_info::Demand const *);
01089     static char test(...);
01090     enum { value = sizeof(test(static_cast<T*>(nullptr))) == sizeof(l4_proto_t) };
01091   };
01092
01093   template< typename T, typename ... >
01094   struct First : T { typedef T type; };
01095 } // Typeid
01096
01102 template< typename Derived, l4_proto_t PROTO, typename S_DEMAND, typename ...BASES>
01103 struct __Kobject_base : BASES...
01104 {
01105 protected:
01106   typedef Derived Class;
01107   typedef Typeid::Iface<PROTO, Derived> __Iface;
01108   typedef Typeid_xx::Merge_list<
```

```
01109     Typeid::Iface_list<__Iface>,
01110     typename BASES::__Iface_list...
01111   > __Iface_list;
01112
01113   static void __check_protocols__() noexcept
01114   {
01115     typedef Typeid_xx::Iface_conflict<__Iface, typename BASES::__Iface_list...> Conflict;
01116     static_assert(!Conflict::value, "ambiguous protocol ID, protocol also used in base class");
01117
01118     typedef Typeid_xx::Conflict<typename BASES::__Iface_list...> Base_conflict;
01119     static_assert(!Base_conflict::value, "ambiguous protocol IDs in base classes");
01120   }
01121
01122   // disambiguate cap()
01123   l4_cap_idx_t cap() const noexcept
01124   { return Typeid_xx::First<BASES...>::type::cap(); }
01125
01126   L4::Cap<Class> c() const noexcept { return L4::Cap<Class>(this->cap()); }
01127
01128   L4____GEN_TI_MEMBERS(Kobject_demand<BASES...>)
01129
01130 private:
01131   // This function returns the first base class (used below)
01132   template<typename B1, typename ...> struct Base1 { typedef B1 type; };
01133
01134 public:
01135   // Provide non-ambiguous conversion to Kobject
01136   operator Kobject const & () const noexcept
01137   { return *static_cast<typename Base1<BASES...>::type const *>(this); }
01138
01139   // Provide non-ambiguous access of dec_refcnt()
01140   l4_msgtag_t dec_refcnt(l4_mword_t diff, l4_utcb_t *utcb = l4_utcb())
01141     noexcept(noexcept(static_cast<typename Base1<BASES...>::type *>(nullptr)
01142                       ->dec_refcnt(diff, utcb)))
01143   { return Base1<BASES...>::type::dec_refcnt(diff, utcb); }
01144 };
01145
01147 template< typename Derived, l4_proto_t PROTO, typename S_DEMAND, typename ...BASES>
01148 Type_info const *const
01149 __Kobject_base<Derived, PROTO, S_DEMAND, BASES...>::__Kobject_typeid::_b[] =
01150 {
01151   (&BASES::__Kobject_typeid::_m)...
01152 };
01154
01155 template< typename Derived, l4_proto_t PROTO, typename S_DEMAND, typename ...BASES>
01156 L4____GEN_TI(__Kobject_base<Derived, PROTO, S_DEMAND, BASES...>);
01157
01158
01159 // Test if the there is a Demand argument to Kobject_x
01160 template< typename Derived, l4_proto_t PROTO, bool HAS_DEMAND, typename DEMAND, typename ...ARGS >
01161 struct __Kobject_x_proto;
01162
01163 // YES: pass it to __Kobject_base
01164 template< typename Derived, l4_proto_t PROTO, typename DEMAND, typename ...BASES>
01165 struct __Kobject_x_proto<Derived, PROTO, true, DEMAND, BASES...> :
01166   __Kobject_base<Derived, PROTO, DEMAND, BASES...> {};
01167
01168 // NO: pass it empty Type_info::Demand_t
01169 template< typename Derived, l4_proto_t PROTO, typename B1, typename ...BASES>
01170 struct __Kobject_x_proto<Derived, PROTO, false, B1, BASES...> :
01171   __Kobject_base<Derived, PROTO, Type_info::Demand_t<>, B1, BASES...> {};
01172
01180 template< l4_proto_t P = PROTO_EMPTY >
01181 struct Proto_t {};
01182
01196 template< typename Derived, typename ...ARGS >
01197 struct Kobject_x;
01198
01199 template< typename Derived, typename A, typename ...ARGS >
01200 struct Kobject_x<Derived, A, ARGS...> :
01201   __Kobject_x_proto<Derived, PROTO_ANY, Typeid_xx::Is_demand<A>::value, A, ARGS...>
01202 {};
01203
01204 template< typename Derived, l4_proto_t PROTO, typename A, typename ...ARGS >
01205 struct Kobject_x<Derived, Proto_t<PROTO>, A, ARGS...> :
01206   __Kobject_x_proto<Derived, PROTO, Typeid_xx::Is_demand<A>::value, A, ARGS...>
01207 {};
01208
01209 }
01210 #endif
01211
01212 #undef L4____GEN_TI
01213 #undef L4____GEN_TI_MEMBERS
```

16.433 __vcpu-arm.h

```
00001 /*
00002  * (c) 2017 Alexander Warg <alexander.warg@kernkonzept.com>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
00008 typedef struct l4_arm_vcpu_e_info_t
00009 {
00010   l4_uint8_t  version;     // must be 0
00011   l4_uint8_t  gic_version;
00012   l4_uint8_t  _rsvd0[2];
00013   l4_uint32_t features;
00014   l4_uint32_t _rsvd1[14];
00015   l4_umword_t user[8];
00016 } l4_arm_vcpu_e_info_t;
00017
00018 L4_INLINE void *l4_vcpu_e_ptr(void const *vcpu, unsigned id) L4_NOTHROW;
00019
00020 enum L4_vcpu_e_consts
00021 {
00022   L4_VCPU_E_NUM_LR = 4,
00023 };
00024
00025 L4_INLINE l4_arm_vcpu_e_info_t const *
00026 l4_vcpu_e_info(void const *vcpu) L4_NOTHROW;
00027
00028 L4_INLINE l4_umword_t *
00029 l4_vcpu_e_info_user(void *vcpu) L4_NOTHROW;
00030
00031 L4_INLINE l4_umword_t *
00032 l4_vcpu_e_info_user(void *vcpu) L4_NOTHROW
00033 {
00034   return ((l4_arm_vcpu_e_info_t *)l4_vcpu_e_info(vcpu))->user;
00035 }
00036
00037
00045 L4_INLINE l4_uint32_t
00046 l4_vcpu_e_read_32(void const *vcpu, unsigned id) L4_NOTHROW;
00047
00048 L4_INLINE l4_uint32_t
00049 l4_vcpu_e_read_32(void const *vcpu, unsigned id) L4_NOTHROW
00050 { return *(l4_uint32_t const *)l4_vcpu_e_ptr(vcpu, id); }
00051
00059 L4_INLINE void
00060 l4_vcpu_e_write_32(void *vcpu, unsigned id, l4_uint32_t val) L4_NOTHROW;
00061
00062 L4_INLINE void
00063 l4_vcpu_e_write_32(void *vcpu, unsigned id, l4_uint32_t val) L4_NOTHROW
00064 { *((l4_uint32_t *)l4_vcpu_e_ptr(vcpu, + id)) = val; }
00065
00073 L4_INLINE l4_uint64_t
00074 l4_vcpu_e_read_64(void const *vcpu, unsigned id) L4_NOTHROW;
00075
00076 L4_INLINE l4_uint64_t
00077 l4_vcpu_e_read_64(void const *vcpu, unsigned id) L4_NOTHROW
00078 { return *(l4_uint64_t const *)l4_vcpu_e_ptr(vcpu, id); }
00079
00087 L4_INLINE void
00088 l4_vcpu_e_write_64(void *vcpu, unsigned id, l4_uint64_t val) L4_NOTHROW;
00089
00090 L4_INLINE void
00091 l4_vcpu_e_write_64(void *vcpu, unsigned id, l4_uint64_t val) L4_NOTHROW
00092 { *((l4_uint64_t *)l4_vcpu_e_ptr(vcpu, id)) = val; }
00093
00101 L4_INLINE l4_umword_t
00102 l4_vcpu_e_read(void const *vcpu, unsigned id) L4_NOTHROW;
00103
00104 L4_INLINE l4_umword_t
00105 l4_vcpu_e_read(void const *vcpu, unsigned id) L4_NOTHROW
00106 { return *(l4_umword_t const *)l4_vcpu_e_ptr(vcpu, id); }
00107
00115 L4_INLINE void
00116 l4_vcpu_e_write(void *vcpu, unsigned id, l4_umword_t val) L4_NOTHROW;
00117
00118 L4_INLINE void
00119 l4_vcpu_e_write(void *vcpu, unsigned id, l4_umword_t val) L4_NOTHROW
00120 { *((l4_umword_t *)l4_vcpu_e_ptr(vcpu, id)) = val; }
```

16.434 __vm-svm.h

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/types.h>
00016
00022
00023
00028 typedef struct l4_vm_svm_vmcb_control_area
00029 {
00030   l4_uint16_t intercept_rd_crX;
00031   l4_uint16_t intercept_wr_crX;
00032
00033   l4_uint16_t intercept_rd_drX;
00034   l4_uint16_t intercept_wr_drX;
00035
00036   l4_uint32_t intercept_exceptions;
00037
00038   l4_uint32_t intercept_instruction0;
00039   l4_uint32_t intercept_instruction1;
00040
00041   l4_uint8_t _reserved0[40];
00042
00043   l4_uint16_t pause_filter_threshold;
00044   l4_uint16_t pause_filter_count;
00045
00046   l4_uint64_t iopm_base_pa;
00047   l4_uint64_t msrpm_base_pa;
00048   l4_uint64_t tsc_offset;
00049   l4_uint64_t guest_asid_tlb_ctl;
00050   l4_uint64_t interrupt_ctl;
00051   l4_uint64_t interrupt_shadow;
00052   l4_uint64_t exitcode;
00053   l4_uint64_t exitinfo1;
00054   l4_uint64_t exitinfo2;
00055   l4_uint64_t exitintinfo;
00056   l4_uint64_t np_enable;
00057
00058   l4_uint8_t _reserved1[16];
00059
00060   l4_uint64_t eventinj;
00061   l4_uint64_t n_cr3;
00062   l4_uint64_t lbr_virtualization_enable;
00063   l4_uint64_t clean_bits;
00064   l4_uint64_t n_rip;
00065
00066   l4_uint8_t _reserved2[816];
00067 } __attribute__((packed)) l4_vm_svm_vmcb_control_area_t;
00068
00073 typedef struct l4_vm_svm_vmcb_state_save_area_seg
00074 {
00075   l4_uint16_t selector;
00076   l4_uint16_t attrib;
00077   l4_uint32_t limit;
00078   l4_uint64_t base;
00079 } __attribute__((packed)) l4_vm_svm_vmcb_state_save_area_seg_t;
00080
00085 typedef struct l4_vm_svm_vmcb_state_save_area
00086 {
00087   struct l4_vm_svm_vmcb_state_save_area_seg es;
00088   struct l4_vm_svm_vmcb_state_save_area_seg cs;
00089   struct l4_vm_svm_vmcb_state_save_area_seg ss;
00090   struct l4_vm_svm_vmcb_state_save_area_seg ds;
00091   struct l4_vm_svm_vmcb_state_save_area_seg fs;
00092   struct l4_vm_svm_vmcb_state_save_area_seg gs;
00093   struct l4_vm_svm_vmcb_state_save_area_seg gdtr;
00094   struct l4_vm_svm_vmcb_state_save_area_seg ldtr;
00095   struct l4_vm_svm_vmcb_state_save_area_seg idtr;
00096   struct l4_vm_svm_vmcb_state_save_area_seg tr;
00097
00098   l4_uint8_t _reserved0[43];
00099
00100   l4_uint8_t cpl;
00101
00102   l4_uint32_t _reserved1;
00103
00104   l4_uint64_t efer;
00105
```

```
00106   l4_uint8_t _reserved2[112];
00107
00108   l4_uint64_t cr4;
00109   l4_uint64_t cr3;
00110   l4_uint64_t cr0;
00111   l4_uint64_t dr7;
00112   l4_uint64_t dr6;
00113   l4_uint64_t rflags;
00114   l4_uint64_t rip;
00115
00116   l4_uint8_t _reserved3[88];
00117
00118   l4_uint64_t rsp;
00119
00120   l4_uint8_t _reserved4[24];
00121
00122   l4_uint64_t rax;
00123   l4_uint64_t star;
00124   l4_uint64_t lstar;
00125   l4_uint64_t cstar;
00126   l4_uint64_t sfmask;
00127   l4_uint64_t kernelgsbase;
00128   l4_uint64_t sysenter_cs;
00129   l4_uint64_t sysenter_esp;
00130   l4_uint64_t sysenter_eip;
00131   l4_uint64_t cr2;
00132
00133   l4_uint8_t _reserved5[32];
00134
00135   l4_uint64_t g_pat;
00136   l4_uint64_t dbgctl;
00137   l4_uint64_t br_from;
00138   l4_uint64_t br_to;
00139   l4_uint64_t lastexcpfrom;
00140   l4_uint64_t last_excpto;
00141
00142   // this field is _NOT_ part of the official VMCB specification
00143   // a (userlevel) VMM needs this for proper FPU state virtualization
00144   l4_uint64_t xcr0;
00145
00146   l4_uint8_t _reserved6[2400];
00147 } __attribute__((packed)) l4_vm_svm_vmcb_state_save_area_t;
00148
00149
00154 typedef struct l4_vm_svm_vmcb_t
00155 {
00156   l4_vm_svm_vmcb_control_area_t    control_area;
00157   l4_vm_svm_vmcb_state_save_area_t state_save_area;
00158 } l4_vm_svm_vmcb_t;
```

16.435 __vm-vmx.h

```
00001
00006 /*
00007  * (c) 2010-2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/vcpu.h>
00017
00023
00028 enum L4_vm_vmx_caps_regs
00029 {
00030   L4_VM_VMX_BASIC_REG               = 0,
00031   L4_VM_VMX_TRUE_PINBASED_CTLS_REG  = 1,
00032   L4_VM_VMX_TRUE_PROCBASED_CTLS_REG = 2,
00033   L4_VM_VMX_TRUE_EXIT_CTLS_REG      = 3,
00034   L4_VM_VMX_TRUE_ENTRY_CTLS_REG     = 4,
00035   L4_VM_VMX_MISC_REG                = 5,
00036   L4_VM_VMX_CR0_FIXED0_REG          = 6,
00037   L4_VM_VMX_CR0_FIXED1_REG          = 7,
00038   L4_VM_VMX_CR4_FIXED0_REG          = 8,
00039   L4_VM_VMX_CR4_FIXED1_REG          = 9,
00040   L4_VM_VMX_VMCS_ENUM_REG           = 10,
00041   L4_VM_VMX_PROCBASED_CTLS2_REG     = 11,
00042   L4_VM_VMX_EPT_VPID_CAP_REG        = 12,
00043   L4_VM_VMX_NESTED_REVISION         = 13,
00044   L4_VM_VMX_NUM_CAPS_REGS
00045 };
```

```
00046
00051 enum L4_vm_vmx_dfl1_regs
00052 {
00053   L4_VM_VMX_PINBASED_CTLS_DFL1_REG  = 0,
00054   L4_VM_VMX_PROCBASED_CTLS_DFL1_REG = 1,
00055   L4_VM_VMX_EXIT_CTLS_DFL1_REG      = 2,
00056   L4_VM_VMX_ENTRY_CTLS_DFL1_REG     = 3,
00057   L4_VM_VMX_NUM_DFL1_REGS
00058 };
00059
00069 enum L4_vm_vmx_sw_fields
00070 {
00078   L4_VM_VMX_VMCS_CR2               = 0x6880,
00080   L4_VM_VMX_VMCS_NAT_ARG0          = 0x6882,
00082   L4_VM_VMX_VMCS_NAT_ARG1          = 0x6884,
00084   L4_VM_VMX_VMCS_NAT_ARG2          = 0x6886,
00086   L4_VM_VMX_VMCS_NAT_ARG3          = 0x6888,
00088   L4_VM_VMX_VMCS_XCR0              = 0x2880,
00090   L4_VM_VMX_VMCS_MSR_SYSCALL_MASK  = 0x2882,
00092   L4_VM_VMX_VMCS_MSR_LSTAR         = 0x2884,
00094   L4_VM_VMX_VMCS_MSR_CSTAR         = 0x2886,
00096   L4_VM_VMX_VMCS_MSR_TSC_AUX       = 0x2888,
00098   L4_VM_VMX_VMCS_MSR_STAR          = 0x288a,
00100   L4_VM_VMX_VMCS_MSR_KERNEL_GS_BASE = 0x288c,
00101 };
00102
00155 typedef struct l4_vmx_offset_table_t
00156 {
00157   l4_uint8_t offsets[4][4];
00158   l4_uint8_t limits[4][4];
00159   l4_uint8_t index_shifts[4];
00160   l4_uint8_t base_offset;
00161   l4_uint8_t size;
00162
00163   l4_uint8_t reserved[2];
00164 } l4_vmx_offset_table_t;
00165
00170 enum L4_vm_vmx_vmcs_sizes
00171 {
00173   L4_VM_VMX_VMCS_SIZE_VALUES = 2560,
00175   L4_VM_VMX_VMCS_SIZE_DIRTY_BITMAP = 320,
00176 };
00177
00205 typedef struct l4_vm_vmx_vcpu_vmcs_t
00206 {
00207   l4_uint64_t reserved0;
00208
00209   l4_uint64_t user_data;
00210   l4_uint32_t cr2_index;
00211   l4_uint8_t reserved1[4];
00212
00213   l4_cap_idx_t vmcs;
00214
00215   /*
00216    * Since the capability type size depends on the platform, we add a 32-bit
00217    * padding if necessary.
00218    */
00219
00220 #if L4_MWORD_BITS == 32
00221   l4_uint32_t padding0;
00222 #elif L4_MWORD_BITS == 64
00223   /* No padding needed. */
00224 #else
00225   #error Unsupported machine word size.
00226 #endif
00227
00228   l4_vmx_offset_table_t offset_table;
00229   l4_uint8_t reserved2[120];
00230
00231   l4_uint8_t values[L4_VM_VMX_VMCS_SIZE_VALUES];
00232   l4_uint8_t dirty_bitmap[L4_VM_VMX_VMCS_SIZE_DIRTY_BITMAP];
00233 } l4_vm_vmx_vcpu_vmcs_t;
00234
00239 typedef struct l4_vm_vmx_vcpu_infos_t
00240 {
00242   l4_uint64_t caps[L4_VM_VMX_NUM_CAPS_REGS];
00243
00246   l4_uint32_t dfl1[L4_VM_VMX_NUM_DFL1_REGS];
00247 } l4_vm_vmx_vcpu_infos_t;
00248
00267 typedef struct l4_vm_vmx_vcpu_state_t
00268 {
00269   l4_vcpu_state_t vcpu_state;
00270   l4_uint8_t padding0[L4_VCPU_OFFSET_EXT_INFOS - sizeof(l4_vcpu_state_t)];
00271
00272   l4_vm_vmx_vcpu_infos_t infos;
00273   l4_uint8_t padding1[L4_VCPU_OFFSET_EXT_STATE - L4_VCPU_OFFSET_EXT_INFOS
```

```
00274                       - sizeof(l4_vm_vmx_vcpu_infos_t)];
00275
00276   l4_vm_vmx_vcpu_vmcs_t vmcs;
00277 } l4_vm_vmx_vcpu_state_t;
00278
00288 L4_INLINE
00289 l4_uint64_t
00290 l4_vm_vmx_get_caps(l4_vm_vmx_vcpu_state_t const *vcpu_state,
00291                    enum L4_vm_vmx_caps_regs caps_reg) L4_NOTHROW;
00292
00303 L4_INLINE
00304 l4_uint32_t
00305 l4_vm_vmx_get_caps_default1(l4_vm_vmx_vcpu_state_t const *vcpu_state,
00306                             enum L4_vm_vmx_dfl1_regs dfl1_reg) L4_NOTHROW;
00307
00315 L4_INLINE
00316 unsigned
00317 l4_vm_vmx_field_len(unsigned field) L4_NOTHROW;
00318
00326 L4_INLINE
00327 unsigned
00328 l4_vm_vmx_field_order(unsigned field) L4_NOTHROW;
00329
00344 L4_INLINE
00345 void *
00346 l4_vm_vmx_field_ptr(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW;
00347
00357 L4_INLINE
00358 void
00359 l4_vm_vmx_clear(l4_vm_vmx_vcpu_vmcs_t *vmcs,
00360                 l4_vm_vmx_vcpu_vmcs_t *dest_vmcs) L4_NOTHROW;
00361
00371 L4_INLINE
00372 void
00373 l4_vm_vmx_ptr_load(l4_vm_vmx_vcpu_vmcs_t *vmcs,
00374                    l4_vm_vmx_vcpu_vmcs_t *src_vmcs) L4_NOTHROW;
00375
00391 L4_INLINE
00392 l4_uint32_t
00393 l4_vm_vmx_get_cr2_index(l4_vm_vmx_vcpu_vmcs_t const *vmcs) L4_NOTHROW;
00394
00404 L4_INLINE
00405 l4_umword_t
00406 l4_vm_vmx_read_nat(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW;
00407
00417 L4_INLINE
00418 l4_uint16_t
00419 l4_vm_vmx_read_16(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW;
00420
00430 L4_INLINE
00431 l4_uint32_t
00432 l4_vm_vmx_read_32(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW;
00433
00443 L4_INLINE
00444 l4_uint64_t
00445 l4_vm_vmx_read_64(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW;
00446
00456 L4_INLINE
00457 l4_uint64_t
00458 l4_vm_vmx_read(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW;
00459
00468 L4_INLINE
00469 void
00470 l4_vm_vmx_write_nat(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00471                     l4_umword_t val) L4_NOTHROW;
00472
00481 L4_INLINE
00482 void
00483 l4_vm_vmx_write_16(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00484                    l4_uint16_t val) L4_NOTHROW;
00485
00494 L4_INLINE
00495 void
00496 l4_vm_vmx_write_32(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00497                    l4_uint32_t val) L4_NOTHROW;
00498
00507 L4_INLINE
00508 void
00509 l4_vm_vmx_write_64(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00510                    l4_uint64_t val) L4_NOTHROW;
00511
00520 L4_INLINE
00521 void
00522 l4_vm_vmx_write(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00523                 l4_uint64_t val) L4_NOTHROW;
00524
00571 L4_INLINE
```

```
00572 void
00573 l4_vm_vmx_set_hw_vmcs(l4_vm_vmx_vcpu_vmcs_t *vmcs,
00574                       l4_cap_idx_t vmcs_cap) L4_NOTHROW;
00575
00585 L4_INLINE
00586 l4_cap_idx_t
00587 l4_vm_vmx_get_hw_vmcs(l4_vm_vmx_vcpu_vmcs_t *vmcs) L4_NOTHROW;
00588
00589 /* Implementations */
00590
00591 L4_INLINE
00592 unsigned
00593 l4_vm_vmx_field_len(unsigned field) L4_NOTHROW
00594 {
00595   return 1 << l4_vm_vmx_field_order(field);
00596 }
00597
00598 L4_INLINE
00599 unsigned
00600 l4_vm_vmx_field_order(unsigned field) L4_NOTHROW
00601 {
00602   unsigned size = (field >> 13) & 0x03U;
00603
00604   switch (size)
00605     {
00606     case 0: return 1; /* 16 bits */
00607     case 1: return 3; /* 64 bits */
00608     case 2: return 2; /* 32 bits */
00609     case 3: return (sizeof(l4_umword_t) == 8) ? 3 : 2; /* Natural width */
00610     }
00611
00612   __builtin_trap();
00613 }
00614
00620 L4_INLINE
00621 unsigned
00622 l4_vm_vmx_field_offset(l4_vm_vmx_vcpu_vmcs_t const *vmcs,
00623                        unsigned field) L4_NOTHROW
00624 {
00625   unsigned index = field & 0x3feU;
00626   unsigned size = (field >> 13) & 0x03U;
00627   unsigned group = (field >> 10) & 0x03U;
00628
00629   unsigned shifted_index = index << vmcs->offset_table.index_shifts[size];
00630
00631   if (shifted_index >= (unsigned)vmcs->offset_table.limits[size][group] * 64)
00632     return ~0U;
00633
00634   return (unsigned)vmcs->offset_table.offsets[size][group] * 64
00635          + shifted_index;
00636 }
00637
00638 L4_INLINE
00639 void *
00640 l4_vm_vmx_field_ptr(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW
00641 {
00642   unsigned offset = l4_vm_vmx_field_offset(vmcs, field);
00643   if (offset == ~0U)
00644     return 0;
00645
00646   return (void *)(vmcs->values + offset);
00647 }
00648
00654 L4_INLINE
00655 void *
00656 l4_vm_vmx_field_ptr_offset(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00657                            unsigned *offset) L4_NOTHROW
00658 {
00659   *offset = l4_vm_vmx_field_offset(vmcs, field);
00660   if (*offset == ~0U)
00661     return 0;
00662
00663   return (void *)(vmcs->values + *offset);
00664 }
00665
00671 L4_INLINE
00672 void
00673 l4_vm_vmx_offset_dirty(l4_vm_vmx_vcpu_vmcs_t *vmcs,
00674                        unsigned offset) L4_NOTHROW
00675 {
00676   vmcs->dirty_bitmap[offset / 8] |= 1U << (offset % 8);
00677 }
00678
00683 L4_INLINE
00684 void
00685 l4_vm_vmx_copy_values(l4_vm_vmx_vcpu_vmcs_t const *vmcs, l4_uint8_t *_dst,
00686                       l4_uint8_t const *_src) L4_NOTHROW
```

```
00687 {
00688   unsigned base_offset = vmcs->offset_table.base_offset * 64;
00689   unsigned size = vmcs->offset_table.size * 64;
00690
00691   void *dst = _dst + base_offset;
00692   void const *src = _src + base_offset;
00693   __builtin_memcpy(dst, src, size);
00694 }
00695
00696 L4_INLINE
00697 void
00698 l4_vm_vmx_clear(l4_vm_vmx_vcpu_vmcs_t *vmcs,
00699                 l4_vm_vmx_vcpu_vmcs_t *dest_vmcs) L4_NOTHROW
00700 {
00701   l4_vm_vmx_vcpu_vmcs_t **current_vmcs_ptr
00702     = (l4_vm_vmx_vcpu_vmcs_t **)&vmcs->user_data;
00703
00704   if (*current_vmcs_ptr != dest_vmcs)
00705     return;
00706
00707   l4_vm_vmx_set_hw_vmcs(dest_vmcs, l4_vm_vmx_get_hw_vmcs(vmcs));
00708   l4_vm_vmx_copy_values(vmcs, dest_vmcs->values, vmcs->values);
00709
00710   /* Due to its size, the dirty bitmap is always copied in its entirety. */
00711   __builtin_memcpy(dest_vmcs->dirty_bitmap, vmcs->dirty_bitmap,
00712     L4_VM_VMX_VMCS_SIZE_DIRTY_BITMAP);
00713
00714   *current_vmcs_ptr = 0;
00715 }
00716
00717 L4_INLINE
00718 void
00719 l4_vm_vmx_ptr_load(l4_vm_vmx_vcpu_vmcs_t *vmcs,
00720                    l4_vm_vmx_vcpu_vmcs_t *src_vmcs) L4_NOTHROW
00721 {
00722   l4_vm_vmx_vcpu_vmcs_t **current_vmcs_ptr
00723     = (l4_vm_vmx_vcpu_vmcs_t **)&vmcs->user_data;
00724
00725   if (*current_vmcs_ptr == src_vmcs)
00726     return;
00727
00728   if (*current_vmcs_ptr && *current_vmcs_ptr != src_vmcs)
00729     l4_vm_vmx_clear(vmcs, *current_vmcs_ptr);
00730
00731   *current_vmcs_ptr = src_vmcs;
00732
00733   l4_vm_vmx_set_hw_vmcs(vmcs, l4_vm_vmx_get_hw_vmcs(src_vmcs));
00734   l4_vm_vmx_copy_values(vmcs, vmcs->values, src_vmcs->values);
00735
00736   /* Due to its size, the dirty bitmap is always copied in its entirety. */
00737   __builtin_memcpy(vmcs->dirty_bitmap, src_vmcs->dirty_bitmap,
00738     L4_VM_VMX_VMCS_SIZE_DIRTY_BITMAP);
00739 }
00740
00741 L4_INLINE
00742 l4_umword_t
00743 l4_vm_vmx_read_nat(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW
00744 {
00745   l4_umword_t *ptr = (l4_umword_t *)l4_vm_vmx_field_ptr(vmcs, field);
00746   if (!ptr)
00747     return 0;
00748
00749   return *ptr;
00750 }
00751
00752 L4_INLINE
00753 l4_uint16_t
00754 l4_vm_vmx_read_16(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW
00755 {
00756   l4_uint16_t *ptr = (l4_uint16_t *)l4_vm_vmx_field_ptr(vmcs, field);
00757   if (!ptr)
00758     return 0;
00759
00760   return *ptr;
00761 }
00762
00763 L4_INLINE
00764 l4_uint32_t
00765 l4_vm_vmx_read_32(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW
00766 {
00767   l4_uint32_t *ptr = (l4_uint32_t *)l4_vm_vmx_field_ptr(vmcs, field);
00768   if (!ptr)
00769     return 0;
00770
00771   return *ptr;
00772 }
00773
```

```
00774 L4_INLINE
00775 l4_uint64_t
00776 l4_vm_vmx_read_64(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW
00777 {
00778   l4_uint64_t *ptr = (l4_uint64_t *)l4_vm_vmx_field_ptr(vmcs, field);
00779   if (!ptr)
00780     return 0;
00781
00782   return *ptr;
00783 }
00784
00785 L4_INLINE
00786 l4_uint64_t
00787 l4_vm_vmx_read(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field) L4_NOTHROW
00788 {
00789   unsigned size = (field » 13) & 0x03U;
00790
00791   switch (size)
00792     {
00793     case 0: return l4_vm_vmx_read_16(vmcs, field);
00794     case 1: return l4_vm_vmx_read_64(vmcs, field);
00795     case 2: return l4_vm_vmx_read_32(vmcs, field);
00796     case 3: return l4_vm_vmx_read_nat(vmcs, field);
00797     }
00798
00799   __builtin_trap();
00800 }
00801
00802 L4_INLINE
00803 void
00804 l4_vm_vmx_write_nat(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00805                     l4_umword_t val) L4_NOTHROW
00806 {
00807   unsigned offset;
00808   l4_umword_t *ptr
00809     = (l4_umword_t *)l4_vm_vmx_field_ptr_offset(vmcs, field, &offset);
00810
00811   if ((ptr) && (*ptr != val))
00812     {
00813       *ptr = val;
00814       l4_vm_vmx_offset_dirty(vmcs, offset);
00815     }
00816 }
00817
00818 L4_INLINE
00819 void
00820 l4_vm_vmx_write_16(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00821                    l4_uint16_t val) L4_NOTHROW
00822 {
00823   unsigned offset;
00824   l4_uint16_t *ptr
00825     = (l4_uint16_t *)l4_vm_vmx_field_ptr_offset(vmcs, field, &offset);
00826
00827   if ((ptr) && (*ptr != val))
00828     {
00829       *ptr = val;
00830       l4_vm_vmx_offset_dirty(vmcs, offset);
00831     }
00832 }
00833
00834 L4_INLINE
00835 void
00836 l4_vm_vmx_write_32(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00837                    l4_uint32_t val) L4_NOTHROW
00838 {
00839   unsigned offset;
00840   l4_uint32_t *ptr
00841     = (l4_uint32_t *)l4_vm_vmx_field_ptr_offset(vmcs, field, &offset);
00842
00843   if ((ptr) && (*ptr != val))
00844     {
00845       *ptr = val;
00846       l4_vm_vmx_offset_dirty(vmcs, offset);
00847     }
00848 }
00849
00850 L4_INLINE
00851 void
00852 l4_vm_vmx_write_64(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00853                    l4_uint64_t val) L4_NOTHROW
00854 {
00855   unsigned offset;
00856   l4_uint64_t *ptr
00857     = (l4_uint64_t *)l4_vm_vmx_field_ptr_offset(vmcs, field, &offset);
00858
00859   if ((ptr) && (*ptr != val))
00860     {
```

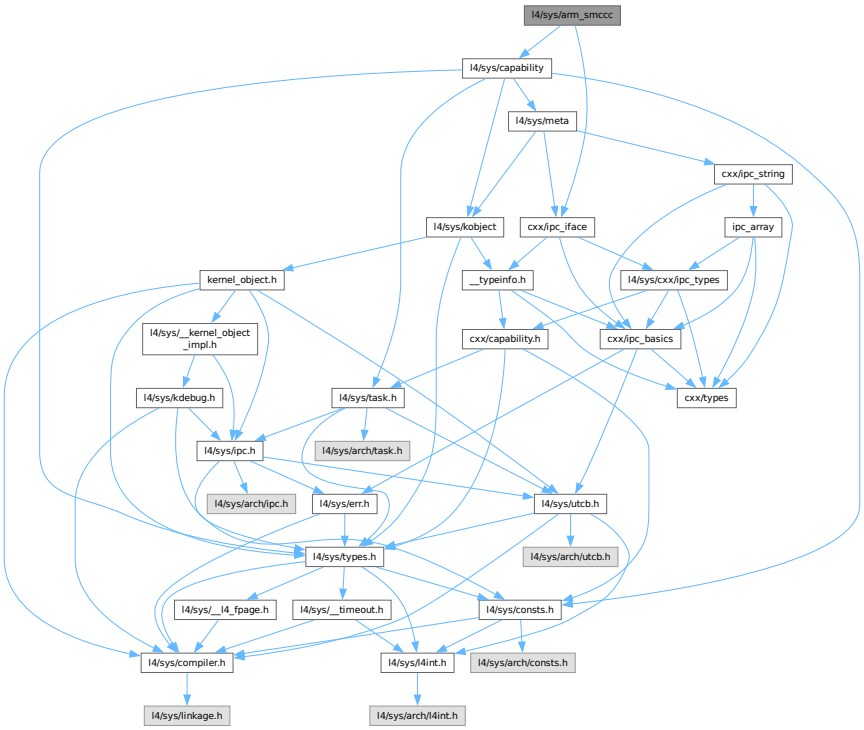
```
00861       *ptr = val;
00862       l4_vm_vmx_offset_dirty(vmcs, offset);
00863     }
00864 }
00865
00866 L4_INLINE
00867 void
00868 l4_vm_vmx_write(l4_vm_vmx_vcpu_vmcs_t *vmcs, unsigned field,
00869                 l4_uint64_t val) L4_NOTHROW
00870 {
00871   unsigned size = (field » 13) & 0x03U;
00872
00873   switch (size)
00874     {
00875     case 0: l4_vm_vmx_write_16(vmcs, field, val); break;
00876     case 1: l4_vm_vmx_write_64(vmcs, field, val); break;
00877     case 2: l4_vm_vmx_write_32(vmcs, field, val); break;
00878     case 3: l4_vm_vmx_write_nat(vmcs, field, val); break;
00879     }
00880 }
00881
00882 L4_INLINE
00883 l4_uint64_t
00884 l4_vm_vmx_get_caps(l4_vm_vmx_vcpu_state_t const *vcpu_state,
00885                    enum L4_vm_vmx_caps_regs caps_reg) L4_NOTHROW
00886 {
00887   return vcpu_state->infos.caps[caps_reg];
00888 }
00889
00890 L4_INLINE
00891 l4_uint32_t
00892 l4_vm_vmx_get_caps_default1(l4_vm_vmx_vcpu_state_t const *vcpu_state,
00893                             enum L4_vm_vmx_dfl1_regs dfl1_reg) L4_NOTHROW
00894 {
00895   return vcpu_state->infos.dfl1[dfl1_reg];
00896 }
00897
00898 L4_INLINE
00899 l4_uint32_t
00900 l4_vm_vmx_get_cr2_index(l4_vm_vmx_vcpu_vmcs_t const *vmcs) L4_NOTHROW
00901 {
00902   return vmcs->cr2_index;
00903 }
00904
00905 L4_INLINE
00906 void
00907 l4_vm_vmx_set_hw_vmcs(l4_vm_vmx_vcpu_vmcs_t *vmcs,
00908                       l4_cap_idx_t vmcs_cap) L4_NOTHROW
00909 {
00910   vmcs->vmcs = vmcs_cap;
00911 }
00912
00913 L4_INLINE
00914 l4_cap_idx_t
00915 l4_vm_vmx_get_hw_vmcs(l4_vm_vmx_vcpu_vmcs_t *vmcs) L4_NOTHROW
00916 {
00917   return vmcs->vmcs & L4_CAP_MASK;
00918 }
```

16.436 l4/sys/arm_smccc File Reference

ARM secure monitor call functions.

```
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for arm_smccc:



Data Structures

- class L4::Arm_smccc

  Wrapper for function calls that follow the ARM SMC/HVC calling convention.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.436.1 Detailed Description

ARM secure monitor call functions.
Definition in file arm_smccc.

16.437 arm_smccc

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2018, 2022, 2024 Kernkonzept GmbH.
00004  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012 #pragma once
00013
00014 #include <l4/sys/capability>
00015 #include <l4/sys/cxx/ipc_iface>
00016
00017 namespace L4 {
00018
00023 class L4_EXPORT Arm_smccc : public Kobject_0t<Arm_smccc, L4_PROTO_SMCCC>
```

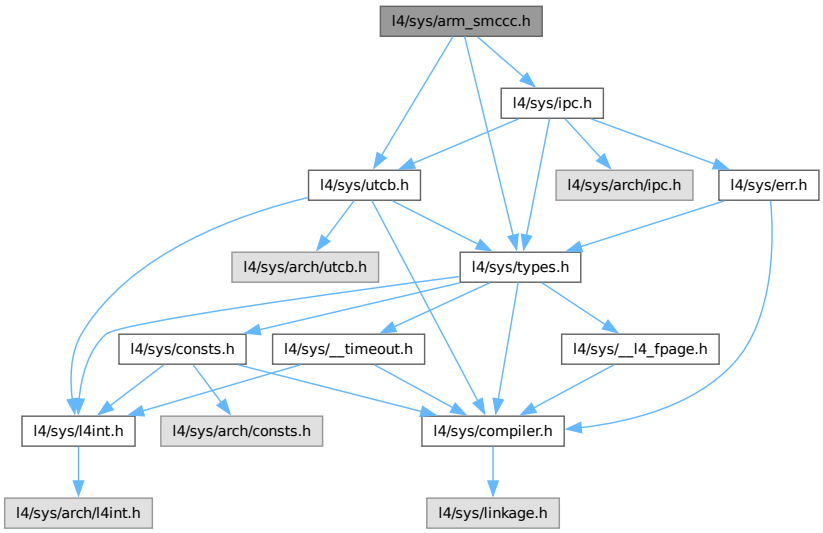
```
00024 {
00025 public:
00064   L4_INLINE_RPC(l4_msgtag_t, call,
00065                 (l4_umword_t func, l4_umword_t in0, l4_umword_t in1,
00066                  l4_umword_t in2, l4_umword_t in3, l4_umword_t in4,
00067                  l4_umword_t in5, l4_umword_t *out0, l4_umword_t *out1,
00068                  l4_umword_t *out2, l4_umword_t *out3,
00069                  l4_umword_t client_id));
00070
00071   typedef L4::Typeid::Rpc_nocode<call_t> Rpcs;
00072 };
00073
00074 }
```

16.438 l4/sys/arm_smccc.h File Reference

ARM secure monitor call functions.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for arm_smccc.h:



Functions

- l4_msgtag_t l4_arm_smccc_call (l4_cap_idx_t pfc, l4_umword_t func, l4_umword_t in0, l4_umword_t in1, l4_umword_t in2, l4_umword_t in3, l4_umword_t in4, l4_umword_t in5, l4_umword_t *out0, l4_umword_t *out1, l4_umword_t *out2, l4_umword_t *out3, l4_umword_t client_id) L4_NOTHROW

  C interface for calling the ARM secure monitor, see L4::Arm_smccc::call() for the C++ interface.

16.438.1 Detailed Description

ARM secure monitor call functions.
Definition in file arm_smccc.h.

16.438.2 Function Documentation

16.438.2.1 l4_arm_smccc_call()

```
l4_msgtag_t l4_arm_smccc_call (
            l4_cap_idx_t pfc,
```

```
l4_umword_t func,
l4_umword_t in0,
l4_umword_t in1,
l4_umword_t in2,
l4_umword_t in3,
l4_umword_t in4,
l4_umword_t in5,
l4_umword_t * out0,
l4_umword_t * out1,
l4_umword_t * out2,
l4_umword_t * out3,
l4_umword_t client_id)  [inline]
```

C interface for calling the ARM secure monitor, see L4::Arm_smccc::call() for the C++ interface.

Parameters

	pfc	Capability of the SMC kernel object. The input parameters consist of a function identifier, 6 arguments and a client id. Results are returned in 4 output parameters.
	func	Function identifier. • Bit 31 has to be set: This marks the call as *Fast Call*. *Yielding Calls* (bit 31 unset) are rejected by the kernel. • Bit 30 defines the calling convention: • Bit 30 == 1: 64-bit calling convention. • Bit 30 == 0: 32-bit calling convention. • Bits 24..29 determine the service call ID. The permitted IDs are set in the kernel configuration. By default only service IDs >= 0x30000000 (*Trusted Application Calls* and *Trusted OS Calls*) are allowed.
in	*in0*	First input parameter.
in	*in1*	Second input parameter.
in	*in2*	Third input parameter.
in	*in3*	Fourth input parameter.
in	*in4*	Fifth input parameter.
in	*in5*	Sixth input parameter.
out	*out0*	First output parameter.
out	*out1*	Second output parameter.
out	*out2*	Third output parameter.
out	*out3*	Fourth output parameter.
in	*client_id*	Client ID. According to the specification, this value might be ignored by certain functions.

Return values

-L4_ENOSYS	Either bit 31 of the function call not set or service ID outside the range permitted by kernel configuration.
-L4_EINVAL	Invalid number of parameters.
<0	Other L4 error.

0	Success.

Definition at line 42 of file arm_smccc.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



16.439 arm_smccc.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2018, 2022, 2024 Kernkonzept GmbH.
00003  * Author(s): Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00011 #pragma once
00012
00013 #include <l4/sys/types.h>
00014 #include <l4/sys/utcb.h>
00015
00016 L4_INLINE l4_msgtag_t
00017 l4_arm_smccc_call(l4_cap_idx_t pfc, l4_umword_t func, l4_umword_t in0,
00018                   l4_umword_t in1, l4_umword_t in2, l4_umword_t in3,
00019                   l4_umword_t in4, l4_umword_t in5, l4_umword_t *out0,
00020                   l4_umword_t *out1, l4_umword_t *out2, l4_umword_t *out3,
00021                   l4_umword_t client_id) L4_NOTHROW;
00022
00023 L4_INLINE l4_msgtag_t
00024 l4_arm_smccc_call_u(l4_cap_idx_t pfc, l4_umword_t func, l4_umword_t in0,
00025                     l4_umword_t in1, l4_umword_t in2, l4_umword_t in3,
00026                     l4_umword_t in4, l4_umword_t in5, l4_umword_t *out0,
00027                     l4_umword_t *out1, l4_umword_t *out2, l4_umword_t *out3,
00028                     l4_umword_t client_id, l4_utcb_t *utcb) L4_NOTHROW;
00029
00030 /* IMPLEMENTATION ----------------------------------------------------------*/
00031
00032 #include <l4/sys/ipc.h>
00033
00041 L4_INLINE l4_msgtag_t
00042 l4_arm_smccc_call(l4_cap_idx_t pfc, l4_umword_t func,
00043                   l4_umword_t in0, l4_umword_t in1,
00044                   l4_umword_t in2, l4_umword_t in3,
00045                   l4_umword_t in4, l4_umword_t in5,
00046                   l4_umword_t *out0, l4_umword_t *out1,
00047                   l4_umword_t *out2, l4_umword_t *out3,
00048                   l4_umword_t client_id) L4_NOTHROW
00049 {
00050   return l4_arm_smccc_call_u(pfc, func, in0, in1, in2, in3, in4, in5,
00051                              out0, out1, out2, out3, client_id, l4_utcb());
00052 }
00053
00054
00055 L4_INLINE l4_msgtag_t
00056 l4_arm_smccc_call_u(l4_cap_idx_t pfc, l4_umword_t func, l4_umword_t in0,
00057                     l4_umword_t in1, l4_umword_t in2, l4_umword_t in3,
00058                     l4_umword_t in4, l4_umword_t in5, l4_umword_t *out0,
00059                     l4_umword_t *out1, l4_umword_t *out2, l4_umword_t *out3,
00060                     l4_umword_t client_id, l4_utcb_t *utcb) L4_NOTHROW
00061 {
00062   l4_msgtag_t ret;
00063   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00064   v->mr[0] = func;
00065   v->mr[1] = in0;
00066   v->mr[2] = in1;
00067   v->mr[3] = in2;
```

```
00068   v->mr[4] = in3;
00069   v->mr[5] = in4;
00070   v->mr[6] = in5;
00071   v->mr[7] = client_id;
00072
00073   ret = l4_ipc_call(pfc, utcb, l4_msgtag(L4_PROTO_SMCCC, 8, 0, 0),
00074                     L4_IPC_NEVER);
00075
00076   if (l4_error(ret) >= 0)
00077     {
00078       *out0 = v->mr[0];
00079       *out1 = v->mr[1];
00080       *out2 = v->mr[2];
00081       *out3 = v->mr[3];
00082     }
00083
00084   return ret;
00085 }
```

16.440 amd64/l4/sys/arch/cache.h File Reference

Cache functions.

Functions

- int l4_cache_clean_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache clean a range in D-cache; writes back to PoC.
- int l4_cache_flush_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache flush a range; writes back to PoC.
- int l4_cache_inv_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache invalidate a range; might write back to PoC.
- int l4_cache_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent between I-cache and D-cache; writes back to PoU.
- int l4_cache_dma_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.
- int **l4_cache_dma_coherent_full** (void) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.

16.440.1 Detailed Description

Cache functions.
Definition in file cache.h.

16.441 cache.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #ifndef __L4SYS__INCLUDE__ARCH_AMD64__CACHE_H__
00012 #define __L4SYS__INCLUDE__ARCH_AMD64__CACHE_H__
00013
00014 L4_INLINE int
00015 l4_cache_clean_data(unsigned long start,
00016                     unsigned long end) L4_NOTHROW
00017 {
00018   (void)start; (void)end;
00019   return 0;
00020 }
00021
00022 L4_INLINE int
00023 l4_cache_flush_data(unsigned long start,
00024                     unsigned long end) L4_NOTHROW
00025 {
```

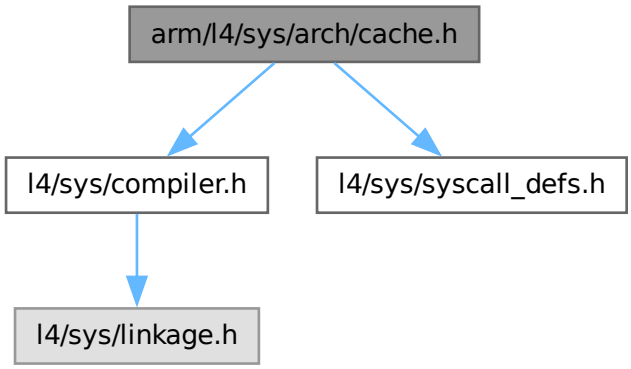
```
00026   (void)start; (void)end;
00027   return 0;
00028 }
00029
00030 L4_INLINE int
00031 l4_cache_inv_data(unsigned long start,
00032                   unsigned long end) L4_NOTHROW
00033 {
00034   (void)start; (void)end;
00035   return 0;
00036 }
00037
00038 L4_INLINE int
00039 l4_cache_coherent(unsigned long start,
00040                   unsigned long end) L4_NOTHROW
00041 {
00042   (void)start; (void)end;
00043   return 0;
00044 }
00045
00046 L4_INLINE int
00047 l4_cache_dma_coherent(unsigned long start,
00048                       unsigned long end) L4_NOTHROW
00049 {
00050   (void)start; (void)end;
00051   return 0;
00052 }
00053
00054 L4_INLINE int
00055 l4_cache_dma_coherent_full(void) L4_NOTHROW
00056 {
00057   return 0;
00058 }
00059
00060 #endif /* ! __L4SYS__INCLUDE__ARCH_AMD64__CACHE_H__ */
```

16.442 arm/l4/sys/arch/cache.h File Reference

Cache functions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/syscall_defs.h>
```

Include dependency graph for cache.h:



Functions

- int l4_cache_clean_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache clean a range in D-cache; writes back to PoC.
- int l4_cache_flush_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache flush a range; writes back to PoC.

- int l4_cache_inv_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache invalidate a range; might write back to PoC.
- int l4_cache_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent between I-cache and D-cache; writes back to PoU.
- int l4_cache_dma_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.
- int **l4_cache_dma_coherent_full** (void) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.

16.442.1 Detailed Description

Cache functions.

Date

2007-11

Author

Adam Lackorzynski adam@os.inf.tu-dresden.de

Definition in file cache.h.

16.443 cache.h

Go to the documentation of this file.

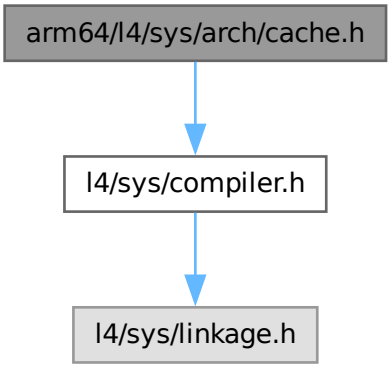
```
00001
00009 /*
00010  * (c) 2007-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #ifndef __L4SYS__INCLUDE__ARCH_ARM__CACHE_H__
00016 #define __L4SYS__INCLUDE__ARCH_ARM__CACHE_H__
00017
00018 #include <l4/sys/compiler.h>
00019 #include <l4/sys/syscall_defs.h>
00020
00024 L4_INLINE void
00025 l4_cache_op_arm_call(unsigned long op,
00026                      unsigned long start,
00027                      unsigned long end);
00028
00029 L4_INLINE void
00030 l4_cache_op_arm_call(unsigned long op,
00031                      unsigned long start,
00032                      unsigned long end)
00033 {
00034   register unsigned long _op    __asm__ ("r0") = op;
00035   register unsigned long _start __asm__ ("r1") = start;
00036   register unsigned long _end   __asm__ ("r2") = end;
00037
00038   __asm__ __volatile__
00039     ("@ l4_cache_op_arm_call(start) \n\t"
00040      "mov     r5, %[sc]             \n\t"
00041      "blx     __l4_sys_syscall      \n\t"
00042      "@ l4_cache_op_arm_call(end)   \n\t"
00043        :
00044   "=r" (_op),
00045   "=r" (_start),
00046   "=r" (_end)
00047        :
00048        [sc] "i" (L4_SYSCALL_MEM_OP),
00049   "0" (_op),
00050   "1" (_start),
00051   "2" (_end)
00052        :
00053   "cc", "memory", "r5", "ip", "lr"
00054        );
00055 }
00056
00057 enum L4_mem_cache_ops
00058 {
```

```
00059   L4_MEM_CACHE_OP_CLEAN_DATA        = 0,
00060   L4_MEM_CACHE_OP_FLUSH_DATA        = 1,
00061   L4_MEM_CACHE_OP_INV_DATA          = 2,
00062   L4_MEM_CACHE_OP_COHERENT          = 3,
00063   L4_MEM_CACHE_OP_DMA_COHERENT      = 4,
00064   L4_MEM_CACHE_OP_DMA_COHERENT_FULL = 5,
00065 };
00066
00067 L4_INLINE int
00068 l4_cache_clean_data(unsigned long start,
00069                     unsigned long end) L4_NOTHROW
00070 {
00071   l4_cache_op_arm_call(L4_MEM_CACHE_OP_CLEAN_DATA, start, end);
00072   return 0;
00073 }
00074
00075 L4_INLINE int
00076 l4_cache_flush_data(unsigned long start,
00077                     unsigned long end) L4_NOTHROW
00078 {
00079   l4_cache_op_arm_call(L4_MEM_CACHE_OP_FLUSH_DATA, start, end);
00080   return 0;
00081 }
00082
00083 L4_INLINE int
00084 l4_cache_inv_data(unsigned long start,
00085                   unsigned long end) L4_NOTHROW
00086 {
00087   l4_cache_op_arm_call(L4_MEM_CACHE_OP_INV_DATA, start, end);
00088   return 0;
00089 }
00090
00091 L4_INLINE int
00092 l4_cache_coherent(unsigned long start,
00093                   unsigned long end) L4_NOTHROW
00094 {
00095   l4_cache_op_arm_call(L4_MEM_CACHE_OP_COHERENT, start, end);
00096   return 0;
00097 }
00098
00099 L4_INLINE int
00100 l4_cache_dma_coherent(unsigned long start,
00101                       unsigned long end) L4_NOTHROW
00102 {
00103   l4_cache_op_arm_call(L4_MEM_CACHE_OP_DMA_COHERENT, start, end);
00104   return 0;
00105 }
00106
00107 L4_INLINE int
00108 l4_cache_dma_coherent_full(void) L4_NOTHROW
00109 {
00110   l4_cache_op_arm_call(L4_MEM_CACHE_OP_DMA_COHERENT_FULL, 0, 0);
00111   return 0;
00112 }
00113
00114 #endif /* ! __L4SYS__INCLUDE__ARCH_ARM__CACHE_H__ */
```

16.444 arm64/l4/sys/arch/cache.h File Reference

Cache functions.

```
#include <l4/sys/compiler.h>
```
Include dependency graph for cache.h:



Functions

- int l4_cache_clean_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache clean a range in D-cache; writes back to PoC.
- int l4_cache_flush_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache flush a range; writes back to PoC.
- int l4_cache_inv_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache invalidate a range; might write back to PoC.
- int l4_cache_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent between I-cache and D-cache; writes back to PoU.
- int l4_cache_dma_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.

16.444.1 Detailed Description

Cache functions.

Date

2007-11

Author

Adam Lackorzynski adam@os.inf.tu-dresden.de

Definition in file cache.h.

16.445 cache.h

Go to the documentation of this file.

```
00001
00009 /*
00010  * (c) 2007-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
```

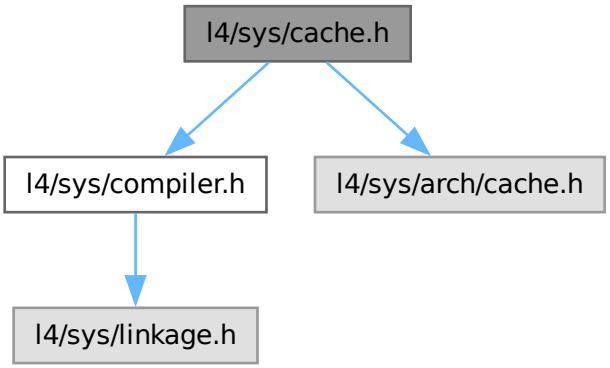
```
00015 #ifndef __L4SYS__INCLUDE__ARCH_ARM__CACHE_H__
00016 #define __L4SYS__INCLUDE__ARCH_ARM__CACHE_H__
00017
00018 #include <l4/sys/compiler.h>
00019
00020 L4_INLINE unsigned long __attribute__((pure, always_inline))
00021 l4_cache_arm_ctr(void);
00022
00023 L4_INLINE unsigned long __attribute__((pure, always_inline))
00024 l4_cache_arm_ctr(void)
00025 {
00026   unsigned long v;
00027   asm ("mrs %0, CTR_EL0" : "=r"(v));
00028   return v;
00029 }
00030
00031 L4_INLINE unsigned __attribute__((pure, always_inline))
00032 l4_cache_dmin_line(void);
00033
00034 L4_INLINE unsigned __attribute__((pure, always_inline))
00035 l4_cache_dmin_line(void)
00036 {
00037   return 4U << ((l4_cache_arm_ctr() >> 16) & 0xf);
00038 }
00039
00040 #define L4_ARM_CACHE_LOOP(op)                                    \
00041   unsigned long step;                                            \
00042                                                                  \
00043   if (start > end)                                               \
00044     __builtin_unreachable();                                     \
00045                                                                  \
00046   step = l4_cache_dmin_line();                                   \
00047   start &= ~(step - 1);                                          \
00048   end = (end + step - 1) & ~(step - 1);                          \
00049   for (; start != end; start += step)                            \
00050     asm volatile (op ", %0" : : "r"(start) : "memory");          \
00051   asm volatile ("dsb ish");
00052
00053
00054 L4_INLINE int
00055 l4_cache_clean_data(unsigned long start,
00056                     unsigned long end) L4_NOTHROW
00057 {
00058   L4_ARM_CACHE_LOOP("dc cvac");
00059   return 0;
00060 }
00061
00062 L4_INLINE int
00063 l4_cache_flush_data(unsigned long start,
00064                     unsigned long end) L4_NOTHROW
00065 {
00066   L4_ARM_CACHE_LOOP("dc civac");
00067   return 0;
00068 }
00069
00070 L4_INLINE int
00071 l4_cache_inv_data(unsigned long start,
00072                   unsigned long end) L4_NOTHROW
00073 {
00074   // DC IVAC is always privileged, use DC CIVAC instead
00075   L4_ARM_CACHE_LOOP("dc civac");
00076   return 0;
00077 }
00078
00079 L4_INLINE int
00080 l4_cache_coherent(unsigned long start,
00081                   unsigned long end) L4_NOTHROW
00082 {
00083   L4_ARM_CACHE_LOOP("dc cvau, %0; ic ivau");
00084   asm volatile ("isb");
00085   return 0;
00086 }
00087
00088 L4_INLINE int
00089 l4_cache_dma_coherent(unsigned long start,
00090                       unsigned long end) L4_NOTHROW
00091 {
00092   L4_ARM_CACHE_LOOP("dc civac");
00093   return 0;
00094 }
00095
00096 #undef L4_ARM_CACHE_LOOP
00097
00098 #endif /* ! __L4SYS__INCLUDE__ARCH_ARM__CACHE_H__ */
```

16.446 l4/sys/cache.h File Reference

Cache-consistency functions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/arch/cache.h>
```

Include dependency graph for cache.h:



Functions

- L4_BEGIN_DECLS int l4_cache_clean_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache clean a range in D-cache; writes back to PoC.
- int l4_cache_flush_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache flush a range; writes back to PoC.
- int l4_cache_inv_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache invalidate a range; might write back to PoC.
- int l4_cache_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent between I-cache and D-cache; writes back to PoU.
- int l4_cache_dma_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.
- int **l4_cache_dma_coherent_full** (void) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.

16.446.1 Detailed Description

Cache-consistency functions.

Date

2007-11

Author

Adam Lackorzynski adam@os.inf.tu-dresden.de

Definition in file cache.h.

16.447 cache.h

Go to the documentation of this file.

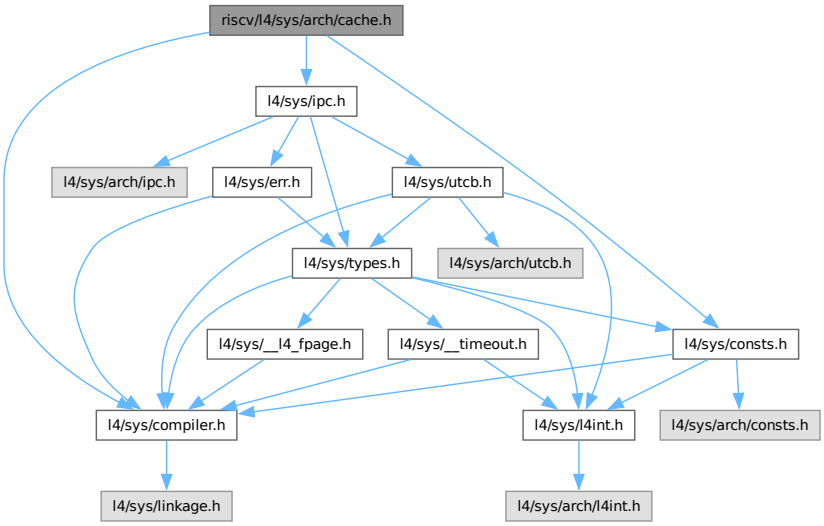
```
00001
00010 /*
00011  * (c) 2007-2009 Author(s)
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  *
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016
00017 #ifndef __L4SYS__INCLUDE__CACHE_H__
00018 #define __L4SYS__INCLUDE__CACHE_H__
00019
00020 #include <l4/sys/compiler.h>
00021
00036
00037 L4_BEGIN_DECLS
00038
00053 L4_INLINE int
00054 l4_cache_clean_data(unsigned long start,
00055                     unsigned long end) L4_NOTHROW;
00056
00071 L4_INLINE int
00072 l4_cache_flush_data(unsigned long start,
00073                     unsigned long end) L4_NOTHROW;
00074
00093 L4_INLINE int
00094 l4_cache_inv_data(unsigned long start,
00095                   unsigned long end) L4_NOTHROW;
00096
00108 L4_INLINE int
00109 l4_cache_coherent(unsigned long start,
00110                   unsigned long end) L4_NOTHROW;
00111
00123 L4_INLINE int
00124 l4_cache_dma_coherent(unsigned long start,
00125                       unsigned long end) L4_NOTHROW;
00126
00127 #if !defined(ARCH_arm64)
00132 L4_INLINE int
00133 l4_cache_dma_coherent_full(void) L4_NOTHROW;
00134 #endif
00135
00136 L4_END_DECLS
00137
00138 #include <l4/sys/arch/cache.h>
00139
00140 #endif /* ! __L4SYS__INCLUDE__CACHE_H__ */
```

16.448 riscv/l4/sys/arch/cache.h File Reference

Cache functions.

```
#include <l4/sys/ipc.h>
#include <l4/sys/consts.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for cache.h:



Functions

- int l4_cache_clean_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache clean a range in D-cache; writes back to PoC.
- int l4_cache_flush_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache flush a range; writes back to PoC.
- int l4_cache_inv_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache invalidate a range; might write back to PoC.
- int l4_cache_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent between I-cache and D-cache; writes back to PoU.
- int l4_cache_dma_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.
- int **l4_cache_dma_coherent_full** (void) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.

16.448.1 Detailed Description

Cache functions.
Definition in file cache.h.

16.449 cache.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00007  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/ipc.h>
00014 #include <l4/sys/consts.h>
00015 #include <l4/sys/compiler.h>
00016
```

```
00017 L4_INLINE int
00018 l4_cache_clean_data(unsigned long start,
00019                     unsigned long end) L4_NOTHROW
00020 {
00021   (void)start;(void)end;
00022   return 0;
00023 }
00024
00025 L4_INLINE int
00026 l4_cache_flush_data(unsigned long start,
00027                     unsigned long end) L4_NOTHROW
00028 {
00029   (void)start;(void)end;
00030   return 0;
00031 }
00032
00033 L4_INLINE int
00034 l4_cache_inv_data(unsigned long start,
00035                   unsigned long end) L4_NOTHROW
00036 {
00037   (void)start;(void)end;
00038   return 0;
00039 }
00040
00041 L4_INLINE int
00042 l4_cache_coherent(unsigned long start,
00043                   unsigned long end) L4_NOTHROW
00044 {
00045   (void)start;(void)end;
00046   asm volatile ("fence.i");
00047   return 0;
00048 }
00049
00050 L4_INLINE int
00051 l4_cache_dma_coherent(unsigned long start,
00052                       unsigned long end) L4_NOTHROW
00053 {
00054   (void)start;(void)end;
00055   return 0;
00056 }
00057
00058 L4_INLINE int
00059 l4_cache_dma_coherent_full(void) L4_NOTHROW
00060 {
00061   return 0;
00062 }
```

16.450 x86/l4/sys/arch/cache.h File Reference

Cache functions.

Functions

- int l4_cache_clean_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache clean a range in D-cache; writes back to PoC.
- int l4_cache_flush_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache flush a range; writes back to PoC.
- int l4_cache_inv_data (unsigned long start, unsigned long end) L4_NOTHROW

  Cache invalidate a range; might write back to PoC.
- int l4_cache_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent between I-cache and D-cache; writes back to PoU.
- int l4_cache_dma_coherent (unsigned long start, unsigned long end) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.
- int **l4_cache_dma_coherent_full** (void) L4_NOTHROW

  Make memory coherent for use with external memory; writes back to PoC.

16.450.1 Detailed Description

Cache functions.
Definition in file cache.h.

16.451 cache.h

Go to the documentation of this file.

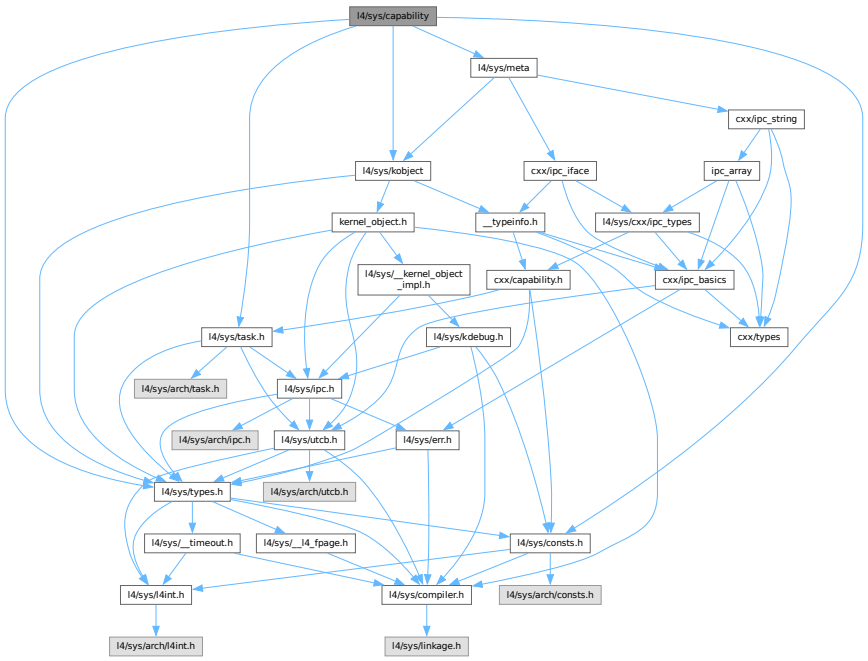
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #ifndef __L4SYS__INCLUDE__ARCH_X86__CACHE_H__
00012 #define __L4SYS__INCLUDE__ARCH_X86__CACHE_H__
00013
00014 L4_INLINE int
00015 l4_cache_clean_data(unsigned long start,
00016                     unsigned long end) L4_NOTHROW
00017 {
00018   (void)start; (void)end;
00019   return 0;
00020 }
00021
00022 L4_INLINE int
00023 l4_cache_flush_data(unsigned long start,
00024                     unsigned long end) L4_NOTHROW
00025 {
00026   (void)start; (void)end;
00027   return 0;
00028 }
00029
00030 L4_INLINE int
00031 l4_cache_inv_data(unsigned long start,
00032                   unsigned long end) L4_NOTHROW
00033 {
00034   (void)start; (void)end;
00035   return 0;
00036 }
00037
00038 L4_INLINE int
00039 l4_cache_coherent(unsigned long start,
00040                   unsigned long end) L4_NOTHROW
00041 {
00042   (void)start; (void)end;
00043   return 0;
00044 }
00045
00046 L4_INLINE int
00047 l4_cache_dma_coherent(unsigned long start,
00048                       unsigned long end) L4_NOTHROW
00049 {
00050   (void)start; (void)end;
00051   return 0;
00052 }
00053
00054 L4_INLINE int
00055 l4_cache_dma_coherent_full(void) L4_NOTHROW
00056 {
00057   return 0;
00058 }
00059
00060 #endif /* ! __L4SYS__INCLUDE__ARCH_X86__CACHE_H__ */
```

16.452 l4/sys/capability File Reference

L4::Cap related definitions.

```
#include <l4/sys/consts.h>
#include <l4/sys/types.h>
#include <l4/sys/kobject>
#include <l4/sys/task.h>
#include <l4/sys/meta>
```

Include dependency graph for capability:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4

  L4 low-level kernel interface.

Macros

- #define L4_DISABLE_COPY(_class)

  Disable copy of a class.

Functions

- template<typename T, typename F>
  Cap< T > L4::cap_dynamic_cast (Cap< F > const &c) noexcept

  `dynamic_cast` *for capabilities.*

16.452.1 Detailed Description

L4::Cap related definitions.

Author

Alexander Warg `alexander.warg@os.inf.tu-dresden.de`

Definition in file capability.

16.452.2 Macro Definition Documentation

16.452.2.1 L4_DISABLE_COPY

```
#define L4_DISABLE_COPY(
              _class)
```

Value:

```
  public:                                          \
    _class(_class const &) = delete;               \
    _class operator = (_class const &) = delete; \
  private:
```

Disable copy of a class.

Parameters

_class	Name of the class that shall not have value copy semantics.

The typical use of this is:

```
class Non_value
{
  L4_DISABLE_COPY(Non_value)

  ...
}
```

Definition at line 52 of file capability.

16.453 capability

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00009 /*
00010  * (c) 2008-2009,2015 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #pragma once
00016
00017 #include <l4/sys/consts.h>
00018 #include <l4/sys/types.h>
00019 #include <l4/sys/kobject>
00020 #include <l4/sys/task.h>
00021
00022 namespace L4
00023 {
00024
00025 /* Forward declarations for our kernel object classes. */
00026 class Task;
00027 class Thread;
00028 class Thread_group;
00029 class Factory;
00030 class Irq;
00031 class Log;
00032 class Vm;
00033 class Vcpu_context;
00034 class Kobject;
00035
00051 #if __cplusplus >= 201103L
00052 #  define L4_DISABLE_COPY(_class)                \
00053   public:                                       \
00054     _class(_class const &) = delete;            \
00055     _class operator = (_class const &) = delete; \
00056   private:
00057 #else
00058 #  define L4_DISABLE_COPY(_class)       \
00059   private:                              \
00060     _class(_class const &);             \
00061     _class operator = (_class const &);
00062 #endif
00063
00064
00065 #define L4_KOBJECT_DISABLE_COPY(_class) \
00066   protected:                            \
00067     _class();                           \
00068   L4_DISABLE_COPY(_class)
00069
```

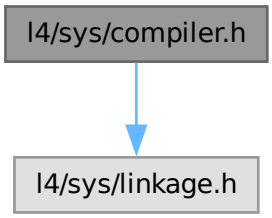
```
00070
00071 #define L4_KOBJECT(_class) L4_KOBJECT_DISABLE_COPY(_class)
00072
00073 inline l4_msgtag_t
00074 Cap_base::validate(Cap<Task> task, l4_utcb_t *u) const noexcept
00075 {
00076   return is_valid() ? l4_task_cap_valid_u(task.cap(), _c, u)
00077                     : l4_msgtag(0, 0, 0, 0);
00078 }
00079
00080 inline l4_msgtag_t
00081 Cap_base::validate(l4_utcb_t *u) const noexcept
00082 {
00083   return is_valid() ? l4_task_cap_valid_u(L4_BASE_TASK_CAP, _c, u)
00084                     : l4_msgtag(0, 0, 0, 0);
00085 }
00086
00087 }; // namespace L4
00088
00089 #include <l4/sys/meta>
00090
00091 namespace L4 {
00092
00114 template< typename T, typename F >
00115 inline
00116 Cap<T> cap_dynamic_cast(Cap<F> const &c) noexcept
00117 {
00118   if (!c.is_valid())
00119     return Cap<T>::Invalid;
00120
00121   Cap<Meta> mc = cap_reinterpret_cast<Meta>(c);
00122   Type_info const *m = kobject_typeid<T>();
00123   if (m->proto() && l4_error(mc->supports(m->proto())) > 0)
00124     return Cap<T>(c.cap());
00125
00126   // FIXME: use generic checker
00127 #if 0
00128   if (l4_error(mc->supports(T::kobject_proto())) > 0)
00129     return Cap<T>(c.cap());
00130 #endif
00131
00132   return Cap<T>::Invalid;
00133 }
00134
00135 }
```

16.454 l4/sys/compiler.h File Reference

L4 compiler related defines.

`#include <l4/sys/linkage.h>`

Include dependency graph for compiler.h:



This graph shows which files directly or indirectly include this file:



Macros

- #define **L4_INLINE**

  L4 Inline function attribute.
- #define **L4_ALWAYS_INLINE**

  Always inline a function.
- #define L4_NOTHROW

  Mark a function declaration and definition as never throwing an exception.
- #define **L4_BEGIN_DECLS**

  Start section with C types and functions.
- #define **L4_END_DECLS**

  End section with C types and functions.
- #define **L4_CONSTEXPR**

  Constexpr function attribute.
- #define **L4_NORETURN**

  Noreturn function attribute.
- #define **L4_NOINSTRUMENT**

  No instrumentation function attribute.
- #define L4_HIDDEN

  Attribute to mark functions, variables, and data types as being explicitly hidden from users of a library.
- #define L4_EXPORT

  Attribute to mark functions, variables, and data types as being exported from a library.
- #define **L4_LIKELY**(x)

  Expression is likely to execute.
- #define **L4_UNLIKELY**(x)

  Expression is unlikely to execute.
- #define **L4_STICKY**(x)

  Mark symbol sticky (even not there).
- #define **L4_DEPRECATED**(s)

  Mark symbol deprecated.
- #define **L4_stringify_helper**(x)

  stringify helper.
- #define **L4_stringify**(x)

  stringify.

Functions

- unsigned long l4_align_stack_for_direct_fncall (unsigned long stack)

  Specify the desired alignment of the stack pointer.
- void **l4_barrier** (void)

  Memory barrier.
- void **l4_mb** (void)

  Memory barrier.
- void **l4_wmb** (void)

  Write memory barrier.
- L4_NORETURN void l4_infinite_loop (void)

  Infinite loop.

16.454.1 Detailed Description

L4 compiler related defines.
Definition in file compiler.h.

16.455 compiler.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>,
00011  *               Jork Löser <jork@os.inf.tu-dresden.de>,
00012  *               Ronald Aigner <ra3@os.inf.tu-dresden.de>
00013  *     economic rights: Technische Universität Dresden (Germany)
00014  *
00015  * License: see LICENSE.spdx (in this directory or the directories above)
00016  */
00017 /*****************************************************************************/
00018 #ifndef __L4_COMPILER_H__
00019 #define __L4_COMPILER_H__
00020
00021 #if !defined(__ASSEMBLY__) && !defined(__ASSEMBLER__)
00022
00029
00034 #ifndef L4_INLINE
00035 #ifndef __cplusplus
00036 #  ifdef __OPTIMIZE__
00037 #    define L4_INLINE_STATIC static __inline__
00038 #    define L4_INLINE_EXTERN extern __inline__
00039 #    ifdef __GNUC_STDC_INLINE__
00040 #      define L4_INLINE L4_INLINE_STATIC
00041 #    else
00042 #      define L4_INLINE L4_INLINE_EXTERN
00043 #    endif
00044 #  else /* ! __OPTIMIZE__ */
00045 #    define L4_INLINE static
00046 #  endif /* ! __OPTIMIZE__ */
00047 #else /* __cplusplus */
00048 #  define L4_INLINE inline
00049 #endif  /* __cplusplus */
00050 #elif defined DOXYGEN
00051 #  define L4_INLINE inline
00052 #endif  /* L4_INLINE */
00053
00058 #ifdef __OPTIMIZE__
00059 #define L4_ALWAYS_INLINE L4_INLINE __attribute__((__always_inline__))
00060 #elif defined(__cplusplus)
00061 #define L4_ALWAYS_INLINE inline __attribute__((__always_inline__))
00062 #else
00063 #define L4_ALWAYS_INLINE static inline __attribute__((__always_inline__))
00064 #endif
00065
00066
00067 #define L4_DECLARE_CONSTRUCTOR(func, prio) \
00068   static inline __attribute__((constructor(prio))) void func ## _ctor_func(void) { func(); }
00069
00070
00081
00104
00130
00153 #ifndef __cplusplus
00154 #  define L4_NOTHROW__A       __attribute__((nothrow))
00155 #  define L4_NOTHROW
00156 #  ifndef __BEGIN_DECLS
00157 #    define __BEGIN_DECLS
00158 #  endif
00159 #  ifndef __END_DECLS
00160 #    define __END_DECLS
00161 #  endif
00162 #  define L4_BEGIN_DECLS
00163 #  define L4_END_DECLS
00164 #  define L4_DEFAULT_PARAM(x)
00165 #else /* __cplusplus */
00166 #  if __cplusplus >= 201103L
00167 #    define L4_NOTHROW noexcept
00168 #  else /* C++ < 11 */
00169 #    define L4_NOTHROW throw()
00170 #  endif
00171 #  define L4_BEGIN_DECLS extern "C" {
00172 #  define L4_END_DECLS }
00173 #  if !defined __BEGIN_DECLS || defined DOXYGEN
00174 #    define __BEGIN_DECLS extern "C" {
00175 #  endif
00176 #  if !defined __END_DECLS || defined DOXYGEN
00177 #    define __END_DECLS }
00178 #  endif
00179 #  define L4_DEFAULT_PARAM(x) = x
00180 #endif /* __cplusplus */
00181
```

```
00182 /* Deprecation hints during compile -- remove later (2025+) */
00183 #ifndef EXTERN_C
00184 #define EXTERN_C DO_NOT_USE_EXTERN_C_ANY_MORE
00185 #endif
00186 #ifndef EXTERN_C_BEGIN
00187 #define EXTERN_C_BEGIN DO_NOT_USE_EXTERN_C_BEGIN_ANY_MORE__USE_L4_BEGIN_DECLS
00188 #endif
00189 #ifndef EXTERN_C_END
00190 #define EXTERN_C_END DO_NOT_USE_EXTERN_C_END_ANY_MORE__USE_L4_END_DECLS
00191 #endif
00192
00197 #if defined __cplusplus && __cplusplus >= 201402L
00198 # define L4_CONSTEXPR constexpr
00199 #else
00200 # define L4_CONSTEXPR
00201 #endif
00202
00207 #define L4_NORETURN __attribute__((noreturn))
00208
00209 #define L4_PURE __attribute__((pure))
00210
00215 #define L4_NOINSTRUMENT __attribute__((no_instrument_function))
00216 #ifndef L4_HIDDEN
00217 #  define L4_HIDDEN __attribute__((visibility("hidden")))
00218 #endif
00219 #if !defined L4_EXPORT || defined DOXYGEN
00220 #  define L4_EXPORT __attribute__((visibility("default")))
00221 #endif
00222 #ifndef L4_EXPORT_TYPE
00223 #  ifdef __cplusplus
00224 #    define L4_EXPORT_TYPE __attribute__((visibility("default")))
00225 #  else
00226 #    define L4_EXPORT_TYPE
00227 #  endif
00228 #endif
00229 #define L4_STRONG_ALIAS(name, aliasname) L4__STRONG_ALIAS(name, aliasname)
00230 #define L4_WEAK_ALIAS(name, aliasname)   L4__WEAK_ALIAS(name, aliasname)
00231 #ifdef __clang__
00232 #define L4__STRONG_ALIAS(name, aliasname) \
00233   extern __typeof (name) aliasname __attribute__ ((alias (#name)));
00234 #define L4__WEAK_ALIAS(name, aliasname) \
00235   extern __typeof (name) aliasname __attribute__ ((weak, alias (#name)));
00236 #else
00237 #define L4__STRONG_ALIAS(name, aliasname) \
00238   extern __typeof (name) aliasname __attribute__ ((alias (#name), copy(name)));
00239 #define L4__WEAK_ALIAS(name, aliasname) \
00240   extern __typeof (name) aliasname __attribute__ ((weak, alias (#name), copy(name)));
00241 #endif
00242
00250 #if defined(__i386__) || defined(__amd64__) || \
00251   defined(__arm__) || defined(__aarch64__) || \
00252   defined(__mips__) || defined(__riscv) || \
00253   defined(__powerpc__) || defined(__sparc__)
00254 # define L4_STACK_ALIGN         __BIGGEST_ALIGNMENT__
00255 #else
00256 # error Define L4_STACK_ALIGN for this target!
00257 #endif
00258
00276 #if defined(__i386__) || defined(__amd64__)
00277 L4_INLINE unsigned long l4_align_stack_for_direct_fncall(unsigned long stack)
00278 {
00279   if ((stack & (L4_STACK_ALIGN - 1)) == (L4_STACK_ALIGN - sizeof(unsigned long)))
00280     return stack;
00281   return (stack & ~(L4_STACK_ALIGN)) - sizeof(unsigned long);
00282 }
00283 #else
00284 L4_INLINE unsigned long l4_align_stack_for_direct_fncall(unsigned long stack)
00285 {
00286   return stack & ~(L4_STACK_ALIGN);
00287 }
00288 #endif
00289
00290 #endif /* !__ASSEMBLY__ */
00291
00292 #include <l4/sys/linkage.h>
00293
00294 #define L4_LIKELY(x)  __builtin_expect((x),1)
00295 #define L4_UNLIKELY(x)  __builtin_expect((x),0)
00296
00297 /* Make sure that the function is not removed by optimization. Without the
00298  * "used" attribute, unreferenced static functions are removed. */
00299 #define L4_STICKY(x)     __attribute__((used)) x
00300 #define L4_DEPRECATED(s) __attribute__((deprecated(s)))
00301
00302 #ifndef static_assert
00303 # if !defined(__cplusplus)
00304 #  define static_assert _Static_assert
```

```
00305 # elif __cplusplus < 201103L
00306 #  define static_assert(x, y) \
00307    extern int l4_static_assert[-(!(x))] __attribute__((unused))
00308 # endif
00309 #endif
00310
00311 #define L4_stringify_helper(x) #x
00312 #define L4_stringify(x)        L4_stringify_helper(x)
00313
00314 #ifdef __has_builtin
00315 #define L4_HAS_BUILTIN(def) __has_builtin(def)
00316 #else
00317 #define L4_HAS_BUILTIN(def) 0
00318 #endif
00319
00320 #ifndef __ASSEMBLER__
00324 L4_INLINE void l4_barrier(void);
00325
00329 L4_INLINE void l4_mb(void);
00330
00334 L4_INLINE void l4_wmb(void);
00335
00339 L4_INLINE L4_NORETURN void l4_infinite_loop(void);
00340
00341
00342 /* Implementations */
00343 L4_INLINE void l4_barrier(void)
00344 {
00345   __asm__ __volatile__ ("" : : : "memory");
00346 }
00347
00348 L4_INLINE void l4_mb(void)
00349 {
00350   __asm__ __volatile__ ("" : : : "memory");
00351 }
00352
00353 L4_INLINE void l4_wmb(void)
00354 {
00355   __asm__ __volatile__ ("" : : : "memory");
00356 }
00357
00358 L4_INLINE L4_NORETURN void l4_infinite_loop(void)
00359 {
00360   while (1)
00361     l4_barrier();
00362 }
00363 #endif
00364
00366
00367 #endif /* !__L4_COMPILER_H__ */
```

16.456 amd64/l4/sys/arch/consts.h File Reference

Common L4 constants, AMD64 version.

Macros

- #define L4_PAGESHIFT 12

  Size of a page, log2-based.
- #define L4_SUPERPAGESHIFT 21

  Size of a large page, log2-based.

16.456.1 Detailed Description

Common L4 constants, AMD64 version.
Definition in file consts.h.

16.457 consts.h

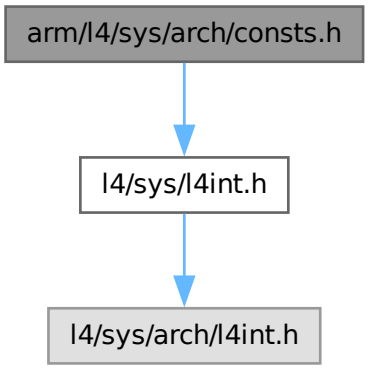
Go to the documentation of this file.

```
00001 /*****************************************************************************/
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
```

```
00010  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00011  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  *
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016 /***************************************************************************/
00017 #ifndef __L4SYS__INCLUDE__ARCH_AMD64__CONSTS_H__
00018 #define __L4SYS__INCLUDE__ARCH_AMD64__CONSTS_H__
00019
00024 #define L4_PAGESHIFT    12
00025
00030 #define L4_SUPERPAGESHIFT 21
00031
00032 #endif /* ! __L4SYS__INCLUDE__ARCH_AMD64__CONSTS_H__ */
```

16.458 arm/l4/sys/arch/consts.h File Reference

Common L4 constants, arm version.
`#include <l4/sys/l4int.h>`
Include dependency graph for consts.h:



Macros

- #define L4_PAGESHIFT 12

  Size of a page, log2-based.
- #define L4_SUPERPAGESHIFT 21

  Size of a large page, log2-based.

16.458.1 Detailed Description

Common L4 constants, arm version.
Definition in file consts.h.

16.459 consts.h

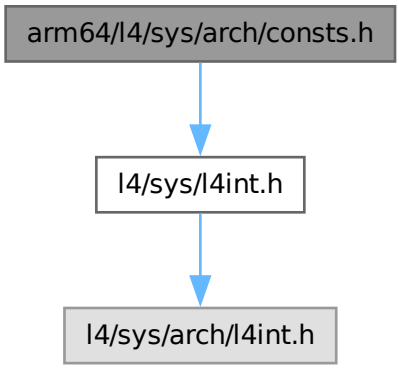
Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
```

```
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef _L4_SYS_CONSTS_H
00015 #define _L4_SYS_CONSTS_H
00016
00017 /* L4 includes */
00018 #include <l4/sys/l4int.h>
00026 #define L4_PAGESHIFT    12
00027
00031 #define L4_SUPERPAGESHIFT 21
00032
00034
00035 #endif /* !_L4_SYS_CONSTS_H */
```

16.460 arm64/l4/sys/arch/consts.h File Reference

Common L4 constants, arm version.
`#include <l4/sys/l4int.h>`
Include dependency graph for consts.h:



Macros

- #define L4_PAGESHIFT 12

  Size of a page, log2-based.
- #define L4_SUPERPAGESHIFT 21

  Size of a large page, log2-based.

16.460.1 Detailed Description

Common L4 constants, arm version.
Definition in file consts.h.

16.461 consts.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
```

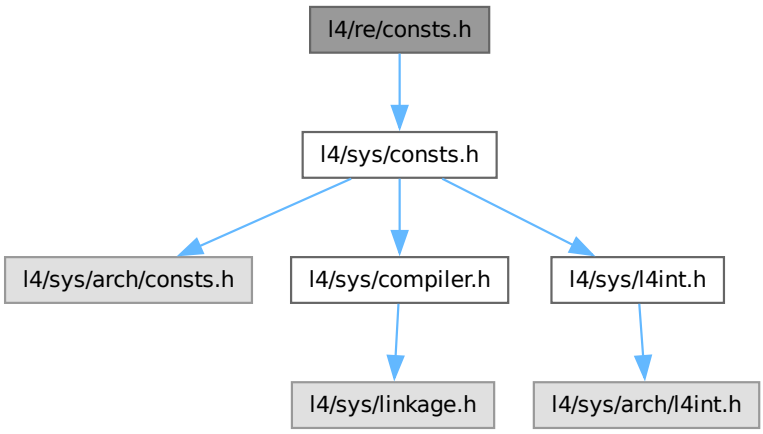
```
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef _L4_SYS_CONSTS_H
00015 #define _L4_SYS_CONSTS_H
00016
00017 /* L4 includes */
00018 #include <l4/sys/l4int.h>
00026 #define L4_PAGESHIFT    12
00027
00031 #define L4_SUPERPAGESHIFT 21
00032
00034
00035 #endif /* !_L4_SYS_CONSTS_H */
```

16.462 l4/re/consts.h File Reference

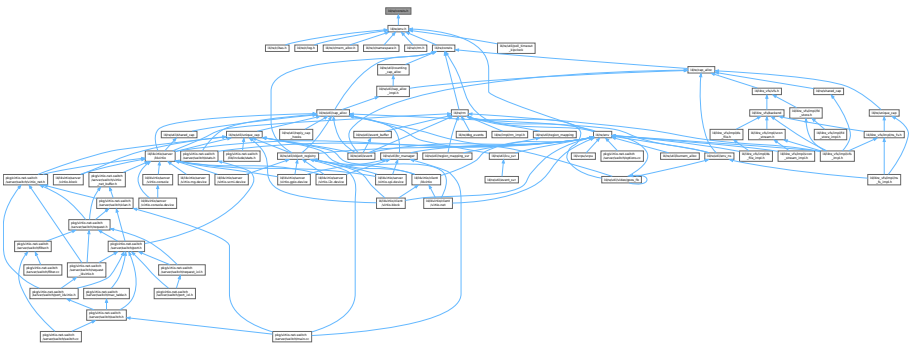
Constants.

`#include <l4/sys/consts.h>`

Include dependency graph for consts.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum

  Defaults for local thread priorities.

16.462.1 Detailed Description

Constants.
Definition in file consts.h.

16.462.2 Enumeration Type Documentation

16.462.2.1 anonymous enum

```
anonymous enum
```

Defaults for local thread priorities.
Priorities are to be seen as local. These are used by the loader and libpthread. They are to be understood as 'local', which means the actual priority of the thread (as seen by the kernel) is the base priority as defined by the scheduler plus the local priority.
Definition at line 28 of file consts.h.

16.463 consts.h

Go to the documentation of this file.

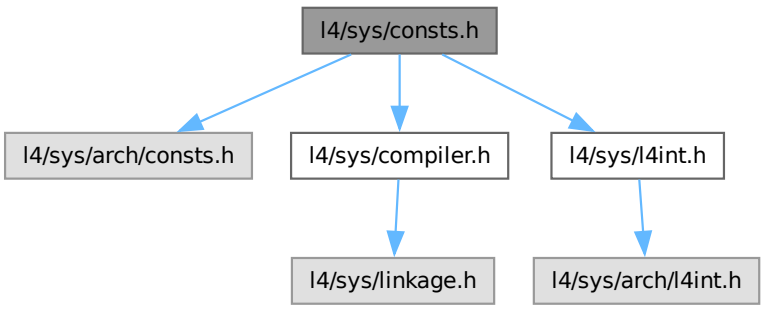
```
00001
00005 /*
00006  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/consts.h>
00014
00015 enum
00016 {
00017   L4RE_THIS_TASK_CAP = L4_BASE_TASK_CAP,
00018 };
00019
00028 enum
00029 {
00030   L4RE_MAIN_THREAD_PRIO = 2, /* Priority of the main thread */
00031 };
00032
```

16.464 l4/sys/consts.h File Reference

Common constants.

```
#include <l4/sys/arch/consts.h>
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
```

Include dependency graph for consts.h:



This graph shows which files directly or indirectly include this file:



Macros

- #define **L4_SYSF_NONE**

  Empty set of flags.
- #define L4_SYSF_SEND

  Send-phase flag.
- #define L4_SYSF_RECV

  Receive-phase flag.
- #define L4_SYSF_OPEN_WAIT

  Open-wait flag.
- #define L4_SYSF_REPLY

  Reply flag.
- #define L4_SYSF_CALL

  Call flags (combines send and receive).
- #define L4_SYSF_WAIT

  Wait flags (combines receive and open wait).
- #define L4_SYSF_SEND_AND_WAIT

  Send-and-wait flags.
- #define L4_SYSF_REPLY_AND_WAIT

  Reply-and-wait flags.
- #define **L4_CAP_SHIFT**

  Capability index shift; see l4_cap_idx_t.
- #define L4_CAP_SIZE

  Deprecated.
- #define **L4_CAP_OFFSET**

  Offset of two consecutive capability indices.
- #define **L4_CAP_MASK**

  Mask to get only the relevant bits of an l4_cap_idx_t.
- #define **L4_INVALID_CAP**

  Invalid capability selector; see l4_cap_idx_t.
- #define L4_INVALID_CAP_BIT

  Bit indicating if a capability selector is invalid.
- #define **L4_PAGESIZE**

  Minimal page size (in bytes).
- #define L4_PAGEMASK

  Mask for the page number.
- #define L4_LOG2_PAGESIZE

  Number of bits used for page offset.
- #define L4_SUPERPAGESIZE

  Size of a large page.
- #define L4_SUPERPAGEMASK

  Mask for the number of a large page.
- #define L4_LOG2_SUPERPAGESIZE

  Number of bits used as offset for a large page.
- #define **L4_INVALID_PTR** ((void *)L4_INVALID_ADDR)

  Invalid address as pointer type.

Enumerations

- enum l4_unmap_flags_t { L4_FP_ALL_SPACES , L4_FP_DELETE_OBJ , L4_FP_OTHER_SPACES }

  Flags for the unmap operation.
- enum l4_msg_item_consts_t { L4_ITEM_MAP = 8 , L4_ITEM_CONT = 1 , L4_MAP_ITEM_GRANT = 2 , L4_MAP_ITEM_MAP = 0 , L4_RCV_ITEM_FORWARD_MAPPINGS = 1 , L4_RCV_ITEM_SINGLE_CAP = L4_ITEM_MAP | 2 , L4_RCV_ITEM_LOCAL_ID = 4 }

  Constants for message items.
- enum l4_buffer_desc_consts_t { L4_BDR_MEM_SHIFT = 0 , L4_BDR_IO_SHIFT = 5 , L4_BDR_OBJ_SHIFT = 10 , **L4_BDR_OFFSET_MASK** = (1UL << 20) - 1 }

  Constants for buffer descriptors.
- enum l4_default_caps_t { L4_BASE_TASK_CAP , L4_BASE_FACTORY_CAP , L4_BASE_THREAD_CAP , L4_BASE_PAGER_CAP , L4_BASE_LOG_CAP , L4_BASE_ICU_CAP , L4_BASE_SCHEDULER_CAP , L4_BASE_IOMMU_CAP , L4_BASE_DEBUGGER_CAP , L4_BASE_ARM_SMCCC_CAP , **L4_BASE_CAPS_LAST_P1** , L4_BASE_CAPS_LAST = L4_BASE_CAPS_LAST_P1 - 1 }

  Default capabilities setup for the initial tasks.
- enum l4_addr_consts_t { L4_INVALID_ADDR = ~0UL }

  Address related constants.

Functions

- l4_addr_t l4_trunc_page (l4_addr_t address) L4_NOTHROW

  Round an address down to the next lower page boundary.
- l4_addr_t l4_trunc_size (l4_addr_t address, unsigned char bits) L4_NOTHROW

  Round an address down to the next lower flexpage with size bits.
- l4_addr_t l4_round_page (l4_addr_t address) L4_NOTHROW

  Round address up to the next page.
- l4_addr_t l4_round_size (l4_addr_t value, unsigned char bits) L4_NOTHROW

  Round value up to the next alignment with bits size.
- unsigned l4_bytes_to_mwords (unsigned size) L4_NOTHROW

  Determine how many machine words (l4_umword_t) are required to store a buffer of 'size' bytes.

16.464.1 Detailed Description

Common constants.
Definition in file consts.h.

16.465 consts.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00010  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #ifndef __L4_SYS__INCLUDE__CONSTS_H__
00016 #define __L4_SYS__INCLUDE__CONSTS_H__
00017
00018 #include <l4/sys/arch/consts.h>
00019 #include <l4/sys/compiler.h>
00020 #include <l4/sys/l4int.h>
00021
00053
00058 #define L4_SYSF_NONE      0x00
```

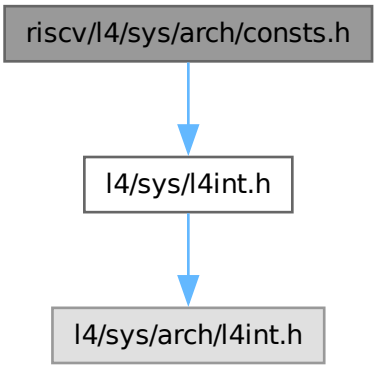
```
00059
00071 #define L4_SYSF_SEND      0x01
00072
00082 #define L4_SYSF_RECV      0x02
00083
00093 #define L4_SYSF_OPEN_WAIT 0x04
00094
00102 #define L4_SYSF_REPLY     0x08
00103
00110 #define L4_SYSF_CALL           (L4_SYSF_SEND | L4_SYSF_RECV)
00111
00118 #define L4_SYSF_WAIT           (L4_SYSF_OPEN_WAIT | L4_SYSF_RECV)
00119
00126 #define L4_SYSF_SEND_AND_WAIT  (L4_SYSF_OPEN_WAIT | L4_SYSF_CALL)
00127
00134 #define L4_SYSF_REPLY_AND_WAIT (L4_SYSF_WAIT | L4_SYSF_SEND | L4_SYSF_REPLY)
00135
00137
00138
00143 #define L4_CAP_SHIFT   12UL
00149 #define L4_CAP_SIZE    (1UL << L4_CAP_SHIFT)
00154 #define L4_CAP_OFFSET  (1UL << L4_CAP_SHIFT)
00160 #define L4_CAP_MASK    (~0UL << (L4_CAP_SHIFT - 1))
00165 #define L4_INVALID_CAP (~0UL << (L4_CAP_SHIFT - 1))
00166
00173 #define L4_INVALID_CAP_BIT (1UL << (L4_CAP_SHIFT - 1))
00174
00175 enum l4_sched_consts_t
00176 {
00177   L4_SCHED_MIN_PRIO = 1,
00178   L4_SCHED_MAX_PRIO = 255,
00179 };
00180
00186 enum l4_unmap_flags_t
00187 {
00200   L4_FP_ALL_SPACES   = 0x80000000UL,
00201
00214   L4_FP_DELETE_OBJ   = 0xc0000000UL,
00215
00222   L4_FP_OTHER_SPACES = 0x0UL
00223 };
00224
00229 enum l4_msg_item_consts_t
00230 {
00231   L4_ITEM_MAP       = 8,
00232
00237   L4_ITEM_CONT      = 1,
00238
00239   // send
00262   L4_MAP_ITEM_GRANT = 2,
00263
00264   L4_MAP_ITEM_MAP   = 0,
00265
00266   // receive
00277   L4_RCV_ITEM_FORWARD_MAPPINGS = 1,
00278
00292   L4_RCV_ITEM_SINGLE_CAP = L4_ITEM_MAP | 2,
00293
00313   L4_RCV_ITEM_LOCAL_ID   = 4,
00314 };
00315
00320 enum l4_buffer_desc_consts_t
00321 {
00322   L4_BDR_MEM_SHIFT   = 0,
00323   L4_BDR_IO_SHIFT    = 5,
00324   L4_BDR_OBJ_SHIFT   = 10,
00325   L4_BDR_OFFSET_MASK = (1UL << 20) - 1,
00326 };
00327
00341 enum l4_default_caps_t
00342 {
00344   L4_BASE_TASK_CAP      = 1UL << L4_CAP_SHIFT,
00346   L4_BASE_FACTORY_CAP   = 2UL << L4_CAP_SHIFT,
00348   L4_BASE_THREAD_CAP    = 3UL << L4_CAP_SHIFT,
00356   L4_BASE_PAGER_CAP     = 4UL << L4_CAP_SHIFT,
00364   L4_BASE_LOG_CAP       = 5UL << L4_CAP_SHIFT,
00366   L4_BASE_ICU_CAP       = 6UL << L4_CAP_SHIFT,
00368   L4_BASE_SCHEDULER_CAP = 7UL << L4_CAP_SHIFT,
00375   L4_BASE_IOMMU_CAP     = 8UL << L4_CAP_SHIFT,
00383   L4_BASE_DEBUGGER_CAP  = 10UL << L4_CAP_SHIFT,
00390   L4_BASE_ARM_SMCCC_CAP = 11UL << L4_CAP_SHIFT,
00391
00393   L4_BASE_CAPS_LAST_P1,
00395   L4_BASE_CAPS_LAST = L4_BASE_CAPS_LAST_P1 - 1
00396 };
00397
00408 #define L4_PAGESIZE   (1UL << L4_PAGESHIFT)
```

```
00409
00417 #define L4_PAGEMASK    (~(L4_PAGESIZE - 1))
00418
00426 #define L4_LOG2_PAGESIZE  L4_PAGESHIFT
00427
00435 #define L4_SUPERPAGESIZE  (1UL << L4_SUPERPAGESHIFT)
00436
00444 #define L4_SUPERPAGEMASK  (~(L4_SUPERPAGESIZE - 1))
00445
00452 #define L4_LOG2_SUPERPAGESIZE L4_SUPERPAGESHIFT
00453
00464 L4_INLINE l4_addr_t l4_trunc_page(l4_addr_t address) L4_NOTHROW;
00465 L4_INLINE l4_addr_t l4_trunc_page(l4_addr_t address) L4_NOTHROW
00466 { return address & L4_PAGEMASK; }
00467
00475 L4_INLINE l4_addr_t l4_trunc_size(l4_addr_t address, unsigned char bits) L4_NOTHROW;
00476 L4_INLINE l4_addr_t l4_trunc_size(l4_addr_t address, unsigned char bits) L4_NOTHROW
00477 { return address & (~0UL << bits); }
00478
00489 L4_INLINE l4_addr_t l4_round_page(l4_addr_t address) L4_NOTHROW;
00490 L4_INLINE l4_addr_t l4_round_page(l4_addr_t address) L4_NOTHROW
00491 { return (address + L4_PAGESIZE - 1) & L4_PAGEMASK; }
00492
00500 L4_INLINE l4_addr_t l4_round_size(l4_addr_t value, unsigned char bits) L4_NOTHROW;
00501 L4_INLINE l4_addr_t l4_round_size(l4_addr_t value, unsigned char bits) L4_NOTHROW
00502 { return (value + (1UL << bits) - 1) & (~0UL << bits); }
00503
00512 L4_INLINE unsigned l4_bytes_to_mwords(unsigned size) L4_NOTHROW;
00513 L4_INLINE unsigned l4_bytes_to_mwords(unsigned size) L4_NOTHROW
00514 { return (size + sizeof(l4_umword_t) - 1) / sizeof(l4_umword_t); }
00515
00520 enum l4_addr_consts_t {
00522   L4_INVALID_ADDR = ~0UL
00523 };
00524
00529 #define L4_INVALID_PTR ((void *)L4_INVALID_ADDR)
00530
00531 #ifndef NULL
00532 #ifndef __cplusplus
00533 # define NULL ((void *)0)
00537 #elif __cplusplus >= 201103L
00538 # define NULL nullptr
00539 #else
00540 # define NULL 0
00541 #endif
00542 #endif
00543
00544 #endif /* ! __L4_SYS__INCLUDE__CONSTS_H__ */
```

16.466 riscv/l4/sys/arch/consts.h File Reference

Common L4 constants, RISC-V version.

`#include <l4/sys/l4int.h>`
Include dependency graph for consts.h:



Macros

- #define **L4_PAGESHIFT** 12

  Sizeof a page in log2.
- #define **L4_SUPERPAGESHIFT** 21

  Sizeof a large page in log2.

16.466.1 Detailed Description

Common L4 constants, RISC-V version.
Definition in file consts.h.

16.467 consts.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00008  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #ifndef _L4_SYS_CONSTS_H
00013 #define _L4_SYS_CONSTS_H
00014
00015 /* L4 includes */
00016 #include <l4/sys/l4int.h>
00017
00022 #define L4_PAGESHIFT 12 // 4K pages
00023
00028 #if __riscv_xlen == 32
00029 #define L4_SUPERPAGESHIFT 22
00030 #else
00031 #define L4_SUPERPAGESHIFT 21
00032 #endif
00033
00034 #endif /* !_L4_SYS_CONSTS_H */
```

16.468 x86/l4/sys/arch/consts.h File Reference

Common L4 constants, x86 version.

Macros

- #define L4_PAGESHIFT 12

  Size of a page log2-based.
- #define L4_SUPERPAGESHIFT 22

  Size of a large page log2-based.

16.468.1 Detailed Description

Common L4 constants, x86 version.
Definition in file consts.h.

16.469 consts.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00011  *               Lars Reuther <reuther@os.inf.tu-dresden.de>
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  *
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016 /*****************************************************************************/
00017 #ifndef __L4SYS__INCLUDE__ARCH_X86__CONSTS_H__
00018 #define __L4SYS__INCLUDE__ARCH_X86__CONSTS_H__
00019
00024 #define L4_PAGESHIFT    12
00025
00030 #define L4_SUPERPAGESHIFT 22
00031
00032 #endif /* ! __L4SYS__INCLUDE__ARCH_X86__CONSTS_H__ */
```

16.470 capability.h

```
00001
00002 #pragma once
00003
00004 #include <l4/sys/consts.h>
00005 #include <l4/sys/types.h>
00006 #include <l4/sys/task.h>
00007
00008 namespace L4 {
00009
00010 class Task;
00011 class Kobject;
00012
00013 template< typename T > class L4_EXPORT Cap;
00014
00025 class L4_EXPORT Cap_base
00026 {
00027 public:
00029   enum No_init_type
00030   {
00034     No_init
00035   };
00036
00040   enum Cap_type
00041   {
00042     Invalid = L4_INVALID_CAP
00043   };
00044
00049   l4_cap_idx_t cap() const noexcept { return _c; }
00050
00057   bool is_valid() const noexcept { return !(_c & L4_INVALID_CAP_BIT); }
00058
00062   int invalid_cap_error() const noexcept { return _c & ~L4_INVALID_CAP_BIT; }
00063
00064   explicit operator bool () const noexcept
00065   { return !(_c & L4_INVALID_CAP_BIT); }
00066
00074   l4_fpage_t fpage(unsigned rights = L4_CAP_FPAGE_RWS) const noexcept
00075   { return l4_obj_fpage(_c, 0, rights); }
```

```
00076
00086   l4_umword_t snd_base(unsigned grant = L4_MAP_ITEM_MAP,
00087                        l4_cap_idx_t base = L4_INVALID_CAP) const noexcept
00088   {
00089     if (base == L4_INVALID_CAP)
00090       base = _c;
00091     return l4_map_obj_control(base, grant);
00092   }
00093
00094
00098   bool operator == (Cap_base const &o) const noexcept
00099   { return _c == o._c; }
00100
00104   bool operator != (Cap_base const &o) const noexcept
00105   { return _c != o._c; }
00106
00120   inline l4_msgtag_t validate(l4_utcb_t *u = l4_utcb()) const noexcept;
00121
00136   inline l4_msgtag_t validate(Cap<Task> task,
00137                               l4_utcb_t *u = l4_utcb()) const noexcept;
00138
00142   void invalidate() noexcept { _c = L4_INVALID_CAP; }
00143 protected:
00149   explicit Cap_base(l4_cap_idx_t c) noexcept : _c(c) {}
00153   explicit Cap_base(Cap_type cap) noexcept : _c(cap) {}
00154
00160   explicit Cap_base(l4_default_caps_t cap) noexcept : _c(cap) {}
00161
00165   explicit Cap_base() noexcept {}
00166
00176   bool move(Cap_base const &src) const noexcept
00177   {
00178     if (!is_valid() || !src.is_valid())
00179       return false;
00180
00181     l4_msgtag_t res
00182       = l4_task_map(L4_BASE_TASK_CAP, L4_BASE_TASK_CAP,
00183                     src.fpage(L4_CAP_FPAGE_RWSD),
00184                     snd_base(L4_MAP_ITEM_GRANT) | L4_FPAGE_C_OBJ_RIGHTS);
00185     return l4_error(res) >= 0;
00186   }
00187
00195   bool copy(Cap_base const &src) const noexcept
00196   {
00197     if (!is_valid() || !src.is_valid())
00198       return false;
00199
00200     l4_msgtag_t res = l4_task_map(L4_BASE_TASK_CAP, L4_BASE_TASK_CAP,
00201                                   src.fpage(L4_CAP_FPAGE_RWSD),
00202                                   snd_base() | L4_FPAGE_C_OBJ_RIGHTS);
00203     return l4_error(res) >= 0;
00204   }
00205
00215   bool is_equal(Cap_base const &other) const noexcept
00216   {
00217     if (!is_valid())
00218       return !other.is_valid();
00219
00220     if (other.is_valid())
00221       return l4_task_cap_equal(L4_BASE_TASK_CAP, _c, other._c).label() > 0;
00222     else
00223       return false;
00224   }
00225
00228   l4_cap_idx_t _c;
00229 };
00230
00231
00247 template< typename T >
00248 class L4_EXPORT Cap : public Cap_base
00249 {
00250 private:
00251   friend class L4::Kobject;
00252
00264   explicit Cap(T const *p) noexcept
00265   : Cap_base(reinterpret_cast<l4_cap_idx_t>(p)) {}
00266
00267 public:
00268
00275   template< typename From >
00276   static void check_convertible_from() noexcept
00277   {
00278     using To = T;
00279     [[maybe_unused]] To* t = static_cast<From*>(nullptr);
00280   }
00281
00288   template< typename From >
```

```
00289   static void check_castable_from() noexcept
00290   {
00291     using To = T;
00292     [[maybe_unused]] To *t = static_cast<To *>(static_cast<From *>(nullptr));
00293   }
00294
00299   template< typename O >
00300   Cap(Cap<O> const &o) noexcept : Cap_base(o.cap())
00301   { check_convertible_from<O>(); }
00302
00307   Cap(Cap_type cap) noexcept : Cap_base(cap) {}
00308
00313   Cap(l4_default_caps_t cap) noexcept : Cap_base(cap) {}
00314
00319   explicit Cap(l4_cap_idx_t idx = L4_INVALID_CAP) noexcept : Cap_base(idx) {}
00320
00324   explicit Cap(No_init_type) noexcept {}
00325
00329   bool move(Cap const &src) const noexcept
00330   { return Cap_base::move(src); }
00331
00335   bool copy(Cap const &src) const noexcept
00336   { return Cap_base::copy(src); }
00337
00341   bool is_equal(Cap const &other) const noexcept
00342   { return Cap_base::is_equal(other); }
00343
00347   T *operator -> () const noexcept
00348   {
00349     static_assert(sizeof(_c) <= sizeof(T*));
00350     return reinterpret_cast<T*>(_c);
00351   }
00352 };
00353
00354
00365 template<>
00366 class L4_EXPORT Cap<void> : public Cap_base
00367 {
00368 public:
00369
00370   explicit Cap(void const *p) noexcept
00371   : Cap_base(reinterpret_cast<l4_cap_idx_t>(p)) {}
00372
00376   Cap(Cap_type cap) noexcept : Cap_base(cap) {}
00377
00382   Cap(l4_default_caps_t cap) noexcept : Cap_base(cap) {}
00383
00388   explicit Cap(l4_cap_idx_t idx = L4_INVALID_CAP) noexcept : Cap_base(idx) {}
00389   explicit Cap(No_init_type) noexcept {}
00390
00391   template< typename From >
00392   static void check_convertible_from() noexcept {}
00393
00394   template< typename From >
00395   static void check_castable_from() noexcept {}
00396
00400   bool move(Cap const &src) const noexcept
00401   { return Cap_base::move(src); }
00402
00406   bool copy(Cap const &src) const noexcept
00407   { return Cap_base::copy(src); }
00408
00412   bool is_equal(Cap const &other) const noexcept
00413   { return Cap_base::is_equal(other); }
00414
00415   template< typename T >
00416   Cap(Cap<T> const &o) noexcept : Cap_base(o.cap()) {}
00417 };
00418
00435 template< typename T, typename F >
00436 inline
00437 Cap<T> cap_cast(Cap<F> const &c) noexcept
00438 {
00439   Cap<T>::template check_castable_from<F>();
00440   return Cap<T>(c.cap());
00441 }
00442
00443 // gracefully deal with L4::Kobject ambiguity
00444 template< typename T >
00445 inline
00446 Cap<T> cap_cast(Cap<L4::Kobject> const &c) noexcept
00447 {
00448   return Cap<T>(c.cap());
00449 }
00450
00466 template< typename T, typename F >
00467 inline
```

```
00468 Cap<T> cap_reinterpret_cast(Cap<F> const &c) noexcept
00469 {
00470   return Cap<T>(c.cap());
00471 }
00472
00478 class Reply_cap_idx
00479 {
00480   l4_cap_idx_t _i;
00481
00482 public:
00483   constexpr explicit Reply_cap_idx() noexcept : _i(L4_INVALID_CAP) {}
00484   constexpr explicit Reply_cap_idx(l4_cap_idx_t i) noexcept
00485   : _i(i) {}
00486
00487   constexpr l4_cap_idx_t cap() const noexcept
00488   { return _i; }
00489
00490   explicit constexpr operator l4_cap_idx_t() const noexcept
00491   { return _i; }
00492
00493   explicit constexpr operator bool() const noexcept
00494   { return !(_i & L4_INVALID_CAP_BIT); }
00495
00496   constexpr bool operator==(Reply_cap_idx o) const noexcept
00497   { return _i == o._i; }
00498
00499   constexpr bool operator!=(Reply_cap_idx o) const noexcept
00500   { return _i != o._i; }
00501 };
00502
00503 class Reply_cap;
00504
00508 class Reply_cap_alloc
00509 {
00510   friend class Reply_cap;
00511
00512 public:
00513   constexpr Reply_cap_alloc() = default;
00514
00515   // Attention: do *not* define a destructor! We must keep the class trivially
00516   // destructible so that no global destructor is created for
00517   // L4Re::Util::reply_cap_alloc.
00518   // virtual ~Reply_cap_alloc() = default;
00519
00520   Reply_cap_alloc(Reply_cap_alloc const &) = delete;
00521   Reply_cap_alloc &operator = (Reply_cap_alloc const &) = delete;
00522
00528   virtual Reply_cap alloc() noexcept = 0;
00529
00530 protected:
00538   virtual void free(Reply_cap_idx cap) noexcept = 0;
00539 };
00540
00549 class Reply_cap
00550 {
00551 public:
00553   constexpr Reply_cap() noexcept = default;
00554
00564   constexpr Reply_cap(Reply_cap_idx cap, Reply_cap_alloc *alloc) noexcept
00565   : _cap(cap), _alloc(alloc)
00566   {}
00567
00574   ~Reply_cap()
00575   { reset(); }
00576
00577   // not copyable
00578   Reply_cap(Reply_cap const &) = delete;
00579   Reply_cap &operator=(Reply_cap const &) = delete;
00580
00581   constexpr Reply_cap(Reply_cap &&o) noexcept
00582   : _cap(o._cap), _alloc(o._alloc)
00583   {
00584     o._cap = Reply_cap_idx();
00585     o._alloc = nullptr;
00586   }
00587
00588   Reply_cap &operator=(Reply_cap &&o) noexcept
00589   {
00590     reset(o._cap, o._alloc);
00591     o._cap = Reply_cap_idx();
00592     o._alloc = nullptr;
00593     return *this;
00594   }
00595
00609   l4_ret_t reply(l4_msgtag_t tag, l4_utcb_t *utcb = l4_utcb()) noexcept
00610   {
00611     l4_umword_t err = L4_IPC_ENOT_EXISTENT;
```

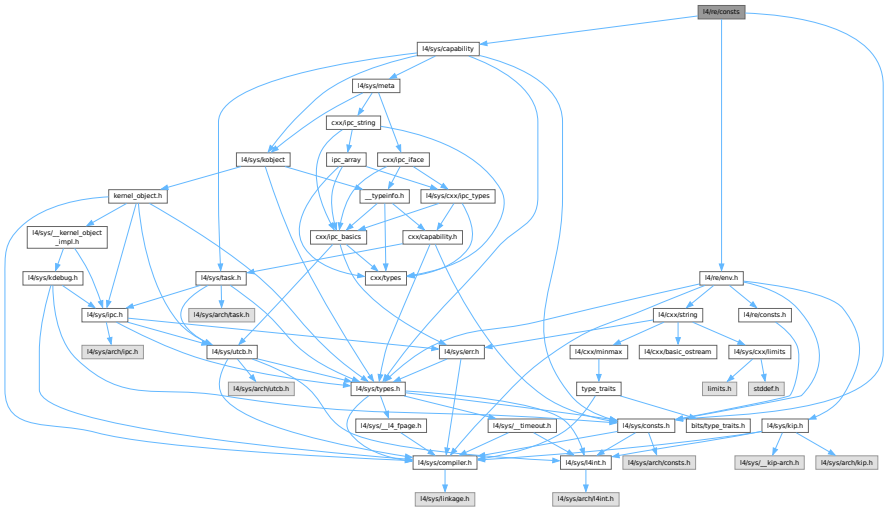
```
00612     if (is_valid()) [[likely]]
00613       {
00614         err = l4_ipc_error(l4_ipc_reply(_cap.cap(), utcb, tag,
00615                                         L4_IPC_BOTH_TIMEOUT_0), utcb);
00616         _alloc->free(_cap);
00617         _cap = Reply_cap_idx();
00618       }
00619
00620     if (err) [[unlikely]]
00621       return l4_ipc_to_errno(err);
00622     else
00623       return 0;
00624   }
00625
00632   constexpr Reply_cap_idx get() const noexcept
00633   { return _cap; }
00634
00635   constexpr bool is_valid() const noexcept
00636   { return static_cast<bool>(_cap); }
00637
00638   explicit constexpr operator bool () const noexcept
00639   { return is_valid(); }
00640
00641   constexpr bool operator==(Reply_cap const &o) const noexcept
00642   { return _cap == o._cap; }
00643
00644   constexpr bool operator==(Reply_cap_idx o) const noexcept
00645   { return _cap == o; }
00646
00647   constexpr bool operator!=(Reply_cap const &o) const noexcept
00648   { return _cap != o._cap; }
00649
00650   constexpr bool operator!=(Reply_cap_idx o) const noexcept
00651   { return _cap != o; }
00652
00659   void reset(Reply_cap_idx cap = Reply_cap_idx(),
00660              Reply_cap_alloc *alloc = nullptr) noexcept
00661   {
00662     if (is_valid()) [[unlikely]]
00663       {
00664         // If the reply cap is still valid, reply to the caller that we've
00665         // dropped the reply. Should not happen in a well behaved server.
00666         auto tag = l4_msgtag(-L4_EDROPREPLY, 0, 0, 0);
00667         l4_ipc_reply(_cap.cap(), l4_utcb(), tag, L4_IPC_BOTH_TIMEOUT_0);
00668         _alloc->free(_cap);
00669       }
00670
00671     _cap = cap;
00672     _alloc = alloc;
00673   }
00674
00675 private:
00676   Reply_cap_idx _cap = Reply_cap_idx();
00677   Reply_cap_alloc *_alloc = nullptr;
00678 };
00679
00680 }
```

16.471 l4/re/consts File Reference

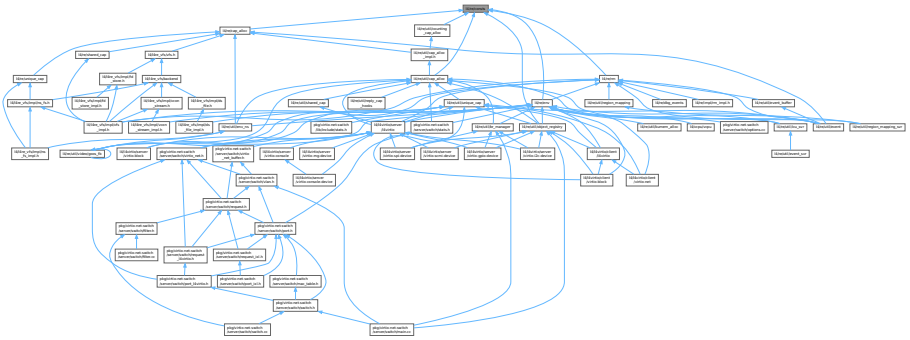
Constants.

```
#include <l4/sys/capability>
#include <l4/sys/consts.h>
#include <l4/re/env.h>
```

Include dependency graph for consts:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4Re

  L4Re C++ Interfaces.

16.471.1 Detailed Description

Constants.
Definition in file consts.

16.472 consts

Go to the documentation of this file.

```
00001 // -*- Mode: C++ -*-
00002 // vim:ft=cpp
00007 /*
00008  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/capability>
```

```
00016 #include <l4/sys/consts.h>
00017 #include <l4/re/env.h>
00018
00019 namespace L4Re {
00020   static L4::Cap<L4::Task>::Cap_type const This_task
00021     = static_cast<L4::Cap<L4::Task>::Cap_type>(L4RE_THIS_TASK_CAP);
00022 }
```

16.473 consts

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002
00003 #pragma once
00004
00005 #include <l4/sys/consts.h>
00006
00007 namespace L4 {
00008
00017   template<typename T>
00018   constexpr T trunc_order(T val, unsigned char order)
00019   {
00020     return val & ((~T(0)) << order);
00021   }
00022
00031   template<typename T>
00032   constexpr T round_order(T val, unsigned char order)
00033   {
00034     return (val + (T(1) << order) - T(1)) & ((~T(0)) << order);
00035   }
00036
00037   template<typename T>
00038   constexpr T trunc_page(T val)
00039   {
00040     return trunc_order(val, L4_PAGESHIFT);
00041   }
00042
00043   template<typename T>
00044   constexpr T round_page(T val)
00045   {
00046     return round_order(val, L4_PAGESHIFT);
00047   }
00048
00049   template<typename T>
00050   inline unsigned char
00051   max_order(unsigned char order, T addr,
00052             T min_addr, T max_addr,
00053             T hotspot = T(0))
00054   {
00055     while (order < 30 /* limit to 1GB flexpages */)
00056       {
00057         T mask;
00058         T base = trunc_order(addr, order + 1);
00059         if (base < min_addr)
00060           return order;
00061
00062         if (base + (T(1) << (order + 1)) - T(1) > max_addr - T(1))
00063           return order;
00064
00065         mask = ~((~T(0)) << (order + 1));
00066         if (hotspot == ~T(0) || ((addr ^ hotspot) & mask))
00067           break;
00068
00069         ++order;
00070       }
00071
00072     return order;
00073   }
00074
00075 }
```

16.474 ipc_array

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "types"
```

```
00010 #include "ipc_basics"
00011 #include "ipc_types"
00012
00013 namespace L4 { namespace Ipc L4_EXPORT {
00014
00016 using Array_len_default = unsigned short;
00017
00027 template< typename ELEM_TYPE, typename LEN_TYPE = Array_len_default >
00028 struct Array_ref
00029 {
00030   using ptr_type = ELEM_TYPE *;
00031   using len_type = LEN_TYPE;
00032
00033   len_type length;
00034   ptr_type data;
00035   Array_ref() = default;
00036   Array_ref(len_type length, ptr_type data)
00037   : length(length), data(data)
00038   {}
00039
00040   template<typename X> struct Non_const
00041   { using type = Array_ref<X, LEN_TYPE>; };
00042
00043   template<typename X> struct Non_const<X const>
00044   { using type = Array_ref<X, LEN_TYPE>; };
00045
00046   Array_ref(typename Non_const<ELEM_TYPE>::type const &other)
00047   : length(other.length), data(other.data)
00048   {}
00049
00050   Array_ref &operator = (typename Non_const<ELEM_TYPE>::type const &other)
00051   {
00052     this->length = other.length;
00053     this->data = other.data;
00054     return *this;
00055   }
00056 };
00057
00080 template<typename ELEM_TYPE, typename LEN_TYPE = Array_len_default>
00081 struct Array : Array_ref<ELEM_TYPE , LEN_TYPE>
00082 {
00084   Array() {}
00086   Array(LEN_TYPE length, ELEM_TYPE *data)
00087   : Array_ref<ELEM_TYPE, LEN_TYPE>(length, data)
00088   {}
00089
00090   template<typename X> struct Non_const
00091   { using type = Array<X, LEN_TYPE>; };
00092
00093   template<typename X> struct Non_const<X const>
00094   { using type = Array<X, LEN_TYPE>; };
00095
00097   Array(typename Non_const<ELEM_TYPE>::type const &other)
00098   : Array_ref<ELEM_TYPE, LEN_TYPE>(other.length, other.data)
00099   {}
00100
00101   Array &operator = (typename Non_const<ELEM_TYPE>::type const &other)
00102   {
00103     this->length = other.length;
00104     this->data = other.data;
00105     return *this;
00106   }
00107 };
00108
00122 template< typename ELEM_TYPE,
00123           typename LEN_TYPE = Array_len_default,
00124           LEN_TYPE MAX      = (L4_UTCB_GENERIC_DATA_SIZE *
00125                                sizeof(l4_umword_t)) / sizeof(ELEM_TYPE) >
00126 struct Array_in_buf
00127 {
00128   using array = Array_ref<ELEM_TYPE, LEN_TYPE>;
00129   using const_array = Array_ref<ELEM_TYPE const, LEN_TYPE>;
00130
00132   ELEM_TYPE data[MAX];
00134   LEN_TYPE length;
00135
00137   void copy_in(const_array a)
00138   {
00139     length = a.length;
00140     if (length > MAX)
00141       length = MAX;
00142
00143     for (LEN_TYPE i = 0; i < length; ++i)
00144       data[i] = a.data[i];
00145   }
00146
00148   Array_in_buf(const_array a)  { copy_in(a); }
```

```
00150   Array_in_buf(array a)  { copy_in(a); }
00151 };
00152
00153 // implementation details for transmission
00154 namespace Msg {
00155
00157 template<typename A, typename LEN>
00158 struct Elem< Array<A, LEN> >
00159 {
00161   using arg_type = Array<A, LEN>;
00163   using svr_type = Array_ref<A, LEN>;
00164   using svr_arg_type = svr_type;
00165   static constexpr bool Is_optional = false;
00166   static constexpr bool Is_input = true;
00167   static constexpr bool Is_output = false;
00168 };
00169
00171 template<typename A, typename LEN>
00172 struct Elem< Array<A, LEN> & >
00173 {
00175   using arg_type = Array<A, LEN> &;
00177   using svr_type = Array_ref<A, LEN>;
00179   using svr_arg_type = svr_type &;
00180   static constexpr bool Is_optional = false;
00181   static constexpr bool Is_input = false;
00182   static constexpr bool Is_output = true;
00183 };
00184
00186 template<typename A, typename LEN>
00187 struct Elem< Array_ref<A, LEN> & >
00188 {
00190   using arg_type = Array_ref<A, LEN> &;
00192   using svr_type = Array_ref<L4::Types::Remove_const_t<A>, LEN>;
00194   using svr_arg_type = svr_type &;
00195   static constexpr bool Is_optional = false;
00196   static constexpr bool Is_input = false;
00197   static constexpr bool Is_output = true;
00198 };
00199
00200 namespace Detail {
00201
00202 template<typename A, typename LEN, typename ARRAY, bool REF>
00203 struct Clnt_val_ops_d_in : Clnt_noops<ARRAY>
00204 {
00205   static int to_msg_data(char *msg, unsigned offset, unsigned limit,
00206                          ARRAY const &a)
00207   {
00208     offset = align_to<LEN>(offset);
00209     if (L4_UNLIKELY(!check_size<LEN>(offset, limit)))
00210       return -L4_EMSGTOOLONG;
00211     *reinterpret_cast<LEN *>(msg + offset) = a.length;
00212     offset = align_to<A>(offset + sizeof(LEN));
00213     if (L4_UNLIKELY(!check_size<A>(offset, limit, a.length)))
00214       return -L4_EMSGTOOLONG;
00215     using elem_type = L4::Types::Remove_const_t<A>;
00216     elem_type *data = reinterpret_cast<elem_type*>(msg + offset);
00217
00218     // we do not correctly handle overlaps
00219     if (!REF || data != a.data)
00220       {
00221         for (LEN i = 0; i < a.length; ++i)
00222           data[i] = a.data[i];
00223       }
00224
00225     return offset + a.length * sizeof(A);
00226   }
00227 };
00228
00229 } // namespace Detail
00230
00231 template<typename A, typename LEN>
00232 struct Clnt_val_ops<Array<A, LEN>> :
00233   Detail::Clnt_val_ops_d_in<A, LEN, Array<A, LEN>, false>
00234 {
00235   using type = Array<A, LEN>;
00236
00237   static int from_msg_data(char *msg, unsigned offset, unsigned limit, type &a)
00238   {
00239     offset = align_to<LEN>(offset);
00240     if (L4_UNLIKELY(!check_size<LEN>(offset, limit)))
00241       return -L4_EMSGTOOSHORT;
00242
00243     LEN l = *reinterpret_cast<LEN *>(msg + offset);
00244
00245     offset = align_to<A>(offset + sizeof(LEN));
00246     if (L4_UNLIKELY(!check_size<A>(offset, limit, l)))
00247       return -L4_EMSGTOOSHORT;
```

```
00248
00249     A *data = reinterpret_cast<A*>(msg + offset);
00250
00251     if (l > a.length)
00252       l = a.length;
00253     else
00254       a.length = l;
00255
00256     for (unsigned i = 0; i < l; ++i)
00257       a.data[i] = data[i];
00258
00259     return offset + l * sizeof(A);
00260   };
00261 };
00262
00263 template<typename A, typename LEN>
00264 struct Clnt_val_ops<Array_ref<A, LEN» :
00265   Detail::Clnt_val_ops_d_in<A, LEN, Array_ref<A, LEN>, true>
00266 {
00267   using type = Array_ref<A, LEN>;
00268
00269   static int from_msg_data(char *msg, unsigned offset, unsigned limit, type &a)
00270   {
00271     offset = align_to<LEN>(offset);
00272     if (L4_UNLIKELY(!check_size<LEN>(offset, limit)))
00273       return -L4_EMSGTOOSHORT;
00274
00275     LEN l = *reinterpret_cast<LEN *>(msg + offset);
00276
00277     offset = align_to<A>(offset + sizeof(LEN));
00278     if (L4_UNLIKELY(!check_size<A>(offset, limit, l)))
00279       return -L4_EMSGTOOSHORT;
00280
00281     a.data = reinterpret_cast<A*>(msg + offset);
00282     a.length = l;
00283     return offset + l * sizeof(A);
00284   };
00285 };
00286
00287 template<typename A, typename LEN>
00288 struct Svr_val_ops< Array_ref<A, LEN> > :
00289   Svr_noops< Array_ref<A, LEN> >
00290 {
00291   using svr_type = Array_ref<A, LEN>;
00292   using elem_type = L4::Types::Remove_const_t<A>;
00293
00294   static int to_svr_data(char *msg, unsigned offset, unsigned limit,
00295                          svr_type &a)
00296   {
00297     offset = align_to<LEN>(offset);
00298     if (L4_UNLIKELY(!check_size<LEN>(offset, limit)))
00299       return -L4_EMSGTOOSHORT;
00300     a.length = *reinterpret_cast<LEN *>(msg + offset);
00301     offset = align_to<A>(offset + sizeof(LEN));
00302     if (L4_UNLIKELY(!check_size<A>(offset, limit, a.length)))
00303       return -L4_EMSGTOOSHORT;
00304     a.data = reinterpret_cast<A*>(msg + offset);
00305     return offset + a.length * sizeof(A);
00306   }
00307
00308   static int reserve_data(char *msg, unsigned offset, unsigned limit,
00309                           svr_type &a)
00310   {
00311     offset = align_to<LEN>(offset);
00312     if (L4_UNLIKELY(!check_size<LEN>(offset, limit)))
00313       return -L4_EMSGTOOLONG;
00314
00315     offset = align_to<A>(offset + sizeof(LEN));
00316     a.data = reinterpret_cast<elem_type *>(msg + offset);
00317     a.length = (limit-offset) / sizeof(A);
00318     return offset;
00319   }
00320
00321   static int from_svr_data(char *msg, unsigned offset, unsigned limit,
00322                            svr_type const &a)
00323   {
00324     offset = align_to<LEN>(offset);
00325     if (L4_UNLIKELY(!check_size<LEN>(offset, limit)))
00326       return -L4_EMSGTOOLONG;
00327
00328     *reinterpret_cast<LEN *>(msg + offset) = a.length;
00329
00330     offset = align_to<A>(offset + sizeof(LEN));
00331     if (L4_UNLIKELY(!check_size<A>(offset, limit, a.length)))
00332       return -L4_EMSGTOOLONG;
00333
00334     // In case of deferred replies, the Array_ref is pointing to a server
```

```
00335     // provided buffer instead of the UTCB.
00336     elem_type *data = reinterpret_cast<elem_type *>(msg + offset);
00337     if (data != a.data)
00338       for (LEN i = 0; i < a.length; ++i)
00339         data[i] = a.data[i];
00340
00341     return offset + a.length * sizeof(A);
00342   }
00343 };
00344
00345 // Pointer to array is not implemented.
00346 template<typename A, typename LEN>
00347 struct Is_valid_rpc_type< Array_ref<A, LEN> *> : L4::Types::False {};
00348
00349 // Optional input arrays are not implemented.
00350 template<typename A, typename LEN>
00351 struct Is_valid_rpc_type< Opt<Array_ref<A, LEN> > > : L4::Types::False {};
00352
00353 } // namespace Msg
00354
00355 }}
```

16.475 ipc_basics

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "types"
00010 #include <l4/sys/utcb.h>
00011 #include <l4/sys/err.h>
00012
00013 namespace L4 {
00014
00016 namespace Ipc {
00017
00019 namespace Msg {
00020
00027 constexpr unsigned long align_to(unsigned long bytes, unsigned long align) noexcept
00028 { return (bytes + align - 1) & ~(align - 1); }
00029
00036 template<typename T>
00037 constexpr unsigned long align_to(unsigned long bytes) noexcept
00038 { return align_to(bytes, __alignof(T)); }
00039
00049 template<typename T>
00050 constexpr bool check_size(unsigned offset, unsigned limit) noexcept
00051 {
00052   return offset + sizeof(T) <= limit;
00053 }
00054
00067 template<typename T, typename CTYPE>
00068 inline bool check_size(unsigned offset, unsigned limit, CTYPE cnt) noexcept
00069 {
00070   if (L4_UNLIKELY(sizeof(CTYPE) <= sizeof(unsigned) &&
00071                   ~0U / sizeof(T) <= static_cast<unsigned>(cnt)))
00072     return false;
00073
00074   if (L4_UNLIKELY(sizeof(CTYPE) > sizeof(unsigned) &&
00075                   static_cast<CTYPE>(~0U / sizeof(T)) <= cnt))
00076     return false;
00077
00078   return sizeof(T) * cnt <= limit - offset;
00079 }
00080
00081
00082 enum
00083 {
00085   Word_bytes = sizeof(l4_umword_t),
00087   Item_words = 2,
00089   Item_bytes = Word_bytes * Item_words,
00091   Mr_words   = L4_UTCB_GENERIC_DATA_SIZE,
00093   Mr_bytes   = Word_bytes * Mr_words,
00095   Br_bytes   = Word_bytes * L4_UTCB_GENERIC_BUFFERS_SIZE,
00096 };
00097
00098
00110 template<typename T>
00111 inline int msg_add(char *msg, unsigned offs, unsigned limit, T v) noexcept
00112 {
```

```
00113   offs = align_to<T>(offs);
00114   if (L4_UNLIKELY(!check_size<T>(offs, limit)))
00115     return -L4_EMSGTOOLONG;
00116   *reinterpret_cast<L4::Types::Remove_const_t<T> *>(msg + offs) = v;
00117   return offs + sizeof(T);
00118 }
00119
00131 template<typename T>
00132 inline int msg_get(char *msg, unsigned offs, unsigned limit, T &v) noexcept
00133 {
00134   offs = align_to<T>(offs);
00135   if (L4_UNLIKELY(!check_size<T>(offs, limit)))
00136     return -L4_EMSGTOOSHORT;
00137   v = *reinterpret_cast<T *>(msg + offs);
00138   return offs + sizeof(T);
00139 }
00140
00142 enum class Phase
00143 {
00144   Data,
00145   Items,
00146   Buffers,
00147 };
00148
00149 // implementation details
00150 namespace Detail {
00151
00152 // Helper struct to get the plain type of the IPC argument. The various
00153 // specializations remove the pointer or reference.
00154 template<typename T> struct _Plain
00155 {
00156   using type = T;
00157   static T &deref(T &v) noexcept { return v; }
00158   static T const &deref(T const &v) noexcept { return v; }
00159 };
00160
00161 template<typename T> struct _Plain<T *>
00162 {
00163   using type = T;
00164   static T &deref(T *v) noexcept { return *v; }
00165 };
00166
00167 template<typename T> struct _Plain<T &>
00168 {
00169   using type = T;
00170   static T &deref(T &v) noexcept { return v; }
00171
00172 };
00173
00174 template<typename T> struct _Plain<T const &>
00175 {
00176   using type = T;
00177   static T const &deref(T const &v) noexcept { return v; }
00178 };
00179
00180 template<typename T> struct _Plain<T const *>
00181 {
00182   using type = T;
00183   static T const &deref(T const *v) noexcept { return *v; }
00184 };
00185
00186 }
00187
00193 template<typename T> struct Clnt_noops
00194 {
00208   static constexpr int to_msg_data([[maybe_unused]] char *msg, unsigned offset,
00209                                    [[maybe_unused]] unsigned limit,
00210                                    [[maybe_unused]] T const &arg) noexcept
00211   { return offset; }
00212
00226   static constexpr int to_msg_items([[maybe_unused]] char *msg, unsigned offset,
00227                                     [[maybe_unused]] unsigned limit,
00228                                     [[maybe_unused]] T const &arg) noexcept
00229   { return offset; }
00230
00244   static constexpr int to_msg_buffers([[maybe_unused]] char *brs,
00245                                       unsigned offset,
00246                                       [[maybe_unused]] unsigned limit,
00247                                       [[maybe_unused]] T const &arg) noexcept
00248   { return offset; }
00249
00263   static constexpr int from_msg_data([[maybe_unused]] char *msg,
00264                                      unsigned offset,
00265                                      [[maybe_unused]] unsigned limit,
00266                                      [[maybe_unused]] T &arg) noexcept
00267   { return offset; }
00268
```

```
00282   static constexpr int from_msg_items([[maybe_unused]] char *msg,
00283                                       unsigned offset,
00284                                       [[maybe_unused]] unsigned limit,
00285                                       [[maybe_unused]] T &arg) noexcept
00286   { return offset; }
00287 };
00288
00294 template<typename T> struct Svr_noops
00295 {
00309   static constexpr int from_svr_data([[maybe_unused]] char *msg,
00310                                      unsigned offset,
00311                                      [[maybe_unused]] unsigned limit,
00312                                      [[maybe_unused]] T const &arg) noexcept
00313   { return offset; }
00314
00328   static constexpr int from_svr_items([[maybe_unused]] char *msg,
00329                                       unsigned offset,
00330                                       [[maybe_unused]] unsigned limit,
00331                                       [[maybe_unused]] T const &arg) noexcept
00332   { return offset; }
00333
00348   static constexpr int reserve_data([[maybe_unused]] char *msg,
00349                                     unsigned offset,
00350                                     [[maybe_unused]] unsigned limit,
00351                                     [[maybe_unused]] T &arg) noexcept
00352   { return offset; }
00353
00367   static constexpr int to_svr_data([[maybe_unused]] char *msg,
00368                                    unsigned offset,
00369                                    [[maybe_unused]] unsigned limit,
00370                                    [[maybe_unused]] T &arg) noexcept
00371   { return offset; }
00372
00386   static constexpr int to_svr_items([[maybe_unused]] char *msg,
00387                                     unsigned offset,
00388                                     [[maybe_unused]] unsigned limit,
00389                                     [[maybe_unused]] T &arg) noexcept
00390   { return offset; }
00391 };
00392
00407 template<typename MTYPE>
00408 struct Clnt_val_ops : Clnt_noops<MTYPE>
00409 {
00410   static_assert(L4::Types::Is_trivially_copyable_v<MTYPE>,
00411                 "Only trivially copyable types can be used as IPC arguments");
00412
00414   static int to_msg_data(char *msg, unsigned offset, unsigned limit,
00415                          MTYPE const &arg) noexcept
00416   { return msg_add<MTYPE>(msg, offset, limit, arg); }
00417
00419   static int from_msg_data(char *msg, unsigned offset, unsigned limit,
00420                            MTYPE &arg) noexcept
00421   { return msg_get<MTYPE>(msg, offset, limit, arg); }
00422 };
00423
00437 template<typename MTYPE>
00438 struct Svr_val_ops : Svr_noops<MTYPE>
00439 {
00440   static_assert(L4::Types::Is_trivially_copyable_v<MTYPE>,
00441                 "Only trivially copyable types can be used as IPC arguments");
00442
00444   static int to_svr_data(char *msg, unsigned offset, unsigned limit,
00445                          MTYPE &arg) noexcept
00446   { return msg_get<MTYPE>(msg, offset, limit, arg); }
00447
00449   static int reserve_data(char *, unsigned offs, unsigned limit,
00450                           MTYPE &) noexcept
00451   {
00452     offs = align_to<MTYPE>(offs);
00453     if (L4_UNLIKELY(!check_size<MTYPE>(offs, limit)))
00454       return -L4_EMSGTOOLONG;
00455     return offs + sizeof(MTYPE);
00456   }
00457
00459   static int from_svr_data(char *msg, unsigned offset, unsigned limit,
00460                            MTYPE const &arg) noexcept
00461   { return msg_add<MTYPE>(msg, offset, limit, arg); }
00462 };
00463
00471 template<typename T> struct Elem
00472 {
00474   using arg_type = T;
00476   using svr_type = T;
00478   using svr_arg_type = T; // might be const & (depending on the size)
00480   static constexpr bool Is_optional = false;
00482   static constexpr bool Is_input = true;
00484   static constexpr bool Is_output = false;
```

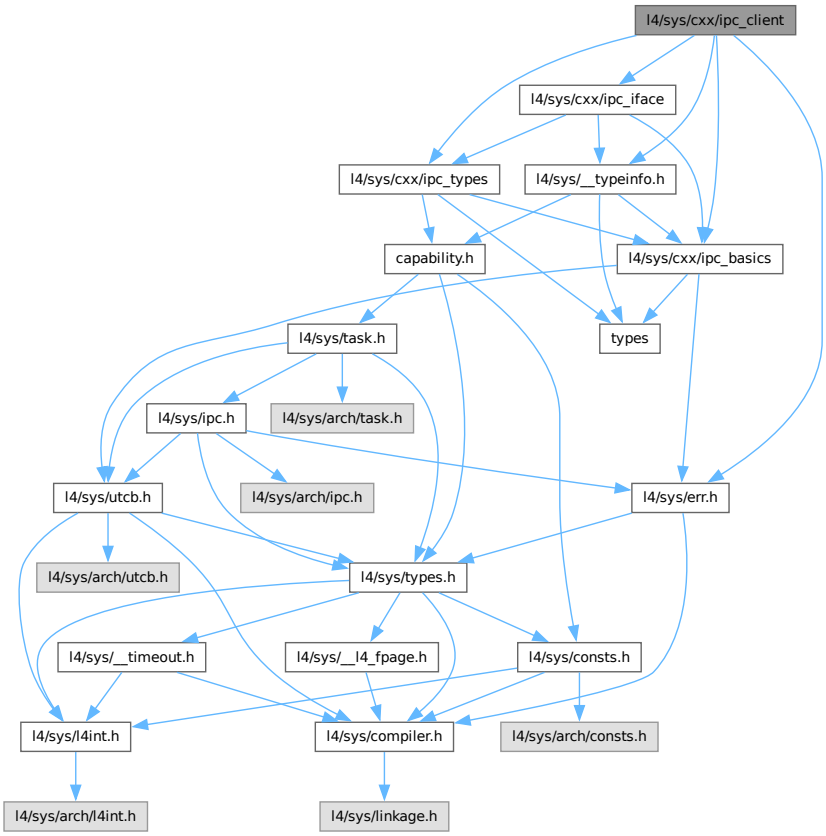
```
00485 };
00486
00487 template<typename T> struct Elem<T &>
00488 {
00489   using arg_type = T &;
00490   using svr_type = T;
00492   using svr_arg_type = T &;
00493   static constexpr bool Is_optional = false;
00494   static constexpr bool Is_input = false;
00495   static constexpr bool Is_output = true;
00496 };
00497
00498 template<typename T> struct Elem<T const &>
00499 {
00500   using arg_type = T const &;
00501   using svr_type = T;
00502   // as the RPC uses a const reference we use it here too,
00503   // we could also use pass by value depending on the size
00504   using svr_arg_type = T const &;
00505   static constexpr bool Is_optional = false;
00506   static constexpr bool Is_input = true;
00507   static constexpr bool Is_output = false;
00508 };
00509
00510 template<typename T> struct Elem<T *> : Elem<T &>
00511 {
00512   using arg_type = T *;
00513 };
00514
00515 template<typename T> struct Elem<T const *> : Elem<T const &>
00516 {
00517   using arg_type = T const *;
00518 };
00519
00521 template<typename T> struct Is_valid_rpc_type : L4::Types::True {};
00522
00523 template<typename T>
00524 struct _Elem : Elem<T>
00525 {
00526   static_assert(Is_valid_rpc_type<T>::value,
00527                 "L4::Ipc::Msg::_Elem<T>: type T is not a valid RPC parameter type.");
00528 };
00529
00530 namespace Detail {
00531
00532 template<typename T>
00533 struct _Clnt_val_ops :
00534   Clnt_val_ops<typename Detail::_Plain<T>::type> {};
00535
00536 template<typename T,
00537          typename ELEM = _Elem<T>,
00538          typename CLNT_OPS = _Clnt_val_ops<typename ELEM::arg_type>
00539          >
00540 struct _Clnt_xmit : CLNT_OPS {};
00541
00542 template<typename T,
00543          typename ELEM = _Elem<T>,
00544          typename SVR_OPS = Svr_val_ops<typename ELEM::svr_type>
00545          >
00546 struct _Svr_xmit : SVR_OPS {};
00547
00548 } //namespace Detail
00549
00550 // Specialize to alias a type X to T in client call signature.
00551 // Needs to be combined with a matching Elem< X > : Elem< T > specialization.
00552 // Or alternatively X needs to inherit from T.
00553 template<typename T> struct Clnt_xmit : Detail::_Clnt_xmit<T> {};
00554 // Specialize to alias a type X to T in server op_... signature.
00555 // Needs to be combined with a matching Elem< X > : Elem< T > specialization.
00556 // Or alternatively X needs to inherit from T.
00557 template<typename T> struct Svr_xmit : Detail::_Svr_xmit<T> {};
00558
00559 }}} // namespace Msg, Ipc, L4
00560
00561
```

16.476 l4/sys/cxx/ipc_client File Reference

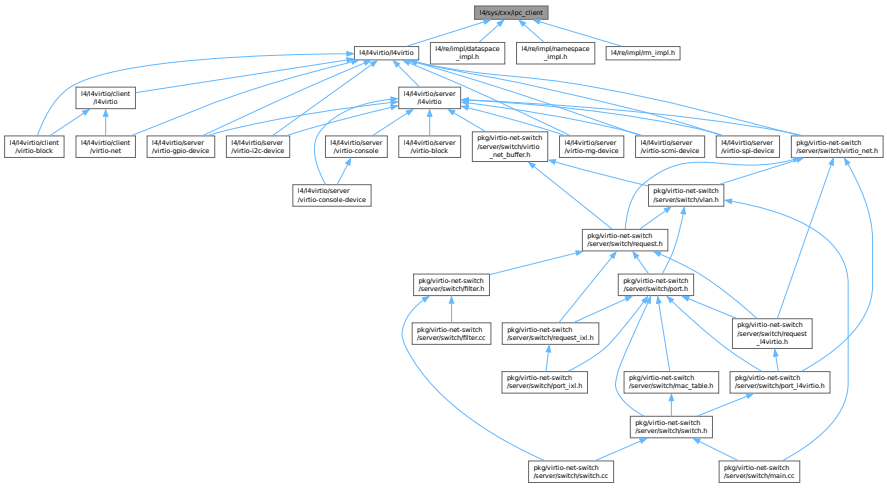
```
#include <l4/sys/cxx/ipc_basics>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/cxx/ipc_iface>
#include <l4/sys/__typeinfo.h>
```

```
#include <l4/sys/err.h>
```

Include dependency graph for ipc_client:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4

  L4 low-level kernel interface.

- namespace L4::Ipc

  IPC related functionality.
- namespace L4::Ipc::Msg

  IPC Message related functionality.

Macros

- #define L4_RPC_DEF(name)

  Generate the definition of an RPC stub.

16.476.1 Macro Definition Documentation

16.476.1.1 L4_RPC_DEF

```
#define L4_RPC_DEF(
                name)
```

Value:

```
  template struct  L4::Ipc::Msg::Rpc_call \
    <name##_t, name##_t::class_type, name##_t::ipc_type, name##_t::flags_type>
```

Generate the definition of an RPC stub.

Parameters

name	The fully qualified method name to be implemented, this means `class::method`.

This macro generates the definition (implementation) for the given RPC interface method.
Definition at line 32 of file ipc_client.

16.477 ipc_client

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008 #pragma GCC system_header
00009
00010 #include <l4/sys/cxx/ipc_basics>
00011 #include <l4/sys/cxx/ipc_types>
00012 #include <l4/sys/cxx/ipc_iface>
00013 #include <l4/sys/__typeinfo.h>
00014 #include <l4/sys/err.h>
00015
00019
00020 namespace L4 { namespace Ipc { namespace Msg {
00021 //----------------------------------------------------------------------------
00022
00032 #define L4_RPC_DEF(name) \
00033   template struct  L4::Ipc::Msg::Rpc_call \
00034     <name##_t, name##_t::class_type, name##_t::ipc_type, name##_t::flags_type>
00035
00036
00038 //-------------------------------------------------------
00039 //Implementation of the RPC call
00040 template<typename OP, typename C, typename FLAGS, typename R, typename ...ARGS>
00041 R L4_EXPORT
00042 Rpc_call<OP, C, R (ARGS...), FLAGS>::
00043   call(L4::Cap<C> cap, typename _Elem<ARGS>::arg_type ...a, l4_utcb_t *utcb) noexcept
00044 {
00045   return Rpc_inline_call<OP, C, R (ARGS...), FLAGS>::call(cap, a..., utcb);
00046 }
00048
00049 } // namespace Msg
00050 } // namespace Ipc
00051 } // namespace L4
00052
```

16.478 ipc_epiface

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014-2015 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008 #pragma GCC system_header
00009
00010 #include "capability.h"
00011 #include "ipc_server"
00012 #include "ipc_string"
00013 #include <l4/sys/types.h>
00014 #include <l4/sys/utcb.h>
00015 #include <l4/sys/__typeinfo.h>
00016 #include <l4/sys/meta>
00017 #include <l4/cxx/result>
00018 #include <l4/cxx/type_traits>
00019
00020 namespace L4 {
00021
00022 // forward for Irqep_t
00023 class Irq;
00024 class Rcv_endpoint;
00025
00026 namespace Ipc_svr {
00027
00028 class Timeout;
00029
00037 class Server_iface
00038 {
00039 private:
00040   Server_iface(Server_iface const &);
00041   Server_iface const &operator = (Server_iface const &);
00042
00043 public:
00050   class Mem_window final
00051   {
00052   public:
00053     class Allocator
00054     {
00055     public:
00056       virtual ~Allocator() = default;
00057
00058       virtual void dispose(l4_fpage_t fp) noexcept = 0;
00059     };
00060
00061     Mem_window() noexcept = default;
00062     Mem_window(l4_fpage_t fp, Allocator *allocator) noexcept
00063     : _fp(fp), _allocator(allocator)
00064     {}
00065
00066     ~Mem_window()
00067     { reset(); }
00068
00069     Mem_window(Mem_window const &) = delete;
00070     Mem_window &operator=(Mem_window const &) = delete;
00071
00072     Mem_window(Mem_window &&other) noexcept
00073     : _fp(other._fp), _allocator(other._allocator)
00074     {
00075       other._fp = l4_fpage_invalid();
00076       other._allocator = nullptr;
00077     }
00078
00079     Mem_window &operator=(Mem_window &&other) noexcept
00080     {
00081       if (this == &other)
00082         return *this;
00083
00084       reset();
00085       _fp = other._fp;
00086       _allocator = other._allocator;
00087
00088       other._fp = l4_fpage_invalid();
00089       other._allocator = nullptr;
00090
00091       return *this;
00092     }
00093
00094     void reset() noexcept
00095     {
00096       if (l4_is_fpage_valid(_fp))
00097         {
```

```
00098           _allocator->dispose(_fp);
00099           _fp = l4_fpage_invalid();
00100           _allocator = nullptr;
00101         }
00102     }
00103
00104     l4_fpage_t release() noexcept
00105     {
00106       l4_fpage_t ret = _fp;
00107       _fp = l4_fpage_invalid();
00108       _allocator = nullptr;
00109       return ret;
00110     }
00111
00112     explicit operator bool() const noexcept
00113     { return l4_is_fpage_valid(_fp); }
00114
00115     l4_fpage_t fp() const noexcept
00116     { return _fp; }
00117
00118     void *get() const noexcept
00119     { return reinterpret_cast<void *>(l4_fpage_memaddr(_fp)); }
00120
00121     unsigned order() const noexcept
00122     { return l4_fpage_order(_fp); }
00123
00124     l4_umword_t size() const noexcept
00125     { return l4_umword_t{1} << order(); }
00126
00127   private:
00128     l4_fpage_t _fp = l4_fpage_invalid();
00129     Allocator *_allocator = nullptr;
00130   };
00131
00133   using Demand = L4::Type_info::Demand;
00134
00135   Server_iface(Server_iface &&) = delete;
00136   Server_iface &operator = (Server_iface &&) = delete;
00137
00139   Server_iface() {}
00140
00141   // Destroy the server interface
00142   virtual ~Server_iface() = 0;
00143
00153   virtual int alloc_buffer_demand(Demand const &demand) = 0;
00154
00163   virtual L4::Cap<void> get_rcv_cap(int index) const = 0;
00164
00179   virtual int realloc_rcv_cap(int index) = 0;
00180
00187   virtual cxx::Result<L4::Reply_cap> take_reply_cap() noexcept
00188   { return cxx::Error(-L4_ENOSYS); }
00189
00201   virtual cxx::Result<Mem_window> get_rcv_mem() noexcept
00202   { return cxx::Error(-L4_ENOSYS); }
00203
00211   virtual int add_timeout(Timeout *timeout, l4_kernel_clock_t time) = 0;
00212
00218   virtual int remove_timeout(Timeout *timeout) = 0;
00219
00231   template<typename T>
00232   L4::Cap<T> rcv_cap(int index) const
00233   { return L4::cap_cast<T>(get_rcv_cap(index)); }
00234
00244   L4::Cap<void> rcv_cap(int index) const
00245   { return get_rcv_cap(index); }
00246 };
00247
00248 inline Server_iface::~Server_iface() {}
00249
00250 } // namespace Ipc_svr
00251
00263 struct Epiface
00264 {
00265   Epiface(Epiface const &) = delete;
00266   Epiface &operator = (Epiface const &) = delete;
00267
00269   using Server_iface = Ipc_svr::Server_iface;
00271   using Demand = Ipc_svr::Server_iface::Demand;
00272
00273   class Stored_cap : public Cap<void>
00274   {
00275   private:
00276     enum { Managed = 0x10 };
00277
00278   public:
00279     Stored_cap() = default;
```

```
00280     Stored_cap(Cap<void> const &c, bool managed = false)
00281     : Cap<void>((c.cap() & L4_CAP_MASK) | (managed ? Managed : 0))
00282     {
00283       static_assert (!(L4_CAP_MASK & Managed), "conflicting bits used...");
00284     }
00285
00286     bool managed() const { return cap() & Managed; }
00287   };
00288
00290   Epiface() : _data(0) {}
00291
00304   virtual l4_msgtag_t dispatch(l4_msgtag_t tag, unsigned rights,
00305                                l4_utcb_t *utcb) = 0;
00306
00313   virtual Demand get_buffer_demand() const = 0; //{ return Demand(0); }
00314
00316   virtual ~Epiface() = 0;
00317
00324   Stored_cap obj_cap() const { return _cap; }
00325
00331   Server_iface *server_iface() const { return _data; }
00332
00342   int set_server(Server_iface *srv, Cap<void> cap, bool managed = false)
00343   {
00344     if ((srv && cap) || (!srv && !cap))
00345       {
00346         _data = srv;
00347         _cap  = Stored_cap(cap, managed);
00348         return 0;
00349       }
00350
00351     return -L4_EINVAL;
00352   }
00353
00357   void set_obj_cap(Cap<void> const &cap) { _cap = cap; }
00358
00359 private:
00360   Server_iface *_data;
00361   Stored_cap _cap;
00362 };
00363
00364 inline Epiface::~Epiface() {}
00365
00373 template<typename RPC_IFACE, typename BASE = Epiface>
00374 struct Epiface_t0 : BASE
00375 {
00377   using Interface = RPC_IFACE;
00378
00380   typename Type_info::Demand get_buffer_demand() const
00381   { return typename Kobject_typeid<RPC_IFACE>::Demand(); }
00382
00387   Cap<RPC_IFACE> obj_cap() const
00388   { return L4::cap_cast<RPC_IFACE>(BASE::obj_cap()); }
00389 };
00390
00398 template<typename Derived, typename BASE = Epiface,
00399          bool = cxx::is_polymorphic<BASE>::value>
00400 struct Irqep_t : Epiface_t0<void, BASE>
00401 {
00402   l4_msgtag_t dispatch(l4_msgtag_t, unsigned, l4_utcb_t *) final
00403   {
00404     static_cast<Derived*>(this)->handle_irq();
00405     return l4_msgtag(-L4_ENOREPLY, 0, 0, 0);
00406   }
00407
00412   Cap<L4::Irq> obj_cap() const
00413   { return L4::cap_cast<L4::Irq>(BASE::obj_cap()); }
00414 };
00415
00416 template<typename Derived, typename BASE>
00417 struct Irqep_t<Derived, BASE, false> : Epiface_t0<void, BASE>
00418 {
00419   l4_msgtag_t dispatch(l4_msgtag_t, unsigned, l4_utcb_t *)
00420   {
00421     static_cast<Derived*>(this)->handle_irq();
00422     return l4_msgtag(-L4_ENOREPLY, 0, 0, 0);
00423   }
00424
00429   Cap<L4::Irq> obj_cap() const
00430   { return L4::cap_cast<L4::Irq>(BASE::obj_cap()); }
00431 };
00432
00440 class Registry_iface
00441 {
00442 public:
00443   virtual ~Registry_iface() = 0;
00444
```

```
00457   virtual L4::Cap<void>
00458   register_obj(L4::Epiface *o, char const *service) = 0;
00459
00474   virtual L4::Cap<void>
00475   register_obj(L4::Epiface *o) = 0;
00476
00490   virtual L4::Cap<L4::Irq> register_irq_obj(L4::Epiface *o) = 0;
00491
00504   virtual L4::Cap<L4::Rcv_endpoint>
00505   register_obj(L4::Epiface *o, L4::Cap<L4::Rcv_endpoint> ep) = 0;
00506
00519   virtual void
00520   unregister_obj(L4::Epiface *o, bool unmap = true) = 0;
00521 };
00522
00523 inline Registry_iface::~Registry_iface() {}
00524
00525 namespace Ipc {
00526 namespace Detail {
00527
00528 using namespace L4::Typeid;
00529
00530 template<typename IFACE>
00531 struct Meta_svr
00532 {
00533   l4_ret_t op_num_interfaces(L4::Meta::Rights)
00534   {
00535     l4_ret_t ret = 0;
00536     auto iter = [&ret](L4::Type_info const *)
00537       {
00538         ++ret;
00539         return false;
00540       };
00541     _iter_interfaces(iter);
00542     return ret;
00543   }
00544
00545   l4_ret_t op_interface(L4::Meta::Rights, l4_umword_t idx, long &proto,
00546                         L4::Ipc::String<char> &name)
00547   {
00548     auto iter =
00549       [idx, &proto, &name, num = 0U](L4::Type_info const *t) mutable
00550       {
00551         if (idx == num)
00552           {
00553             proto = t->proto();
00554             if (auto *n = t->name())
00555               name.copy_in(n);
00556             else
00557               name.copy_in("");
00558
00559             return true;
00560           }
00561
00562         ++num;
00563         return false;
00564       };
00565
00566     return _iter_interfaces(iter) ? 0 : -L4_ERANGE;
00567   }
00568
00569   l4_ret_t op_supports(L4::Meta::Rights, l4_mword_t proto)
00570   { return L4::kobject_typeid<IFACE>()->has_proto(proto); }
00571
00572 private:
00573   template<typename F>
00574   static bool _iter_interfaces(F &f)
00575   { return _iter_interfaces<F>(L4::kobject_typeid<IFACE>(), f); }
00576
00577   template<typename F>
00578   static bool _iter_interfaces(L4::Type_info const *t, F &f)
00579   {
00580     // Don't report L4::Kobject (no base) or L4::PROTO_EMPTY. The latter
00581     // interfaces are not dispatched and shall remain invisible.
00582     if (t->num_bases() && t->proto() != L4::PROTO_EMPTY)
00583       if (f(t))
00584         return true;
00585
00586     for (unsigned i = 0; i < t->num_bases(); ++i)
00587       if (_iter_interfaces(t->base(i), f))
00588         return true;
00589
00590     return false;
00591   }
00592 };
00593
00594 template<typename IFACE, typename LIST>
```

```
00595 struct _Dispatch;
00596
00597 // No match dispatcher found
00598 template<typename IFACE>
00599 struct _Dispatch<IFACE, Iface_list_end>
00600 {
00601   template< typename THIS, typename A1, typename A2 >
00602   static l4_msgtag_t f(THIS *, l4_msgtag_t, A1, A2 &)
00603   { return l4_msgtag(-L4_EBADPROTO, 0, 0, 0); }
00604 };
00605
00606 // call matching p_dispatch() function
00607 template<typename IFACE, typename I, typename LIST >
00608 struct _Dispatch<IFACE, Iface_list<I, LIST> >
00609 {
00610   // special handling for the meta protocol, to avoid 'using' murx
00611   template< typename THIS >
00612   static l4_msgtag_t _f(THIS *, l4_msgtag_t tag, unsigned r,
00613                         l4_utcb_t *utcb, True::type)
00614   {
00615     using L4::Ipc::Msg::dispatch_call;
00616     using Meta = L4::Meta::Rpcs;
00617     using Msvr = Meta_svr<IFACE>;
00618     return dispatch_call<Meta>(static_cast<Msvr *>(nullptr), utcb, tag, r);
00619   }
00620
00621   // normal dispatch to the op_<func> methods of \a self.
00622   template< typename THIS >
00623   static l4_msgtag_t _f(THIS *self, l4_msgtag_t t, unsigned r,
00624                         l4_utcb_t *utcb, False::type)
00625   {
00626     using L4::Ipc::Msg::dispatch_call;
00627     return dispatch_call<typename I::iface_type::Rpcs>(self, utcb, t, r);
00628   }
00629
00630   // dispatch function with switch for meta protocol
00631   template< typename THIS >
00632   static l4_msgtag_t f(THIS *self, l4_msgtag_t tag, unsigned r,
00633                        l4_utcb_t *utcb)
00634   {
00635     if (I::Proto == tag.label())
00636       return _f(self, tag, r, utcb,
00637                 Bool<I::Proto == static_cast<long>(L4_PROTO_META)>());
00638
00639     return _Dispatch<IFACE, typename LIST::type>::f(self, tag, r, utcb);
00640   }
00641 };
00642
00643 template<typename IFACE>
00644 struct Dispatch :
00645   _Dispatch<IFACE, typename L4::Kobject_typeid<IFACE>::Iface_list::type>
00646 {};
00647
00648 } // namespace Detail
00649
00650 template<typename EPIFACE>
00651 struct Dispatch : Detail::Dispatch<typename EPIFACE::Interface>
00652 {};
00653
00654 } // namespace Ipc
00655
00662 template<typename Derived, typename IFACE, typename BASE = L4::Epiface,
00663          bool = cxx::is_polymorphic<BASE>::value>
00664 struct Epiface_t : Epiface_t0<IFACE, BASE>
00665 {
00666   l4_msgtag_t
00667   dispatch(l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb) final
00668   {
00669     using Dispatch = Ipc::Dispatch<Derived>;
00670     return Dispatch::f(static_cast<Derived*>(this), tag, rights, utcb);
00671   }
00672 };
00673
00674 template<typename Derived, typename IFACE, typename BASE>
00675 struct Epiface_t<Derived, IFACE, BASE, false> : Epiface_t0<IFACE, BASE>
00676 {
00677   l4_msgtag_t
00678   dispatch(l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb)
00679   {
00680     using Dispatch = Ipc::Dispatch<Derived>;
00681     return Dispatch::f(static_cast<Derived*>(this), tag, rights, utcb);
00682   }
00683 };
00684
00690 class Basic_registry
00691 {
00692 public:
```

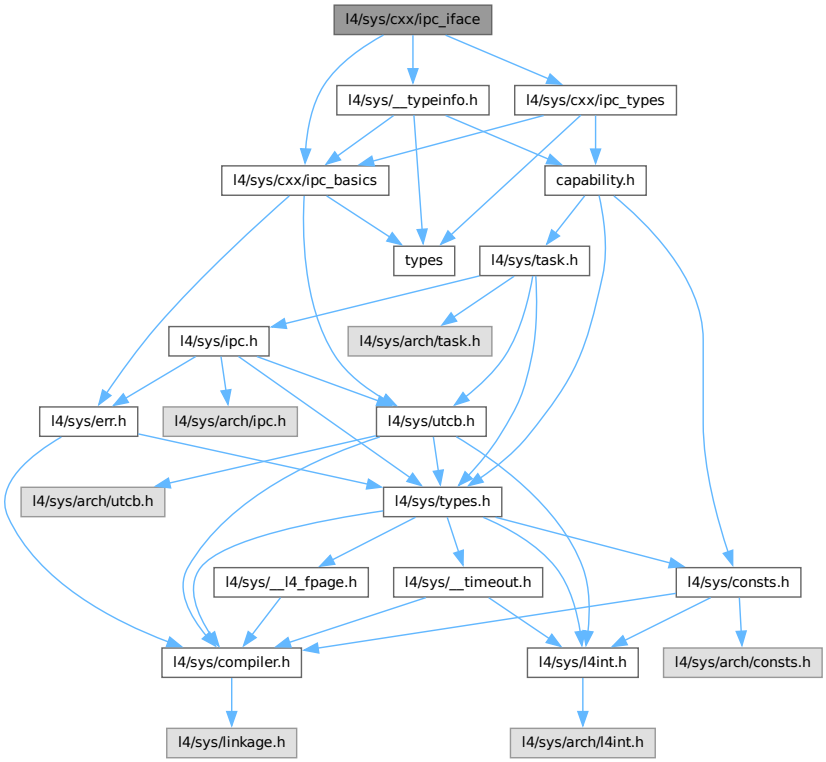
```
00693   using Value = Epiface;
00699   static Value *find(l4_umword_t label)
00700   { return reinterpret_cast<Value*>(label & ~3UL); }
00701
00715   static l4_msgtag_t dispatch(l4_msgtag_t tag, l4_umword_t label,
00716                               l4_utcb_t *utcb)
00717   {
00718     return find(label)->dispatch(tag, label, utcb);
00719   }
00720 };
00721
00722
00723 } // namespace L4
```

16.479 l4/sys/cxx/ipc_iface File Reference

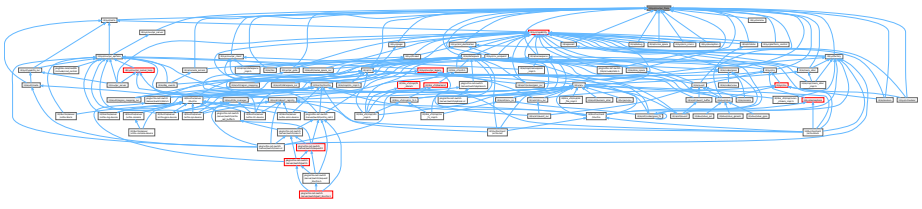
Interface Definition Language.

```
#include <l4/sys/cxx/ipc_basics>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/__typeinfo.h>
```

Include dependency graph for ipc_iface:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct L4::Ipc::Call

  RPC attribute for a standard RPC call.
- struct L4::Ipc::Call_zero_send_timeout

  RPC attribute for an RPC call, with zero send timeout.
- struct L4::Ipc::Call_t< RIGHTS >

  RPC attribute for an RPC call with required rights.
- struct L4::Ipc::Send_only

  RPC attribute for a send-only RPC.

Namespaces

- namespace L4

  L4 low-level kernel interface.
- namespace L4::Ipc

  IPC related functionality.
- namespace L4::Ipc::Msg

  IPC Message related functionality.

Macros

- #define L4_INLINE_RPC_NF(res, name, args...)

  Define an inline RPC call type (the type only, no callable).
- #define L4_INLINE_RPC_NF_OP(op, res, name, args...)

  Define an inline RPC call type with specific opcode (the type only, no callable).
- #define L4_INLINE_RPC(res, name, args, attr...)

  Define an inline RPC call (type and callable).
- #define L4_INLINE_RPC_OP(op, res, name, args, attr...)

  Define an inline RPC call with specific opcode (type and callable).
- #define L4_RPC_NF(res, name, args...)

  Define an RPC call type (the type only, no callable).
- #define L4_RPC_NF_OP(op, res, name, args...)

  Define an RPC call type with specific opcode (the type only, no callable).
- #define L4_RPC(res, name, args, attr...)

  Define an RPC call (type and callable).
- #define L4_RPC_OP(op, res, name, args, attr...)

  Define an RPC call with specific opcode (type and callable).

16.479.1 Detailed Description

Interface Definition Language.

See also

L4_RPC, L4_INLINE_RPC, L4::Ipc::Call L4::Ipc::Send_only, L4::Ipc::Msg::Rpc_call, L4::Ipc::Msg::Rpc_↩ inline_call

Definition in file ipc_iface.

16.479.2 Macro Definition Documentation

16.479.2.1 L4_INLINE_RPC

```
#define L4_INLINE_RPC(
              res,
              name,
              args,
              attr...)
```

Value:

```
res name args
```

Define an inline RPC call (type and callable).

Parameters

res	The result type of the RPC call
name	The name of the function (`name_t` is used for the type.)
args	The argument list of the RPC function.
attr	Optional RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Examples

examples/clntsrv/src/shared.h.

Definition at line 483 of file ipc_iface.
Referenced by L4Re::Mem_alloc::info().

16.479.2.2 L4_INLINE_RPC_NF

```
#define L4_INLINE_RPC_NF(
              res,
              name,
              args...)
```

Value:

```
  struct name##_t : L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args> \
  {                                                                           \
    using type = L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args>;    \
    L4_INLINE_RPC_SRV_FORWARD(name);                                          \
  }
```

Define an inline RPC call type (the type only, no callable).

Parameters

res	The result type of the RPC call
name	The name of the function (`name_t` is used for the type.)
args	The argument list of the RPC function, and RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Stubs generated by this macro can be used explicitly in custom wrapper methods that need to use the underlying RPC code and provide some higher level abstraction, for example with default arguments or extra argument conversion.
Definition at line 454 of file ipc_iface.

16.479.2.3 L4_INLINE_RPC_NF_OP

```
#define L4_INLINE_RPC_NF_OP(
              op,
              res,
```

```
                name,
                args...)
```

Value:

```
struct name##_t : L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args> \
{                                                                          \
  using type = L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args>;   \
  enum { Opcode = (op) };                                                  \
  L4_INLINE_RPC_SRV_FORWARD(name);                                         \
}
```

Define an inline RPC call type with specific opcode (the type only, no callable).

Parameters

op	The opcode number for this function
res	The result type of the RPC call
name	The name of the function (`name_t` is used for the type.)
args	The argument list of the RPC function, and RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Stubs generated by this macro can be used explicitly in custom wrapper methods that need to use the underlying RPC code and provide some higher level abstraction, for example with default arguments or extra argument conversion.
Definition at line 467 of file ipc_iface.

16.479.2.4 L4_INLINE_RPC_OP

```
#define L4_INLINE_RPC_OP(
                op,
                res,
                name,
                args,
                attr...)
```

Value:

```
res name args
```

Define an inline RPC call with specific opcode (type and callable).

Parameters

op	The opcode number for this function
res	The result type of the RPC call
name	The name of the function (`name_t` is used for the type.)
args	The argument list of the RPC function.
attr	Optional RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Definition at line 498 of file ipc_iface.

16.479.2.5 L4_RPC

```
#define L4_RPC(
                res,
                name,
                args,
                attr...)
```

Value:

```
res name args
```

Define an RPC call (type and callable).

Parameters

res	The result type of the RPC call
name	The name of the function (name_t is used for the type.)
args	The argument list of the RPC function.
attr	Optional RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Definition at line 542 of file ipc_iface.
Referenced by L4Re::Dataspace::info().

16.479.2.6 L4_RPC_NF

```
#define L4_RPC_NF(
              res,
              name,
              args...)
```

Value:

```
  struct name##_t : L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>        \
  {                                                                          \
    using type = L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>;          \
    L4_INLINE_RPC_SRV_FORWARD(name);                                         \
  }
```

Define an RPC call type (the type only, no callable).

Parameters

res	The result type of the RPC call
name	The name of the function (name_t is used for the type.)
args	The argument list of the RPC function, and RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Definition at line 511 of file ipc_iface.
Referenced by L4Re::Dataspace::info().

16.479.2.7 L4_RPC_NF_OP

```
#define L4_RPC_NF_OP(
              op,
              res,
              name,
              args...)
```

Value:

```
  struct name##_t : L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>        \
  {                                                                          \
    using type = L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>;          \
    enum { Opcode = (op) };                                                  \
    L4_INLINE_RPC_SRV_FORWARD(name);                                         \
  }
```

Define an RPC call type with specific opcode (the type only, no callable).

Parameters

op	The opcode number for this function
res	The result type of the RPC call
name	The name of the function (name_t is used for the type.)
args	The argument list of the RPC function, and RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Definition at line 526 of file ipc_iface.

16.479.2.8 L4_RPC_OP

```
#define L4_RPC_OP(
              op,
              res,
              name,
              args,
              attr...)
```

Value:

```
res name args
```

Define an RPC call with specific opcode (type and callable).

Parameters

op	The opcode number for this function
res	The result type of the RPC call
name	The name of the function (`name_t` is used for the type.)
args	The argument list of the RPC function.
attr	Optional RPC attributes (L4::Ipc::Call, L4::Ipc::Call_t etc.).

Definition at line 557 of file ipc_iface.

16.480 ipc_iface

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008 #pragma GCC system_header
00009
00010 #include <l4/sys/cxx/ipc_basics>
00011 #include <l4/sys/cxx/ipc_types>
00012 #include <l4/sys/__typeinfo.h>
00013
00022
00219
00220 // TODO: add some more documentation
00221 namespace L4 { namespace Ipc {
00222
00239 struct L4_EXPORT Call
00240 {
00241   enum { Is_call = true };
00242   enum { Rights = 0 };
00243   static l4_timeout_t timeout() { return L4_IPC_NEVER; }
00244 };
00245
00249 struct L4_EXPORT Call_zero_send_timeout : Call
00250 {
00251   static l4_timeout_t timeout() { return L4_IPC_SEND_TIMEOUT_0; }
00252 };
00253
00269 template<unsigned RIGHTS>
00270 struct L4_EXPORT Call_t : Call
00271 {
00272   enum { Rights = RIGHTS };
00273 };
00274
00287 struct L4_EXPORT Send_only
00288 {
00289   enum { Is_call = false };
00290   enum { Rights = 0 };
00291   static l4_timeout_t timeout() { return L4_IPC_NEVER; }
00292 };
00293
00294 namespace Msg {
00295
00306 template<typename OP, typename CLASS, typename SIG, typename FLAGS = Call>
```

```
00307 struct L4_EXPORT Rpc_inline_call;
00308
00313 template<typename OP, typename CLASS, typename FLAGS, typename R,
00314          typename ...ARGS>
00315 struct L4_EXPORT Rpc_inline_call<OP, CLASS, R (ARGS...), FLAGS>
00316 {
00317   template<typename T> struct Result { using result_type = T; };
00318   enum
00319   {
00320     Return_tag = L4::Types::Same_v<R, l4_msgtag_t>
00321   };
00322
00324   using type = Rpc_inline_call;
00326   using op_type = OP;
00328   using class_type = CLASS;
00330   using result_type = typename Result<R>::result_type;
00332   using ipc_type = R (ARGS...);
00334   using func_type = result_type (typename _Elem<ARGS>::arg_type...);
00335
00337   using flags_type = FLAGS;
00338
00339   template<typename RES>
00340   static L4::Types::Enable_if_t< Return_tag, RES >
00341   return_err(l4_ret_t err) noexcept { return l4_msgtag(err, 0, 0, 0); }
00342
00343   template<typename RES>
00344   static L4::Types::Enable_if_t< Return_tag, RES >
00345   return_ipc_err(l4_msgtag_t tag, l4_utcb_t const *) noexcept { return tag; }
00346
00347   template<typename RES>
00348   static L4::Types::Enable_if_t< Return_tag, RES >
00349   return_code(l4_msgtag_t tag) noexcept { return tag; }
00350
00351   template<typename RES>
00352   static L4::Types::Enable_if_t< !Return_tag, RES >
00353   return_err(long err) noexcept { return err; }
00354
00355   template<typename RES>
00356   static L4::Types::Enable_if_t< !Return_tag, RES >
00357   return_ipc_err(l4_msgtag_t, l4_utcb_t *utcb) noexcept
00358   { return l4_ipc_to_errno(l4_ipc_error_code(utcb)); }
00359
00360   template<typename RES>
00361   static L4::Types::Enable_if_t< !Return_tag, RES >
00362   return_code(l4_msgtag_t tag) noexcept { return tag.label(); }
00363
00364   static R call(L4::Cap<class_type> cap,
00365                 typename _Elem<ARGS>::arg_type ...a,
00366                 l4_utcb_t *utcb = l4_utcb()) noexcept;
00367 };
00368
00373 template<typename OP, typename CLASS, typename SIG, typename FLAGS = Call>
00374 struct L4_EXPORT Rpc_call;
00375
00383 template<typename IPC, typename SIG> struct _Call;
00384
00386 template<typename IPC, typename R, typename ...ARGS>
00387 struct _Call<IPC, R (ARGS...)>
00388 {
00389 public:
00390   using class_type = typename IPC::class_type;
00391   using result_type = typename IPC::result_type;
00392
00393 private:
00394   L4::Cap<class_type> cap() const noexcept
00395   {
00396     return L4::Cap<class_type>(reinterpret_cast<l4_cap_idx_t>(this)
00397                                & L4_CAP_MASK);
00398   }
00399
00400 public:
00402   result_type operator () (ARGS ...a, l4_utcb_t *utcb = l4_utcb()) const noexcept
00403   { return IPC::call(cap(), a..., utcb); }
00404 };
00405
00412 template<typename IPC> struct Call : _Call<IPC, typename IPC::func_type> {};
00413
00418 template<typename OP,
00419          typename CLASS,
00420          typename FLAGS,
00421          typename R,
00422          typename ...ARGS>
00423 struct L4_EXPORT Rpc_call<OP, CLASS, R (ARGS...), FLAGS> :
00424   Rpc_inline_call<OP, CLASS, R (ARGS...), FLAGS>
00425 {
00426   static R call(L4::Cap<CLASS> cap,
00427                 typename _Elem<ARGS>::arg_type ...a,
```

```
00428                 l4_utcb_t *utcb = l4_utcb()) noexcept;
00429 };
00430
00431 #define L4_INLINE_RPC_SRV_FORWARD(name)                                    \
00432   template<typename OBJ> struct fwd                                        \
00433   {                                                                        \
00434     OBJ *o;                                                                \
00435     fwd(OBJ *o) noexcept : o(o) {}                                         \
00436     template<typename ...ARGS>                                             \
00437     decltype(auto) call(ARGS ...a) noexcept(noexcept(o->op_##name(a...)))  \
00438     { return o->op_##name(a...); }                                         \
00439   }
00440
00441
00454 #define L4_INLINE_RPC_NF(res, name, args...)                               \
00455   struct name##_t : L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args> \
00456   {                                                                        \
00457     using type = L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args>; \
00458     L4_INLINE_RPC_SRV_FORWARD(name);                                       \
00459   }
00460
00467 #define L4_INLINE_RPC_NF_OP(op, res, name, args...)                        \
00468   struct name##_t : L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args> \
00469   {                                                                        \
00470     using type = L4::Ipc::Msg::Rpc_inline_call<name##_t, Class, res args>; \
00471     enum { Opcode = (op) };                                                \
00472     L4_INLINE_RPC_SRV_FORWARD(name);                                       \
00473   }
00474
00475 #ifdef DOXYGEN
00483 #define L4_INLINE_RPC(res, name, args, attr...) res name args
00484 #else
00485 #define L4_INLINE_RPC(res, name, args...)                                  \
00486   L4_INLINE_RPC_NF(res, name, args); L4::Ipc::Msg::Call<name##_t> name
00487 #endif
00488
00489 #ifdef DOXYGEN
00498 #define L4_INLINE_RPC_OP(op, res, name, args, attr...) res name args
00499 #else
00500 #define L4_INLINE_RPC_OP(op, res, name, args...)                           \
00501   L4_INLINE_RPC_NF_OP(op, res, name, args); L4::Ipc::Msg::Call<name##_t> name
00502 #endif
00503
00511 #define L4_RPC_NF(res, name, args...)                                      \
00512   struct name##_t : L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>      \
00513   {                                                                        \
00514     using type = L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>;        \
00515     L4_INLINE_RPC_SRV_FORWARD(name);                                       \
00516   }
00517
00526 #define L4_RPC_NF_OP(op, res, name, args...)                               \
00527   struct name##_t : L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>      \
00528   {                                                                        \
00529     using type = L4::Ipc::Msg::Rpc_call<name##_t, Class, res args>;        \
00530     enum { Opcode = (op) };                                                \
00531     L4_INLINE_RPC_SRV_FORWARD(name);                                       \
00532   }
00533
00534 #ifdef DOXYGEN
00542 #define L4_RPC(res, name, args, attr...) res name args
00543 #else
00544 #define L4_RPC(res, name, args...)                                         \
00545   L4_RPC_NF(res, name, args); L4::Ipc::Msg::Call<name##_t> name
00546 #endif
00547
00548 #ifdef DOXYGEN
00557 #define L4_RPC_OP(op, res, name, args, attr...) res name args
00558 #else
00559 #define L4_RPC_OP(op, res, name, args...)                                  \
00560   L4_RPC_NF_OP(op, res, name, args); L4::Ipc::Msg::Call<name##_t> name
00561 #endif
00562
00563
00568 namespace Detail {
00569
00573 template<typename ...ARGS>
00574 struct Buf
00575 {
00576 public:
00577   template<Phase PHASE>
00578   static constexpr int write(char *, int offset, int) noexcept
00579   { return offset; }
00580
00581   template<Phase PHASE>
00582   static constexpr int read(char *, int offset, int) noexcept
00583   { return offset; }
00584
```

```
00585   using Base = void;
00586 };
00587
00588 template<typename A, typename ...M>
00589 struct Buf<A, M...> : Buf<M...>
00590 {
00591   using Base = Buf<M...>;
00592
00593   using xmit = Clnt_xmit<A>;
00594   using arg_type = typename _Elem<A>::arg_type;
00595   using plain = Detail::_Plain<arg_type>;
00596   static constexpr bool Is_input = _Elem<A>::Is_input;
00597   static constexpr bool Is_output = _Elem<A>::Is_output;
00598
00599   template<Phase PHASE>
00600   static int
00601   write(char *base, int offset, int limit,
00602         arg_type a, typename _Elem<M>::arg_type ...m) noexcept
00603   {
00604     if constexpr (PHASE == Phase::Data && Is_input)
00605       offset = xmit::to_msg_data(base, offset, limit, plain::deref(a));
00606     else if constexpr (PHASE == Phase::Items && Is_input)
00607       offset = xmit::to_msg_items(base, offset, limit, plain::deref(a));
00608     else if constexpr (PHASE == Phase::Buffers && Is_output)
00609       offset = xmit::to_msg_buffers(base, offset, limit, plain::deref(a));
00610
00611     return Base::template write<PHASE>(base, offset, limit, m...);
00612   }
00613
00614   template<Phase PHASE>
00615   static int
00616   read(char *base, int offset, int limit,
00617        arg_type a, typename _Elem<M>::arg_type ...m) noexcept
00618   {
00619     int r = offset;
00620     // Read output parameters from UTCB MRs.
00621     if constexpr (Is_output)
00622       {
00623         static_assert(PHASE == Phase::Data || PHASE == Phase::Items);
00624         if constexpr (PHASE == Phase::Data)
00625           r = xmit::from_msg_data(base, offset, limit, plain::deref(a));
00626         else // PHASE == Phase::Items
00627           r = xmit::from_msg_items(base, offset, limit, plain::deref(a));
00628       }
00629
00630     if (L4_LIKELY(r >= 0))
00631       return Base::template read<PHASE>(base, r, limit, m...);
00632
00633     if (_Elem<A>::Is_optional)
00634       return Base::template read<PHASE>(base, offset, limit, m...);
00635
00636     return r;
00637   }
00638 };
00639
00640 template <typename ...ARGS> struct _Part
00641 {
00643   using Data = Buf<ARGS...>;
00644
00645   template<Phase PHASE>
00646   static int write(void *b, int offset, int limit,
00647                    typename _Elem<ARGS>::arg_type ...m) noexcept
00648   {
00649     char *buf = static_cast<char *>(b);
00650     int r = Data::template write<PHASE>(buf, offset, limit, m...);
00651     if (L4_LIKELY(r >= offset))
00652       return r - offset;
00653     return r;
00654   }
00655
00656   template<Phase PHASE>
00657   static int read(void *b, int offset, int limit,
00658                   typename _Elem<ARGS>::arg_type ...m) noexcept
00659   {
00660     char *buf = static_cast<char *>(b);
00661     int r = Data::template read<PHASE>(buf, offset, limit, m...);
00662     if (L4_LIKELY(r >= offset))
00663       return r - offset;
00664     return r;
00665   }
00666 };
00667
00674 template<typename IPC_TYPE, typename OPCODE = void>
00675 struct Part;
00676
00677 // The version without an op-code
00678 template<typename R, typename ...ARGS>
```

```
00679 struct Part<R (ARGS...), void> : _Part<ARGS...>
00680 {
00682   using Data = Buf<ARGS...>;
00683
00684   // write arguments, skipping the dummy opcode
00685   static int write_op(void *b, int offset, int limit,
00686                       int /*placeholder for op*/,
00687                       typename _Elem<ARGS>::arg_type ...m) noexcept
00688   {
00689     char *buf = static_cast<char *>(b);
00690     int r = Data::template write<Phase::Data>(buf, offset, limit, m...);
00691     if (L4_LIKELY(r >= offset))
00692       return r - offset;
00693     return r;
00694   }
00695 };
00696
00697 // Message part with additional opcode
00698 template<typename OPCODE, typename R, typename ...ARGS>
00699 struct Part<R (ARGS...), OPCODE> : _Part<ARGS...>
00700 {
00701   using opcode_type = OPCODE;
00703   using Data = Buf<opcode_type, ARGS...>;
00704
00705   // write arguments, including the opcode
00706   static int write_op(void *b, int offset, int limit,
00707                       opcode_type op, typename _Elem<ARGS>::arg_type ...m) noexcept
00708   {
00709     char *buf = static_cast<char *>(b);
00710     int r = Data::template write<Phase::Data>(buf, offset, limit, op, m...);
00711     if (L4_LIKELY(r >= offset))
00712       return r - offset;
00713     return r;
00714   }
00715 };
00716
00717
00718 } // namespace Detail
00719
00720 //---------------------------------------------------
00721 // Implementation of the RPC call
00722 // TODO: Add support for timeout via special RPC argument
00723 // TODO: Add support for passing the UTCB pointer as argument
00724 //
00725 template<typename OP, typename CLASS, typename FLAGS, typename R,
00726          typename ...ARGS>
00727 inline R
00728 Rpc_inline_call<OP, CLASS, R (ARGS...), FLAGS>::
00729   call(L4::Cap<CLASS> cap,
00730        typename _Elem<ARGS>::arg_type ...a,
00731        l4_utcb_t *utcb) noexcept
00732 {
00733   using namespace Ipc::Msg;
00734
00735   using Rpcs = typename Kobject_typeid<CLASS>::Iface::Rpcs;
00736   using Opt = typename Rpcs::template Rpc<OP>;
00737   using Args = Detail::Part<ipc_type, typename Rpcs::opcode_type>;
00738
00739   l4_msg_regs_t *mrs = l4_utcb_mr_u(utcb);
00740
00741   // handle in-data part of the arguments
00742   int send_bytes =
00743     Args::write_op(mrs->mr, 0, Mr_bytes, Opt::Opcode, a...);
00744
00745   if (L4_UNLIKELY(send_bytes < 0))
00746     return return_err<R>(send_bytes);
00747
00748   send_bytes = align_to<l4_umword_t>(send_bytes);
00749   int const send_words = send_bytes / Word_bytes;
00750   // write the in-items part of the message if there is one
00751   int item_bytes =
00752     Args::template write<Phase::Items>(&mrs->mr[send_words], 0,
00753                                        Mr_bytes - send_bytes, a...);
00754
00755   if (L4_UNLIKELY(item_bytes < 0))
00756     return return_err<R>(item_bytes);
00757
00758   int send_items = item_bytes / Item_bytes;
00759
00760     {
00761       // setup the receive buffers for the RPC call
00762       l4_buf_regs_t *brs = l4_utcb_br_u(utcb);
00763       // XXX: we currently support only one type of receive buffers per call
00764       brs->bdr = 0; // we always start at br[0]
00765
00766       // the limit leaves us at least one register for the zero terminator
00767       // add the buffers given as arguments to the buffer registers
```

```
00768       int bytes =
00769         Args::template write<Phase::Buffers>(brs->br, 0, Br_bytes - Word_bytes,
00770                                              a...);
00771
00772       if (L4_UNLIKELY(bytes < 0))
00773         return return_err<R>(bytes);
00774
00775       brs->br[bytes / Word_bytes] = 0;
00776     }
00777
00778
00779   // here we do the actual IPC ---------------------------------
00780   l4_msgtag_t t;
00781   t = l4_msgtag(CLASS::Protocol, send_words, send_items, 0);
00782   // do the call (Q: do we need support for timeouts?)
00783   if (flags_type::Is_call)
00784     t = l4_ipc_call(cap.cap(), utcb, t, flags_type::timeout());
00785   else
00786     {
00787       t = l4_ipc_send(cap.cap(), utcb, t, flags_type::timeout());
00788       if (L4_UNLIKELY(t.has_error()))
00789         return return_ipc_err<R>(t, utcb);
00790
00791       return return_code<R>(l4_msgtag(0, 0, 0, t.flags()));
00792     }
00793
00794   // unmarshalling starts here ---------------------------------
00795
00796   // bail out early in the case of an IPC error
00797   if (L4_UNLIKELY(t.has_error()))
00798     return return_ipc_err<R>(t, utcb);
00799
00800   // take the label as return value
00801   l4_ret_t r = t.label();
00802
00803   // bail out on negative error codes too
00804   if (L4_UNLIKELY(r < 0))
00805     return return_err<R>(r);
00806
00807   int const rcv_bytes = t.words() * Word_bytes;
00808
00809   // read the static out-data values to the arguments
00810   int err = Args::template read<Phase::Data>(mrs->mr, 0, rcv_bytes, a...);
00811
00812   int const item_limit = t.items() * Item_bytes;
00813
00814   if (L4_UNLIKELY(err < 0 || item_limit > Mr_bytes))
00815     return return_err<R>(-L4_EMSGTOOSHORT);
00816
00817   // read the static out-items to the arguments
00818   err = Args::template read<Phase::Items>(&mrs->mr[t.words()], 0, item_limit,
00819                                           a...);
00820
00821   if (L4_UNLIKELY(err < 0))
00822     return return_err<R>(-L4_EMSGTOOSHORT);
00823
00824   return return_code<R>(t);
00825 }
00826
00827 } // namespace Msg
00828 } // namespace Ipc
00829 } // namespace L4
```

16.481 ipc_legacy

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2015, 2017, 2024 Kernkonzept GmbH.
00004  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/sys/cxx/ipc_epiface>
00011 #ifndef L4_RPC_DISABLE_LEGACY_DISPATCH
00012 #define L4_RPC_LEGACY_DISPATCH(IFACE)                                  \
00013   template<typename IOS>                                               \
00014   int dispatch(unsigned rights, IOS &ios)                              \
00015   {                                                                    \
00016     using Dispatch = ::L4::Ipc::Detail::Dispatch<IFACE>;               \
00017     l4_msgtag_t r = Dispatch::f(this, ios.tag(), rights, ios.utcb()); \
00018     ios.set_ipc_params(r);                                             \
00019     return r.label();                                                  \
```

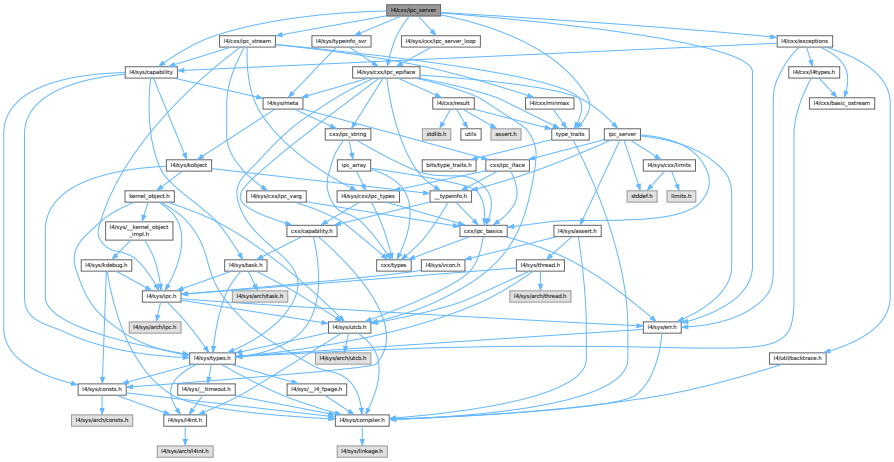
```
00020   }                                                                   \
00021                                                                       \
00022   template<typename IOS>                                              \
00023   int p_dispatch(IFACE *, unsigned rights, IOS &ios)                  \
00024   {                                                                   \
00025     using ::L4::Ipc::Msg::dispatch_call;                              \
00026     l4_msgtag_t r;                                                    \
00027     r = dispatch_call<typename IFACE::Rpcs>(this, ios.utcb(),         \
00028                                             ios.tag(), rights);       \
00029     ios.set_ipc_params(r);                                            \
00030     return r.label();                                                 \
00031   }
00032
00033 #define L4_RPC_LEGACY_USING(IFACE) \
00034   using IFACE::p_dispatch
00035
00036 #else
00037 #define L4_RPC_LEGACY_DISPATCH(IFACE)
00038 #define L4_RPC_LEGACY_USING(IFACE)
00039 #endif
```

16.482 l4/cxx/ipc_server File Reference

IPC server loop.

```
#include <l4/sys/capability>
#include <l4/sys/typeinfo_svr>
#include <l4/sys/err.h>
#include <l4/cxx/ipc_stream>
#include <l4/sys/cxx/ipc_epiface>
#include <l4/sys/cxx/ipc_server_loop>
#include <l4/cxx/type_traits>
#include <l4/cxx/exceptions>
```

Include dependency graph for ipc_server:



Data Structures

- class L4::Server_object

  Abstract server object to be used with L4::Server and L4::Basic_registry.
- struct L4::Server_object_t< IFACE, BASE >

  Base class (template) for server implementing server objects.
- struct L4::Server_object_x< Derived, IFACE, BASE >

  Helper class to implement p_dispatch based server objects.
- struct L4::Irq_handler_object

  Server object base class for handling IRQ messages.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.482.1 Detailed Description

IPC server loop.
Definition in file ipc_server.

16.483 ipc_server

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/capability>
00017 #include <l4/sys/typeinfo_svr>
00018 #include <l4/sys/err.h>
00019 #include <l4/cxx/ipc_stream>
00020 #include <l4/sys/cxx/ipc_epiface>
00021 #include <l4/sys/cxx/ipc_server_loop>
00022 #include <l4/cxx/type_traits>
00023 #include <l4/cxx/exceptions>
00024
00025 namespace L4 {
00026
00038 class Server_object : public Epiface
00039 {
00040 public:
00058   virtual int dispatch(unsigned long rights, Ipc::Iostream &ios) = 0;
00059
00060   l4_msgtag_t dispatch(l4_msgtag_t tag, unsigned rights, l4_utcb_t *utcb) override
00061   {
00062     L4::Ipc::Iostream ios(utcb);
00063     ios.tag() = tag;
00064     int r = dispatch(rights, ios);
00065     return ios.prepare_ipc(r);
00066   }
00067
00068   Cap<Kobject> obj_cap() const
00069   { return cap_cast<Kobject>(Epiface::obj_cap()); }
00070 };
00071
00079 template<typename IFACE, typename BASE = L4::Server_object>
00080 struct Server_object_t : BASE
00081 {
00083   typedef IFACE Interface;
00084
00086   typename BASE::Demand get_buffer_demand() const override
00087   { return typename L4::Kobject_typeid<IFACE>::Demand(); }
00088
00099   int dispatch_meta_request(L4::Ipc::Iostream &ios)
00100   { return L4::Util::handle_meta_request<IFACE>(ios); }
00101
00113   template<typename THIS>
00114   static int proto_dispatch(THIS *self, l4_umword_t rights, L4::Ipc::Iostream &ios)
00115   {
00116     l4_msgtag_t t;
00117     ios >> t;
00118     return Kobject_typeid<IFACE>::proto_dispatch(self, t.label(), rights, ios);
00119   }
00120 };
00121
00142 template<typename Derived, typename IFACE, typename BASE = L4::Server_object>
00143 struct Server_object_x : Server_object_t<IFACE, BASE>
00144 {
00146   int dispatch(l4_umword_t r, L4::Ipc::Iostream &ios)
00147   {
00148     return Server_object_t<IFACE, BASE>::proto_dispatch(static_cast<Derived *>(this),
00149                                                         r, ios);
00150   }
```

```
00151 };
00152
00161 struct Irq_handler_object : Server_object_t<Kobject> {};
00162
00163 }
```

16.484 ipc_server

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008 #pragma GCC system_header
00009
00010 #include <l4/sys/cxx/ipc_basics>
00011 #include <l4/sys/cxx/ipc_iface>
00012 #include <l4/sys/cxx/limits>
00013 #include <l4/sys/__typeinfo.h>
00014 #include <l4/sys/assert.h>
00015 #include <l4/sys/err.h>
00016 #include <stddef.h>
00017
00018 namespace L4 {
00019 namespace Ipc {
00020 namespace Msg {
00021 namespace Detail {
00022
00023 template<typename T> struct Sizeof { enum { size = sizeof(T) }; };
00024 template<> struct Sizeof<void> { enum { size = 0 }; };
00025
00029 template<typename ...> struct Arg_pack
00030 {
00031   template<Phase PHASE>
00032   unsigned get(char *, unsigned offset, unsigned)
00033   { return offset; }
00034
00035   unsigned reserve_data(char *, unsigned offset, unsigned)
00036   { return offset; }
00037
00038   template<Phase PHASE>
00039   unsigned set(char *, unsigned offset, unsigned)
00040   { return offset; }
00041
00042   template<typename F, typename ...ARGS>
00043   decltype(auto) call(F f, ARGS ...args)
00044   { return f(args...); }
00045
00046   template<typename ...>
00047   void reply()
00048   {}
00049
00050   template<typename O, typename FUNC, typename ...ARGS>
00051   auto obj_call(O *o, ARGS ...args)
00052     -> decltype(typename FUNC::template fwd<O>(o).template call<ARGS...>(args...))
00053   {
00054     using Fwd = typename FUNC::template fwd<O>;
00055     using Idl_ret = typename FUNC::result_type;
00056     using Svr_ret = decltype(Fwd(o).template call<ARGS...>(args...));
00057     auto ret = Fwd(o).template call<ARGS...>(args...);
00058
00059     using L4::Types::numeric_limits;
00060     // Truncating a negative return value which is too small could result in a
00061     // positive value pretending "success" to the caller.
00062     if constexpr (numeric_limits<Svr_ret>::min() < numeric_limits<Idl_ret>::min())
00063       {
00064         if (L4_UNLIKELY(ret < numeric_limits<Idl_ret>::min()))
00065           return -L4_EMSGERRRANGE;
00066       }
00067     // Truncating a positive return value which is too large results either in a
00068     // positive value different from the original return value (but interpreted
00069     // as "success" by the caller) or in a negative value. Trigger an assertion
00070     // in these cases but also return an error in case of NDEBUG=y.
00071     if constexpr (numeric_limits<Svr_ret>::max() > numeric_limits<Idl_ret>::max())
00072       {
00073         l4_assert(ret <= numeric_limits<Idl_ret>::max());
00074         if (L4_UNLIKELY(ret > numeric_limits<Idl_ret>::max()))
00075           return -L4_EMSGERRRANGE;
00076       }
00077     // The following two checks are required in case the Idl_ret limits exceed
00078     // the limits of the 'label' part of l4_msgtag_t.
00079     if constexpr (numeric_limits<Svr_ret>::min() < numeric_limits<l4_msgtag_t>::min())
```

```
00080       {
00081         if (L4_UNLIKELY(ret < numeric_limits<l4_msgtag_t>::min()))
00082           return -L4_EMSGERRRANGE;
00083       }
00084     if constexpr (numeric_limits<Svr_ret>::max() > numeric_limits<l4_msgtag_t>::max())
00085       {
00086         l4_assert(ret <= numeric_limits<l4_msgtag_t>::max());
00087         if (L4_UNLIKELY(ret > numeric_limits<l4_msgtag_t>::max()))
00088           return -L4_EMSGERRRANGE;
00089       }
00090
00091     return ret;
00092   }
00093 };
00094
00098 template<typename T, typename SVR_TYPE, typename ...M>
00099 struct Svr_arg : Svr_xmit<T>, Arg_pack<M...>
00100 {
00101   using Base = Arg_pack<M...>;
00102
00103   using svr_type = SVR_TYPE;
00104   using svr_arg_type = typename _Elem<T>::svr_arg_type;
00105   using xmit = Svr_xmit<T>;
00106   static constexpr bool Is_input = _Elem<T>::Is_input;
00107   static constexpr bool Is_output = _Elem<T>::Is_output;
00108
00109   svr_type v;
00110
00111   template<Phase PHASE>
00112   int get(char *msg, unsigned offset, unsigned limit)
00113   {
00114     int r = offset;
00115     if constexpr(Is_input)
00116       {
00117         static_assert(PHASE == Phase::Data || PHASE == Phase::Items);
00118         if constexpr (PHASE == Phase::Data)
00119           r = xmit::to_svr_data(msg, offset, limit, this->v);
00120         else // PHASE == Phase::Items
00121           r = xmit::to_svr_items(msg, offset, limit, this->v);
00122       }
00123
00124     if (L4_LIKELY(r >= 0))
00125       return Base::template get<PHASE>(msg, r, limit);
00126
00127     if (_Elem<T>::Is_optional)
00128       {
00129         v = svr_type();
00130         return Base::template get<PHASE>(msg, offset, limit);
00131       }
00132
00133     return r;
00134   }
00135
00136   int reserve_data(char *msg, unsigned offset, unsigned limit)
00137   {
00138     int r = offset;
00139     if constexpr (Is_output)
00140       r = xmit::reserve_data(msg, offset, limit, this->v);
00141
00142     if (L4_LIKELY(r >= 0))
00143       return Base::reserve_data(msg, r, limit);
00144
00145     return r;
00146   }
00147
00148   template<Phase PHASE>
00149   int set(char *msg, unsigned offset, unsigned limit)
00150   {
00151     int r = offset;
00152     if constexpr (Is_output)
00153       {
00154         static_assert(PHASE == Phase::Data || PHASE == Phase::Items);
00155         if constexpr (PHASE == Phase::Data)
00156           r = xmit::from_svr_data(msg, offset, limit, this->v);
00157         else // PHASE == Phase::Items
00158           r = xmit::from_svr_items(msg, offset, limit, this->v);
00159       }
00160
00161     if (L4_UNLIKELY(r < 0))
00162       return r;
00163
00164     return Base::template set<PHASE>(msg, r, limit);
00165   }
00166
00167   template<typename F, typename ...ARGS>
00168   decltype(auto) call(F f, ARGS ...args)
00169   {
```

```
00170     //As_arg<value_type> check;
00171     return Base::template
00172       call<F, ARGS..., svr_arg_type>(f, args..., this->v);
00173   }
00174
00175   template<typename ...ARGS>
00176   void reply(ARGS &&...args)
00177   {
00178     // Only consume out parameters or parameters of type In_out.
00179     if constexpr (Is_output)
00180       reply_consume_arg<ARGS...>(L4::Types::forward<ARGS>(args)...);
00181     else
00182       Base::template reply<ARGS...>(L4::Types::forward<ARGS>(args)...);
00183   }
00184
00185   template<typename O, typename FUNC, typename ...ARGS>
00186   decltype(auto) obj_call(O *o, ARGS ...args)
00187   {
00188     //As_arg<value_type> check;
00189     return Base::template
00190       obj_call<O, FUNC, ARGS..., svr_arg_type>(o, args..., this->v);
00191   }
00192
00193 private:
00194   template<typename A, typename ...ARGS>
00195   void reply_consume_arg(A &&a, ARGS &&...args)
00196   {
00197     this->v = L4::Types::move(a);
00198     Base::template reply<ARGS...>(L4::Types::forward<ARGS>(args)...);
00199   }
00200 };
00201
00207 template<typename T, typename ...M>
00208 struct Svr_arg<T, void, M...> : Arg_pack<M...>
00209 {};
00210
00211 template<typename A, typename ...M>
00212 struct Arg_pack<A, M...> : Svr_arg<A, typename _Elem<A>::svr_type, M...>
00213 {};
00214
00215 } // namespace Detail
00216
00217 //-----------------------------------------------------------------------
00222 template<typename IPC_TYPE> struct Svr_arg_pack;
00223
00224 template<typename R, typename ...ARGS>
00225 struct Svr_arg_pack<R (ARGS...)> : Detail::Arg_pack<ARGS...>
00226 {
00227   using Base = Detail::Arg_pack<ARGS...>;
00228
00229   template<Phase PHASE>
00230   int get(void *msg, unsigned offset, unsigned limit)
00231   {
00232     char *buf = static_cast<char *>(msg);
00233     return Base::template get<PHASE>(buf, offset, limit);
00234   }
00235
00236   int reserve_data(void *msg, unsigned offset, unsigned limit)
00237   {
00238     char *buf = static_cast<char *>(msg);
00239     return Base::reserve_data(buf, offset, limit);
00240   }
00241
00242   template<Phase PHASE>
00243   int set(void *msg, unsigned offset, unsigned limit)
00244   {
00245     char *buf = static_cast<char *>(msg);
00246     return Base::template set<PHASE>(buf, offset, limit);
00247   }
00248 };
00249
00253 template<typename IPC_TYPE, typename O, typename ...ARGS>
00254 static l4_msgtag_t
00255 handle_svr_obj_call(O *o, l4_utcb_t *utcb, l4_msgtag_t tag, ARGS ...args)
00256 {
00257   using Pack = Svr_arg_pack<typename IPC_TYPE::rpc::ipc_type>;
00258   enum
00259   {
00260     Do_reply  = IPC_TYPE::rpc::flags_type::Is_call,
00261     Short_err = Do_reply ? -L4_EMSGTOOSHORT : -L4_ENOREPLY,
00262   };
00263
00264   // XXX: send a reply or just do not reply in case of a cheating client
00265   if (L4_UNLIKELY(tag.words() + tag.items() * Item_words > Mr_words))
00266     return l4_msgtag(Short_err, 0, 0, 0);
00267
00268   // our whole arguments data structure
```

```
00269   Pack pack;
00270   l4_msg_regs_t *mrs = l4_utcb_mr_u(utcb);
00271
00272   int in_pos = Detail::Sizeof<typename IPC_TYPE::opcode_type>::size;
00273
00274   unsigned const in_bytes = tag.words() * Word_bytes;
00275
00276   in_pos = pack.template get<Phase::Data>(&mrs->mr[0], in_pos, in_bytes);
00277
00278   if (L4_UNLIKELY(in_pos < 0))
00279     return l4_msgtag(Short_err, 0, 0, 0);
00280
00281   if (L4_UNLIKELY(pack.reserve_data(mrs->mr, 0, Mr_bytes) < 0))
00282     return l4_msgtag(Short_err, 0, 0, 0);
00283
00284
00285   in_pos = pack.template get<Phase::Items>(&mrs->mr[tag.words()], 0,
00286                                            tag.items() * Item_bytes);
00287
00288   if (L4_UNLIKELY(in_pos < 0))
00289     return l4_msgtag(Short_err, 0, 0, 0);
00290
00291   asm volatile ("" : "=m" (mrs->mr));
00292
00293   // call the server function
00294   auto ret = pack.template obj_call<O, typename IPC_TYPE::rpc, ARGS...>(o, args...);
00295
00296   if (!Do_reply)
00297     return l4_msgtag(-L4_ENOREPLY, 0, 0, 0);
00298
00299   // our convention says that negative return value means no
00300   // reply data
00301   if (L4_UNLIKELY(ret < 0))
00302     return l4_msgtag(ret, 0, 0, 0);
00303
00304   // reply with the reply data from the server function
00305   int bytes = pack.template set<Phase::Data>(mrs->mr, 0, Mr_bytes);
00306   if (L4_UNLIKELY(bytes < 0))
00307     return l4_msgtag(-L4_EMSGTOOLONG, 0, 0, 0);
00308
00309   unsigned words = (bytes + Word_bytes - 1) / Word_bytes;
00310   bytes = pack.template set<Phase::Items>(&mrs->mr[words], 0,
00311                                           Mr_bytes - words * Word_bytes);
00312   if (L4_UNLIKELY(bytes < 0))
00313     return l4_msgtag(-L4_EMSGTOOLONG, 0, 0, 0);
00314
00315   unsigned const items = bytes / Item_bytes;
00316   return l4_msgtag(ret, words, items, 0);
00317 }
00318
00319
00320 template<typename RPC, typename ...OUT_ARGS>
00321 static l4_msgtag_t
00322 pack_svr_reply(l4_utcb_t *utcb, l4_ret_t ret, OUT_ARGS && ...args)
00323 {
00324   static_assert(RPC::flags_type::Is_call, "RPC to reply to must be a call.");
00325
00326   // our convention says that negative return value means no
00327   // reply data
00328   if (L4_UNLIKELY(ret < 0))
00329     return l4_msgtag(ret, 0, 0, 0);
00330
00331   // TODO: Could try to filter out Dir_in parameters already in the arg pack.
00332   using Pack = Svr_arg_pack<typename RPC::ipc_type>;
00333
00334   // our whole arguments data structure
00335   Pack pack;
00336   l4_msg_regs_t *mrs = l4_utcb_mr_u(utcb);
00337
00338   // Reserves spaces for all data output arguments.
00339   if (L4_UNLIKELY(pack.reserve_data(mrs->mr, 0, Mr_bytes) < 0))
00340     return l4_msgtag(-L4_EMSGTOOSHORT, 0, 0, 0);
00341
00342   // call the server reply function
00343   pack.template reply<OUT_ARGS...>(L4::Types::forward<OUT_ARGS>(args)...);
00344
00345   // reply with the reply data from the server function
00346   int bytes = pack.template set<Phase::Data>(mrs->mr, 0, Mr_bytes);
00347   if (L4_UNLIKELY(bytes < 0))
00348     return l4_msgtag(-L4_EMSGTOOLONG, 0, 0, 0);
00349
00350   unsigned words = (bytes + Word_bytes - 1) / Word_bytes;
00351   bytes = pack.template set<Phase::Items>(&mrs->mr[words], 0,
00352                                           Mr_bytes - words * Word_bytes);
00353   if (L4_UNLIKELY(bytes < 0))
00354     return l4_msgtag(-L4_EMSGTOOLONG, 0, 0, 0);
00355
```

```
00356   unsigned const items = bytes / Item_bytes;
00357   return l4_msgtag(ret, words, items, 0);
00358 }
00359
00373 template<typename RPC, typename ...OUT_ARGS>
00374 static l4_ret_t
00375 reply(L4::Reply_cap reply_cap, l4_ret_t res, OUT_ARGS && ...args)
00376 {
00377   l4_utcb_t *u = l4_utcb();
00378   return reply_cap.reply(
00379     L4::Ipc::Msg::pack_svr_reply<RPC, OUT_ARGS...>(
00380       u, res, L4::Types::forward<OUT_ARGS>(args)...),
00381     u);
00382 }
00383
00384 //---------------------------------------------------------------------------
00385
00386 template<typename RPCS, typename OPCODE_TYPE>
00387 struct Dispatch_call;
00388
00389 template<typename CLASS>
00390 struct Dispatch_call<L4::Typeid::Raw_ipc<CLASS>, void>
00391 {
00392   template<typename OBJ, typename ...ARGS>
00393   static l4_msgtag_t
00394   call(OBJ *o, l4_utcb_t *utcb, l4_msgtag_t tag, ARGS ...a)
00395   {
00396     return o->op_dispatch(utcb, tag, a...);
00397   }
00398 };
00399
00400 template<typename RPCS>
00401 struct Dispatch_call<RPCS, void>
00402 {
00403   constexpr static unsigned rmask()
00404   { return RPCS::rpc::flags_type::Rights & 3UL; }
00405
00406   template<typename OBJ, typename ...ARGS>
00407   static l4_msgtag_t
00408   call(OBJ *o, l4_utcb_t *utcb, l4_msgtag_t tag, unsigned rights, ARGS ...a)
00409   {
00410     if ((rights & rmask()) != rmask())
00411       return l4_msgtag(-L4_EPERM, 0, 0, 0);
00412
00413     using Rights = L4::Typeid::Rights<typename RPCS::rpc::class_type>;
00414     return handle_svr_obj_call<RPCS>(o, utcb, tag,
00415                                      Rights(rights), a...);
00416
00417   }
00418 };
00419
00420 template<typename RPCS, typename OPCODE_TYPE>
00421 struct Dispatch_call
00422 {
00423   constexpr static unsigned rmask()
00424   { return RPCS::rpc::flags_type::Rights & 3UL; }
00425
00426   template<typename OBJ, typename ...ARGS>
00427   static l4_msgtag_t
00428   _call(OBJ *o, l4_utcb_t *utcb, l4_msgtag_t tag, unsigned rights, OPCODE_TYPE op, ARGS ...a)
00429   {
00430     if (L4::Types::Same_v<typename RPCS::opcode_type, void>
00431         || RPCS::Opcode == op)
00432       {
00433         if ((rights & rmask()) != rmask())
00434           return l4_msgtag(-L4_EPERM, 0, 0, 0);
00435
00436         using Rights = L4::Typeid::Rights<typename RPCS::rpc::class_type>;
00437         return handle_svr_obj_call<RPCS>(o, utcb, tag,
00438                                          Rights(rights), a...);
00439       }
00440     return Dispatch_call<typename RPCS::next, OPCODE_TYPE>::template
00441       _call<OBJ, ARGS...>(o, utcb, tag, rights, op, a...);
00442   }
00443
00444   template<typename OBJ, typename ...ARGS>
00445   static l4_msgtag_t
00446   call(OBJ *o, l4_utcb_t *utcb, l4_msgtag_t tag, unsigned rights, ARGS ...a)
00447   {
00448     OPCODE_TYPE op;
00449     unsigned limit = tag.words() * Word_bytes;
00450     using xmit = Svr_xmit<OPCODE_TYPE>;
00451     auto *mrs = reinterpret_cast<char *>(l4_utcb_mr_u(utcb)->mr);
00452     l4_ret_t err = xmit::to_svr_data(mrs, 0, limit, op);
00453     if (L4_UNLIKELY(err < 0))
00454       return l4_msgtag(-L4_EMSGTOOSHORT, 0, 0, 0);
00455
```

```
00456     return _call<OBJ, ARGS...>(o, utcb, tag, rights, op, a...);
00457   }
00458 };
00459
00460 template<>
00461 struct Dispatch_call<Typeid::Detail::Rpcs_end, void>
00462 {
00463   template<typename OBJ, typename ...ARGS>
00464   static l4_msgtag_t
00465   _call(OBJ *, l4_utcb_t *, l4_msgtag_t, unsigned, int, ARGS ...)
00466   { return l4_msgtag(-L4_ENOSYS, 0, 0, 0); }
00467
00468   template<typename OBJ, typename ...ARGS>
00469   static l4_msgtag_t
00470   call(OBJ *, l4_utcb_t *, l4_msgtag_t, unsigned, ARGS ...)
00471   { return l4_msgtag(-L4_ENOSYS, 0, 0, 0); }
00472 };
00473
00474 template<typename OPCODE_TYPE>
00475 struct Dispatch_call<Typeid::Detail::Rpcs_end, OPCODE_TYPE> :
00476   Dispatch_call<Typeid::Detail::Rpcs_end, void> {};
00477
00478 template<typename RPCS, typename OBJ, typename ...ARGS>
00479 static l4_msgtag_t
00480 dispatch_call(OBJ *o, l4_utcb_t *utcb, l4_msgtag_t tag, unsigned rights, ARGS ...a)
00481 {
00482   return Dispatch_call<typename RPCS::type, typename RPCS::opcode_type>::template
00483     call<OBJ, ARGS...>(o, utcb, tag, rights, a...);
00484 }
00485
00486 } // namespace Msg
00487 } // namespace Ipc
00488 } // namespace L4
```

16.485 ipc_server_loop

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2015, 2017, 2019, 2021-2025 Kernkonzept GmbH.
00004  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include "ipc_epiface"
00011
00012 namespace L4 {
00013
00019
00031 namespace Ipc_svr {
00032
00046 enum Reply_mode
00047 {
00048   Reply_compound,
00049   Reply_separate
00050 };
00051
00057 struct Ignore_errors
00058 { static void error(l4_msgtag_t, l4_utcb_t *) {} };
00059
00065 struct Default_timeout
00066 { static l4_timeout_t timeout() { return L4_IPC_SEND_TIMEOUT_0; } };
00067
00073 struct Compound_reply
00074 {
00075   static Reply_mode before_reply(l4_msgtag_t, l4_utcb_t *)
00076   { return Reply_compound; }
00077 };
00078
00084 struct Default_setup_wait
00085 { static void setup_wait(l4_utcb_t *, Reply_mode) {} };
00086
00094 template< typename R >
00095 struct Direct_dispatch
00096 {
00098   R &r;
00099
00101   Direct_dispatch(R &r) : r(r) {}
00102
00104   l4_msgtag_t operator () (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)
00105   { return r.dispatch(tag, obj, utcb); }
00106 };
00107
```

```
00115 template< typename R >
00116 struct Direct_dispatch<R*>
00117 {
00119   R *r;
00120
00122   Direct_dispatch(R *r) : r(r) {}
00123
00125   l4_msgtag_t operator () (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)
00126   { return r->dispatch(tag, obj, utcb); }
00127 };
00128
00129 #ifdef __EXCEPTIONS
00139 template< typename R, typename Exc> // = L4::Runtime_error>
00140 struct Exc_dispatch : private Direct_dispatch<R>
00141 {
00143   Exc_dispatch(R r) : Direct_dispatch<R>(r) {}
00144
00148   l4_msgtag_t operator () (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)
00149   {
00150     try
00151       {
00152         return Direct_dispatch<R>::operator () (tag, obj, utcb);
00153       }
00154     catch (Exc &e)
00155       {
00156         return l4_msgtag(e.err_no(), 0, 0, 0);
00157       }
00158     catch (int err)
00159       {
00160         return l4_msgtag(err, 0, 0, 0);
00161       }
00162     catch (long err)
00163       {
00164         return l4_msgtag(err, 0, 0, 0);
00165       }
00166   }
00167 };
00168
00183 template< typename R, typename Exc, typename Printer >
00184 struct Dbg_dispatch : private Direct_dispatch<R>
00185 {
00187   Dbg_dispatch(R r, Printer p) : Direct_dispatch<R>(r), _printer(p) {}
00188
00193   l4_msgtag_t operator () (l4_msgtag_t tag, l4_umword_t obj, l4_utcb_t *utcb)
00194   {
00195     try
00196       {
00197         return Direct_dispatch<R>::operator () (tag, obj, utcb);
00198       }
00199     catch (Exc &e)
00200       {
00201         _printer.printf("Error in handling IPC: %s: %s\n", e.str(),
00202                         e.extra_str());
00203         return l4_msgtag(e.err_no(), 0, 0, 0);
00204       }
00205     catch (int err)
00206       {
00207         _printer.printf("Error in handling IPC: %d (%s)\n", err,
00208                         l4sys_errtostr(err));
00209         return l4_msgtag(err, 0, 0, 0);
00210       }
00211     catch (long err)
00212       {
00213         _printer.printf("Error in handling IPC: %ld (%s)\n", err,
00214                         l4sys_errtostr(err));
00215         return l4_msgtag(err, 0, 0, 0);
00216       }
00217   }
00218
00219   Printer _printer;
00220 };
00221 #endif
00222
00233 class Br_manager_no_buffers : public Server_iface
00234 {
00235 public:
00240   int alloc_buffer_demand(Demand const &demand) override
00241   {
00242     if (!demand.no_demand())
00243       return -L4_ENOMEM;
00244     return L4_EOK;
00245   }
00246
00248   L4::Cap<void> get_rcv_cap(int) const override
00249   { return L4::Cap<void>::Invalid; }
00250
00252   int realloc_rcv_cap(int) override
```

```
00253   { return -L4_ENOMEM; }
00254
00256   int add_timeout(Timeout *, l4_kernel_clock_t) override
00257   { return -L4_ENOSYS; }
00258
00260   int remove_timeout(Timeout *) override
00261   { return -L4_ENOSYS; }
00262
00263 protected:
00265   unsigned first_free_br() const
00266   { return 1; }
00267
00269   void setup_wait(l4_utcb_t *utcb, L4::Ipc_svr::Reply_mode)
00270   {
00271     l4_buf_regs_t *br = l4_utcb_br_u(utcb);
00272     br->bdr = 0;
00273     br->br[0] = 0;
00274   }
00275 };
00276
00285 struct Default_loop_hooks :
00286   public Ignore_errors, public Default_timeout, public Compound_reply,
00287   Br_manager_no_buffers
00288 {};
00289
00290 }
00291
00306 template< typename LOOP_HOOKS = Ipc_svr::Default_loop_hooks >
00307 class Server :
00308   public LOOP_HOOKS
00309 {
00310 public:
00317   /* Internal note: After all users have been converted, remove this
00318    * constructor. Also remove the constructor below then. */
00319   explicit Server(l4_utcb_t *)
00320     L4_DEPRECATED("Do not specify the UTCB with the constructor. "
00321             "Supply it on the loop function if needed.")
00322   {}
00323
00327   /* Internal note: Remove this constructor when the above deprecated
00328    * constructor with the UTCB pointer is also removed. */
00329   Server() {}
00330
00337   template< typename DISPATCH >
00338   inline L4_NORETURN void internal_loop(DISPATCH dispatch, l4_utcb_t *);
00339
00343   template< typename R >
00344   inline L4_NORETURN void loop_noexc(R r, l4_utcb_t *u = l4_utcb())
00345   { internal_loop(Ipc_svr::Direct_dispatch<R>(r), u); }
00346
00347 #ifdef __EXCEPTIONS
00354   template< typename EXC, typename R >
00355   inline L4_NORETURN void loop(R r, l4_utcb_t *u = l4_utcb())
00356   {
00357     internal_loop(Ipc_svr::Exc_dispatch<R, EXC>(r), u);
00358     // function will never return
00359   }
00360
00367   template< typename EXC, typename R, typename Printer >
00368   inline L4_NORETURN void loop_dbg(R r, Printer p, l4_utcb_t *u = l4_utcb())
00369   {
00370     internal_loop(Ipc_svr::Dbg_dispatch<R, EXC, Printer>(r, p), u);
00371     // function will never return
00372   }
00373 #endif
00374 protected:
00376   inline l4_msgtag_t reply_n_wait(l4_msgtag_t reply, l4_umword_t *p, l4_utcb_t *);
00377
00378 private:
00379   template<typename U> static auto _has_setup_reply_cap(int)
00380     -> decltype(&U::setup_reply_cap, L4::Types::True());
00381   template<typename> static L4::Types::False _has_setup_reply_cap(...);
00382
00383   // Backwards compatibility check via `if constexpr` in reply_n_wait() if
00384   // explicit reply cap mechanism is present. Once we move to C++20, this can
00385   // be replaced by `requires{Server::setup_reply_cap();}`.
00386   static constexpr bool Has_setup_reply_cap
00387     = L4::Types::Same_v<decltype(_has_setup_reply_cap<Server>(0)),
00388                         L4::Types::True>;
00389 };
00390
00391 template< typename L >
00392 inline l4_msgtag_t
00393 Server<L>::reply_n_wait(l4_msgtag_t reply, l4_umword_t *p, l4_utcb_t *utcb)
00394 {
00395   l4_cap_idx_t reply_cap = L4_INVALID_CAP;
00396   if constexpr (Has_setup_reply_cap)
```

```
00397     reply_cap = this->setup_reply_cap().cap();
00398
00399   if (reply.label() != -L4_ENOREPLY)
00400     {
00401       Ipc_svr::Reply_mode m = this->before_reply(reply, utcb);
00402       if (m == Ipc_svr::Reply_compound)
00403         {
00404           this->setup_wait(utcb, m);
00405           return l4_ipc(reply_cap, utcb, L4_SYSF_REPLY_AND_WAIT, 0, reply, p,
00406                         this->timeout()); // l4_ipc_reply_and_wait
00407         }
00408       else
00409         {
00410           l4_msgtag_t res = l4_ipc_reply(reply_cap, utcb, reply,
00411                                          this->timeout());
00412           if (res.has_error())
00413             return res;
00414         }
00415     }
00416   this->setup_wait(utcb, Ipc_svr::Reply_separate);
00417   return l4_ipc(reply_cap, utcb, L4_SYSF_WAIT, 0, l4_msgtag_t{0}, p,
00418                 this->timeout()); // l4_ipc_wait
00419 }
00420
00421 template< typename L >
00422 template< typename DISPATCH >
00423 inline L4_NORETURN void
00424 Server<L>::internal_loop(DISPATCH dispatch, l4_utcb_t *utcb)
00425 {
00426   l4_msgtag_t res;
00427   l4_umword_t p;
00428   l4_msgtag_t r = l4_msgtag(-L4_ENOREPLY, 0, 0, 0);
00429
00430   while (true)
00431     {
00432       res = reply_n_wait(r, &p, utcb);
00433       if (res.has_error())
00434         {
00435           this->error(res, utcb);
00436           r = l4_msgtag(-L4_ENOREPLY, 0, 0, 0);
00437           continue;
00438         }
00439
00440       r = dispatch(res, p, utcb);
00441     }
00442 }
00443
00444 } // namespace L4
```

16.486 ipc_string

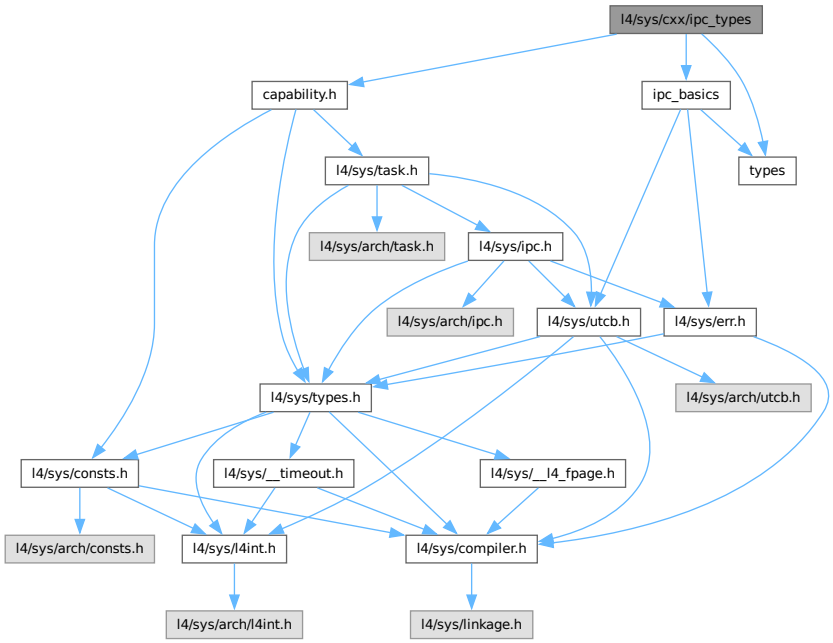
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "types"
00010 #include "ipc_basics"
00011 #include "ipc_array"
00012
00013 namespace L4 { namespace Ipc {
00014
00015 template<typename CHAR = char const, typename LEN = unsigned long>
00016 struct String : Array<CHAR, LEN>
00017 {
00018   static LEN strlength(CHAR *d) { LEN l = 0; while (d[l]) ++l; return l; }
00019   String() {}
00020   String(CHAR *d) : Array<CHAR, LEN>(strlength(d) + 1, d) {}
00021   String(LEN len, CHAR *d) : Array<CHAR, LEN>(len, d) {}
00022   void copy_in(CHAR const *s)
00023   {
00024     if (this->length < 1)
00025       return;
00026
00027     LEN i;
00028     for (i = 0; i < this->length - 1 && s[i]; ++i)
00029       this->data[i] = s[i];
00030     this->length = i + 1;
00031     this->data[i] = CHAR();
00032   }
00033 };
```

```
00034
00035 template< typename CHAR = char, typename LEN_TYPE = unsigned long,
00036           LEN_TYPE MAX  = (L4_UTCB_GENERIC_DATA_SIZE *
00037                           sizeof(l4_umword_t)) / sizeof(CHAR) >
00038 using String_in_buf = Array_in_buf<CHAR, LEN_TYPE, MAX>;
00039
00040 namespace Msg {
00041
00042 template<typename A, typename LEN>
00043 struct Svr_val_ops< String<A, LEN> > : Svr_val_ops< Array_ref<A, LEN> >
00044 {
00045   using Base = Svr_val_ops< Array_ref<A, LEN> >;
00046   using svr_type = typename Base::svr_type;
00047
00048   static int to_svr_data(char *msg, unsigned offset, unsigned limit,
00049                          svr_type &a)
00050   {
00051     int r = Base::to_svr_data(msg, offset, limit, a);
00052     if (r < 0)
00053       return r;
00054
00055     // correct clients send at least the zero terminator
00056     if (a.length < 1)
00057       return -L4_EMSGTOOSHORT;
00058
00059     using elem_type = L4::Types::Remove_const_t<A>;
00060     const_cast<elem_type*>(a.data)[a.length - 1] = A();
00061     return r;
00062   }
00063 };
00064
00065 template<typename A, typename LEN>
00066 struct Clnt_val_ops<String<A, LEN» : Clnt_val_ops<Array<A, LEN»
00067 {
00068   using Base = Clnt_val_ops<Array<A, LEN»;
00069   using type = typename Base::type;
00070
00071   static int from_msg_data(char *msg, unsigned offset, unsigned limit, type &a)
00072   {
00073     int r = Base::from_msg_data(msg, offset, limit, a);
00074     if (r < 0)
00075       return r;
00076
00077     // check for a bad server
00078     if (a.length < 1)
00079       return -L4_EMSGTOOSHORT;
00080
00081     a.data[a.length - 1] = A();
00082     return r;
00083   };
00084 };
00085
00086 template<typename A, typename LEN>
00087 struct Is_valid_rpc_type<String<A, LEN> const *> : L4::Types::False {};
00088 template<typename A, typename LEN>
00089 struct Is_valid_rpc_type<String<A, LEN> const &> : L4::Types::False {};
00090
00091 } // namespace Msg
00092
00093 }}
```

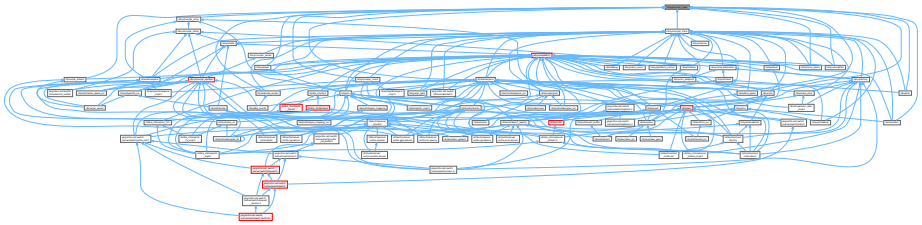
16.487 l4/sys/cxx/ipc_types File Reference

```
#include "capability.h"
#include "types"
#include "ipc_basics"
```

Include dependency graph for ipc_types:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct L4::Ipc::In_out< T >

  Mark an argument as in-out argument.
- struct L4::Ipc::Opt< T >

  Attribute for defining an optional RPC argument.
- class L4::Ipc::Small_buf

  A receive item for receiving a single object capability.
- class L4::Ipc::Gen_fpage

  Generic RPC base for typed message items.
- class L4::Ipc::Snd_fpage

  Send item or return item.
- class L4::Ipc::Rcv_fpage

  Non-small receive item.
- class L4::Ipc::Cap< T >

  Capability type for RPC interfaces (see `L4::Cap<T>`).

Namespaces

- namespace L4

  L4 low-level kernel interface.
- namespace L4::Ipc

  IPC related functionality.
- namespace L4::Ipc::Msg

  IPC Message related functionality.

Functions

- template<typename T>
  Cap< T > L4::Ipc::make_cap (L4::Cap< T > cap, unsigned rights) noexcept

  Make an L4::Ipc::Cap<T> for the given capability and rights.
- template<typename T>
  Cap< T > L4::Ipc::make_cap_rw (L4::Cap< T > cap) noexcept

  Make an L4::Ipc::Cap<T> for the given capability with L4_CAP_FPAGE_RW rights.
- template<typename T>
  Cap< T > L4::Ipc::make_cap_rws (L4::Cap< T > cap) noexcept

  Make an L4::Ipc::Cap<T> for the given capability with L4_CAP_FPAGE_RWS rights.
- template<typename T>
  Cap< T > L4::Ipc::make_cap_full (L4::Cap< T > cap) noexcept

  Make an L4::IPC::Cap<T> for the given capability with full fpage and object-specific rights.
- template<typename T>
  Cap< T > L4::Ipc::make_cap_grant (L4::Cap< T > cap) noexcept

  Make an L4::IPC::Cap<T> for the given capability that shall be granted with full rights.

16.488 ipc_types

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include "capability.h"
00010 #include "types"
00011 #include "ipc_basics"
00015
00016 namespace L4 {
00017
00019 using Opcode = int;
00020
00021 namespace Ipc {
00022
00031 template<typename T> struct L4_EXPORT Out;
00032
00033
00041 template<typename T> struct  L4_EXPORT In_out
00042 {
00043   T v;
00044   In_out() {}
00045   In_out(T v) : v(v) {}
00046   operator T () const { return v; }
00047   operator T & () { return v; }
00048 };
00049
00050 namespace Msg {
00051
00052 template<typename A> struct Elem< In_out<A *> > : Elem<A *>
00053 {
00054   static constexpr bool Is_input = true;
00055   static constexpr bool Is_output = true;
00056 };
00057
```

```
00058 template<typename A>
00059 struct Is_valid_rpc_type< In_out<A *> > : Is_valid_rpc_type<A *> {};
00060 template<typename A>
00061 struct Is_valid_rpc_type< In_out<A const *> > : L4::Types::False {};
00062
00063 template<typename A>
00064 struct Is_valid_rpc_type< In_out<A &> > : L4::Types::False {};
00065
00066 // Value types don't make sense for output.
00067 template<typename A>
00068 struct Is_valid_rpc_type< In_out<A> > : L4::Types::False {};
00069
00070 }
00071
00072
00080 template<typename T> struct L4_EXPORT Opt
00081 {
00082   T _value{};
00083   bool _valid = false;
00084
00086   Opt() noexcept = default;
00087
00089   Opt(T value) noexcept : _value(value), _valid(true) {}
00090
00092   Opt &operator = (T value) noexcept
00093   {
00094     this->_value = value;
00095     this->_valid = true;
00096     return *this;
00097   }
00098
00100   void set_valid(bool valid = true) noexcept { _valid = valid; }
00101
00103   T *operator -> () noexcept { return &this->_value; }
00105   T const *operator -> () const noexcept { return &this->_value; }
00107   T const &value() const noexcept { return this->_value; }
00109   T &value() noexcept { return this->_value; }
00111   bool is_valid() const noexcept { return this->_valid; }
00112 };
00113
00114 namespace Msg {
00115
00116 template<typename T> struct Elem< Opt<T &> > : Elem<T &>
00117 {
00118   static constexpr bool Is_optional = true;
00119   using svr_arg_type = Opt<typename Elem<T &>::svr_type> &;
00120   using svr_type = Opt<typename Elem<T &>::svr_type>;
00121 };
00122
00123 template<typename T> struct Elem< Opt<T *> > : Elem<T *>
00124 {
00125   static constexpr bool Is_optional = true;
00126   using svr_arg_type = Opt<typename Elem<T *>::svr_type> &;
00127   using svr_type = Opt<typename Elem<T *>::svr_type>;
00128 };
00129
00130 template<typename T> struct Elem< Opt<T> > : Elem<T>
00131 {
00132   static constexpr bool Is_optional = true;
00133   using arg_type = Opt<T>;
00134 };
00135
00136 template<typename T> struct Elem< Opt<T const *> > : Elem<T const *>
00137 {
00138   static constexpr bool Is_optional = true;
00139   using arg_type = Opt<T const *>;
00140 };
00141
00142 template<typename T>
00143 struct Is_valid_rpc_type< Opt<T const &> > : L4::Types::False {};
00144
00145 // This specialization is only used for optional input arguments. Optional
00146 // output arguments use a plain `T &' or `T *' on the client side. If the
00147 // argument is not present, it stays default constructed.
00148 template<typename T>
00149 struct Clnt_val_ops<Opt<T»
00150 {
00151   using Native = Detail::_Clnt_val_ops<T>;
00152   using Plain = Detail::_Plain<T>;
00153
00154   static int to_msg_data(char *msg, unsigned offset, unsigned limit,
00155                          Opt<T> const &arg) noexcept
00156   {
00157     if (arg.is_valid())
00158       return Native::to_msg_data(msg, offset, limit, Plain::deref(arg.value()));
00159     return offset;
00160   }
```

```
00161
00162   static int to_msg_items(char *msg, unsigned offset, unsigned limit,
00163                           Opt<T> const &arg) noexcept
00164   {
00165     if (arg.is_valid())
00166       return Native::to_msg_items(msg, offset, limit,
00167                                   Plain::deref(arg.value()));
00168     return offset;
00169   }
00170
00171   // No to_msg_* methods. They are never called because optional output
00172   // arguments don't use the Opt<> type on the client side (see Elem<Opt<...»
00173   // above). Likewise, intentionally left without to_msg_buffers(). Buffer
00174   // items are not supported because they are client side output arguments.
00175 };
00176
00177 // This specialization is only used for optional output arguments. Optional
00178 // input arguments use a plain `T' on the server side. If the argument is not
00179 // present, it stays default constructed.
00180 template<typename T>
00181 struct Svr_val_ops<Opt<T»
00182 {
00183   using Native = Svr_val_ops<T>;
00184
00185   // Intentinally without to_svr_data() and to_svr_items(). They are never
00186   // called. Optional input arguments don't use the Opt<> type on the server
00187   // side. See Elem<Opt<...» above.
00188
00189   static int reserve_data(char *msg, unsigned offset, unsigned limit,
00190                           Opt<T> &arg) noexcept
00191   {
00192     return Native::reserve_data(msg, offset, limit, arg.value());
00193   }
00194
00195   static int from_svr_data(char *msg, unsigned offset, unsigned limit,
00196                            Opt<T> const &arg) noexcept
00197   {
00198     if (arg.is_valid())
00199       return Native::from_svr_data(msg, offset, limit, arg.value());
00200     return offset;
00201   }
00202
00203   static int from_svr_items(char *msg, unsigned offset, unsigned limit,
00204                             Opt<T> const &arg) noexcept
00205   {
00206     if (arg.is_valid())
00207       return Native::from_svr_items(msg, offset, limit, arg.value());
00208     return offset;
00209   }
00210 };
00211
00212 }
00213
00233 class  L4_EXPORT Small_buf
00234 {
00235 public:
00243   explicit Small_buf(L4::Cap<void> cap, unsigned long flags = 0) noexcept
00244   : _data(cap.cap() | L4_RCV_ITEM_SINGLE_CAP | flags) {}
00245
00250   explicit Small_buf(l4_cap_idx_t cap, unsigned long flags = 0) noexcept
00251   : _data(cap | L4_RCV_ITEM_SINGLE_CAP | flags) {}
00252
00254   l4_umword_t raw() const noexcept { return _data; }
00255 private:
00256   l4_umword_t _data;
00257 };
00258
00262 class L4_EXPORT Gen_fpage
00263 {
00264 public:
00266   enum Type
00267   {
00268     Special = L4_FPAGE_SPECIAL « 4,
00269     Memory  = L4_FPAGE_MEMORY  « 4,
00270     Io      = L4_FPAGE_IO      « 4,
00271     Obj     = L4_FPAGE_OBJ     « 4
00272   };
00273
00275   Gen_fpage(l4_umword_t base, l4_umword_t data) noexcept
00276   : _base(base), _data(data)
00277   {}
00278
00280   l4_umword_t data() const noexcept { return _data; }
00282   l4_umword_t base_x() const noexcept { return _base; }
00283
00284 protected:
00285   l4_umword_t _base;
```

```
00286   l4_umword_t _data;
00287 };
00288
00299 class Snd_fpage : public Gen_fpage
00300 {
00301 public:
00304   enum Map_type
00305   {
00306     Map   = L4_MAP_ITEM_MAP,
00307     Grant = L4_MAP_ITEM_GRANT,
00308   };
00309
00312   enum Cacheopt
00313   {
00314     None      = 0,
00315     Cached    = L4_FPAGE_CACHEABLE   << 4,
00316     Buffered  = L4_FPAGE_BUFFERABLE  << 4,
00317     Uncached  = L4_FPAGE_UNCACHEABLE << 4
00318   };
00319
00322   enum Continue
00323   {
00324     Single   = 0,
00325     Last     = 0,
00326     More     = L4_ITEM_CONT,
00327     Compound = L4_ITEM_CONT,
00328   };
00329
00331   Snd_fpage(l4_umword_t base = 0, l4_umword_t data = 0) noexcept
00332   : Gen_fpage(base, data)
00333   {}
00334
00346   Snd_fpage(l4_fpage_t const &fp, l4_addr_t snd_base = 0,
00347             Map_type map_type = Map,
00348             Cacheopt cache = None, Continue cont = Last) noexcept
00349   : Gen_fpage(L4_ITEM_MAP | (snd_base & (~0UL << 12)) | l4_umword_t(map_type)
00350                 | l4_umword_t(cache) | l4_umword_t(cont),
00351               fp.raw)
00352   {}
00353
00362   Snd_fpage(L4::Cap<void> cap, unsigned rights, Map_type map_type = Map) noexcept
00363   : Gen_fpage(L4_ITEM_MAP | l4_umword_t(map_type) | (rights & 0xf0),
00364               cap.fpage(rights).raw)
00365   {}
00366
00378   static Snd_fpage obj(l4_cap_idx_t base, int order,
00379                        unsigned char rights,
00380                        l4_addr_t snd_base = 0,
00381                        Map_type map_type = Map,
00382                        Continue cont = Last) noexcept
00383   {
00384     return Snd_fpage(l4_obj_fpage(base, order, rights), snd_base,
00385                      map_type, None, cont);
00386   }
00387
00400   static Snd_fpage mem(l4_addr_t base, int order,
00401                        unsigned char rights,
00402                        l4_addr_t snd_base = 0,
00403                        Map_type map_type = Map,
00404                        Cacheopt cache = None, Continue cont = Last) noexcept
00405   {
00406     return Snd_fpage(l4_fpage(base, order, rights), snd_base, map_type, cache,
00407                      cont);
00408   }
00409
00421   static Snd_fpage io(unsigned long base, int order,
00422                       unsigned char rights,
00423                       l4_addr_t snd_base = 0,
00424                       Map_type map_type = Map,
00425                       Continue cont = Last) noexcept
00426   {
00427     return Snd_fpage(l4_fpage_set_rights(l4_iofpage(base, order), rights),
00428                      snd_base, map_type, None, cont);
00429   }
00430
00433   unsigned order() const noexcept { return (_data >> 6) & 0x3f; }
00434
00437   unsigned snd_order() const noexcept { return (_data >> 6) & 0x3f; }
00438
00441   unsigned rcv_order() const noexcept { return (_base >> 6) & 0x3f; }
00442
00445   l4_addr_t base() const noexcept { return _data & (~0UL << 12); }
00446
00449   l4_addr_t snd_base() const noexcept { return _base & (~0UL << 12); }
00450
00453   void snd_base(l4_addr_t b) noexcept { _base = (_base & ~(~0UL << 12)) | (b & (~0UL << 12)); }
00454
```

```
00456   bool is_valid() const noexcept { return _base & L4_ITEM_MAP; }
00457
00472   bool cap_received() const noexcept { return (_base & 0x3e) == 0x38; }
00488   bool id_received() const noexcept { return (_base & 0x3e) == 0x3c; }
00504   bool local_id_received() const noexcept { return (_base & 0x3e) == 0x3e; }
00511   bool is_compound() const noexcept { return _base & 1; }
00512 };
00513
00531 class Rcv_fpage : public Gen_fpage
00532 {
00533 public:
00537   Rcv_fpage() noexcept : Gen_fpage(0, 0), _rcv_task(L4_INVALID_CAP) {}
00538
00548   Rcv_fpage(l4_fpage_t const &fp, l4_addr_t snd_base = 0,
00549             l4_cap_idx_t rcv_task = L4_INVALID_CAP) noexcept
00550   : Gen_fpage(L4_ITEM_MAP | (snd_base & (~0UL << 12))
00551               | (l4_is_valid_cap(rcv_task) ? L4_RCV_ITEM_FORWARD_MAPPINGS : 0),
00552               fp.raw),
00553     _rcv_task(rcv_task)
00554   {}
00555
00565   static Rcv_fpage obj(l4_cap_idx_t base, int order, l4_addr_t snd_base = 0,
00566                        L4::Cap<void> rcv_task = L4::Cap<void>::Invalid) noexcept
00567   {
00568     return Rcv_fpage(l4_obj_fpage(base, order, 0), snd_base,
00569                      rcv_task.cap());
00570   }
00571
00581   static Rcv_fpage mem(l4_addr_t base, int order, l4_addr_t snd_base = 0,
00582                        L4::Cap<void> rcv_task = L4::Cap<void>::Invalid) noexcept
00583   {
00584     return Rcv_fpage(l4_fpage(base, order, 0), snd_base, rcv_task.cap());
00585   }
00586
00596   static Rcv_fpage io(unsigned long base, int order, l4_addr_t snd_base = 0,
00597                       L4::Cap<void> rcv_task = L4::Cap<void>::Invalid) noexcept
00598   {
00599     return Rcv_fpage(l4_iofpage(base, order), snd_base, rcv_task.cap());
00600   }
00601
00607   l4_cap_idx_t rcv_task() const { return _rcv_task; }
00608
00612   bool forward_mappings() const noexcept
00613   { return _base & L4_RCV_ITEM_FORWARD_MAPPINGS; }
00614
00615 protected:
00616   l4_cap_idx_t _rcv_task;
00617 };
00618
00619
00620 namespace Msg {
00621
00622 template<>
00623 struct Clnt_val_ops<L4::Ipc::Snd_fpage>
00624   : Clnt_noops<L4::Ipc::Snd_fpage>
00625 {
00626   static int to_msg_items(char *msg, unsigned offset, unsigned limit,
00627                           L4::Ipc::Snd_fpage const &arg) noexcept
00628   { return msg_add<L4::Ipc::Snd_fpage>(msg, offset, limit, arg); }
00629
00630   static int from_msg_items(char *msg, unsigned offset, unsigned limit,
00631                             L4::Ipc::Snd_fpage &arg) noexcept
00632   { return msg_get<L4::Ipc::Snd_fpage>(msg, offset, limit, arg); }
00633 };
00634
00635 template<>
00636 struct Svr_val_ops<L4::Ipc::Snd_fpage>
00637   : Svr_noops<L4::Ipc::Snd_fpage>
00638 {
00639   static int to_svr_items(char *msg, unsigned offset, unsigned limit,
00640                           L4::Ipc::Snd_fpage &arg) noexcept
00641   { return msg_get<L4::Ipc::Snd_fpage>(msg, offset, limit, arg); }
00642
00643   static int from_svr_items(char *msg, unsigned offset, unsigned limit,
00644                             L4::Ipc::Snd_fpage const &arg) noexcept
00645   { return msg_add(msg, offset, limit, arg); }
00646 };
00647
00648 // Rcv_fpage are special buffer items. They are invisible on the server side
00649 // and must be passed literally to setup the client receive buffers.
00650 template<> struct Is_valid_rpc_type<L4::Ipc::Rcv_fpage *> : L4::Types::False {};
00651 template<> struct Is_valid_rpc_type<L4::Ipc::Rcv_fpage &> : L4::Types::False {};
00652
00653 template<>
00654 struct Clnt_val_ops<L4::Ipc::Rcv_fpage>
00655   : Clnt_noops<L4::Ipc::Rcv_fpage>
00656 {
```

```
00657   static int to_msg_buffers(char *brs, unsigned offs, unsigned limit,
00658                             L4::Ipc::Rcv_fpage const &arg) noexcept
00659   {
00660     offs = align_to<l4_umword_t>(offs);
00661     unsigned words = arg.forward_mappings() ? 3 : 2;
00662     if (L4_UNLIKELY(!check_size<l4_umword_t>(offs, limit, words)))
00663       return -L4_EMSGTOOLONG;
00664     auto *buf = reinterpret_cast<l4_umword_t*>(brs + offs);
00665     *buf++ = arg.base_x();
00666     *buf++ = arg.data();
00667     if (arg.forward_mappings())
00668       *buf++ = arg.rcv_task();
00669     return offs + sizeof(l4_umword_t) * words;
00670   }
00671 };
00672
00673
00674 // Remove receive buffers from server-side arguments
00675 template<> struct Elem<L4::Ipc::Rcv_fpage>
00676 {
00677   using arg_type = L4::Ipc::Rcv_fpage;
00678   using svr_type = void;
00679   using svr_arg_type = void;
00680   static constexpr bool Is_optional = false;
00681   static constexpr bool Is_input = false;
00682   static constexpr bool Is_output = true;
00683 };
00684
00685 // Small_buf are special buffer items. They are invisible on the server side
00686 // and must be passed literally to setup the client receive buffers.
00687 template<> struct Is_valid_rpc_type<L4::Ipc::Small_buf *> : L4::Types::False {};
00688 template<> struct Is_valid_rpc_type<L4::Ipc::Small_buf &> : L4::Types::False {};
00689
00690 template<>
00691 struct Clnt_val_ops<L4::Ipc::Small_buf>
00692   : Clnt_noops<L4::Ipc::Small_buf>
00693 {
00694   static int to_msg_buffers(char *brs, unsigned offs, unsigned limit,
00695                             L4::Ipc::Small_buf const &arg) noexcept
00696   { return msg_add<L4::Ipc::Small_buf>(brs, offs, limit, arg); }
00697 };
00698
00699 // Remove receive buffers from server-side arguments
00700 template<> struct Elem<L4::Ipc::Small_buf>
00701 {
00702   using arg_type = L4::Ipc::Small_buf;
00703   using svr_type = void;
00704   using svr_arg_type = void;
00705   static constexpr bool Is_optional = false;
00706   static constexpr bool Is_input = false;
00707   static constexpr bool Is_output = true;
00708 };
00709
00710 } // namespace Msg
00711
00712 // L4::Cap<> handling
00713
00724 template<typename T> class Cap
00725 {
00726   template<typename O> friend class Cap;
00727   l4_umword_t _cap_n_rights;
00728
00729 public:
00730   enum
00731   {
00737     Rights_mask = 0xff,
00738
00742     Map_type_mask  = 0x100,
00743
00748     Cap_mask    = L4_CAP_MASK
00749   };
00750
00752   enum Map_type
00753   {
00755     Map   = 0,
00757     Grant = 0x100,
00758   };
00759
00761   template<typename O>
00762   Cap(Cap<O> const &o) noexcept : _cap_n_rights(o._cap_n_rights)
00763   {
00764     L4::Cap<T>::template check_convertible_from<O>();
00765   }
00766
00768   Cap(L4::Cap<T> cap) noexcept
00769   : _cap_n_rights((cap.cap() & Cap_mask) | (cap ? L4_CAP_FPAGE_R : 0))
00770   {}
```

```
00771
00773   template<typename O>
00774   Cap(L4::Cap<O> cap) noexcept
00775   : _cap_n_rights((cap.cap() & Cap_mask) | (cap ? L4_CAP_FPAGE_R : 0))
00776   {
00777     L4::Cap<T>::template check_convertible_from<O>();
00778   }
00779
00781   Cap() noexcept : _cap_n_rights(L4_INVALID_CAP) {}
00782
00790   Cap(L4::Cap<T> cap, unsigned char rights) noexcept
00791   : _cap_n_rights((cap.cap() & Cap_mask) | (rights & Rights_mask)) {}
00792
00801   Cap(L4::Cap<T> cap, unsigned char rights, Map_type map_type) noexcept
00802   : _cap_n_rights((cap.cap() & Cap_mask) | (rights & Rights_mask)
00803                   | (static_cast<l4_umword_t>(map_type) & Map_type_mask))
00804   {}
00805
00811   static Cap from_ci(l4_cap_idx_t c) noexcept
00812   { return Cap(L4::Cap<T>(c & Cap_mask), c & Rights_mask); }
00813
00815   L4::Cap<T> cap() const noexcept
00816   { return L4::Cap<T>(_cap_n_rights & Cap_mask); }
00817
00819   unsigned rights() const noexcept
00820   { return _cap_n_rights & Rights_mask; }
00821
00822   Map_type map_type() const noexcept
00823   { return static_cast<Map_type>(_cap_n_rights & Map_type_mask); }
00824
00826   L4::Ipc::Snd_fpage fpage() const noexcept
00827   {
00828     return L4::Ipc::Snd_fpage(cap(), rights(), map_type() == Map
00829                                                  ? Snd_fpage::Map
00830                                                  : Snd_fpage::Grant);
00831   }
00832
00834   bool is_valid() const noexcept
00835   { return !(_cap_n_rights & L4_INVALID_CAP_BIT); }
00836 };
00837
00844 template<typename T>
00845 Cap<T> make_cap(L4::Cap<T> cap, unsigned rights) noexcept
00846 { return Cap<T>(cap, rights); }
00847
00854 template<typename T>
00855 Cap<T> make_cap_rw(L4::Cap<T> cap) noexcept
00856 { return Cap<T>(cap, L4_CAP_FPAGE_RW); }
00857
00864 template<typename T>
00865 Cap<T> make_cap_rws(L4::Cap<T> cap) noexcept
00866 { return Cap<T>(cap, L4_CAP_FPAGE_RWS); }
00867
00883 template<typename T>
00884 Cap<T> make_cap_full(L4::Cap<T> cap) noexcept
00885 { return Cap<T>(cap, L4_CAP_FPAGE_RWSD | L4_FPAGE_C_OBJ_RIGHTS); }
00886
00896 template<typename T>
00897 Cap<T> make_cap_grant(L4::Cap<T> cap) noexcept
00898 {
00899   return Cap<T>(cap, L4_CAP_FPAGE_RWSD | L4_FPAGE_C_OBJ_RIGHTS, Cap<T>::Grant);
00900 }
00901
00902 // caps are special, they have an invalid representation
00903 template<typename T> struct L4_EXPORT Opt< Cap<T> >
00904 {
00905   Cap<T> _value;
00906   Opt() noexcept {}
00907   Opt(Cap<T> value) noexcept : _value(value) {}
00908   Opt(L4::Cap<T> value) noexcept : _value(value) {}
00909   Opt &operator = (Cap<T> value) noexcept
00910   { this->_value = value; return *this; }
00911   Opt &operator = (L4::Cap<T> value) noexcept
00912   { this->_value = value; return *this; }
00913
00914   Cap<T> value() const noexcept { return this->_value; }
00915   bool is_valid() const noexcept { return this->_value.is_valid(); }
00916 };
00917
00918
00919 namespace Msg {
00920 // prohibit L4::Cap as argument
00921 template<typename A>
00922 struct Is_valid_rpc_type< L4::Cap<A> > : L4::Types::False {};
00923
00924 template<typename A> struct Elem< Cap<A> >
00925 {
```

```
00926   using arg_type = Cap<A>;
00927   using svr_type = L4::Ipc::Snd_fpage;
00928   using svr_arg_type = L4::Ipc::Snd_fpage;
00929   static constexpr bool Is_optional = false;
00930   static constexpr bool Is_input = true;
00931   static constexpr bool Is_output = false;
00932 };
00933
00934
00935 template<typename A>
00936 struct Svr_val_ops<Cap<A»
00937   : Svr_noops<Cap<A»
00938 {
00939   static int from_svr_items(char *msg, unsigned offset, unsigned limit,
00940                             Cap<A> const &arg) noexcept
00941   {
00942     if (L4_UNLIKELY(!arg.is_valid()))
00943       // do not map anything
00944       return msg_add(msg, offset, limit, L4::Ipc::Snd_fpage(arg.cap(), 0));
00945
00946     return msg_add(msg, offset, limit, arg.fpage());
00947   }
00948 };
00949
00950 template<typename A>
00951 struct Clnt_val_ops<Cap<A» :
00952   Clnt_noops< Cap<A> >
00953 {
00954   static int to_msg_items(char *msg, unsigned offset, unsigned limit,
00955                           Cap<A> const &arg) noexcept
00956   {
00957     // passing an invalid cap as mandatory argument is an error
00958     if (L4_UNLIKELY(!arg.is_valid()))
00959       return -L4_EMSGMISSARG;
00960
00961     return msg_add(msg, offset, limit, arg.fpage());
00962   }
00963 };
00964
00965 template<typename A>
00966 struct Elem<Out<L4::Cap<A> > >
00967 {
00968   using arg_type = L4::Cap<A>;
00969   using svr_type = Ipc::Cap<A>;
00970   using svr_arg_type = svr_type &;
00971   static constexpr bool Is_optional = false;
00972   static constexpr bool Is_input = false;
00973   static constexpr bool Is_output = true;
00974 };
00975
00976 template<typename A>
00977 struct Clnt_val_ops< L4::Cap<A> > :
00978   Clnt_noops< L4::Cap<A> >
00979 {
00980   static int to_msg_buffers(char *brs, unsigned offset, unsigned limit,
00981                             L4::Cap<A> const &arg) noexcept
00982   {
00983     if (L4_UNLIKELY(!arg.is_valid()))
00984       return -L4_EMSGMISSARG; // no buffer inserted
00985     return msg_add(brs, offset, limit, Small_buf(arg));
00986   }
00987 };
00988
00989 // prohibit a UTCB pointer as normal RPC argument
00990 template<> struct Is_valid_rpc_type<l4_utcb_t *> : L4::Types::False {};
00991
00992 } // namespace Msg
00993 } // namespace Ipc
00994 } // namespace L4
```

16.489 ipc_varg

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008 #pragma GCC system_header
00009
00010 #include "types"
00011 #include "ipc_basics"
00012
```

```
00013 namespace L4 { namespace Ipc L4_EXPORT {
00014
00015 template< typename T, template <typename X> class B >
00016 struct Generic_va_type : B<T>
00017 {
00018   enum { Id = B<T>::Id };
00019   using ID = B<T>;
00020   using Ret_value = T const &;
00021   using Value = T;
00022
00023   static Ret_value value(void const *d)
00024   { return *reinterpret_cast<Value const *>(d); }
00025
00026   static void const *addr_of(Value const &v) { return &v; }
00027
00028   static unsigned size(void const *) { return sizeof(T); }
00029
00030   static L4_varg_type unsigned_id()
00031   {
00032     return static_cast<L4_varg_type>(Id & ~L4_VARG_TYPE_SIGN);
00033   }
00034
00035   static L4_varg_type signed_id()
00036   {
00037     return static_cast<L4_varg_type>(Id | L4_VARG_TYPE_SIGN);
00038   }
00039
00040   static L4_varg_type id()
00041   {
00042     return static_cast<L4_varg_type>(Id);
00043   }
00044 };
00045
00046 template< typename T > struct Va_type_id;
00047 template<> struct Va_type_id<l4_umword_t>  { enum { Id = L4_VARG_TYPE_UMWORD }; };
00048 template<> struct Va_type_id<l4_mword_t>   { enum { Id = L4_VARG_TYPE_MWORD }; };
00049 template<> struct Va_type_id<l4_fpage_t>   { enum { Id = L4_VARG_TYPE_FPAGE }; };
00050 template<> struct Va_type_id<void>         { enum { Id = L4_VARG_TYPE_NIL }; };
00051 template<> struct Va_type_id<char const *> { enum { Id = L4_VARG_TYPE_STRING }; };
00052
00053 template< typename T > struct Va_type;
00054
00055 template<> struct Va_type<l4_umword_t> : Generic_va_type<l4_umword_t, Va_type_id> {};
00056 template<> struct Va_type<l4_mword_t> : Generic_va_type<l4_mword_t, Va_type_id> {};
00057 template<> struct Va_type<l4_fpage_t> : Generic_va_type<l4_fpage_t, Va_type_id> {};
00058
00059 template<> struct Va_type<void>
00060 {
00061   using Ret_value = void;
00062   using Value = void;
00063
00064   static void const *addr_of(void) { return 0; }
00065
00066   static void value(void const *) {}
00067   static L4_varg_type id() { return L4_VARG_TYPE_NIL; }
00068   static unsigned size(void const *) { return 0; }
00069 };
00070
00071 template<> struct Va_type<char const *>
00072 {
00073   using Ret_value = char const *;
00074   using Value = char const *;
00075
00076   static void const *addr_of(Value v) { return v; }
00077
00078   static L4_varg_type id() { return L4_VARG_TYPE_STRING; }
00079   static unsigned size(void const *s)
00080   {
00081     char const *_s = reinterpret_cast<char const *>(s);
00082     int l = 1;
00083     while (*_s)
00084       {
00085         ++_s; ++l;
00086       }
00087     return l;
00088   }
00089
00090   static Ret_value value(void const *d) { return static_cast<char const *>(d); }
00091 };
00092
00096 class Varg
00097 {
00098 public:
00100   using Tag = l4_umword_t;
00101
00102 private:
00103   enum { Direct_data = 0x8000 };
```

```
00104   Tag _tag;
00105   char const *_d;
00106
00107 public:
00109   L4_varg_type type() const { return static_cast<L4_varg_type>(_tag & 0xff); }
00114   unsigned length() const { return _tag >> 16; }
00116   Tag tag() const { return _tag & ~static_cast<Tag>(Direct_data); }
00118   void tag(Tag tag)
00119   {
00120     // Direct_data bit is not part of the write format. Make sure it cannot be
00121     // set by a remote sender. Otherwise we would mistakenly treat the _d
00122     // pointer as direct data.
00123     _tag = tag & ~static_cast<Tag>(Direct_data);
00124   }
00126   void data(char const *d) { _d = d; }
00127
00129   char const *data() const
00130   {
00131     if (_tag & Direct_data)
00132       {
00133         union T { char const *d; char v[sizeof(char const *)]; };
00134         return reinterpret_cast<T const *>(&_d)->v;
00135       }
00136     return _d;
00137   }
00138
00140 #if __cplusplus >= 201103L
00141   Varg() = default;
00142 #else
00143   Varg() {}
00144 #endif
00145
00147   Varg(L4_varg_type t, void const *v, int len)
00148   : _tag(t | (static_cast<l4_mword_t>(len) << 16)),
00149     _d(static_cast<char const *>(v))
00150   {}
00151
00152   static Varg nil() { return Varg(L4_VARG_TYPE_NIL, 0, 0); }
00153
00160   template< typename V >
00161   typename Va_type<V>::Ret_value value() const
00162   {
00163     if (_tag & Direct_data)
00164       {
00165         union X { char const *d; V v; };
00166         return reinterpret_cast<X const &>(_d).v;
00167       }
00168
00169     return Va_type<V>::value(_d);
00170   }
00171
00172
00174   template< typename T >
00175   bool is_of() const { return Va_type<T>::id() == type(); }
00176
00178   bool is_nil() const { return is_of<void>(); }
00179
00181   bool is_of_int() const
00182   { return (type() & ~L4_VARG_TYPE_SIGN) == L4_VARG_TYPE_UMWORD; }
00183
00190   template< typename T >
00191   bool get_value(typename Va_type<T>::Value *v) const
00192   {
00193     if (!is_of<T>())
00194       return false;
00195
00196     *v = this->value<T>();
00197     return true;
00198   }
00199
00201   template< typename T >
00202   void set_value(void const *d)
00203   {
00204     using Vt = Va_type<T>;
00205     _tag = Vt::id() | (Vt::size(d) << 16);
00206     _d = static_cast<char const *>(d);
00207   }
00208
00210   template<typename T>
00211   void set_direct_value(T val, L4::Types::Enable_if_t<sizeof(T) <= sizeof(char const *), bool> = true)
00212   {
00213     static_assert(sizeof(T) <= sizeof(char const *), "direct Varg value too big");
00214     using Vt = Va_type<T>;
00215     _tag = Vt::id() | (sizeof(T) << 16) | Direct_data;
00216     union X { char const *d; T v; };
00217     reinterpret_cast<X &>(_d).v = val;
00218   }
```

```
00219
00221   template<typename T> explicit
00222   Varg(T const *data) { set_value<T>(data); }
00224   Varg(char const *data) { set_value<char const *>(data); }
00225
00227   template<typename T> explicit
00228   Varg(T data, L4::Types::Enable_if_t<sizeof(T) <= sizeof(char const *), bool> = true)
00229   { set_direct_value<T>(data); }
00230 };
00231
00232
00233 template<typename T>
00234 class Varg_t : public Varg
00235 {
00236 public:
00237   using Value = typename Va_type<T>::Value;
00238   explicit Varg_t(Value v) : Varg()
00239   { _data = v; set_value<T>(Va_type<T>::addr_of(_data)); }
00240
00241 private:
00242   Value _data;
00243 };
00244
00245 template<unsigned MAX = L4_UTCB_GENERIC_DATA_SIZE>
00246 class Varg_list;
00247
00259 class Varg_list_ref
00260 {
00261 private:
00262   template<unsigned T>
00263   friend class Varg_list;
00264
00266   class Iter_state
00267   {
00268   private:
00269     using M = l4_umword_t;
00270     using Mp = M const *;
00271     Mp _c;
00272     Mp _e;
00273
00275     Mp next_arg(Varg const &a) const
00276     {
00277       return _c + 1 + (Msg::align_to<M>(a.length()) / sizeof(M));
00278     }
00279
00280   public:
00282     Iter_state() : _c(nullptr), _e(nullptr) {}
00283
00285     Iter_state(Mp c, Mp e) : _c(c), _e(e)
00286     {}
00287
00289     bool valid() const
00290     { return _c && _c < _e; }
00291
00293     Mp begin() const { return _c; }
00294
00296     Mp end() const { return _e; }
00297
00302     Varg pop()
00303     {
00304       if (!valid())
00305         return Varg::nil();
00306
00307       Varg a;
00308       a.tag(_c[0]);
00309       a.data(reinterpret_cast<char const *>(&_c[1]));
00310       _c = next_arg(a);
00311       if (_c > _e)
00312         return Varg::nil();
00313
00314       return a;
00315     }
00316
00318     bool operator == (Iter_state const &o) const
00319     { return _c == o._c; }
00320
00322     bool operator != (Iter_state const &o) const
00323     { return _c != o._c; }
00324   };
00325
00326   Iter_state _s;
00327
00328 public:
00330   Varg_list_ref() = default;
00331
00338   Varg_list_ref(void const *start, void const *end)
00339   : _s(reinterpret_cast<l4_umword_t const *>(start),
```

```
00340         reinterpret_cast<l4_umword_t const *>(end))
00341   {}
00342
00344   class Iterator
00345   {
00346   private:
00347     Iter_state _s;
00348     Varg _a;
00349
00350   public:
00352     Iterator(Iter_state const &s)
00353     : _s(s)
00354     {
00355       _a = _s.pop();
00356     }
00357
00359     explicit operator bool () const
00360     { return !_a.is_nil(); }
00361
00363     Iterator &operator ++ ()
00364     {
00365       if (!_a.is_nil())
00366         _a = _s.pop();
00367
00368       return *this;
00369     }
00370
00372     Varg operator * () const
00373     { return _a; }
00374
00376     bool equals(Iterator const &o) const
00377     {
00378       if (_a.is_nil() && o._a.is_nil())
00379         return true;
00380
00381       return _s ==  o._s;
00382     }
00383
00384     bool operator == (Iterator const &o) const
00385     { return equals(o); }
00386
00387     bool operator != (Iterator const &o) const
00388     { return !equals(o); }
00389   };
00390
00392   Varg pop_front()
00393   { return _s.pop(); }
00394
00396   Varg next()
00397     L4_DEPRECATED("Use range for or pop_front.")
00398   { return _s.pop(); }
00399
00401   Iterator begin() const
00402   { return Iterator(_s); }
00403
00405   Iterator end() const
00406   { return Iterator(Iter_state()); }
00407 };
00408
00420 template<unsigned MAX>
00421 class Varg_list : public Varg_list_ref
00422 {
00423   l4_umword_t data[MAX];
00424   Varg_list(Varg_list const &);
00425
00426 public:
00428   Varg_list(Varg_list_ref const &r)
00429   {
00430     if (!r._s.valid())
00431       return;
00432
00433     l4_umword_t const *rs = r._s.begin();
00434     unsigned c = r._s.end() - rs;
00435
00436     // The list comes from a message, so its length is up to the sender.
00437     if (c > MAX)
00438       c = MAX;
00439
00440     for (unsigned i = 0; i < c; ++i)
00441       data[i] = rs[i];
00442
00443     this->_s = Iter_state(data, data + c);
00444   }
00445 };
00446
00447
00448 namespace Msg {
```

```
00449 template<> struct Elem<Varg const *>
00450 {
00451   using arg_type = Varg const *;
00452   using svr_type = Varg_list_ref;
00453   using svr_arg_type = Varg_list_ref;
00454   static constexpr bool Is_optional = false;
00455   static constexpr bool Is_input = true;
00456   static constexpr bool Is_output = false;
00457 };
00458
00459 template<> struct Is_valid_rpc_type<Varg> : L4::Types::False {};
00460 template<> struct Is_valid_rpc_type<Varg *> : L4::Types::False {};
00461 template<> struct Is_valid_rpc_type<Varg &> : L4::Types::False {};
00462 template<> struct Is_valid_rpc_type<Varg const &> : L4::Types::False {};
00463
00464 template<>
00465 struct Clnt_val_ops<Varg> :
00466   Clnt_noops<Varg const &>
00467 {
00468   static int to_msg_data(char *msg, unsigned offs, unsigned limit,
00469                          Varg const &a)
00470   {
00471     for (Varg const *i = &a; i->tag(); ++i)
00472       {
00473         offs = align_to<l4_umword_t>(offs);
00474         if (L4_UNLIKELY(!check_size<l4_umword_t>(offs, limit)))
00475           return -L4_EMSGTOOLONG;
00476         *reinterpret_cast<l4_umword_t*>(msg + offs) = i->tag();
00477         offs += sizeof(l4_umword_t);
00478         if (L4_UNLIKELY(!check_size<char>(offs, limit, i->length())))
00479           return -L4_EMSGTOOLONG;
00480         char const *d = i->data();
00481         for (unsigned x = 0; x < i->length(); ++x)
00482           msg[offs++] = *d++;
00483       }
00484
00485     return offs;
00486   }
00487 };
00488
00489 template<>
00490 struct Svr_val_ops<Varg_list_ref> :
00491   Svr_noops<Varg_list_ref>
00492 {
00493   static int to_svr_data(char *msg, unsigned offset, unsigned limit,
00494                          Varg_list_ref &a)
00495   {
00496     unsigned start = align_to<l4_umword_t>(offset);
00497     unsigned offs;
00498     for (offs = start; offs < limit;)
00499       {
00500         unsigned noffs = align_to<l4_umword_t>(offs);
00501         if (L4_UNLIKELY(!check_size<l4_umword_t>(noffs, limit)))
00502           break;
00503
00504         offs = noffs;
00505         Varg arg;
00506         arg.tag(*reinterpret_cast<l4_umword_t*>(msg + offs));
00507
00508         if (!arg.tag())
00509           break;
00510
00511         offs += sizeof(l4_umword_t);
00512
00513         if (L4_UNLIKELY(!check_size<char>(offs, limit, arg.length())))
00514           return -L4_EMSGTOOLONG;
00515         offs += arg.length();
00516       }
00517
00518     a = Varg_list_ref(msg + start, msg + align_to<l4_umword_t>(offs));
00519     return offs;
00520   }
00521 };
00522 }
00523 }}
```

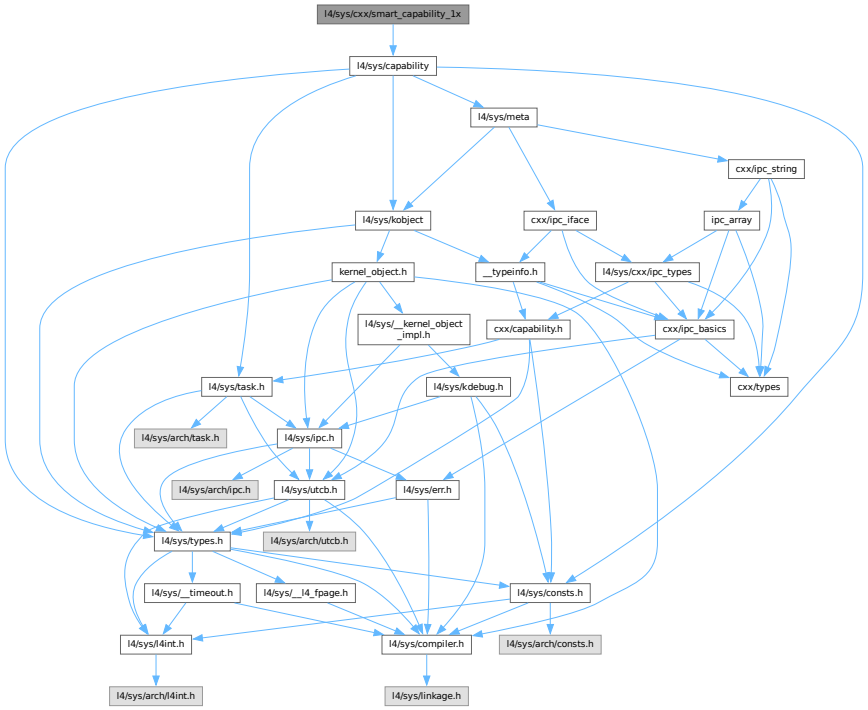
16.490 limits

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2026 Kernkonzept GmbH.
00004  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
```

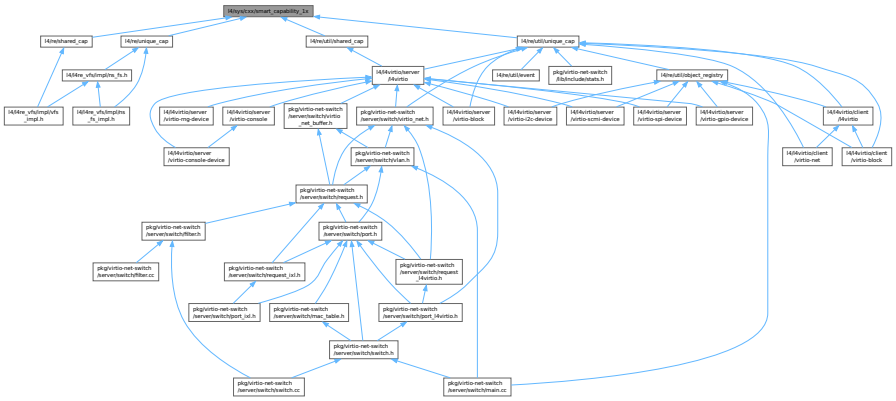
```
00007  */
00008
00009 #pragma once
00010 #pragma GCC system_header
00011
00012 #include <stddef.h>
00013 #include <limits.h>
00014
00015 typedef struct l4_msgtag_t l4_msgtag_t;
00016
00017 // unfortunately we cannot include <limits>
00018 namespace L4 { namespace Types {
00019
00020   template< typename T > struct numeric_limits;
00021   template<> struct numeric_limits<bool>
00022   {
00023     static constexpr bool min() { return false; }
00024     static constexpr bool max() { return true; }
00025   };
00026   template<> struct numeric_limits<char>
00027   {
00028     static constexpr char min() { return CHAR_MIN; }
00029     static constexpr char max() { return CHAR_MAX; }
00030   };
00031   template<> struct numeric_limits<signed char>
00032   {
00033     static constexpr signed char min() { return SCHAR_MIN; }
00034     static constexpr signed char max() { return SCHAR_MAX; }
00035   };
00036   template<> struct numeric_limits<unsigned char>
00037   {
00038     static constexpr unsigned char min() { return 0; }
00039     static constexpr unsigned char max() { return UCHAR_MAX; }
00040   };
00041   template<> struct numeric_limits<signed short int>
00042   {
00043     static constexpr signed short int min() { return SHRT_MIN; }
00044     static constexpr signed short int max() { return SHRT_MAX; }
00045   };
00046   template<> struct numeric_limits<unsigned short int>
00047   {
00048     static constexpr unsigned short int min() { return 0; }
00049     static constexpr unsigned short int max() { return USHRT_MAX; }
00050   };
00051   template<> struct numeric_limits<signed int>
00052   {
00053     static constexpr signed int min() { return INT_MIN; }
00054     static constexpr signed int max() { return INT_MAX; }
00055   };
00056   template<> struct numeric_limits<unsigned int>
00057   {
00058     static constexpr unsigned int min() { return 0U; }
00059     static constexpr unsigned int max() { return UINT_MAX; }
00060   };
00061   template<> struct numeric_limits<signed long int>
00062   {
00063     static constexpr signed long min() { return LONG_MIN; }
00064     static constexpr signed long max() { return LONG_MAX; }
00065   };
00066   template<> struct numeric_limits<unsigned long int>
00067   {
00068     static constexpr unsigned long int min() { return 0UL; }
00069     static constexpr unsigned long int max() { return ULONG_MAX; }
00070   };
00071   template<> struct numeric_limits<signed long long int>
00072   {
00073     static constexpr signed long long min() { return LLONG_MIN; }
00074     static constexpr signed long long max() { return LLONG_MAX; }
00075   };
00076   template<> struct numeric_limits<unsigned long long int>
00077   {
00078     static constexpr unsigned long long min() { return 0ULL; }
00079     static constexpr unsigned long long max() { return ULLONG_MAX; }
00080   };
00081   template<> struct numeric_limits<l4_msgtag_t>
00082   {
00083     static constexpr long min() { return -max() - 1L; }
00084     static constexpr long max() { return numeric_limits<long>::max() » 16; }
00085   };
00086
00087 }} // namespace Types, namespace L4
00088
```

16.491 l4/sys/cxx/smart_capability_1x File Reference

`#include <l4/sys/capability>`
Include dependency graph for smart_capability_1x:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4

  L4 low-level kernel interface.

16.492 smart_capability_1x

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
```

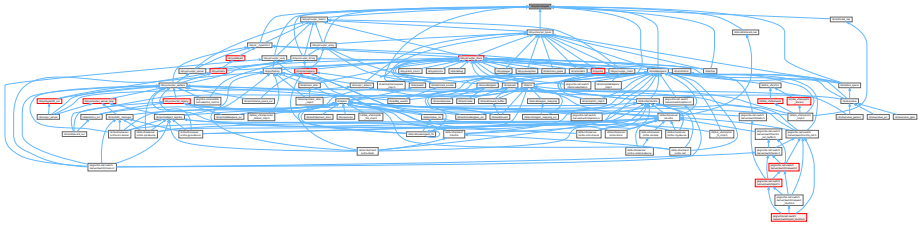
```
00006 /*
00007  * (c) 2017 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/capability>
00015
00016 namespace L4 { namespace Detail {
00017
00018 template< typename T, typename IMPL >
00019 class Smart_cap_base : public Cap_base, protected IMPL
00020 {
00021 protected:
00022   template<typename X>
00023   static IMPL &impl(Smart_cap_base<X, IMPL> &o) { return o; }
00024
00025   template<typename X>
00026   static IMPL const &impl(Smart_cap_base<X, IMPL> const &o) { return o; }
00027
00028 public:
00029   template<typename X, typename I>
00030   friend class ::L4::Detail::Smart_cap_base;
00031
00032   Smart_cap_base(Smart_cap_base const &) = delete;
00033   Smart_cap_base &operator = (Smart_cap_base const &) = delete;
00034
00035   Smart_cap_base() noexcept : Cap_base(Invalid) {}
00036
00037   explicit Smart_cap_base(Cap_base::Cap_type t) noexcept
00038   : Cap_base(t)
00039   {}
00040
00041   template<typename O>
00042   explicit constexpr Smart_cap_base(Cap<O> c) noexcept
00043   : Cap_base(c.cap())
00044   {}
00045
00046   template<typename O>
00047   explicit constexpr Smart_cap_base(Cap<O> c, IMPL const &impl) noexcept
00048   : Cap_base(c.cap()), IMPL(impl)
00049   {}
00050
00051   Cap<T> release() noexcept
00052   {
00053     l4_cap_idx_t c = this->cap();
00054     IMPL::invalidate(*this);
00055     return Cap<T>(c);
00056   }
00057
00058   void reset()
00059   {
00060     IMPL::free(*this);
00061     IMPL::invalidate(*this);
00062   }
00063
00064   Cap<T> operator -> () const noexcept { return Cap<T>(this->cap()); }
00065   Cap<T> get() const noexcept { return Cap<T>(this->cap()); }
00066   ~Smart_cap_base() noexcept { IMPL::free(*this); }
00067 };
00068
00069
00070 template< typename T, typename IMPL >
00071 class Unique_cap_impl final :  public Smart_cap_base<T, IMPL>
00072 {
00073 private:
00074   using Base = Smart_cap_base<T, IMPL>;
00075
00076 public:
00077   using Base::Base;
00078   Unique_cap_impl() noexcept = default;
00079
00080   Unique_cap_impl(Unique_cap_impl &&o) noexcept
00081   : Base(o.release(), Base::impl(o))
00082   {}
00083
00084   template<typename O>
00085   Unique_cap_impl(Unique_cap_impl<O, IMPL> &&o) noexcept
00086   : Base(o.release(), Base::impl(o))
00087   { Cap<T>::template check_convertible_from<O>(); }
00088
00089   Unique_cap_impl &operator = (Unique_cap_impl &&o) noexcept
00090   {
00091     if (&o == this)
00092       return *this;
```

```
00093
00094     IMPL::free(*this);
00095     this->_c = o.release().cap();
00096     this->IMPL::operator = (Base::impl(o));
00097     return *this;
00098   }
00099
00100   template<typename O>
00101   Unique_cap_impl &operator = (Unique_cap_impl<O, IMPL> &&o) noexcept
00102   {
00103     Cap<T>::template check_convertible_from<O>();
00104
00105     IMPL::free(*this);
00106     this->_c = o.release().cap();
00107     this->IMPL::operator = (Base::impl(o));
00108     return *this;
00109   }
00110 };
00111
00112 template<typename T, typename IMPL>
00113 class Shared_cap_impl final : public Smart_cap_base<T, IMPL>
00114 {
00115 private:
00116   using Base = Smart_cap_base<T, IMPL>;
00117
00118 public:
00119   using Base::Base;
00120   Shared_cap_impl() noexcept = default;
00121
00122   Shared_cap_impl(Shared_cap_impl &&o) noexcept
00123   : Base(o.release(), Base::impl(o))
00124   {}
00125
00126   template<typename O>
00127   Shared_cap_impl(Shared_cap_impl<O, IMPL> &&o) noexcept
00128   : Base(o.release(), Base::impl(o))
00129   { Cap<T>::template check_convertible_from<O>(); }
00130
00131   template<typename O>
00132   Shared_cap_impl(Shared_cap_impl<O, IMPL> &&o, Cap<T> cap) noexcept
00133   : Base(cap, Base::impl(o))
00134   { o.release(); }
00135
00136   Shared_cap_impl &operator = (Shared_cap_impl &&o) noexcept
00137   {
00138     if (&o == this)
00139       return *this;
00140
00141     IMPL::free(*this);
00142     this->_c = o.release().cap();
00143     this->IMPL::operator = (Base::impl(o));
00144     return *this;
00145   }
00146
00147   template<typename O>
00148   Shared_cap_impl &operator = (Shared_cap_impl<O, IMPL> &&o) noexcept
00149   {
00150     Cap<T>::template check_convertible_from<O>();
00151
00152     IMPL::free(*this);
00153     this->_c = o.release().cap();
00154     this->IMPL::operator = (Base::impl(o));
00155     return *this;
00156   }
00157
00158   Shared_cap_impl(Shared_cap_impl const &o) noexcept
00159   : Base()
00160   {
00161     this->IMPL::operator = (Base::impl(o));
00162     this->_c = IMPL::copy(o).cap();
00163   }
00164
00165   template<typename O>
00166   Shared_cap_impl(Shared_cap_impl<O, IMPL> const &o) noexcept
00167   : Base()
00168   {
00169     Cap<T>::template check_convertible_from<O>();
00170     this->IMPL::operator = (Base::impl(o));
00171     this->_c = IMPL::copy(o).cap();
00172   }
00173
00174   template<typename O>
00175   Shared_cap_impl(Shared_cap_impl<O, IMPL> const &o, Cap<T> cap) noexcept
00176   : Base()
00177   {
00178     this->IMPL::operator = (Base::impl(o));
00179     this->_c = IMPL::copy(cap).cap();
```

```
00180   }
00181
00182   Shared_cap_impl &operator = (Shared_cap_impl const &o) noexcept
00183   {
00184     if (&o == this)
00185       return *this;
00186
00187     IMPL::free(*this);
00188     this->IMPL::operator = (static_cast<IMPL const &>(o));
00189     this->_c = this->IMPL::copy(o).cap();
00190     return *this;
00191   }
00192
00193   template<typename O>
00194   Shared_cap_impl &operator = (Shared_cap_impl<O, IMPL> const &o) noexcept
00195   {
00196     Cap<T>::template check_convertible_from<O>();
00197     IMPL::free(*this);
00198     this->IMPL::operator = (static_cast<IMPL const &>(o));
00199     this->_c = this->IMPL::copy(o).cap();
00200     return *this;
00201   }
00202 };
00203
00204 }} // L4::Detail
```

16.493 l4/sys/cxx/types File Reference

This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Types::Flags< BITS_ENUM, UNDERLYING >

  Template for defining typical Flags bitmaps.
- struct L4::Types::Int_for_type< T >

  Metafunction to get an integral type of the same size as `T`.
- struct L4::Types::Flags_ops_t< DT >

  Mixin class to define a set of friend bitwise operators on `DT`.
- struct L4::Types::Flags_t< DT, T >

  Template type to define a flags type with bitwise operations.
- struct L4::Types::__Add_rvalue_reference_helper< T, typename >

  Helper template for Add_rvalue_reference.
- struct L4::Types::__Add_rvalue_reference_helper< T, Void< T && > >

  Helper template for Add_rvalue_reference.
- struct L4::Types::Add_rvalue_reference< T >

  Create an rvalue reference of the given type.
- struct L4::Types::Bool< V >

  Boolean meta type.
- struct L4::Types::False

  False meta value.
- struct L4::Types::True

  True meta value.
- struct L4::Types::Integral_constant< T, Value >

Wrapper for a static constant of the given type.

- struct L4::Types::Is_enum< T >

  Check whether the given type is an enumeration type.
- struct L4::Types::Is_trivially_copyable< T >

  Check whether the given type is trivially copyable.
- struct L4::Types::__Underlying_type_helper< T, bool >

  Helper template for Underlying_type.
- struct L4::Types::__Underlying_type_helper< T, false >

  Helper template for Underlying_type.
- struct L4::Types::Underlying_type< T >

  Get an underlying type of an enumeration type.
- struct L4::Types::Same< A, B >

  Compare two data types for equality.
- struct L4::Types::Same_template< T, Template >

  Check if a type T is an instantiation of a given template.
- struct Enum_bitops::Has_marker< typename, typename >

  Marker for the opt-in ADL function.
- struct Enum_bitops::Has_marker< T, Void< decltype(enum_bitops_enable(declval< T >()))> >

  Marker for the opt-in ADL function.
- struct Enum_bitops::Enable< T >

  Check whether the given enum type opts in for the bitwise operators.

Namespaces

- namespace L4

  L4 low-level kernel interface.
- namespace L4::Types

  L4 basic type helpers for C++.
- namespace Enum_bitops

  Mechanism to opt-in for enum bitwise operators.
- namespace Enum_bitops_impl

  Bitwise operators on enumeration types.

Typedefs

- template<typename...>
  using **L4::Types::Void** = void

  Map a sequence of any types to the void type.
- template<typename T>
  using **L4::Types::Add_rvalue_reference_t** = typename Add_rvalue_reference<T>::type

  Helper type for the Add_rvalue_reference.
- template<typename T>
  using **L4::Types::Underlying_type_t** = typename Underlying_type<T>::type

  Helper type for Underlying_type.
- template<bool Condition, typename T = void>
  using **L4::Types::Enable_if_t** = typename Enable_if<Condition, T>::type

  Helper type for Enable_if.

Functions

- template<typename T>
  Add_rvalue_reference_t< T > L4::Types::declval () noexcept

  Template for writing typed expressions in unevaluated contexts.
- template<typename T, typename = L4::Types::Enable_if_t<L4::Types::Is_enum<T>::value>>
  constexpr L4::Types::Underlying_type_t< T > **Enum_bitops_impl::to_underlying** (T const arg) noexcept

  Convert enum value to its underlying type value.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **Enum_bitops_impl::operator~** (T const a) noexcept

  Negate enum value.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **Enum_bitops_impl::operator&** (T l, T r) noexcept

  Intersect enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T & **Enum_bitops_impl::operator&=** (T &a, T const b) noexcept

  Intersect and assign enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **Enum_bitops_impl::operator|** (T l, T r) noexcept

  Union enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T & **Enum_bitops_impl::operator|=** (T &a, T const b) noexcept

  Union and assign enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T **Enum_bitops_impl::operator-** (T l, T r) noexcept

  Difference (intersect with negation, clear bits) enum values.
- template<typename T, typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value>>
  constexpr T & **Enum_bitops_impl::operator-=** (T &a, T const b) noexcept

  Difference (intersect with negation, clear bits) and assign enum values.

16.494 types

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00009
00010 #pragma once
00011
00012 // very simple type traits for basic L4 functions, for a more complete set
00013 // use <l4/cxx/type_traits> or the standard <type_traits>.
00014
00015 namespace L4 {
00016
00020 namespace Types {
00021
00051   template<typename BITS_ENUM, typename UNDERLYING = unsigned long>
00052   class Flags
00053   {
00054   public:
00056     using value_type = UNDERLYING;
00058     using bits_enum_type = BITS_ENUM;
00060     using type = Flags<BITS_ENUM, UNDERLYING>;
00061
00062   private:
00063     value_type _v;
00064     explicit constexpr Flags(value_type v) noexcept : _v(v) {}
00065
00066   public:
00068     enum None_type { None  };
00069
00078     constexpr Flags(None_type) noexcept : _v(0) {}
```

```
00079
00081     constexpr Flags() noexcept : _v(0) {}
00082
00091     constexpr Flags(BITS_ENUM e) noexcept
00092     : _v(static_cast<value_type>(1) << e)
00093     {}
00094
00100     static constexpr type from_raw(value_type v) noexcept { return type(v); }
00101
00103     explicit constexpr operator bool () const noexcept
00104     { return _v != 0; }
00105
00107     constexpr bool operator ! () const noexcept { return _v == 0; }
00108
00110     friend constexpr type operator | (type lhs, type rhs) noexcept
00111     { return type(lhs._v | rhs._v); }
00112
00114     friend constexpr type operator | (type lhs, bits_enum_type rhs) noexcept
00115     { return lhs | type(rhs); }
00116
00118     friend constexpr type operator & (type lhs, type rhs) noexcept
00119     { return type(lhs._v & rhs._v); }
00120
00122     friend constexpr type operator & (type lhs, bits_enum_type rhs) noexcept
00123     { return lhs & type(rhs); }
00124
00126     constexpr type &operator |= (type rhs) noexcept
00127     { _v |= rhs._v; return *this; }
00128
00130     constexpr type &operator |= (bits_enum_type rhs)
00131     { return operator |= (type(rhs)); }
00132
00134     constexpr type &operator &= (type rhs) { _v &= rhs._v; return *this; }
00135
00137     constexpr type &operator &= (bits_enum_type rhs)
00138     { return operator &= (type(rhs)); }
00139
00141     constexpr type operator ~ () const noexcept { return type(~_v); }
00142
00149     constexpr type &clear(bits_enum_type flag) noexcept
00150     { return operator &= (~type(flag)); }
00151
00153     constexpr value_type as_value() const noexcept { return _v; }
00154   };
00155
00161   template<unsigned SIZE, bool = true> struct Int_for_size;
00162
00163   template<> struct Int_for_size<sizeof(unsigned char), true>
00164   { using type = unsigned char; };
00165
00166   template<> struct Int_for_size<sizeof(unsigned short),
00167                                  (sizeof(unsigned short) > sizeof(unsigned char))>
00168   { using type = unsigned short; };
00169
00170   template<> struct Int_for_size<sizeof(unsigned),
00171                                  (sizeof(unsigned) > sizeof(unsigned short))>
00172   { using type = unsigned; };
00173
00174   template<> struct Int_for_size<sizeof(unsigned long),
00175                                  (sizeof(unsigned long) > sizeof(unsigned))>
00176   { using type = unsigned long; };
00177
00178   template<> struct Int_for_size<sizeof(unsigned long long),
00179                                  (sizeof(unsigned long long) > sizeof(unsigned long))>
00180   { using type = unsigned long long; };
00181
00188   template<typename T> struct Int_for_type
00189   {
00193     using type = typename Int_for_size<sizeof(T)>::type;
00194   };
00195
00202   template<typename DT>
00203   struct Flags_ops_t
00204   {
00206     friend constexpr DT operator | (DT l, DT r)
00207     { return DT(l.raw | r.raw); }
00208
00210     friend constexpr DT operator & (DT l, DT r)
00211     { return DT(l.raw & r.raw); }
00212
00214     friend constexpr DT operator - (DT l, DT r)
00215     { return DT(l.raw & ~r.raw); }
00216
00218     friend constexpr bool operator == (DT l, DT r)
00219     { return l.raw == r.raw; }
00220
00222     friend constexpr bool operator != (DT l, DT r)
```

```
00223     { return l.raw != r.raw; }
00224
00226     constexpr DT &operator |= (DT const r)
00227     {
00228       static_cast<DT *>(this)->raw |= r.raw;
00229       return *static_cast<DT *>(this);
00230     }
00231
00233     constexpr DT &operator &= (DT const r)
00234     {
00235       static_cast<DT *>(this)->raw &= r.raw;
00236       return *static_cast<DT *>(this);
00237     }
00238
00240     constexpr DT &operator -= (DT const r)
00241     {
00242       static_cast<DT *>(this)->raw &= ~r.raw;
00243       return *static_cast<DT *>(this);
00244     }
00245
00247     explicit constexpr operator bool () const
00248     { return static_cast<DT const *>(this)->raw != 0; }
00249
00251     constexpr DT operator ~ () const
00252     { return DT(~static_cast<DT const *>(this)->raw); }
00253   };
00254
00263   template<typename DT, typename T>
00264   struct Flags_t : Flags_ops_t<Flags_t<DT, T»
00265   {
00267     enum None_type { None  };
00268
00270     T raw = 0;
00272     constexpr Flags_t() = default;
00274     constexpr Flags_t(None_type) {}
00276     constexpr Flags_t(DT f) : raw(static_cast<T>(f)) {}
00278     explicit constexpr Flags_t(T f) : raw(f) {}
00279   };
00280
00282   template<typename...> using Void = void;
00283
00285   template<typename T, typename = void> struct __Add_rvalue_reference_helper
00286   { using type = T; };
00287
00289   template<typename T> struct __Add_rvalue_reference_helper<T, Void<T &&>>
00290   { using type = T &&; };
00291
00293   template<typename T> struct Add_rvalue_reference
00294   { using type = typename __Add_rvalue_reference_helper<T>::type; };
00295
00297   template<typename T> using Add_rvalue_reference_t
00298     = typename Add_rvalue_reference<T>::type;
00299
00308   template<typename T> Add_rvalue_reference_t<T> declval() noexcept;
00309
00315   template< bool V > struct Bool
00316   {
00317     using type = Bool<V>;
00318     enum { value = V };
00319   };
00320
00323   struct False : Bool<false> {};
00324
00327   struct True : Bool<true> {};
00328
00330   template<typename T, T Value>
00331   struct Integral_constant
00332   {
00333     static T const value = Value;
00334
00335     typedef T value_type;
00336     typedef Integral_constant<T, Value> type;
00337   };
00338
00350   template<typename T>
00351   struct Is_enum : Integral_constant<bool, __is_enum(T)> {};
00352
00361   template<typename T>
00362   struct Is_trivially_copyable
00363   : Integral_constant<bool, __is_trivially_copyable(T)>
00364   {};
00365
00366   template<typename T>
00367   inline constexpr bool Is_trivially_copyable_v = __is_trivially_copyable(T);
00368
00380   template<typename T, bool = Is_enum<T>::value>
00381   struct __Underlying_type_helper { using type = __underlying_type(T); };
```

```
00382
00384   template<typename T> struct __Underlying_type_helper<T, false> {};
00385
00387   template<typename T> struct Underlying_type
00388     : public __Underlying_type_helper<T> {};
00389
00391   template<typename T> using Underlying_type_t
00392     = typename Underlying_type<T>::type;
00393
00394   /*********************/
00403   template<typename A, typename B>
00404   struct Same : False {};
00405
00406   template<typename A>
00407   struct Same<A, A> : True {};
00408
00409   template< typename T1, typename T2 >
00410   inline constexpr bool Same_v = Same<T1, T2>::value;
00411
00413   template <typename T, template <typename...> typename Template>
00414   struct Same_template : False {};
00415
00416   template <template <typename...> typename Template, typename... Args>
00417   struct Same_template<Template<Args...>, Template> : True {};
00418
00419   template <typename T, template <typename...> typename Template>
00420   inline constexpr bool Same_template_v = Same_template<T, Template>::value;
00421
00422   template<bool, typename = void> struct Enable_if {};
00423   template<typename T> struct Enable_if<true, T> { using type = T; };
00424
00426   template<bool Condition, typename T = void>
00427     using Enable_if_t = typename Enable_if<Condition, T>::type;
00428
00429   template<typename T1, typename T2, typename T = void>
00430   struct Enable_if_same : Enable_if<Same_v<T1, T2>, T> {};
00431
00432   template<typename T> struct Remove_const { using type = T; };
00433   template<typename T> struct Remove_const<T const> { using type = T; };
00434   template<typename T> using Remove_const_t = typename Remove_const<T>::type;
00435
00436   template<typename T> struct Remove_volatile { using type = T; };
00437   template<typename T> struct Remove_volatile<T volatile> { using type = T; };
00438   template<typename T> using Remove_volatile_t = typename Remove_volatile<T>::type;
00439
00440   template<typename T> struct Remove_cv
00441   { using type = Remove_const_t<Remove_volatile_t<T»; };
00442   template<typename T> using Remove_cv_t = typename Remove_cv<T>::type;
00443
00444   template<typename T> struct Remove_pointer { using type = T; };
00445   template<typename T> struct Remove_pointer<T*> { using type = T; };
00446   template<typename T> using Remove_pointer_t = typename Remove_pointer<T>::type;
00447
00448   template<typename T> struct Remove_reference { using type = T; };
00449   template<typename T> struct Remove_reference<T&> { using type = T; };
00450   template<typename T> using Remove_reference_t = typename Remove_reference<T>::type;
00451
00452   template<typename T> struct Remove_pr { using type = T; };
00453   template<typename T> struct Remove_pr<T&> { using type = T; };
00454   template<typename T> struct Remove_pr<T*> { using type = T; };
00455   template<typename T> using Remove_pr_t = typename Remove_pr<T>::type;
00456
00457   template<typename T>
00458   constexpr T &&
00459   forward(Remove_reference_t<T> &t)
00460   { return static_cast<T &&>(t); }
00461
00462   template<typename T>
00463   constexpr T &&
00464   forward(Remove_reference_t<T> &&t)
00465   { return static_cast<T &&>(t); }
00466
00467   template<typename T>
00468   constexpr Remove_reference_t<T> &&
00469   move(T &&t) { return static_cast<Remove_reference_t<T> &&>(t); }
00470
00471   template< typename... > using Void_t = void;
00472 } // Types
00473
00474 } // L4
00475
00487 namespace Enum_bitops {
00488   using namespace L4::Types;
00489
00491   template<typename, typename = void> struct Has_marker : False {};
00492
00494   template<typename T>
```

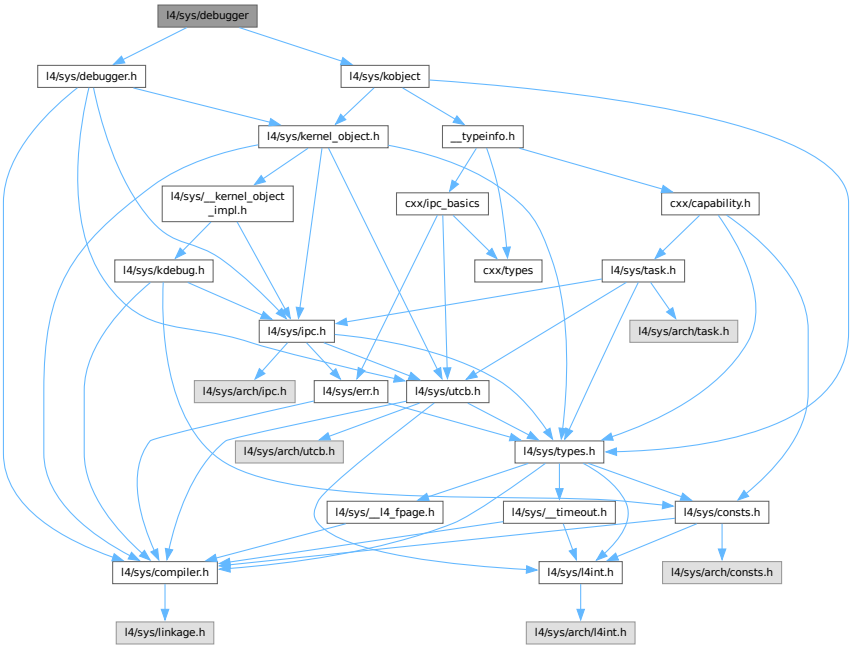
```
00495   struct Has_marker<T, Void<decltype(enum_bitops_enable(declval<T>()))»
00496     : True {};
00497
00499   template<typename T>
00500   struct Enable
00501     : Integral_constant<bool, Is_enum<T>::value && Has_marker<T>::value> {};
00502 } // Enum_bitops
00503
00515 inline namespace Enum_bitops_impl {
00517   template<typename T,
00518            typename = L4::Types::Enable_if_t<L4::Types::Is_enum<T>::value»
00519   constexpr L4::Types::Underlying_type_t<T> to_underlying(T const arg) noexcept
00520   { return static_cast<L4::Types::Underlying_type_t<T>>(arg); }
00521
00523   template<typename T,
00524            typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value»
00525   constexpr T operator ~ (T const a) noexcept
00526   { return static_cast<T>(~to_underlying(a)); }
00527
00529   template<typename T,
00530            typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value»
00531   constexpr T operator & (T l, T r) noexcept
00532   { return static_cast<T>(to_underlying(l) & to_underlying(r)); }
00533
00535   template<typename T,
00536            typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value»
00537   constexpr T &operator &= (T &a, T const b) noexcept
00538   {
00539     a = a & b;
00540     return a;
00541   }
00542
00544   template<typename T,
00545            typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value»
00546   constexpr T operator | (T l, T r) noexcept
00547   { return static_cast<T>(to_underlying(l) | to_underlying(r)); }
00548
00550   template<typename T,
00551            typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value»
00552   constexpr T &operator |= (T &a, T const b) noexcept
00553   {
00554     a = a | b;
00555     return a;
00556   }
00557
00559   template<typename T,
00560            typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value»
00561   constexpr T operator - (T l, T r) noexcept
00562   { return static_cast<T>(to_underlying(l) & ~to_underlying(r)); }
00563
00565   template<typename T,
00566            typename = L4::Types::Enable_if_t<Enum_bitops::Enable<T>::value»
00567   constexpr T &operator -= (T &a, T const b) noexcept
00568   {
00569     a = a - b;
00570     return a;
00571   }
00572 } // Enum_bitops_impl
```

16.495 l4/sys/debugger File Reference

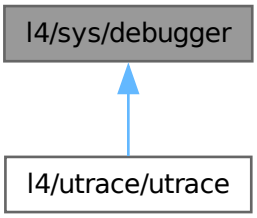
The debugger interface specifies common debugging related definitions.

```
#include <l4/sys/debugger.h>
#include <l4/sys/kobject>
```

Include dependency graph for debugger:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Debugger

  C++ kernel debugger API.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.495.1 Detailed Description

The debugger interface specifies common debugging related definitions.
Definition in file debugger.

16.496 debugger

Go to the documentation of this file.

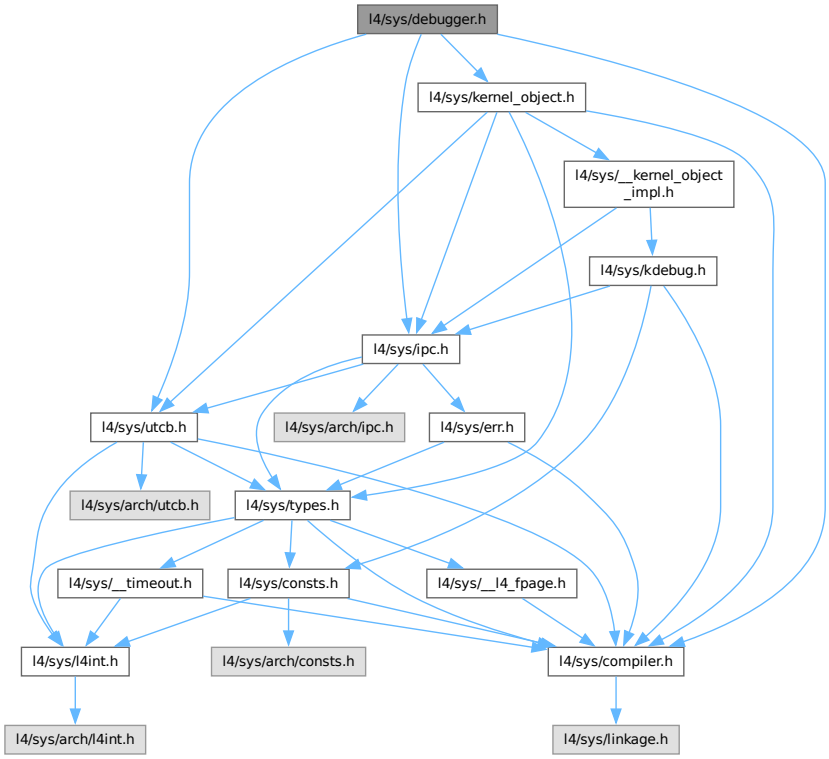
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2010-2011 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/debugger.h>
00016 #include <l4/sys/kobject>
00017
00018 namespace L4 {
00019
00042 class Debugger : public Kobject_t<Debugger, Kobject, L4_PROTO_DEBUGGER>
00043 {
00044 public:
00045   enum
00046   {
00047     Switch_log_on  = L4_DEBUGGER_SWITCH_LOG_ON,
00048     Switch_log_off = L4_DEBUGGER_SWITCH_LOG_OFF,
00049   };
00050
00059   l4_msgtag_t set_object_name(const char *name,
00060                               l4_utcb_t *utcb = l4_utcb()) noexcept
00061   { return l4_debugger_set_object_name_u(cap(), name, utcb); }
00062
00071   unsigned long global_id(l4_utcb_t *utcb = l4_utcb()) noexcept
00072   { return l4_debugger_global_id_u(cap(), utcb); }
00073
00083   unsigned long kobj_to_id(l4_addr_t kobjp,
00084                            l4_utcb_t *utcb = l4_utcb()) noexcept
00085   { return l4_debugger_kobj_to_id_u(cap(), kobjp, utcb); }
00086
00097   l4_ret_t query_log_typeid(const char *name, unsigned idx,
00098                             l4_utcb_t *utcb = l4_utcb()) noexcept
00099   { return l4_debugger_query_log_typeid_u(cap(), name, idx, utcb); }
00100
00116   l4_ret_t query_log_name(unsigned idx,
00117                           char *name, unsigned namelen,
00118                           char *shortname, unsigned shortnamelen,
00119                           l4_utcb_t *utcb = l4_utcb()) noexcept
00120   {
00121     return l4_debugger_query_log_name_u(cap(), idx, name, namelen,
00122                                         shortname, shortnamelen, utcb);
00123   }
00124
00133   l4_msgtag_t switch_log(const char *name, unsigned on_off,
00134                          l4_utcb_t *utcb = l4_utcb()) noexcept
00135   { return l4_debugger_switch_log_u(cap(), name, on_off, utcb); }
00136
00149   l4_ret_t query_object_name(unsigned id, char *name, unsigned size,
00150                              l4_utcb_t *utcb = l4_utcb()) noexcept
00151   { return l4_debugger_query_object_name_u(cap(), id, name, size, utcb); }
00152
00164   l4_ret_t get_object_name(char *name, unsigned size,
00165                            l4_utcb_t *utcb = l4_utcb()) noexcept
00166   { return l4_debugger_get_object_name_u(cap(), name, size, utcb); }
00167
00177   l4_msgtag_t add_image_info(l4_addr_t base, const char *name,
00178                              l4_utcb_t *utcb = l4_utcb()) noexcept
00179   { return l4_debugger_add_image_info_u(cap(), base, name, utcb); }
00180 };
00181 }
```

16.497 l4/sys/debugger.h File Reference

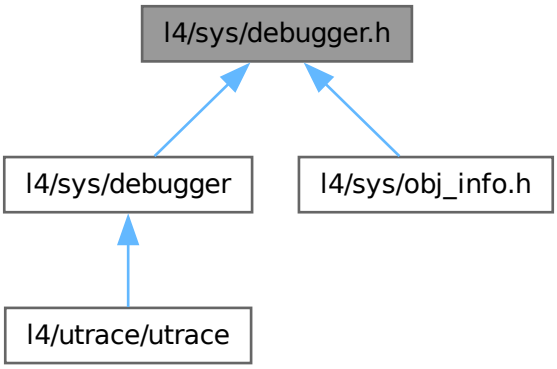
Debugger related definitions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
#include <l4/sys/kernel_object.h>
```

Include dependency graph for debugger.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum {
  L4_DEBUGGER_KOBJ_SET_NAME_OP = 0UL , L4_DEBUGGER_KOBJ_GET_GLOBAL_ID_OP = 1UL ,
  L4_DEBUGGER_KOBJ_PTR_GET_GLOBAL_ID_OP = 2UL , L4_DEBUGGER_LOG_QUERY_TYPEID_OP
  = 3UL ,

L4_DEBUGGER_LOG_SWITCH_OP = 4UL , L4_DEBUGGER_GLOBAL_ID_GET_NAME_OP = 5UL , L4_DEBUGGER_LOG_QUERY_NAME_OP = 6UL , L4_DEBUGGER_TASK_ADD_IMAGE_INFO_OP = 7UL ,
L4_DEBUGGER_KOBJ_GET_NAME_OP = 8UL , L4_DEBUGGER_OBJ_INFO_OP = 16UL }

Functions

- l4_msgtag_t l4_debugger_set_object_name (l4_cap_idx_t cap, const char *name) L4_NOTHROW
  Set the name of a kernel object.
- l4_ret_t l4_debugger_query_object_name (l4_cap_idx_t cap, unsigned id, char *name, unsigned size) L4_NOTHROW
  Get name of the kernel object with Id `id`.
- l4_ret_t l4_debugger_get_object_name (l4_cap_idx_t cap, char *name, unsigned size) L4_NOTHROW
  Get name of a kernel object.
- unsigned long l4_debugger_global_id (l4_cap_idx_t cap) L4_NOTHROW
  Get the globally unique ID of the object behind a capability.
- unsigned long l4_debugger_kobj_to_id (l4_cap_idx_t cap, l4_addr_t kobjp) L4_NOTHROW
  Get the globally unique ID of the object behind the kobject pointer.
- l4_ret_t l4_debugger_query_log_typeid (l4_cap_idx_t cap, const char *name, unsigned idx) L4_NOTHROW
  Query the log-id for a log type.
- l4_ret_t l4_debugger_query_log_name (l4_cap_idx_t cap, unsigned idx, char *name, unsigned namelen, char *shortname, unsigned shortnamelen) L4_NOTHROW
  Query the name of a log type given the ID.
- l4_msgtag_t l4_debugger_switch_log (l4_cap_idx_t cap, const char *name, int on_off) L4_NOTHROW
  Set or unset log.
- l4_msgtag_t l4_debugger_add_image_info (l4_cap_idx_t cap, l4_addr_t base, const char *name) L4_NOTHROW
  Add loaded image information for a task.

16.497.1 Detailed Description

Debugger related definitions.
Definition in file debugger.h.

16.497.2 Enumeration Type Documentation

16.497.2.1 anonymous enum

`anonymous enum`

Enumerator

L4_DEBUGGER_KOBJ_SET_NAME_OP	Set debug name of kernel object.
L4_DEBUGGER_KOBJ_GET_GLOBAL_ID_OP	Get debug ID of kernel object.
L4_DEBUGGER_KOBJ_PTR_GET_GLOBAL_ID_OP	Get debug ID of kernel object by pointer.
L4_DEBUGGER_LOG_QUERY_TYPEID_OP	Query log-id for log type.
L4_DEBUGGER_LOG_SWITCH_OP	Enable / disable log.
L4_DEBUGGER_GLOBAL_ID_GET_NAME_OP	Get debug name of kernel object by debug ID.
L4_DEBUGGER_LOG_QUERY_NAME_OP	Get name of log type for given log-id.
L4_DEBUGGER_TASK_ADD_IMAGE_INFO_OP	Add image information for task.
L4_DEBUGGER_KOBJ_GET_NAME_OP	Get debug name of kernel object.
L4_DEBUGGER_OBJ_INFO_OP	Query information about all kernel objects.

Definition at line 236 of file debugger.h.

16.498 debugger.h

Go to the documentation of this file.

```
00001 #pragma once
00007 /*
00008  * (c) 2008-2011 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #include <l4/sys/compiler.h>
00016 #include <l4/sys/utcb.h>
00017 #include <l4/sys/ipc.h>
00018
00031
00042 L4_INLINE l4_msgtag_t
00043 l4_debugger_set_object_name(l4_cap_idx_t cap, const char *name) L4_NOTHROW;
00044
00048 L4_INLINE l4_msgtag_t
00049 l4_debugger_set_object_name_u(l4_cap_idx_t cap, const char *name, l4_utcb_t *utcb) L4_NOTHROW;
00050
00064 L4_INLINE l4_ret_t
00065 l4_debugger_query_object_name(l4_cap_idx_t cap, unsigned id,
00066                               char *name, unsigned size) L4_NOTHROW;
00067
00071 L4_INLINE l4_ret_t
00072 l4_debugger_query_object_name_u(l4_cap_idx_t cap, unsigned id,
00073                                 char *name, unsigned size,
00074                                 l4_utcb_t *utcb) L4_NOTHROW;
00075
00088 L4_INLINE l4_ret_t
00089 l4_debugger_get_object_name(l4_cap_idx_t cap,
00090                               char *name, unsigned size) L4_NOTHROW;
00091
00095 L4_INLINE l4_ret_t
00096 l4_debugger_get_object_name_u(l4_cap_idx_t cap,
00097                               char *name, unsigned size,
00098                               l4_utcb_t *utcb) L4_NOTHROW;
00099
00111 L4_INLINE unsigned long
00112 l4_debugger_global_id(l4_cap_idx_t cap) L4_NOTHROW;
00113
00117 L4_INLINE unsigned long
00118 l4_debugger_global_id_u(l4_cap_idx_t cap, l4_utcb_t *utcb) L4_NOTHROW;
00119
00132 L4_INLINE unsigned long
00133 l4_debugger_kobj_to_id(l4_cap_idx_t cap, l4_addr_t kobjp) L4_NOTHROW;
00134
00138 L4_INLINE unsigned long
00139 l4_debugger_kobj_to_id_u(l4_cap_idx_t cap, l4_addr_t kobjp, l4_utcb_t *utcb) L4_NOTHROW;
00140
00153 L4_INLINE l4_ret_t
00154 l4_debugger_query_log_typeid(l4_cap_idx_t cap, const char *name,
00155                              unsigned idx) L4_NOTHROW;
00156
00160 L4_INLINE l4_ret_t
00161 l4_debugger_query_log_typeid_u(l4_cap_idx_t cap, const char *name,
00162                                unsigned idx, l4_utcb_t *utcb) L4_NOTHROW;
00163
00180 L4_INLINE l4_ret_t
00181 l4_debugger_query_log_name(l4_cap_idx_t cap, unsigned idx,
00182                            char *name, unsigned namelen,
00183                            char *shortname, unsigned shortnamelen) L4_NOTHROW;
00184
00188 L4_INLINE l4_ret_t
00189 l4_debugger_query_log_name_u(l4_cap_idx_t cap, unsigned idx,
00190                              char *name, unsigned namelen,
00191                              char *shortname, unsigned shortnamelen,
00192                              l4_utcb_t *utcb) L4_NOTHROW;
00193
00204 L4_INLINE l4_msgtag_t
00205 l4_debugger_switch_log(l4_cap_idx_t cap, const char *name,
00206                        int on_off) L4_NOTHROW;
00207
00211 L4_INLINE l4_msgtag_t
00212 l4_debugger_switch_log_u(l4_cap_idx_t cap, const char *name, int on_off,
00213                          l4_utcb_t *utcb) L4_NOTHROW;
00214
00225 L4_INLINE l4_msgtag_t
00226 l4_debugger_add_image_info(l4_cap_idx_t cap, l4_addr_t base,
```

```
00227                             const char *name) L4_NOTHROW;
00228
00232 L4_INLINE l4_msgtag_t
00233 l4_debugger_add_image_info_u(l4_cap_idx_t cap, l4_addr_t base, const char *name,
00234                               l4_utcb_t *utcb) L4_NOTHROW;
00235
00236 enum
00237 {
00239   L4_DEBUGGER_KOBJ_SET_NAME_OP = 0UL,
00241   L4_DEBUGGER_KOBJ_GET_GLOBAL_ID_OP = 1UL,
00243   L4_DEBUGGER_KOBJ_PTR_GET_GLOBAL_ID_OP = 2UL,
00245   L4_DEBUGGER_LOG_QUERY_TYPEID_OP = 3UL,
00247   L4_DEBUGGER_LOG_SWITCH_OP = 4UL,
00249   L4_DEBUGGER_GLOBAL_ID_GET_NAME_OP = 5UL,
00251   L4_DEBUGGER_LOG_QUERY_NAME_OP = 6UL,
00253   L4_DEBUGGER_TASK_ADD_IMAGE_INFO_OP = 7UL,
00255   L4_DEBUGGER_KOBJ_GET_NAME_OP = 8UL,
00256
00258   L4_DEBUGGER_OBJ_INFO_OP = 16UL,
00259 };
00260
00261 enum
00262 {
00263   L4_DEBUGGER_SWITCH_LOG_ON  = 1,
00264   L4_DEBUGGER_SWITCH_LOG_OFF = 0,
00265 };
00266
00267 /* IMPLEMENTATION ----------------------------------------------------------*/
00268
00269 #include <l4/sys/kernel_object.h>
00270
00284 L4_INLINE unsigned
00285 __strcpy_maxlen(char *dst, char const *src, unsigned maxlen)
00286 {
00287   unsigned i;
00288   if (!maxlen)
00289     return 0;
00290
00291   for (i = 0; i < maxlen - 1 && src[i]; ++i)
00292     dst[i] = src[i];
00293   dst[i] = '\0';
00294
00295   return i + 1;
00296 }
00297
00298 L4_INLINE l4_msgtag_t
00299 l4_debugger_set_object_name_u(l4_cap_idx_t cap,
00300                               const char *name, l4_utcb_t *utcb) L4_NOTHROW
00301 {
00302   unsigned i;
00303   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_KOBJ_SET_NAME_OP;
00304   i = __strcpy_maxlen((char *)&l4_utcb_mr_u(utcb)->mr[1], name,
00305                       (L4_UTCB_GENERIC_DATA_SIZE - 2) * sizeof(l4_umword_t));
00306   i = l4_bytes_to_mwords(i);
00307   return l4_invoke_debugger(cap, l4_msgtag(0, 1 + i, 0, 0), utcb);
00308 }
00309
00310 L4_INLINE unsigned long
00311 l4_debugger_global_id_u(l4_cap_idx_t cap, l4_utcb_t *utcb) L4_NOTHROW
00312 {
00313   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_KOBJ_GET_GLOBAL_ID_OP;
00314   if (l4_error_u(l4_invoke_debugger(cap, l4_msgtag(0, 1, 0, 0), utcb), utcb))
00315     return ~0UL;
00316   return l4_utcb_mr_u(utcb)->mr[0];
00317 }
00318
00319 L4_INLINE unsigned long
00320 l4_debugger_kobj_to_id_u(l4_cap_idx_t cap, l4_addr_t kobjp, l4_utcb_t *utcb) L4_NOTHROW
00321 {
00322   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_KOBJ_PTR_GET_GLOBAL_ID_OP;
00323   l4_utcb_mr_u(utcb)->mr[1] = kobjp;
00324   if (l4_error_u(l4_invoke_debugger(cap, l4_msgtag(0, 2, 0, 0), utcb), utcb))
00325     return ~0UL;
00326   return l4_utcb_mr_u(utcb)->mr[0];
00327 }
00328
00329 L4_INLINE l4_ret_t
00330 l4_debugger_query_log_typeid_u(l4_cap_idx_t cap, const char *name,
00331                                unsigned idx,
00332                                l4_utcb_t *utcb) L4_NOTHROW
00333 {
00334   unsigned i;
00335   l4_ret_t e;
00336   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_LOG_QUERY_TYPEID_OP;
00337   l4_utcb_mr_u(utcb)->mr[1] = idx;
00338   i = __strcpy_maxlen((char *)&l4_utcb_mr_u(utcb)->mr[2], name, 32);
00339   i = l4_bytes_to_mwords(i);
```

```
00340   e = l4_error_u(l4_invoke_debugger(cap, l4_msgtag(0, 2 + i, 0, 0), utcb), utcb);
00341   if (e < 0)
00342     return e;
00343
00344   return l4_utcb_mr_u(utcb)->mr[0];
00345 }
00346
00347 L4_INLINE l4_ret_t
00348 l4_debugger_query_log_name_u(l4_cap_idx_t cap, unsigned idx,
00349                              char *name, unsigned namelen,
00350                              char *shortname, unsigned shortnamelen,
00351                              l4_utcb_t *utcb) L4_NOTHROW
00352 {
00353   l4_ret_t e;
00354   char const *n;
00355   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_LOG_QUERY_NAME_OP;
00356   l4_utcb_mr_u(utcb)->mr[1] = idx;
00357   e = l4_error_u(l4_invoke_debugger(cap, l4_msgtag(0, 2, 0, 0), utcb), utcb);
00358   if (e < 0)
00359     return e;
00360
00361   n = (char const *)&l4_utcb_mr_u(utcb)->mr[0];
00362   __strcpy_maxlen(name, n, namelen);
00363   __strcpy_maxlen(shortname, n + __builtin_strlen(n) + 1, shortnamelen);
00364   return 0;
00365 }
00366
00367
00368 L4_INLINE l4_msgtag_t
00369 l4_debugger_switch_log_u(l4_cap_idx_t cap, const char *name, int on_off,
00370                          l4_utcb_t *utcb) L4_NOTHROW
00371 {
00372   unsigned i;
00373   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_LOG_SWITCH_OP;
00374   l4_utcb_mr_u(utcb)->mr[1] = on_off;
00375   i = __strcpy_maxlen((char *)&l4_utcb_mr_u(utcb)->mr[2], name, 32);
00376   i = l4_bytes_to_mwords(i);
00377   return l4_invoke_debugger(cap, l4_msgtag(0, 2 + i, 0, 0), utcb);
00378 }
00379
00380 L4_INLINE l4_ret_t
00381 l4_debugger_query_object_name_u(l4_cap_idx_t cap, unsigned id,
00382                                 char *name, unsigned size,
00383                                 l4_utcb_t *utcb) L4_NOTHROW
00384 {
00385   l4_ret_t e;
00386   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_GLOBAL_ID_GET_NAME_OP;
00387   l4_utcb_mr_u(utcb)->mr[1] = id;
00388   e = l4_error_u(l4_invoke_debugger(cap, l4_msgtag(0, 2, 0, 0), utcb), utcb);
00389   if (e < 0)
00390     return e;
00391
00392   __strcpy_maxlen(name, (char const *)&l4_utcb_mr_u(utcb)->mr[0], size);
00393   return 0;
00394 }
00395
00396 L4_INLINE l4_ret_t
00397 l4_debugger_get_object_name_u(l4_cap_idx_t cap,
00398                               char *name, unsigned size,
00399                               l4_utcb_t *utcb) L4_NOTHROW
00400 {
00401   l4_ret_t e;
00402   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_KOBJ_GET_NAME_OP;
00403   e = l4_error_u(l4_invoke_debugger(cap, l4_msgtag(0, 1, 0, 0), utcb), utcb);
00404   if (e < 0)
00405     return e;
00406
00407   __strcpy_maxlen(name, (char const *)&l4_utcb_mr_u(utcb)->mr[0], size);
00408   return 0;
00409 }
00410
00411 L4_INLINE l4_msgtag_t
00412 l4_debugger_add_image_info_u(l4_cap_idx_t cap, l4_addr_t base,
00413                              const char *name, l4_utcb_t *utcb) L4_NOTHROW
00414 {
00415   unsigned i;
00416   l4_utcb_mr_u(utcb)->mr[0] = L4_DEBUGGER_TASK_ADD_IMAGE_INFO_OP;
00417   l4_utcb_mr_u(utcb)->mr[1] = base;
00418   i = __strcpy_maxlen((char *)&l4_utcb_mr_u(utcb)->mr[2], name,
00419                       (L4_UTCB_GENERIC_DATA_SIZE - 3) * sizeof(l4_umword_t));
00420   i = l4_bytes_to_mwords(i);
00421   return l4_invoke_debugger(cap, l4_msgtag(0, 2 + i, 0, 0), utcb);
00422 }
00423
00424
00425 L4_INLINE l4_msgtag_t
00426 l4_debugger_set_object_name(l4_cap_idx_t cap,
```

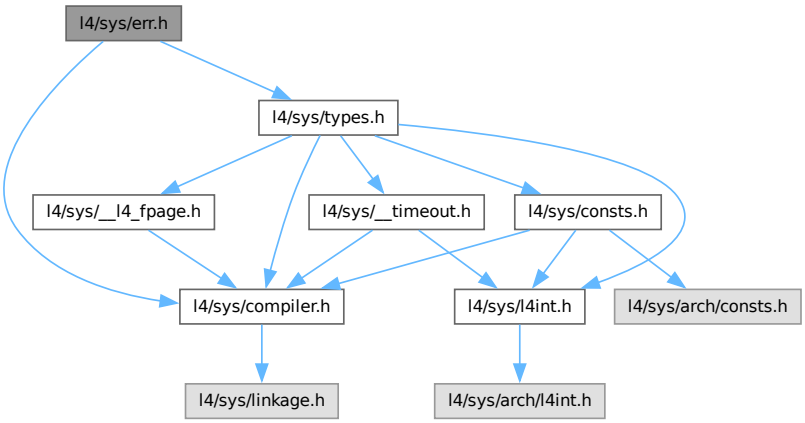
```
00427                             const char *name) L4_NOTHROW
00428 {
00429   return l4_debugger_set_object_name_u(cap, name, l4_utcb());
00430 }
00431
00432 L4_INLINE unsigned long
00433 l4_debugger_global_id(l4_cap_idx_t cap) L4_NOTHROW
00434 {
00435   return l4_debugger_global_id_u(cap, l4_utcb());
00436 }
00437
00438 L4_INLINE unsigned long
00439 l4_debugger_kobj_to_id(l4_cap_idx_t cap, l4_addr_t kobjp) L4_NOTHROW
00440 {
00441   return l4_debugger_kobj_to_id_u(cap, kobjp, l4_utcb());
00442 }
00443
00444 L4_INLINE l4_ret_t
00445 l4_debugger_query_log_typeid(l4_cap_idx_t cap, const char *name,
00446                              unsigned idx) L4_NOTHROW
00447 {
00448   return l4_debugger_query_log_typeid_u(cap, name, idx, l4_utcb());
00449 }
00450
00451 L4_INLINE l4_ret_t
00452 l4_debugger_query_log_name(l4_cap_idx_t cap, unsigned idx,
00453                            char *name, unsigned namelen,
00454                            char *shortname, unsigned shortnamelen) L4_NOTHROW
00455 {
00456   return l4_debugger_query_log_name_u(cap, idx, name, namelen,
00457                                       shortname, shortnamelen, l4_utcb());
00458 }
00459
00460 L4_INLINE l4_msgtag_t
00461 l4_debugger_switch_log(l4_cap_idx_t cap, const char *name,
00462                        int on_off) L4_NOTHROW
00463 {
00464   return l4_debugger_switch_log_u(cap, name, on_off, l4_utcb());
00465 }
00466
00467 L4_INLINE l4_ret_t
00468 l4_debugger_query_object_name(l4_cap_idx_t cap, unsigned id,
00469                               char *name, unsigned size) L4_NOTHROW
00470 {
00471   return l4_debugger_query_object_name_u(cap, id, name, size, l4_utcb());
00472 }
00473
00474 L4_INLINE l4_ret_t
00475 l4_debugger_get_object_name(l4_cap_idx_t cap,
00476                             char *name, unsigned size) L4_NOTHROW
00477 {
00478   return l4_debugger_get_object_name_u(cap, name, size, l4_utcb());
00479 }
00480
00481 L4_INLINE l4_msgtag_t
00482 l4_debugger_add_image_info(l4_cap_idx_t cap, l4_addr_t base,
00483                            const char *name) L4_NOTHROW
00484 {
00485   return l4_debugger_add_image_info_u(cap, base, name, l4_utcb());
00486 }
```

16.499 l4/sys/err.h File Reference

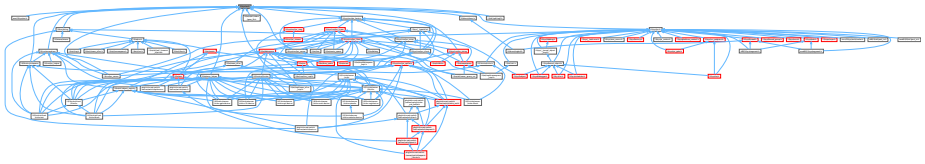
Error codes.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
```

Include dependency graph for err.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum l4_error_code_t {
  L4_EOK = 0 , L4_EPERM = 1 , L4_ENOENT = 2 , L4_EIO = 5 ,
  L4_ENXIO = 6 , L4_E2BIG = 7 , L4_EAGAIN = 11 , L4_ENOMEM = 12 ,
  L4_EACCESS = 13 , L4_EFAULT = 14 , L4_EBUSY = 16 , L4_EEXIST = 17 ,
  L4_ENODEV = 19 , L4_ENOTDIR = 20 , L4_EINVAL = 22 , L4_ENOSPC = 28 ,
  L4_ERANGE = 34 , L4_EDEADLK = 35 , L4_ENAMETOOLONG = 36 , L4_ENOSYS = 38 ,
  L4_EBADPROTO = 39 , L4_EADDRNOTAVAIL = 99 , L4_ERRNOMAX = 100 , L4_ENOREPLY = 1000 ,
  L4_EMSGTOOSHORT = 1001 , L4_EMSGTOOLONG = 1002 , L4_EMSGMISSARG = 1003 ,
  L4_EMSGERRRANGE = 1004 ,
  L4_EDROPREPLY = 1005 , L4_EIPC_LO = 2000 , L4_EIPC_HI = 2000 + 0x1f }

  L4 error codes.

16.499.1 Detailed Description

Error codes.
Definition in file err.h.

16.500 err.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
```

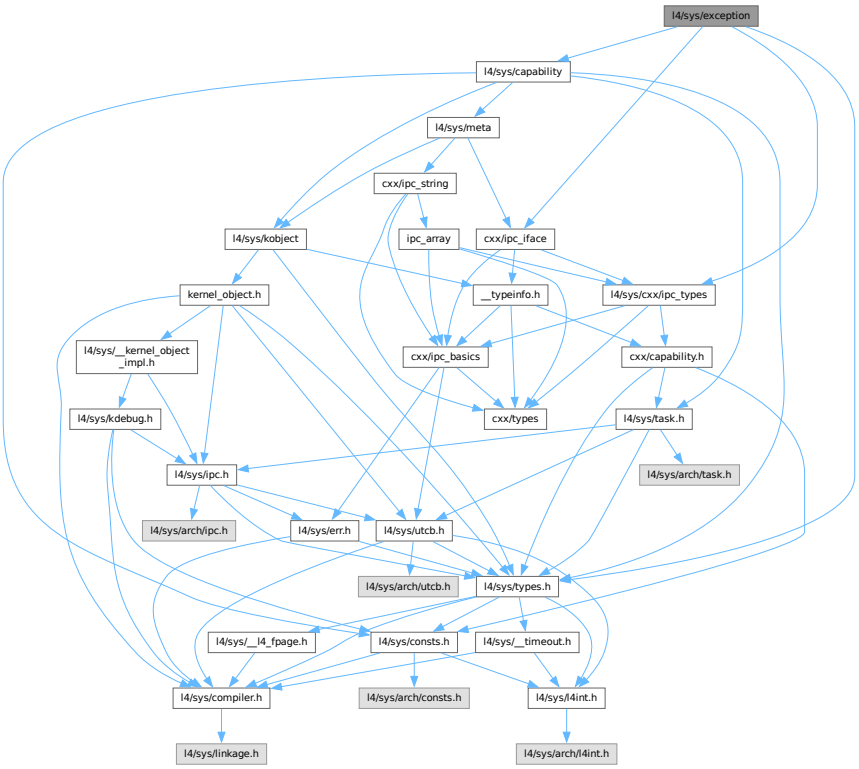
```
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/compiler.h>
00015 #include <l4/sys/types.h>
00016
00024
00031 enum l4_error_code_t
00032 {
00033   L4_EOK           =  0,
00034   L4_EPERM         =  1,
00035   L4_ENOENT        =  2,
00036   L4_EIO           =  5,
00037   L4_ENXIO         =  6,
00038   L4_E2BIG         =  7,
00039   L4_EAGAIN        = 11,
00040   L4_ENOMEM        = 12,
00041   L4_EACCESS       = 13,
00042   L4_EFAULT        = 14,
00043   L4_EBUSY         = 16,
00044   L4_EEXIST        = 17,
00045   L4_ENODEV        = 19,
00046   L4_ENOTDIR       = 20,
00047   L4_EINVAL        = 22,
00048   L4_ENOSPC        = 28,
00049   L4_ERANGE        = 34,
00050   L4_EDEADLK       = 35,
00051   L4_ENAMETOOLONG  = 36,
00052   L4_ENOSYS        = 38,
00053   L4_EBADPROTO     = 39,
00054   L4_EADDRNOTAVAIL = 99,
00055   L4_ERRNOMAX      = 100,
00056
00057   L4_ENOREPLY      = 1000,
00058   L4_EMSGTOOSHORT  = 1001,
00059   L4_EMSGTOOLONG   = 1002,
00060   L4_EMSGMISSARG   = 1003,
00061   L4_EMSGERRRANGE  = 1004,
00062   L4_EDROPREPLY    = 1005,
00063
00064   L4_EIPC_LO       = 2000,
00065   L4_EIPC_HI       = 2000 + 0x1f,
00066 };
00067
00068 L4_BEGIN_DECLS
00069 L4_CV char const *l4sys_errtostr(long err) L4_NOTHROW;
00070 L4_END_DECLS
00071
00072
```

16.501 l4/sys/exception File Reference

Exception C++ interface.

```
#include <l4/sys/capability>
#include <l4/sys/types.h>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for exception:



Data Structures

- class L4::Exception

  Exception interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.501.1 Detailed Description

Exception C++ interface.
Definition in file exception.

16.502 exception

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/capability>
00015 #include <l4/sys/types.h>
00016 #include <l4/sys/cxx/ipc_types>
00017 #include <l4/sys/cxx/ipc_iface>
```

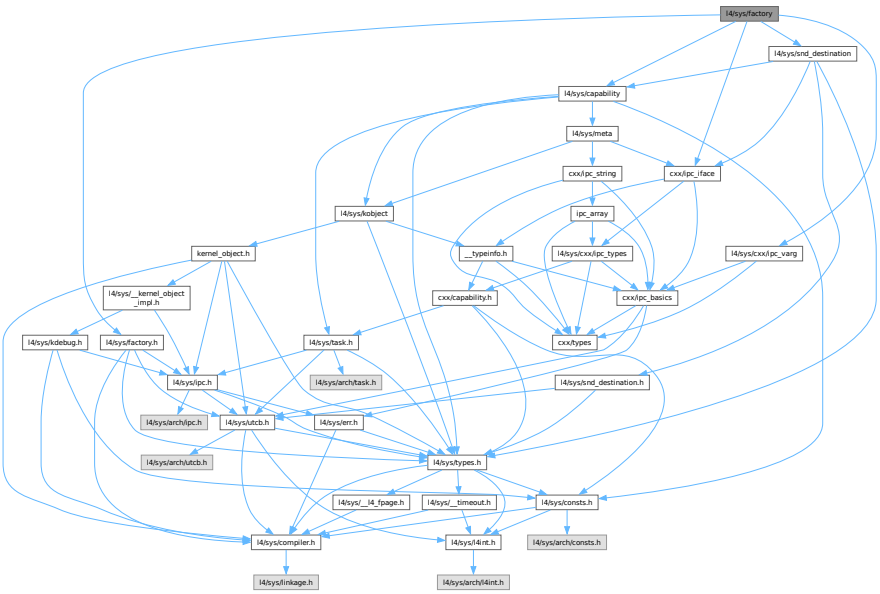
```
00018
00019 namespace L4 {
00020
00031 class L4_EXPORT Exception :
00032   public Kobject_0t<Exception, L4_PROTO_EXCEPTION>
00033 {
00034 public:
00035   // TODO: pass a reference/pointer to the UTCB not copy the regs
00046   L4_INLINE_RPC(
00047       l4_msgtag_t, exception, (L4::Ipc::In_out<l4_exc_regs_t *> regs,
00048                                L4::Ipc::Rcv_fpage rwin,
00049                                L4::Ipc::Opt<L4::Ipc::Snd_fpage &> fp));
00050
00051   typedef L4::Typeid::Rpc_nocode<exception_t> Rpcs;
00052 };
00053
00054 }
```

16.503 l4/sys/factory File Reference

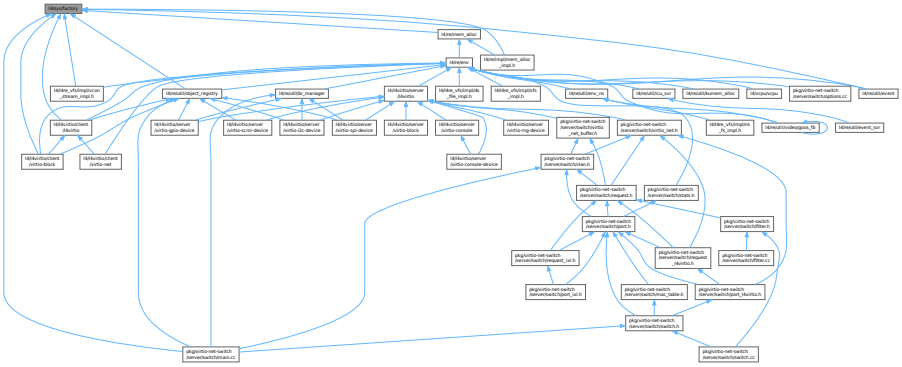
Common factory related definitions.

```
#include <l4/sys/factory.h>
#include <l4/sys/capability>
#include <l4/sys/snd_destination>
#include <l4/sys/cxx/ipc_iface>
#include <l4/sys/cxx/ipc_varg>
```

Include dependency graph for factory:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Factory

  C++ Factory interface, see Factory for the C interface.
- struct L4::Factory::Nil

  Special type to add a void argument into the factory create stream.
- struct L4::Factory::Lstr

  Special type to add a pascal string into the factory create stream.
- class L4::Factory::S

  Stream class for the create() argument stream.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.503.1 Detailed Description

Common factory related definitions.
Definition in file factory.

16.504 factory

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/factory.h>
00017 #include <l4/sys/capability>
00018 #include <l4/sys/snd_destination>
00019 #include <l4/sys/cxx/ipc_iface>
00020 #include <l4/sys/cxx/ipc_varg>
00021
00022 namespace L4 {
00023
00038 class Factory : public Kobject_t<Factory, Kobject, L4_PROTO_FACTORY>
00039 {
00040 public:
00041
00042   typedef l4_mword_t Proto;
```

```
00043
00047   struct Nil {};
00048
00054   struct Lstr
00055   {
00059     char const *s;
00060
00064     unsigned len;
00065
00070     Lstr(char const *s, unsigned len) noexcept : s(s), len(len) {}
00071   };
00072
00079   class S
00080   {
00081   private:
00082     l4_utcb_t *u;
00083     l4_msgtag_t t;
00084     l4_cap_idx_t f;
00085
00086     template<typename T>
00087     static T &&_move(T &c) { return static_cast<T &&>(c); }
00088
00089   public:
00090     S(S const &) = delete;
00091     S &operator = (S const &) & = delete;
00092
00098     S(S &&o) noexcept
00099     : u(o.u), t(o.t), f(o.f)
00100     { o.t.raw = 0; }
00101
00102     S &operator = (S &&o) & noexcept
00103     {
00104       u = o.u;
00105       t = o.t;
00106       f = o.f;
00107       o.t.raw = 0;
00108       return *this;
00109     }
00110
00125     S(l4_cap_idx_t f, long obj, L4::Cap<void> target,
00126       l4_utcb_t *utcb) noexcept
00127     : u(utcb), t(l4_factory_create_start_u(obj, target.cap(), u)), f(f)
00128     {}
00129
00139     ~S() noexcept
00140     {
00141       if (t.raw)
00142   l4_factory_create_commit_u(f, t, u);
00143     }
00144
00157     operator l4_msgtag_t () noexcept
00158     {
00159       l4_msgtag_t r = l4_factory_create_commit_u(f, t, u);
00160       t.raw = 0;
00161       return r;
00162     }
00163
00169     void put(l4_mword_t i) noexcept
00170     {
00171       l4_factory_create_add_int_u(i, &t, u);
00172     }
00173
00179     void put(l4_umword_t i) noexcept
00180     {
00181       l4_factory_create_add_uint_u(i, &t, u);
00182     }
00183
00191     void put(char const *s) & noexcept
00192     {
00193       l4_factory_create_add_str_u(s, &t, u);
00194     }
00195
00205     void put(Lstr const &s) & noexcept
00206     {
00207       l4_factory_create_add_lstr_u(s.s, s.len, &t, u);
00208     }
00209
00213     void put(Nil) & noexcept
00214     {
00215       l4_factory_create_add_nil_u(&t, u);
00216     }
00217
00223     void put(l4_fpage_t d) & noexcept
00224     {
00225       l4_factory_create_add_fpage_u(d, &t, u);
00226     }
00227
```

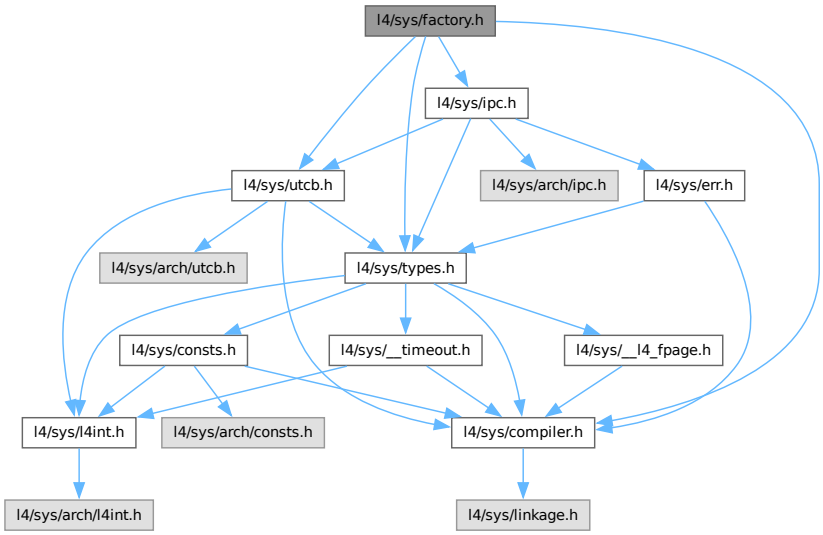
```
00236     template<typename T>
00237     S &operator « (T const &d) & noexcept
00238     {
00239       put(d);
00240       return *this;
00241     }
00242
00251     template<typename T>
00252     S &&operator « (T const &d) && noexcept
00253     {
00254       put(d);
00255       return _move(*this);
00256     }
00257   };
00258
00259
00260 public:
00261
00292   S create(Cap<void> target, long obj, l4_utcb_t *utcb = l4_utcb()) noexcept
00293   {
00294     return S(cap(), obj, target, utcb);
00295   }
00296
00328   template<typename OBJ>
00329   S create(Cap<OBJ> target, l4_utcb_t *utcb = l4_utcb()) noexcept
00330   {
00331     return S(cap(), OBJ::Protocol, target, utcb);
00332   }
00333
00334   L4_INLINE_RPC_NF(
00335       l4_msgtag_t, create, (L4::Ipc::Out<L4::Cap<void> > target, l4_mword_t obj,
00336                             L4::Ipc::Varg const *args),
00337       L4::Ipc::Call_t<L4_CAP_FPAGE_S>);
00338
00370   l4_msgtag_t create_task(Cap<Task> const & target_cap,
00371                           l4_fpage_t *utcb_area,
00372                           l4_utcb_t *utcb = l4_utcb()) noexcept
00373   { return l4_factory_create_task_u(cap(), target_cap.cap(), utcb_area, utcb); }
00374
00404   l4_msgtag_t create_factory(Cap<Factory> const &target_cap,
00405                              unsigned long limit,
00406                              l4_utcb_t *utcb = l4_utcb()) noexcept
00407   { return l4_factory_create_factory_u(cap(), target_cap.cap(), limit, utcb); }
00408
00440   l4_msgtag_t create_gate(Cap<void> const &target_cap,
00441                           Cap<Snd_destination> const &snd_dst_cap,
00442                           l4_umword_t label,
00443                           l4_utcb_t *utcb = l4_utcb()) noexcept
00444   {
00445     return l4_factory_create_gate_u(cap(), target_cap.cap(), snd_dst_cap.cap(),
00446                                     label, utcb);
00447   }
00448
00475   l4_msgtag_t create_thread_group(Cap<Thread_group> const &target_cap,
00476                                   unsigned policy,
00477                                   l4_utcb_t *utcb = l4_utcb()) noexcept
00478   {
00479     return l4_factory_create_thread_group_u(cap(), target_cap.cap(),
00480                                             policy, utcb);
00481   }
00482
00483   typedef L4::Typeid::Rpc_nocode<create_t> Rpcs;
00484 };
00485
00486 }
```

16.505 l4/sys/factory.h File Reference

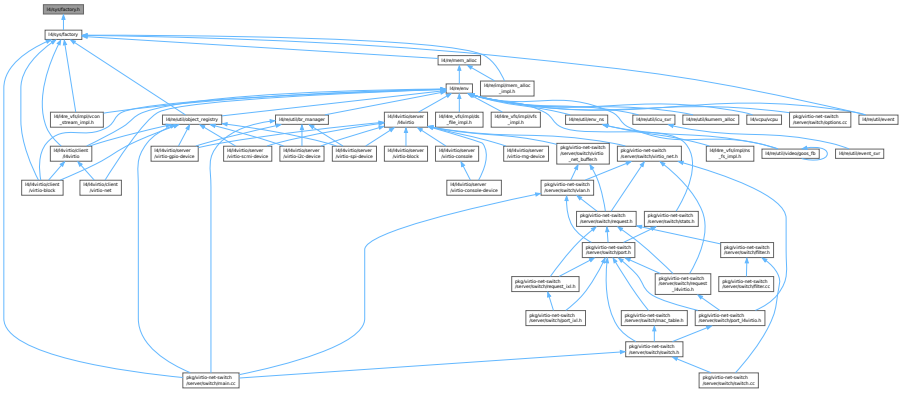
Common factory related definitions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for factory.h:



This graph shows which files directly or indirectly include this file:



Functions

- l4_msgtag_t l4_factory_create_task (l4_cap_idx_t factory, l4_cap_idx_t target_cap, l4_fpage_t *utcb_area) L4_NOTHROW

  Create a new task.
- l4_msgtag_t l4_factory_create_thread (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

  Create a new thread.
- l4_msgtag_t l4_factory_create_factory (l4_cap_idx_t factory, l4_cap_idx_t target_cap, unsigned long limit) L4_NOTHROW

  Create a new factory.
- l4_msgtag_t l4_factory_create_gate (l4_cap_idx_t factory, l4_cap_idx_t target_cap, l4_cap_idx_t snd_dst_↩ cap, l4_umword_t label) L4_NOTHROW

  Create a new IPC gate, optionally bound to a send destination (a thread or thread group).
- l4_msgtag_t l4_factory_create_irq (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

  Create a new IRQ sender.
- l4_msgtag_t l4_factory_create_vm (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

Create a new virtual machine.

- l4_msgtag_t l4_factory_create_vcpu_context (l4_cap_idx_t factory, l4_cap_idx_t target_cap) L4_NOTHROW

  Create a new vCPU context.

- l4_msgtag_t l4_factory_create_thread_group (l4_cap_idx_t factory, l4_cap_idx_t target_cap, unsigned policy) L4_NOTHROW

  Create a new thread group.

- l4_msgtag_t l4_factory_create_pi_mutex (l4_cap_idx_t factory, l4_cap_idx_t target_cap, l4_addr_t ku_status, l4_cap_idx_t task_cap) L4_NOTHROW

  Create a new priority inheritance mutex.

- l4_msgtag_t l4_factory_create (l4_cap_idx_t factory, long obj, l4_cap_idx_t target) L4_NOTHROW

  Create a new object.

16.505.1 Detailed Description

Common factory related definitions.
Definition in file factory.h.

16.506 factory.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00010  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>,
00011  *               Henning Schild <hschild@os.inf.tu-dresden.de>
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  *
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016 #pragma once
00017
00018 #include <l4/sys/compiler.h>
00019 #include <l4/sys/types.h>
00020 #include <l4/sys/utcb.h>
00021
00050
00056
00086 L4_INLINE l4_msgtag_t
00087 l4_factory_create_task(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00088                        l4_fpage_t *utcb_area) L4_NOTHROW;
00089
00094 L4_INLINE l4_msgtag_t
00095 l4_factory_create_task_u(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00096                          l4_fpage_t *utcb_area, l4_utcb_t *utcb) L4_NOTHROW;
00097
00116 L4_INLINE l4_msgtag_t
00117 l4_factory_create_thread(l4_cap_idx_t factory,
00118                          l4_cap_idx_t target_cap) L4_NOTHROW;
00119
00124 L4_INLINE l4_msgtag_t
00125 l4_factory_create_thread_u(l4_cap_idx_t factory,
00126                            l4_cap_idx_t target_cap, l4_utcb_t *utcb) L4_NOTHROW;
00127
00153 L4_INLINE l4_msgtag_t
00154 l4_factory_create_factory(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00155                           unsigned long limit) L4_NOTHROW;
00156
00161 L4_INLINE l4_msgtag_t
00162 l4_factory_create_factory_u(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00163                             unsigned long limit, l4_utcb_t *utcb) L4_NOTHROW;
00164
00194 L4_INLINE l4_msgtag_t
00195 l4_factory_create_gate(l4_cap_idx_t factory,
00196                        l4_cap_idx_t target_cap,
00197                        l4_cap_idx_t snd_dst_cap, l4_umword_t label) L4_NOTHROW;
00198
00203 L4_INLINE l4_msgtag_t
00204 l4_factory_create_gate_u(l4_cap_idx_t factory,
00205                          l4_cap_idx_t target_cap,
00206                          l4_cap_idx_t snd_dst_cap, l4_umword_t label,
00207                          l4_utcb_t *utcb) L4_NOTHROW;
00208
```

```
00225 L4_INLINE l4_msgtag_t
00226 l4_factory_create_irq(l4_cap_idx_t factory,
00227                       l4_cap_idx_t target_cap) L4_NOTHROW;
00228
00233 L4_INLINE l4_msgtag_t
00234 l4_factory_create_irq_u(l4_cap_idx_t factory,
00235                         l4_cap_idx_t target_cap, l4_utcb_t *utcb) L4_NOTHROW;
00236
00255 L4_INLINE l4_msgtag_t
00256 l4_factory_create_vm(l4_cap_idx_t factory,
00257                      l4_cap_idx_t target_cap) L4_NOTHROW;
00258
00278 L4_INLINE l4_msgtag_t
00279 l4_factory_create_vcpu_context(l4_cap_idx_t factory,
00280                                l4_cap_idx_t target_cap) L4_NOTHROW;
00281
00309 L4_INLINE l4_msgtag_t
00310 l4_factory_create_thread_group(l4_cap_idx_t factory,
00311                                l4_cap_idx_t target_cap,
00312                                unsigned policy) L4_NOTHROW;
00313
00340 L4_INLINE l4_msgtag_t
00341 l4_factory_create_pi_mutex(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00342                            l4_addr_t ku_status, l4_cap_idx_t task_cap) L4_NOTHROW;
00343
00348 L4_INLINE l4_msgtag_t
00349 l4_factory_create_vm_u(l4_cap_idx_t factory,
00350                        l4_cap_idx_t target_cap, l4_utcb_t *utcb) L4_NOTHROW;
00351
00356 L4_INLINE l4_msgtag_t
00357 l4_factory_create_vcpu_context_u(l4_cap_idx_t factory,
00358                                  l4_cap_idx_t target_cap,
00359                                  l4_utcb_t *utcb) L4_NOTHROW;
00360
00365 L4_INLINE l4_msgtag_t
00366 l4_factory_create_thread_group_u(l4_cap_idx_t factory,
00367                                  l4_cap_idx_t target_cap,
00368                                  unsigned policy,
00369                                  l4_utcb_t *u) L4_NOTHROW;
00370
00375 L4_INLINE l4_msgtag_t
00376 l4_factory_create_pi_mutex_u(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00377                              l4_addr_t ku_status, l4_cap_idx_t task_cap,
00378                              l4_utcb_t *u) L4_NOTHROW;
00379
00384 L4_INLINE l4_msgtag_t
00385 l4_factory_create_start_u(long obj, l4_cap_idx_t target,
00386                           l4_utcb_t *utcb) L4_NOTHROW;
00387
00392 L4_INLINE int
00393 l4_factory_create_add_fpage_u(l4_fpage_t d, l4_msgtag_t *tag,
00394                               l4_utcb_t *utcb) L4_NOTHROW;
00395
00400 L4_INLINE int
00401 l4_factory_create_add_int_u(l4_mword_t d, l4_msgtag_t *tag,
00402                             l4_utcb_t *utcb) L4_NOTHROW;
00403
00408 L4_INLINE int
00409 l4_factory_create_add_uint_u(l4_umword_t d, l4_msgtag_t *tag,
00410                              l4_utcb_t *utcb) L4_NOTHROW;
00411
00416 L4_INLINE int
00417 l4_factory_create_add_str_u(char const *s, l4_msgtag_t *tag,
00418                             l4_utcb_t *utcb) L4_NOTHROW;
00419
00424 L4_INLINE int
00425 l4_factory_create_add_lstr_u(char const *s, unsigned len, l4_msgtag_t *tag,
00426                              l4_utcb_t *utcb) L4_NOTHROW;
00427
00432 L4_INLINE int
00433 l4_factory_create_add_nil_u(l4_msgtag_t *tag, l4_utcb_t *utcb) L4_NOTHROW;
00434
00439 L4_INLINE l4_msgtag_t
00440 l4_factory_create_commit_u(l4_cap_idx_t factory, l4_msgtag_t tag,
00441                            l4_utcb_t *utcb) L4_NOTHROW;
00442
00447 L4_INLINE l4_msgtag_t
00448 l4_factory_create_u(l4_cap_idx_t factory, long obj, l4_cap_idx_t target,
00449                     l4_utcb_t *utcb) L4_NOTHROW;
00450
00451
00469 L4_INLINE l4_msgtag_t
00470 l4_factory_create(l4_cap_idx_t factory, long obj,
00471                   l4_cap_idx_t target) L4_NOTHROW;
00472
00473 /* IMPLEMENTATION ----------------------------------------------------*/
00474
```

```
00475 #include <l4/sys/ipc.h>
00476
00477 L4_INLINE l4_msgtag_t
00478 l4_factory_create_task_u(l4_cap_idx_t factory,
00479                          l4_cap_idx_t target_cap, l4_fpage_t *utcb_area,
00480                          l4_utcb_t *u) L4_NOTHROW
00481 {
00482   l4_msgtag_t t;
00483   t = l4_factory_create_start_u(L4_PROTO_TASK, target_cap, u);
00484   l4_factory_create_add_fpage_u(*utcb_area, &t, u);
00485   t = l4_factory_create_commit_u(factory, t, u);
00486   if (!l4_msgtag_has_error(t))
00487     {
00488       l4_msg_regs_t *v = l4_utcb_mr_u(u);
00489       utcb_area->raw = v->mr[0];
00490     }
00491   return t;
00492 }
00493
00494 L4_INLINE l4_msgtag_t
00495 l4_factory_create_thread_u(l4_cap_idx_t factory,
00496                            l4_cap_idx_t target_cap, l4_utcb_t *u) L4_NOTHROW
00497 {
00498   return l4_factory_create_u(factory, L4_PROTO_THREAD, target_cap, u);
00499 }
00500
00501 L4_INLINE l4_msgtag_t
00502 l4_factory_create_factory_u(l4_cap_idx_t factory,
00503                             l4_cap_idx_t target_cap, unsigned long limit,
00504                             l4_utcb_t *u) L4_NOTHROW
00505 {
00506   l4_msgtag_t t;
00507   t = l4_factory_create_start_u(L4_PROTO_FACTORY, target_cap, u);
00508   l4_factory_create_add_uint_u(limit, &t, u);
00509   return l4_factory_create_commit_u(factory, t, u);
00510 }
00511
00512 L4_INLINE l4_msgtag_t
00513 l4_factory_create_gate_u(l4_cap_idx_t factory,
00514                          l4_cap_idx_t target_cap,
00515                          l4_cap_idx_t snd_dst_cap, l4_umword_t label,
00516                          l4_utcb_t *u) L4_NOTHROW
00517 {
00518   l4_msgtag_t t;
00519   l4_msg_regs_t *v;
00520   int items = 0;
00521   t = l4_factory_create_start_u(0, target_cap, u);
00522   l4_factory_create_add_uint_u(label, &t, u);
00523   v = l4_utcb_mr_u(u);
00524   if (!(snd_dst_cap & L4_INVALID_CAP_BIT))
00525     {
00526       items = 1;
00527       v->mr[3] = l4_map_obj_control(0,0);
00528       v->mr[4] = l4_obj_fpage(snd_dst_cap, 0, L4_CAP_FPAGE_RWS).raw;
00529     }
00530   t = l4_msgtag(l4_msgtag_label(t), l4_msgtag_words(t), items, l4_msgtag_flags(t));
00531   return l4_factory_create_commit_u(factory, t, u);
00532 }
00533
00534 L4_INLINE l4_msgtag_t
00535 l4_factory_create_irq_u(l4_cap_idx_t factory,
00536                         l4_cap_idx_t target_cap, l4_utcb_t *u) L4_NOTHROW
00537 {
00538   return l4_factory_create_u(factory, L4_PROTO_IRQ_SENDER, target_cap, u);
00539 }
00540
00541 L4_INLINE l4_msgtag_t
00542 l4_factory_create_vm_u(l4_cap_idx_t factory,
00543                        l4_cap_idx_t target_cap,
00544                        l4_utcb_t *u) L4_NOTHROW
00545 {
00546   return l4_factory_create_u(factory, L4_PROTO_VM, target_cap, u);
00547 }
00548
00549 L4_INLINE l4_msgtag_t
00550 l4_factory_create_vcpu_context_u(l4_cap_idx_t factory,
00551                                  l4_cap_idx_t target_cap,
00552                                  l4_utcb_t *u) L4_NOTHROW
00553 {
00554   return l4_factory_create_u(factory, L4_PROTO_VCPU_CONTEXT, target_cap, u);
00555 }
00556
00557 L4_INLINE l4_msgtag_t
00558 l4_factory_create_thread_group_u(l4_cap_idx_t factory,
00559                                  l4_cap_idx_t target_cap,
00560                                  unsigned policy,
00561                                  l4_utcb_t *u) L4_NOTHROW
```

```
00562 {
00563   l4_msgtag_t t = l4_factory_create_start_u(L4_PROTO_THREAD_GROUP, target_cap, u);
00564   l4_factory_create_add_uint_u(policy, &t, u);
00565   return l4_factory_create_commit_u(factory, t, u);
00566 }
00567
00568 L4_INLINE l4_msgtag_t
00569 l4_factory_create_pi_mutex_u(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00570                              l4_addr_t ku_status, l4_cap_idx_t task_cap,
00571                              l4_utcb_t *u) L4_NOTHROW
00572 {
00573   l4_msgtag_t t;
00574   l4_msg_regs_t *v;
00575   t = l4_factory_create_start_u(L4_PROTO_PI_MUTEX, target_cap, u);
00576   l4_factory_create_add_uint_u(ku_status, &t, u);
00577   v = l4_utcb_mr_u(u);
00578   v->mr[l4_msgtag_words(t)] = l4_map_obj_control(0,0);
00579   v->mr[l4_msgtag_words(t) + 1] = l4_obj_fpage(task_cap, 0, L4_CAP_FPAGE_RS).raw;
00580   t = l4_msgtag(l4_msgtag_label(t), l4_msgtag_words(t), 1, l4_msgtag_flags(t));
00581   return l4_factory_create_commit_u(factory, t, u);
00582 }
00583
00584 L4_INLINE l4_msgtag_t
00585 l4_factory_create_task(l4_cap_idx_t factory,
00586                        l4_cap_idx_t target_cap, l4_fpage_t *utcb_area) L4_NOTHROW
00587 {
00588   return l4_factory_create_task_u(factory, target_cap, utcb_area, l4_utcb());
00589 }
00590
00591 L4_INLINE l4_msgtag_t
00592 l4_factory_create_thread(l4_cap_idx_t factory,
00593                          l4_cap_idx_t target_cap) L4_NOTHROW
00594 {
00595   return l4_factory_create_thread_u(factory, target_cap, l4_utcb());
00596 }
00597
00598 L4_INLINE l4_msgtag_t
00599 l4_factory_create_factory(l4_cap_idx_t factory,
00600                           l4_cap_idx_t target_cap, unsigned long limit) L4_NOTHROW
00601
00602 {
00603   return l4_factory_create_factory_u(factory, target_cap, limit, l4_utcb());
00604 }
00605
00606 L4_INLINE l4_msgtag_t
00607 l4_factory_create_gate(l4_cap_idx_t factory,
00608                        l4_cap_idx_t target_cap,
00609                        l4_cap_idx_t snd_dst_cap, l4_umword_t label) L4_NOTHROW
00610 {
00611   return l4_factory_create_gate_u(factory, target_cap, snd_dst_cap, label, l4_utcb());
00612 }
00613
00614 L4_INLINE l4_msgtag_t
00615 l4_factory_create_irq(l4_cap_idx_t factory,
00616                       l4_cap_idx_t target_cap) L4_NOTHROW
00617 {
00618   return l4_factory_create_irq_u(factory, target_cap, l4_utcb());
00619 }
00620
00621 L4_INLINE l4_msgtag_t
00622 l4_factory_create_vm(l4_cap_idx_t factory,
00623                      l4_cap_idx_t target_cap) L4_NOTHROW
00624 {
00625   return l4_factory_create_vm_u(factory, target_cap, l4_utcb());
00626 }
00627
00628 L4_INLINE l4_msgtag_t
00629 l4_factory_create_vcpu_context(l4_cap_idx_t factory,
00630                                l4_cap_idx_t target_cap) L4_NOTHROW
00631 {
00632   return l4_factory_create_vcpu_context_u(factory, target_cap, l4_utcb());
00633 }
00634
00635 L4_INLINE l4_msgtag_t
00636 l4_factory_create_thread_group(l4_cap_idx_t factory,
00637                                l4_cap_idx_t target_cap,
00638                                unsigned policy) L4_NOTHROW
00639 {
00640   return l4_factory_create_thread_group_u(factory, target_cap, policy, l4_utcb());
00641 }
00642
00643 L4_INLINE l4_msgtag_t
00644 l4_factory_create_pi_mutex(l4_cap_idx_t factory, l4_cap_idx_t target_cap,
00645                            l4_addr_t ku_status,
00646                            l4_cap_idx_t task_cap) L4_NOTHROW
00647 {
00648   return l4_factory_create_pi_mutex_u(factory, target_cap, ku_status, task_cap,
```

```
00649                                       l4_utcb());
00650 }
00651
00652 L4_INLINE l4_msgtag_t
00653 l4_factory_create_start_u(long obj, l4_cap_idx_t target_cap,
00654                           l4_utcb_t *u) L4_NOTHROW
00655 {
00656   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00657   l4_buf_regs_t *b = l4_utcb_br_u(u);
00658   v->mr[0] = obj;
00659   b->bdr = 0;
00660   b->br[0] = target_cap | L4_RCV_ITEM_SINGLE_CAP;
00661   return l4_msgtag(L4_PROTO_FACTORY, 1, 0, 0);
00662 }
00663
00664 L4_INLINE int
00665 l4_factory_create_add_fpage_u(l4_fpage_t d, l4_msgtag_t *tag,
00666                               l4_utcb_t *u) L4_NOTHROW
00667 {
00668   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00669   int w = l4_msgtag_words(*tag);
00670   if (w + 2 > L4_UTCB_GENERIC_DATA_SIZE)
00671     return 0;
00672   v->mr[w] = L4_VARG_TYPE_FPAGE | (sizeof(l4_fpage_t) << 16);
00673   v->mr[w + 1] = d.raw;
00674   w += 2;
00675   tag->raw = (tag->raw & ~0x3fUL) | (w & 0x3f);
00676   return 1;
00677 }
00678
00679 L4_INLINE int
00680 l4_factory_create_add_int_u(l4_mword_t d, l4_msgtag_t *tag,
00681                             l4_utcb_t *u) L4_NOTHROW
00682 {
00683   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00684   int w = l4_msgtag_words(*tag);
00685   if (w + 2 > L4_UTCB_GENERIC_DATA_SIZE)
00686     return 0;
00687   v->mr[w] = L4_VARG_TYPE_MWORD | (sizeof(l4_mword_t) << 16);
00688   v->mr[w + 1] = d;
00689   w += 2;
00690   tag->raw = (tag->raw & ~0x3fUL) | (w & 0x3f);
00691   return 1;
00692 }
00693
00694 L4_INLINE int
00695 l4_factory_create_add_uint_u(l4_umword_t d, l4_msgtag_t *tag,
00696                              l4_utcb_t *u) L4_NOTHROW
00697 {
00698   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00699   int w = l4_msgtag_words(*tag);
00700   if (w + 2 > L4_UTCB_GENERIC_DATA_SIZE)
00701     return 0;
00702   v->mr[w] = L4_VARG_TYPE_UMWORD | (sizeof(l4_umword_t) << 16);
00703   v->mr[w + 1] = d;
00704   w += 2;
00705   tag->raw = (tag->raw & ~0x3fUL) | (w & 0x3f);
00706   return 1;
00707 }
00708
00709 L4_INLINE int
00710 l4_factory_create_add_str_u(char const *s, l4_msgtag_t *tag,
00711                             l4_utcb_t *u) L4_NOTHROW
00712 {
00713   return l4_factory_create_add_lstr_u(s, __builtin_strlen(s) + 1, tag, u);
00714 }
00715
00716 L4_INLINE int
00717 l4_factory_create_add_lstr_u(char const *s, unsigned len, l4_msgtag_t *tag,
00718                              l4_utcb_t *u) L4_NOTHROW
00719 {
00720
00721   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00722   unsigned w = l4_msgtag_words(*tag);
00723   char *c;
00724   unsigned i;
00725
00726   if (w + 1 + l4_bytes_to_mwords(len) > L4_UTCB_GENERIC_DATA_SIZE)
00727     return 0;
00728
00729   v->mr[w] = L4_VARG_TYPE_STRING | (len << 16);
00730   c = (char*)&v->mr[w + 1];
00731   for (i = 0; i < len; ++i)
00732     *c++ = *s++;
00733
00734   w = w + 1 + l4_bytes_to_mwords(len);
00735
```

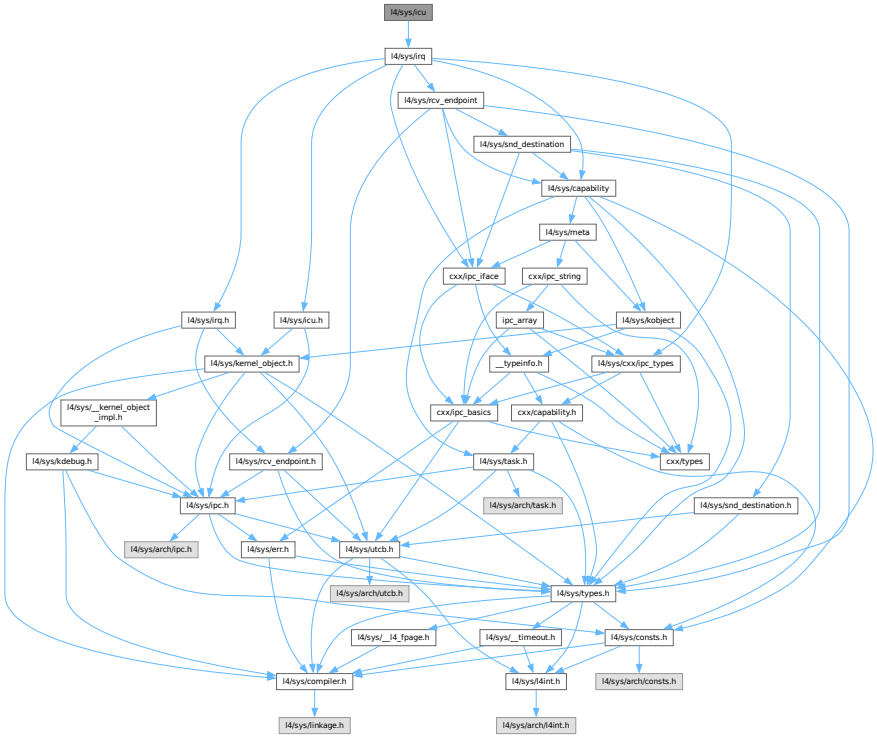
```
00736   tag->raw = (tag->raw & ~0x3fUL) | (w & 0x3f);
00737   return 1;
00738 }
00739
00740 L4_INLINE int
00741 l4_factory_create_add_nil_u(l4_msgtag_t *tag, l4_utcb_t *utcb) L4_NOTHROW
00742 {
00743   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00744   int w = l4_msgtag_words(*tag);
00745   v->mr[w] = L4_VARG_TYPE_NIL;
00746   ++w;
00747   tag->raw = (tag->raw & ~0x3fUL) | (w & 0x3f);
00748   return 1;
00749 }
00750
00751
00752 L4_INLINE l4_msgtag_t
00753 l4_factory_create_commit_u(l4_cap_idx_t factory, l4_msgtag_t tag,
00754                            l4_utcb_t *u) L4_NOTHROW
00755 {
00756   return l4_ipc_call(factory, u, tag, L4_IPC_NEVER);
00757 }
00758
00759 L4_INLINE l4_msgtag_t
00760 l4_factory_create_u(l4_cap_idx_t factory, long obj, l4_cap_idx_t target,
00761                     l4_utcb_t *utcb) L4_NOTHROW
00762 {
00763   l4_msgtag_t t = l4_factory_create_start_u(obj, target, utcb);
00764   return l4_factory_create_commit_u(factory, t, utcb);
00765 }
00766
00767
00768 L4_INLINE l4_msgtag_t
00769 l4_factory_create(l4_cap_idx_t factory, long obj,
00770                   l4_cap_idx_t target) L4_NOTHROW
00771 {
00772   return l4_factory_create_u(factory, obj, target, l4_utcb());
00773 }
```

16.507 l4/sys/icu File Reference

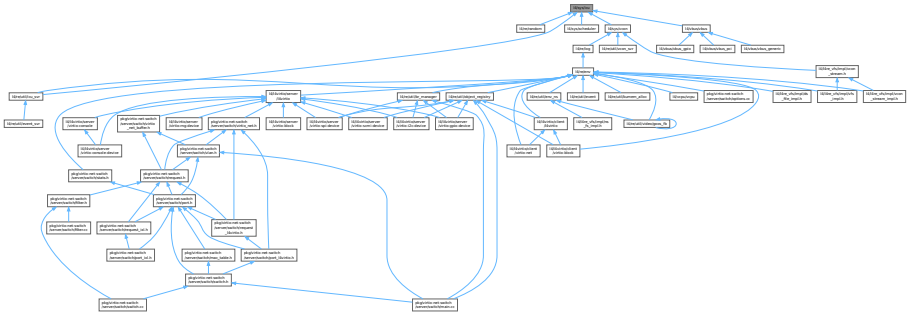
Interrupt controller.

```
#include <l4/sys/irq>
```

Include dependency graph for icu:



This graph shows which files directly or indirectly include this file:



16.507.1 Detailed Description

Interrupt controller.
Definition in file icu.

16.508 icu

Go to the documentation of this file.

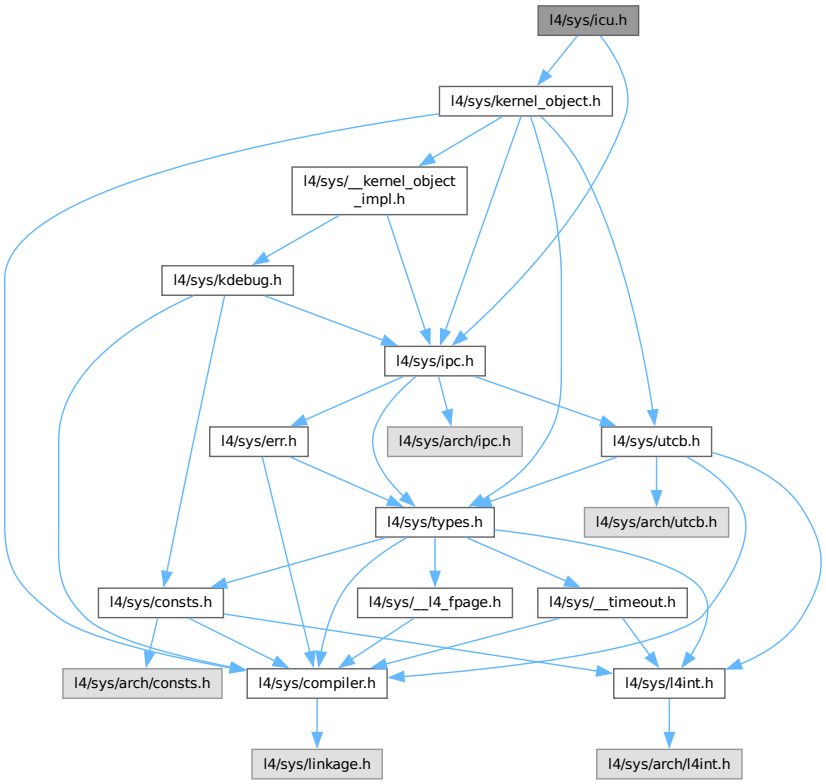
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00007 /*
00008  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
```

```
00013 #pragma once
00014
00015 #include <l4/sys/irq>
```

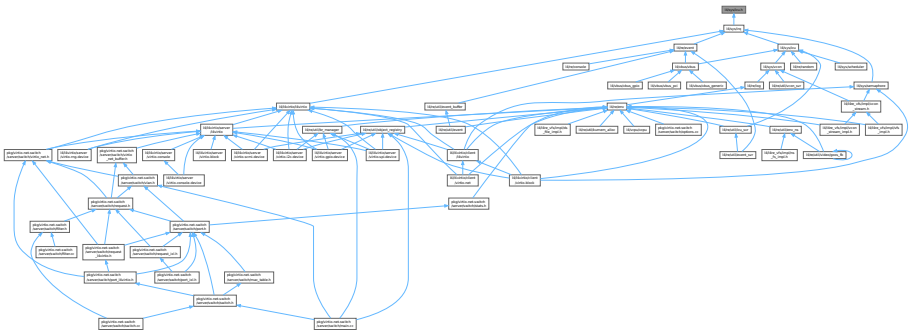
16.509 l4/sys/icu.h File Reference

Interrupt controller.

`#include <l4/sys/kernel_object.h>`
`#include <l4/sys/ipc.h>`
Include dependency graph for icu.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4_icu_info_t

Info structure for an ICU.

- struct l4_icu_msi_info_t

  Info to use for a specific MSI.

Typedefs

- typedef struct l4_icu_info_t l4_icu_info_t

  Info structure for an ICU.

- typedef struct l4_icu_msi_info_t **l4_icu_msi_info_t**

  Info to use for a specific MSI.

Enumerations

- enum L4_icu_flags { L4_ICU_FLAG_MSI }

  Flags for IRQ numbers used for the ICU.

- enum L4_irq_mode {
  L4_IRQ_F_NONE = 0 , L4_IRQ_F_SET_MODE = 0x1 , L4_IRQ_F_LEVEL = 0x2 , L4_IRQ_F_EDGE = 0x0 ,
  L4_IRQ_F_POS = 0x0 , L4_IRQ_F_NEG = 0x4 , L4_IRQ_F_BOTH = 0x8 , L4_IRQ_F_LEVEL_HIGH = L4_IRQ_F_SET_MODE | L4_IRQ_F_LEVEL | L4_IRQ_F_POS ,
  L4_IRQ_F_LEVEL_LOW = L4_IRQ_F_SET_MODE | L4_IRQ_F_LEVEL | L4_IRQ_F_NEG , L4_IRQ_F_POS_EDGE = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE | L4_IRQ_F_POS , L4_IRQ_F_NEG_EDGE = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE | L4_IRQ_F_NEG , L4_IRQ_F_BOTH_EDGE = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE | L4_IRQ_F_BOTH ,
  L4_IRQ_F_MASK = 0xf , L4_IRQ_F_SET_WAKEUP = 0x10 , L4_IRQ_F_CLEAR_WAKEUP = 0x20 }

  Interrupt attributes.

- enum L4_icu_opcode {
  L4_ICU_OP_BIND , L4_ICU_OP_UNBIND , L4_ICU_OP_INFO , L4_ICU_OP_MSI_INFO ,
  L4_ICU_OP_UNMASK , L4_ICU_OP_MASK , L4_ICU_OP_SET_MODE }

  Opcodes to the ICU interface.

Functions

- l4_msgtag_t l4_icu_bind (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW

  Bind an interrupt line of an interrupt controller to an interrupt object.

- l4_msgtag_t l4_icu_bind_u (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Bind an interrupt line of an interrupt controller to an interrupt object.

- l4_msgtag_t l4_icu_unbind (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW

  Remove binding of an interrupt line from the interrupt controller object.

- l4_msgtag_t l4_icu_unbind_u (l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq, l4_utcb_t *utcb) L4_NOTHROW

  Remove binding of an interrupt line from the interrupt controller object.

- l4_msgtag_t l4_icu_set_mode (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode) L4_NOTHROW

  Set interrupt mode.

- l4_msgtag_t l4_icu_set_mode_u (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode, l4_utcb_t *utcb) L4_NOTHROW

  Set interrupt mode.

- l4_msgtag_t l4_icu_info (l4_cap_idx_t icu, l4_icu_info_t *info) L4_NOTHROW

  Get information about the ICU features.

- l4_msgtag_t l4_icu_info_u (l4_cap_idx_t icu, l4_icu_info_t *info, l4_utcb_t *utcb) L4_NOTHROW

  Get information about the ICU features.

- l4_msgtag_t l4_icu_msi_info (l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info) L4_NOTHROW

  Get MSI info about IRQ.

- l4_msgtag_t l4_icu_msi_info_u (l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source, l4_icu_msi_info_t *msi_info, l4_utcb_t *utcb) L4_NOTHROW

  Get MSI info about IRQ.
- l4_msgtag_t l4_icu_unmask (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to) L4_NOTHROW

  Unmask an IRQ line.
- l4_msgtag_t l4_icu_unmask_u (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW

  Unmask the given interrupt line.
- l4_msgtag_t l4_icu_mask (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to) L4_NOTHROW

  Mask an IRQ line.
- l4_msgtag_t l4_icu_mask_u (l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label, l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW

  Mask an IRQ line.

16.509.1 Detailed Description

Interrupt controller.
Definition in file icu.h.

16.510 icu.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/kernel_object.h>
00017 #include <l4/sys/ipc.h>
00018
00047
00048
00053 enum L4_icu_flags
00054 {
00062   L4_ICU_FLAG_MSI = 0x80000000,
00063 };
00064
00065
00070 enum L4_irq_mode
00071 {
00073   L4_IRQ_F_NONE         = 0,
00074   L4_IRQ_F_SET_MODE     = 0x1,
00075   L4_IRQ_F_LEVEL        = 0x2,
00076   L4_IRQ_F_EDGE         = 0x0,
00077   L4_IRQ_F_POS          = 0x0,
00078   L4_IRQ_F_NEG          = 0x4,
00079   L4_IRQ_F_BOTH         = 0x8,
00080   L4_IRQ_F_LEVEL_HIGH   = L4_IRQ_F_SET_MODE | L4_IRQ_F_LEVEL | L4_IRQ_F_POS,
00081   L4_IRQ_F_LEVEL_LOW    = L4_IRQ_F_SET_MODE | L4_IRQ_F_LEVEL | L4_IRQ_F_NEG,
00082   L4_IRQ_F_POS_EDGE     = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE  | L4_IRQ_F_POS,
00083   L4_IRQ_F_NEG_EDGE     = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE  | L4_IRQ_F_NEG,
00084   L4_IRQ_F_BOTH_EDGE    = L4_IRQ_F_SET_MODE | L4_IRQ_F_EDGE  | L4_IRQ_F_BOTH,
00085   L4_IRQ_F_MASK         = 0xf,
00086
00088   L4_IRQ_F_SET_WAKEUP   = 0x10,
00089   L4_IRQ_F_CLEAR_WAKEUP = 0x20,
00090 };
00091
00092
00097 enum L4_icu_opcode
00098 {
00104   L4_ICU_OP_BIND = 0,
00105
00111   L4_ICU_OP_UNBIND = 1,
```

```
00112
00118   L4_ICU_OP_INFO = 2,
00119
00125   L4_ICU_OP_MSI_INFO = 3,
00126
00132   L4_ICU_OP_UNMASK   = 4,
00133
00139   L4_ICU_OP_MASK     = 5,
00140
00146   L4_ICU_OP_SET_MODE = 6,
00147 };
00148
00149 enum L4_icu_ctl_op
00150 {
00151   L4_ICU_CTL_UNMASK = 0,
00152   L4_ICU_CTL_MASK   = 1
00153 };
00154
00155
00163 typedef struct l4_icu_info_t
00164 {
00170   unsigned features;
00171
00175   unsigned nr_irqs;
00176
00180   unsigned nr_msis;
00181 } l4_icu_info_t;
00182
00184 typedef struct l4_icu_msi_info_t
00185 {
00187   l4_uint64_t msi_addr;
00189   l4_uint32_t msi_data;
00190 } l4_icu_msi_info_t;
00191
00219 L4_INLINE l4_msgtag_t
00220 l4_icu_bind(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW;
00221
00228 L4_INLINE l4_msgtag_t
00229 l4_icu_bind_u(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq,
00230               l4_utcb_t *utcb) L4_NOTHROW;
00231
00242 L4_INLINE l4_msgtag_t
00243 l4_icu_unbind(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW;
00244
00251 L4_INLINE l4_msgtag_t
00252 l4_icu_unbind_u(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq,
00253                 l4_utcb_t *utcb) L4_NOTHROW;
00254
00265 L4_INLINE l4_msgtag_t
00266 l4_icu_set_mode(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode) L4_NOTHROW;
00267
00274 L4_INLINE l4_msgtag_t
00275 l4_icu_set_mode_u(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode,
00276                   l4_utcb_t *utcb) L4_NOTHROW;
00277
00286 L4_INLINE l4_msgtag_t
00287 l4_icu_info(l4_cap_idx_t icu, l4_icu_info_t *info) L4_NOTHROW;
00288
00295 L4_INLINE l4_msgtag_t
00296 l4_icu_info_u(l4_cap_idx_t icu, l4_icu_info_t *info,
00297               l4_utcb_t *utcb) L4_NOTHROW;
00298
00305 L4_INLINE l4_msgtag_t
00306 l4_icu_msi_info(l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source,
00307                 l4_icu_msi_info_t *msi_info) L4_NOTHROW;
00308
00315 L4_INLINE l4_msgtag_t
00316 l4_icu_msi_info_u(l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source,
00317                   l4_icu_msi_info_t *msi_info, l4_utcb_t *utcb) L4_NOTHROW;
00318
00319
00337 L4_INLINE l4_msgtag_t
00338 l4_icu_unmask(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00339               l4_timeout_t to) L4_NOTHROW;
00340
00347 L4_INLINE l4_msgtag_t
00348 l4_icu_unmask_u(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00349                 l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW;
00350
00368 L4_INLINE l4_msgtag_t
00369 l4_icu_mask(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00370             l4_timeout_t to) L4_NOTHROW;
00371
00378 L4_INLINE l4_msgtag_t
00379 l4_icu_mask_u(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00380               l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW;
00381
```

```
00385 L4_INLINE l4_msgtag_t
00386 l4_icu_control_u(l4_cap_idx_t icu, unsigned irqnum, unsigned op,
00387                  l4_umword_t *label,l4_timeout_t to,
00388                  l4_utcb_t *utcb) L4_NOTHROW;
00389
00390
00391 /*****************************************************************************
00392  * Implementations
00393  */
00394
00395 L4_INLINE l4_msgtag_t
00396 l4_icu_bind_u(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq,
00397               l4_utcb_t *utcb) L4_NOTHROW
00398 {
00399   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00400   m->mr[0] = L4_ICU_OP_BIND;
00401   m->mr[1] = irqnum;
00402   m->mr[2] = l4_map_obj_control(0, 0);
00403   m->mr[3] = l4_obj_fpage(irq, 0, L4_CAP_FPAGE_RWS).raw;
00404   return l4_ipc_call(icu, utcb, l4_msgtag(L4_PROTO_IRQ, 2, 1, 0), L4_IPC_NEVER);
00405 }
00406
00407 L4_INLINE l4_msgtag_t
00408 l4_icu_unbind_u(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq,
00409                 l4_utcb_t *utcb) L4_NOTHROW
00410 {
00411   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00412   m->mr[0] = L4_ICU_OP_UNBIND;
00413   m->mr[1] = irqnum;
00414   m->mr[2] = l4_map_obj_control(0, 0);
00415   m->mr[3] = l4_obj_fpage(irq, 0, L4_CAP_FPAGE_RWS).raw;
00416   return l4_ipc_call(icu, utcb, l4_msgtag(L4_PROTO_IRQ, 2, 1, 0), L4_IPC_NEVER);
00417 }
00418
00419 L4_INLINE l4_msgtag_t
00420 l4_icu_info_u(l4_cap_idx_t icu, l4_icu_info_t *info,
00421               l4_utcb_t *utcb) L4_NOTHROW
00422 {
00423   l4_msgtag_t res;
00424   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00425   m->mr[0] = L4_ICU_OP_INFO;
00426   res = l4_ipc_call(icu, utcb, l4_msgtag(L4_PROTO_IRQ, 1, 0, 0), L4_IPC_NEVER);
00427   info->features = m->mr[0];
00428   info->nr_irqs  = m->mr[1];
00429   info->nr_msis  = m->mr[2];
00430   return res;
00431 }
00432
00433 L4_INLINE l4_msgtag_t
00434 l4_icu_msi_info_u(l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source,
00435                   l4_icu_msi_info_t *msi_info, l4_utcb_t *utcb) L4_NOTHROW
00436 {
00437   l4_msgtag_t res;
00438   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00439   m->mr[0] = L4_ICU_OP_MSI_INFO;
00440   m->mr[1] = irqnum;
00441   m->mr64[l4_utcb_mr64_idx(2)] = source;
00442   res = l4_ipc_call(icu, utcb, l4_msgtag(L4_PROTO_IRQ,
00443                                          2 + 1 * sizeof(l4_uint64_t)
00444                                                / sizeof(l4_umword_t),
00445                                          0, 0), L4_IPC_NEVER);
00446   if (L4_UNLIKELY(l4_msgtag_has_error(res)))
00447     return res;
00448
00449   if (L4_UNLIKELY(l4_msgtag_words(res) * sizeof(l4_umword_t) < sizeof(*msi_info)))
00450     return res;
00451
00452   __builtin_memcpy(msi_info, &m->mr[0], sizeof(*msi_info));
00453   return res;
00454 }
00455
00456 L4_INLINE l4_msgtag_t
00457 l4_icu_set_mode_u(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode,
00458                   l4_utcb_t *utcb) L4_NOTHROW
00459 {
00460   l4_msg_regs_t *mr = l4_utcb_mr_u(utcb);
00461   mr->mr[0] = L4_ICU_OP_SET_MODE;
00462   mr->mr[1] = irqnum;
00463   mr->mr[2] = mode;
00464   return l4_ipc_call(icu, utcb, l4_msgtag(L4_PROTO_IRQ, 3, 0, 0), L4_IPC_NEVER);
00465 }
00466
00467 L4_INLINE l4_msgtag_t
00468 l4_icu_control_u(l4_cap_idx_t icu, unsigned irqnum, unsigned op,
00469                  l4_umword_t *label, l4_timeout_t to,
00470                  l4_utcb_t *utcb) L4_NOTHROW
00471 {
```

```
00472   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00473   m->mr[0] = L4_ICU_OP_UNMASK + op;
00474   m->mr[1] = irqnum;
00475   if (label)
00476     return l4_ipc_send_and_wait(icu, utcb, l4_msgtag(L4_PROTO_IRQ, 2, 0, 0),
00477                                 label, to);
00478   else
00479     return l4_ipc_send(icu, utcb, l4_msgtag(L4_PROTO_IRQ, 2, 0, 0), to);
00480 }
00481
00482 L4_INLINE l4_msgtag_t
00483 l4_icu_mask_u(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00484               l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW
00485 { return l4_icu_control_u(icu, irqnum, L4_ICU_CTL_MASK, label, to, utcb); }
00486
00487 L4_INLINE l4_msgtag_t
00488 l4_icu_unmask_u(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00489                 l4_timeout_t to, l4_utcb_t *utcb) L4_NOTHROW
00490 { return l4_icu_control_u(icu, irqnum, L4_ICU_CTL_UNMASK, label, to, utcb); }
00491
00492
00493
00494
00495 L4_INLINE l4_msgtag_t
00496 l4_icu_bind(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW
00497 { return l4_icu_bind_u(icu, irqnum, irq, l4_utcb()); }
00498
00499 L4_INLINE l4_msgtag_t
00500 l4_icu_unbind(l4_cap_idx_t icu, unsigned irqnum, l4_cap_idx_t irq) L4_NOTHROW
00501 { return l4_icu_unbind_u(icu, irqnum, irq, l4_utcb()); }
00502
00503 L4_INLINE l4_msgtag_t
00504 l4_icu_info(l4_cap_idx_t icu, l4_icu_info_t *info) L4_NOTHROW
00505 { return l4_icu_info_u(icu, info, l4_utcb()); }
00506
00507 L4_INLINE l4_msgtag_t
00508 l4_icu_msi_info(l4_cap_idx_t icu, unsigned irqnum, l4_uint64_t source,
00509                 l4_icu_msi_info_t *msi_info) L4_NOTHROW
00510 { return l4_icu_msi_info_u(icu, irqnum, source, msi_info, l4_utcb()); }
00511
00512 L4_INLINE l4_msgtag_t
00513 l4_icu_unmask(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00514               l4_timeout_t to) L4_NOTHROW
00515 { return l4_icu_control_u(icu, irqnum, L4_ICU_CTL_UNMASK, label, to, l4_utcb()); }
00516
00517 L4_INLINE l4_msgtag_t
00518 l4_icu_mask(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t *label,
00519             l4_timeout_t to) L4_NOTHROW
00520 { return l4_icu_control_u(icu, irqnum, L4_ICU_CTL_MASK, label, to, l4_utcb()); }
00521
00522 L4_INLINE l4_msgtag_t
00523 l4_icu_set_mode(l4_cap_idx_t icu, unsigned irqnum, l4_umword_t mode) L4_NOTHROW
00524 {
00525   return l4_icu_set_mode_u(icu, irqnum, mode, l4_utcb());
00526 }
```

16.511 iommu

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /* \file
00003  * IO-MMU interface description.
00004  */
00005 #pragma once
00006
00007 #include <l4/sys/cxx/ipc_iface>
00008
00009 namespace L4 {
00021 class Iommu :
00022   public Kobject_x<Iommu, Proto_t<L4_PROTO_IOMMU>, Type_info::Demand_t<1> >
00023 {
00024 public:
00044   L4_INLINE_RPC(
00045       l4_msgtag_t, bind, (l4_uint64_t src_id, Ipc::Cap<Task> dma_space,
00046                           l4_uint64_t *min_addr, l4_uint64_t *max_addr));
00047
00058   L4_INLINE_RPC(
00059       l4_msgtag_t, unbind, (l4_uint64_t src_id, Ipc::Cap<Task> dma_space));
00060
00061   typedef Typeid::Rpcs_code<l4_umword_t>::F<bind_t, unbind_t> Rpcs;
00062 };
00063
00064 }
```

16.512 ipc.h

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>,
00010  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #ifndef __L4SYS__INCLUDE__ARCH_AMD64__L4API_L4F__IPC_H__
00016 #define __L4SYS__INCLUDE__ARCH_AMD64__L4API_L4F__IPC_H__
00017
00018 L4_INLINE l4_msgtag_t
00019 l4_ipc(l4_cap_idx_t dest, l4_utcb_t *utcb,
00020        l4_umword_t flags,
00021        l4_umword_t slabel,
00022        l4_msgtag_t tag,
00023        l4_umword_t *rlabel,
00024        l4_timeout_t timeout) L4_NOTHROW
00025 {
00026   l4_umword_t dummy, dummy2;
00027   register l4_umword_t to __asm__("r8") = timeout.raw;
00028
00029   (void)utcb;
00030
00031   __asm__ __volatile__
00032     ("syscall"
00033      :
00034      "=d" (dummy2),
00035      "=S" (slabel),
00036      "=D" (dummy),
00037      "=a" (tag.raw)
00038      :
00039      "S" (slabel),
00040      "r" (to),
00041      "a" (tag.raw),
00042      "d" (dest | flags)
00043      :
00044      "memory", "cc", "rcx", "r11", "r15"
00045      );
00046
00047   if (rlabel)
00048     *rlabel = slabel;
00049
00050   return tag;
00051 }
00052
00053 #endif /* ! __L4SYS__INCLUDE__ARCH_AMD64__L4API_L4F__IPC_H__ */
```

16.513 ipc.h

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/compiler.h>
00016 #include <l4/sys/syscall_defs.h>
00017
00018 L4_INLINE l4_msgtag_t
00019 l4_ipc(l4_cap_idx_t dest, l4_utcb_t *utcb,
00020        l4_umword_t flags,
00021        l4_umword_t slabel,
00022        l4_msgtag_t tag,
00023        l4_umword_t *rlabel,
00024        l4_timeout_t timeout) L4_NOTHROW
00025 {
00026   register l4_umword_t _dest     __asm__("r2") = dest | flags;
00027   register l4_umword_t _timeout  __asm__("r3") = timeout.raw;
00028   register l4_mword_t _tag       __asm__("r0") = tag.raw;
00029   register l4_umword_t _label    __asm__("r4") = slabel;
00030   (void)utcb;
00031
00032   __asm__ __volatile__
00033     (".type __l4_sys_syscall, #function\n"
```

```
00034       "mov r5, %[sc]          \n"
00035       "blx __l4_sys_syscall   \n"
00036       :
00037       "+r" (_dest),
00038       "+r" (_timeout),
00039       "+r" (_label),
00040       "+r" (_tag)
00041       :
00042       [sc] "i" (L4_SYSCALL_INVOKE)
00043       :
00044       "cc", "memory", "r5", "ip", "lr");
00045
00046   if (rlabel)
00047     *rlabel = _label;
00048   tag.raw = _tag;
00049
00050   return tag;
00051 }
```

16.514 ipc.h

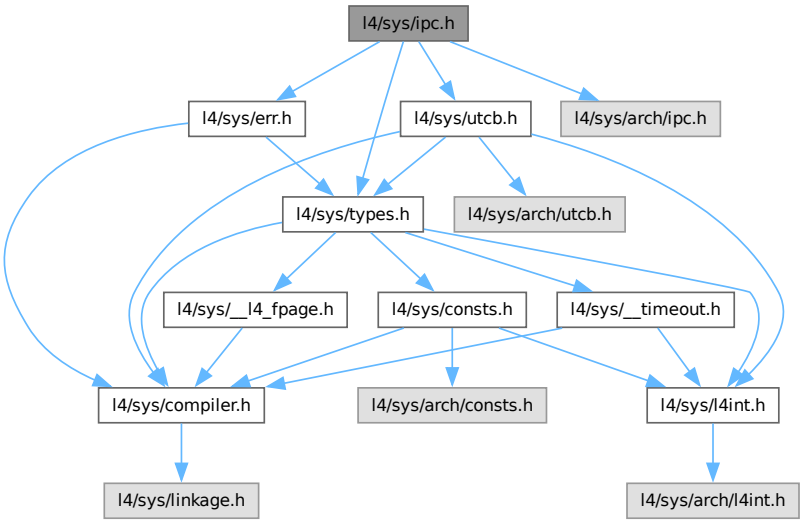
```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/compiler.h>
00016
00017 L4_BEGIN_DECLS
00018
00019 struct __l4_sys_syscall_res
00020 {
00021   l4_mword_t tag;
00022   l4_umword_t label;
00023 };
00024
00025 extern struct __l4_sys_syscall_res
00026 __l4_sys_syscall(l4_mword_t tag,
00027                  l4_umword_t slabel,
00028                  l4_umword_t dest,
00029                  l4_umword_t timeout) L4_NOTHROW;
00030
00031 L4_END_DECLS
00032
00033 L4_INLINE l4_msgtag_t
00034 l4_ipc(l4_cap_idx_t dest, l4_utcb_t *utcb,
00035        l4_umword_t flags,
00036        l4_umword_t slabel,
00037        l4_msgtag_t tag,
00038        l4_umword_t *rlabel,
00039        l4_timeout_t timeout) L4_NOTHROW
00040 {
00041   // No need for memory clobbers. The compiler has to assume that all global
00042   // data is read/written because __l4_sys_syscall is implemented in a
00043   // different translation unit.
00044   struct __l4_sys_syscall_res res
00045     = __l4_sys_syscall(tag.raw, slabel, dest | flags, timeout.raw);
00046
00047   (void)utcb;
00048
00049   if (rlabel)
00050     *rlabel = res.label;
00051   tag.raw = res.tag;
00052
00053   return tag;
00054 }
```

16.515 l4/sys/ipc.h File Reference

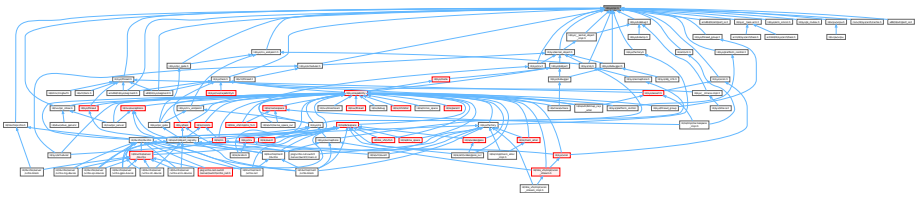
Common IPC interface.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/err.h>
#include <l4/sys/arch/ipc.h>
```

Include dependency graph for ipc.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum l4_ipc_tcr_error_t {
  L4_IPC_ERROR_MASK = 0x1F , L4_IPC_SND_ERR_MASK = 0x01 , L4_IPC_ENOT_EXISTENT = 0x04 ,
  L4_IPC_RETIMEOUT = 0x03 ,
  L4_IPC_SETIMEOUT = 0x02 , L4_IPC_RECANCELED = 0x07 , L4_IPC_SECANCELED = 0x06 ,
  L4_IPC_REMAPFAILED = 0x11 ,
  L4_IPC_SEMAPFAILED = 0x10 , L4_IPC_RESNDPFTO = 0x0b , L4_IPC_SESNDPFTO = 0x0a ,
  L4_IPC_RERCVPFTO = 0x0d ,
  L4_IPC_SERCVPFTO = 0x0c , L4_IPC_REABORTED = 0x0f , L4_IPC_SEABORTED = 0x0e ,
  L4_IPC_REMSGCUT = 0x09 ,
  L4_IPC_SEMSGCUT = 0x08 , L4_IPC_NO_REPLY_CAP = 0x13 }

  Error codes in the error TCR.

Functions

- l4_umword_t l4_ipc_error (l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW

  Get the IPC error code for an IPC operation.
- l4_ret_t l4_error (l4_msgtag_t tag) L4_NOTHROW

  Get IPC error code if any or message tag label otherwise for an IPC call.
- int l4_ipc_is_snd_error (l4_utcb_t *utcb) L4_NOTHROW

  Returns whether an error occurred in send phase of an invocation.
- int l4_ipc_is_rcv_error (l4_utcb_t *utcb) L4_NOTHROW

Returns whether an error occurred in receive phase of an invocation.

- int l4_ipc_error_code (l4_utcb_t *utcb) L4_NOTHROW

  Get the error condition of the last invocation from the TCR.

- L4_CONSTEXPR l4_ret_t l4_ipc_to_errno (unsigned long ipc_error_code) L4_NOTHROW

  Get a negative error code for the given IPC error code.

- l4_msgtag_t l4_ipc_send (l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag, l4_timeout_t timeout) L4_NOTHROW

  *Send a message to an object (do **not** wait for a reply).*

- l4_msgtag_t l4_ipc_wait_ext (l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Wait for an incoming message from any possible sender.

- l4_msgtag_t **l4_ipc_wait** (l4_utcb_t *utcb, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Same as l4_ipc_wait_ext() with `reply_cap` set to L4_INVALID_CAP to specify the implicit reply capability.

- l4_msgtag_t l4_ipc_receive (l4_cap_idx_t object, l4_utcb_t *utcb, l4_timeout_t timeout) L4_NOTHROW

  Wait for a message from a specific source.

- l4_msgtag_t l4_ipc_call (l4_cap_idx_t object, l4_utcb_t *utcb, l4_msgtag_t tag, l4_timeout_t timeout) L4_NOTHROW

  Object call (usual invocation).

- l4_msgtag_t l4_ipc_reply (l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_msgtag_t tag, l4_timeout_t timeout) L4_NOTHROW

  Reply operation (uses a reply capability).

- l4_msgtag_t l4_ipc_reply_and_wait_ext (l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_msgtag_t tag, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Reply and wait operation (uses the reply capability).

- l4_msgtag_t **l4_ipc_reply_and_wait** (l4_utcb_t *utcb, l4_msgtag_t tag, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Same as l4_ipc_reply_and_wait_ext() with `reply_cap` set to L4_INVALID_CAP to specify the implicit reply capability.

- l4_msgtag_t l4_ipc_send_and_wait (l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag, l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW

  Send a message and do an open wait.

- l4_msgtag_t l4_ipc (l4_cap_idx_t dest, l4_utcb_t *utcb, l4_umword_t flags, l4_umword_t slabel, l4_msgtag_t tag, l4_umword_t *rlabel, l4_timeout_t timeout) L4_NOTHROW

  Generic L4 object invocation.

- l4_msgtag_t l4_ipc_sleep (l4_timeout_t timeout) L4_NOTHROW

  Sleep for an amount of time.

- l4_msgtag_t l4_ipc_sleep_ms (l4_uint32_t ms) L4_NOTHROW

  Sleep for a certain amount of milliseconds.

- l4_msgtag_t l4_ipc_sleep_us (l4_uint64_t us) L4_NOTHROW

  Sleep for a certain amount of microseconds.

- int l4_sndfpage_add (l4_fpage_t const snd_fpage, unsigned long snd_base, l4_msgtag_t *tag) L4_NOTHROW

  Add a flexpage to be sent to the UTCB.

16.515.1 Detailed Description

Common IPC interface.
Definition in file ipc.h.

16.515.2 Function Documentation

16.515.2.1 l4_ipc_to_errno()

```
L4_CONSTEXPR l4_ret_t l4_ipc_to_errno (
            unsigned long ipc_error_code)  [inline]
```

Get a negative error code for the given IPC error code.

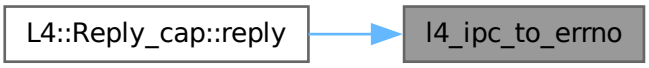
Parameters

ipc_error_code	IPC error code as delivered by the kernel. (or returned by the l4_ipc_error_code() function).

Returns

negative error code in the range of L4_EIPC_LO to L4_EIPC_HI.

Definition at line 621 of file ipc.h.
References L4_EIPC_LO, and L4_NOTHROW.
Referenced by L4::Reply_cap::reply().
Here is the caller graph for this function:



16.516 ipc.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00010  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #ifndef __L4SYS__INCLUDE__L4API_FIASCO__IPC_H__
00016 #define __L4SYS__INCLUDE__L4API_FIASCO__IPC_H__
00017
00018 #include <l4/sys/types.h>
00019 #include <l4/sys/utcb.h>
00020 #include <l4/sys/err.h>
00021
00061
00062 /*****************************************************************************
00063  *** IPC result checking
00064  *****************************************************************************/
00065
00073
00081 enum l4_ipc_tcr_error_t
00082 {
00083   L4_IPC_ERROR_MASK       = 0x1F,
00084   L4_IPC_SND_ERR_MASK     = 0x01,
00085
00086   L4_IPC_ENOT_EXISTENT    = 0x04,
00089   L4_IPC_RETIMEOUT        = 0x03,
00092   L4_IPC_SETIMEOUT        = 0x02,
00095   L4_IPC_RECANCELED       = 0x07,
00098   L4_IPC_SECANCELED       = 0x06,
00101   L4_IPC_REMAPFAILED      = 0x11,
00105   L4_IPC_SEMAPFAILED      = 0x10,
00108   L4_IPC_RESNDPFTO        = 0x0b,
```

```
00112   L4_IPC_SESNDPFTO        = 0x0a,
00116   L4_IPC_RERCVPFTO        = 0x0d,
00120   L4_IPC_SERCVPFTO        = 0x0c,
00124   L4_IPC_REABORTED        = 0x0f,
00127   L4_IPC_SEABORTED        = 0x0e,
00136   L4_IPC_REMSGCUT         = 0x09,
00137
00143   L4_IPC_SEMSGCUT         = 0x08,
00144
00150   L4_IPC_NO_REPLY_CAP     = 0x13,
00151 };
00152
00153
00164 L4_INLINE l4_umword_t
00165 l4_ipc_error(l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW;
00166
00167
00184 L4_INLINE l4_ret_t
00185 l4_error(l4_msgtag_t tag) L4_NOTHROW;
00186
00187 L4_INLINE l4_ret_t
00188 l4_error_u(l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW;
00189
00190 /*****************************************************************************
00191  *** IPC results
00192  *****************************************************************************/
00193
00203 L4_INLINE int l4_ipc_is_snd_error(l4_utcb_t *utcb) L4_NOTHROW;
00204
00214 L4_INLINE int l4_ipc_is_rcv_error(l4_utcb_t *utcb) L4_NOTHROW;
00215
00225 L4_INLINE int l4_ipc_error_code(l4_utcb_t *utcb) L4_NOTHROW;
00226
00233 L4_CONSTEXPR L4_INLINE l4_ret_t
00234 l4_ipc_to_errno(unsigned long ipc_error_code) L4_NOTHROW;
00235
00236
00237 /*****************************************************************************
00238  *** IPC calls
00239  *****************************************************************************/
00240
00269 L4_INLINE l4_msgtag_t
00270 l4_ipc_send(l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag,
00271             l4_timeout_t timeout) L4_NOTHROW;
00272
00273
00303 L4_INLINE l4_msgtag_t
00304 l4_ipc_wait_ext(l4_cap_idx_t reply_cap,
00305                 l4_utcb_t *utcb, l4_umword_t *label,
00306                 l4_timeout_t timeout) L4_NOTHROW;
00307
00313 L4_INLINE l4_msgtag_t
00314 l4_ipc_wait(l4_utcb_t *utcb, l4_umword_t *label,
00315             l4_timeout_t timeout) L4_NOTHROW;
00316
00317
00344 L4_INLINE l4_msgtag_t
00345 l4_ipc_receive(l4_cap_idx_t object, l4_utcb_t *utcb,
00346                l4_timeout_t timeout) L4_NOTHROW;
00347
00378 L4_INLINE l4_msgtag_t
00379 l4_ipc_call(l4_cap_idx_t object, l4_utcb_t *utcb, l4_msgtag_t tag,
00380             l4_timeout_t timeout) L4_NOTHROW;
00381
00401 L4_INLINE l4_msgtag_t
00402 l4_ipc_reply(l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_msgtag_t tag,
00403              l4_timeout_t timeout) L4_NOTHROW;
00404
00433 L4_INLINE l4_msgtag_t
00434 l4_ipc_reply_and_wait_ext(l4_cap_idx_t reply_cap,
00435                           l4_utcb_t *utcb, l4_msgtag_t tag,
00436                           l4_umword_t *label,
00437                           l4_timeout_t timeout) L4_NOTHROW;
00438
00444 L4_INLINE l4_msgtag_t
00445 l4_ipc_reply_and_wait(l4_utcb_t *utcb, l4_msgtag_t tag,
00446                       l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW;
00447
00476 L4_INLINE l4_msgtag_t
00477 l4_ipc_send_and_wait(l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag,
00478                      l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW;
00479
00485
00486 #if 0
00497 L4_INLINE l4_msgtag_t
00498 l4_ipc_wait_next_period(l4_utcb_t *utcb,
00499                         l4_umword_t *label,
```

```
00500                         l4_timeout_t timeout);
00501
00502 #endif
00503
00523 L4_ALWAYS_INLINE l4_msgtag_t
00524 l4_ipc(l4_cap_idx_t dest,
00525        l4_utcb_t *utcb,
00526        l4_umword_t flags,
00527        l4_umword_t slabel,
00528        l4_msgtag_t tag,
00529        l4_umword_t *rlabel,
00530        l4_timeout_t timeout) L4_NOTHROW;
00531
00548 L4_INLINE l4_msgtag_t
00549 l4_ipc_sleep(l4_timeout_t timeout) L4_NOTHROW;
00550
00567 L4_INLINE l4_msgtag_t
00568 l4_ipc_sleep_ms(l4_uint32_t ms) L4_NOTHROW;
00569
00586 L4_INLINE l4_msgtag_t
00587 l4_ipc_sleep_us(l4_uint64_t us) L4_NOTHROW;
00588
00603 L4_INLINE int
00604 l4_sndfpage_add(l4_fpage_t const snd_fpage, unsigned long snd_base,
00605                 l4_msgtag_t *tag) L4_NOTHROW;
00606
00607 /*
00608  * \internal
00609  * \ingroup l4_ipc_api
00610  */
00611 L4_INLINE int
00612 l4_sndfpage_add_u(l4_fpage_t const snd_fpage, unsigned long snd_base,
00613                   l4_msgtag_t *tag, l4_utcb_t *utcb) L4_NOTHROW;
00614
00615
00616 /*****************************************************************************
00617  * Implementations
00618  *****************************/
00619
00620 L4_CONSTEXPR L4_INLINE l4_ret_t
00621 l4_ipc_to_errno(unsigned long ipc_error_code) L4_NOTHROW
00622 { return -(L4_EIPC_LO + ipc_error_code); }
00623
00624 L4_INLINE l4_msgtag_t
00625 l4_ipc_call(l4_cap_idx_t object, l4_utcb_t *utcb, l4_msgtag_t tag,
00626             l4_timeout_t timeout) L4_NOTHROW
00627 {
00628   return l4_ipc(object, utcb, L4_SYSF_CALL, 0, tag, 0, timeout);
00629 }
00630
00631 L4_INLINE l4_msgtag_t
00632 l4_ipc_reply(l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_msgtag_t tag,
00633              l4_timeout_t timeout) L4_NOTHROW
00634 {
00635   return l4_ipc(reply_cap, utcb, L4_SYSF_REPLY | L4_SYSF_SEND, 0, tag, 0,
00636                 timeout);
00637 }
00638
00639 L4_INLINE l4_msgtag_t
00640 l4_ipc_reply_and_wait_ext(l4_cap_idx_t reply_cap,
00641                           l4_utcb_t *utcb,
00642                           l4_msgtag_t tag, l4_umword_t *label,
00643                           l4_timeout_t timeout) L4_NOTHROW
00644 {
00645   return l4_ipc(reply_cap, utcb, L4_SYSF_REPLY_AND_WAIT, 0, tag, label, timeout);
00646 }
00647
00648 L4_INLINE l4_msgtag_t
00649 l4_ipc_reply_and_wait(l4_utcb_t *utcb, l4_msgtag_t tag,
00650                       l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW
00651 {
00652   return l4_ipc_reply_and_wait_ext(L4_INVALID_CAP, utcb, tag, label, timeout);
00653 }
00654
00655 L4_INLINE l4_msgtag_t
00656 l4_ipc_send_and_wait(l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag,
00657                      l4_umword_t *label, l4_timeout_t timeout) L4_NOTHROW
00658 {
00659   return l4_ipc(dest, utcb, L4_SYSF_SEND_AND_WAIT, 0, tag, label, timeout);
00660 }
00661
00662 L4_INLINE l4_msgtag_t
00663 l4_ipc_send(l4_cap_idx_t dest, l4_utcb_t *utcb, l4_msgtag_t tag,
00664             l4_timeout_t timeout) L4_NOTHROW
00665 {
00666   return l4_ipc(dest, utcb, L4_SYSF_SEND, 0, tag, 0, timeout);
00667 }
```

```
00668
00669 L4_INLINE l4_msgtag_t
00670 l4_ipc_wait_ext(l4_cap_idx_t reply_cap, l4_utcb_t *utcb, l4_umword_t *label,
00671                 l4_timeout_t timeout) L4_NOTHROW
00672 {
00673   l4_msgtag_t t;
00674   t.raw = 0;
00675   return l4_ipc(reply_cap, utcb, L4_SYSF_WAIT, 0, t, label, timeout);
00676 }
00677
00678 L4_INLINE l4_msgtag_t
00679 l4_ipc_wait(l4_utcb_t *utcb, l4_umword_t *label,
00680             l4_timeout_t timeout) L4_NOTHROW
00681 {
00682   return l4_ipc_wait_ext(L4_INVALID_CAP, utcb, label, timeout);
00683 }
00684
00685 L4_INLINE l4_msgtag_t
00686 l4_ipc_receive(l4_cap_idx_t object, l4_utcb_t *utcb,
00687                l4_timeout_t timeout) L4_NOTHROW
00688 {
00689   l4_msgtag_t t;
00690   t.raw = 0;
00691   return l4_ipc(object, utcb, L4_SYSF_RECV, 0, t, 0, timeout);
00692 }
00693
00694 L4_INLINE l4_msgtag_t
00695 l4_ipc_sleep(l4_timeout_t timeout) L4_NOTHROW
00696 { return l4_ipc_receive(L4_INVALID_CAP, NULL, timeout); }
00697
00698 L4_INLINE l4_msgtag_t
00699 l4_ipc_sleep_ms(l4_uint32_t ms) L4_NOTHROW
00700 {
00701   l4_uint64_t us = ms * 1000ULL; // cannot overflow because ms < 2^32
00702   return l4_ipc_sleep(l4_timeout(L4_IPC_TIMEOUT_NEVER, l4_timeout_from_us(us)));
00703 }
00704
00705 L4_INLINE l4_msgtag_t
00706 l4_ipc_sleep_us(l4_uint64_t us) L4_NOTHROW
00707 {
00708   return l4_ipc_sleep(l4_timeout(L4_IPC_TIMEOUT_NEVER,
00709                                  l4_timeout_from_us(us)));
00710 }
00711
00712 L4_INLINE l4_umword_t
00713 l4_ipc_error(l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW
00714 {
00715   if (L4_LIKELY(!l4_msgtag_has_error(tag)))
00716     return 0;
00717   return l4_utcb_tcr_u(utcb)->error & L4_IPC_ERROR_MASK;
00718 }
00719
00720 L4_INLINE l4_ret_t
00721 l4_error_u(l4_msgtag_t tag, l4_utcb_t *u) L4_NOTHROW
00722 {
00723   if (L4_UNLIKELY(l4_msgtag_has_error(tag)))
00724     return l4_ipc_to_errno(l4_utcb_tcr_u(u)->error & L4_IPC_ERROR_MASK);
00725
00726   return l4_msgtag_label(tag);
00727 }
00728
00729 L4_INLINE l4_ret_t
00730 l4_error(l4_msgtag_t tag) L4_NOTHROW
00731 {
00732   return l4_error_u(tag, l4_utcb());
00733 }
00734
00735
00736 L4_INLINE int l4_ipc_is_snd_error(l4_utcb_t *u) L4_NOTHROW
00737 { return (l4_utcb_tcr_u(u)->error & 1) == 0; }
00738
00739 L4_INLINE int l4_ipc_is_rcv_error(l4_utcb_t *u) L4_NOTHROW
00740 { return l4_utcb_tcr_u(u)->error & 1; }
00741
00742 L4_INLINE int l4_ipc_error_code(l4_utcb_t *u) L4_NOTHROW
00743 { return l4_utcb_tcr_u(u)->error & L4_IPC_ERROR_MASK; }
00744
00745
00746 /*
00747  * \internal
00748  * \ingroup l4_ipc_api
00749  */
00750 L4_INLINE int
00751 l4_sndfpage_add_u(l4_fpage_t const snd_fpage, unsigned long snd_base,
00752                   l4_msgtag_t *tag, l4_utcb_t *utcb) L4_NOTHROW
00753 {
00754   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
```

```
00755   int i = l4_msgtag_words(*tag) + 2 * l4_msgtag_items(*tag);
00756
00757   if (i >= L4_UTCB_GENERIC_DATA_SIZE - 1)
00758     return -L4_ENOMEM;
00759
00760   v->mr[i]     = snd_base | L4_ITEM_MAP | L4_ITEM_CONT;
00761   v->mr[i + 1] = snd_fpage.raw;
00762
00763   *tag = l4_msgtag(l4_msgtag_label(*tag), l4_msgtag_words(*tag),
00764                    l4_msgtag_items(*tag) + 1, l4_msgtag_flags(*tag));
00765   return 0;
00766 }
00767
00768 L4_INLINE int
00769 l4_sndfpage_add(l4_fpage_t const snd_fpage, unsigned long snd_base,
00770                 l4_msgtag_t *tag) L4_NOTHROW
00771 {
00772   return l4_sndfpage_add_u(snd_fpage, snd_base, tag, l4_utcb());
00773 }
00774
00775 #include <l4/sys/arch/ipc.h>
00776
00777 #endif /* ! __L4SYS__INCLUDE__L4API_FIASCO__IPC_H__ */
```

16.517 ipc.h

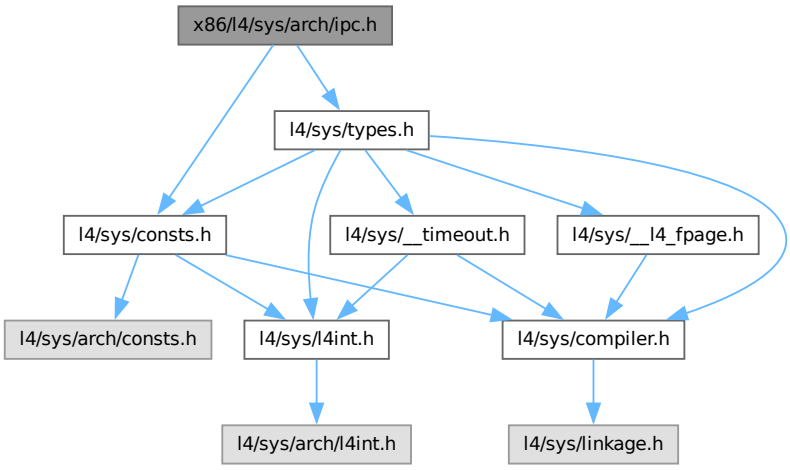
```
00001
00006 /*
00007  * Copyright (C) 2021, 2024-2025 Kernkonzept GmbH.
00008  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/compiler.h>
00015
00016 L4_INLINE l4_msgtag_t
00017 l4_ipc(l4_cap_idx_t dest, l4_utcb_t *utcb,
00018        l4_umword_t flags,
00019        l4_umword_t slabel,
00020        l4_msgtag_t tag,
00021        l4_umword_t *rlabel,
00022        l4_timeout_t timeout) L4_NOTHROW
00023 {
00024   register l4_mword_t _tag       __asm__("a0") = tag.raw;
00025   register l4_umword_t _dest     __asm__("a1") = dest | flags;
00026   register l4_umword_t _timeout  __asm__("a2") = timeout.raw;
00027   register l4_umword_t _label    __asm__("a3") = slabel;
00028   (void)utcb;
00029
00030   __asm__ __volatile__
00031     ("ecall"
00032      :
00033      "+r" (_tag),
00034      "+r" (_dest),
00035      "+r" (_timeout),
00036      "+r" (_label)
00037      :
00038      :
00039      "memory");
00040
00041   if (rlabel)
00042     *rlabel = _label;
00043   tag.raw = _tag;
00044
00045   return tag;
00046 }
```

16.518 x86/l4/sys/arch/ipc.h File Reference

L4 IPC System Calls, x86.

```
#include <l4/sys/types.h>
#include <l4/sys/consts.h>
```

Include dependency graph for ipc.h:



Functions

- l4_msgtag_t l4_ipc (l4_cap_idx_t dest, l4_utcb_t *u, l4_umword_t flags, l4_umword_t slabel, l4_msgtag_t tag, l4_umword_t *rlabel, l4_timeout_t timeout) L4_NOTHROW

  Generic L4 object invocation.

16.518.1 Detailed Description

L4 IPC System Calls, x86.
Definition in file ipc.h.

16.519 ipc.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Lars Reuther <reuther@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #ifndef __L4_IPC_H__
00015 #define __L4_IPC_H__
00016
00017 #include <l4/sys/types.h>
00018 #include <l4/sys/consts.h>
00019
00020 #ifdef __PIC__
00021 # define L4S_PIC_SAVE "push %%ebx; "
00022 # define L4S_PIC_RESTORE "pop %%ebx; "
00023 # define L4S_PIC_CLOBBER
00024 # define L4S_PIC_SYSCALL , [func] "m" (__l4sys_invoke_indirect)
00025 extern void (*__l4sys_invoke_indirect)(void);
00026 # define IPC_SYSENTER      "# indirect sys invoke \n\t" \
00027                            "call *%[func]    \n\t"
00028 # define IPC_SYSENTER_ASM   call __l4sys_invoke_direct@plt
00029 #else
00034 #define IPC_SYSENTER      "call __l4sys_invoke_direct    \n\t"
00039 #define IPC_SYSENTER_ASM   call __l4sys_invoke_direct
00044 #  define L4S_PIC_SAVE
00049 #  define L4S_PIC_RESTORE
00054 #  define L4S_PIC_CLOBBER ,"ebx"
```

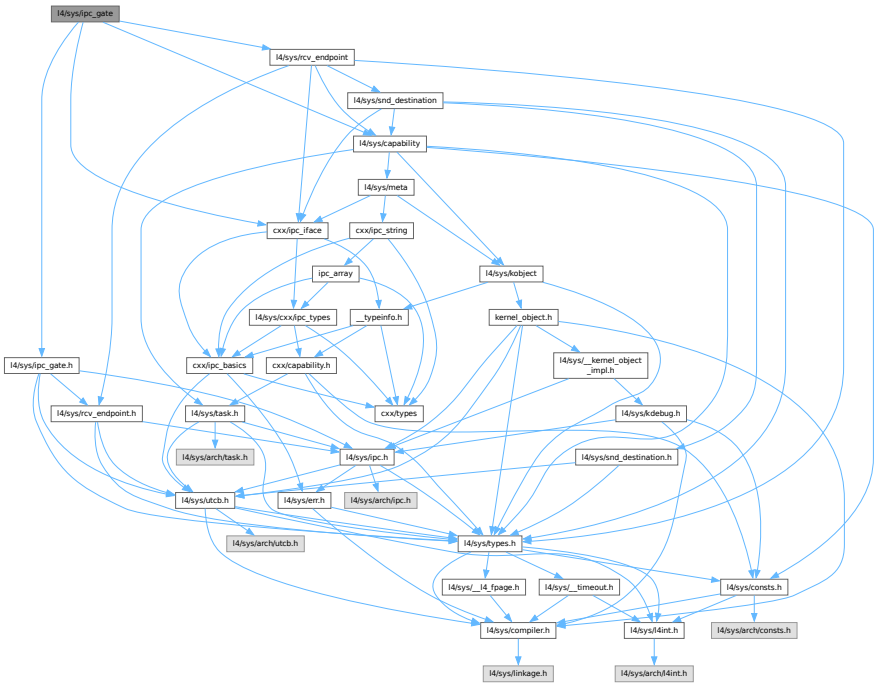
```
00055 #  define L4S_PIC_SYSCALL
00056
00057 #endif
00058
00059 L4_INLINE l4_msgtag_t
00060 l4_ipc(l4_cap_idx_t dest, l4_utcb_t *u,
00061        l4_umword_t flags,
00062        l4_umword_t slabel,
00063        l4_msgtag_t tag,
00064        l4_umword_t *rlabel,
00065        l4_timeout_t timeout) L4_NOTHROW
00066 {
00067   l4_umword_t dummy, dummy1, dummy2;
00068
00069   (void)u;
00070
00071   __asm__ __volatile__
00072     (L4S_PIC_SAVE "push %%ebp; " IPC_SYSENTER " pop %%ebp; " L4S_PIC_RESTORE
00073      :
00074      "=d" (dummy2),
00075      "=S" (slabel),
00076      "=c" (dummy1),
00077      "=D" (dummy),
00078      "=a" (tag.raw)
00079      :
00080      "S" (slabel),
00081      "c" (timeout),
00082      "a" (tag.raw),
00083      "d" (dest | flags)
00084      L4S_PIC_SYSCALL
00085      :
00086      "memory", "cc" L4S_PIC_CLOBBER
00087      );
00088
00089   if (rlabel)
00090     *rlabel = slabel;
00091
00092   return tag;
00093 }
00094
00095 #endif /* !__L4_IPC_H__ */
```

16.520 l4/sys/ipc_gate File Reference

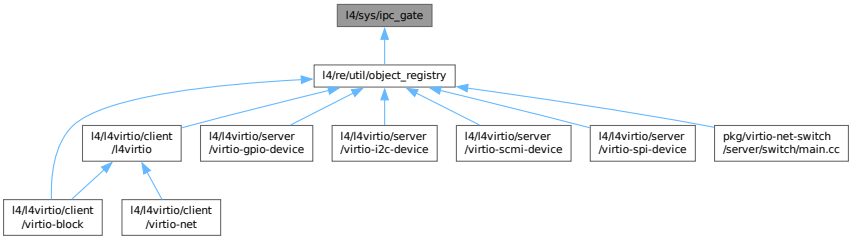
The C++ IPC gate interface.

```
#include <l4/sys/ipc_gate.h>
#include <l4/sys/capability>
#include <l4/sys/rcv_endpoint>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for ipc_gate:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Ipc_gate

  The C++ IPC gate interface, see IPC-Gate API for the C interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.520.1 Detailed Description

The C++ IPC gate interface.
Definition in file ipc_gate.

16.521 ipc_gate

Go to the documentation of this file.

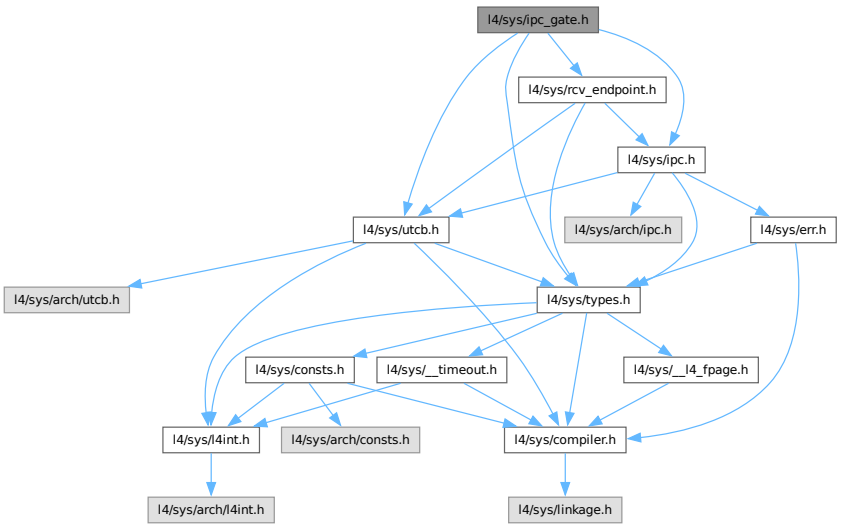
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2009-2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/ipc_gate.h>
00016 #include <l4/sys/capability>
00017 #include <l4/sys/rcv_endpoint>
00018 #include <l4/sys/cxx/ipc_iface>
00019
00020 namespace L4 {
00021
00022 class Thread;
00023
00085 class L4_EXPORT Ipc_gate :
00086   public Kobject_t<Ipc_gate, Rcv_endpoint, L4_PROTO_KOBJECT,
00087                    Type_info::Demand_t<1> >
00088 {
00089 public:
00103   L4_INLINE_RPC_OP(L4_IPC_GATE_GET_INFO_OP,
00104       l4_msgtag_t, get_infos, (l4_umword_t *label));
00105
00106   typedef L4::Typeid::Rpcs_sys<bind_thread_t, get_infos_t> Rpcs;
00107 };
00108
00109 }
```

16.522 l4/sys/ipc_gate.h File Reference

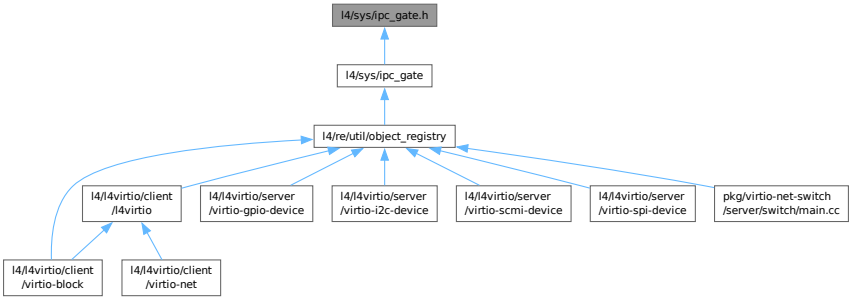
The C IPC gate interface, see L4::Ipc_gate for the C++ interface.

```
#include <l4/sys/utcb.h>
#include <l4/sys/types.h>
#include <l4/sys/rcv_endpoint.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for ipc_gate.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum L4_ipc_gate_ops { L4_IPC_GATE_BIND_OP = 0x10 , L4_IPC_GATE_GET_INFO_OP = 0x11 }

  Operations on the IPC-gate.

Functions

- l4_msgtag_t l4_ipc_gate_get_infos (l4_cap_idx_t gate, l4_umword_t *label)

  Get information about the IPC-gate.

16.522.1 Detailed Description

The C IPC gate interface, see L4::Ipc_gate for the C++ interface.
IPC gates are used to create secure communication channels between protection domains. An IPC gate can be created using the Factory interface.
Depending on the permissions of the capability used, an IPC gate forwards IPC to the Thread the IPC gate is *bound* to (cf. l4_rcv_ep_bind_thread() and l4_rcv_ep_bind_snd_destination()). If the capability has the L4_FPAGE_C_IPCGATE_SVR permission, only IPC using a protocol different from the L4_PROTO_KOBJECT protocol is forwarded. Without the L4_FPAGE_C_IPCGATE_SVR permission, all IPC is forwarded. The latter is the usual case for a client in a client/server scenario. When not bound to a thread or thread group yet, the forwarded IPC blocks until the IPC gate is bound to a thread or thread group, or the IPC times out.
Forwarded IPC is always forwarded to the userland of the thread the IPC gate is bound to, either directly or indirectly using a thread group. That means, the Thread interface of that thread is not accessible via an IPC gate. The IPC-Gate API of an IPC gate is only accessible if the capability used has the L4_FPAGE_C_IPCGATE_SVR permission (cf. previous paragraph). Conversely that means, if the capability used lacks the L4_FPAGE_C_IPCGATE_SVR permission, IPC-Gate API calls are forwarded to the thread or thread group the IPC gate is bound to instead of being processed by the IPC gate itself. In a client/server scenario, a client should only get IPC gate capabilities without L4_FPAGE_C_IPCGATE_SVR permission so the client cannot tamper with the IPC gate.
When binding an IPC gate to a thread or thread group, a user-defined, kernel protected, machine-word sized payload called the IPC gate's *label* is assigned to the IPC gate (note that the two least significant bits of the label must be zero; cf. l4_rcv_ep_bind_thread() and l4_rcv_ep_bind_snd_destination()). When a send-only IPC or call IPC is forwarded via an IPC gate, the label provided by the sender is ignored and replaced by the IPC gate's label where the two least significant bits are set to the L4_CAP_FPAGE_S and L4_CAP_FPAGE_W permissions of the capability used. The replaced label is only visible to the thread the IPC gate is bound to upon receive (or to the selected thread from the thread group the IPC gate is bound to). However, the configured label of an IPC gate can also be queried via l4_ipc_gate_get_infos() if the capability used has the L4_FPAGE_C_IPCGATE_SVR permission.
When deleting an IPC gate or when unbinding it from a thread or thread group, the label of IPC already in flight won't be changed. To ensure that no IPC from this IPC gate is received by a thread with an unexpected label, l4_thread_modify_sender_start() shall be used to change the labels of every pending IPC to that gate. This is also required if the label of an already bound IPC gate is changed. It is not necessary after binding the IPC gate to a thread or thread group for the first time.

When binding a currently bound IPC gate to a new thread or thread group, the same label should be used that was used with the old thread. Otherwise the old and the new thread need to synchronize to avoid IPC messages with unexpected labels.

Include File

```
#include <l4/sys/ipc_gate.h>
```

For the C++ interface refer to the L4::Ipc_gate documentation.

See also

Object Invocation

Definition in file ipc_gate.h.

16.523 ipc_gate.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009-2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00071
00072 #pragma once
00073
00074 #include <l4/sys/utcb.h>
00075 #include <l4/sys/types.h>
00076 #include <l4/sys/rcv_endpoint.h>
00077
00092 L4_INLINE l4_msgtag_t
00093 l4_ipc_gate_get_infos(l4_cap_idx_t gate, l4_umword_t *label);
00094
00099 L4_INLINE l4_msgtag_t
00100 l4_ipc_gate_get_infos_u(l4_cap_idx_t gate, l4_umword_t *label, l4_utcb_t *utcb);
00101
00108 enum L4_ipc_gate_ops
00109 {
00110   L4_IPC_GATE_BIND_OP     = 0x10,
00111   L4_IPC_GATE_GET_INFO_OP = 0x11,
00112 };
00113
00114
00115 /* IMPLEMENTATION ----------------------------------------------------------*/
00116
00117 #include <l4/sys/ipc.h>
00118
00119 L4_INLINE l4_msgtag_t
00120 l4_ipc_gate_bind_thread_u(l4_cap_idx_t gate,
00121                           l4_cap_idx_t thread, l4_umword_t label,
00122                           l4_utcb_t *utcb)
00123 {
00124   return l4_rcv_ep_bind_thread_u(gate, thread, label, utcb);
00125 }
00126
00127 L4_INLINE l4_msgtag_t
00128 l4_ipc_gate_bind_snd_destination_u(l4_cap_idx_t gate,
00129                                    l4_cap_idx_t snd_dst, l4_umword_t label,
00130                                    l4_utcb_t *utcb)
00131 {
00132   return l4_rcv_ep_bind_snd_destination_u(gate, snd_dst, label, utcb);
00133 }
00134
00135 L4_INLINE l4_msgtag_t
00136 l4_ipc_gate_get_infos_u(l4_cap_idx_t gate, l4_umword_t *label, l4_utcb_t *utcb)
00137 {
00138   l4_msgtag_t tag;
00139   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00140   m->mr[0] = L4_IPC_GATE_GET_INFO_OP;
00141   tag = l4_ipc_call(gate, utcb, l4_msgtag(L4_PROTO_KOBJECT, 1, 0, 0),
00142                     L4_IPC_NEVER);
00143   if (!l4_msgtag_has_error(tag) && l4_msgtag_label(tag) >= 0)
00144     *label = m->mr[0];
00145
00146   return tag;
00147 }
```

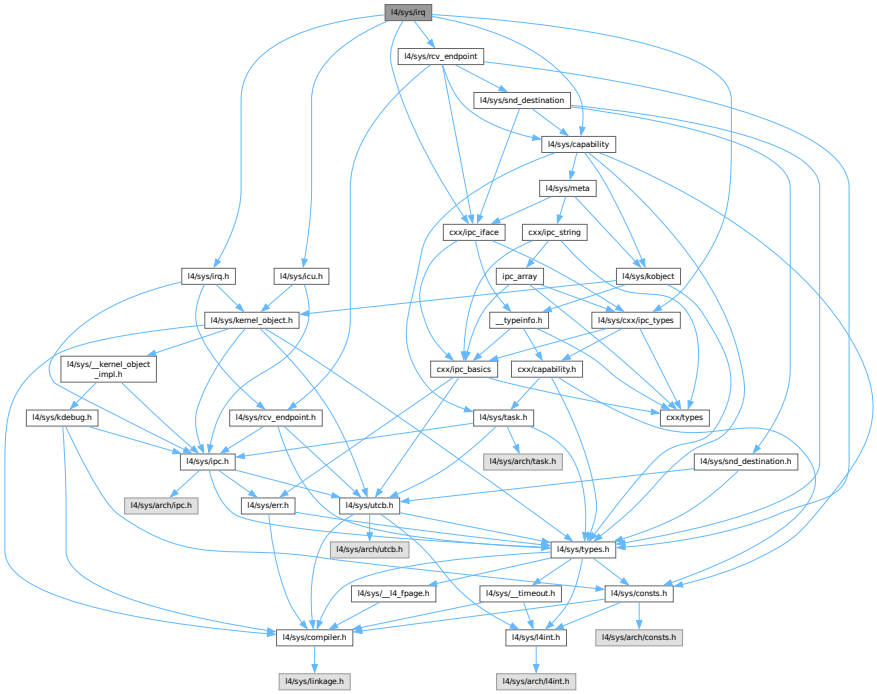
```
00148
00149
00150
00151 L4_INLINE l4_msgtag_t
00152 l4_ipc_gate_bind_thread(l4_cap_idx_t gate, l4_cap_idx_t thread,
00153                         l4_umword_t label)
00154 {
00155   return l4_rcv_ep_bind_thread_u(gate, thread, label, l4_utcb());
00156 }
00157
00158 L4_INLINE l4_msgtag_t
00159 l4_ipc_gate_bind_snd_destination(l4_cap_idx_t gate, l4_cap_idx_t snd_dst,
00160                                  l4_umword_t label)
00161 {
00162   return l4_rcv_ep_bind_snd_destination_u(gate, snd_dst, label, l4_utcb());
00163 }
00164
00165 L4_INLINE l4_msgtag_t
00166 l4_ipc_gate_get_infos(l4_cap_idx_t gate, l4_umword_t *label)
00167 {
00168   return l4_ipc_gate_get_infos_u(gate, label, l4_utcb());
00169 }
```

16.524 l4/sys/irq File Reference

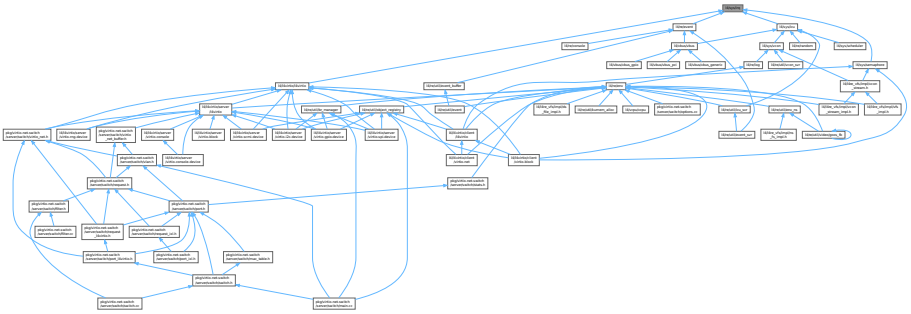
C++ Irq interface.

```
#include <l4/sys/icu.h>
#include <l4/sys/irq.h>
#include <l4/sys/capability>
#include <l4/sys/rcv_endpoint>
#include <l4/sys/cxx/ipc_iface>
#include <l4/sys/cxx/ipc_types>
```

Include dependency graph for irq:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Irq_eoi

  Interface for sending an unmask message to an object.
- struct L4::Triggerable

  Interface that allows an object to be triggered by some source.
- class L4::Irq

  C++ Irq interface, see IRQs for the C interface.
- class L4::Icu

  C++ Icu interface, see Interrupt controller for the C interface.
- class L4::Icu::Info

  This class encapsulates information about an ICU.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.524.1 Detailed Description

C++ Irq interface.
Definition in file irq.

16.525 irq

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/icu.h>
00017 #include <l4/sys/irq.h>
00018 #include <l4/sys/capability>
00019 #include <l4/sys/rcv_endpoint>
00020 #include <l4/sys/cxx/ipc_iface>
00021 #include <l4/sys/cxx/ipc_types>
00022
00023 namespace L4 {
00024
00037 class Irq_eoi : public Kobject_0t<Irq_eoi, L4::PROTO_EMPTY>
00038 {
00039 public:
```

```
00064   l4_msgtag_t unmask(unsigned irqnum, l4_umword_t *label = 0,
00065                      l4_timeout_t to = L4_IPC_NEVER,
00066                      l4_utcb_t *utcb = l4_utcb()) noexcept
00067   {
00068     return l4_icu_control_u(cap(), irqnum, L4_ICU_CTL_UNMASK, label, to, utcb);
00069   }
00070 };
00071
00079 struct Triggerable : Kobject_t<Triggerable, Irq_eoi, L4_PROTO_IRQ>
00080 {
00091   l4_msgtag_t trigger(l4_utcb_t *utcb = l4_utcb()) noexcept
00092   { return l4_irq_trigger_u(cap(), utcb); }
00093 };
00094
00120 class Irq : public Kobject_2t<Irq, Triggerable, Rcv_endpoint, L4_PROTO_IRQ_SENDER>
00121 {
00122 public:
00123   using Triggerable::unmask;
00124
00158   l4_msgtag_t bind_vcpu(L4::Cap<Thread> const &thread, l4_umword_t cfg,
00159                         l4_utcb_t *utcb = l4_utcb()) noexcept
00160   { return l4_irq_bind_vcpu_u(cap(), thread.cap(), cfg, utcb); }
00161
00176   l4_msgtag_t detach(l4_utcb_t *utcb = l4_utcb()) noexcept
00177   { return l4_irq_detach_u(cap(), utcb); }
00178
00179
00191   l4_msgtag_t receive(l4_timeout_t timeout = L4_IPC_NEVER,
00192                       l4_utcb_t *utcb = l4_utcb()) noexcept
00193   { return l4_irq_receive_u(cap(), timeout, utcb); }
00194
00204   l4_msgtag_t wait(l4_umword_t *label, l4_timeout_t timeout = L4_IPC_NEVER,
00205                    l4_utcb_t *utcb = l4_utcb()) noexcept
00206   { return unmask(-1, label, timeout, utcb); }
00207
00221   l4_msgtag_t unmask(l4_utcb_t *utcb = l4_utcb()) noexcept
00222   { return unmask(-1, 0, L4_IPC_NEVER, utcb); }
00223 };
00224
00250 class Icu :
00251   public Kobject_t<Icu, Irq_eoi, L4_PROTO_IRQ,
00252                    Type_info::Demand_t<1> >
00253 {
00254 public:
00255   enum Mode
00256   {
00257     F_none          = L4_IRQ_F_NONE,
00258     F_level_high    = L4_IRQ_F_LEVEL_HIGH,
00259     F_level_low     = L4_IRQ_F_LEVEL_LOW,
00260     F_pos_edge      = L4_IRQ_F_POS_EDGE,
00261     F_neg_edge      = L4_IRQ_F_NEG_EDGE,
00262     F_both_edge     = L4_IRQ_F_BOTH_EDGE,
00263     F_mask          = L4_IRQ_F_MASK,
00264
00265     F_set_wakeup    = L4_IRQ_F_SET_WAKEUP,
00266     F_clear_wakeup = L4_IRQ_F_CLEAR_WAKEUP,
00267   };
00268
00269   enum Flags
00270   {
00271     F_msi = L4_ICU_FLAG_MSI
00272   };
00273
00277   class Info : public l4_icu_info_t
00278   {
00279   public:
00281     bool supports_msi() const noexcept { return features & F_msi; }
00282   };
00283
00310   l4_msgtag_t bind(unsigned irqnum, L4::Cap<Triggerable> irq,
00311                    l4_utcb_t *utcb = l4_utcb()) noexcept
00312   { return l4_icu_bind_u(cap(), irqnum, irq.cap(), utcb); }
00313
00314   L4_RPC_NF_OP(
00315     L4_ICU_OP_BIND,
00316     l4_msgtag_t, bind, (l4_umword_t irqnum, Ipc::Cap<Irq> irq)
00317   );
00318
00328   l4_msgtag_t unbind(unsigned irqnum, L4::Cap<Triggerable> irq,
00329                      l4_utcb_t *utcb = l4_utcb()) noexcept
00330   { return l4_icu_unbind_u(cap(), irqnum, irq.cap(), utcb); }
00331
00332   L4_RPC_NF_OP(
00333     L4_ICU_OP_UNBIND,
00334     l4_msgtag_t, unbind, (l4_umword_t irqnum, Ipc::Cap<Irq> irq)
00335   );
00336
```

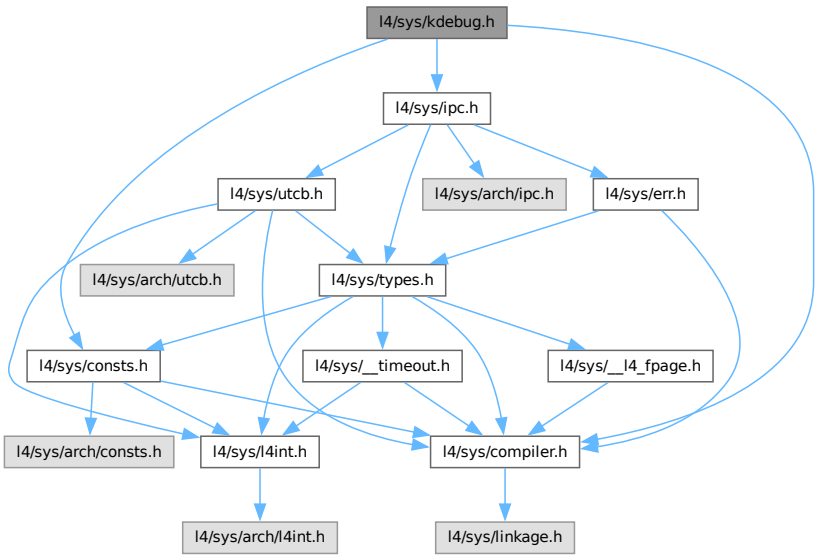
```
00345   l4_msgtag_t info(l4_icu_info_t *info, l4_utcb_t *utcb = l4_utcb()) noexcept
00346   { return l4_icu_info_u(cap(), info, utcb); }
00347
00348   struct _Info { l4_umword_t features, nr_irqs, nr_msis; };
00349   L4_RPC_NF_OP(L4_ICU_OP_INFO, l4_msgtag_t, info, (_Info *info));
00350
00363   L4_INLINE_RPC_OP(L4_ICU_OP_MSI_INFO,
00364       l4_msgtag_t, msi_info, (l4_umword_t irqnum, l4_uint64_t source,
00365                               l4_icu_msi_info_t *msi_info));
00366
00370   l4_msgtag_t control(unsigned irqnum, unsigned op, l4_umword_t *label,
00371                       l4_timeout_t to, l4_utcb_t *utcb = l4_utcb()) noexcept
00372   { return l4_icu_control_u(cap(), irqnum, op, label, to, utcb); }
00373
00393   l4_msgtag_t mask(unsigned irqnum,
00394                    l4_umword_t *label = 0,
00395                    l4_timeout_t to = L4_IPC_NEVER,
00396                    l4_utcb_t *utcb = l4_utcb()) noexcept
00397   { return l4_icu_mask_u(cap(), irqnum, label, to, utcb); }
00398
00399   L4_RPC_NF_OP(
00400     L4_ICU_OP_MASK,
00401     l4_msgtag_t, mask, (l4_umword_t irqnum),
00402     L4::Ipc::Send_only
00403   );
00404
00405
00406   L4_RPC_NF_OP(
00407     L4_ICU_OP_UNMASK,
00408     l4_msgtag_t, unmask, (l4_umword_t irqnum),
00409     L4::Ipc::Send_only
00410   );
00411
00421   l4_msgtag_t set_mode(unsigned irqnum, l4_umword_t mode,
00422                        l4_utcb_t *utcb = l4_utcb()) noexcept
00423   { return l4_icu_set_mode_u(cap(), irqnum, mode, utcb); }
00424
00425   L4_RPC_NF_OP(
00426     L4_ICU_OP_SET_MODE,
00427     l4_msgtag_t, set_mode, (l4_umword_t irqnum, l4_umword_t mode)
00428   );
00429
00430   typedef L4::Typeid::Rpcs_sys<
00431     bind_t, unbind_t, info_t, msi_info_t, unmask_t, mask_t, set_mode_t
00432   > Rpcs;
00433 };
00434
00435 }
```

16.526 l4/sys/kdebug.h File Reference

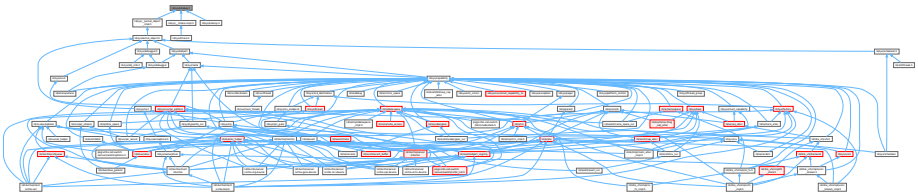
Functionality for invoking the kernel debugger.

```
#include <l4/sys/compiler.h>
#include <l4/sys/consts.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for kdebug.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum l4_kdebug_group_t

  Opcode groups for operations that can be invoked on the base debugger capability.
- enum l4_kdebug_ops_t

  Op-codes for operations that can be invoked on the base debugger capability.

Functions

- void l4_kd_enter (char const ∗text) L4_NOTHROW

  Enter the kernel debugger.
- l4_msgtag_t __l4_kdebug_op (unsigned op) L4_NOTHROW

  Invoke a nullary operation on the base debugger capability.
- l4_msgtag_t __l4_kdebug_text (unsigned op, char const ∗text, unsigned len) L4_NOTHROW

  Invoke a text output operation on the base debugger capability.
- l4_msgtag_t __l4_kdebug_3_text (unsigned op, char const ∗text, unsigned len, l4_umword_t v1, l4_umword_t v2, l4_umword_t v3) L4_NOTHROW

  Invoke a text output operation with 3 additional machine word arguments on the base debugger capability.
- l4_msgtag_t __l4_kdebug_op_1 (unsigned op, l4_mword_t val) L4_NOTHROW

  Invoke an unary operation on the base debugger capability.
- void l4_kd_outnstring (char const ∗text, unsigned len)

Output a fixed-length string via the kernel debugger.

- void l4_kd_outstring (char const *text)

  Output a string via the kernel debugger.
- void l4_kd_outchar (char c)

  Output a single character via the kernel debugger.
- void l4_kd_outumword (l4_umword_t number)

  Output a hexadecimal unsigned machine word via the kernel debugger.
- void l4_kd_outhex64 (l4_uint64_t number)

  Output a 64-bit unsigned hexadecimal number via the kernel debugger.
- void l4_kd_outhex32 (l4_uint32_t number)

  Output a 32-bit unsigned hexadecimal number via the kernel debugger.
- void l4_kd_outhex20 (l4_uint32_t number)

  Output a 20-bit unsigned hexadecimal number via the kernel debugger.
- void l4_kd_outhex16 (l4_uint16_t number)

  Output a 16-bit unsigned hexadecimal number via the kernel debugger.
- void l4_kd_outhex12 (l4_uint16_t number)

  Output a 12-bit unsigned hexadecimal number via the kernel debugger.
- void l4_kd_outhex8 (l4_uint8_t number)

  Output an 8-bit unsigned hexadecimal number via the kernel debugger.
- void l4_kd_outdec (l4_mword_t number)

  Output a decimal unsigned machine word via the kernel debugger.

16.526.1 Detailed Description

Functionality for invoking the kernel debugger.
Definition in file kdebug.h.

16.526.2 Enumeration Type Documentation

16.526.2.1 l4_kdebug_ops_t

```
enum l4_kdebug_ops_t
```

Op-codes for operations that can be invoked on the base debugger capability.
See also __ktrace-impl.h for additional op-codes.
Definition at line 44 of file kdebug.h.

16.526.3 Function Documentation

16.526.3.1 __l4_kdebug_3_text()

```
l4_msgtag_t __l4_kdebug_3_text (
             unsigned op,
             char const * text,
             unsigned len,
             l4_umword_t v1,
             l4_umword_t v2,
             l4_umword_t v3)  [inline]
```

Invoke a text output operation with 3 additional machine word arguments on the base debugger capability.

Parameters

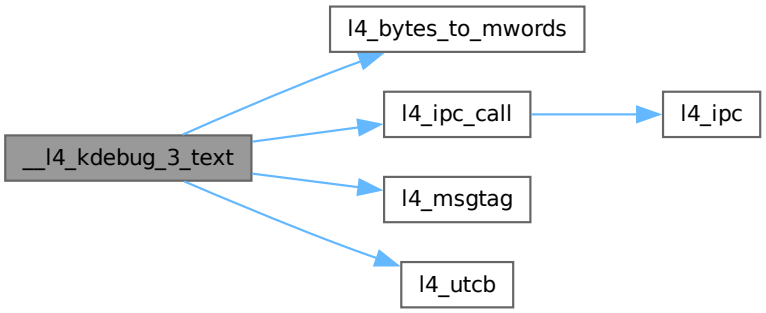
op	Text output operation code from l4_kdebug_ops_t or a value above 0x200 used by the kernel trace buffer implementation (__ktrace-impl.h).
text	Output string.

len	Length of the output string. The maximum length is limited to L4_UTCB_GENERIC_DATA_SIZE - 5 machine words. Output strings longer than this limit will be cropped.
v1	First machine word argument.
v2	Second machine word argument.
v3	Third machine word argument.

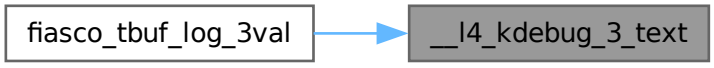
Return values

Message	tag returned from the IPC on the base debugger capability.

Definition at line 139 of file kdebug.h.
References L4_BASE_DEBUGGER_CAP, l4_bytes_to_mwords(), l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_DEBUGGER, l4_utcb(), and l4_msg_regs_t::mr.
Referenced by fiasco_tbuf_log_3val().
Here is the call graph for this function:



Here is the caller graph for this function:



16.526.3.2 __l4_kdebug_op()

```
l4_msgtag_t __l4_kdebug_op (
             unsigned op)  [inline]
```

Invoke a nullary operation on the base debugger capability.

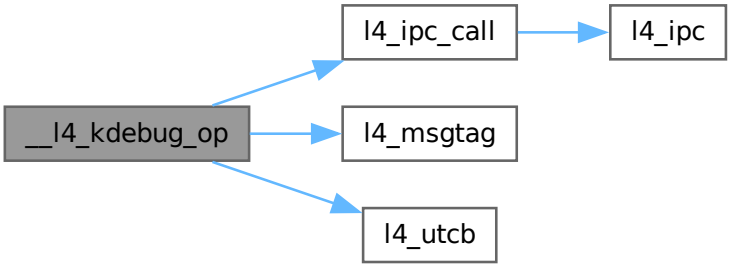
Parameters

op	Nullary operation code from l4_kdebug_ops_t or a value above 0x200 used by the kernel trace buffer implementation (__ktrace-impl.h).

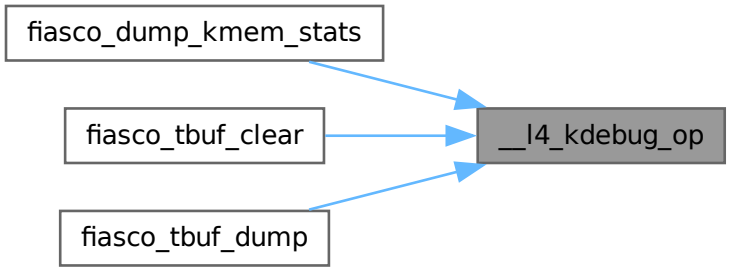
Return values

Message	tag returned from the IPC on the base debugger capability.

Definition at line 68 of file kdebug.h.
References L4_BASE_DEBUGGER_CAP, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_DEBUGGER, l4_utcb(), and l4_msg_regs_t::mr.
Referenced by fiasco_dump_kmem_stats(), fiasco_tbuf_clear(), and fiasco_tbuf_dump().
Here is the call graph for this function:



Here is the caller graph for this function:



16.526.3.3 __l4_kdebug_op_1()

```
l4_msgtag_t __l4_kdebug_op_1 (
             unsigned op,
             l4_mword_t val)  [inline]
```

Invoke an unary operation on the base debugger capability.

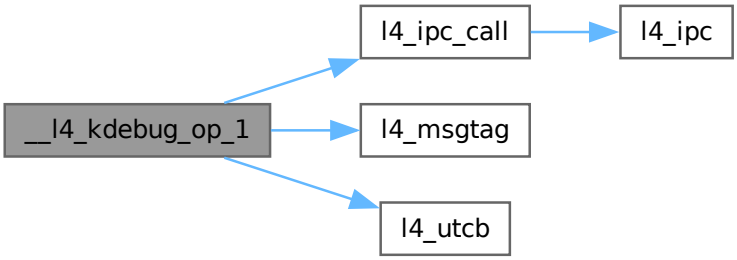
Parameters

op	Unary operation code from l4_kdebug_ops_t or a value above 0x200 used by the kernel trace buffer implementation (__ktrace-impl.h).
val	Machine word argument to the unary operation.

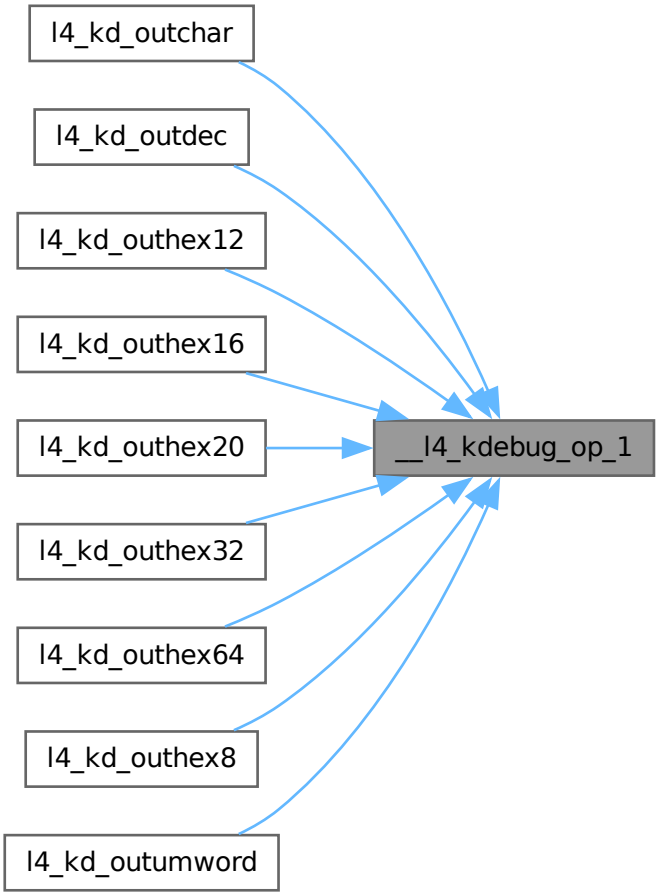
Return values

Message	tag returned from the IPC on the base debugger capability.

Definition at line 176 of file kdebug.h.
References L4_BASE_DEBUGGER_CAP, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_DEBUGGER, l4_utcb(), and l4_msg_regs_t::mr.
Referenced by l4_kd_outchar(), l4_kd_outdec(), l4_kd_outhex12(), l4_kd_outhex16(), l4_kd_outhex20(), l4_kd_outhex32(), l4_kd_outhex64(), l4_kd_outhex8(), and l4_kd_outumword().
Here is the call graph for this function:



Here is the caller graph for this function:



16.526.3.4 __l4_kdebug_text()

```
l4_msgtag_t __l4_kdebug_text (
             unsigned op,
             char const * text,
             unsigned len)  [inline]
```

Invoke a text output operation on the base debugger capability.

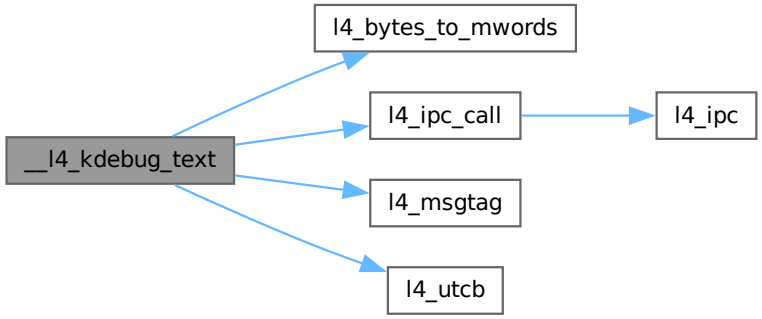
Parameters

op	Text output operation code from l4_kdebug_ops_t or a value above 0x200 used by the kernel trace buffer implementation (__ktrace-impl.h).
text	Output string.
len	Length of the output string. The maximum length is limited to L4_UTCB_GENERIC_DATA_SIZE - 2 machine words. Output strings longer than this limit will be cropped.

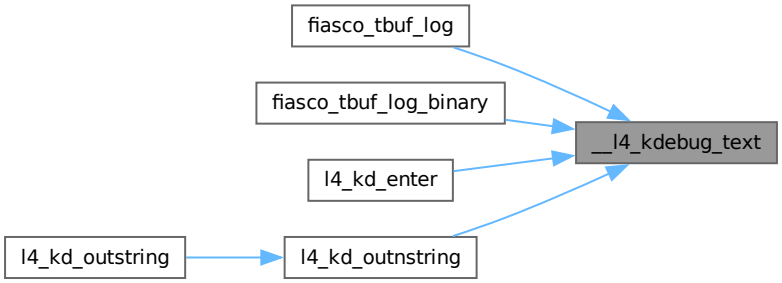
Return values

Message	tag returned from the IPC on the base debugger capability.

Definition at line 98 of file kdebug.h.
References L4_BASE_DEBUGGER_CAP, l4_bytes_to_mwords(), l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, L4_PROTO_DEBUGGER, l4_utcb(), and l4_msg_regs_t::mr.
Referenced by fiasco_tbuf_log(), fiasco_tbuf_log_binary(), l4_kd_enter(), and l4_kd_outnstring().
Here is the call graph for this function:



Here is the caller graph for this function:



16.526.3.5 l4_kd_enter()

```
void l4_kd_enter (
            char const * text)  [inline]
```

Enter the kernel debugger.

Parameters

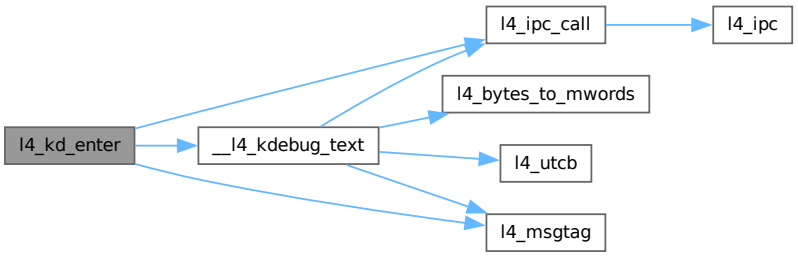
text	Optional message displayed by the kernel debugger when entered.

Enter the kernel debugger, if configured. An optional message can be passed to the kernel debugger which is printed upon the entering of the debugger.

Examples

examples/sys/singlestep/main.c.

Definition at line 204 of file kdebug.h.
References __l4_kdebug_text(), L4_BASE_DEBUGGER_CAP, L4_INLINE, l4_ipc_call(), L4_IPC_NEVER, l4_msgtag(), L4_NOTHROW, and L4_PROTO_DEBUGGER.
Here is the call graph for this function:



16.526.3.6 l4_kd_outchar()

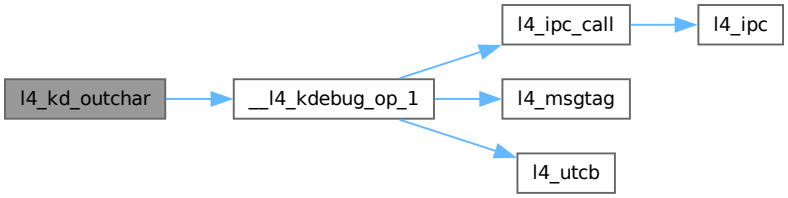
```
void l4_kd_outchar (
            char c)  [inline]
```

Output a single character via the kernel debugger.

Parameters

c	Output character.

Definition at line 245 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.7 l4_kd_outdec()

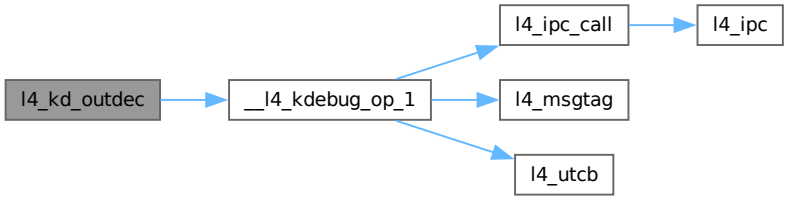
```
void l4_kd_outdec (
            l4_mword_t number)  [inline]
```

Output a decimal unsigned machine word via the kernel debugger.

Parameters

number	Output machine word.

Definition at line 334 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.8 l4_kd_outhex12()

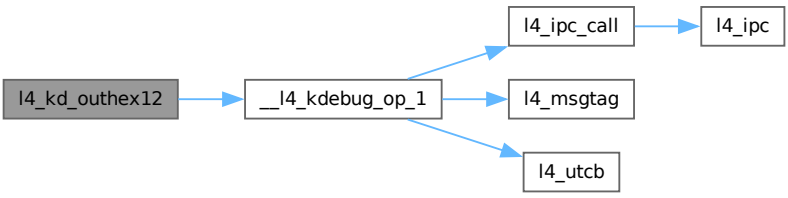
```
void l4_kd_outhex12 (
            l4_uint16_t number)  [inline]
```

Output a 12-bit unsigned hexadecimal number via the kernel debugger.

Parameters

number	Output 12-bit number. Only the 12 LSB bits are used.

Definition at line 314 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.9 l4_kd_outhex16()

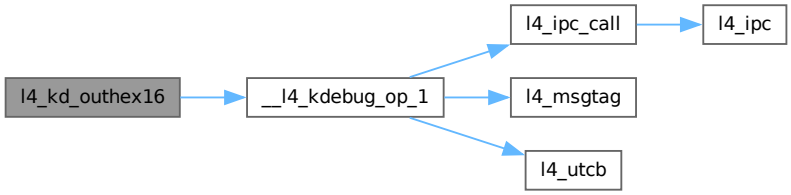
```
void l4_kd_outhex16 (
            l4_uint16_t number)  [inline]
```

Output a 16-bit unsigned hexadecimal number via the kernel debugger.

Parameters

number	Output 16-bit number.

Definition at line 304 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.10 l4_kd_outhex20()

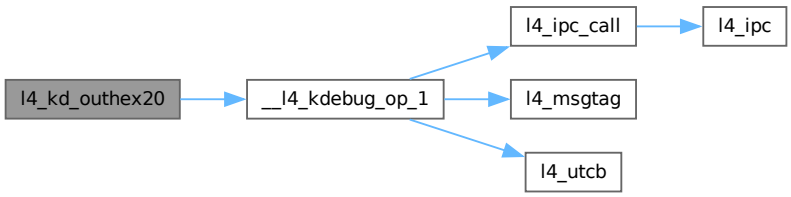
```
void l4_kd_outhex20 (
            l4_uint32_t number)  [inline]
```

Output a 20-bit unsigned hexadecimal number via the kernel debugger.

Parameters

number	Output 20-bit number. Only the 20 LSB bits are used.

Definition at line 294 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.11 l4_kd_outhex32()

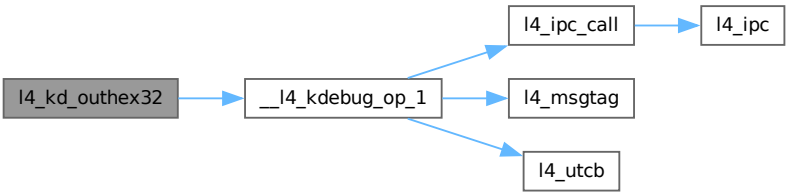
```
void l4_kd_outhex32 (
            l4_uint32_t number)  [inline]
```

Output a 32-bit unsigned hexadecimal number via the kernel debugger.

Parameters

number	Output 32-bit number.

Definition at line 284 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.12 l4_kd_outhex64()

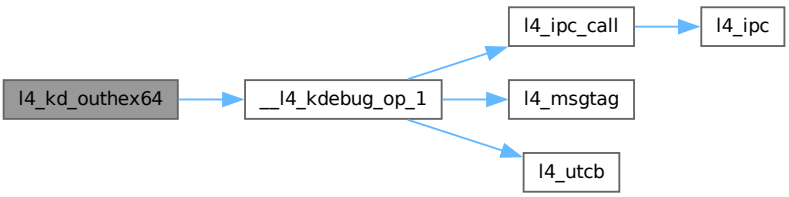
```
void l4_kd_outhex64 (
            l4_uint64_t number)  [inline]
```

Output a 64-bit unsigned hexadecimal number via the kernel debugger.

Parameters

number	Output 64-bit number.

The two 32-bit halves are printed non-atomically.
Definition at line 273 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.13 l4_kd_outhex8()

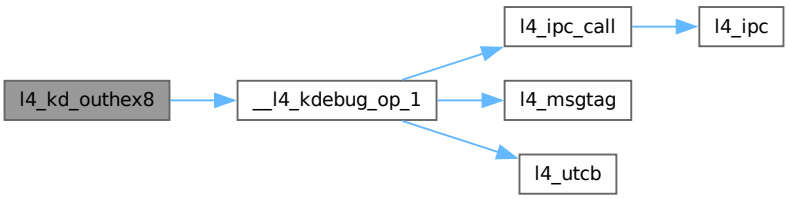
```
void l4_kd_outhex8 (
            l4_uint8_t number)  [inline]
```

Output an 8-bit unsigned hexadecimal number via the kernel debugger.

Parameters

number	Output 8-bit number.

Definition at line 324 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.
Here is the call graph for this function:



16.526.3.14 l4_kd_outnstring()

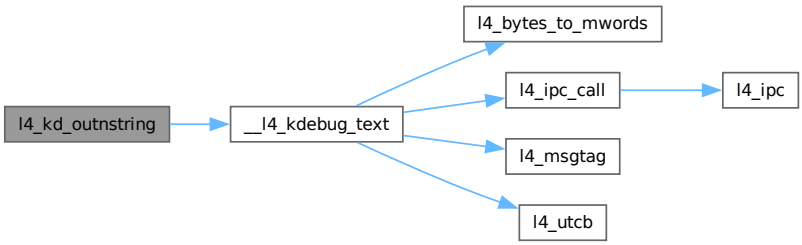
```
void l4_kd_outnstring (
            char const * text,
            unsigned len)  [inline]
```

Output a fixed-length string via the kernel debugger.

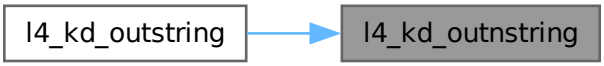
Parameters

text	Beginning of the output string.
len	Length of the output string. The maximum length is limited to L4_UTCB_GENERIC_DATA_SIZE - 2 machine words. Output strings longer than this limit will be cropped.

Definition at line 226 of file kdebug.h.
References __l4_kdebug_text(), and L4_INLINE.
Referenced by l4_kd_outstring().
Here is the call graph for this function:



Here is the caller graph for this function:



16.526.3.15 l4_kd_outstring()

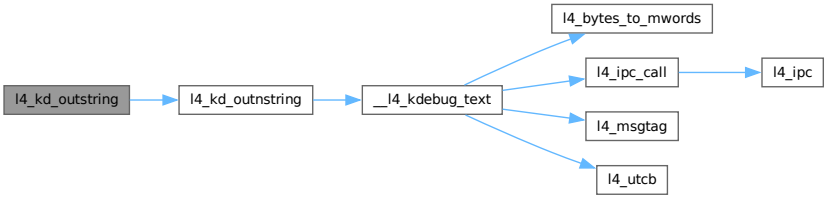
```
void l4_kd_outstring (
            char const * text)  [inline]
```

Output a string via the kernel debugger.

Parameters

text	Beginning of the output string. The maximum length of the output string is limited to L4_UTCB_GENERIC_DATA_SIZE - 2 machine words. Output strings longer than this limit will be cropped.

Definition at line 237 of file kdebug.h.
References L4_INLINE, and l4_kd_outnstring().
Here is the call graph for this function:



16.526.3.16 l4_kd_outumword()

```
void l4_kd_outumword (
            l4_umword_t number)  [inline]
```

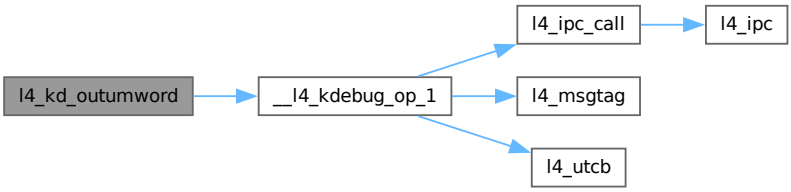
Output a hexadecimal unsigned machine word via the kernel debugger.

Parameters

number	Output machine word.

If the machine word is 64 bits long, it is printed non-atomically as two 32-bit numbers.
Definition at line 258 of file kdebug.h.
References __l4_kdebug_op_1(), and L4_INLINE.

Here is the call graph for this function:



16.527 kdebug.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00015
00016 #ifndef __KDEBUG_H__
00017 #define __KDEBUG_H__
00018
00019 #include <l4/sys/compiler.h>
00020 #include <l4/sys/consts.h>
00021 #include <l4/sys/ipc.h>
00022
00023
00024 L4_INLINE void
00025 l4_kd_enter(char const *text) L4_NOTHROW;
00026
00031 enum l4_kdebug_group_t
00032 {
00033   L4_KDEBUG_GROUP_JDB   = 0x000,
00034   L4_KDEBUG_GROUP_KOBJ  = 0x100,  // see __kernel_object_impl.h
00035   L4_KDEBUG_GROUP_TRACE = 0x200,  // see __ktrace-impl.h
00036   L4_KDEBUG_GROUP_COV   = 0x400,
00037   L4_KDEBUG_GROUP_DUMP  = 0x500,  // see kdump.h
00038 };
00039
00044 enum l4_kdebug_ops_t
00045 {
00046   L4_KDEBUG_ENTER      = L4_KDEBUG_GROUP_JDB + 0,
00047   L4_KDEBUG_OUTCHAR    = L4_KDEBUG_GROUP_JDB + 1,
00048   L4_KDEBUG_OUTNSTRING = L4_KDEBUG_GROUP_JDB + 2,
00049   L4_KDEBUG_OUTHEX32   = L4_KDEBUG_GROUP_JDB + 3,
00050   L4_KDEBUG_OUTHEX20   = L4_KDEBUG_GROUP_JDB + 4,
00051   L4_KDEBUG_OUTHEX16   = L4_KDEBUG_GROUP_JDB + 5,
00052   L4_KDEBUG_OUTHEX12   = L4_KDEBUG_GROUP_JDB + 6,
00053   L4_KDEBUG_OUTHEX8    = L4_KDEBUG_GROUP_JDB + 7,
00054   L4_KDEBUG_OUTDEC     = L4_KDEBUG_GROUP_JDB + 8,
00055 };
00056
00057
00067 L4_INLINE l4_msgtag_t
00068 __l4_kdebug_op(unsigned op) L4_NOTHROW
00069 {
00070   l4_msgtag_t res;
00071   l4_utcb_t *u = l4_utcb();
00072   l4_msg_regs_t *mr = l4_utcb_mr_u(u);
00073   l4_umword_t mr0 = mr->mr[0];
00074
00075   mr->mr[0] = op;
00076   res = l4_ipc_call(L4_BASE_DEBUGGER_CAP, u,
00077                     l4_msgtag(L4_PROTO_DEBUGGER, 1, 0, 0),
00078                     L4_IPC_NEVER);
00079   mr->mr[0] = mr0;
00080   return res;
00081 }
00082
```

```
00097 L4_INLINE l4_msgtag_t
00098 __l4_kdebug_text(unsigned op, char const *text, unsigned len) L4_NOTHROW
00099 {
00100   l4_msg_regs_t store;
00101   l4_msgtag_t res;
00102   l4_utcb_t *u = l4_utcb();
00103   l4_msg_regs_t *mr = l4_utcb_mr_u(u);
00104
00105   if (len > (sizeof(store) - (2 * sizeof(l4_umword_t))))
00106     len = sizeof(store) - (2 * sizeof(l4_umword_t));
00107
00108   __builtin_memcpy(&store, mr, sizeof(store));
00109   mr->mr[0] = op;
00110   mr->mr[1] = len;
00111   __builtin_memcpy(&mr->mr[2], text, len);
00112   res = l4_ipc_call(L4_BASE_DEBUGGER_CAP, u,
00113                     l4_msgtag(L4_PROTO_DEBUGGER,
00114                               l4_bytes_to_mwords(len) + 2, 0, 0),
00115                     L4_IPC_NEVER);
00116   __builtin_memcpy(mr, &store, sizeof(*mr));
00117   return res;
00118 }
00119
00138 L4_INLINE l4_msgtag_t
00139 __l4_kdebug_3_text(unsigned op, char const *text, unsigned len,
00140                    l4_umword_t v1, l4_umword_t v2, l4_umword_t v3) L4_NOTHROW
00141 {
00142   l4_msg_regs_t store;
00143   l4_msgtag_t res;
00144   l4_utcb_t *u = l4_utcb();
00145   l4_msg_regs_t *mr = l4_utcb_mr_u(u);
00146
00147   if (len > (sizeof(store) - (5 * sizeof(l4_umword_t))))
00148     len = sizeof(store) - (5 * sizeof(l4_umword_t));
00149
00150   __builtin_memcpy(&store, mr, sizeof(store));
00151   mr->mr[0] = op;
00152   mr->mr[1] = v1;
00153   mr->mr[2] = v2;
00154   mr->mr[3] = v3;
00155   mr->mr[4] = len;
00156   __builtin_memcpy(&mr->mr[5], text, len);
00157   res = l4_ipc_call(L4_BASE_DEBUGGER_CAP, u,
00158                     l4_msgtag(L4_PROTO_DEBUGGER,
00159                               l4_bytes_to_mwords(len) + 5, 0, 0),
00160                     L4_IPC_NEVER);
00161   __builtin_memcpy(mr, &store, sizeof(*mr));
00162   return res;
00163 }
00164
00175 L4_INLINE l4_msgtag_t
00176 __l4_kdebug_op_1(unsigned op, l4_mword_t val) L4_NOTHROW
00177 {
00178   l4_umword_t m[2];
00179   l4_msgtag_t res;
00180   l4_utcb_t *u = l4_utcb();
00181   l4_msg_regs_t *mr = l4_utcb_mr_u(u);
00182
00183   m[0] = mr->mr[0];
00184   m[1] = mr->mr[1];
00185   mr->mr[0] = op;
00186   mr->mr[1] = val;
00187   res = l4_ipc_call(L4_BASE_DEBUGGER_CAP, u,
00188                     l4_msgtag(L4_PROTO_DEBUGGER, 2, 0, 0),
00189                     L4_IPC_NEVER);
00190   mr->mr[0] = m[0];
00191   mr->mr[1] = m[1];
00192   return res;
00193 }
00194
00204 L4_INLINE void l4_kd_enter(char const *text) L4_NOTHROW
00205 {
00206   /* special case, enter without any text and use of the UTCB */
00207   if (!text)
00208     {
00209       l4_ipc_call(L4_BASE_DEBUGGER_CAP, 0,
00210                   l4_msgtag(L4_PROTO_DEBUGGER, 0, 0, 0),
00211                   L4_IPC_NEVER);
00212       return;
00213     }
00214
00215   __l4_kdebug_text(L4_KDEBUG_ENTER, text, __builtin_strlen(text));
00216 }
00217
00226 L4_INLINE void l4_kd_outnstring(char const *text, unsigned len)
00227 { __l4_kdebug_text(L4_KDEBUG_OUTNSTRING, text, len); }
00228
```

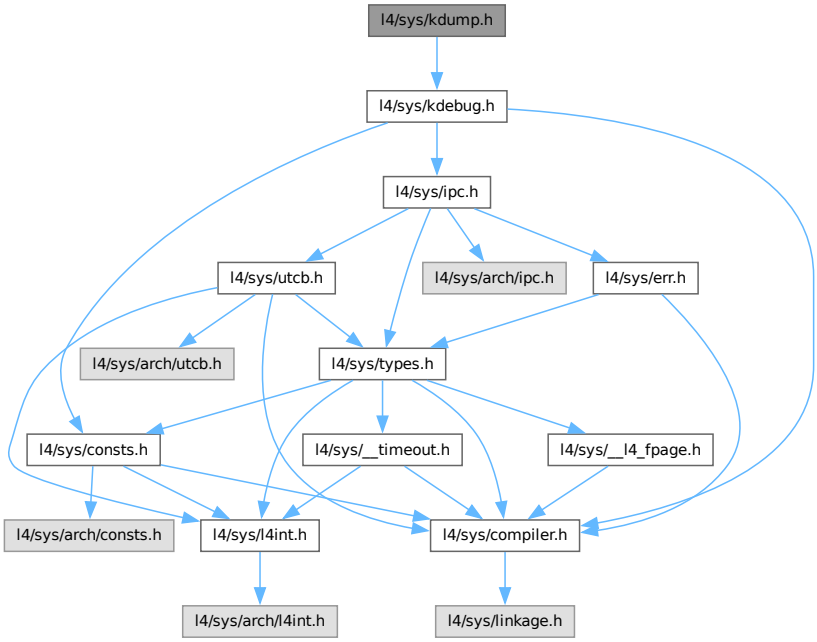
```
00237 L4_INLINE void l4_kd_outstring(char const *text)
00238 { l4_kd_outnstring(text, __builtin_strlen(text)); }
00239
00245 L4_INLINE void l4_kd_outchar(char c)
00246 {
00247   __l4_kdebug_op_1(L4_KDEBUG_OUTCHAR, c);
00248 }
00249
00258 L4_INLINE void l4_kd_outumword(l4_umword_t number)
00259 {
00260   if (sizeof(l4_umword_t) == sizeof(l4_uint64_t))
00261     __l4_kdebug_op_1(L4_KDEBUG_OUTHEX32, (l4_uint64_t)number » 32);
00262
00263   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX32, number);
00264 }
00265
00273 L4_INLINE void l4_kd_outhex64(l4_uint64_t number)
00274 {
00275   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX32, number » 32);
00276   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX32, number);
00277 }
00278
00284 L4_INLINE void l4_kd_outhex32(l4_uint32_t number)
00285 {
00286   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX32, number);
00287 }
00288
00294 L4_INLINE void l4_kd_outhex20(l4_uint32_t number)
00295 {
00296   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX20, number);
00297 }
00298
00304 L4_INLINE void l4_kd_outhex16(l4_uint16_t number)
00305 {
00306   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX16, number);
00307 }
00308
00314 L4_INLINE void l4_kd_outhex12(l4_uint16_t number)
00315 {
00316   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX12, number);
00317 }
00318
00324 L4_INLINE void l4_kd_outhex8(l4_uint8_t number)
00325 {
00326   __l4_kdebug_op_1(L4_KDEBUG_OUTHEX8, number);
00327 }
00328
00334 L4_INLINE void l4_kd_outdec(l4_mword_t number)
00335 {
00336   __l4_kdebug_op_1(L4_KDEBUG_OUTDEC, number);
00337 }
00338
00339 #endif //__KDEBUG_H__
```

16.528 l4/sys/kdump.h File Reference

Functionality for dumping kernel information.

```
#include <l4/sys/kdebug.h>
```

Include dependency graph for kdump.h:



Functions

- long fiasco_dump_kmem_stats (void)

  Dump kernel memory statistics on console.

16.528.1 Detailed Description

Functionality for dumping kernel information.
Definition in file kdump.h.

16.528.2 Function Documentation

16.528.2.1 fiasco_dump_kmem_stats()

```
long fiasco_dump_kmem_stats (
            void )  [inline]
```

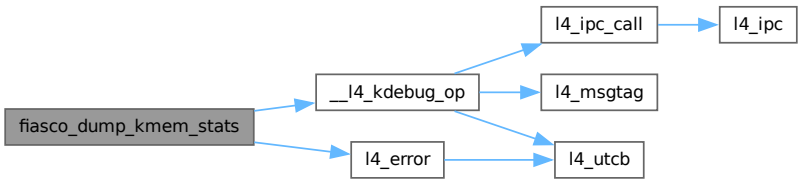
Dump kernel memory statistics on console.

Return values

0	Success.
-L4_ENOSYS	Not implemented by kernel.

Definition at line 38 of file kdump.h.
References __l4_kdebug_op(), and l4_error().

Here is the call graph for this function:



16.529 kdump.h

Go to the documentation of this file.

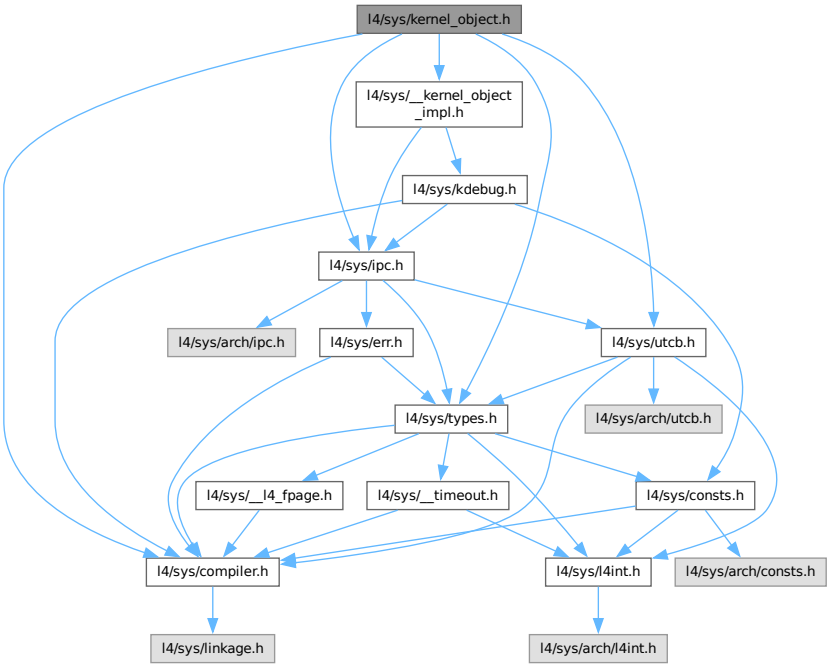
```
00001 /*
00002  * Copyright (C) 2024-2025 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00014
00025
00026 #include <l4/sys/kdebug.h>
00027
00034 L4_INLINE long
00035 fiasco_dump_kmem_stats(void);
00036
00037 L4_INLINE long
00038 fiasco_dump_kmem_stats(void)
00039 {
00040   enum { DUMP_KMEM_STATS = L4_KDEBUG_GROUP_DUMP + 0x00 };
00041   return l4_error(__l4_kdebug_op(DUMP_KMEM_STATS));
00042 }
```

16.530 l4/sys/kernel_object.h File Reference

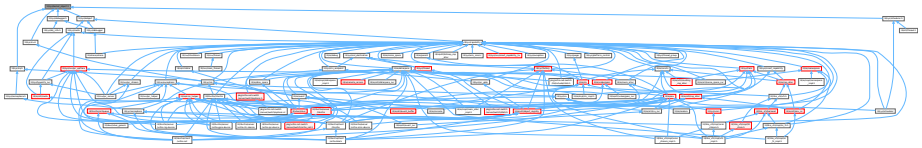
Kernel object system calls.

```
#include <l4/sys/types.h>
#include <l4/sys/compiler.h>
#include <l4/sys/utcb.h>
#include <l4/sys/__kernel_object_impl.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for kernel_object.h:



This graph shows which files directly or indirectly include this file:



16.530.1 Detailed Description

Kernel object system calls.
Definition in file kernel_object.h.

16.531 kernel_object.h

Go to the documentation of this file.

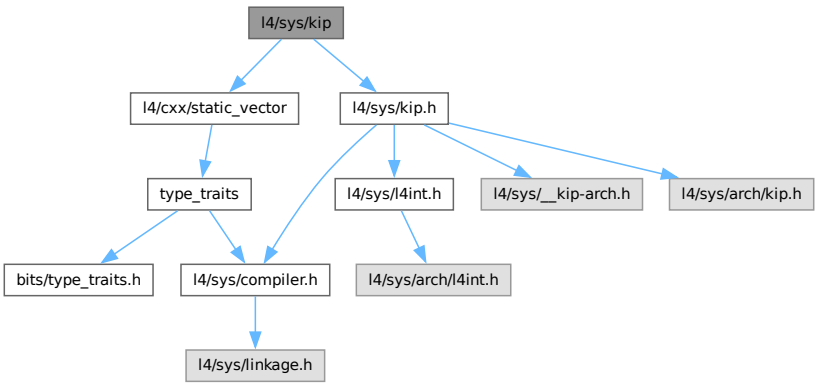
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Björn Döbel <doebel@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #ifndef __L4SYS__KERNEL_OBJECT_H__
00014 #define __L4SYS__KERNEL_OBJECT_H__
00015
00016 #include <l4/sys/types.h>
00017 #include <l4/sys/compiler.h>
00018 #include <l4/sys/utcb.h>
00019
00027
00038 L4_INLINE l4_msgtag_t
00039 l4_invoke_debugger(l4_cap_idx_t obj, l4_msgtag_t tag, l4_utcb_t *utcb) L4_NOTHROW;
```

```
00040
00041
00042 /*****************************************************************************
00043  * Implementation
00044  *****************************************************************************/
00045
00046 #include <l4/sys/__kernel_object_impl.h>
00047 #include <l4/sys/ipc.h>
00048
00049 enum L4_kobject_op {
00050   L4_KOBJECT_OP_DEC_REFCNT = 0,
00051   L4_KOBJECT_OP_REGISTER_IRQ,
00052 };
00053
00054 L4_INLINE l4_msgtag_t
00055 l4_kobject_dec_refcnt_u(l4_cap_idx_t obj, l4_mword_t diff, l4_utcb_t *u) L4_NOTHROW;
00056
00057 L4_INLINE l4_msgtag_t
00058 l4_kobject_dec_refcnt(l4_cap_idx_t obj, l4_mword_t diff) L4_NOTHROW;
00059
00060 L4_INLINE l4_msgtag_t
00061 l4_kobject_dec_refcnt_u(l4_cap_idx_t obj, l4_mword_t diff, l4_utcb_t *u) L4_NOTHROW
00062 {
00063   l4_msg_regs_t *m = l4_utcb_mr_u(u);
00064   m->mr[0] = L4_KOBJECT_OP_DEC_REFCNT;
00065   m->mr[1] = diff;
00066   return l4_ipc_call(obj, u, l4_msgtag(L4_PROTO_KOBJECT, 2, 0, 0), L4_IPC_NEVER);
00067 }
00068
00069 L4_INLINE l4_msgtag_t
00070 l4_kobject_dec_refcnt(l4_cap_idx_t obj, l4_mword_t diff) L4_NOTHROW
00071 {
00072   return l4_kobject_dec_refcnt_u(obj, diff, l4_utcb());
00073 }
00074
00075 #endif /* ! __L4SYS__KERNEL_OBJECT_H__ */
```

16.532 l4/sys/kip File Reference

```
#include <l4/cxx/static_vector>
#include <l4/sys/kip.h>
```

Include dependency graph for kip:



Data Structures

- class L4::Kip::Mem_desc

  Memory descriptors stored in the kernel interface page.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.532.1 Detailed Description

L4::Kip class, memory descriptors.

Author

Alexander Warg alexander.warg@os.inf.tu-dresden.de

Definition in file kip.

16.533 kip

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00010 /*
00011  * (c) 2008-2009 Author(s)
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  *
00014  * License: see LICENSE.spdx (in this directory or the directories above)
00015  */
00016 #pragma once
00017
00018 #include <l4/cxx/static_vector>
00019 #include <l4/sys/kip.h>
00020
00021 /* C++ version of memory descriptors */
00022
00031
00032 namespace L4
00033 {
00034   namespace Kip
00035   {
00042     class Mem_desc
00043     {
00044     public:
00048       enum Mem_type
00049       {
00050         Undefined    = 0x0,
00051         Conventional = 0x1,
00052         Reserved     = 0x2,
00053         Dedicated    = 0x3,
00054         Shared       = 0x4,
00055         Kmem         = 0x5,
00056
00057         // 0x7 is internally used by the kernel
00058
00059         Info         = 0xd,
00060         Bootloader   = 0xe,
00061         Arch         = 0xf
00062       };
00063
00067       enum Info_sub_type
00068       {
00069         Info_acpi_rsdp = 0,
00070
00071         Reserved_kernel = 0,
00072         Reserved_heap   = 1,
00073         Reserved_mmio   = 2,
00074       };
00075
00079       enum Arch_sub_type_common
00080       {
00081         Arch_acpi_tables  = 3,
00082         Arch_acpi_nvs     = 4,
00083         Arch_cpu_fw       = 5,
00084       };
00085
00086     private:
00087       unsigned long _l, _h;
00088
00089     public:
00097       static Mem_desc *first(l4_kernel_info_t *kip) noexcept
00098       {
00099         return reinterpret_cast<Mem_desc *>(reinterpret_cast<char *>(kip) + kip->mem_descs);
00100       }
00101
00102       static Mem_desc const *first(l4_kernel_info_t const *kip) noexcept
00103       {
00104         char const *addr = reinterpret_cast<char const *>(kip) + kip->mem_descs;
00105         return reinterpret_cast<Mem_desc const *>(addr);
00106       }
00107
```

```
00115       static unsigned long count(l4_kernel_info_t const *kip) noexcept
00116       {
00117         return kip->mem_descs_num;
00118       }
00119
00126       static void count(l4_kernel_info_t *kip, unsigned count) noexcept
00127       {
00128         kip->mem_descs_num = count;
00129       }
00130
00136       static inline cxx::static_vector<Mem_desc const> all(l4_kernel_info_t const *kip)
00137       {
00138         return cxx::static_vector<Mem_desc const>(Mem_desc::first(kip),
00139                                                   Mem_desc::count(kip));
00140       }
00141
00147       static inline cxx::static_vector<Mem_desc> all(l4_kernel_info_t *kip)
00148       {
00149         return cxx::static_vector<Mem_desc>(Mem_desc::first(kip),
00150                                             Mem_desc::count(kip));
00151       }
00152
00166       Mem_desc(unsigned long start, unsigned long end,
00167                Mem_type t, unsigned char st = 0, bool virt = false,
00168                bool eager = false) noexcept
00169       : _l((start & ~0x3ffUL) | (t & 0x0f) | ((st « 4) & 0x0f0)
00170            | (virt ? 0x0200 : 0x0) | (eager ? 0x100 : 0x0)), _h(end | 0x3ffUL)
00171       {}
00172
00178       unsigned long start() const noexcept { return _l & ~0x3ffUL; }
00179
00185       unsigned long end() const noexcept { return _h | 0x3ffUL; }
00186
00192       unsigned long size() const noexcept { return end() + 1 - start(); }
00193
00199       Mem_type type() const noexcept
00200       {
00201         return static_cast<Mem_type>(_l & 0x0f);
00202       }
00203
00209       unsigned char sub_type() const noexcept { return (_l » 4) & 0x0f; }
00210
00217       unsigned is_virtual() const noexcept { return _l & 0x200; }
00218
00223       unsigned eager_map() const noexcept { return _l & 0x100; }
00224
00237       void set(unsigned long start, unsigned long end,
00238                Mem_type t, unsigned char st = 0, bool virt = false,
00239                bool eager = false) noexcept
00240       {
00241         _l = (start & ~0x3ffUL) | (t & 0x0f) | ((st « 4) & 0x0f0)
00242              | (virt?0x0200:0x0) | (eager ? 0x0100 : 0x0);
00243
00244         _h = end | 0x3ffUL;
00245       }
00246
00247     };
00248   };
00249 };
```

16.534 kobject

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /* \file
00003  * Kobject C++ interface.
00004  */
00005 /*
00006  * Copyright (C) 2015-2017, 2019, 2021, 2023-2024 Kernkonzept GmbH.
00007  * Author(s): Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include "kernel_object.h"
00014 #include "types.h"
00015 #include "__typeinfo.h"
00016
00017 namespace L4 {
00018
00036 class L4_EXPORT Kobject
00037 {
00038 private:
00039   Kobject();
```

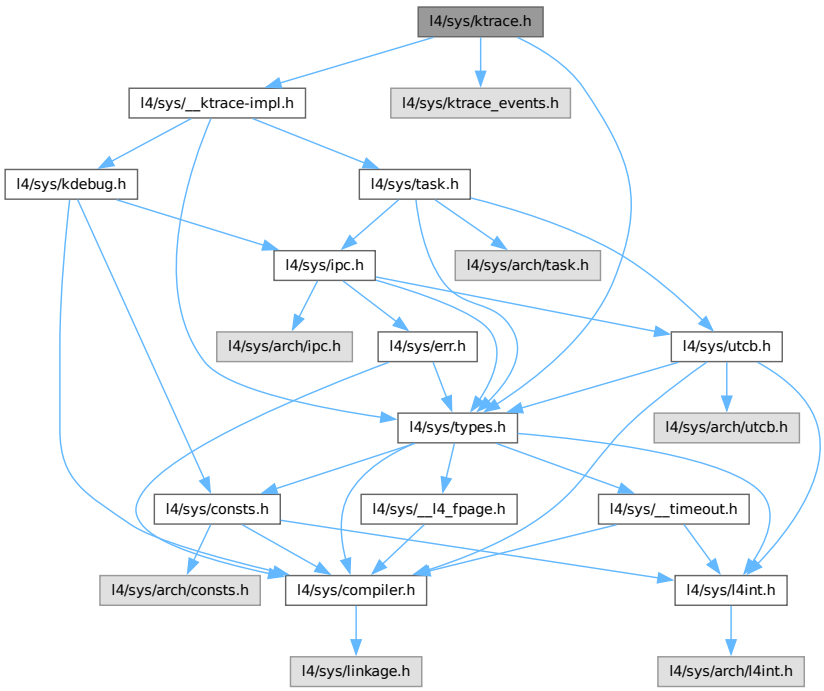
```
00040   Kobject(Kobject const  &);
00041   Kobject &operator = (Kobject const &);
00042
00043   template<typename T> friend struct Kobject_typeid;
00044
00045 protected:
00046   typedef Typeid::Iface<L4_PROTO_META, Kobject> __Iface;
00047   typedef Typeid::Iface_list<__Iface> __Iface_list;
00048
00055   struct __Kobject_typeid
00056   {
00057     typedef Type_info::Demand_t<> Demand;
00058     static Type_info const _m;
00059   };
00060
00069   l4_cap_idx_t cap() const noexcept { return _c(); }
00070
00071 private:
00072
00077   l4_cap_idx_t _c() const noexcept
00078   { return reinterpret_cast<l4_cap_idx_t>(this) & L4_CAP_MASK; }
00079
00080 public:
00100   l4_msgtag_t dec_refcnt(l4_mword_t diff, l4_utcb_t *utcb = l4_utcb())
00101   { return l4_kobject_dec_refcnt_u(cap(), diff, utcb); }
00102 };
00103
00104 template<typename Derived, l4_proto_t PROTO = L4::PROTO_ANY,
00105          typename S_DEMAND = Type_info::Demand_t<> >
00106 struct Kobject_0t : Kobject_t<Derived, L4::Kobject, PROTO, S_DEMAND> {};
00107
00108 }
00109
```

16.535 l4/sys/ktrace.h File Reference

L4 kernel event tracing.

```
#include <l4/sys/types.h>
#include <l4/sys/ktrace_events.h>
#include <l4/sys/__ktrace-impl.h>
```

Include dependency graph for ktrace.h:



Functions

- l4_msgtag_t fiasco_tbuf_validate (void)

  Validate the kernel base debugger capability.
- l4_umword_t fiasco_tbuf_log (const char *text)

  Create new trace-buffer entry with describing <text>.
- l4_umword_t fiasco_tbuf_log_3val (const char *text, l4_umword_t v1, l4_umword_t v2, l4_umword_t v3)

  Create new trace-buffer entry with describing <text> and three additional values.
- l4_umword_t fiasco_tbuf_log_binary (const unsigned char *data)

  Create new trace-buffer entry with binary data.
- void **fiasco_tbuf_clear** (void)

  Clear trace-buffer.
- void **fiasco_tbuf_dump** (void)

  Dump trace-buffer to kernel console.
- l4_msgtag_t fiasco_tbuf_map_status (l4_fpage_t *ku_mem)

  Map kernel trace-buffer status page.
- l4_msgtag_t fiasco_tbuf_map_slots (l4_fpage_t *ku_mem)

  Map kernel trace-buffer slots.

16.535.1 Detailed Description

L4 kernel event tracing.
Definition in file ktrace.h.

16.536 ktrace.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     2015      Adam Lackorzynski <adam@l4re.org>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 /*****************************************************************************/
00016 #ifndef __L4_KTRACE_H__
00017 #define __L4_KTRACE_H__
00018
00019 #include <l4/sys/types.h>
00020 #include <l4/sys/ktrace_events.h>
00021
00033
00041 L4_INLINE l4_msgtag_t
00042 fiasco_tbuf_validate(void);
00043
00051 L4_INLINE l4_umword_t
00052 fiasco_tbuf_log(const char *text);
00053
00065 L4_INLINE l4_umword_t
00066 fiasco_tbuf_log_3val(const char *text, l4_umword_t v1, l4_umword_t v2, l4_umword_t v3);
00067
00075 L4_INLINE l4_umword_t
00076 fiasco_tbuf_log_binary(const unsigned char *data);
00077
00082 L4_INLINE void
00083 fiasco_tbuf_clear(void);
00084
00089 L4_INLINE void
00090 fiasco_tbuf_dump(void);
00091
00101 L4_INLINE l4_msgtag_t
00102 fiasco_tbuf_map_status(l4_fpage_t *ku_mem);
00103
00113 L4_INLINE l4_msgtag_t
00114 fiasco_tbuf_map_slots(l4_fpage_t *ku_mem);
00115
```

```
00116 #include <l4/sys/__ktrace-impl.h>
00117
00118 #endif
```

16.537 amd64/l4/sys/arch/l4int.h File Reference

Fixed sized integer types, AMD64 version.

Macros

- #define **L4_MWORD_BITS** 64

  Size of machine words in bits.

Typedefs

- typedef unsigned long **l4_size_t**

  Unsigned size type.
- typedef signed long **l4_ssize_t**

  Signed size type.

16.537.1 Detailed Description

Fixed sized integer types, AMD64 version.
Definition in file l4int.h.

16.538 l4int.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00020
00021 #define L4_MWORD_BITS           64
00022
00023 typedef unsigned long           l4_size_t;
00024 typedef signed long             l4_ssize_t;
00026
```

16.539 arm/l4/sys/arch/l4int.h File Reference

Fixed sized integer types, arm version.

Macros

- #define **L4_MWORD_BITS** 32

  Size of machine words in bits.

Typedefs

- typedef unsigned int **l4_size_t**

  Unsigned size type.
- typedef signed int **l4_ssize_t**

  Signed size type.

16.539.1 Detailed Description

Fixed sized integer types, arm version.
Definition in file l4int.h.

16.540 l4int.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00019
00020 #define L4_MWORD_BITS           32
00021
00022 typedef unsigned int            l4_size_t;
00023 typedef signed int              l4_ssize_t;
00025
```

16.541 arm64/l4/sys/arch/l4int.h File Reference

Fixed sized integer types, arm version.

Macros

- #define **L4_MWORD_BITS** 64

  Size of machine words in bits.

Typedefs

- typedef unsigned long **l4_size_t**

  Unsigned size type.
- typedef signed long **l4_ssize_t**

  Signed size type.

16.541.1 Detailed Description

Fixed sized integer types, arm version.
Definition in file l4int.h.

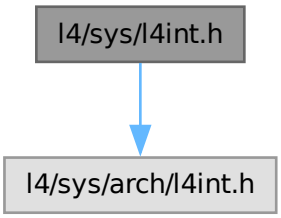
16.542 l4int.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00019
00020 #define L4_MWORD_BITS           64
00021
00022 typedef unsigned long            l4_size_t;
00023 typedef signed long              l4_ssize_t;
00025
```

16.543 l4/sys/l4int.h File Reference

Fixed sized integer types, generic version.
`#include <l4/sys/arch/l4int.h>`
Include dependency graph for l4int.h:



This graph shows which files directly or indirectly include this file:



Typedefs

- typedef signed char **l4_int8_t**
  Signed 8bit value.
- typedef unsigned char **l4_uint8_t**
  Unsigned 8bit value.
- typedef signed short int **l4_int16_t**
  Signed 16bit value.
- typedef unsigned short int **l4_uint16_t**
  Unsigned 16bit value.
- typedef signed int **l4_int32_t**
  Signed 32bit value.
- typedef unsigned int **l4_uint32_t**
  Unsigned 32bit value.
- typedef signed long long **l4_int64_t**
  Signed 64bit value.
- typedef unsigned long long **l4_uint64_t**
  Unsigned 64bit value.
- typedef unsigned long **l4_addr_t**
  Address type.
- typedef signed long **l4_mword_t**
  Signed machine word.
- typedef unsigned long **l4_umword_t**
  Unsigned machine word.
- typedef l4_uint64_t **l4_cpu_time_t**
  CPU clock type.
- typedef l4_uint64_t **l4_kernel_clock_t**
  Kernel clock type.

16.543.1 Detailed Description

Fixed sized integer types, generic version.
Definition in file l4int.h.

16.544 l4int.h

Go to the documentation of this file.

```
00001
00007
00013 /*
00014  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00015  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00016  *     economic rights: Technische Universität Dresden (Germany)
00017  *
00018  * License: see LICENSE.spdx (in this directory or the directories above)
00019  */
00020 #ifndef __L4_SYS_L4INT_H__
00021 #define __L4_SYS_L4INT_H__
00022
00023 /* fixed sized data types */
00024 typedef signed char             l4_int8_t;
00025 typedef unsigned char           l4_uint8_t;
00026 typedef signed short int        l4_int16_t;
00027 typedef unsigned short int      l4_uint16_t;
00028 typedef signed int              l4_int32_t;
00029 typedef unsigned int            l4_uint32_t;
00030 typedef signed long long        l4_int64_t;
00031 typedef unsigned long long      l4_uint64_t;
00032
00033 /* some common data types */
00034 typedef unsigned long           l4_addr_t;
00035
00036
00037 typedef signed long             l4_mword_t;
00040 typedef unsigned long           l4_umword_t;
00047 typedef l4_uint64_t l4_cpu_time_t;
00048
00053 typedef l4_uint64_t l4_kernel_clock_t;
00054
00055 #include <l4/sys/arch/l4int.h>
00056
00057 #endif /* !__L4_SYS_L4INT_H__ */
```

16.545 riscv/l4/sys/arch/l4int.h File Reference

Fixed sized integer types, RISC-V version.

Macros

- #define **L4_MWORD_BITS** __riscv_xlen

  Size of machine words in bits.

Typedefs

- typedef unsigned int **l4_size_t**

  Unsigned size type.
- typedef signed int **l4_ssize_t**

  Signed size type.

16.545.1 Detailed Description

Fixed sized integer types, RISC-V version.
Definition in file l4int.h.

16.546 l4int.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00008  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00018
00019 #define L4_MWORD_BITS           __riscv_xlen
00020
00021 #if __riscv_xlen == 64
00022 typedef unsigned long           l4_size_t;
00023 typedef signed long             l4_ssize_t;
00024 #else
00025 typedef unsigned int            l4_size_t;
00026 typedef signed int              l4_ssize_t;
00027 #endif
```

16.547 x86/l4/sys/arch/l4int.h File Reference

Fixed sized integer types, x86 version.

Macros

- #define **L4_MWORD_BITS** 32

  Size of machine words in bits.

Typedefs

- typedef unsigned int **l4_size_t**

  Unsigned size type.
- typedef signed int **l4_ssize_t**

  Signed size type.

16.547.1 Detailed Description

Fixed sized integer types, x86 version.
Definition in file l4int.h.

16.548 l4int.h

Go to the documentation of this file.

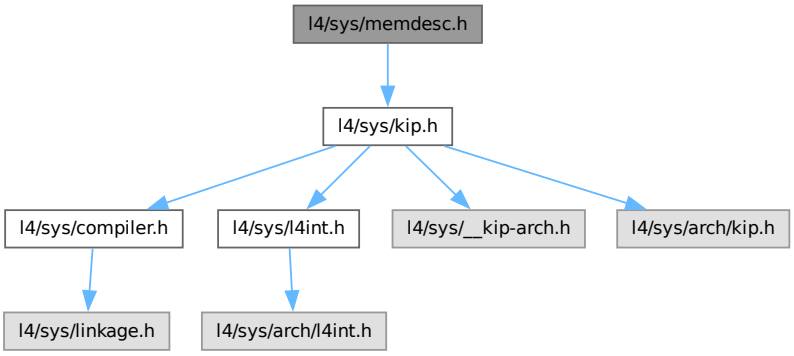
```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00019
00020 #define L4_MWORD_BITS           32
00021
00022 typedef unsigned int            l4_size_t;
00023 typedef signed int              l4_ssize_t;
00025
```

16.549 l4/sys/memdesc.h File Reference

Memory description functions.

```
#include <l4/sys/kip.h>
```

Include dependency graph for memdesc.h:



Data Structures

- struct l4_kernel_info_mem_desc_t

  Memory descriptor data structure.

Typedefs

- typedef struct l4_kernel_info_mem_desc_t l4_kernel_info_mem_desc_t

  Memory descriptor data structure.

Enumerations

- enum l4_mem_type_t {
  l4_mem_type_undefined = 0x0 , l4_mem_type_conventional = 0x1 , l4_mem_type_reserved = 0x2 ,
  l4_mem_type_dedicated = 0x3 ,
  l4_mem_type_shared = 0x4 , l4_mem_type_kmem = 0x5 , l4_mem_type_info = 0xd , l4_mem_type_bootloader = 0xe ,
  l4_mem_type_archspecific = 0xf }

  Type of a memory descriptor.
- enum l4_mem_info_sub_type_t { l4_mem_info_acpi_rsdp = 0 , l4_mem_reserved_kernel = 0 , l4_mem_reserved_heap = 1 , l4_mem_reserved_mmio = 2 }

  Memory sub types for l4_mem_type_info descriptors.
- enum l4_mem_archspecific_sub_type_common_t { l4_mem_archspecific_acpi_tables = 3 , l4_mem_archspecific_acpi_nvs = 4 , l4_mem_archspecific_cpu_fw = 5 }

  Memory sub types for l4_mem_type_archspecific descriptors.

Functions

- l4_kernel_info_mem_desc_t * **l4_kernel_info_get_mem_descs** (l4_kernel_info_t *kip) L4_NOTHROW

  Get pointer to memory descriptors from KIP.
- unsigned l4_kernel_info_get_num_mem_descs (l4_kernel_info_t *kip) L4_NOTHROW

  Get number of memory descriptors in KIP.
- void l4_kernel_info_set_mem_desc (l4_kernel_info_mem_desc_t *md, l4_addr_t start, l4_addr_t end, unsigned type, unsigned virt, unsigned sub_type) L4_NOTHROW

  Populate a memory descriptor.
- l4_umword_t l4_kernel_info_get_mem_desc_start (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

Get start address of the region described by the memory descriptor.

- l4_umword_t l4_kernel_info_get_mem_desc_end (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get end address of the region described by the memory descriptor.

- l4_umword_t l4_kernel_info_get_mem_desc_type (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get type of the memory region.

- l4_umword_t l4_kernel_info_get_mem_desc_subtype (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get sub-type of memory region.

- l4_umword_t l4_kernel_info_get_mem_desc_is_virtual (l4_kernel_info_mem_desc_t *md) L4_NOTHROW

  Get virtual flag of the memory descriptor.

16.549.1 Detailed Description

Memory description functions.
Definition in file memdesc.h.

16.550 memdesc.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2007-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #ifndef __L4SYS__MEMDESC_H__
00014 #define __L4SYS__MEMDESC_H__
00015
00016 #include <l4/sys/kip.h>
00017
00028
00033 enum l4_mem_type_t
00034 {
00035   l4_mem_type_undefined    = 0x0,
00036   l4_mem_type_conventional = 0x1,
00037   l4_mem_type_reserved     = 0x2,
00038   l4_mem_type_dedicated    = 0x3,
00039   l4_mem_type_shared       = 0x4,
00040   l4_mem_type_kmem         = 0x5,
00041
00042   // 0x7 is internally used by the kernel
00043
00044   l4_mem_type_info         = 0xd,
00045   l4_mem_type_bootloader   = 0xe,
00046   l4_mem_type_archspecific = 0xf,
00047 };
00048
00053 enum l4_mem_info_sub_type_t
00054 {
00055   l4_mem_info_acpi_rsdp = 0,
00056
00057   l4_mem_reserved_kernel = 0,
00058   l4_mem_reserved_heap   = 1,
00059   l4_mem_reserved_mmio   = 2,
00060 };
00061
00066 enum l4_mem_archspecific_sub_type_common_t
00067 {
00068   l4_mem_archspecific_acpi_tables = 3,
00069   l4_mem_archspecific_acpi_nvs    = 4,
00070   l4_mem_archspecific_cpu_fw      = 5,
00071 };
00072
00073
00081 typedef struct l4_kernel_info_mem_desc_t
00082 {
00084   l4_umword_t l;
00086   l4_umword_t h;
00087 } l4_kernel_info_mem_desc_t;
00088
00089
00094 L4_INLINE
00095 l4_kernel_info_mem_desc_t *
00096 l4_kernel_info_get_mem_descs(l4_kernel_info_t *kip) L4_NOTHROW;
```

```
00097
00104 L4_INLINE
00105 unsigned
00106 l4_kernel_info_get_num_mem_descs(l4_kernel_info_t *kip) L4_NOTHROW;
00107
00119 L4_INLINE
00120 void
00121 l4_kernel_info_set_mem_desc(l4_kernel_info_mem_desc_t *md,
00122                             l4_addr_t start,
00123           l4_addr_t end,
00124           unsigned type,
00125           unsigned virt,
00126           unsigned sub_type) L4_NOTHROW;
00127
00134 L4_INLINE
00135 l4_umword_t
00136 l4_kernel_info_get_mem_desc_start(l4_kernel_info_mem_desc_t *md) L4_NOTHROW;
00137
00144 L4_INLINE
00145 l4_umword_t
00146 l4_kernel_info_get_mem_desc_end(l4_kernel_info_mem_desc_t *md) L4_NOTHROW;
00147
00154 L4_INLINE
00155 l4_umword_t
00156 l4_kernel_info_get_mem_desc_type(l4_kernel_info_mem_desc_t *md) L4_NOTHROW;
00157
00167 L4_INLINE
00168 l4_umword_t
00169 l4_kernel_info_get_mem_desc_subtype(l4_kernel_info_mem_desc_t *md) L4_NOTHROW;
00170
00177 L4_INLINE
00178 l4_umword_t
00179 l4_kernel_info_get_mem_desc_is_virtual(l4_kernel_info_mem_desc_t *md) L4_NOTHROW;
00180
00181 /*****************************************************************************
00182  * Implementations
00183  *****************************************************************************/
00184
00185 L4_INLINE
00186 l4_kernel_info_mem_desc_t *
00187 l4_kernel_info_get_mem_descs(l4_kernel_info_t *kip) L4_NOTHROW
00188 {
00189   return (l4_kernel_info_mem_desc_t *)((l4_addr_t)kip + kip->mem_descs);
00190 }
00191
00192 L4_INLINE
00193 unsigned
00194 l4_kernel_info_get_num_mem_descs(l4_kernel_info_t *kip) L4_NOTHROW
00195 {
00196   return kip->mem_descs_num;
00197 }
00198
00199 L4_INLINE
00200 void
00201 l4_kernel_info_set_mem_desc(l4_kernel_info_mem_desc_t *md,
00202                             l4_addr_t start,
00203           l4_addr_t end,
00204           unsigned type,
00205           unsigned virt,
00206           unsigned sub_type) L4_NOTHROW
00207 {
00208   md->l = (start & ~0x3ffUL) | (type & 0x0f) | ((sub_type << 4) & 0x0f0)
00209     | (virt ? 0x200 : 0x0);
00210   md->h = end;
00211 }
00212
00213
00214 L4_INLINE
00215 l4_umword_t
00216 l4_kernel_info_get_mem_desc_start(l4_kernel_info_mem_desc_t *md) L4_NOTHROW
00217 {
00218   return md->l & ~0x3ffUL;
00219 }
00220
00221 L4_INLINE
00222 l4_umword_t
00223 l4_kernel_info_get_mem_desc_end(l4_kernel_info_mem_desc_t *md) L4_NOTHROW
00224 {
00225   return md->h | 0x3ffUL;
00226 }
00227
00228 L4_INLINE
00229 l4_umword_t
00230 l4_kernel_info_get_mem_desc_type(l4_kernel_info_mem_desc_t *md) L4_NOTHROW
00231 {
00232   return md->l & 0xf;
00233 }
```

```
00234
00235 L4_INLINE
00236 l4_umword_t
00237 l4_kernel_info_get_mem_desc_subtype(l4_kernel_info_mem_desc_t *md) L4_NOTHROW
00238 {
00239   return (md->l & 0xf0) >> 4;
00240 }
00241
00242 L4_INLINE
00243 l4_umword_t
00244 l4_kernel_info_get_mem_desc_is_virtual(l4_kernel_info_mem_desc_t *md) L4_NOTHROW
00245 {
00246   return md->l & 0x200;
00247 }
00248
00249 #endif /* ! __L4SYS__MEMDESC_H__ */
```

16.551 meta

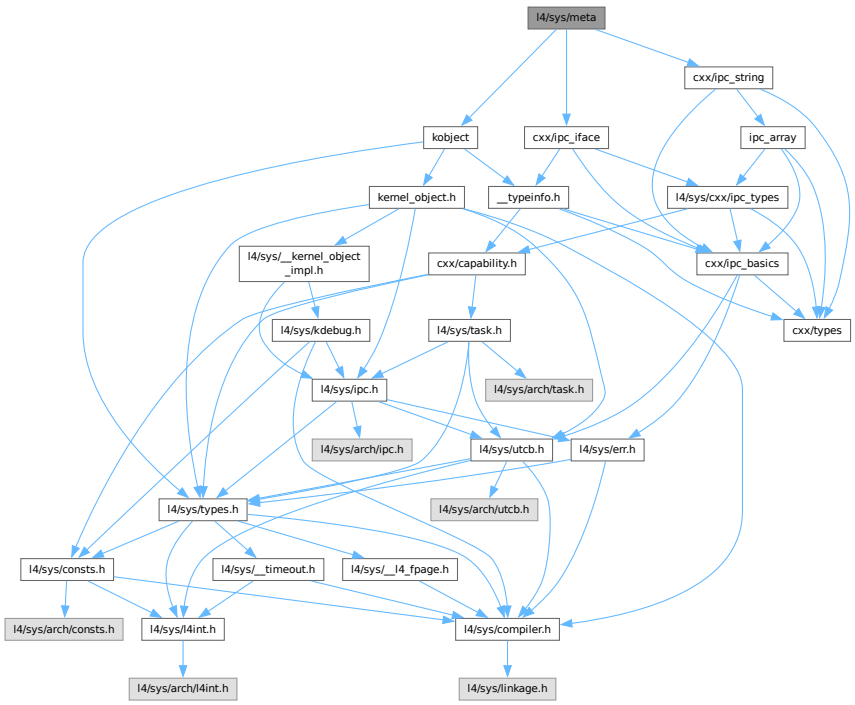
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002
00003 #pragma once
00004
00005 #include <l4/sys/meta>
00006 #include <l4/sys/typeinfo_svr>
00007
00008 namespace L4Re { namespace Util {
00009 using L4::Util::handle_meta_request;
00010 }}
```

16.552 l4/sys/meta File Reference

Meta interface for getting dynamic type information about objects behind capabilities.

```
#include "kobject"
#include "cxx/ipc_iface"
#include "cxx/ipc_string"
```

Include dependency graph for meta:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Meta

  Meta interface that shall be implemented by each L4Re object and gives access to the dynamic type information for L4Re objects.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.552.1 Detailed Description

Meta interface for getting dynamic type information about objects behind capabilities.
Definition in file meta.

16.553 meta

Go to the documentation of this file.

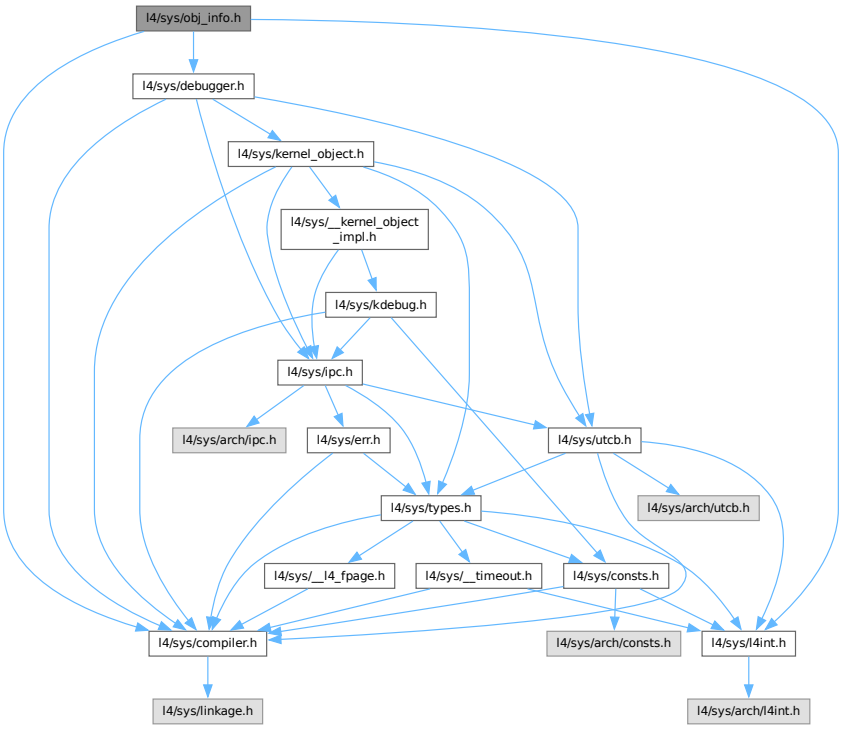
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00007 /*
00008  * (c) 2008-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include "kobject"
00017 #include "cxx/ipc_iface"
00018 #include "cxx/ipc_string"
00019
00020 namespace L4 {
00021
00026 class Meta : public Kobject_t<Meta, Kobject, L4_PROTO_META>
00027 {
00028 public:
00035   L4_INLINE_RPC(l4_msgtag_t, num_interfaces, ());
00036
00050   L4_INLINE_RPC(l4_msgtag_t, interface, (l4_umword_t idx, long *proto,
00051                                          L4::Ipc::String<char> *name));
00052
00064   L4_INLINE_RPC(l4_msgtag_t, supports, (l4_mword_t protocol));
00065
00066   typedef L4::Typeid::Rpcs<num_interfaces_t, interface_t, supports_t> Rpcs;
00067 };
00068
00069 }
```

16.554 l4/sys/obj_info.h File Reference

Debugger related functions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/debugger.h>
```

`#include <l4/sys/l4int.h>`
Include dependency graph for obj_info.h:



Functions

- l4_msgtag_t l4_debugger_query_obj_infos (l4_cap_idx_t cap, l4_addr_t ku_mem_addr, l4_size_t ku_mem↩ _size, l4_umword_t skip, l4_umword_t ∗result_cnt, l4_umword_t ∗result_all) L4_NOTHROW

  Retrieve information from the kernel about all objects in the mapping database and write data to the passed KU memory.

16.554.1 Detailed Description

Debugger related functions.

Attention

This API is subject to change!

Definition in file obj_info.h.

16.554.2 Function Documentation

16.554.2.1 l4_debugger_query_obj_infos()

```
l4_msgtag_t l4_debugger_query_obj_infos (
             l4_cap_idx_t cap,
             l4_addr_t ku_mem_addr,
             l4_size_t ku_mem_size,
             l4_umword_t skip,
             l4_umword_t * result_cnt,
             l4_umword_t * result_all)  [inline]
```

Retrieve information from the kernel about all objects in the mapping database and write data to the passed KU memory.

Parameters

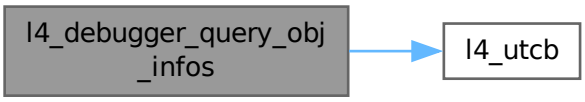
	cap	Capability of the debugger object.
	ku_mem_addr	Address of the KU memory for writing the information.
	ku_mem_size	Size of the KU memory for writing the information.
	skip	Number of objects to skip.
out	*result_cnt*	Number of objects in the mapping database.
out	*result_all*	Number of objects written to the KU memory.

Note

The kernel will only write a number of object information which fits to the passed KU memory. To retrieve missing object information, repeat the call and adapt the `skip` parameter accordingly.

If this system call is performed several times, the number of kernel objects might have changed in the meantime.

Definition at line 177 of file obj_info.h.
References L4_NOTHROW, and l4_utcb().
Here is the call graph for this function:



16.555 obj_info.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2023, 2025 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00014
00015 #pragma once
00016
00017 #include <l4/sys/compiler.h>
00018 #include <l4/sys/debugger.h>
00019 #include <l4/sys/l4int.h>
00020
00021 struct L4_kobj_info
00022 {
00023   // Type_mapping: See Jdb_mapdb::info_obj_mapping().
00024   struct Mapping
00025   {
00026     enum { Type = 0 };
00027     l4_uint64_t mapping_ptr;
00028     char space_name[16];
00029     l4_uint32_t cap_idx;
00030     l4_uint16_t entry_rights;
00031     l4_uint16_t entry_flags;
00032     l4_uint64_t entry_ptr;
00033   };
00034
00035   // Type_thread: See Jdb_tcb::info_kobject().
00036   struct Thread
```

```
00037   {
00038     enum { Type = 1 };
00039     bool is_kernel;
00040     bool is_current;
00041     bool in_ready_list;
00042     bool is_kernel_task;
00043     l4_uint32_t home_cpu;
00044     l4_uint32_t current_cpu;
00045     l4_int64_t ref_cnt;
00046     l4_uint64_t space_id;
00047   };
00048
00049   // Type_space: See Jdb_space::info_kobject().
00050   struct Space
00051   {
00052     enum { Type = 2 };
00053     bool is_kernel;
00054     l4_int64_t ref_cnt;
00055   };
00056
00057   // Type_vm: See Jdb_vm::info_kobject().
00058   struct Vm
00059   {
00060     enum { Type = 3 };
00061     l4_uint64_t utcb;
00062     l4_uint64_t pc;
00063   };
00064
00065   // Type_ipc_gate: See Jdb_ipc_gate::info_kobject().
00066   struct Ipc_gate
00067   {
00068     enum { Type = 4 };
00069     l4_uint64_t label;
00070     l4_uint64_t thread_id;
00071   };
00072
00073   // Type_irq: See Jdb_kobject_irq::info_kobject().
00074   struct Irq_sender
00075   {
00076     enum { Type = 5 };
00077     char chip_type[10];
00078     l4_uint16_t flags;
00079     l4_uint32_t pin;
00080     l4_uint64_t label;
00081     l4_uint64_t target_id;
00082     l4_int64_t queued;
00083   };
00084
00085   // Type_irq: See Jdb_kobject_irq::info_kobject().
00086   struct Irq_semaphore
00087   {
00088     enum { Type = 6 };
00089     char chip_type[10];
00090     l4_uint16_t flags;
00091     l4_uint32_t pin;
00092     l4_uint64_t sender_id;
00093     l4_uint64_t target_id;
00094     l4_int64_t queued;
00095   };
00096
00097   // Type_factory: See Jdb_factory::info_kobject().
00098   struct Factory
00099   {
00100     enum { Type = 7 };
00101     l4_uint64_t current;
00102     l4_uint64_t limit;
00103   };
00104
00105   struct Jdb         { enum { Type =  8 }; };
00106   struct Scheduler   { enum { Type =  9 }; };
00107   struct Vlog        { enum { Type = 10 }; };
00108   struct Pfc         { enum { Type = 11 }; };
00109   struct Dmar_space  { enum { Type = 12 }; };
00110   struct Iommu       { enum { Type = 13 }; };
00111   struct Smmu        { enum { Type = 14 }; };
00112
00113   l4_uint64_t type:5;
00114   l4_uint64_t id:59;
00115   l4_uint64_t mapping_ptr;
00116   l4_uint64_t ref_cnt;
00117   union
00118   {
00119     Thread thread;
00120     Space space;
00121     Vm vm;
00122     Ipc_gate ipc_gate;
00123     Irq_sender irq_sender;
```

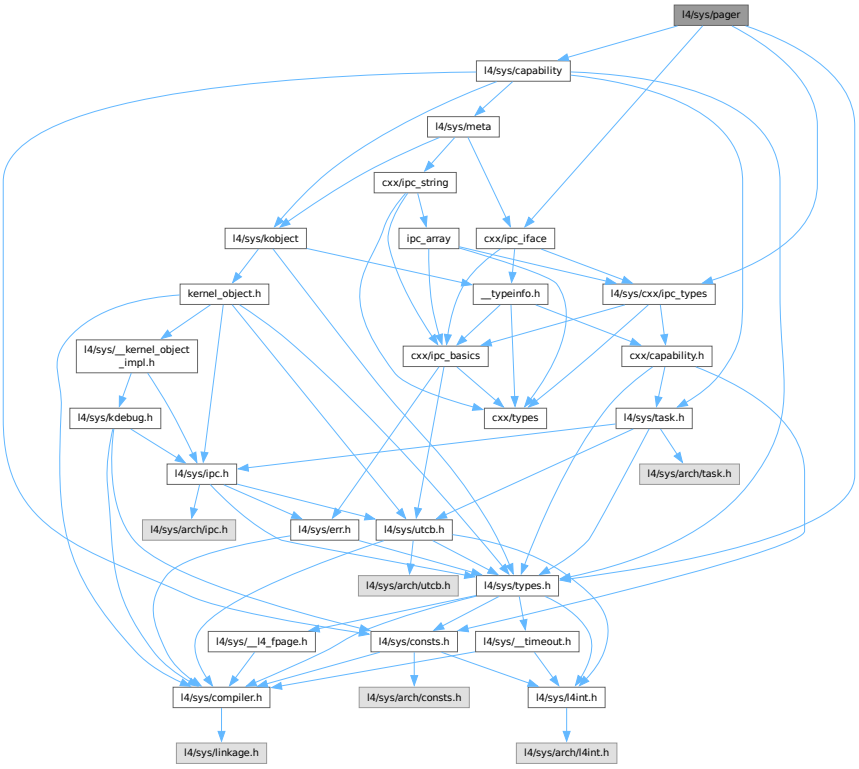
```
00124     Irq_semaphore irq_semaphore;
00125     Factory factory;
00126     Mapping mapping;
00127     l4_uint64_t raw[5];
00128   };
00129 };
00130
00131 static_assert(sizeof(L4_kobj_info) == 64, "Size of Jobj_info");
00132
00151 L4_INLINE l4_msgtag_t
00152 l4_debugger_query_obj_infos(l4_cap_idx_t cap, l4_addr_t ku_mem_addr,
00153                             l4_size_t ku_mem_size, l4_umword_t skip,
00154                             l4_umword_t *result_cnt, l4_umword_t *result_all)
00155                             L4_NOTHROW;
00156
00157 L4_INLINE l4_msgtag_t
00158 l4_debugger_query_obj_infos_u(l4_cap_idx_t cap, l4_addr_t ku_mem_addr,
00159                               l4_size_t ku_mem_size, l4_umword_t skip,
00160                               l4_umword_t *result_cnt, l4_umword_t *result_all,
00161                               l4_utcb_t *utcb) L4_NOTHROW
00162 {
00163   l4_utcb_mr()->mr[0] = L4_DEBUGGER_OBJ_INFO_OP;
00164   l4_utcb_mr()->mr[1] = ku_mem_addr;
00165   l4_utcb_mr()->mr[2] = ku_mem_size;
00166   l4_utcb_mr()->mr[3] = skip;
00167
00168   l4_msgtag_t tag = l4_invoke_debugger(cap, l4_msgtag(0, 4, 0, 0), utcb);
00169
00170   *result_cnt = l4_utcb_mr()->mr[0];
00171   *result_all = l4_utcb_mr()->mr[1];
00172
00173   return tag;
00174 }
00175
00176 L4_INLINE l4_msgtag_t
00177 l4_debugger_query_obj_infos(l4_cap_idx_t cap, l4_addr_t ku_mem_addr,
00178                             l4_size_t ku_mem_size, l4_umword_t skip,
00179                             l4_umword_t *result_cnt, l4_umword_t *result_all)
00180                             L4_NOTHROW
00181 {
00182   return l4_debugger_query_obj_infos_u(cap, ku_mem_addr, ku_mem_size, skip,
00183                                        result_cnt, result_all, l4_utcb());
00184 }
```

16.556 l4/sys/pager File Reference

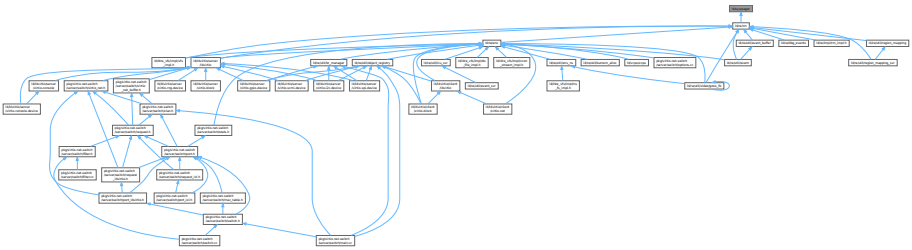
Pager and Io_pager C++ interface.

```
#include <l4/sys/capability>
#include <l4/sys/types.h>
#include <l4/sys/cxx/ipc_types>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for pager:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Io_pager

  Io_pager interface.
- class L4::Pager

  Pager interface including the Io_pager interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.556.1 Detailed Description

Pager and Io_pager C++ interface.
Definition in file pager.

16.557 pager

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/capability>
00015 #include <l4/sys/types.h>
00016 #include <l4/sys/cxx/ipc_types>
00017 #include <l4/sys/cxx/ipc_iface>
00018
00019 namespace L4 {
00020
00051 class L4_EXPORT Io_pager :
00052   public Kobject_0t<Io_pager, L4_PROTO_IO_PAGE_FAULT>
00053 {
00054 public:
00070   L4_INLINE_RPC(
00071       l4_msgtag_t, io_page_fault, (l4_fpage_t io_pfa, l4_umword_t pc,
00072                                    L4::Ipc::Rcv_fpage rwin,
00073                                    L4::Ipc::Opt<L4::Ipc::Snd_fpage &> fp));
00074
00075   typedef L4::Typeid::Rpc_nocode<io_page_fault_t> Rpcs;
00076 };
00077
00088 class L4_EXPORT Pager :
00089   public Kobject_t<Pager, Io_pager, L4_PROTO_PAGE_FAULT>
00090 {
00091 public:
00124   L4_INLINE_RPC(
00125       l4_msgtag_t, page_fault, (l4_umword_t pfa, l4_umword_t pc,
00126                                 L4::Ipc::Rcv_fpage rwin,
00127                                 L4::Ipc::Opt<L4::Ipc::Snd_fpage &> fp));
00128
00129   typedef L4::Typeid::Rpc_nocode<page_fault_t> Rpcs;
00130 };
00131
00132 }
```

16.558 amd64/l4/sys/arch/pf_trampoline.h File Reference

Page fault trampoline handler definitions for AMD64.

Data Structures

- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

16.558.1 Detailed Description

Page fault trampoline handler definitions for AMD64.
Definition in file pf_trampoline.h.

16.559 pf_trampoline.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012
00013 #pragma once
00014
00019
00024 struct l4_pf_trampoline_regs_t
```

```
00025 {
00026   l4_umword_t reserved1[11]; // r15..r8, rdi, rsi, rbp
00027   l4_umword_t pfa;
00028   l4_umword_t reserved2[4];  // rbx, rdx, rcx, rax
00029   l4_umword_t reserved3[2];  // trapno, err
00030   l4_umword_t ip;
00031   l4_umword_t reserved4[4];  // cs, rflags, sp, ss
00032 };
```

16.560 arm/l4/sys/arch/pf_trampoline.h File Reference

Page fault trampoline handler definitions for ARM.

Data Structures

- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

16.560.1 Detailed Description

Page fault trampoline handler definitions for ARM.
Definition in file pf_trampoline.h.

16.561 pf_trampoline.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012
00013 #pragma once
00014
00019
00024 struct l4_pf_trampoline_regs_t
00025 {
00026   l4_umword_t pfa;
00027   l4_umword_t reserved1[1];  // err
00028   l4_umword_t reserved2[16]; // GP registers, sp, ulr, dummy
00029   l4_umword_t ip;
00030   l4_umword_t reserved3[1];  // cpsr
00031 };
```

16.562 arm64/l4/sys/arch/pf_trampoline.h File Reference

Page fault trampoline handler definitions for ARM64.

Data Structures

- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

16.562.1 Detailed Description

Page fault trampoline handler definitions for ARM64.
Definition in file pf_trampoline.h.

16.563 pf_trampoline.h

Go to the documentation of this file.

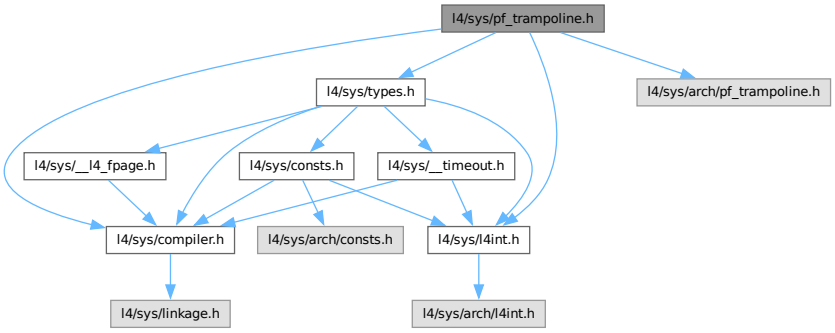
```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012
00013 #pragma once
00014
00019
00024 struct l4_pf_trampoline_regs_t
00025 {
00026   l4_umword_t reserved1[34]; // eret_work, GP registers, err
00027   l4_umword_t pfa;
00028   l4_umword_t reserved2[1];  // sp
00029   l4_umword_t ip;
00030   l4_umword_t reserved3[1];  // pstate
00031 };
```

16.564 l4/sys/pf_trampoline.h File Reference

Page fault trampoline handlers.

```
#include <l4/sys/types.h>
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
#include <l4/sys/arch/pf_trampoline.h>
```

Include dependency graph for pf_trampoline.h:



Data Structures

- struct l4_pf_trampoline_t

  State for page fault trampoline handler.

Typedefs

- typedef struct l4_pf_trampoline_regs_t **l4_pf_trampoline_regs_t**

  Opaque type for the page fault trampoline register state.
- typedef struct l4_pf_trampoline_t l4_pf_trampoline_t

  Opaque type for the page fault trampoline state.

Enumerations

- enum L4_pf_trampoline_flags { Page_fault_in_progress = 1 << 0 , Trigger_exception_after_resume = 1 << 1 }

  Definitions for l4_pf_trampoline_t::flags.

16.564.1 Detailed Description

Page fault trampoline handlers.
Definition in file pf_trampoline.h.

16.565 pf_trampoline.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012
00013 #pragma once
00014
00015 #include <l4/sys/types.h>
00016 #include <l4/sys/compiler.h>
00017 #include <l4/sys/l4int.h>
00018
00035
00040 enum L4_pf_trampoline_flags
00041 {
00048   Page_fault_in_progress = 1 « 0,
00062   Trigger_exception_after_resume = 1 « 1,
00063 };
00064
00069 typedef struct l4_pf_trampoline_regs_t l4_pf_trampoline_regs_t;
00070
00075 typedef struct l4_pf_trampoline_t l4_pf_trampoline_t;
00076
00077 #include <l4/sys/arch/pf_trampoline.h>
00078
00079
00084 typedef struct l4_pf_trampoline_t
00085 {
00086   l4_umword_t   handler_ip;
00087   l4_umword_t   user_data[2];
00088   l4_umword_t   saved_mr0;
00089   l4_umword_t   flags;
00090   l4_pf_trampoline_regs_t state;
00091 } l4_pf_trampoline_t;
```

16.566 riscv/l4/sys/arch/pf_trampoline.h File Reference

Page fault trampoline handler definitions for RISC-V.

Data Structures

- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

16.566.1 Detailed Description

Page fault trampoline handler definitions for RISC-V.
Definition in file pf_trampoline.h.

16.567 pf_trampoline.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012
00013 #pragma once
```

```
00014
00019
00024 struct l4_pf_trampoline_regs_t
00025 {
00026   l4_umword_t reserved1[1];  // eret_work
00027   l4_umword_t reserved2[31]; // GP registers
00028   l4_umword_t ip;
00029   l4_umword_t reserved3[2];  // status, cause
00030   l4_umword_t pfa;
00031   l4_umword_t reserved4[1];  // hstatus
00032 };
```

16.568 x86/l4/sys/arch/pf_trampoline.h File Reference

Page fault trampoline handler definitions for x86.

Data Structures

- struct l4_pf_trampoline_regs_t

  Register state for page fault trampoline handlers.

16.568.1 Detailed Description

Page fault trampoline handler definitions for x86.
Definition in file pf_trampoline.h.

16.569 pf_trampoline.h

Go to the documentation of this file.

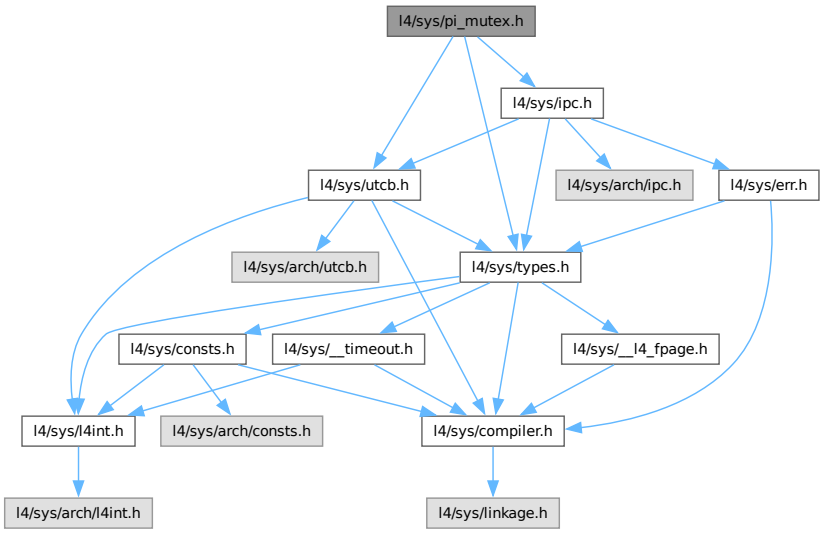
```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012
00013 #pragma once
00014
00019
00024 struct l4_pf_trampoline_regs_t
00025 {
00026   l4_umword_t reserved1[4]; // es, ds, gs, fs
00027   l4_umword_t reserved2[3]; // edi, esi, ebp
00028   l4_umword_t pfa;
00029   l4_umword_t reserved3[4]; // ebx, edx, ecx, eax
00030   l4_umword_t reserved4[2]; // trapno, err
00031   l4_umword_t ip;
00032   l4_umword_t reserved5[4]; // cs, eflags, sp, ss
00033 };
```

16.570 l4/sys/pi_mutex.h File Reference

Priority Inheritance Mutex object.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for pi_mutex.h:



Enumerations

- enum L4_pi_mutex_ops { L4_PI_MUTEX_LOCK_OP = 0UL , L4_PI_MUTEX_UNLOCK_OP = 1UL }

  Operations on priority inheritance mutex objects.

Functions

- l4_msgtag_t l4_pi_mutex_lock (l4_cap_idx_t mutex, l4_timeout_t timeout) L4_NOTHROW

  Lock contended priority inheritance mutex on slow path.
- l4_msgtag_t l4_pi_mutex_unlock (l4_cap_idx_t mutex) L4_NOTHROW

  Unlock contended priority inheritance mutex from fast path or slow path.

16.570.1 Detailed Description

Priority Inheritance Mutex object.
Definition in file pi_mutex.h.

16.571 pi_mutex.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * Copyright (C) 2025-2026 Kernkonzept GmbH.
00007  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015 #include <l4/sys/utcb.h>
00016
00049
00072 L4_INLINE l4_msgtag_t
00073 l4_pi_mutex_lock(l4_cap_idx_t mutex, l4_timeout_t timeout) L4_NOTHROW;
00074
00078 L4_INLINE l4_msgtag_t
00079 l4_pi_mutex_lock_u(l4_cap_idx_t mutex, l4_timeout_t timeout,
```

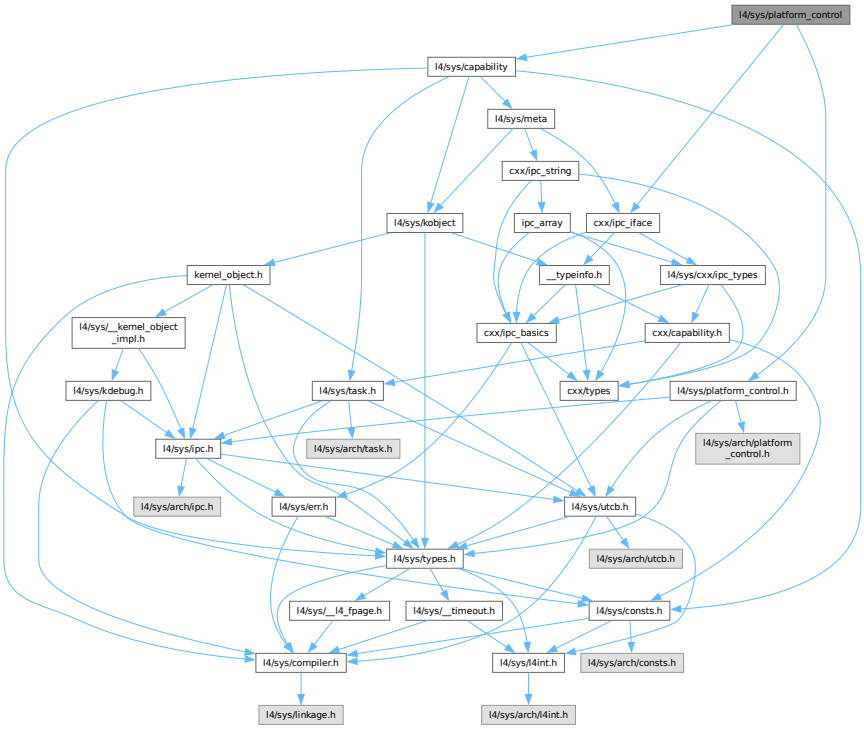
```
00080                   l4_utcb_t *utcb) L4_NOTHROW;
00081
00094 L4_INLINE l4_msgtag_t
00095 l4_pi_mutex_unlock(l4_cap_idx_t mutex) L4_NOTHROW;
00096
00100 L4_INLINE l4_msgtag_t
00101 l4_pi_mutex_unlock_u(l4_cap_idx_t mutex, l4_utcb_t *utcb) L4_NOTHROW;
00102  /* ends l4_pi_mutex_api group */
00104
00105
00114 enum L4_pi_mutex_ops
00115 {
00116   L4_PI_MUTEX_LOCK_OP      = 0UL,
00117   L4_PI_MUTEX_UNLOCK_OP    = 1UL,
00118 };
00119
00120 /* IMPLEMENTATION ---------------------------------------------------------*/
00121
00122 #include <l4/sys/ipc.h>
00123
00124 L4_INLINE l4_msgtag_t
00125 l4_pi_mutex_lock_u(l4_cap_idx_t mutex, l4_timeout_t timeout,
00126                    l4_utcb_t *utcb) L4_NOTHROW
00127 {
00128   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00129   v->mr[0] = L4_PI_MUTEX_LOCK_OP;
00130   return l4_ipc_call(mutex, utcb, l4_msgtag(L4_PROTO_PI_MUTEX, 1, 0, 0),
00131                      timeout);
00132 }
00133
00134 L4_INLINE l4_msgtag_t
00135 l4_pi_mutex_unlock_u(l4_cap_idx_t mutex, l4_utcb_t *utcb) L4_NOTHROW
00136 {
00137   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00138   v->mr[0] = L4_PI_MUTEX_UNLOCK_OP;
00139   return l4_ipc_call(mutex, utcb, l4_msgtag(L4_PROTO_PI_MUTEX, 1, 0, 0),
00140                      L4_IPC_NEVER);
00141 }
00142
00143
00144 L4_INLINE l4_msgtag_t
00145 l4_pi_mutex_lock(l4_cap_idx_t mutex, l4_timeout_t timeout) L4_NOTHROW
00146 {
00147   return l4_pi_mutex_lock_u(mutex, timeout, l4_utcb());
00148 }
00149
00150 L4_INLINE l4_msgtag_t
00151 l4_pi_mutex_unlock(l4_cap_idx_t mutex) L4_NOTHROW
00152 {
00153   return l4_pi_mutex_unlock_u(mutex, l4_utcb());
00154 }
```

16.572 l4/sys/platform_control File Reference

Platform control object.

```
#include <l4/sys/capability>
#include <l4/sys/platform_control.h>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for platform_control:



Data Structures

- class L4::Platform_control

  L4 C++ interface for controlling platform-wide properties, see Platform Control C API for the C interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.572.1 Detailed Description

Platform control object.
Definition in file platform_control.

16.573 platform_control

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2014 Steffen Liebergeld <steffen.liebergeld@kernkonzept.com>
00008  *          Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #pragma once
00016
00017 #include <l4/sys/capability>
00018 #include <l4/sys/platform_control.h>
00019 #include <l4/sys/cxx/ipc_iface>
```

```
00020
00021 namespace L4 {
00022
00036 class L4_EXPORT Platform_control
00037 : public Kobject_t<Platform_control, Kobject, L4_PROTO_PLATFORM_CTL>
00038 {
00039 public:
00054   L4_INLINE_RPC_OP(L4_PLATFORM_CTL_SYS_SUSPEND_OP,
00055                    l4_msgtag_t, system_suspend, (l4_umword_t extras));
00056
00062   L4_INLINE_RPC_OP(L4_PLATFORM_CTL_SYS_SHUTDOWN_OP,
00063                    l4_msgtag_t, system_shutdown, (l4_umword_t reboot));
00064
00074   L4_INLINE_RPC_OP(L4_PLATFORM_CTL_CPU_ALLOW_SHUTDOWN_OP,
00075                    l4_msgtag_t, cpu_allow_shutdown,
00076                    (l4_umword_t phys_id, l4_umword_t enable));
00077
00087   L4_INLINE_RPC_OP(L4_PLATFORM_CTL_CPU_ENABLE_OP,
00088                    l4_msgtag_t, cpu_enable, (l4_umword_t phys_id));
00089
00099   L4_INLINE_RPC_OP(L4_PLATFORM_CTL_CPU_DISABLE_OP,
00100                    l4_msgtag_t, cpu_disable, (l4_umword_t phys_id));
00101
00102   typedef L4::Typeid::Rpcs_sys<system_suspend_t, system_shutdown_t,
00103                                cpu_allow_shutdown_t, cpu_enable_t,
00104                                cpu_disable_t> Rpcs;
00105 };
00106
00107 }
00108
```

16.574 platform_control.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.575 platform_control.h

```
00001 /*
00002  * Copyright (C) 2024 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/__platform_control-arm.h>
```

16.576 platform_control.h

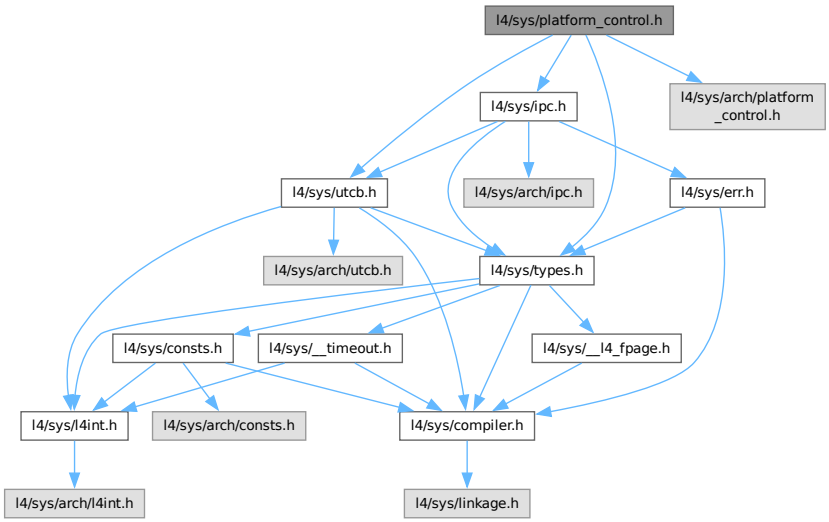
```
00001 /*
00002  * Copyright (C) 2024 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/__platform_control-arm.h>
```

16.577 l4/sys/platform_control.h File Reference

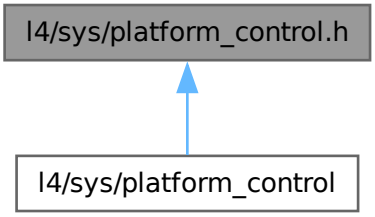
Platform control object.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
```

`#include <l4/sys/arch/platform_control.h>`
Include dependency graph for platform_control.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum L4_platform_ctl_ops {
  L4_PLATFORM_CTL_SYS_SUSPEND_OP = 0UL , L4_PLATFORM_CTL_SYS_SHUTDOWN_OP = 1UL ,
  L4_PLATFORM_CTL_CPU_ALLOW_SHUTDOWN_OP = 2UL , L4_PLATFORM_CTL_CPU_ENABLE_OP =
  3UL ,
  L4_PLATFORM_CTL_CPU_DISABLE_OP = 4UL , L4_PLATFORM_CTL_SET_TASK_ASID_OP = 0x10UL }

  Operations on platform-control objects.

Functions

- l4_msgtag_t l4_platform_ctl_system_suspend (l4_cap_idx_t pfc, l4_umword_t extras) L4_NOTHROW

  Enter suspend to RAM.
- l4_msgtag_t l4_platform_ctl_system_shutdown (l4_cap_idx_t pfc, l4_umword_t reboot) L4_NOTHROW

  Shutdown or reboot the system.

- l4_msgtag_t l4_platform_ctl_cpu_allow_shutdown (l4_cap_idx_t pfc, l4_umword_t phys_id, l4_umword_t enable) L4_NOTHROW

  Allow a CPU to be shut down.
- l4_msgtag_t l4_platform_ctl_cpu_enable (l4_cap_idx_t pfc, l4_umword_t phys_id) L4_NOTHROW

  Enable an offline CPU.
- l4_msgtag_t l4_platform_ctl_cpu_disable (l4_cap_idx_t pfc, l4_umword_t phys_id) L4_NOTHROW

  Disable an online CPU.

16.577.1 Detailed Description

Platform control object.
Definition in file platform_control.h.

16.578 platform_control.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2014 Alexander Warg <alexander.warg@kernkonzept.com>
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010
00011 #pragma once
00012
00013 #include <l4/sys/types.h>
00014 #include <l4/sys/utcb.h>
00015
00030
00031
00049 L4_INLINE l4_msgtag_t
00050 l4_platform_ctl_system_suspend(l4_cap_idx_t pfc,
00051                                l4_umword_t extras) L4_NOTHROW;
00052
00056 L4_INLINE l4_msgtag_t
00057 l4_platform_ctl_system_suspend_u(l4_cap_idx_t pfc,
00058                                  l4_umword_t extras,
00059                                  l4_utcb_t *utcb) L4_NOTHROW;
00060
00061
00070 L4_INLINE l4_msgtag_t
00071 l4_platform_ctl_system_shutdown(l4_cap_idx_t pfc,
00072                                 l4_umword_t reboot) L4_NOTHROW;
00073
00077 L4_INLINE l4_msgtag_t
00078 l4_platform_ctl_system_shutdown_u(l4_cap_idx_t pfc,
00079                                   l4_umword_t reboot,
00080                                   l4_utcb_t *utcb) L4_NOTHROW;
00081
00091 L4_INLINE l4_msgtag_t
00092 l4_platform_ctl_cpu_allow_shutdown(l4_cap_idx_t pfc,
00093                                    l4_umword_t phys_id,
00094                                    l4_umword_t enable) L4_NOTHROW;
00095
00099 L4_INLINE l4_msgtag_t
00100 l4_platform_ctl_cpu_allow_shutdown_u(l4_cap_idx_t pfc,
00101                                      l4_umword_t phys_id,
00102                                      l4_umword_t enable,
00103                                      l4_utcb_t *utcb) L4_NOTHROW;
00114 L4_INLINE l4_msgtag_t
00115 l4_platform_ctl_cpu_enable(l4_cap_idx_t pfc,
00116                            l4_umword_t phys_id) L4_NOTHROW;
00117
00121 L4_INLINE l4_msgtag_t
00122 l4_platform_ctl_cpu_enable_u(l4_cap_idx_t pfc,
00123                              l4_umword_t phys_id,
00124                              l4_utcb_t *utcb) L4_NOTHROW;
00125
00136 L4_INLINE l4_msgtag_t
00137 l4_platform_ctl_cpu_disable(l4_cap_idx_t pfc,
00138                             l4_umword_t phys_id) L4_NOTHROW;
00139
00143 L4_INLINE l4_msgtag_t
00144 l4_platform_ctl_cpu_disable_u(l4_cap_idx_t pfc,
00145                               l4_umword_t phys_id,
00146                               l4_utcb_t *utcb) L4_NOTHROW;
00147  /* ends l4_platform_control_api group */
```

```
00149
00150
00159 enum L4_platform_ctl_ops
00160 {
00161   L4_PLATFORM_CTL_SYS_SUSPEND_OP        = 0UL,
00162   L4_PLATFORM_CTL_SYS_SHUTDOWN_OP       = 1UL,
00163   L4_PLATFORM_CTL_CPU_ALLOW_SHUTDOWN_OP = 2UL,
00164   L4_PLATFORM_CTL_CPU_ENABLE_OP         = 3UL,
00165   L4_PLATFORM_CTL_CPU_DISABLE_OP        = 4UL,
00166
00167   L4_PLATFORM_CTL_SET_TASK_ASID_OP      = 0x10UL,
00168 };
00169
00170 /* IMPLEMENTATION ---------------------------------------------------------*/
00171
00172 #include <l4/sys/ipc.h>
00173
00174 L4_INLINE l4_msgtag_t
00175 l4_platform_ctl_system_suspend_u(l4_cap_idx_t pfc,
00176                                  l4_umword_t extras,
00177                                  l4_utcb_t *utcb) L4_NOTHROW
00178 {
00179   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00180   v->mr[0] = L4_PLATFORM_CTL_SYS_SUSPEND_OP;
00181   v->mr[1] = extras;
00182   return l4_ipc_call(pfc, utcb, l4_msgtag(L4_PROTO_PLATFORM_CTL, 2, 0, 0),
00183                                          L4_IPC_NEVER);
00184 }
00185
00186 L4_INLINE l4_msgtag_t
00187 l4_platform_ctl_system_shutdown_u(l4_cap_idx_t pfc,
00188                                   l4_umword_t reboot,
00189                                   l4_utcb_t *utcb) L4_NOTHROW
00190 {
00191   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00192   v->mr[0] = L4_PLATFORM_CTL_SYS_SHUTDOWN_OP;
00193   v->mr[1] = reboot;
00194   return l4_ipc_call(pfc, utcb, l4_msgtag(L4_PROTO_PLATFORM_CTL, 2, 0, 0),
00195                                          L4_IPC_NEVER);
00196 }
00197
00198
00199 L4_INLINE l4_msgtag_t
00200 l4_platform_ctl_system_suspend(l4_cap_idx_t pfc,
00201                                l4_umword_t extras) L4_NOTHROW
00202 {
00203   return l4_platform_ctl_system_suspend_u(pfc, extras, l4_utcb());
00204 }
00205
00206 L4_INLINE l4_msgtag_t
00207 l4_platform_ctl_system_shutdown(l4_cap_idx_t pfc,
00208                                 l4_umword_t reboot) L4_NOTHROW
00209 {
00210   return l4_platform_ctl_system_shutdown_u(pfc, reboot, l4_utcb());
00211 }
00212
00213 L4_INLINE l4_msgtag_t
00214 l4_platform_ctl_cpu_allow_shutdown_u(l4_cap_idx_t pfc,
00215                                      l4_umword_t phys_id,
00216                                      l4_umword_t enable,
00217                                      l4_utcb_t *utcb) L4_NOTHROW
00218 {
00219   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00220   v->mr[0] = L4_PLATFORM_CTL_CPU_ALLOW_SHUTDOWN_OP;
00221   v->mr[1] = phys_id;
00222   v->mr[2] = enable;
00223   return l4_ipc_call(pfc, utcb, l4_msgtag(L4_PROTO_PLATFORM_CTL, 3, 0, 0),
00224                                          L4_IPC_NEVER);
00225 }
00226
00227 L4_INLINE l4_msgtag_t
00228 l4_platform_ctl_cpu_allow_shutdown(l4_cap_idx_t pfc,
00229                                    l4_umword_t phys_id,
00230                                    l4_umword_t enable) L4_NOTHROW
00231 {
00232   return l4_platform_ctl_cpu_allow_shutdown_u(pfc, phys_id, enable, l4_utcb());
00233 }
00234
00235 L4_INLINE l4_msgtag_t
00236 l4_platform_ctl_cpu_enable_u(l4_cap_idx_t pfc,
00237                              l4_umword_t phys_id,
00238                              l4_utcb_t *utcb) L4_NOTHROW
00239 {
00240   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00241   v->mr[0] = L4_PLATFORM_CTL_CPU_ENABLE_OP;
00242   v->mr[1] = phys_id;
00243   return l4_ipc_call(pfc, utcb, l4_msgtag(L4_PROTO_PLATFORM_CTL, 2, 0, 0),
```

```
00244                                           L4_IPC_NEVER);
00245 }
00246
00247 L4_INLINE l4_msgtag_t
00248 l4_platform_ctl_cpu_disable_u(l4_cap_idx_t pfc,
00249                               l4_umword_t phys_id,
00250                               l4_utcb_t *utcb) L4_NOTHROW
00251 {
00252   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00253   v->mr[0] = L4_PLATFORM_CTL_CPU_DISABLE_OP;
00254   v->mr[1] = phys_id;
00255   return l4_ipc_call(pfc, utcb, l4_msgtag(L4_PROTO_PLATFORM_CTL, 2, 0, 0),
00256                                           L4_IPC_NEVER);
00257 }
00258
00259 L4_INLINE l4_msgtag_t
00260 l4_platform_ctl_cpu_enable(l4_cap_idx_t pfc,
00261                            l4_umword_t phys_id) L4_NOTHROW
00262 {
00263   return l4_platform_ctl_cpu_enable_u(pfc, phys_id, l4_utcb());
00264 }
00265
00266 L4_INLINE l4_msgtag_t
00267 l4_platform_ctl_cpu_disable(l4_cap_idx_t pfc,
00268                             l4_umword_t phys_id) L4_NOTHROW
00269 {
00270   return l4_platform_ctl_cpu_disable_u(pfc, phys_id, l4_utcb());
00271 }
00272
00273 #include <l4/sys/arch/platform_control.h>
```

16.579 platform_control.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.580 platform_control.h

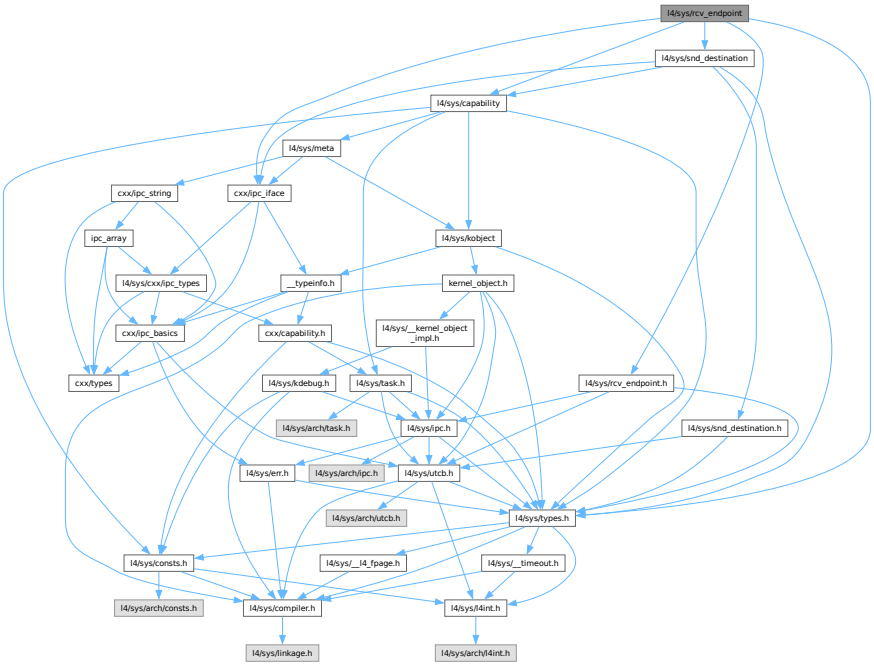
```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.581 l4/sys/rcv_endpoint File Reference

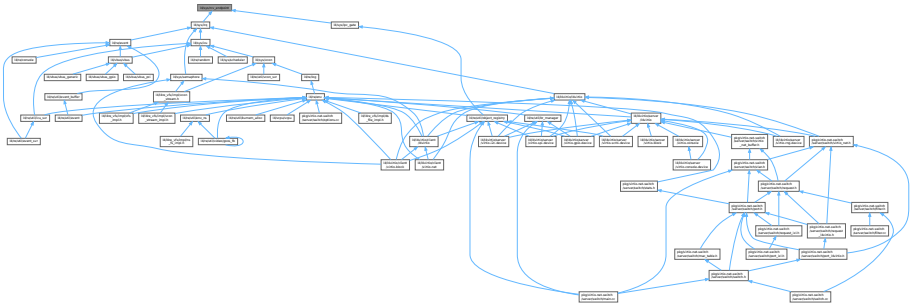
The C++ Receive endpoint interface.

```
#include <l4/sys/rcv_endpoint.h>
#include <l4/sys/snd_destination>
#include <l4/sys/types.h>
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for rcv_endpoint:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Rcv_endpoint

  Interface for kernel objects that allow to receive IPC from them.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.581.1 Detailed Description

The C++ Receive endpoint interface.
Definition in file rcv_endpoint.

16.582 rcv_endpoint

Go to the documentation of this file.

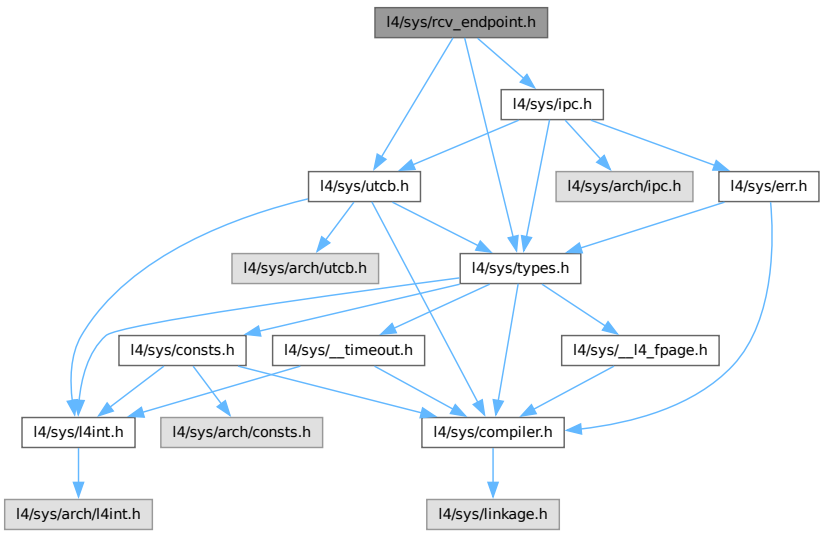
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2017 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/rcv_endpoint.h>
00014 #include <l4/sys/snd_destination>
00015 #include <l4/sys/types.h>
00016 #include <l4/sys/capability>
00017 #include <l4/sys/cxx/ipc_iface>
00018
00019 namespace L4 {
00020
00021 class Thread;
00022
00030 class L4_EXPORT Rcv_endpoint :
00031   public Kobject_t<Rcv_endpoint, Kobject, L4_PROTO_KOBJECT,
00032                    Type_info::Demand_t<1> >
00033 {
00034 public:
00066   L4_INLINE_RPC_OP(L4_RCV_EP_BIND_OP,
00067       l4_msgtag_t, bind_thread, (Ipc::Cap<Thread> t, l4_umword_t label));
00068
00101   l4_msgtag_t bind_snd_destination(Cap<Snd_destination> snd_dst, l4_umword_t label)
00102   {
00103     return l4_rcv_ep_bind_snd_destination(cap(), snd_dst.cap(), label);
00104   }
00105
00106   typedef L4::Typeid::Rpcs_sys<bind_thread_t> Rpcs;
00107 };
00108
00109 }
```

16.583 l4/sys/rcv_endpoint.h File Reference

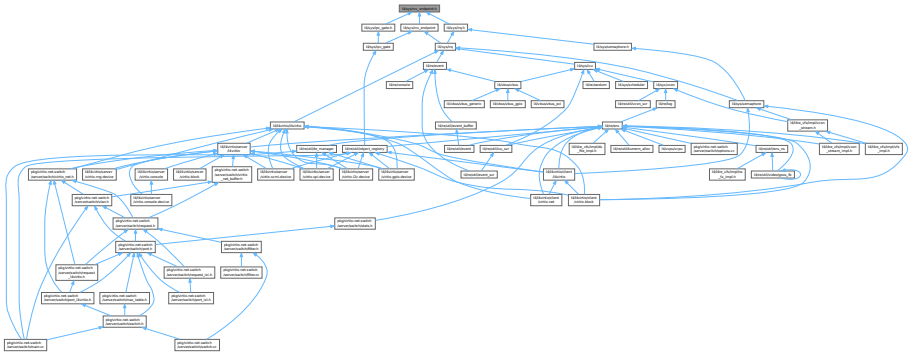
Receive endpoint C interface.

```
#include <l4/sys/utcb.h>
#include <l4/sys/types.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for rcv_endpoint.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum L4_rcv_ep_ops { L4_RCV_EP_BIND_OP = 0x10 }

  Receive endpoint operations.

Functions

- l4_msgtag_t l4_rcv_ep_bind_thread (l4_cap_idx_t ep, l4_cap_idx_t thread, l4_umword_t label)

  Bind the IPC receive endpoint to a thread.
- l4_msgtag_t l4_rcv_ep_bind_snd_destination (l4_cap_idx_t ep, l4_cap_idx_t snd_dst, l4_umword_t label)

  Bind the IPC receive endpoint to a send destination (a thread).

16.583.1 Detailed Description

Receive endpoint C interface.
Definition in file rcv_endpoint.h.

16.583.2 Enumeration Type Documentation

16.583.2.1 L4_rcv_ep_ops

`enum L4_rcv_ep_ops`
Receive endpoint operations.

Enumerator

L4_RCV_EP_BIND_OP	Bind to thread or thread group.

Definition at line 93 of file rcv_endpoint.h.

16.584 rcv_endpoint.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2017 Alexander Warg <alexander.warg@kernkonzept.com>
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #pragma once
00011
00012 #include <l4/sys/utcb.h>
00013 #include <l4/sys/types.h>
00014
```

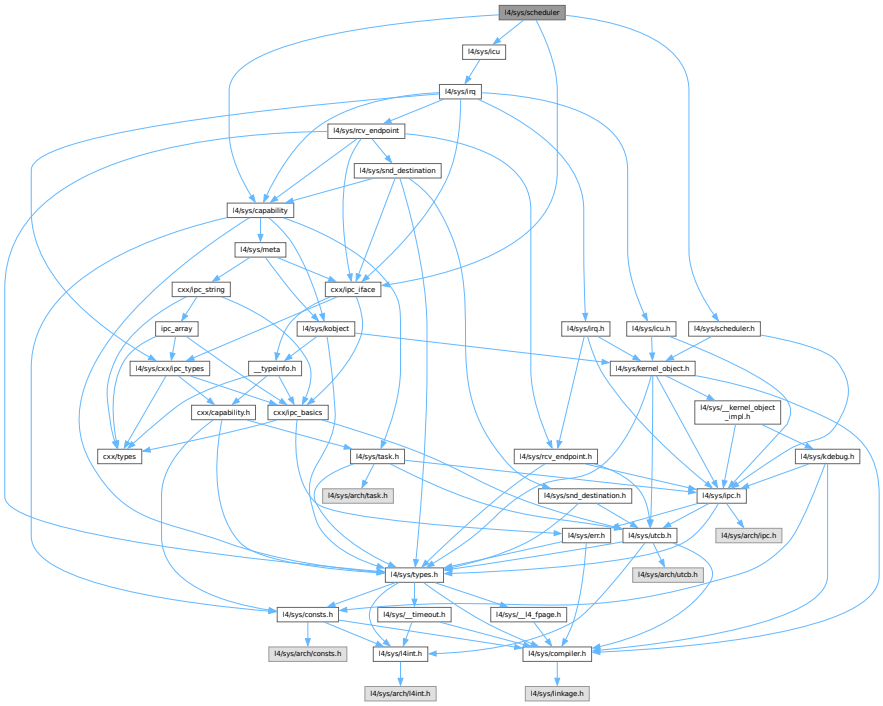
```
00045 L4_INLINE l4_msgtag_t
00046 l4_rcv_ep_bind_thread(l4_cap_idx_t ep, l4_cap_idx_t thread,
00047                       l4_umword_t label);
00048
00076 L4_INLINE l4_msgtag_t
00077 l4_rcv_ep_bind_snd_destination(l4_cap_idx_t ep, l4_cap_idx_t snd_dst,
00078                                 l4_umword_t label);
00079
00084 L4_INLINE l4_msgtag_t
00085 l4_rcv_ep_bind_thread_u(l4_cap_idx_t ep, l4_cap_idx_t thread,
00086                         l4_umword_t label, l4_utcb_t *utcb);
00087
00088 L4_INLINE l4_msgtag_t
00089 l4_rcv_ep_bind_snd_destination_u(l4_cap_idx_t ep, l4_cap_idx_t snd_dst,
00090                                  l4_umword_t label, l4_utcb_t *utcb);
00091
00093 enum L4_rcv_ep_ops
00094 {
00095   L4_RCV_EP_BIND_OP     = 0x10,
00096 };
00097
00098 /* IMPLEMENTATION ---------------------------------------------------------*/
00099
00100 #include <l4/sys/ipc.h>
00101
00102 L4_INLINE l4_msgtag_t
00103 l4_rcv_ep_bind_thread_u(l4_cap_idx_t ep,
00104                         l4_cap_idx_t thread, l4_umword_t label,
00105                         l4_utcb_t *utcb)
00106 {
00107   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00108   m->mr[0] = L4_RCV_EP_BIND_OP;
00109   m->mr[1] = label;
00110   m->mr[2] = l4_map_obj_control(0, 0);
00111   m->mr[3] = l4_obj_fpage(thread, 0, L4_CAP_FPAGE_RWS).raw;
00112   return l4_ipc_call(ep, utcb, l4_msgtag(L4_PROTO_KOBJECT, 2, 1, 0),
00113                      L4_IPC_NEVER);
00114 }
00115
00116 L4_INLINE l4_msgtag_t
00117 l4_rcv_ep_bind_snd_destination_u(l4_cap_idx_t ep,
00118                                  l4_cap_idx_t snd_dst, l4_umword_t label,
00119                                  l4_utcb_t *utcb)
00120 {
00121   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00122   m->mr[0] = L4_RCV_EP_BIND_OP;
00123   m->mr[1] = label;
00124   m->mr[2] = l4_map_obj_control(0, 0);
00125   m->mr[3] = l4_obj_fpage(snd_dst, 0, L4_CAP_FPAGE_RWS).raw;
00126   return l4_ipc_call(ep, utcb, l4_msgtag(L4_PROTO_KOBJECT, 2, 1, 0),
00127                      L4_IPC_NEVER);
00128 }
00129
00130 L4_INLINE l4_msgtag_t
00131 l4_rcv_ep_bind_thread(l4_cap_idx_t ep, l4_cap_idx_t thread,
00132                       l4_umword_t label)
00133 {
00134   return l4_rcv_ep_bind_thread_u(ep, thread, label, l4_utcb());
00135 }
00136
00137 L4_INLINE l4_msgtag_t
00138 l4_rcv_ep_bind_snd_destination(l4_cap_idx_t ep, l4_cap_idx_t snd_dst,
00139                                l4_umword_t label)
00140 {
00141   return l4_rcv_ep_bind_snd_destination_u(ep, snd_dst, label, l4_utcb());
00142 }
```

16.585 l4/sys/scheduler File Reference

Scheduler object functions.

```
#include <l4/sys/icu>
#include <l4/sys/scheduler.h>
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for scheduler:



Data Structures

- class L4::Scheduler

  C++ interface of the Scheduler kernel object, see Scheduler for the C interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.585.1 Detailed Description

Scheduler object functions.
Definition in file scheduler.

16.586 scheduler

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/icu>
00016 #include <l4/sys/scheduler.h>
00017 #include <l4/sys/capability>
00018 #include <l4/sys/cxx/ipc_iface>
00019
00020 namespace L4 {
00021
```

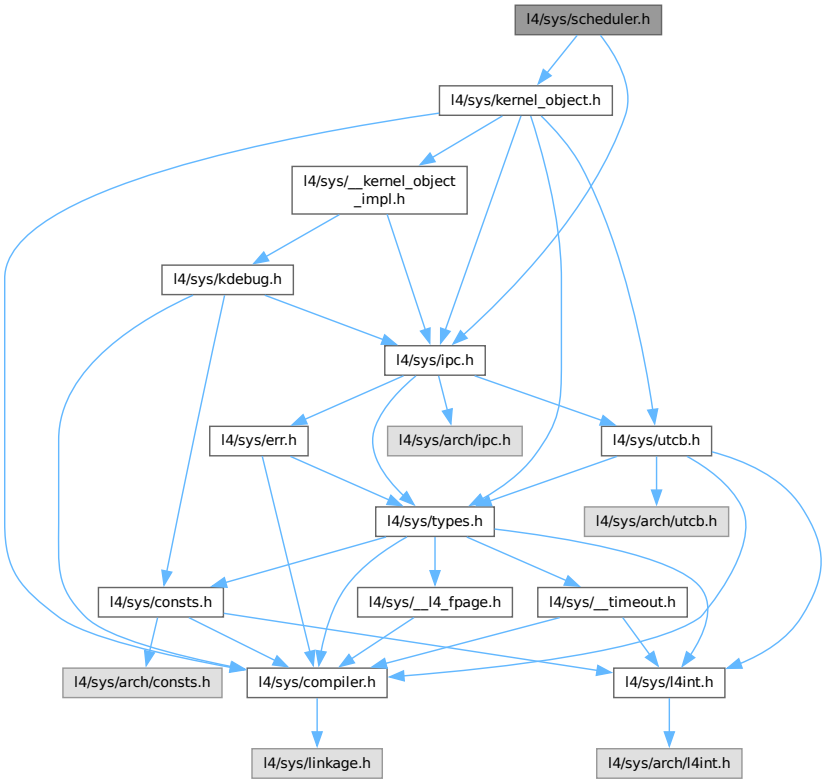
```
00046 class L4_EXPORT Scheduler :
00047   public Kobject_t<Scheduler, Icu, L4_PROTO_SCHEDULER,
00048                    Type_info::Demand_t<1> >
00049 {
00050 public:
00051   // ABI function for 'info' call
00052   L4_INLINE_RPC_NF_OP(L4_SCHEDULER_INFO_OP,
00053       l4_msgtag_t, info, (l4_umword_t gran_offset, l4_umword_t *map,
00054                           l4_umword_t *cpu_max, l4_umword_t *sched_classes));
00055
00074   l4_msgtag_t info(l4_umword_t *cpu_max, l4_sched_cpu_set_t *cpus,
00075                    l4_umword_t *sched_classes = nullptr,
00076                    l4_utcb_t *utcb = l4_utcb()) const noexcept
00077   {
00078     l4_umword_t max = 0;
00079     l4_umword_t sc = 0;
00080     l4_msgtag_t t =
00081       info_t::call(c(), cpus->gran_offset, &cpus->map, &max, &sc, utcb);
00082     if (cpu_max)
00083       *cpu_max = max;
00084     if (sched_classes)
00085       *sched_classes = sc;
00086     return t;
00087   }
00088
00112   L4_INLINE_RPC_OP(L4_SCHEDULER_RUN_THREAD_OP,
00113       l4_msgtag_t, run_thread, (Ipc::Cap<Thread> thread, l4_sched_param_t const &sp));
00114
00141   L4_INLINE_RPC_OP(L4_SCHEDULER_IDLE_TIME_OP,
00142       l4_msgtag_t, idle_time, (l4_sched_cpu_set_t const &cpus,
00143                                l4_kernel_clock_t *us));
00144
00154   bool is_online(l4_umword_t cpu, l4_utcb_t *utcb = l4_utcb()) const noexcept
00155   { return l4_scheduler_is_online_u(cap(), cpu, utcb); }
00156
00157   typedef L4::Typeid::Rpcs_sys<info_t, run_thread_t, idle_time_t> Rpcs;
00158 };
00159 }
```

16.587 l4/sys/scheduler.h File Reference

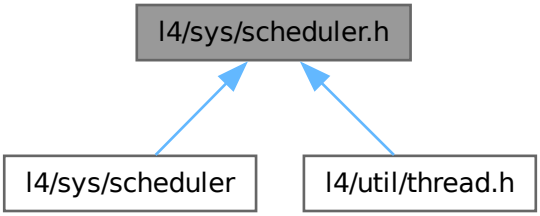
Scheduler object functions.

```
#include <l4/sys/kernel_object.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for scheduler.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4_sched_cpu_set_t
  CPU sets.
- struct l4_sched_param_t
  Scheduler parameter set.

Typedefs

- typedef struct l4_sched_cpu_set_t **l4_sched_cpu_set_t**

CPU sets.

- typedef struct l4_sched_param_t **l4_sched_param_t**

  Scheduler parameter set.

Enumerations

- enum L4_scheduler_classes { L4_SCHEDULER_CLASS_FIXED_PRIO = 1UL << 1 , L4_SCHEDULER_CLASS_WFQ = 1UL << 2 }

  Supported scheduler classes.
- enum L4_scheduler_ops { L4_SCHEDULER_INFO_OP = 0UL , L4_SCHEDULER_RUN_THREAD_OP = 1UL , L4_SCHEDULER_IDLE_TIME_OP = 2UL }

  Operations on the Scheduler object.

Functions

- l4_sched_cpu_set_t l4_sched_cpu_set (l4_umword_t offset, unsigned char granularity, l4_umword_t map=1) L4_NOTHROW
- l4_msgtag_t l4_scheduler_info (l4_cap_idx_t scheduler, l4_umword_t *cpu_max, l4_sched_cpu_set_t *cpus) L4_NOTHROW))

  Get scheduler information.
- l4_msgtag_t l4_scheduler_info_with_classes (l4_cap_idx_t scheduler, l4_umword_t *cpu_max, l4_sched_cpu_set_t *cpus, l4_umword_t *sched_classes) L4_NOTHROW))

  Get scheduler information.
- l4_sched_param_t l4_sched_param (unsigned prio, l4_umword_t quantum=0) L4_NOTHROW

  Construct scheduler parameter.
- l4_msgtag_t l4_scheduler_run_thread (l4_cap_idx_t scheduler, l4_cap_idx_t thread, l4_sched_param_t const *sp) L4_NOTHROW)

  Run a thread on a Scheduler.
- l4_msgtag_t l4_scheduler_idle_time (l4_cap_idx_t scheduler, l4_sched_cpu_set_t const *cpus, l4_kernel_clock_t *us) L4_NOTHROW)

  Query the idle time (in µs) of a CPU.
- int l4_scheduler_is_online (l4_cap_idx_t scheduler, l4_umword_t cpu) L4_NOTHROW

  Query if a CPU is online.

16.587.1 Detailed Description

Scheduler object functions.
Definition in file scheduler.h.

16.588 scheduler.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/kernel_object.h>
00015 #include <l4/sys/ipc.h>
00016
00040
00046 enum L4_scheduler_classes
00047 {
00049   L4_SCHEDULER_CLASS_FIXED_PRIO = 1UL << 1,
00051   L4_SCHEDULER_CLASS_WFQ        = 1UL << 2,
00052 };
```

```
00053
00058 typedef struct l4_sched_cpu_set_t
00059 {
00072   l4_umword_t gran_offset;
00073
00077   l4_umword_t map;
00078
00079 #ifdef __cplusplus
00081   unsigned char granularity() const { return gran_offset » 24; }
00083   unsigned offset() const { return gran_offset & 0x00ffffff; }
00090   void set(unsigned char granularity, unsigned offset)
00091   {
00092     gran_offset = (static_cast<l4_umword_t>(granularity) « 24)
00093       | (offset & 0x00ffffff);
00094   }
00095 #endif
00096 } l4_sched_cpu_set_t;
00097
00108 L4_INLINE l4_sched_cpu_set_t
00109 l4_sched_cpu_set(l4_umword_t offset, unsigned char granularity,
00110                  l4_umword_t map L4_DEFAULT_PARAM(1)) L4_NOTHROW;
00111
00128 L4_INLINE l4_msgtag_t
00129 l4_scheduler_info(l4_cap_idx_t scheduler, l4_umword_t *cpu_max,
00130                   l4_sched_cpu_set_t *cpus)
00131                  L4_NOTHROW __attribute__((nonnull (3)));
00132
00154 L4_INLINE l4_msgtag_t
00155 l4_scheduler_info_with_classes(l4_cap_idx_t scheduler, l4_umword_t *cpu_max,
00156                                l4_sched_cpu_set_t *cpus,
00157                                l4_umword_t *sched_classes)
00158                               L4_NOTHROW __attribute__((nonnull (3)));
00159
00163 L4_INLINE l4_msgtag_t
00164 l4_scheduler_info_u(l4_cap_idx_t scheduler, l4_umword_t *cpu_max,
00165                     l4_sched_cpu_set_t *cpus, l4_umword_t *sched_classes,
00166                     l4_utcb_t *utcb) L4_NOTHROW __attribute__((nonnull (3, 5)));
00167
00168
00173 typedef struct l4_sched_param_t
00174 {
00176   l4_sched_cpu_set_t affinity;
00182   l4_umword_t        prio;
00184   l4_umword_t        quantum;
00185 } l4_sched_param_t;
00186
00195 L4_INLINE l4_sched_param_t
00196 l4_sched_param(unsigned prio,
00197                l4_umword_t quantum L4_DEFAULT_PARAM(0)) L4_NOTHROW;
00198
00206 L4_INLINE l4_msgtag_t
00207 l4_scheduler_run_thread(l4_cap_idx_t scheduler,
00208                         l4_cap_idx_t thread, l4_sched_param_t const *sp)
00209                        L4_NOTHROW __attribute__((nonnull));
00210
00214 L4_INLINE l4_msgtag_t
00215 l4_scheduler_run_thread_u(l4_cap_idx_t scheduler, l4_cap_idx_t thread,
00216                           l4_sched_param_t const *sp, l4_utcb_t *utcb)
00217                          L4_NOTHROW __attribute__((nonnull));
00218
00226 L4_INLINE l4_msgtag_t
00227 l4_scheduler_idle_time(l4_cap_idx_t scheduler, l4_sched_cpu_set_t const *cpus,
00228                        l4_kernel_clock_t *us)
00229                       L4_NOTHROW __attribute__((nonnull));
00230
00234 L4_INLINE l4_msgtag_t
00235 l4_scheduler_idle_time_u(l4_cap_idx_t scheduler, l4_sched_cpu_set_t const *cpus,
00236                          l4_kernel_clock_t *us, l4_utcb_t *utcb)
00237                         L4_NOTHROW __attribute__((nonnull));
00238
00239
00240
00251 L4_INLINE int
00252 l4_scheduler_is_online(l4_cap_idx_t scheduler, l4_umword_t cpu) L4_NOTHROW;
00253
00257 L4_INLINE int
00258 l4_scheduler_is_online_u(l4_cap_idx_t scheduler, l4_umword_t cpu,
00259                          l4_utcb_t *utcb) L4_NOTHROW __attribute__((nonnull));
00260
00261
00262
00269 enum L4_scheduler_ops
00270 {
00271   L4_SCHEDULER_INFO_OP       = 0UL,
00272   L4_SCHEDULER_RUN_THREAD_OP = 1UL,
00273   L4_SCHEDULER_IDLE_TIME_OP  = 2UL,
00274 };
```

```
00275
00276 /*************** Implementations ******************/
00277
00278 L4_INLINE l4_sched_cpu_set_t
00279 l4_sched_cpu_set(l4_umword_t offset, unsigned char granularity,
00280                  l4_umword_t map) L4_NOTHROW
00281 {
00282   l4_sched_cpu_set_t cs;
00283   cs.gran_offset = ((l4_umword_t)granularity << 24) | (offset & 0x00ffffff);
00284   cs.map         = map;
00285   return cs;
00286 }
00287
00288 L4_INLINE l4_sched_param_t
00289 l4_sched_param(unsigned prio, l4_umword_t quantum) L4_NOTHROW
00290 {
00291   l4_sched_param_t sp;
00292   sp.prio     = prio;
00293   sp.quantum  = quantum;
00294   sp.affinity = l4_sched_cpu_set(0, ~0, 1);
00295   return sp;
00296 }
00297
00298
00299 L4_INLINE l4_msgtag_t
00300 l4_scheduler_info_u(l4_cap_idx_t scheduler, l4_umword_t *cpu_max,
00301                     l4_sched_cpu_set_t *cpus, l4_umword_t *sched_classes,
00302                     l4_utcb_t *utcb) L4_NOTHROW
00303 {
00304   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00305   l4_msgtag_t res;
00306
00307   m->mr[0] = L4_SCHEDULER_INFO_OP;
00308   m->mr[1] = cpus->gran_offset;
00309
00310   res = l4_ipc_call(scheduler, utcb, l4_msgtag(L4_PROTO_SCHEDULER, 2, 0, 0), L4_IPC_NEVER);
00311
00312   if (l4_msgtag_has_error(res))
00313     return res;
00314
00315   cpus->map = m->mr[0];
00316
00317   if (cpu_max)
00318     *cpu_max = m->mr[1];
00319
00320   if (sched_classes)
00321     *sched_classes = m->mr[2];
00322
00323   return res;
00324 }
00325
00326 L4_INLINE l4_msgtag_t
00327 l4_scheduler_run_thread_u(l4_cap_idx_t scheduler, l4_cap_idx_t thread,
00328                           l4_sched_param_t const *sp, l4_utcb_t *utcb) L4_NOTHROW
00329 {
00330   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00331   m->mr[0] = L4_SCHEDULER_RUN_THREAD_OP;
00332   m->mr[1] = sp->affinity.gran_offset;
00333   m->mr[2] = sp->affinity.map;
00334   m->mr[3] = sp->prio;
00335   m->mr[4] = sp->quantum;
00336   m->mr[5] = l4_map_obj_control(0, 0);
00337   m->mr[6] = l4_obj_fpage(thread, 0, L4_CAP_FPAGE_RWS).raw;
00338
00339   return l4_ipc_call(scheduler, utcb, l4_msgtag(L4_PROTO_SCHEDULER, 5, 1, 0), L4_IPC_NEVER);
00340 }
00341
00342 L4_INLINE l4_msgtag_t
00343 l4_scheduler_idle_time_u(l4_cap_idx_t scheduler, l4_sched_cpu_set_t const *cpus,
00344                          l4_kernel_clock_t *us, l4_utcb_t *utcb) L4_NOTHROW
00345 {
00346   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00347   l4_msgtag_t res;
00348
00349   v->mr[0] = L4_SCHEDULER_IDLE_TIME_OP;
00350   v->mr[1] = cpus->gran_offset;
00351   v->mr[2] = cpus->map;
00352
00353   res = l4_ipc_call(scheduler, utcb,
00354                     l4_msgtag(L4_PROTO_SCHEDULER, 3, 0, 0), L4_IPC_NEVER);
00355
00356   if (l4_msgtag_has_error(res))
00357     return res;
00358
00359   *us = v->mr64[l4_utcb_mr64_idx(0)];
00360
00361   return res;
```

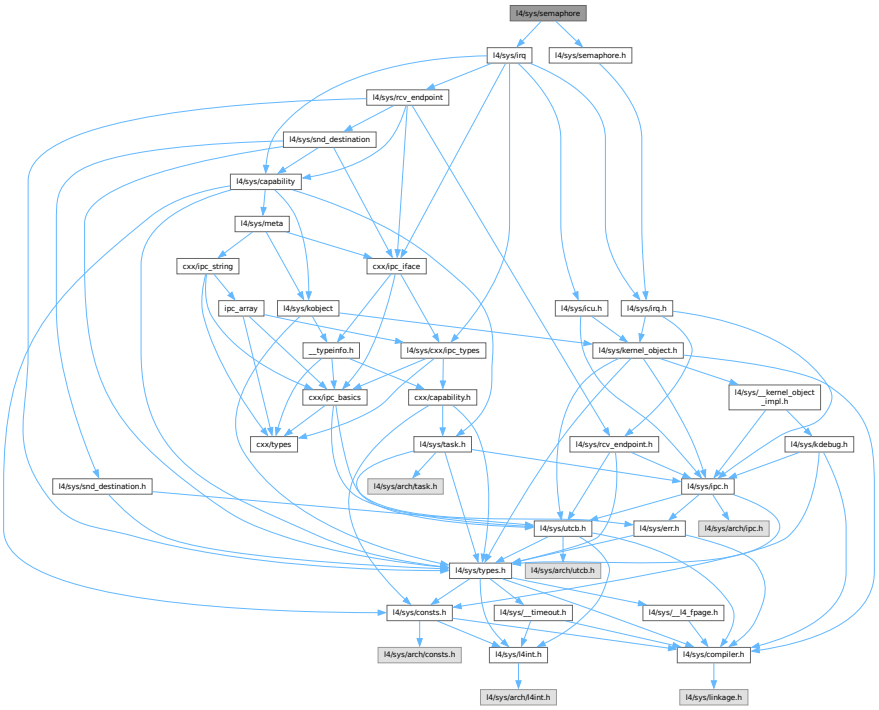
```
00362 }
00363
00364
00365 L4_INLINE int
00366 l4_scheduler_is_online_u(l4_cap_idx_t scheduler, l4_umword_t cpu,
00367                          l4_utcb_t *utcb) L4_NOTHROW
00368 {
00369   l4_sched_cpu_set_t s;
00370   l4_msgtag_t r;
00371   s.gran_offset = cpu;
00372   r = l4_scheduler_info_u(scheduler, NULL, &s, NULL, utcb);
00373   if (l4_msgtag_has_error(r) || l4_msgtag_label(r) < 0)
00374     return 0;
00375
00376   return s.map & 1;
00377 }
00378
00379
00380 L4_INLINE l4_msgtag_t
00381 l4_scheduler_info(l4_cap_idx_t scheduler, l4_umword_t *cpu_max,
00382                   l4_sched_cpu_set_t *cpus) L4_NOTHROW
00383 {
00384   return l4_scheduler_info_u(scheduler, cpu_max, cpus, NULL, l4_utcb());
00385 }
00386
00387 L4_INLINE l4_msgtag_t
00388 l4_scheduler_info_with_classes(l4_cap_idx_t scheduler, l4_umword_t *cpu_max,
00389                                l4_sched_cpu_set_t *cpus,
00390                                l4_umword_t *sched_classes) L4_NOTHROW
00391 {
00392   return l4_scheduler_info_u(scheduler, cpu_max, cpus, sched_classes, l4_utcb());
00393 }
00394
00395 L4_INLINE l4_msgtag_t
00396 l4_scheduler_run_thread(l4_cap_idx_t scheduler,
00397                         l4_cap_idx_t thread, l4_sched_param_t const *sp) L4_NOTHROW
00398 {
00399   return l4_scheduler_run_thread_u(scheduler, thread, sp, l4_utcb());
00400 }
00401
00402 L4_INLINE l4_msgtag_t
00403 l4_scheduler_idle_time(l4_cap_idx_t scheduler, l4_sched_cpu_set_t const *cpus,
00404                        l4_kernel_clock_t *us) L4_NOTHROW
00405 {
00406   return l4_scheduler_idle_time_u(scheduler, cpus, us, l4_utcb());
00407 }
00408
00409 L4_INLINE int
00410 l4_scheduler_is_online(l4_cap_idx_t scheduler, l4_umword_t cpu) L4_NOTHROW
00411 {
00412   return l4_scheduler_is_online_u(scheduler, cpu, l4_utcb());
00413 }
```

16.589 l4/sys/semaphore File Reference

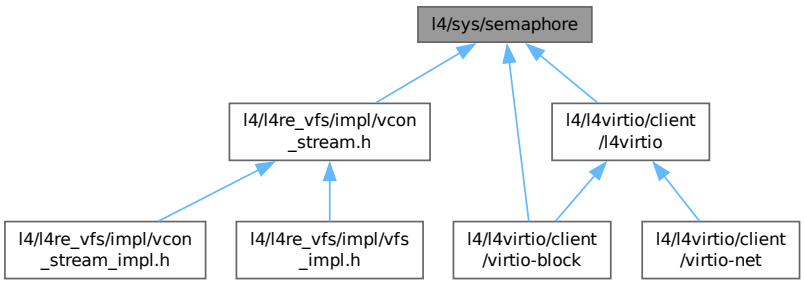
Semaphore class definition.

```
#include <l4/sys/irq>
#include <l4/sys/semaphore.h>
```

Include dependency graph for semaphore:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct L4::Semaphore

  C++ Kernel-provided semaphore interface, see Kernel-provided semaphore for the C interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.589.1 Detailed Description

Semaphore class definition.
Definition in file semaphore.

16.590 semaphore

Go to the documentation of this file.

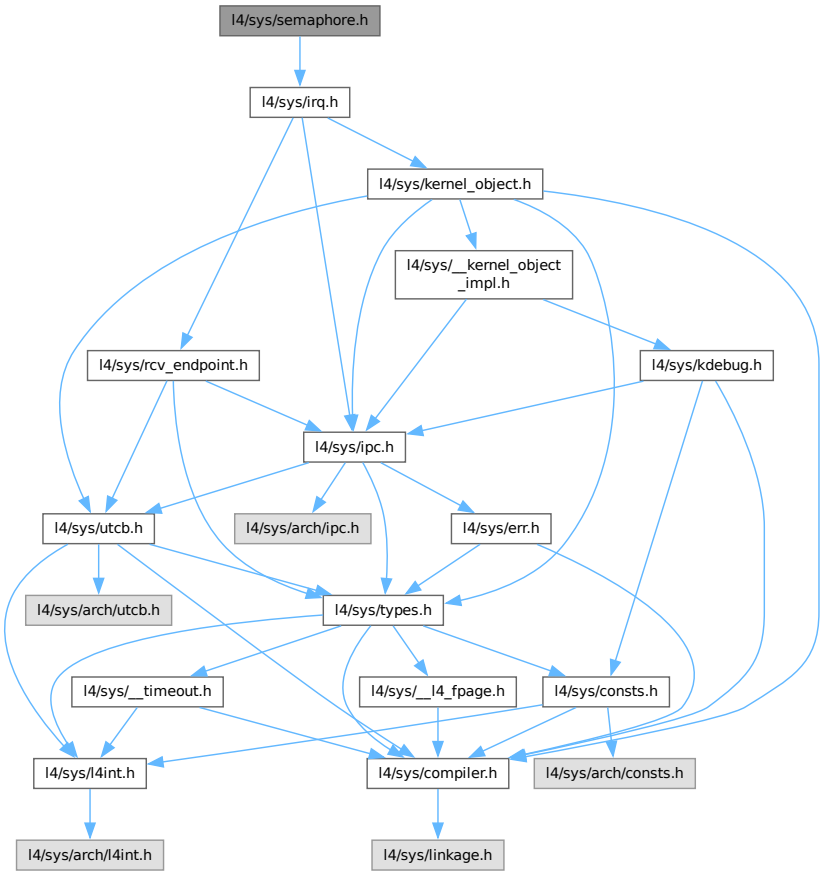
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2015 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/irq>
00015 #include <l4/sys/semaphore.h>
00016
00017 namespace L4 {
00018
00051 struct Semaphore : Kobject_t<Semaphore, Triggerable, L4_PROTO_SEMAPHORE>
00052 {
00067   l4_msgtag_t up(l4_utcb_t *utcb = l4_utcb()) noexcept
00068   { return trigger(utcb); }
00069
00089   l4_msgtag_t down(l4_timeout_t timeout = L4_IPC_NEVER,
00090                    l4_utcb_t *utcb = l4_utcb()) noexcept
00091   { return l4_semaphore_down_u(cap(), timeout, utcb);  }
00092 };
00093
00094 }
```

16.591 l4/sys/semaphore.h File Reference

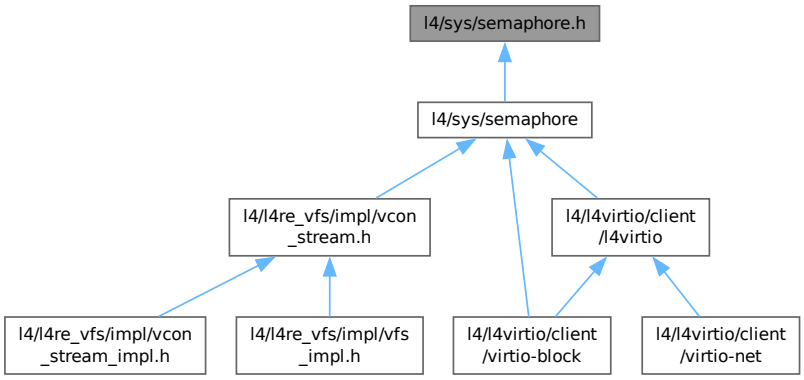
C semaphore interface.

```
#include <l4/sys/irq.h>
```

Include dependency graph for semaphore.h:



This graph shows which files directly or indirectly include this file:



Functions

- l4_msgtag_t l4_semaphore_up (l4_cap_idx_t sem) L4_NOTHROW

Semaphore up operation (wrapper for trigger()).

- l4_msgtag_t l4_semaphore_down (l4_cap_idx_t sem, l4_timeout_t timeout) L4_NOTHROW

  Semaphore down operation.

16.591.1 Detailed Description

C semaphore interface.
Definition in file semaphore.h.

16.592 semaphore.h

Go to the documentation of this file.

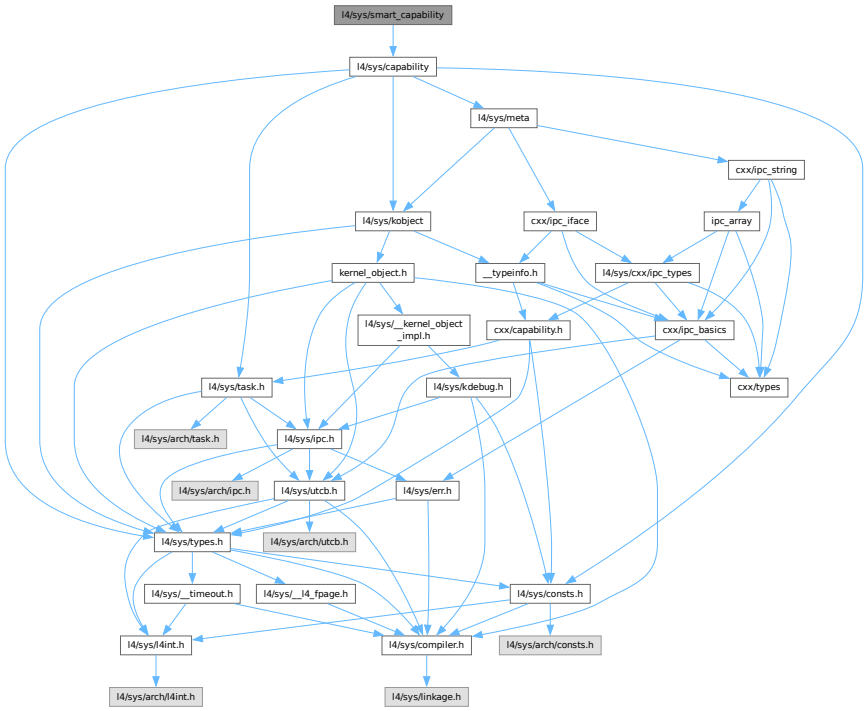
```
00001
00006 /*
00007  * (c) 2015 Alexander Warg <alexander.warg@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/irq.h>
00015
00024
00025 enum L4_semaphore_op
00026 {
00027   L4_SEMAPHORE_OP_DOWN    = 0,
00028   // semaphore up is IRQ_OP_TRIGGER with IRQ/Triggerable protocol
00029 };
00030
00044 L4_INLINE l4_msgtag_t
00045 l4_semaphore_up(l4_cap_idx_t sem) L4_NOTHROW
00046 {
00047   return l4_irq_trigger(sem);
00048 }
00049
00053 L4_INLINE l4_msgtag_t
00054 l4_semaphore_up_u(l4_cap_idx_t sem, l4_utcb_t *utcb) L4_NOTHROW
00055 {
00056   return l4_irq_trigger_u(sem, utcb);
00057 }
00058
00078 L4_INLINE l4_msgtag_t
00079 l4_semaphore_down(l4_cap_idx_t sem, l4_timeout_t timeout) L4_NOTHROW;
00080
00084 L4_INLINE l4_msgtag_t
00085 l4_semaphore_down_u(l4_cap_idx_t sem, l4_timeout_t to,
00086                     l4_utcb_t *utcb) L4_NOTHROW;
00087
00088
00089 L4_INLINE l4_msgtag_t
00090 l4_semaphore_down_u(l4_cap_idx_t sem, l4_timeout_t to,
00091                     l4_utcb_t *utcb) L4_NOTHROW
00092 {
00093   l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00094   m->mr[0] = L4_SEMAPHORE_OP_DOWN;
00095   return l4_ipc_call(sem, utcb, l4_msgtag(L4_PROTO_SEMAPHORE, 1, 0, 0), to);
00096 }
00097
00098
00099 L4_INLINE l4_msgtag_t
00100 l4_semaphore_down(l4_cap_idx_t sem, l4_timeout_t to) L4_NOTHROW
00101 {
00102   return l4_semaphore_down_u(sem, to, l4_utcb());
00103 }
00104
```

16.593 l4/sys/smart_capability File Reference

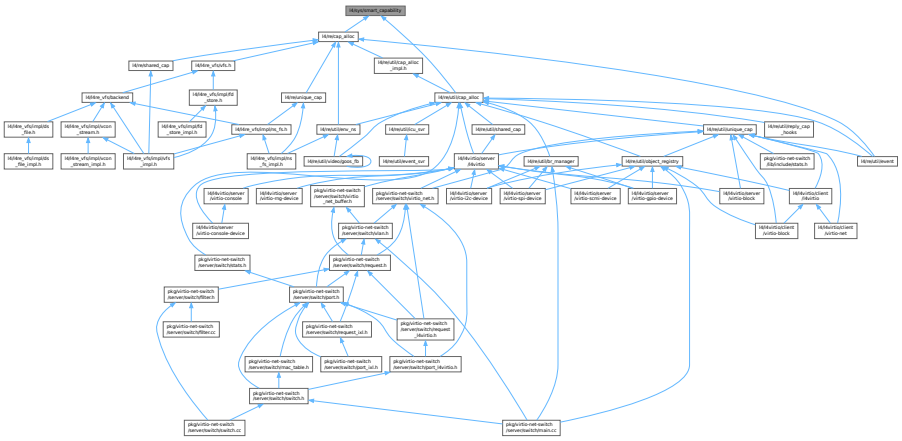
L4::Capability class.

```
#include <l4/sys/capability>
```

Include dependency graph for smart_capability:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Smart_cap< T, SMART >

  Smart capability class.

Namespaces

- namespace L4

  L4 low-level kernel interface.

Functions

- template<typename T, typename F, typename SMART>
  Smart_cap< T, SMART > L4::cap_cast (Smart_cap< F, SMART > const &c) noexcept

  `static_cast` for (smart) capabilities.
- template<typename T, typename F, typename SMART>
  Smart_cap< T, SMART > L4::cap_reinterpret_cast (Smart_cap< F, SMART > const &c) noexcept

  `reinterpret_cast` for (smart) capabilities.

16.593.1 Detailed Description

L4::Capability class.

Author

Alexander Warg alexander.warg@os.inf.tu-dresden.de

Definition in file smart_capability.

16.594 smart_capability

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00009 /*
00010  * (c) 2008-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 #pragma once
00016
00017 #include <l4/sys/capability>
00018
00019 namespace L4 {
00020
00024 template< typename T, typename SMART >
00025 class Smart_cap : public Cap_base, private SMART
00026 {
00027 public:
00028
00029   SMART const &smart() const noexcept { return *this; }
00030
00031   void _delete() noexcept
00032   {
00033     SMART::free(const_cast<Smart_cap<T,SMART>&>(*this));
00034   }
00035
00036   Cap<T> release() const noexcept
00037   {
00038     l4_cap_idx_t r = cap();
00039     SMART::invalidate(const_cast<Smart_cap<T,SMART>&>(*this));
00040
00041     return Cap<T>(r);
00042   }
00043
00044   void reset() noexcept
00045   {
00046     _c = L4_INVALID_CAP;
00047   }
00048
00049   Smart_cap() noexcept : Cap_base(Invalid) {}
00050
00051   Smart_cap(Cap_base::Cap_type t) noexcept : Cap_base(t) {}
00052
00061   template< typename O >
00062   Smart_cap(Cap<O> const &p) noexcept : Cap_base(p.cap())
00063   { Cap<T>::template check_convertible_from<O>(); }
00064
00065   template< typename O >
00066   Smart_cap(Cap<O> const &p, SMART const &smart) noexcept
00067   : Cap_base(p.cap()), SMART(smart)
00068   { Cap<T>::template check_convertible_from<O>(); }
00069
00070   template< typename O >
00071   Smart_cap(Smart_cap<O, SMART> const &o) noexcept
00072   : Cap_base(SMART::copy(o)), SMART(o.smart())
00073   { Cap<T>::template check_convertible_from<O>(); }
```

```
00074
00075   Smart_cap(Smart_cap const &o) noexcept
00076   : Cap_base(SMART::copy(o)), SMART(o.smart())
00077   { }
00078
00079   template< typename O >
00080   Smart_cap(typename Cap<O>::Cap_type cap) noexcept : Cap_base(cap)
00081   { Cap<T>::template check_convertible_from<O>(); }
00082
00083   void operator = (typename Cap<T>::Cap_type cap) noexcept
00084   {
00085     _delete();
00086     _c = cap;
00087   }
00088
00089   template< typename O >
00090   void operator = (Smart_cap<O, SMART> const &o) noexcept
00091   {
00092     _delete();
00093     _c = this->SMART::copy(o).cap();
00094     this->SMART::operator = (o.smart());
00095     // return *this;
00096   }
00097
00098   Smart_cap const &operator = (Smart_cap const &o) noexcept
00099   {
00100     if (&o == this)
00101       return *this;
00102
00103     _delete();
00104     _c = this->SMART::copy(o).cap();
00105     this->SMART::operator = (o.smart());
00106     return *this;
00107   }
00108
00109 #if __cplusplus >= 201103L
00110   template< typename O >
00111   Smart_cap(Smart_cap<O, SMART> &&o) noexcept
00112   : Cap_base(o.release()), SMART(o.smart())
00113   { Cap<T>::template check_convertible_from<O>(); }
00114
00115   Smart_cap(Smart_cap &&o) noexcept
00116   : Cap_base(o.release()), SMART(o.smart())
00117   { }
00118
00119   template< typename O >
00120   void operator = (Smart_cap<O, SMART> &&o) noexcept
00121   {
00122     _delete();
00123     _c = o.release().cap();
00124     this->SMART::operator = (o.smart());
00125     // return *this;
00126   }
00127
00128   Smart_cap const &operator = (Smart_cap &&o) noexcept
00129   {
00130     if (&o == this)
00131       return *this;
00132
00133     _delete();
00134     _c = o.release().cap();
00135     this->SMART::operator = (o.smart());
00136     return *this;
00137   }
00138 #endif
00139
00143   Cap<T> operator -> () const noexcept { return Cap<T>(_c); }
00144
00145   Cap<T> get() const noexcept { return Cap<T>(_c); }
00146
00147   ~Smart_cap() noexcept { _delete(); }
00148 };
00149
00150 template< typename T >
00151 class Weak_cap : public Cap_base
00152 {
00153 public:
00154   Weak_cap() noexcept : Cap_base(Invalid) {}
00155
00156   template< typename O >
00157   Weak_cap(typename Cap<O>::Cap_type t) noexcept : Cap_base(t)
00158   { Cap<T>::template check_convertible_from<O>(); }
00159
00160   template< typename O, typename S >
00161   Weak_cap(Smart_cap<O, S> const &c) noexcept : Cap_base(c.cap())
00162   { Cap<T>::template check_convertible_from<O>(); }
00163
```

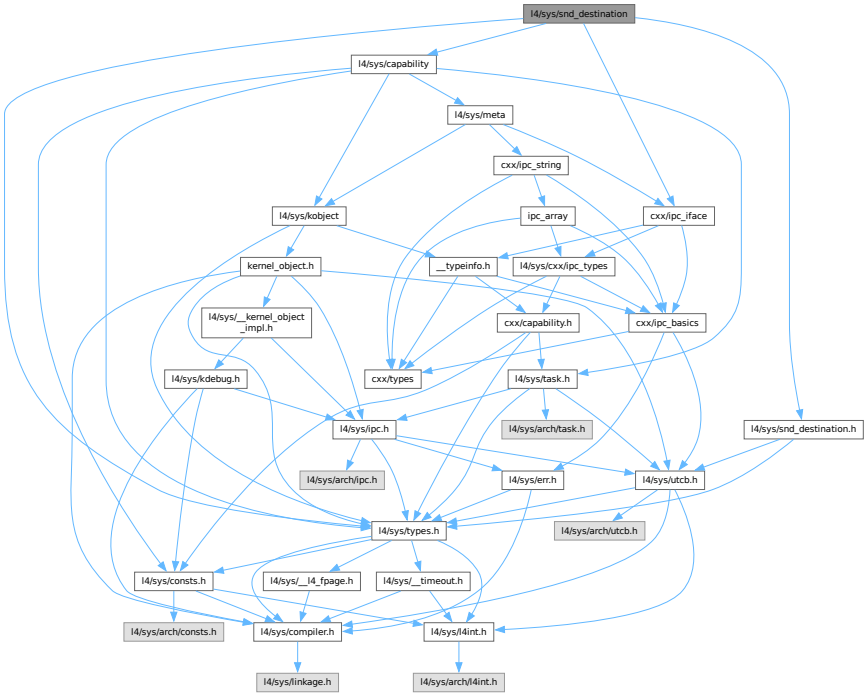
```
00164   Weak_cap(Weak_cap const &o) noexcept : Cap_base(o) {}
00165
00166   template< typename O >
00167   Weak_cap(Weak_cap<O> const &o) noexcept : Cap_base(o)
00168   { Cap<T>::template check_convertible_from<O>(); }
00169
00170 };
00171
00172 namespace Cap_traits {
00173   template< typename T1, typename T2 >
00174   struct Type { enum { Equal = false }; };
00175
00176   template< typename T1 >
00177   struct Type<T1,T1> { enum { Equal = true }; };
00178 };
00179
00190 template< typename T, typename F, typename SMART >
00191 inline
00192 Smart_cap<T, SMART> cap_cast(Smart_cap<F, SMART> const &c) noexcept
00193 {
00194   Cap<T>::template check_castable_from<F>();
00195   return Smart_cap<T, SMART>(Cap<T>(SMART::copy(c).cap()));
00196 }
00197
00198
00209 template< typename T, typename F, typename SMART >
00210 inline
00211 Smart_cap<T, SMART> cap_reinterpret_cast(Smart_cap<F, SMART> const &c) noexcept
00212 {
00213   return Smart_cap<T, SMART>(Cap<T>(SMART::copy(c).cap()));
00214 }
00215
00216
00217 }
```

16.595 l4/sys/snd_destination File Reference

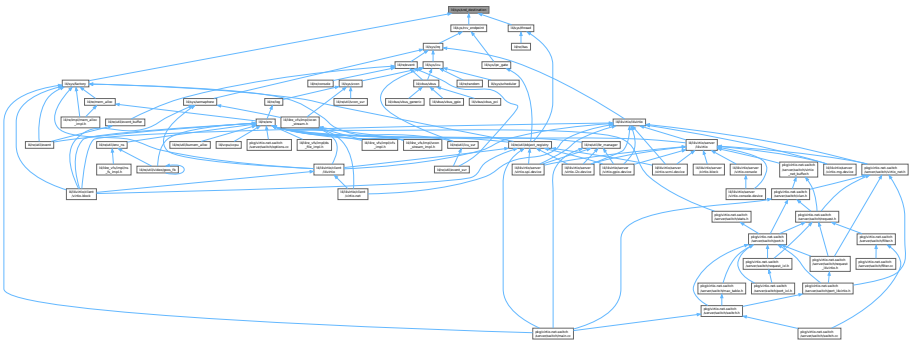
The C++ Sender destination interface.

```
#include <l4/sys/snd_destination.h>
#include <l4/sys/types.h>
#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_iface>
```

Include dependency graph for snd_destination:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4

  L4 low-level kernel interface.

16.595.1 Detailed Description

The C++ Sender destination interface.
Definition in file snd_destination.

16.596 snd_destination

Go to the documentation of this file.

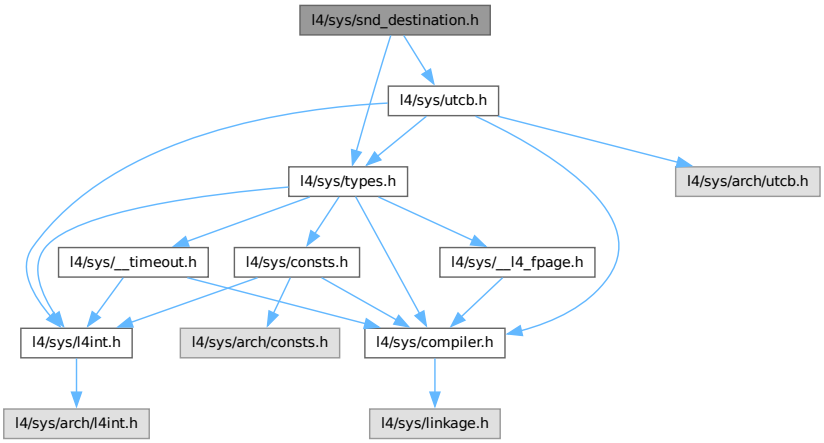
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2025 Frank Mehnert <frank.mehnert@kernkonzept.com>
00008  *
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/snd_destination.h>
00014 #include <l4/sys/types.h>
00015 #include <l4/sys/capability>
00016 #include <l4/sys/cxx/ipc_iface>
00017
00018 namespace L4 {
00019
00020 class L4_EXPORT Snd_destination :
00021   public Kobject_t<Snd_destination, Kobject, L4_PROTO_KOBJECT>
00022 {
00023 };
00024
00025 }
```

16.597 l4/sys/snd_destination.h File Reference

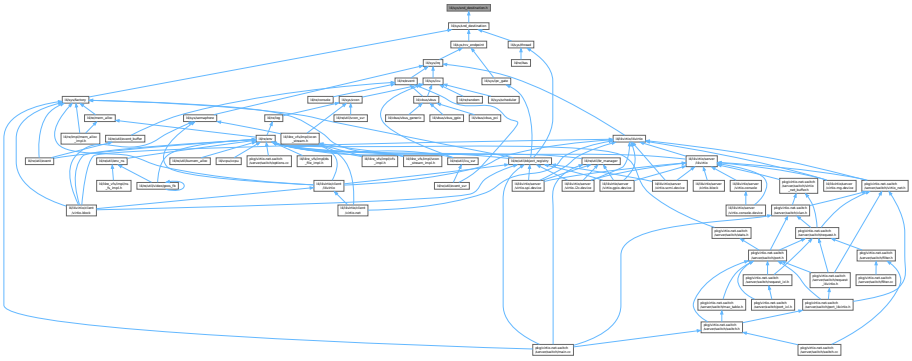
Sender destination endpoint C interface.

```
#include <l4/sys/utcb.h>
#include <l4/sys/types.h>
```

Include dependency graph for snd_destination.h:



This graph shows which files directly or indirectly include this file:



16.597.1 Detailed Description

Sender destination endpoint C interface.
Definition in file snd_destination.h.

16.598 snd_destination.h

Go to the documentation of this file.

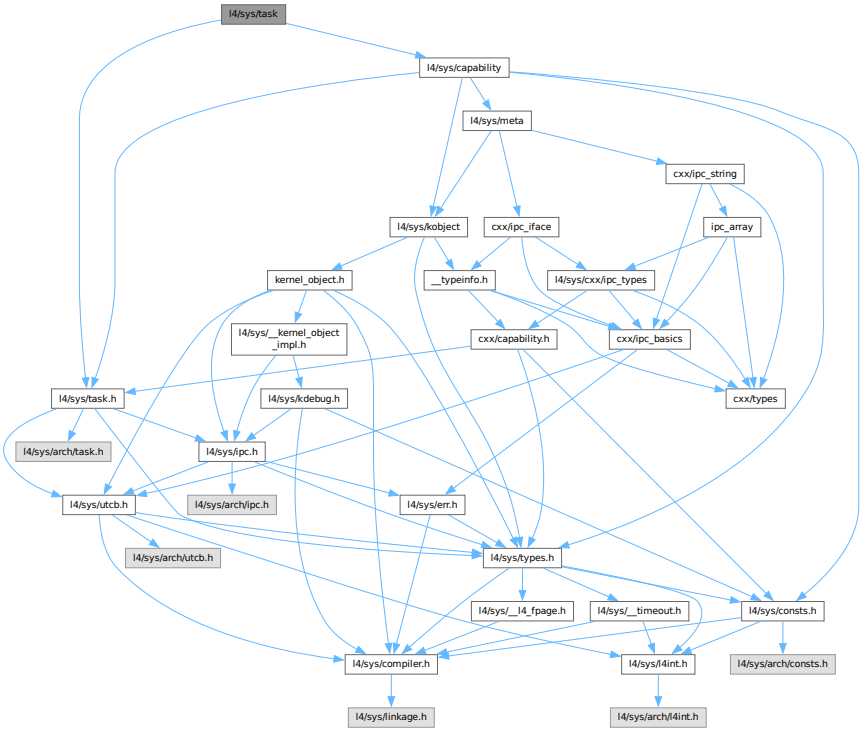
```
00001
00005 /*
00006  * (c) 2025 Frank Mehnert <frank.mehnert@kernkonzept.com>
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #pragma once
00011
00012 #include <l4/sys/utcb.h>
00013 #include <l4/sys/types.h>
```

16.599 l4/sys/task File Reference

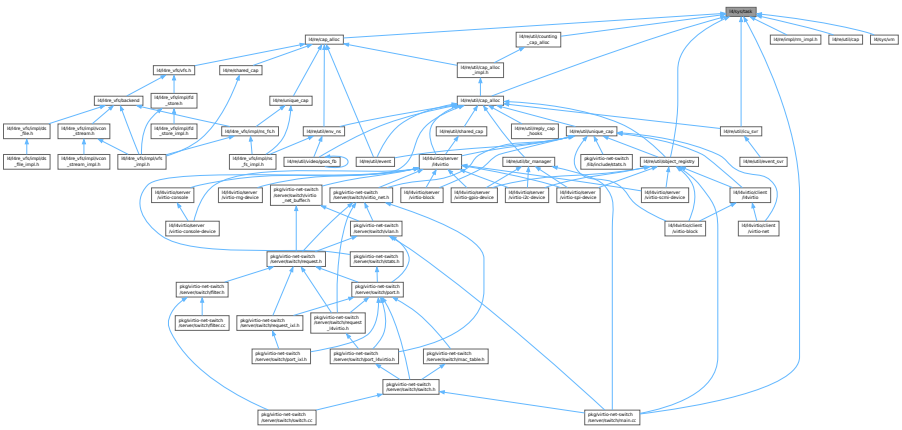
Common task related definitions.

```
#include <l4/sys/task.h>
#include <l4/sys/capability>
```

Include dependency graph for task:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Task

  C++ interface of the Task kernel object, see Task for the C interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.599.1 Detailed Description

Common task related definitions.
Definition in file task.

16.600 task

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/task.h>
00017 #include <l4/sys/capability>
00018
00019 namespace L4 {
00020
00033 class Task :
00034   public Kobject_t<Task, Kobject, L4_PROTO_TASK,
00035                    Type_info::Demand_t<2> >
00036 {
00037 public:
00085   l4_msgtag_t map(Cap<Task> const &src_task,
00086                   l4_fpage_t const &snd_fpage, l4_umword_t snd_base,
00087                   l4_utcb_t *utcb = l4_utcb()) noexcept
00088   { return l4_task_map_u(cap(), src_task.cap(), snd_fpage, snd_base, utcb); }
00089
00135   l4_msgtag_t unmap(l4_fpage_t const &fpage,
00136                     l4_umword_t map_mask,
00137                     l4_utcb_t *utcb = l4_utcb()) noexcept
00138   { return l4_task_unmap_u(cap(), fpage, map_mask, utcb); }
00139
00154   l4_msgtag_t unmap_batch(l4_fpage_t const *fpages,
00155                           unsigned num_fpages,
00156                           l4_umword_t map_mask,
00157                           l4_utcb_t *utcb = l4_utcb()) noexcept
00158   { return l4_task_unmap_batch_u(cap(), fpages, num_fpages, map_mask, utcb); }
00159
00180   l4_msgtag_t delete_obj(L4::Cap<void> obj,
00181                          l4_utcb_t *utcb = l4_utcb()) noexcept
00182   { return l4_task_delete_obj_u(cap(), obj.cap(), utcb); }
00183
00201   l4_msgtag_t release_cap(L4::Cap<void> cap,
00202                           l4_utcb_t *utcb = l4_utcb()) noexcept
00203   { return l4_task_release_cap_u(this->cap(), cap.cap(), utcb); }
00204
00222   l4_msgtag_t cap_valid(Cap<void> const &cap,
00223                         l4_utcb_t *utcb = l4_utcb()) noexcept
00224   { return l4_task_cap_valid_u(this->cap(), cap.cap(), utcb); }
00225
00251   l4_msgtag_t cap_equal(Cap<void> const &cap_a,
00252                         Cap<void> const &cap_b,
00253                         l4_utcb_t *utcb = l4_utcb()) noexcept
00254   { return l4_task_cap_equal_u(cap(), cap_a.cap(), cap_b.cap(), utcb); }
00255
00281   l4_msgtag_t add_ku_mem(l4_fpage_t *fpage,
00282                          l4_utcb_t *utcb = l4_utcb()) noexcept
00283   { return l4_task_add_ku_mem_u(cap(), fpage, utcb); }
00284
00285 };
00286 }
00287
00288
```

16.601 task.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.602 task.h

```
00001 /*
00002  * (c) 2018 Adam Lackorzynski <adam@l4re.org>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
00008 #include <l4/sys/__task-arm.h>
```

16.603 task.h

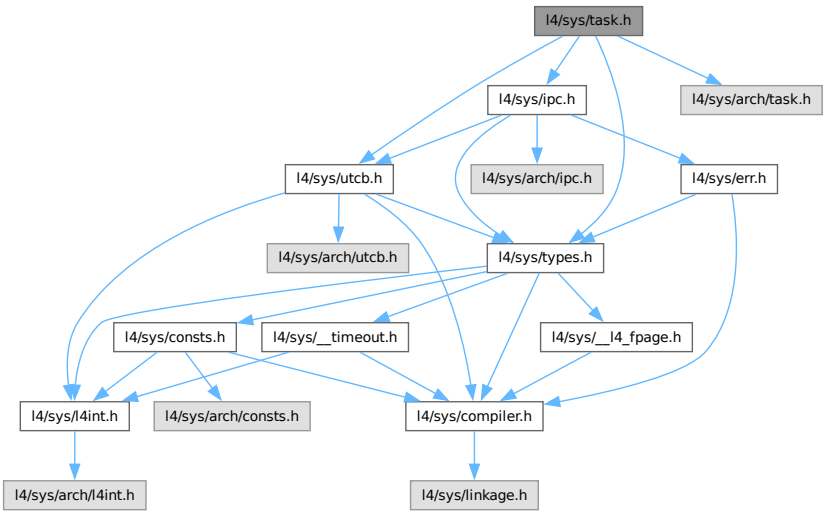
```
00001 /*
00002  * (c) 2018 Adam Lackorzynski <adam@l4re.org>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
00008 #include <l4/sys/__task-arm.h>
```

16.604 l4/sys/task.h File Reference

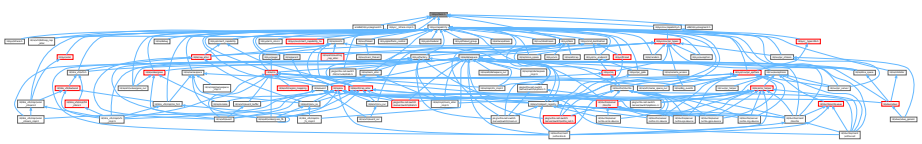
Common task related definitions.

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
#include <l4/sys/arch/task.h>
```

Include dependency graph for task.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum L4_task_ops {
  L4_TASK_MAP_OP = 0UL , L4_TASK_UNMAP_OP = 1UL , L4_TASK_CAP_INFO_OP = 2UL ,
  L4_TASK_ADD_KU_MEM_OP = 3UL ,
  L4_TASK_LDT_SET_X86_OP = 0x11UL , L4_TASK_MAP_VGICC_ARM_OP = 0x12UL }

  Operations on task objects.

Functions

- l4_msgtag_t l4_task_map (l4_cap_idx_t dst_task, l4_cap_idx_t src_task, l4_fpage_t snd_fpage, l4_umword_t snd_base) L4_NOTHROW

  Map resources available in the source task to a destination task.
- l4_msgtag_t l4_task_unmap (l4_cap_idx_t task, l4_fpage_t fpage, l4_umword_t map_mask) L4_NOTHROW

  Revoke rights from the task.
- l4_msgtag_t l4_task_unmap_batch (l4_cap_idx_t task, l4_fpage_t const *fpages, unsigned num_fpages, l4_umword_t map_mask) L4_NOTHROW

  Revoke rights from a task.
- l4_msgtag_t l4_task_delete_obj (l4_cap_idx_t task, l4_cap_idx_t obj) L4_NOTHROW

  Release capability and delete object.
- l4_msgtag_t l4_task_release_cap (l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW

  Release object capability.
- l4_msgtag_t l4_task_cap_valid (l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW

  Check whether a capability is present (refers to an object).
- l4_msgtag_t l4_task_cap_equal (l4_cap_idx_t task, l4_cap_idx_t cap_a, l4_cap_idx_t cap_b) L4_NOTHROW

  Test whether two capabilities point to the same object with the same permissions (only considering selected permissions).
- l4_msgtag_t l4_task_add_ku_mem (l4_cap_idx_t task, l4_fpage_t *ku_mem) L4_NOTHROW

  Add kernel-user memory.

16.604.1 Detailed Description

Common task related definitions.
Definition in file task.h.

16.605 task.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015 #include <l4/sys/types.h>
00016 #include <l4/sys/utcb.h>
00017
00031
00079 L4_INLINE l4_msgtag_t
00080 l4_task_map(l4_cap_idx_t dst_task, l4_cap_idx_t src_task,
00081             l4_fpage_t snd_fpage, l4_umword_t snd_base) L4_NOTHROW;
00082
00086 L4_INLINE l4_msgtag_t
00087 l4_task_map_u(l4_cap_idx_t dst_task, l4_cap_idx_t src_task,
00088               l4_fpage_t snd_fpage, l4_umword_t snd_base, l4_utcb_t *utcb) L4_NOTHROW;
00089
00134 L4_INLINE l4_msgtag_t
00135 l4_task_unmap(l4_cap_idx_t task, l4_fpage_t fpage,
00136               l4_umword_t map_mask) L4_NOTHROW;
```

```
00137
00141 L4_INLINE l4_msgtag_t
00142 l4_task_unmap_u(l4_cap_idx_t task, l4_fpage_t fpage,
00143                 l4_umword_t map_mask, l4_utcb_t *utcb) L4_NOTHROW;
00144
00164 L4_INLINE l4_msgtag_t
00165 l4_task_unmap_batch(l4_cap_idx_t task, l4_fpage_t const *fpages,
00166                     unsigned num_fpages, l4_umword_t map_mask) L4_NOTHROW;
00167
00171 L4_INLINE l4_msgtag_t
00172 l4_task_unmap_batch_u(l4_cap_idx_t task, l4_fpage_t const *fpages,
00173                       unsigned num_fpages, l4_umword_t map_mask,
00174                       l4_utcb_t *u) L4_NOTHROW;
00175
00197 L4_INLINE l4_msgtag_t
00198 l4_task_delete_obj(l4_cap_idx_t task, l4_cap_idx_t obj) L4_NOTHROW;
00199
00203 L4_INLINE l4_msgtag_t
00204 l4_task_delete_obj_u(l4_cap_idx_t task, l4_cap_idx_t obj,
00205                      l4_utcb_t *u) L4_NOTHROW;
00206
00225 L4_INLINE l4_msgtag_t
00226 l4_task_release_cap(l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW;
00227
00231 L4_INLINE l4_msgtag_t
00232 l4_task_release_cap_u(l4_cap_idx_t task, l4_cap_idx_t cap,
00233                       l4_utcb_t *u) L4_NOTHROW;
00234
00235
00253 L4_INLINE l4_msgtag_t
00254 l4_task_cap_valid(l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW;
00255
00259 L4_INLINE l4_msgtag_t
00260 l4_task_cap_valid_u(l4_cap_idx_t task, l4_cap_idx_t cap, l4_utcb_t *utcb) L4_NOTHROW;
00261
00289 L4_INLINE l4_msgtag_t
00290 l4_task_cap_equal(l4_cap_idx_t task, l4_cap_idx_t cap_a,
00291                   l4_cap_idx_t cap_b) L4_NOTHROW;
00292
00296 L4_INLINE l4_msgtag_t
00297 l4_task_add_ku_mem_u(l4_cap_idx_t task, l4_fpage_t *ku_mem,
00298                      l4_utcb_t *u) L4_NOTHROW;
00299
00326 L4_INLINE l4_msgtag_t
00327 l4_task_add_ku_mem(l4_cap_idx_t task, l4_fpage_t *ku_mem) L4_NOTHROW;
00328
00329
00333 L4_INLINE l4_msgtag_t
00334 l4_task_cap_equal_u(l4_cap_idx_t task, l4_cap_idx_t cap_a,
00335                     l4_cap_idx_t cap_b, l4_utcb_t *utcb) L4_NOTHROW;
00336
00341 enum L4_task_ops
00342 {
00343   L4_TASK_MAP_OP           = 0UL,
00344   L4_TASK_UNMAP_OP         = 1UL,
00345   L4_TASK_CAP_INFO_OP      = 2UL,
00346   L4_TASK_ADD_KU_MEM_OP    = 3UL,
00347   L4_TASK_LDT_SET_X86_OP   = 0x11UL,
00348   L4_TASK_MAP_VGICC_ARM_OP = 0x12UL,
00349 };
00350
00351
00352 /* IMPLEMENTATION ---------------------------------------------------------*/
00353
00354 #include <l4/sys/ipc.h>
00355
00356
00357 L4_INLINE l4_msgtag_t
00358 l4_task_map_u(l4_cap_idx_t dst_task, l4_cap_idx_t src_task,
00359               l4_fpage_t snd_fpage, l4_umword_t snd_base, l4_utcb_t *u) L4_NOTHROW
00360 {
00361   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00362   v->mr[0] = L4_TASK_MAP_OP;
00363   v->mr[3] = l4_map_obj_control(0,0);
00364   v->mr[4] = l4_obj_fpage(src_task, 0, L4_CAP_FPAGE_RWS).raw;
00365   v->mr[1] = snd_base;
00366   v->mr[2] = snd_fpage.raw;
00367   return l4_ipc_call(dst_task, u, l4_msgtag(L4_PROTO_TASK, 3, 1, 0), L4_IPC_NEVER);
00368 }
00369
00370 L4_INLINE l4_msgtag_t
00371 l4_task_unmap_u(l4_cap_idx_t task, l4_fpage_t fpage,
00372                 l4_umword_t map_mask, l4_utcb_t *u) L4_NOTHROW
00373 {
00374   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00375   v->mr[0] = L4_TASK_UNMAP_OP;
00376   v->mr[1] = map_mask;
```

```
00377   v->mr[2] = fpage.raw;
00378   return l4_ipc_call(task, u, l4_msgtag(L4_PROTO_TASK, 3, 0, 0), L4_IPC_NEVER);
00379 }
00380
00381 L4_INLINE l4_msgtag_t
00382 l4_task_unmap_batch_u(l4_cap_idx_t task, l4_fpage_t const *fpages,
00383                       unsigned num_fpages, l4_umword_t map_mask,
00384                       l4_utcb_t *u) L4_NOTHROW
00385 {
00386   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00387   v->mr[0] = L4_TASK_UNMAP_OP;
00388   v->mr[1] = map_mask;
00389   __builtin_memcpy(&v->mr[2], fpages, num_fpages * sizeof(l4_fpage_t));
00390   return l4_ipc_call(task, u, l4_msgtag(L4_PROTO_TASK, 2 + num_fpages, 0, 0), L4_IPC_NEVER);
00391 }
00392
00393 L4_INLINE l4_msgtag_t
00394 l4_task_cap_valid_u(l4_cap_idx_t task, l4_cap_idx_t cap, l4_utcb_t *u) L4_NOTHROW
00395 {
00396   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00397   v->mr[0] = L4_TASK_CAP_INFO_OP;
00398   v->mr[1] = cap & ~1UL;
00399   return l4_ipc_call(task, u, l4_msgtag(L4_PROTO_TASK, 2, 0, 0), L4_IPC_NEVER);
00400 }
00401
00402 L4_INLINE l4_msgtag_t
00403 l4_task_cap_equal_u(l4_cap_idx_t task, l4_cap_idx_t cap_a,
00404                     l4_cap_idx_t cap_b, l4_utcb_t *u) L4_NOTHROW
00405 {
00406   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00407   v->mr[0] = L4_TASK_CAP_INFO_OP;
00408   v->mr[1] = cap_a;
00409   v->mr[2] = cap_b;
00410   return l4_ipc_call(task, u, l4_msgtag(L4_PROTO_TASK, 3, 0, 0), L4_IPC_NEVER);
00411 }
00412
00413 L4_INLINE l4_msgtag_t
00414 l4_task_add_ku_mem_u(l4_cap_idx_t task, l4_fpage_t *ku_mem,
00415                      l4_utcb_t *u) L4_NOTHROW
00416 {
00417   l4_msg_regs_t *v = l4_utcb_mr_u(u);
00418   l4_msgtag_t ret;
00419   v->mr[0] = L4_TASK_ADD_KU_MEM_OP;
00420   v->mr[1] = ku_mem->raw;
00421   ret = l4_ipc_call(task, u, l4_msgtag(L4_PROTO_TASK, 2, 0, 0), L4_IPC_NEVER);
00422   if (!l4_msgtag_has_error(ret))
00423     {
00424       l4_msg_regs_t *v = l4_utcb_mr_u(u);
00425       ku_mem->raw = v->mr[0];
00426     }
00427   return ret;
00428 }
00429
00430
00431
00432 L4_INLINE l4_msgtag_t
00433 l4_task_map(l4_cap_idx_t dst_task, l4_cap_idx_t src_task,
00434             l4_fpage_t snd_fpage, l4_umword_t snd_base) L4_NOTHROW
00435 {
00436   return l4_task_map_u(dst_task, src_task, snd_fpage, snd_base, l4_utcb());
00437 }
00438
00439 L4_INLINE l4_msgtag_t
00440 l4_task_unmap(l4_cap_idx_t task, l4_fpage_t fpage,
00441               l4_umword_t map_mask) L4_NOTHROW
00442 {
00443   return l4_task_unmap_u(task, fpage, map_mask, l4_utcb());
00444 }
00445
00446 L4_INLINE l4_msgtag_t
00447 l4_task_unmap_batch(l4_cap_idx_t task, l4_fpage_t const *fpages,
00448                     unsigned num_fpages, l4_umword_t map_mask) L4_NOTHROW
00449 {
00450   return l4_task_unmap_batch_u(task, fpages, num_fpages, map_mask,
00451                                l4_utcb());
00452 }
00453
00454 L4_INLINE l4_msgtag_t
00455 l4_task_delete_obj_u(l4_cap_idx_t task, l4_cap_idx_t obj,
00456                      l4_utcb_t *u) L4_NOTHROW
00457 {
00458   return l4_task_unmap_u(task, l4_obj_fpage(obj, 0, L4_CAP_FPAGE_RWSD),
00459                          L4_FP_DELETE_OBJ, u);
00460 }
00461
00462 L4_INLINE l4_msgtag_t
00463 l4_task_delete_obj(l4_cap_idx_t task, l4_cap_idx_t obj) L4_NOTHROW
```

```
00464 {
00465   return l4_task_delete_obj_u(task, obj, l4_utcb());
00466 }
00467
00468
00469 L4_INLINE l4_msgtag_t
00470 l4_task_release_cap_u(l4_cap_idx_t task, l4_cap_idx_t cap,
00471                       l4_utcb_t *u) L4_NOTHROW
00472 {
00473   return l4_task_unmap_u(task, l4_obj_fpage(cap, 0, L4_CAP_FPAGE_RWSD),
00474                          L4_FP_ALL_SPACES, u);
00475 }
00476
00477 L4_INLINE l4_msgtag_t
00478 l4_task_release_cap(l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW
00479 {
00480   return l4_task_release_cap_u(task, cap, l4_utcb());
00481 }
00482
00483 L4_INLINE l4_msgtag_t
00484 l4_task_cap_valid(l4_cap_idx_t task, l4_cap_idx_t cap) L4_NOTHROW
00485 {
00486   return l4_task_cap_valid_u(task, cap, l4_utcb());
00487 }
00488
00489 L4_INLINE l4_msgtag_t
00490 l4_task_cap_equal(l4_cap_idx_t task, l4_cap_idx_t cap_a,
00491                   l4_cap_idx_t cap_b) L4_NOTHROW
00492 {
00493   return l4_task_cap_equal_u(task, cap_a, cap_b, l4_utcb());
00494 }
00495
00496 L4_INLINE l4_msgtag_t
00497 l4_task_add_ku_mem(l4_cap_idx_t task, l4_fpage_t *ku_mem) L4_NOTHROW
00498 {
00499   return l4_task_add_ku_mem_u(task, ku_mem, l4_utcb());
00500 }
00501
00502 #include <l4/sys/arch/task.h>
```

16.606 task.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.607 task.h

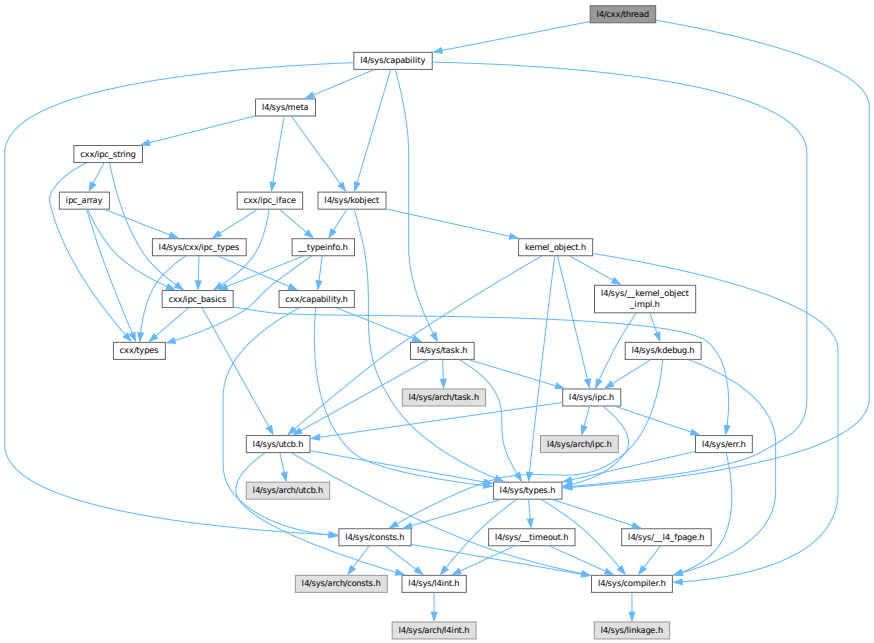
```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.608 l4/cxx/thread File Reference

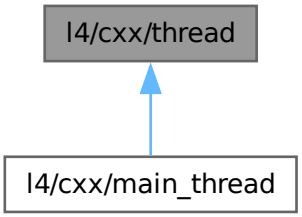
Thread implementation.

```
#include <l4/sys/capability>
#include <l4/sys/types.h>
```

Include dependency graph for thread:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace cxx

  Our C++ library.

16.608.1 Detailed Description

Thread implementation.
Definition in file thread.

16.609 thread

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00006 /*
```

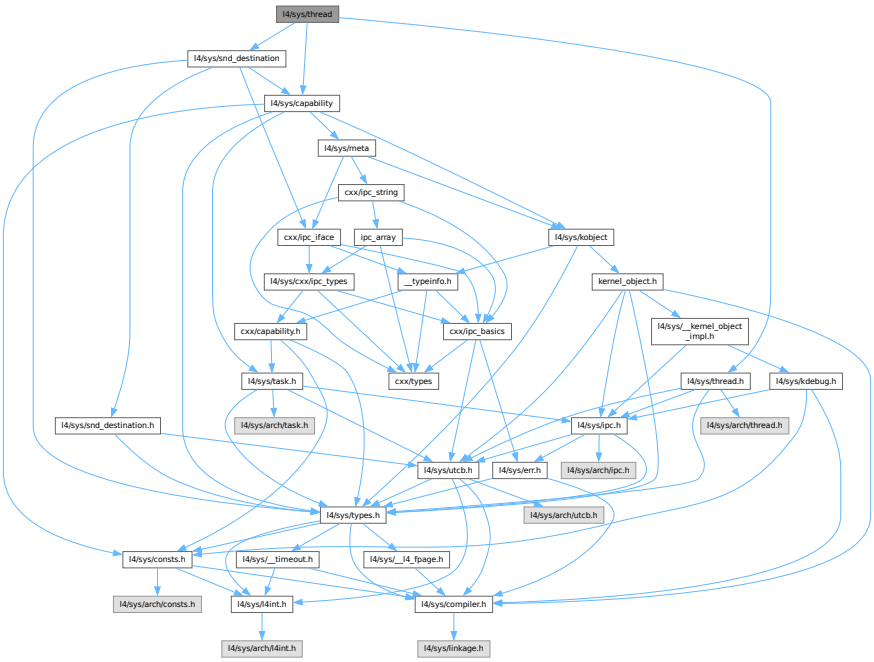
```
00007  * (c) 2004-2009 Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * This file is part of TUD:OS and distributed under the terms of the
00010  * GNU Lesser General Public License 2.1.
00011  * Please see the COPYING-LGPL-2.1 file for details.
00012  */
00013
00014 #ifndef CXX_THREAD_H__
00015 #define CXX_THREAD_H__
00016
00017 #include <l4/sys/capability>
00018 #include <l4/sys/types.h>
00019
00020 namespace cxx {
00021
00022   class Thread
00023   {
00024   public:
00025
00026     enum State
00027     {
00028       Dead    = 0,
00029       Running = 1,
00030       Stopped = 2,
00031     };
00032
00033     Thread(bool initiate);
00034     Thread(void *stack);
00035     Thread(void *stack, L4::Cap<L4::Thread> const &cap);
00036     virtual ~Thread();
00037     void execute() asm ("L4_Thread_execute");
00038     virtual void run() = 0;
00039     virtual void shutdown() asm ("L4_Thread_shutdown");
00040     void start();
00041     void stop();
00042
00043     L4::Cap<L4::Thread> self() const throw()
00044     { return _cap; }
00045
00046     State state() const
00047     { return _state; }
00048
00049     static void start_cxx_thread(Thread *_this)
00050       asm ("L4_Thread_start_cxx_thread");
00051
00052     static void kill_cxx_thread(Thread *_this)
00053       asm ("L4_Thread_kill_cxx_thread");
00054
00055     static void set_pager(L4::Cap<void>const &p) throw()
00056     { _pager = p; }
00057
00058   private:
00059     int create();
00060
00061     L4::Cap<L4::Thread> _cap;
00062     State _state;
00063
00064   protected:
00065     void *_stack;
00066
00067   private:
00068     static L4::Cap<void> _pager;
00069     static L4::Cap<void> _master;
00070   };
00071
00072 };
00073
00074 #endif  /* CXX_THREAD_H__ */
00075
```

16.610 l4/sys/thread File Reference

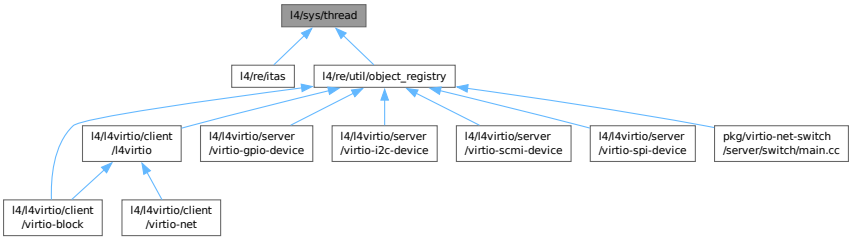
Common thread related definitions.

```
#include <l4/sys/capability>
#include <l4/sys/snd_destination>
#include <l4/sys/thread.h>
```

Include dependency graph for thread:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Thread

  C++ L4 kernel thread interface, see Thread for the C interface.
- class L4::Thread::Attr

  Thread attributes used for control().
- class L4::Thread::Modify_senders

  Class wrapping a list of rules which modify the sender label of IPC messages inbound to this thread.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.610.1 Detailed Description

Common thread related definitions.
Definition in file thread.

16.611 thread

Go to the documentation of this file.

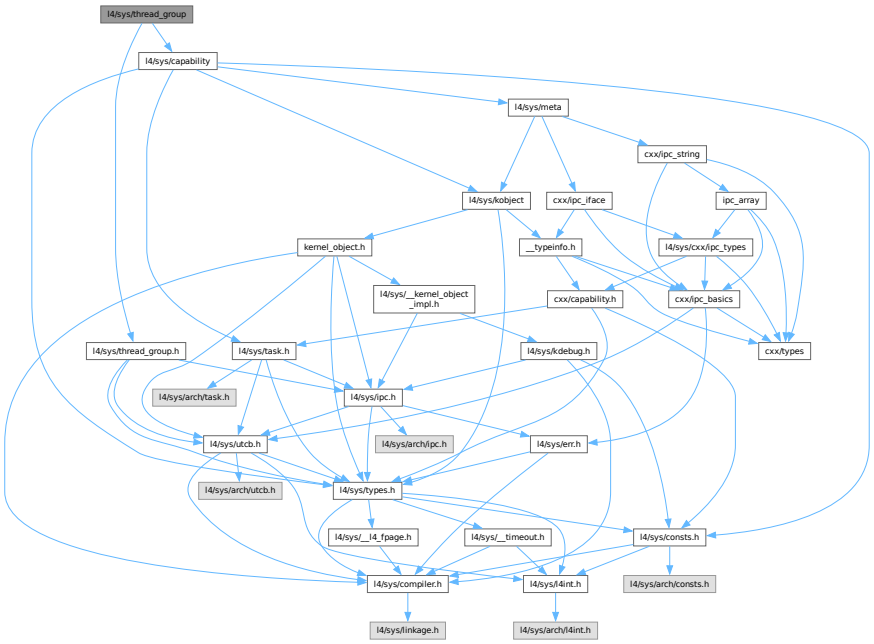
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/capability>
00017 #include <l4/sys/snd_destination>
00018 #include <l4/sys/thread.h>
00019
00020 namespace L4 {
00021
00052 class Thread :
00053   public Kobject_t<Thread, Snd_destination, L4_PROTO_THREAD,
00054                    Type_info::Demand_t<1> >
00055 {
00056 public:
00084   l4_msgtag_t ex_regs(l4_addr_t ip, l4_addr_t sp,
00085                       l4_umword_t flags,
00086                       l4_utcb_t *utcb = l4_utcb()) noexcept
00087   { return l4_thread_ex_regs_u(cap(), ip, sp, flags, utcb); }
00088
00119   l4_msgtag_t ex_regs(l4_addr_t *ip, l4_addr_t *sp,
00120                       l4_umword_t *flags,
00121                       l4_utcb_t *utcb = l4_utcb()) noexcept
00122   { return l4_thread_ex_regs_ret_u(cap(), ip, sp, flags, utcb); }
00123
00124
00137   class Attr
00138   {
00139   private:
00140     friend class L4::Thread;
00141     l4_utcb_t *_u;
00142
00143    public:
00151     explicit Attr(l4_utcb_t *utcb = l4_utcb()) noexcept : _u(utcb)
00152     { l4_thread_control_start_u(utcb); }
00153
00161     void pager(Cap<void> const &pager) noexcept
00162     { l4_thread_control_pager_u(pager.cap(), _u); }
00163
00171     Cap<void> pager() noexcept
00172     { return Cap<void>(l4_utcb_mr_u(_u)->mr[1]); }
00173
00182     void exc_handler(Cap<void> const &exc_handler) noexcept
00183     { l4_thread_control_exc_handler_u(exc_handler.cap(), _u); }
00184
00192     Cap<void> exc_handler() noexcept
00193     { return Cap<void>(l4_utcb_mr_u(_u)->mr[2]); }
00194
00221     void bind(l4_utcb_t *thread_utcb, Cap<Task> const &task) noexcept
00222     { l4_thread_control_bind_u(thread_utcb, task.cap(), _u); }
00223
00227     void alien(int on) noexcept
00228     { l4_thread_control_alien_u(_u, on); }
00229    };
00230
00246   l4_msgtag_t control(Attr const &attr) noexcept
00247   { return l4_thread_control_commit_u(cap(), attr._u); }
00248
00256   l4_msgtag_t switch_to(l4_utcb_t *utcb = l4_utcb()) noexcept
00257   { return l4_thread_switch_u(cap(), utcb); }
00258
00267   l4_msgtag_t stats_time(l4_kernel_clock_t *us,
00268                          l4_utcb_t *utcb = l4_utcb()) noexcept
00269   { return l4_thread_stats_time_u(cap(), us, utcb); }
00270
00286   l4_msgtag_t vcpu_resume_start(l4_utcb_t *utcb = l4_utcb()) noexcept
00287   { return l4_thread_vcpu_resume_start_u(utcb); }
00288
00337   l4_msgtag_t vcpu_resume_commit(l4_msgtag_t tag,
00338                                  l4_utcb_t *utcb = l4_utcb()) noexcept
00339   { return l4_thread_vcpu_resume_commit_u(cap(), tag, utcb); }
00340
00361    l4_msgtag_t vcpu_control(l4_addr_t vcpu_state, l4_utcb_t *utcb = l4_utcb())
00362      noexcept
00363    { return l4_thread_vcpu_control_u(cap(), vcpu_state, utcb); }
00364
```

```
00401    l4_msgtag_t vcpu_control_ext(l4_addr_t ext_vcpu_state,
00402                                 l4_utcb_t *utcb = l4_utcb()) noexcept
00403    { return l4_thread_vcpu_control_ext_u(cap(), ext_vcpu_state, utcb); }
00404
00430    l4_msgtag_t register_del_irq(Cap<Irq> irq, l4_utcb_t *u = l4_utcb()) noexcept
00431    { return l4_thread_register_del_irq_u(cap(), irq.cap(), u); }
00432
00451    class Modify_senders
00452    {
00453    private:
00454      friend class Thread;
00455      l4_utcb_t *utcb;
00456      unsigned cnt;
00457
00458    public:
00459      explicit Modify_senders(l4_utcb_t *u = l4_utcb()) noexcept
00460      : utcb(u), cnt(1)
00461      {
00462        l4_utcb_mr_u(utcb)->mr[0] = L4_THREAD_MODIFY_SENDER_OP;
00463      }
00464
00484      int add(l4_umword_t match_mask, l4_umword_t match,
00485              l4_umword_t del_bits, l4_umword_t add_bits) noexcept
00486      {
00487        l4_msg_regs_t *m = l4_utcb_mr_u(utcb);
00488        if (cnt >= L4_UTCB_GENERIC_DATA_SIZE - 4)
00489          return -L4_ENOMEM;
00490        m->mr[cnt++] = match_mask;
00491        m->mr[cnt++] = match;
00492        m->mr[cnt++] = del_bits;
00493        m->mr[cnt++] = add_bits;
00494        return 0;
00495      }
00496    };
00497
00528    l4_msgtag_t modify_senders(Modify_senders const &todo) noexcept
00529    {
00530      return l4_ipc_call(cap(), todo.utcb, l4_msgtag(L4_PROTO_THREAD, todo.cnt, 0, 0), L4_IPC_NEVER);
00531    }
00532
00556    l4_msgtag_t register_doorbell_irq(Cap<Irq> irq, l4_utcb_t *u = l4_utcb()) noexcept
00557    { return l4_thread_register_doorbell_irq_u(cap(), irq.cap(), u); }
00558
00559
00585    l4_msgtag_t pf_trampoline_setup(l4_addr_t pf_tramp_state,
00586                                    l4_utcb_t *u = l4_utcb()) noexcept
00587    { return l4_thread_pf_trampoline_setup_u(cap(), pf_tramp_state, u); }
00588
00597    l4_msgtag_t pf_trampoline_resume(l4_utcb_t *u = l4_utcb()) noexcept
00598    { return l4_thread_pf_trampoline_resume_u(cap(), u); }
00599
00609    l4_msgtag_t pf_trampoline_reflect(l4_utcb_t *u = l4_utcb()) noexcept
00610    { return l4_thread_pf_trampoline_reflect_u(cap(), u); }
00611
00619    l4_msgtag_t pf_trampoline_disable(int *was_enabled = nullptr,
00620                                      l4_utcb_t *u = l4_utcb()) noexcept
00621    { return l4_thread_pf_trampoline_disable_u(cap(), was_enabled, u); }
00622
00630    l4_msgtag_t pf_trampoline_enable(l4_utcb_t *u = l4_utcb()) noexcept
00631    { return l4_thread_pf_trampoline_enable_u(cap(), u); }
00632 };
00633
00634 }
```

16.612 l4/sys/thread_group File Reference

```
#include <l4/sys/capability>
#include <l4/sys/thread_group.h>
```

Include dependency graph for thread_group:



Data Structures

- class L4::Thread_group

  C++ L4 kernel thread group interface, see Thread groups for the C interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.613 thread_group

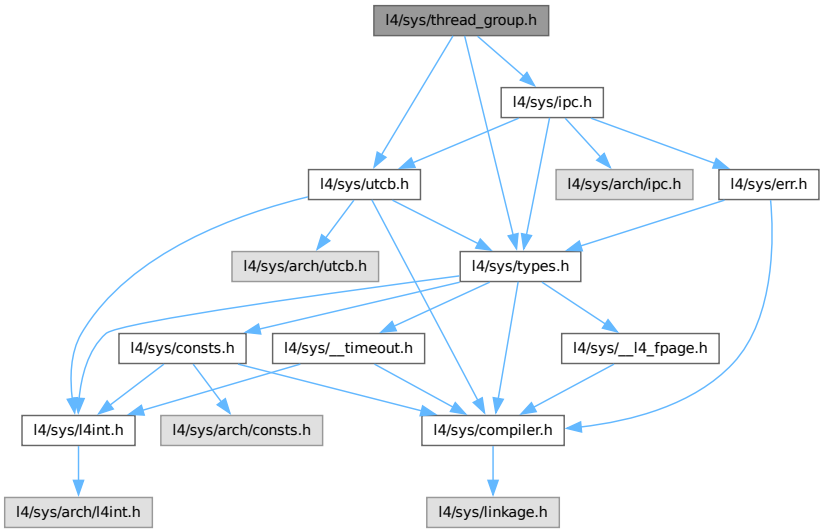
Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2022-2025 Kernkonzept GmbH.
00004  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00005  *            Frank Mehnert <frank.mehnert@kernkonzept.com>
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00012 #pragma once
00013
00014 #include <l4/sys/capability>
00015 #include <l4/sys/thread_group.h>
00016
00017 namespace L4 {
00018
00034 class L4_EXPORT Thread_group :
00035   public Kobject_t<Thread_group, Snd_destination, L4_PROTO_THREAD_GROUP,
00036                    Type_info::Demand_t<1>>
00037 {
00038 public:
00053   l4_msgtag_t add(Cap<Thread> thread, l4_utcb_t *utcb = l4_utcb()) noexcept
00054   { return l4_thread_group_add_u(cap(), thread.cap(), utcb); }
00055
00067   l4_msgtag_t remove(Cap<Thread> thread, l4_utcb_t *utcb = l4_utcb()) noexcept
00068   { return l4_thread_group_remove_u(cap(), thread.cap(), utcb); }
00069 };
00070
00071 }
```

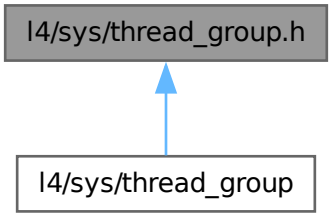
16.614 l4/sys/thread_group.h File Reference

```
#include <l4/sys/types.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
```

Include dependency graph for thread_group.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum L4_thread_group_ops { L4_THREAD_GROUP_ADD_OP = 2UL , L4_THREAD_GROUP_REMOVE_OP = 3UL }

  Operations on the Thread_group object.
- enum L4_thread_group_policy { L4_THREAD_GROUP_POLICY_STRICT_CORE_LOCAL = 0 , L4_THREAD_GROUP_POLIC = 1 }

  Thread group policy.

Functions

- l4_msgtag_t l4_thread_group_add (l4_cap_idx_t tg, l4_cap_idx_t thread) L4_NOTHROW

Add thread to a thread group.

- l4_msgtag_t l4_thread_group_remove (l4_cap_idx_t tg, l4_cap_idx_t thread) L4_NOTHROW

  Remove thread from a thread group.

16.615 thread_group.h

Go to the documentation of this file.

```
00001 /*
00002  * Copyright (C) 2022-2025 Kernkonzept GmbH.
00003  * Author(s): Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *            Frank Mehnert <frank.mehnert@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00011 #pragma once
00012
00013 #include <l4/sys/types.h>
00014 #include <l4/sys/utcb.h>
00015
00033
00040 enum L4_thread_group_ops
00041 {
00042   L4_THREAD_GROUP_ADD_OP = 2UL,
00043   L4_THREAD_GROUP_REMOVE_OP = 3UL,
00044 };
00045
00052 enum L4_thread_group_policy
00053 {
00058   L4_THREAD_GROUP_POLICY_STRICT_CORE_LOCAL = 0,
00059
00064   L4_THREAD_GROUP_POLICY_SOFT_CORE_LOCAL = 1,
00065 };
00066
00073 L4_INLINE l4_msgtag_t
00074 l4_thread_group_add(l4_cap_idx_t tg,
00075                     l4_cap_idx_t thread) L4_NOTHROW;
00076
00080 L4_INLINE l4_msgtag_t
00081 l4_thread_group_add_u(l4_cap_idx_t tg,
00082                       l4_cap_idx_t thread,
00083                       l4_utcb_t *utcb) L4_NOTHROW;
00084
00091 L4_INLINE l4_msgtag_t
00092 l4_thread_group_remove(l4_cap_idx_t tg,
00093                        l4_cap_idx_t thread) L4_NOTHROW;
00094
00098 L4_INLINE l4_msgtag_t
00099 l4_thread_group_remove_u(l4_cap_idx_t tg,
00100                          l4_cap_idx_t thread,
00101                          l4_utcb_t *utcb) L4_NOTHROW;
00102
00103
00104 /* IMPLEMENTATION ----------------------------------------------------------*/
00105
00106 #include <l4/sys/ipc.h>
00107
00108 L4_INLINE l4_msgtag_t
00109 l4_thread_group_add_u(l4_cap_idx_t tg,
00110                       l4_cap_idx_t thread,
00111                       l4_utcb_t *utcb) L4_NOTHROW
00112 {
00113   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00114   v->mr[0] = L4_THREAD_GROUP_ADD_OP;
00115   v->mr[1] = l4_map_obj_control(0, 0);
00116   v->mr[2] = l4_obj_fpage(thread, 0, L4_CAP_FPAGE_RWS).raw;
00117   return l4_ipc_call(tg, utcb,
00118                      l4_msgtag(L4_PROTO_THREAD_GROUP, 1, 1, 0), L4_IPC_NEVER);
00119 }
00120
00121 L4_INLINE l4_msgtag_t
00122 l4_thread_group_remove_u(l4_cap_idx_t tg,
00123                          l4_cap_idx_t thread,
00124                          l4_utcb_t *utcb) L4_NOTHROW
00125 {
00126   l4_msg_regs_t *v = l4_utcb_mr_u(utcb);
00127   v->mr[0] = L4_THREAD_GROUP_REMOVE_OP;
00128   v->mr[1] = l4_map_obj_control(0, 0);
00129   v->mr[2] = l4_obj_fpage(thread, 0, L4_CAP_FPAGE_RWS).raw;
00130   return l4_ipc_call(tg, utcb,
00131                      l4_msgtag(L4_PROTO_THREAD_GROUP, 1, 1, 0), L4_IPC_NEVER);
00132 }
00133
```

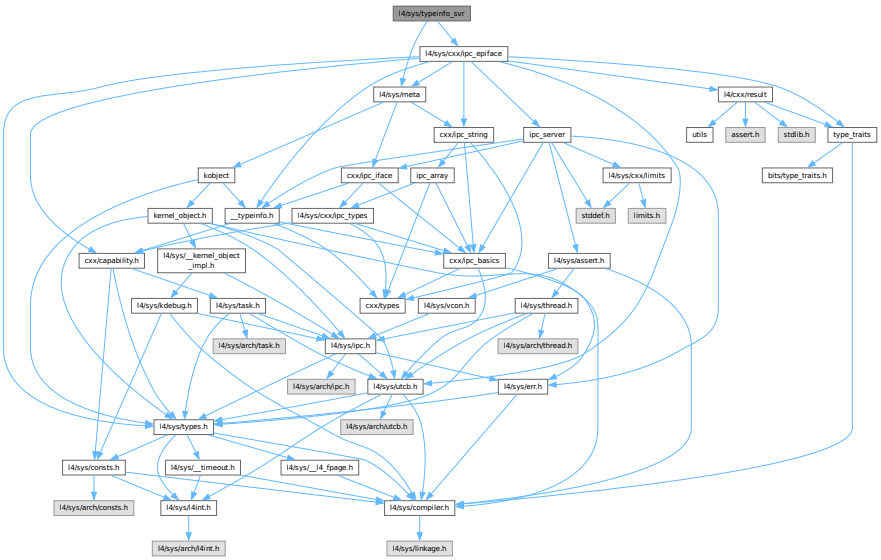
```
00134 L4_INLINE l4_msgtag_t
00135 l4_thread_group_add(l4_cap_idx_t tg,
00136                     l4_cap_idx_t thread) L4_NOTHROW
00137 {
00138   return l4_thread_group_add_u(tg, thread, l4_utcb());
00139 }
00140
00141 L4_INLINE l4_msgtag_t
00142 l4_thread_group_remove(l4_cap_idx_t tg,
00143                        l4_cap_idx_t thread) L4_NOTHROW
00144 {
00145   return l4_thread_group_remove_u(tg, thread, l4_utcb());
00146 }
```

16.616 l4/sys/typeinfo_svr File Reference

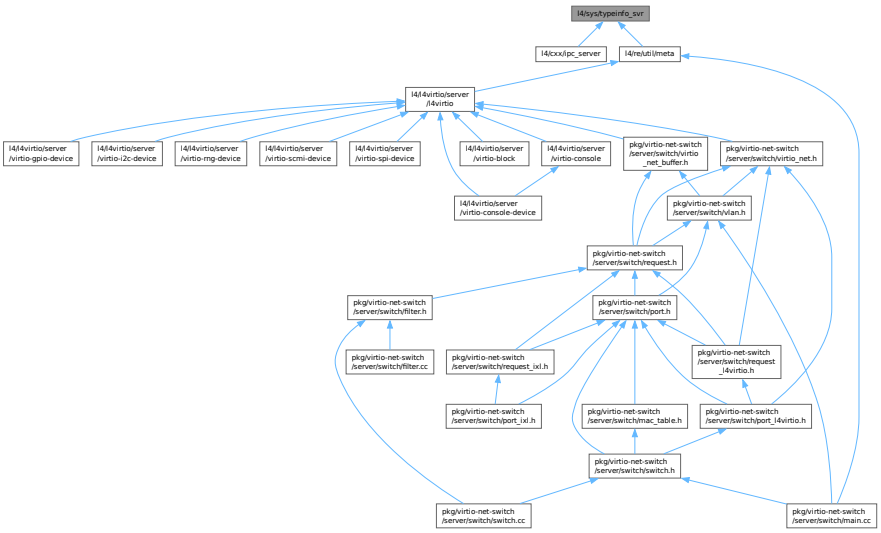
Type information server template.

```
#include <l4/sys/meta>
#include <l4/sys/cxx/ipc_epiface>
```

Include dependency graph for typeinfo_svr:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace L4

  L4 low-level kernel interface.

16.616.1 Detailed Description

Type information server template.
Definition in file typeinfo_svr.

16.617 typeinfo_svr

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2010 Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012
00013 #pragma once
00014
00015 #include <l4/sys/meta>
00016 #include <l4/sys/cxx/ipc_epiface>
00017
00018 namespace L4 { namespace Util {
00019
00020 template<typename KO, typename IOS>
00021 long handle_meta_request(IOS &ios)
00022 {
00023   using L4::Ipc::Msg::dispatch_call;
00024   typedef L4::Ipc::Detail::Meta_svr<KO> Msvr;
00025   typedef L4::Meta::Rpcs Rpcs;
00026   Msvr *svr = nullptr;
00027   l4_msgtag_t tag = dispatch_call<Rpcs>(svr, ios.utcb(), ios.tag(), 0);
00028   ios.set_ipc_params(tag);
00029   return tag.label();
00030 }
00031
00032 }}
```

16.618 types.h

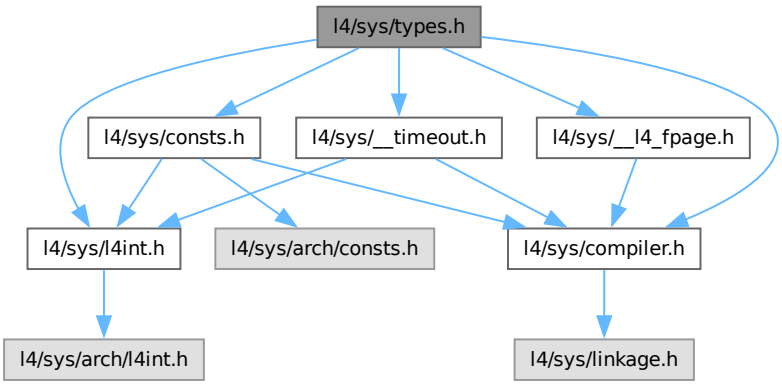
```
00001 /*
00002  * (c) 2008-2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
00008 #include <l4/vbus/vbus_types.h>
00009
00014 enum l4io_iomem_flags_t
00015 {
00016     L4IO_MEM_NONCACHED = 0,
00017     L4IO_MEM_CACHED    = 1,
00018     L4IO_MEM_USE_MTRR  = 2,
00019     L4IO_MEM_ATTR_MASK = 0xf,
00020
00021     // combinations
00022     L4IO_MEM_WRITE_COMBINED = L4IO_MEM_USE_MTRR | L4IO_MEM_CACHED,
00023
00024
00027     L4IO_MEM_USE_RESERVED_AREA = 0x40 << 8,
00029     L4IO_MEM_EAGER_MAP         = 0x80 << 8,
00030 };
00031
00036 enum l4io_device_types_t {
00037   L4IO_DEVICE_INVALID = 0,
00038   L4IO_DEVICE_PCI,
00039   L4IO_DEVICE_USB,
00040   L4IO_DEVICE_OTHER,
00041   L4IO_DEVICE_ANY = ~0
00042 };
00043
00048 enum l4io_resource_types_t {
00049   L4IO_RESOURCE_INVALID = L4VBUS_RESOURCE_INVALID,
00050   L4IO_RESOURCE_IRQ     = L4VBUS_RESOURCE_IRQ,
00051   L4IO_RESOURCE_MEM     = L4VBUS_RESOURCE_MEM,
00052   L4IO_RESOURCE_PORT    = L4VBUS_RESOURCE_PORT,
00053   L4IO_RESOURCE_ANY = ~0
00054 };
00055
00056
00057 typedef l4vbus_device_handle_t l4io_device_handle_t;
00058 typedef unsigned l4io_resource_handle_t;
00059
00067 typedef l4vbus_resource_t l4io_resource_t;
00068
00072 typedef l4vbus_device_t l4io_device_t;
```

16.619 l4/sys/types.h File Reference

Common L4 ABI Data Types.

```
#include <l4/sys/l4int.h>
#include <l4/sys/compiler.h>
#include <l4/sys/consts.h>
#include <l4/sys/__l4_fpage.h>
#include <l4/sys/__timeout.h>
```

Include dependency graph for types.h:



Data Structures

- struct l4_msgtag_t

  Message tag data structure.

Typedefs

- typedef l4_int16_t l4_ret_t

  Return value of an IPC call as well as an RPC call.
- typedef l4_int16_t l4_proto_t

  Prototype value for RPC calls.
- typedef unsigned long l4_cap_idx_t

  Capability selector type.

Enumerations

- enum L4_msgtag_protocol {
  L4_PROTO_NONE = 0 , L4_PROTO_ALLOW_SYSCALL = 1 , L4_PROTO_PF_EXCEPTION = 1 ,
  L4_PROTO_PLATFORM_CTL = 0L ,
  L4_PROTO_IRQ = -1L , L4_PROTO_PAGE_FAULT = -2L , L4_PROTO_EXCEPTION = -5L , L4_PROTO_SIGMA0 = -6L ,
  L4_PROTO_IO_PAGE_FAULT = -8L , L4_PROTO_THREAD_GROUP = -9L , L4_PROTO_KOBJECT = -10L , L4_PROTO_TASK = -11L ,
  L4_PROTO_THREAD = -12L , L4_PROTO_LOG = -13L , L4_PROTO_SCHEDULER = -14L ,
  L4_PROTO_FACTORY = -15L ,
  L4_PROTO_VM = -16L , L4_PROTO_DMA_SPACE = -17L , L4_PROTO_IRQ_SENDER = -18L ,
  L4_PROTO_SEMAPHORE = -20L ,
  L4_PROTO_META = -21L , L4_PROTO_IOMMU = -22L , L4_PROTO_DEBUGGER = -23L , L4_PROTO_SMCCC = -24L ,
  L4_PROTO_VCPU_CONTEXT = -25L , L4_PROTO_PI_MUTEX = -26L }

  Message tag for IPC operations.
- enum L4_msgtag_flags { L4_MSGTAG_ERROR , L4_MSGTAG_TRANSFER_FPU , L4_MSGTAG_SCHEDULE , **L4_MSGTAG_PROPAGATE** = 0x4000 , L4_MSGTAG_FLAGS }

  Flags for message tags.

Functions

- long l4_msgtag_label (l4_msgtag_t t) L4_NOTHROW

  Get the protocol of tag.
- unsigned l4_msgtag_words (l4_msgtag_t t) L4_NOTHROW

  Get the number of untyped words.
- unsigned l4_msgtag_items (l4_msgtag_t t) L4_NOTHROW

  Get the number of typed items.
- unsigned l4_msgtag_flags (l4_msgtag_t t) L4_NOTHROW

  Get the flags.
- unsigned l4_msgtag_has_error (l4_msgtag_t t) L4_NOTHROW

  Test for error indicator flag.
- unsigned l4_msgtag_is_page_fault (l4_msgtag_t t) L4_NOTHROW

  Test for page-fault protocol.
- unsigned l4_msgtag_is_exception (l4_msgtag_t t) L4_NOTHROW

  Test for exception protocol.
- unsigned l4_msgtag_is_sigma0 (l4_msgtag_t t) L4_NOTHROW

  Test for sigma0 protocol.
- unsigned l4_msgtag_is_io_page_fault (l4_msgtag_t t) L4_NOTHROW

  Test for IO-page-fault protocol.
- l4_msgtag_t l4_msgtag (long label, unsigned words, unsigned items, unsigned flags) L4_NOTHROW

  Create a message tag from the specified values.
- unsigned l4_is_invalid_cap (l4_cap_idx_t c) L4_NOTHROW

  Test if a capability selector is invalid (i.e., L4_INVALID_CAP_BIT is set).
- unsigned l4_is_valid_cap (l4_cap_idx_t c) L4_NOTHROW

  Test if a capability selector is valid (i.e., L4_INVALID_CAP_BIT is not set).
- unsigned l4_capability_equal (l4_cap_idx_t c1, l4_cap_idx_t c2) L4_NOTHROW

  Test if the capability indices of two capability selectors are equal.
- l4_cap_idx_t l4_capability_next (l4_cap_idx_t c) L4_NOTHROW

  Get the next capability index after `c`.

16.619.1 Detailed Description

Common L4 ABI Data Types.
Definition in file types.h.

16.619.2 Typedef Documentation

16.619.2.1 l4_proto_t

```
typedef l4_int16_t l4_proto_t
```

Prototype value for RPC calls.
This type must not be larger than the label part of l4_msgtag_t.
Definition at line 36 of file types.h.

16.619.2.2 l4_ret_t

```
typedef l4_int16_t l4_ret_t
```

Return value of an IPC call as well as an RPC call.
This type must not be larger than the label part of l4_msgtag_t.
Definition at line 29 of file types.h.

16.619.3 Function Documentation

16.619.3.1 l4_capability_next()

```
l4_cap_idx_t l4_capability_next (
             l4_cap_idx_t c)  [inline]
```

Get the next capability index after `c`.

Parameters

c	The capability index for which the next one shall be computed.

Returns

The next capability index after `c`.

Definition at line 496 of file types.h.
References L4_CAP_OFFSET, L4_INLINE, and L4_NOTHROW.

16.620 types.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00008 /*
00009  * (c) 2008-2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00010  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00011  *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
00012  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00013  *     economic rights: Technische Universität Dresden (Germany)
00014  *
00015  * License: see LICENSE.spdx (in this directory or the directories above)
00016  */
00017 /*****************************************************************************/
00018 #pragma once
00019
00020 #include <l4/sys/l4int.h>
00021 #include <l4/sys/compiler.h>
00022 #include <l4/sys/consts.h>
00023
00029 typedef l4_int16_t l4_ret_t;
00030
00036 typedef l4_int16_t l4_proto_t;
00037
00038
00046
00053 enum L4_msgtag_protocol
00054 {
00055   L4_PROTO_NONE          = 0,
00056   L4_PROTO_ALLOW_SYSCALL = 1,
00057   L4_PROTO_PF_EXCEPTION  = 1,
00058
00059   L4_PROTO_PLATFORM_CTL  =   0L,
00060   L4_PROTO_IRQ           =  -1L,
00061   L4_PROTO_PAGE_FAULT    =  -2L,
00062   // -3L unused
00063   // -4L unused
00064   L4_PROTO_EXCEPTION     =  -5L,
00065   L4_PROTO_SIGMA0        =  -6L,
00066   L4_PROTO_IO_PAGE_FAULT =  -8L,
00067   L4_PROTO_THREAD_GROUP  =  -9L,
00068   L4_PROTO_KOBJECT       = -10L,
00069   L4_PROTO_TASK          = -11L,
00070   L4_PROTO_THREAD        = -12L,
00071   L4_PROTO_LOG           = -13L,
00072   L4_PROTO_SCHEDULER     = -14L,
00073   L4_PROTO_FACTORY       = -15L,
00074   L4_PROTO_VM            = -16L,
00075   L4_PROTO_DMA_SPACE     = -17L,
00076   L4_PROTO_IRQ_SENDER    = -18L,
00077   // -19L unusable, used for L4::PROTO_EMPTY
00078   L4_PROTO_SEMAPHORE     = -20L,
00079   L4_PROTO_META          = -21L,
00080   L4_PROTO_IOMMU         = -22L,
00081   L4_PROTO_DEBUGGER      = -23L,
00082   L4_PROTO_SMCCC         = -24L,
```

```
00083   L4_PROTO_VCPU_CONTEXT  = -25L,
00084   L4_PROTO_PI_MUTEX      = -26L,
00085 };
00086
00087 enum L4_varg_type
00088 {
00089   L4_VARG_TYPE_NIL    = 0x00,
00090   L4_VARG_TYPE_UMWORD = 0x01,
00091   L4_VARG_TYPE_MWORD  = 0x81,
00092   L4_VARG_TYPE_STRING = 0x02,
00093   L4_VARG_TYPE_FPAGE  = 0x03,
00094
00095   L4_VARG_TYPE_SIGN   = 0x80,
00096 };
00097
00098
00103 enum L4_msgtag_flags
00104 {
00105   // flags for received IPC
00110   L4_MSGTAG_ERROR        = 0x8000,
00111
00112   // flags for sending IPC
00122   L4_MSGTAG_TRANSFER_FPU = 0x1000,
00131   L4_MSGTAG_SCHEDULE     = 0x2000,
00144   L4_MSGTAG_PROPAGATE    = 0x4000,
00145
00150   L4_MSGTAG_FLAGS        = 0xf000,
00151 };
00152
00153 typedef struct l4_msgtag_t l4_msgtag_t;
00154
00163 L4_INLINE long l4_msgtag_label(l4_msgtag_t t) L4_NOTHROW;
00164
00173 L4_INLINE unsigned l4_msgtag_words(l4_msgtag_t t) L4_NOTHROW;
00174
00183 L4_INLINE unsigned l4_msgtag_items(l4_msgtag_t t) L4_NOTHROW;
00184
00195 L4_INLINE unsigned l4_msgtag_flags(l4_msgtag_t t) L4_NOTHROW;
00196
00209 L4_INLINE unsigned l4_msgtag_has_error(l4_msgtag_t t) L4_NOTHROW;
00210
00219 L4_INLINE unsigned l4_msgtag_is_page_fault(l4_msgtag_t t) L4_NOTHROW;
00220
00229 L4_INLINE unsigned l4_msgtag_is_exception(l4_msgtag_t t) L4_NOTHROW;
00230
00239 L4_INLINE unsigned l4_msgtag_is_sigma0(l4_msgtag_t t) L4_NOTHROW;
00240
00249 L4_INLINE unsigned l4_msgtag_is_io_page_fault(l4_msgtag_t t) L4_NOTHROW;
00250
00251
00268 struct l4_msgtag_t
00269 {
00270   l4_mword_t raw;
00271 #ifdef __cplusplus
00273   long label() const L4_NOTHROW { return l4_msgtag_label(*this); }
00275   void label(long v) L4_NOTHROW { raw = (raw & 0x0ffff) | ((l4_umword_t)v « 16); }
00277   unsigned words() const L4_NOTHROW { return l4_msgtag_words(*this); }
00279   unsigned items() const L4_NOTHROW { return l4_msgtag_items(*this); }
00286   unsigned flags() const L4_NOTHROW { return l4_msgtag_flags(*this); }
00288   bool is_page_fault() const L4_NOTHROW
00289   { return l4_msgtag_is_page_fault(*this); }
00291   bool is_exception() const L4_NOTHROW
00292   { return l4_msgtag_is_exception(*this); }
00294   bool is_sigma0() const L4_NOTHROW { return l4_msgtag_is_sigma0(*this); }
00296   bool is_io_page_fault() const L4_NOTHROW
00297   { return l4_msgtag_is_io_page_fault(*this); }
00302   bool has_error() const L4_NOTHROW { return l4_msgtag_has_error(*this); }
00303 #endif
00304 };
00305
00306 // The following declaration should be _after_ the definition of struct
00307 // l4_msgtag_t. Circumvents a clang warning about a *potentially*
00308 // incompatibility with C if the type is incomplete when the function is
00309 // declared.
00310
00322 L4_INLINE l4_msgtag_t l4_msgtag(long label, unsigned words, unsigned items,
00323                                 unsigned flags) L4_NOTHROW;
00324
00325
00338
00374 typedef unsigned long l4_cap_idx_t;
00375
00385 L4_INLINE unsigned l4_is_invalid_cap(l4_cap_idx_t c) L4_NOTHROW;
00386
00397 L4_INLINE unsigned l4_is_valid_cap(l4_cap_idx_t c) L4_NOTHROW;
00398
00412 L4_INLINE unsigned l4_capability_equal(l4_cap_idx_t c1, l4_cap_idx_t c2) L4_NOTHROW;
```

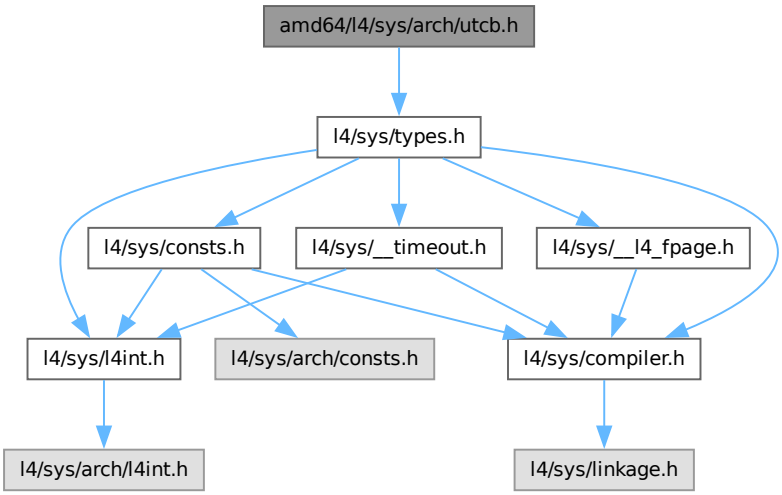
```
00413
00422 L4_INLINE l4_cap_idx_t l4_capability_next(l4_cap_idx_t c) L4_NOTHROW;
00423
00424 /* ************************************************************************ */
00425 /* Implementation */
00426
00427 L4_INLINE unsigned
00428 l4_is_invalid_cap(l4_cap_idx_t c) L4_NOTHROW
00429 { return c & L4_INVALID_CAP_BIT; }
00430
00431 L4_INLINE unsigned
00432 l4_is_valid_cap(l4_cap_idx_t c) L4_NOTHROW
00433 { return !(c & L4_INVALID_CAP_BIT); }
00434
00435 L4_INLINE unsigned
00436 l4_capability_equal(l4_cap_idx_t c1, l4_cap_idx_t c2) L4_NOTHROW
00437 { return (c1 » L4_CAP_SHIFT) == (c2 » L4_CAP_SHIFT); }
00438
00439
00443 L4_INLINE
00444 l4_msgtag_t l4_msgtag(long label, unsigned words, unsigned items,
00445                       unsigned flags) L4_NOTHROW
00446 {
00447   return (l4_msgtag_t){  (l4_mword_t)((l4_umword_t)label « 16)
00448                        | (l4_mword_t)(words & 0x3f)
00449                        | (l4_mword_t)((items & 0x3f) « 6)
00450                        | (l4_mword_t)(flags & 0xf000)};
00451 }
00452
00453
00454
00455 L4_INLINE
00456 long l4_msgtag_label(l4_msgtag_t t) L4_NOTHROW
00457 {
00458 #if defined(__cplusplus) && (__cplusplus >= 202002L)
00459   return t.raw » 16;
00460 #else
00461   return t.raw < 0 ? ~(~t.raw » 16) : t.raw » 16;
00462 #endif
00463 }
00464
00465 L4_INLINE
00466 unsigned l4_msgtag_words(l4_msgtag_t t) L4_NOTHROW
00467 { return t.raw & 0x3f; }
00468
00469 L4_INLINE
00470 unsigned l4_msgtag_items(l4_msgtag_t t) L4_NOTHROW
00471 { return (t.raw » 6) & 0x3f; }
00472
00473 L4_INLINE
00474 unsigned l4_msgtag_flags(l4_msgtag_t t) L4_NOTHROW
00475 { return t.raw & 0xf000; }
00476
00477
00478 L4_INLINE
00479 unsigned l4_msgtag_has_error(l4_msgtag_t t) L4_NOTHROW
00480 { return t.raw & L4_MSGTAG_ERROR; }
00481
00482
00483
00484 L4_INLINE unsigned l4_msgtag_is_page_fault(l4_msgtag_t t) L4_NOTHROW
00485 { return l4_msgtag_label(t) == L4_PROTO_PAGE_FAULT; }
00486
00487 L4_INLINE unsigned l4_msgtag_is_exception(l4_msgtag_t t) L4_NOTHROW
00488 { return l4_msgtag_label(t) == L4_PROTO_EXCEPTION; }
00489
00490 L4_INLINE unsigned l4_msgtag_is_sigma0(l4_msgtag_t t) L4_NOTHROW
00491 { return l4_msgtag_label(t) == L4_PROTO_SIGMA0; }
00492
00493 L4_INLINE unsigned l4_msgtag_is_io_page_fault(l4_msgtag_t t) L4_NOTHROW
00494 { return l4_msgtag_label(t) == L4_PROTO_IO_PAGE_FAULT; }
00495
00496 L4_INLINE l4_cap_idx_t l4_capability_next(l4_cap_idx_t c) L4_NOTHROW
00497 { return c + L4_CAP_OFFSET; }
00498
00499 #include <l4/sys/__l4_fpage.h>
00500 #include <l4/sys/__timeout.h>
```

16.621 amd64/l4/sys/arch/utcb.h File Reference

UTCB definitions for AMD64.

```
#include <l4/sys/types.h>
```

Include dependency graph for utcb.h:



Data Structures

- struct l4_exc_regs_t

  UTCB structure for exceptions.

Functions

- l4_umword_t l4_utcb_exc_pc (l4_exc_regs_t const *u) L4_NOTHROW

  Access function to get the program counter of the exception state.
- void l4_utcb_exc_pc_set (l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW

  Set the program counter register in the exception state.
- l4_umword_t **l4_utcb_exc_typeval** (l4_exc_regs_t const *u) L4_NOTHROW

  Get the value out of an exception UTCB that describes the type of exception.
- int l4_utcb_exc_is_pf (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC is a page fault.
- l4_addr_t **l4_utcb_exc_pfa** (l4_exc_regs_t const *u) L4_NOTHROW

  Function to get the L4 style page fault address out of an exception.
- int l4_utcb_exc_is_ex_regs_exception (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC was triggered via l4_thread_ex_regs().

16.621.1 Detailed Description

UTCB definitions for AMD64.
Definition in file utcb.h.

16.622 utcb.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
```

```
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 /*****************************************************************************/
00014 #ifndef __L4_SYS__INCLUDE__ARCH_AMD64__UTCB_H__
00015 #define __L4_SYS__INCLUDE__ARCH_AMD64__UTCB_H__
00016
00017 #include <l4/sys/types.h>
00018
00023
00028 struct l4_exc_regs_t
00029 {
00030   l4_umword_t r15;
00031   l4_umword_t r14;
00032   l4_umword_t r13;
00033   l4_umword_t r12;
00034   l4_umword_t r11;
00035   l4_umword_t r10;
00036   l4_umword_t r9;
00037   l4_umword_t r8;
00038   l4_umword_t rdi;
00039   l4_umword_t rsi;
00040   l4_umword_t rbp;
00041   l4_umword_t pfa;
00042   l4_umword_t rbx;
00043   l4_umword_t rdx;
00044   l4_umword_t rcx;
00045   l4_umword_t rax;
00046
00047   l4_umword_t trapno;
00048   l4_umword_t err;
00049   l4_umword_t ip;
00050   l4_umword_t dummy1;
00051   l4_umword_t flags;
00052   l4_umword_t sp;
00053   l4_umword_t ss;
00054   l4_umword_t fs_base;
00055   l4_umword_t gs_base;
00056   l4_uint16_t ds, es, fs, gs;
00057 };
00058
00059 #define L4_UTCB_EXCEPTION_REGS_SIZE    (sizeof(l4_exc_regs_t) / sizeof(l4_umword_t))
00060 #define L4_UTCB_GENERIC_DATA_SIZE      63
00061 #define L4_UTCB_GENERIC_BUFFERS_SIZE   58
00062
00063 #define L4_UTCB_MSG_REGS_OFFSET        0
00064 #define L4_UTCB_BUF_REGS_OFFSET        (64 * sizeof(l4_umword_t))
00065 #define L4_UTCB_THREAD_REGS_OFFSET     (123 * sizeof(l4_umword_t))
00066
00067 #define L4_UTCB_INHERIT_FPU            (1UL << 24)
00068 #define L4_UTCB_OFFSET                 1024
00069
00070 /*
00071  * ==================================================================
00072  * Implementations.
00073  */
00074
00075 L4_INLINE l4_utcb_t *l4_utcb_direct(void) L4_NOTHROW
00076 {
00077   l4_utcb_t *res;
00078   __asm__ ( "mov %%gs:0, %0 \n" : "=r"(res));
00079   return res;
00080 }
00081
00082 L4_INLINE l4_umword_t l4_utcb_exc_pc(l4_exc_regs_t const *u) L4_NOTHROW
00083 {
00084   return u->ip;
00085 }
00086
00087 L4_INLINE void l4_utcb_exc_pc_set(l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW
00088 {
00089   u->ip = pc;
00090 }
00091
00092 L4_INLINE l4_umword_t l4_utcb_exc_typeval(l4_exc_regs_t const *u) L4_NOTHROW
00093 {
00094   return u->trapno;
00095 }
00096
00097 L4_INLINE int l4_utcb_exc_is_pf(l4_exc_regs_t const *u) L4_NOTHROW
00098 {
00099   return u->trapno == 14;
00100 }
00101
00102 L4_INLINE l4_addr_t l4_utcb_exc_pfa(l4_exc_regs_t const *u) L4_NOTHROW
00103 {
```

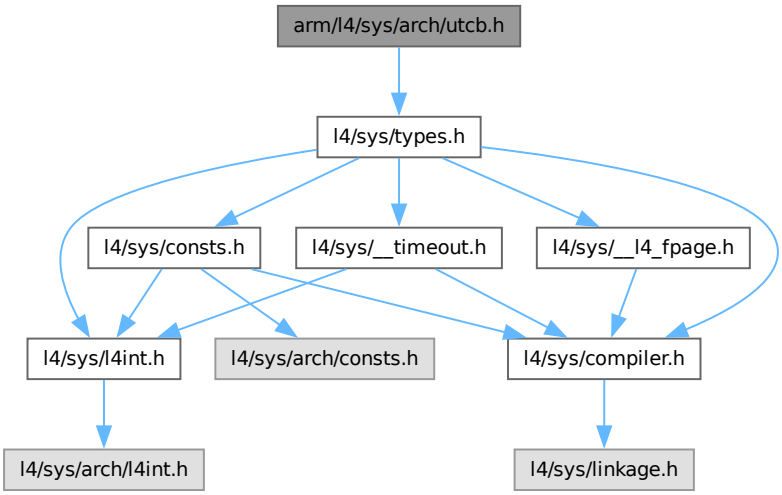
```
00104   return (u->pfa & ~7UL) | (u->err & 2);
00105 }
00106
00107 L4_INLINE int l4_utcb_exc_is_ex_regs_exception(l4_exc_regs_t const *u) L4_NOTHROW
00108 {
00109   return l4_utcb_exc_typeval(u) == 0xff;
00110 }
00111
00112 #endif /* ! __L4_SYS__INCLUDE__ARCH_AMD64__UTCB_H__ */
```

16.623 arm/l4/sys/arch/utcb.h File Reference

UTCB definitions for ARM.

`#include <l4/sys/types.h>`

Include dependency graph for utcb.h:



Data Structures

- struct l4_exc_regs_t

  UTCB structure for exceptions.

Functions

- l4_umword_t l4_utcb_exc_pc (l4_exc_regs_t const *u) L4_NOTHROW

  Access function to get the program counter of the exception state.
- void l4_utcb_exc_pc_set (l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW

  Set the program counter register in the exception state.
- l4_umword_t **l4_utcb_exc_typeval** (l4_exc_regs_t const *u) L4_NOTHROW

  Get the value out of an exception UTCB that describes the type of exception.
- int l4_utcb_exc_is_pf (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC is a page fault.
- l4_addr_t **l4_utcb_exc_pfa** (l4_exc_regs_t const *u) L4_NOTHROW

  Function to get the L4 style page fault address out of an exception.
- int l4_utcb_exc_is_ex_regs_exception (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC was triggered via l4_thread_ex_regs().

16.623.1 Detailed Description

UTCB definitions for ARM.
Definition in file utcb.h.

16.624 utcb.h

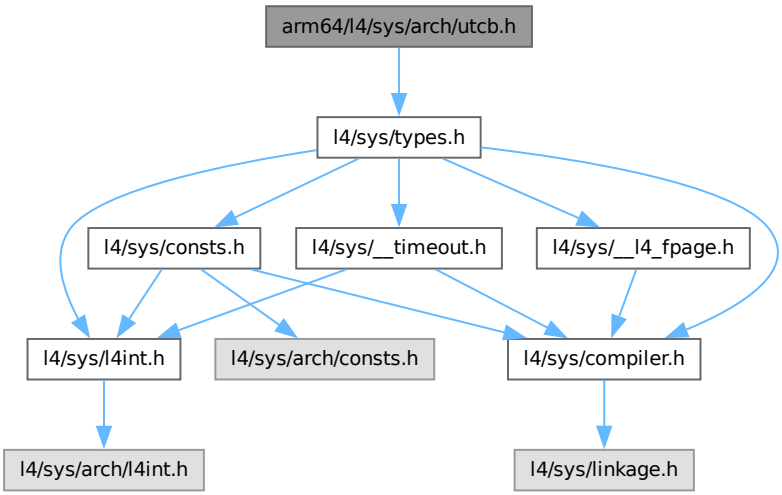
Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #ifndef __L4_SYS__INCLUDE__ARCH_ARM__UTCB_H__
00014 #define __L4_SYS__INCLUDE__ARCH_ARM__UTCB_H__
00015
00016 #include <l4/sys/types.h>
00017
00022
00027 struct l4_exc_regs_t
00028 {
00029   l4_umword_t pfa;
00030   l4_umword_t err;
00031
00032   l4_umword_t r[13];
00033   l4_umword_t sp;
00034   l4_umword_t ulr;
00035   l4_umword_t _dummy1;
00036   union { l4_umword_t ip; l4_umword_t pc; };
00037   l4_umword_t cpsr;
00038   l4_umword_t tpidruro;
00039   l4_umword_t tpidrurw;
00040 };
00041
00042 #define L4_UTCB_EXCEPTION_REGS_SIZE    (sizeof(l4_exc_regs_t) / sizeof(l4_umword_t))
00043 #define L4_UTCB_GENERIC_DATA_SIZE      63
00044 #define L4_UTCB_GENERIC_BUFFERS_SIZE   58
00045
00046 #define L4_UTCB_MSG_REGS_OFFSET        0
00047 #define L4_UTCB_BUF_REGS_OFFSET        (64 * sizeof(l4_umword_t))
00048 #define L4_UTCB_THREAD_REGS_OFFSET     (123 * sizeof(l4_umword_t))
00049
00050 #define L4_UTCB_INHERIT_FPU            (1UL << 24)
00051
00052 #define L4_UTCB_OFFSET                 512
00053
00054 /*
00055  * ====================================================================
00056  * Implementations.
00057  */
00058
00059 #ifdef __GNUC__
00060 L4_INLINE l4_utcb_t *l4_utcb_direct(void) L4_NOTHROW
00061 {
00062 # if defined(__ARM_ARCH) && __ARM_ARCH >= 7
00063   l4_utcb_t *utcb;
00064   __asm__ ("mrc p15, 0, %0, c13, c0, 2" : "=r" (utcb)); // TPIDRURW
00065 #else
00066   register l4_utcb_t *utcb __asm__ ("r0");
00067   __asm__ ("mov lr, pc    \n"
00068            "mvn pc, #0xff \n"      // write 0xffffff00 to pc
00069            : "=r"(utcb) : : "lr");
00070 #endif
00071   return utcb;
00072 }
00073 #endif
00074
00075 L4_INLINE l4_umword_t l4_utcb_exc_pc(l4_exc_regs_t const *u) L4_NOTHROW
00076 {
00077   return u->pc;
00078 }
00079
00080 L4_INLINE void l4_utcb_exc_pc_set(l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW
00081 {
00082   u->pc = pc;
00083 }
00084
00085 L4_INLINE l4_umword_t l4_utcb_exc_typeval(l4_exc_regs_t const *u) L4_NOTHROW
00086 {
00087   return u->err >> 26;
```

```
00088 }
00089
00090 L4_INLINE int l4_utcb_exc_is_pf(l4_exc_regs_t const *u) L4_NOTHROW
00091 {
00092   return ((u->err » 26) & 0x30) == 0x20;
00093 }
00094
00095 L4_INLINE l4_addr_t l4_utcb_exc_pfa(l4_exc_regs_t const *u) L4_NOTHROW
00096 {
00097   return (u->pfa & ~7UL) | ((u->err » 5) & 2);
00098 }
00099
00100 L4_INLINE int l4_utcb_exc_is_ex_regs_exception(l4_exc_regs_t const *u) L4_NOTHROW
00101 {
00102   return l4_utcb_exc_typeval(u) == 0x3e;
00103 }
00104
00105 #endif /* ! __L4_SYS__INCLUDE__ARCH_ARM__UTCB_H__ */
```

16.625 arm64/l4/sys/arch/utcb.h File Reference

UTCB definitions for ARM64.
`#include <l4/sys/types.h>`
Include dependency graph for utcb.h:



Data Structures

- struct l4_exc_regs_t

  UTCB structure for exceptions.

Functions

- l4_umword_t l4_utcb_exc_pc (l4_exc_regs_t const ∗u) L4_NOTHROW

  Access function to get the program counter of the exception state.
- void l4_utcb_exc_pc_set (l4_exc_regs_t ∗u, l4_addr_t pc) L4_NOTHROW

  Set the program counter register in the exception state.
- l4_umword_t **l4_utcb_exc_typeval** (l4_exc_regs_t const ∗u) L4_NOTHROW

  Get the value out of an exception UTCB that describes the type of exception.
- int l4_utcb_exc_is_pf (l4_exc_regs_t const ∗u) L4_NOTHROW

  Check whether an exception IPC is a page fault.

- l4_addr_t **l4_utcb_exc_pfa** (l4_exc_regs_t const *u) L4_NOTHROW

  Function to get the L4 style page fault address out of an exception.
- int l4_utcb_exc_is_ex_regs_exception (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC was triggered via l4_thread_ex_regs().

16.625.1 Detailed Description

UTCB definitions for ARM64.
Definition in file utcb.h.

16.626 utcb.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #ifndef __L4_SYS__INCLUDE__ARCH_ARM64__UTCB_H__
00014 #define __L4_SYS__INCLUDE__ARCH_ARM64__UTCB_H__
00015
00016 #include <l4/sys/types.h>
00017
00022
00027 struct l4_exc_regs_t
00028 {
00029   l4_umword_t eret_work;
00030   l4_umword_t r[31];
00031   l4_umword_t reserved;
00032   l4_umword_t err;
00033
00034   l4_umword_t pfa;
00035   l4_umword_t sp;
00036   union { l4_umword_t ip; l4_umword_t pc; }; /* aliases for PC */
00037   union { l4_umword_t flags; l4_umword_t pstate; }; /* aliases for PSTATE (PSR) */
00038   l4_umword_t tpidruro;
00039   l4_umword_t tpidrurw;
00040 };
00041
00042 #define L4_UTCB_EXCEPTION_REGS_SIZE    (sizeof(l4_exc_regs_t) / sizeof(l4_umword_t))
00043 #define L4_UTCB_GENERIC_DATA_SIZE      63
00044 #define L4_UTCB_GENERIC_BUFFERS_SIZE   58
00045
00046 #define L4_UTCB_MSG_REGS_OFFSET        0
00047 #define L4_UTCB_BUF_REGS_OFFSET        (64 * sizeof(l4_umword_t))
00048 #define L4_UTCB_THREAD_REGS_OFFSET     (123 * sizeof(l4_umword_t))
00049
00050 #define L4_UTCB_INHERIT_FPU            (1UL << 24)
00051
00052 #define L4_UTCB_OFFSET                 1024
00053
00054 /*
00055  * ================================================================
00056  * Implementations.
00057  */
00058
00059 #ifdef __GNUC__
00060 L4_INLINE l4_utcb_t *l4_utcb_direct(void) L4_NOTHROW
00061 {
00062   l4_utcb_t *utcb;
00063   __asm__ ("mrs %0, TPIDRRO_EL0" : "=r" (utcb));
00064   return utcb;
00065 }
00066 #endif
00067
00068 L4_INLINE l4_umword_t l4_utcb_exc_pc(l4_exc_regs_t const *u) L4_NOTHROW
00069 {
00070   return u->pc;
00071 }
00072
00073 L4_INLINE void l4_utcb_exc_pc_set(l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW
00074 {
00075   u->pc = pc;
00076 }
00077
00078 L4_INLINE l4_umword_t l4_utcb_exc_typeval(l4_exc_regs_t const *u) L4_NOTHROW
```

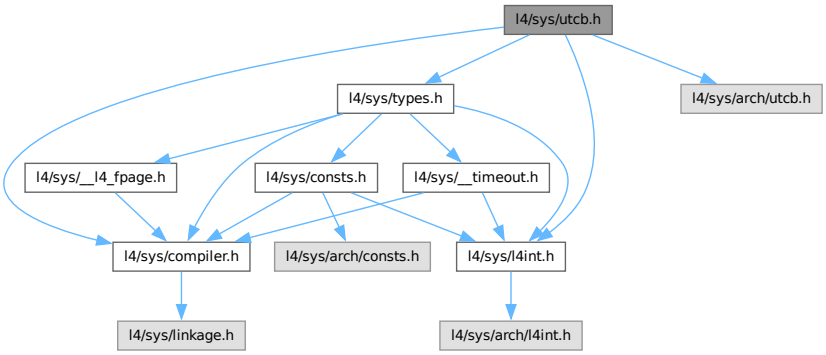
```
00079 {
00080   return u->err » 26;
00081 }
00082
00083 L4_INLINE int l4_utcb_exc_is_pf(l4_exc_regs_t const *u) L4_NOTHROW
00084 {
00085   return ((u->err » 26) & 0x30) == 0x20;
00086 }
00087
00088 L4_INLINE l4_addr_t l4_utcb_exc_pfa(l4_exc_regs_t const *u) L4_NOTHROW
00089 {
00090   return (u->pfa & ~7UL) | ((u->err » 5) & 2);
00091 }
00092
00093 L4_INLINE int l4_utcb_exc_is_ex_regs_exception(l4_exc_regs_t const *u) L4_NOTHROW
00094 {
00095   return (u->err » 26) == 0x3e;
00096 }
00097
00098 #endif /* ! __L4_SYS__INCLUDE__ARCH_ARM64__UTCB_H__ */
```

16.627 l4/sys/utcb.h File Reference

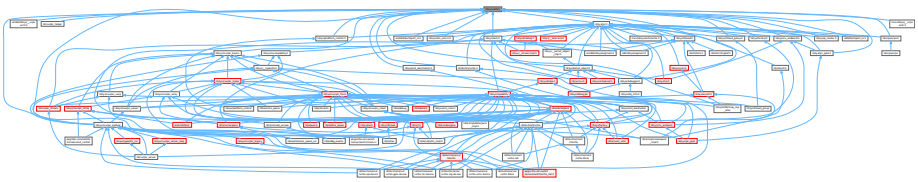
UTCB definitions.

```
#include <l4/sys/types.h>
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
#include <l4/sys/arch/utcb.h>
```

Include dependency graph for utcb.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- union l4_msg_regs_t

  Encapsulation of the message-register block in the UTCB.
- struct l4_buf_regs_t

  Encapsulation of the buffer-registers block in the UTCB.
- struct l4_thread_regs_t

  Encapsulation of the thread-control-register block of the UTCB.

Typedefs

- typedef struct l4_utcb_t l4_utcb_t

  Opaque type for the UTCB.
- typedef union l4_msg_regs_t **l4_msg_regs_t**

  Encapsulation of the message-register block in the UTCB.
- typedef struct l4_buf_regs_t **l4_buf_regs_t**

  Encapsulation of the buffer-registers block in the UTCB.
- typedef struct l4_thread_regs_t **l4_thread_regs_t**

  Encapsulation of the thread-control-register block of the UTCB.

Functions

- l4_umword_t l4_utcb_exc_pc (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE

  Access function to get the program counter of the exception state.
- void l4_utcb_exc_pc_set (l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW

  Set the program counter register in the exception state.
- unsigned long **l4_utcb_exc_typeval** (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE

  Get the value out of an exception UTCB that describes the type of exception.
- int l4_utcb_exc_is_pf (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE

  Check whether an exception IPC is a page fault.
- l4_addr_t **l4_utcb_exc_pfa** (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE

  Function to get the L4 style page fault address out of an exception.
- int l4_utcb_exc_is_ex_regs_exception (l4_exc_regs_t const *u) L4_NOTHROW L4_PURE

  Check whether an exception IPC was triggered via l4_thread_ex_regs().
- l4_utcb_t * **l4_utcb** (void) L4_NOTHROW L4_PURE

  Get the UTCB address.
- l4_msg_regs_t * l4_utcb_mr (void) L4_NOTHROW L4_PURE

  Get the message-register block of a UTCB.
- l4_buf_regs_t * l4_utcb_br (void) L4_NOTHROW L4_PURE

  Get the buffer-register block of a UTCB.
- l4_thread_regs_t * l4_utcb_tcr (void) L4_NOTHROW L4_PURE

  Get the thread-control-register block of a UTCB.
- l4_exc_regs_t * l4_utcb_exc (void) L4_NOTHROW L4_PURE

  Get the message-register block of a UTCB (for an exception IPC).
- void **l4_utcb_inherit_fpu** (int switch_on) L4_NOTHROW

  Enable or disable inheritance of FPU state to receiver.
- l4_umword_t l4_bdr (l4_umword_t mem, l4_umword_t io, l4_umword_t obj, l4_umword_t flags) L4_NOTHROW

  Create a buffer descriptor.
- l4_timeout_s l4_timeout_abs (l4_kernel_clock_t pint, int br) L4_NOTHROW

  Set an absolute timeout.
- unsigned l4_utcb_mr64_idx (unsigned idx) L4_NOTHROW

  Get index into 64bit message registers alias from native-sized index.

16.627.1 Detailed Description

UTCB definitions.
Definition in file utcb.h.

16.628 utcb.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00010  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  *
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015 /*****************************************************************************/
00016 #ifndef _L4_SYS_UTCB_H
00017 #define _L4_SYS_UTCB_H
00018
00019 #include <l4/sys/types.h>
00020 #include <l4/sys/compiler.h>
00021 #include <l4/sys/l4int.h>
00022
00047
00056 typedef struct l4_utcb_t l4_utcb_t;
00057
00058 typedef struct l4_exc_regs_t l4_exc_regs_t;
00059
00065 L4_INLINE l4_utcb_t *l4_utcb_direct(void) L4_NOTHROW L4_PURE;
00066
00074 L4_INLINE l4_umword_t l4_utcb_exc_pc(l4_exc_regs_t const *u) L4_NOTHROW L4_PURE;
00075
00084 L4_INLINE void l4_utcb_exc_pc_set(l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW;
00085
00090 L4_INLINE unsigned long l4_utcb_exc_typeval(l4_exc_regs_t const *u) L4_NOTHROW L4_PURE;
00091
00101 L4_INLINE int l4_utcb_exc_is_pf(l4_exc_regs_t const *u) L4_NOTHROW L4_PURE;
00102
00107 L4_INLINE l4_addr_t l4_utcb_exc_pfa(l4_exc_regs_t const *u) L4_NOTHROW L4_PURE;
00108
00119 L4_INLINE int l4_utcb_exc_is_ex_regs_exception(l4_exc_regs_t const *u) L4_NOTHROW L4_PURE;
00120
00121 #include <l4/sys/arch/utcb.h>
00122
00127
00132 typedef union l4_msg_regs_t
00133 {
00134   l4_umword_t mr[L4_UTCB_GENERIC_DATA_SIZE];
00135   l4_uint64_t mr64[L4_UTCB_GENERIC_DATA_SIZE / (sizeof(l4_uint64_t)/sizeof(l4_umword_t))];
00136 } l4_msg_regs_t;
00137
00147 typedef struct l4_buf_regs_t
00148 {
00150   l4_umword_t bdr;
00151
00153   l4_umword_t br[L4_UTCB_GENERIC_BUFFERS_SIZE];
00154 } l4_buf_regs_t;
00155
00164 typedef struct l4_thread_regs_t
00165 {
00171   l4_umword_t  error;
00172
00185   l4_umword_t  free_marker;
00186
00188   l4_umword_t  user[3];
00189 } l4_thread_regs_t;
00190
00191 L4_BEGIN_DECLS
00192
00203 L4_CV l4_utcb_t *l4_utcb_wrap(void) L4_NOTHROW L4_PURE;
00204
00209 L4_INLINE l4_utcb_t *l4_utcb(void) L4_NOTHROW L4_PURE;
00210
00216 L4_INLINE l4_msg_regs_t *l4_utcb_mr(void) L4_NOTHROW L4_PURE;
00217
00222 L4_INLINE l4_msg_regs_t *l4_utcb_mr_u(l4_utcb_t *u) L4_NOTHROW L4_PURE;
00223
00230 L4_INLINE l4_buf_regs_t *l4_utcb_br(void) L4_NOTHROW L4_PURE;
00231
00236 L4_INLINE l4_buf_regs_t *l4_utcb_br_u(l4_utcb_t *u) L4_NOTHROW L4_PURE;
00237
00243 L4_INLINE l4_thread_regs_t *l4_utcb_tcr(void) L4_NOTHROW L4_PURE;
00244
00249 L4_INLINE l4_thread_regs_t *l4_utcb_tcr_u(l4_utcb_t *u) L4_NOTHROW L4_PURE;
00250
00256
00263 L4_INLINE l4_exc_regs_t *l4_utcb_exc(void) L4_NOTHROW L4_PURE;
00264
00269 L4_INLINE l4_exc_regs_t *l4_utcb_exc_u(l4_utcb_t *u) L4_NOTHROW L4_PURE;
```

```
00270
00275 L4_INLINE void l4_utcb_inherit_fpu(int switch_on) L4_NOTHROW;
00276
00280 L4_INLINE void l4_utcb_inherit_fpu_u(l4_utcb_t *u, int switch_on) L4_NOTHROW;
00281
00292 L4_INLINE l4_umword_t l4_bdr(l4_umword_t mem, l4_umword_t io, l4_umword_t obj,
00293                               l4_umword_t flags) L4_NOTHROW;
00294
00309 L4_INLINE
00310 l4_timeout_s l4_timeout_abs_u(l4_kernel_clock_t pint, int br,
00311                               l4_utcb_t *utcb) L4_NOTHROW;
00325 L4_INLINE
00326 l4_timeout_s l4_timeout_abs(l4_kernel_clock_t pint, int br) L4_NOTHROW;
00327
00335 L4_INLINE
00336 unsigned l4_utcb_mr64_idx(unsigned idx) L4_NOTHROW;
00337
00338 /*****************************************************************************
00339  * Implementations
00340  *****************************************************************************/
00341
00342 L4_INLINE l4_msg_regs_t *l4_utcb_mr_u(l4_utcb_t *u) L4_NOTHROW
00343 { return (l4_msg_regs_t*)((char*)u + L4_UTCB_MSG_REGS_OFFSET); }
00344
00345 L4_INLINE l4_buf_regs_t *l4_utcb_br_u(l4_utcb_t *u) L4_NOTHROW
00346 { return (l4_buf_regs_t*)((char*)u + L4_UTCB_BUF_REGS_OFFSET); }
00347
00348 L4_INLINE l4_thread_regs_t *l4_utcb_tcr_u(l4_utcb_t *u) L4_NOTHROW
00349 { return (l4_thread_regs_t*)((char*)u + L4_UTCB_THREAD_REGS_OFFSET); }
00350
00351 L4_INLINE l4_exc_regs_t *l4_utcb_exc_u(l4_utcb_t *u) L4_NOTHROW
00352 { return (l4_exc_regs_t*)((char*)u + L4_UTCB_MSG_REGS_OFFSET); }
00353
00354 L4_INLINE void l4_utcb_inherit_fpu_u(l4_utcb_t *u, int switch_on) L4_NOTHROW
00355 {
00356   if (switch_on)
00357     l4_utcb_br_u(u)->bdr |= L4_UTCB_INHERIT_FPU;
00358   else
00359     l4_utcb_br_u(u)->bdr &= ~L4_UTCB_INHERIT_FPU;
00360 }
00361
00362 L4_INLINE l4_umword_t l4_bdr(l4_umword_t mem, l4_umword_t io, l4_umword_t obj,
00363                               l4_umword_t flags) L4_NOTHROW
00364 {
00365   // flags (bits 24..31) are already shifted!
00366   return (mem « 0) | (io « 5) | (obj « 10) | flags;
00367 }
00368
00369 L4_INLINE l4_utcb_t *l4_utcb(void) L4_NOTHROW
00370 {
00371 #ifdef L4SYS_USE_UTCB_WRAP
00372   return l4_utcb_wrap();
00373 #else
00374   return l4_utcb_direct();
00375 #endif
00376 }
00377
00378
00379
00380
00381 L4_INLINE l4_msg_regs_t *l4_utcb_mr(void) L4_NOTHROW
00382 { return l4_utcb_mr_u(l4_utcb()); }
00383
00384 L4_INLINE l4_buf_regs_t *l4_utcb_br(void) L4_NOTHROW
00385 { return l4_utcb_br_u(l4_utcb()); }
00386
00387 L4_INLINE l4_thread_regs_t *l4_utcb_tcr(void) L4_NOTHROW
00388 { return l4_utcb_tcr_u(l4_utcb()); }
00389
00390 L4_INLINE l4_exc_regs_t *l4_utcb_exc(void) L4_NOTHROW
00391 { return l4_utcb_exc_u(l4_utcb()); }
00392
00393 L4_INLINE void l4_utcb_inherit_fpu(int switch_on) L4_NOTHROW
00394 { l4_utcb_inherit_fpu_u(l4_utcb(), switch_on); }
00395
00396 L4_INLINE
00397 l4_timeout_s l4_timeout_abs_u(l4_kernel_clock_t val, int pos,
00398                               l4_utcb_t *utcb) L4_NOTHROW
00399 {
00400   union l4_kclock_to_bufregs
00401   {
00402     l4_kernel_clock_t t;
00403     l4_umword_t m[sizeof(l4_kernel_clock_t)/sizeof(l4_umword_t)];
00404   };
00405   l4_timeout_s to;
00406   to.t = 0x8000 | pos;
00407   ((union l4_kclock_to_bufregs *)(l4_utcb_br_u(utcb)->br + pos))->t = val;
```

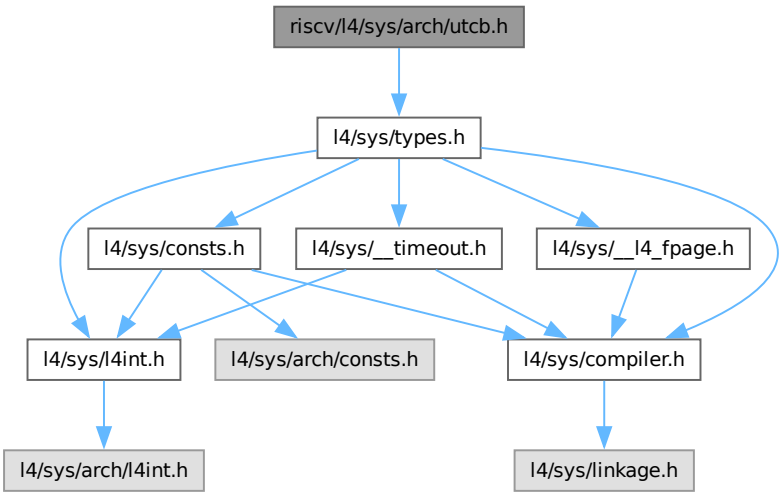
```
00408   return to;
00409 }
00410
00411 L4_INLINE
00412 l4_timeout_s l4_timeout_abs(l4_kernel_clock_t val, int pos) L4_NOTHROW
00413 { return l4_timeout_abs_u(val, pos, l4_utcb()); }
00414
00415 L4_INLINE unsigned l4_utcb_mr64_idx(unsigned idx) L4_NOTHROW
00416 { return idx / (sizeof(l4_uint64_t) / sizeof(l4_umword_t)); }
00417
00418 L4_END_DECLS
00419
00420 #endif /* ! _L4_SYS_UTCB_H */
```

16.629 riscv/l4/sys/arch/utcb.h File Reference

UTCB definitions for RISC-V.

`#include <l4/sys/types.h>`

Include dependency graph for utcb.h:



Data Structures

- struct l4_exc_regs_t

  UTCB structure for exceptions.

Functions

- l4_umword_t l4_utcb_exc_pc (l4_exc_regs_t const *u) L4_NOTHROW

  Access function to get the program counter of the exception state.
- void l4_utcb_exc_pc_set (l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW

  Set the program counter register in the exception state.
- l4_umword_t **l4_utcb_exc_typeval** (l4_exc_regs_t const *u) L4_NOTHROW

  Get the value out of an exception UTCB that describes the type of exception.
- int l4_utcb_exc_is_pf (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC is a page fault.
- l4_addr_t **l4_utcb_exc_pfa** (l4_exc_regs_t const *u) L4_NOTHROW

  Function to get the L4 style page fault address out of an exception.
- int l4_utcb_exc_is_ex_regs_exception (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC was triggered via l4_thread_ex_regs().

16.629.1 Detailed Description

UTCB definitions for RISC-V.
Definition in file utcb.h.

16.630 utcb.h

Go to the documentation of this file.

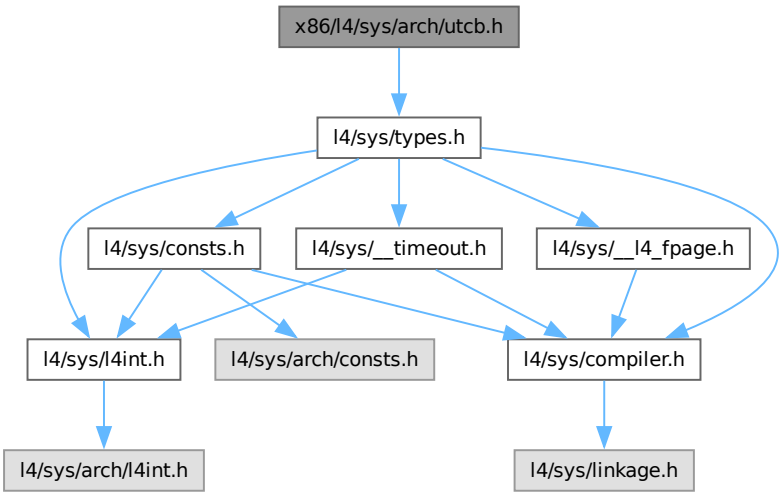
```
00001
00006 /*
00007  * Copyright (C) 2021, 2024 Kernkonzept GmbH.
00008  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015
00020
00021 enum L4_riscv_exc_cause
00022 {
00023   L4_riscv_exc_inst_misaligned        = 0,
00024   L4_riscv_exc_inst_access            = 1,
00025   L4_riscv_exc_illegal_inst           = 2,
00026   L4_riscv_exc_breakpoint             = 3,
00027   L4_riscv_exc_load_access            = 5,
00028   L4_riscv_exc_store_access           = 7,
00029   L4_riscv_exc_ecall                  = 8,
00030   L4_riscv_exc_hcall                  = 10,
00031   L4_riscv_exc_inst_page_fault        = 12,
00032   L4_riscv_exc_load_page_fault        = 13,
00033   L4_riscv_exc_store_page_fault       = 15,
00034   L4_riscv_exc_guest_inst_page_fault  = 20,
00035   L4_riscv_exc_guest_load_page_fault  = 21,
00036   L4_riscv_exc_virtual_inst           = 22,
00037   L4_riscv_exc_guest_store_page_fault = 23,
00038
00039   L4_riscv_ec_l4_ipc_upcall           = 0x18,
00040   L4_riscv_ec_l4_exregs_exception     = 0x19,
00041   L4_riscv_ec_l4_debug_ipi            = 0x1a,
00042   L4_riscv_ec_l4_alien_after_syscall  = 0x1b,
00043 };
00044
00049 struct l4_exc_regs_t
00050 {
00051   l4_umword_t eret_work;
00052   union
00053   {
00054     l4_umword_t r[31];
00055     struct
00056     {
00057       l4_umword_t ra;
00058       l4_umword_t sp;
00059       l4_umword_t gp;
00060       l4_umword_t tp;
00061       l4_umword_t t0, t1, t2;
00062       l4_umword_t s0, s1;
00063       l4_umword_t a0, a1, a2, a3, a4, a5, a6, a7;
00064       l4_umword_t s2, s3, s4, s5, s6, s7, s8, s9, s10, s11;
00065       l4_umword_t t3, t4, t5, t6;
00066     };
00067   };
00068
00069   union { l4_umword_t pc; l4_umword_t ip; };
00070   l4_umword_t status;
00071   l4_umword_t cause;
00072   union { l4_umword_t tval; l4_umword_t pfa; };
00073
00074   l4_umword_t hstatus; // only if virtualization is enabled
00075 };
00076
00077 #define L4_UTCB_EXCEPTION_REGS_SIZE    (sizeof(l4_exc_regs_t) / sizeof(l4_umword_t))
00078 #define L4_UTCB_GENERIC_DATA_SIZE      63
00079 #define L4_UTCB_GENERIC_BUFFERS_SIZE   58
00080
00081 #define L4_UTCB_MSG_REGS_OFFSET        0
00082 #define L4_UTCB_BUF_REGS_OFFSET        (64 * sizeof(l4_umword_t))
00083 #define L4_UTCB_THREAD_REGS_OFFSET     (123 * sizeof(l4_umword_t))
00084
00085 #define L4_UTCB_INHERIT_FPU            (1UL << 24)
00086
00087 #define L4_UTCB_OFFSET                 (128 * sizeof(l4_umword_t))
```

```
00088
00089 /*
00090  * ====================================================================
00091  * Implementations.
00092  */
00093
00094 L4_INLINE l4_utcb_t *l4_utcb_direct(void) L4_NOTHROW
00095 {
00096   // We store the UTCB pointer immediately before the TCB.
00097   l4_addr_t tp;
00098   __asm__ ("mv %0, tp" : "=r" (tp));
00099   return *(l4_utcb_t **)(tp - 3 * sizeof(void*));
00100 }
00101
00102 L4_INLINE l4_umword_t l4_utcb_exc_pc(l4_exc_regs_t const *u) L4_NOTHROW
00103 {
00104   return u->pc;
00105 }
00106
00107 L4_INLINE void l4_utcb_exc_pc_set(l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW
00108 {
00109   u->pc = pc;
00110 }
00111
00112 L4_INLINE l4_umword_t l4_utcb_exc_typeval(l4_exc_regs_t const *u) L4_NOTHROW
00113 {
00114   return u->cause;
00115 }
00116
00117 L4_INLINE int l4_utcb_exc_is_pf(l4_exc_regs_t const *u) L4_NOTHROW
00118 {
00119   switch(u->cause)
00120     {
00121     case L4_riscv_exc_inst_access:
00122     case L4_riscv_exc_load_access:
00123     case L4_riscv_exc_store_access:
00124     case L4_riscv_exc_inst_page_fault:
00125     case L4_riscv_exc_load_page_fault:
00126     case L4_riscv_exc_store_page_fault:
00127       return 1;
00128     default:
00129       return 0;
00130     }
00131 }
00132
00133 L4_INLINE l4_addr_t l4_utcb_exc_pfa(l4_exc_regs_t const *u) L4_NOTHROW
00134 {
00135   return u->tval | (u->cause == L4_riscv_exc_store_page_fault ? 2 : 0);
00136 }
00137
00138 L4_INLINE int l4_utcb_exc_is_ex_regs_exception(l4_exc_regs_t const *u) L4_NOTHROW
00139 {
00140   return l4_utcb_exc_typeval(u) == L4_riscv_ec_l4_exregs_exception;
00141 }
```

16.631 x86/l4/sys/arch/utcb.h File Reference

UTCB definitions for x86.

```
#include <l4/sys/types.h>
```
Include dependency graph for utcb.h:



Data Structures

- struct l4_exc_regs_t

  UTCB structure for exceptions.

Macros

- #define **L4_UTCB_EXCEPTION_REGS_SIZE** (sizeof(l4_exc_regs_t) / sizeof(l4_umword_t))

  Number of message registers used for exception IPC.
- #define **L4_UTCB_GENERIC_DATA_SIZE** 63

  Total number of message register (MRs) available.
- #define **L4_UTCB_GENERIC_BUFFERS_SIZE** 58

  Total number of buffer registers (BRs) available.
- #define **L4_UTCB_MSG_REGS_OFFSET** 0

  Offset of MR[0] relative to the UTCB pointer.
- #define **L4_UTCB_BUF_REGS_OFFSET** (64 * sizeof(l4_umword_t))

  Offset of BR[0] relative to the UTCB pointer.
- #define **L4_UTCB_THREAD_REGS_OFFSET** (123 * sizeof(l4_umword_t))

  Offset of TCR[0] relative to the UTCB pointer.
- #define **L4_UTCB_INHERIT_FPU** (1UL << 24)

  BDR flag to accept reception of FPU state.
- #define **L4_UTCB_OFFSET** 512

  Offset of two consecutive UTCBs.

Functions

- l4_umword_t l4_utcb_exc_pc (l4_exc_regs_t const *u) L4_NOTHROW

  Access function to get the program counter of the exception state.
- void l4_utcb_exc_pc_set (l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW

  Set the program counter register in the exception state.

- l4_umword_t **l4_utcb_exc_typeval** (l4_exc_regs_t const *u) L4_NOTHROW

  Get the value out of an exception UTCB that describes the type of exception.
- int l4_utcb_exc_is_pf (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC is a page fault.
- l4_addr_t **l4_utcb_exc_pfa** (l4_exc_regs_t const *u) L4_NOTHROW

  Function to get the L4 style page fault address out of an exception.
- int l4_utcb_exc_is_ex_regs_exception (l4_exc_regs_t const *u) L4_NOTHROW

  Check whether an exception IPC was triggered via l4_thread_ex_regs().

16.631.1 Detailed Description

UTCB definitions for x86.
Definition in file utcb.h.

16.632 utcb.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00007 /*
00008  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00009  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 /*****************************************************************************/
00015 #ifndef __L4_SYS__INCLUDE__ARCH_X86__UTCB_H__
00016 #define __L4_SYS__INCLUDE__ARCH_X86__UTCB_H__
00017
00018 #include <l4/sys/types.h>
00019
00024
00029 struct l4_exc_regs_t
00030 {
00031   l4_umword_t es;
00032   l4_umword_t ds;
00033   l4_umword_t gs;
00034   l4_umword_t fs;
00035
00036   l4_umword_t edi;
00037   l4_umword_t esi;
00038   l4_umword_t ebp;
00039   l4_umword_t pfa;
00040   l4_umword_t ebx;
00041   l4_umword_t edx;
00042   l4_umword_t ecx;
00043   l4_umword_t eax;
00044
00045   l4_umword_t trapno;
00046   l4_umword_t err;
00047
00048   l4_umword_t ip;
00049   l4_umword_t dummy1;
00050   l4_umword_t flags;
00051   l4_umword_t sp;
00052   l4_umword_t ss;
00053 };
00054
00056 #define L4_UTCB_EXCEPTION_REGS_SIZE    (sizeof(l4_exc_regs_t) / sizeof(l4_umword_t))
00057
00059 #define L4_UTCB_GENERIC_DATA_SIZE      63
00060
00062 #define L4_UTCB_GENERIC_BUFFERS_SIZE   58
00063
00065 #define L4_UTCB_MSG_REGS_OFFSET        0
00066
00068 #define L4_UTCB_BUF_REGS_OFFSET        (64 * sizeof(l4_umword_t))
00069
00071 #define L4_UTCB_THREAD_REGS_OFFSET     (123 * sizeof(l4_umword_t))
00072
00074 #define L4_UTCB_INHERIT_FPU            (1UL << 24)
00075
00077 #define L4_UTCB_OFFSET                 512
00078
00079 /*
00080  * ====================================================================
```

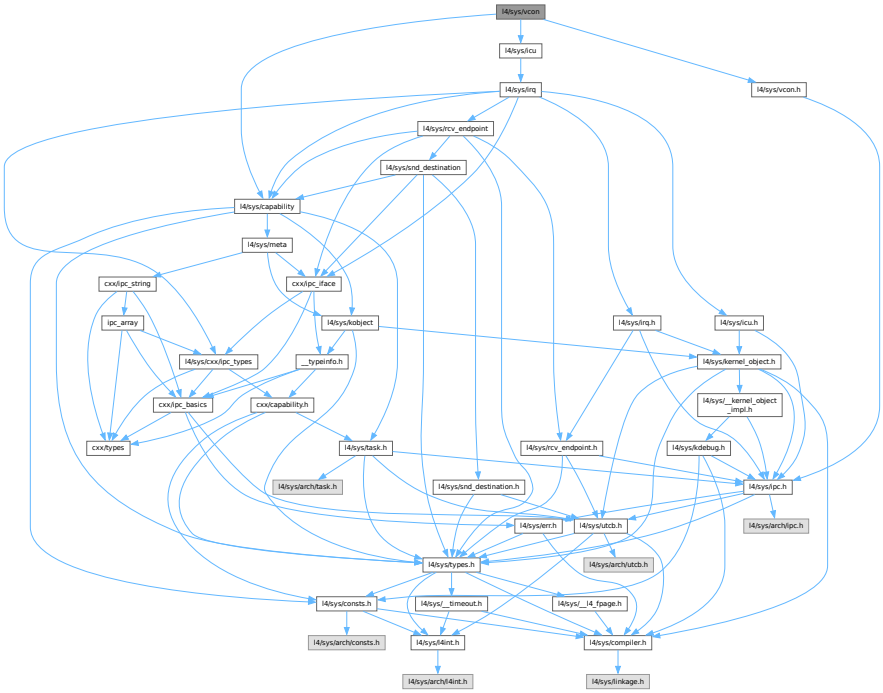
```
00081  * Implementations.
00082  */
00083
00084 L4_INLINE l4_utcb_t *l4_utcb_direct(void) L4_NOTHROW
00085 {
00086   l4_utcb_t *utcb;
00087   __asm__ ("mov %%fs:0, %0" : "=r" (utcb));
00088   return utcb;
00089 }
00090
00091 L4_INLINE l4_umword_t l4_utcb_exc_pc(l4_exc_regs_t const *u) L4_NOTHROW
00092 {
00093   return u->ip;
00094 }
00095
00096 L4_INLINE void l4_utcb_exc_pc_set(l4_exc_regs_t *u, l4_addr_t pc) L4_NOTHROW
00097 {
00098   u->ip = pc;
00099 }
00100
00101 L4_INLINE void l4_utcb_exc_sp_set(l4_exc_regs_t *u, l4_addr_t sp) L4_NOTHROW
00102 {
00103   u->sp = sp;
00104 }
00105
00106 L4_INLINE l4_umword_t l4_utcb_exc_typeval(l4_exc_regs_t const *u) L4_NOTHROW
00107 {
00108   return u->trapno;
00109 }
00110
00111 L4_INLINE int l4_utcb_exc_is_pf(l4_exc_regs_t const *u) L4_NOTHROW
00112 {
00113   return u->trapno == 14;
00114 }
00115
00116 L4_INLINE l4_addr_t l4_utcb_exc_pfa(l4_exc_regs_t const *u) L4_NOTHROW
00117 {
00118   return (u->pfa & ~7UL) | (u->err & 2);
00119 }
00120
00121 L4_INLINE int l4_utcb_exc_is_ex_regs_exception(l4_exc_regs_t const *u) L4_NOTHROW
00122 {
00123   return l4_utcb_exc_typeval(u) == 0xff;
00124 }
00125
00126 #endif /* ! __L4_SYS__INCLUDE__ARCH_X86__UTCB_H__ */
```

16.633 l4/sys/vcon File Reference

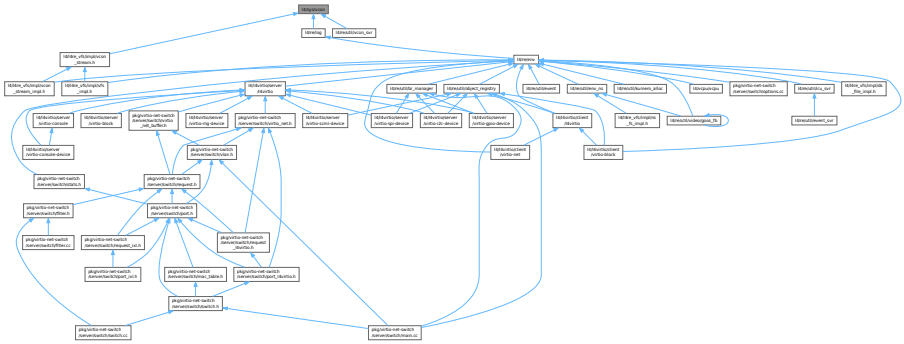
C++ Virtual console interface.

```
#include <l4/sys/icu>
#include <l4/sys/vcon.h>
#include <l4/sys/capability>
```

Include dependency graph for vcon:



This graph shows which files directly or indirectly include this file:



Data Structures

- class L4::Vcon

  C++ L4 Vcon interface, see Virtual Console for the C interface.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.633.1 Detailed Description

C++ Virtual console interface.
Definition in file vcon.

16.634 vcon

Go to the documentation of this file.

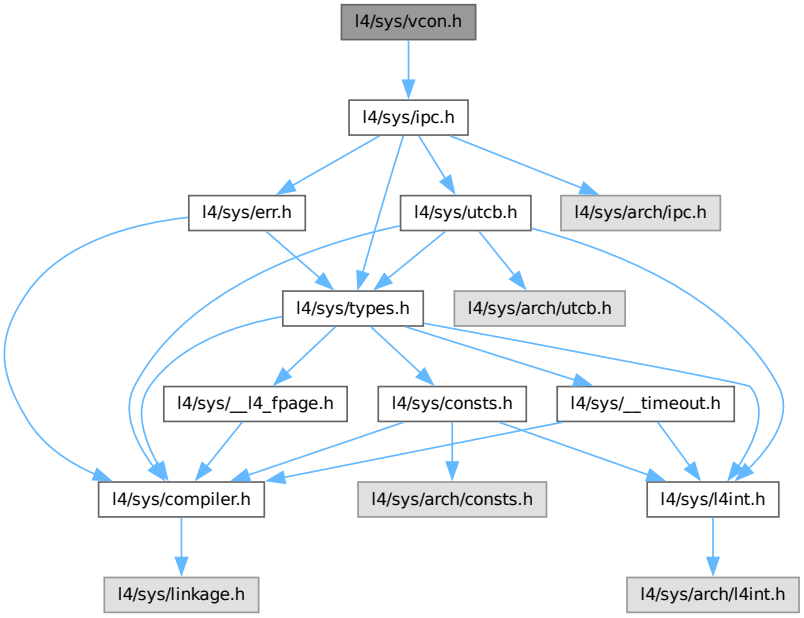
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00009  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  *
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014 #pragma once
00015
00016 #include <l4/sys/icu>
00017 #include <l4/sys/vcon.h>
00018 #include <l4/sys/capability>
00019
00020 namespace L4 {
00021
00045 class Vcon :
00046   public Kobject_t<Vcon, Icu, L4_PROTO_LOG>
00047 {
00048 public:
00064   l4_msgtag_t
00065   send(char const *buf, unsigned size, l4_utcb_t *utcb = l4_utcb()) const noexcept
00066   { return l4_vcon_send_u(cap(), buf, size, utcb); }
00067
00078   long
00079   write(char const *buf, unsigned size, l4_utcb_t *utcb = l4_utcb()) const noexcept
00080   { return l4_vcon_write_u(cap(), buf, size, utcb); }
00081
00097   int
00098   read(char *buf, unsigned size, l4_utcb_t *utcb = l4_utcb()) const noexcept
00099   { return l4_vcon_read_u(cap(), buf, size, utcb); }
00100
00124   int
00125   read_with_flags(char *buf, unsigned size, l4_utcb_t *utcb = l4_utcb()) const noexcept
00126   { return l4_vcon_read_with_flags_u(cap(), buf, size, utcb); }
00127
00137   l4_msgtag_t
00138   set_attr(l4_vcon_attr_t const *attr, l4_utcb_t *utcb = l4_utcb()) const noexcept
00139   { return l4_vcon_set_attr_u(cap(), attr, utcb); }
00140
00150   l4_msgtag_t
00151   get_attr(l4_vcon_attr_t *attr, l4_utcb_t *utcb = l4_utcb()) const noexcept
00152   { return l4_vcon_get_attr_u(cap(), attr, utcb); }
00153
00154   typedef L4::Typeid::Raw_ipc<Vcon> Rpcs;
00155 };
00156
00157 }
```

16.635 l4/sys/vcon.h File Reference

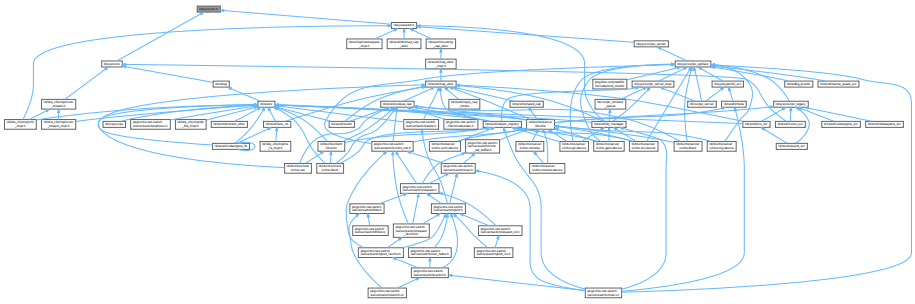
Virtual console interface.

```
#include <l4/sys/ipc.h>
```

Include dependency graph for vcon.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4_vcon_attr_t

  Vcon attribute structure.

Typedefs

- typedef struct l4_vcon_attr_t l4_vcon_attr_t

  Vcon attribute structure.

Enumerations

- enum L4_vcon_size_consts { L4_VCON_WRITE_SIZE = (L4_UTCB_GENERIC_DATA_SIZE - 2) * sizeof(l4_umword_t) , L4_VCON_READ_SIZE = (L4_UTCB_GENERIC_DATA_SIZE - 1) * sizeof(l4_↩ umword_t) }

  Size constants.

- enum L4_vcon_read_flags { L4_VCON_READ_SIZE_MASK = 0x3fffffff , L4_VCON_READ_STAT_BREAK = 1 << 30 , L4_VCON_READ_STAT_DONE = 1 << 31 }

  Vcon read flags.
- enum L4_vcon_i_flags { L4_VCON_INLCR = 000100 , L4_VCON_IGNCR = 000200 , L4_VCON_ICRNL = 000400 }

  Input flags.
- enum L4_vcon_o_flags { L4_VCON_ONLCR = 000004 , L4_VCON_OCRNL = 000010 , L4_VCON_ONLRET = 000040 }

  Output flags.
- enum L4_vcon_l_flags { L4_VCON_ICANON = 000002 , L4_VCON_ECHO = 000010 }

  Local flags.
- enum L4_vcon_ops { L4_VCON_WRITE_OP = 0UL , L4_VCON_READ_OP = 1UL , L4_VCON_SET_ATTR_OP = 2UL , L4_VCON_GET_ATTR_OP = 3UL }

  Operations on vcon objects.

Functions

- l4_msgtag_t l4_vcon_send (l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW

  Send data to virtual console.
- l4_msgtag_t l4_vcon_send_u (l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW

  Send data to `this` virtual console.
- long l4_vcon_write (l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW

  Write data to virtual console.
- long l4_vcon_write_u (l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW

  Write data to `this` virtual console.
- int l4_vcon_read (l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW

  Read data from virtual console.
- int l4_vcon_read_u (l4_cap_idx_t vcon, char *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW

  Read data from `this` virtual console.
- int l4_vcon_read_with_flags (l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW

  Read data from virtual console, extended version including flags.
- l4_msgtag_t l4_vcon_set_attr (l4_cap_idx_t vcon, l4_vcon_attr_t const *attr) L4_NOTHROW

  Set attributes of a Vcon.
- l4_msgtag_t l4_vcon_set_attr_u (l4_cap_idx_t vcon, l4_vcon_attr_t const *attr, l4_utcb_t *utcb) L4_NOTHROW

  Set the attributes of `this` virtual console.
- l4_msgtag_t l4_vcon_get_attr (l4_cap_idx_t vcon, l4_vcon_attr_t *attr) L4_NOTHROW

  Get attributes of a Vcon.
- l4_msgtag_t l4_vcon_get_attr_u (l4_cap_idx_t vcon, l4_vcon_attr_t *attr, l4_utcb_t *utcb) L4_NOTHROW

  Get attributes of `this` virtual console.
- void l4_vcon_set_attr_raw (l4_vcon_attr_t *attr) L4_NOTHROW

  Set terminal attributes to disable all special processing.

16.635.1 Detailed Description

Virtual console interface.
Definition in file vcon.h.

16.635.2 Enumeration Type Documentation

16.635.2.1 L4_vcon_read_flags

enum L4_vcon_read_flags
Vcon read flags.

Enumerator

L4_VCON_READ_SIZE_MASK	Size mask.
L4_VCON_READ_STAT_BREAK	Break condition flag.
L4_VCON_READ_STAT_DONE	Done condition flag.

Definition at line 170 of file vcon.h.

16.636 vcon.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00008  *               Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/ipc.h>
00016
00039
00056 L4_INLINE l4_msgtag_t
00057 l4_vcon_send(l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW;
00058
00065 L4_INLINE l4_msgtag_t
00066 l4_vcon_send_u(l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW;
00067
00079 L4_INLINE long
00080 l4_vcon_write(l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW;
00081
00088 L4_INLINE long
00089 l4_vcon_write_u(l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW;
00090
00095 enum L4_vcon_size_consts
00096 {
00098   L4_VCON_WRITE_SIZE = (L4_UTCB_GENERIC_DATA_SIZE - 2) * sizeof(l4_umword_t),
00100   L4_VCON_READ_SIZE  = (L4_UTCB_GENERIC_DATA_SIZE - 1) * sizeof(l4_umword_t),
00101 };
00102
00119 L4_INLINE int
00120 l4_vcon_read(l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW;
00121
00128 L4_INLINE int
00129 l4_vcon_read_u(l4_cap_idx_t vcon, char *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW;
00130
00157 L4_INLINE int
00158 l4_vcon_read_with_flags(l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW;
00159
00163 L4_INLINE int
00164 l4_vcon_read_with_flags_u(l4_cap_idx_t vcon, char *buf, unsigned size,
00165                           l4_utcb_t *utcb) L4_NOTHROW;
00166
00170 enum L4_vcon_read_flags
00171 {
00172   L4_VCON_READ_SIZE_MASK  = 0x3fffffff,
00173   L4_VCON_READ_STAT_BREAK = 1 << 30,
00174   L4_VCON_READ_STAT_DONE  = 1 << 31,
00175 };
00176
00187 typedef struct l4_vcon_attr_t
00188 {
00189   l4_umword_t i_flags;
00190   l4_umword_t o_flags;
00191   l4_umword_t l_flags;
00192
00193 #ifdef __cplusplus
```

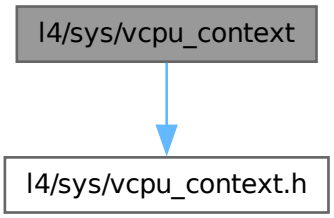
```
00200   inline void set_raw();
00201 #endif
00202 } l4_vcon_attr_t;
00203
00208 enum L4_vcon_i_flags
00209 {
00210   L4_VCON_INLCR  = 000100,
00211   L4_VCON_IGNCR  = 000200,
00212   L4_VCON_ICRNL  = 000400,
00213 };
00214
00219 enum L4_vcon_o_flags
00220 {
00221   L4_VCON_ONLCR  = 000004,
00222   L4_VCON_OCRNL  = 000010,
00223   L4_VCON_ONLRET = 000040,
00224 };
00225
00230 enum L4_vcon_l_flags
00231 {
00232   L4_VCON_ICANON = 000002,
00233   L4_VCON_ECHO   = 000010,
00234 };
00235
00244 L4_INLINE l4_msgtag_t
00245 l4_vcon_set_attr(l4_cap_idx_t vcon, l4_vcon_attr_t const *attr) L4_NOTHROW;
00246
00253 L4_INLINE l4_msgtag_t
00254 l4_vcon_set_attr_u(l4_cap_idx_t vcon, l4_vcon_attr_t const *attr,
00255                    l4_utcb_t *utcb) L4_NOTHROW;
00256
00265 L4_INLINE l4_msgtag_t
00266 l4_vcon_get_attr(l4_cap_idx_t vcon, l4_vcon_attr_t *attr) L4_NOTHROW;
00267
00274 L4_INLINE l4_msgtag_t
00275 l4_vcon_get_attr_u(l4_cap_idx_t vcon, l4_vcon_attr_t *attr,
00276                    l4_utcb_t *utcb) L4_NOTHROW;
00277
00283 L4_INLINE void
00284 l4_vcon_set_attr_raw(l4_vcon_attr_t *attr) L4_NOTHROW;
00285
00286
00291 enum L4_vcon_ops
00292 {
00293   L4_VCON_WRITE_OP       = 0UL,
00294   L4_VCON_READ_OP        = 1UL,
00295   L4_VCON_SET_ATTR_OP    = 2UL,
00296   L4_VCON_GET_ATTR_OP    = 3UL,
00297 };
00298
00299 /******* Implementations ********************/
00300
00301 L4_INLINE l4_msgtag_t
00302 l4_vcon_send_u(l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW
00303 {
00304   l4_msg_regs_t *mr = l4_utcb_mr_u(utcb);
00305   mr->mr[0] = L4_VCON_WRITE_OP;
00306   mr->mr[1] = size;
00307   __builtin_memcpy(&mr->mr[2], buf, size);
00308   return l4_ipc_send(vcon, utcb,
00309                      l4_msgtag(L4_PROTO_LOG, 2 + l4_bytes_to_mwords(size),
00310                                0, L4_MSGTAG_SCHEDULE),
00311                      L4_IPC_NEVER);
00312 }
00313
00314 L4_INLINE l4_msgtag_t
00315 l4_vcon_send(l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW
00316 {
00317   return l4_vcon_send_u(vcon, buf, size, l4_utcb());
00318 }
00319
00320 L4_INLINE long
00321 l4_vcon_write_u(l4_cap_idx_t vcon, char const *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW
00322 {
00323   l4_msgtag_t t;
00324
00325   if (size > L4_VCON_WRITE_SIZE)
00326     size = L4_VCON_WRITE_SIZE;
00327
00328   t = l4_vcon_send_u(vcon, buf, size, utcb);
00329   if (l4_msgtag_has_error(t))
00330     return l4_error(t);
00331
00332   return (long) size;
00333 }
00334
00335 L4_INLINE long
```

```
00336 l4_vcon_write(l4_cap_idx_t vcon, char const *buf, unsigned size) L4_NOTHROW
00337 {
00338   return l4_vcon_write_u(vcon, buf, size, l4_utcb());
00339 }
00340
00341 L4_INLINE int
00342 l4_vcon_read_with_flags_u(l4_cap_idx_t vcon, char *buf, unsigned size,
00343                           l4_utcb_t *utcb) L4_NOTHROW
00344 {
00345   int ret;
00346   unsigned r;
00347   l4_msg_regs_t *mr;
00348
00349   mr = l4_utcb_mr_u(utcb);
00350   mr->mr[0] = (size << 16) | L4_VCON_READ_OP;
00351
00352   ret = l4_error_u(l4_ipc_call(vcon, utcb,
00353                                l4_msgtag(L4_PROTO_LOG, 1, 0, 0),
00354                                L4_IPC_NEVER),
00355                    utcb);
00356   if (ret < 0)
00357     return ret;
00358
00359   r = mr->mr[0] & L4_VCON_READ_SIZE_MASK;
00360
00361   if (!(mr->mr[0] & L4_VCON_READ_STAT_DONE)) // !eof
00362     ret = size + 1;
00363   else if (r < size)
00364     ret = r;
00365   else
00366     ret = size;
00367
00368   if (L4_LIKELY(buf != NULL))
00369     __builtin_memcpy(buf, &mr->mr[1], r < size ? r : size);
00370
00371   return ret | (mr->mr[0] & ~(L4_VCON_READ_STAT_DONE | L4_VCON_READ_SIZE_MASK));
00372 }
00373
00374 L4_INLINE int
00375 l4_vcon_read_with_flags(l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW
00376 {
00377   return l4_vcon_read_with_flags_u(vcon, buf, size, l4_utcb());
00378 }
00379
00380 L4_INLINE int
00381 l4_vcon_read_u(l4_cap_idx_t vcon, char *buf, unsigned size, l4_utcb_t *utcb) L4_NOTHROW
00382 {
00383   int r = l4_vcon_read_with_flags_u(vcon, buf, size, utcb);
00384   if (r < 0)
00385     return r;
00386
00387   return r & L4_VCON_READ_SIZE_MASK;
00388 }
00389
00390 L4_INLINE int
00391 l4_vcon_read(l4_cap_idx_t vcon, char *buf, unsigned size) L4_NOTHROW
00392 {
00393   return l4_vcon_read_u(vcon, buf, size, l4_utcb());
00394 }
00395
00396 L4_INLINE l4_msgtag_t
00397 l4_vcon_set_attr_u(l4_cap_idx_t vcon, l4_vcon_attr_t const *attr,
00398                    l4_utcb_t *utcb) L4_NOTHROW
00399 {
00400   l4_msg_regs_t *mr = l4_utcb_mr_u(utcb);
00401
00402   mr->mr[0] = L4_VCON_SET_ATTR_OP;
00403   __builtin_memcpy(&mr->mr[1], attr, sizeof(*attr));
00404
00405   return l4_ipc_call(vcon, utcb,
00406                      l4_msgtag(L4_PROTO_LOG, 4, 0, 0),
00407                      L4_IPC_NEVER);
00408 }
00409
00410 L4_INLINE l4_msgtag_t
00411 l4_vcon_set_attr(l4_cap_idx_t vcon, l4_vcon_attr_t const *attr) L4_NOTHROW
00412 {
00413   return l4_vcon_set_attr_u(vcon, attr, l4_utcb());
00414 }
00415
00416 L4_INLINE l4_msgtag_t
00417 l4_vcon_get_attr_u(l4_cap_idx_t vcon, l4_vcon_attr_t *attr,
00418                    l4_utcb_t *utcb) L4_NOTHROW
00419 {
00420   l4_msgtag_t res;
00421   l4_msg_regs_t *mr = l4_utcb_mr_u(utcb);
00422
```

```
00423   mr->mr[0] = L4_VCON_GET_ATTR_OP;
00424
00425   res = l4_ipc_call(vcon, utcb,
00426                     l4_msgtag(L4_PROTO_LOG, 1, 0, 0),
00427                     L4_IPC_NEVER);
00428   if (l4_error_u(res, utcb) >= 0)
00429     __builtin_memcpy(attr, &mr->mr[1], sizeof(*attr));
00430
00431   return res;
00432 }
00433
00434 L4_INLINE l4_msgtag_t
00435 l4_vcon_get_attr(l4_cap_idx_t vcon, l4_vcon_attr_t *attr) L4_NOTHROW
00436 {
00437   return l4_vcon_get_attr_u(vcon, attr, l4_utcb());
00438 }
00439
00440 L4_INLINE void
00441 l4_vcon_set_attr_raw(l4_vcon_attr_t *attr) L4_NOTHROW
00442 {
00443   attr->i_flags = 0;
00444   attr->o_flags = 0;
00445   attr->l_flags = 0;
00446 }
00447
00448 #ifdef __cplusplus
00449 inline void
00450 l4_vcon_attr_t::set_raw()
00451 { l4_vcon_set_attr_raw(this); }
00452 #endif
```

16.637 l4/sys/vcpu_context File Reference

Hardware vCPU context interface.
`#include <l4/sys/vcpu_context.h>`
Include dependency graph for vcpu_context:



Namespaces

- namespace L4

  L4 low-level kernel interface.

16.637.1 Detailed Description

Hardware vCPU context interface.
Definition in file vcpu_context.

16.638 vcpu_context

Go to the documentation of this file.

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
```

```
00006
00007 #pragma once
00008
00009 #include <l4/sys/vcpu_context.h>
00010
00011 namespace L4 {
00012
00013 class Vcpu_context :
00014   public Kobject_t<Vcpu_context, Kobject, L4_PROTO_VCPU_CONTEXT>
00015 {
00016 public:
00017   Vcpu_context(Vcpu_context const &) = delete;
00018   void operator = (Vcpu_context const &) = delete;
00019
00020 protected:
00021   Vcpu_context();
00022 };
00023
00024 };
```

16.639 vcpu_context.h

```
00001
00006
00007 #pragma once
```

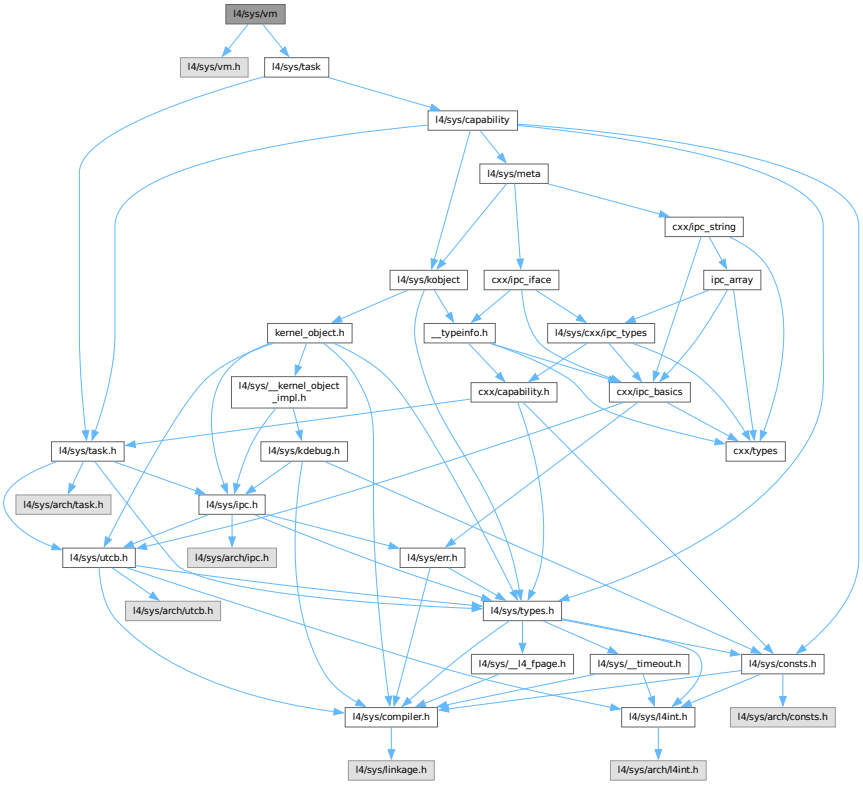
16.640 l4/sys/vm File Reference

Virtualization interface.

`#include <l4/sys/vm.h>`

`#include <l4/sys/task>`

Include dependency graph for vm:



Data Structures

- class L4::Vm

  Virtual machine host address space.

Namespaces

- namespace L4

  L4 low-level kernel interface.

16.640.1 Detailed Description

Virtualization interface.
Definition in file vm.

16.641 vm

Go to the documentation of this file.

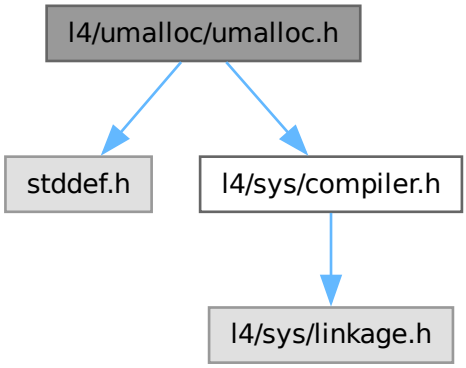
```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00006 /*
00007  * (c) 2008-2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
00014 #pragma once
00015
00016 #include <l4/sys/vm.h>
00017 #include <l4/sys/task>
00018
00019 namespace L4 {
00020
00030 class Vm : public Kobject_t<Vm, Task, L4_PROTO_VM>
00031 {
00032 public:
00033 #if defined(__arm__) || defined(__aarch64__)
00044   l4_msgtag_t vgicc_map(l4_fpage_t const vgicc_fpage,
00045                         l4_utcb_t *utcb = l4_utcb()) noexcept
00046   { return l4_task_vgicc_map_u(cap(), vgicc_fpage, utcb); }
00047 #endif
00048
00049 protected:
00050   Vm();
00051
00052 private:
00053   Vm(Vm const &);
00054   void operator = (Vm const &);
00055 };
00056
00057 };
```

16.642 l4/umalloc/umalloc.h File Reference

Public API for the basic next-fit memory allocator.

```
#include <stddef.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for umalloc.h:



Functions

- void * umalloc_area_create (size_t area_size) L4_NOTHROW

  Create a new heap area.

Variables

- L4_BEGIN_DECLS size_t umalloc_area_granularity

  Heap area granularity.

16.642.1 Detailed Description

Public API for the basic next-fit memory allocator.
The user of this allocator is required to provide the implementation of the umalloc_area_create() function and provide the umalloc_area_granularity symbol with a value.

Note

The current implementation is NOT thread-safe. If the user wants to use this allocator concurrently, they need to deploy their custom mutual exclusion mechanism around the public calls to the allocator.

Definition in file umalloc.h.

16.642.2 Function Documentation

16.642.2.1 umalloc_area_create()

```
void * umalloc_area_create (
            size_t area_size)
```

Create a new heap area.

Parameters

area_size	Requested heap area size. Always a multiple of the heap area granularity as reported by umalloc_area_granularity().

Returns

Pointer to the successfully created heap area of (at least) the requested size. It is assumed that the pointer satisfies at least the umalloc::Base_alignment alignment. If the value is nullptr, then it is assumed that the creation of the heap area failed.

References L4_END_DECLS, and L4_NOTHROW.

16.642.3 Variable Documentation

16.642.3.1 umalloc_area_granularity

```
L4_BEGIN_DECLS size_t umalloc_area_granularity  [extern]
```

Heap area granularity.
The allocator only requests the creation of heap areas with this granularity.

16.643 umalloc.h

Go to the documentation of this file.

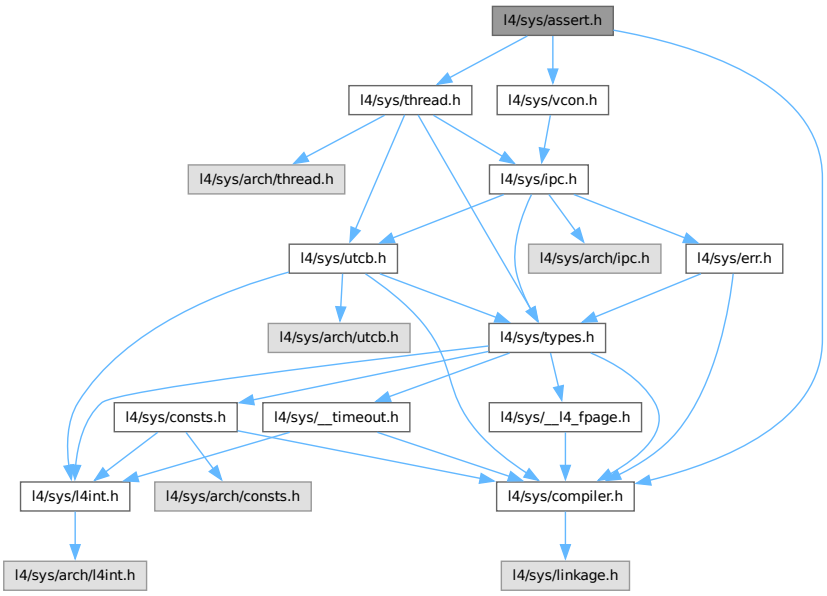
```
00001 /*
00002  * Copyright (C) 2025 Kernkonzept GmbH.
00003  * Author(s): Martin Decky <martin.decky@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00020
00021 #pragma once
00022
00023 #include <stddef.h>
00024 #include <l4/sys/compiler.h>
00025
00026 L4_BEGIN_DECLS
00027
00033 extern size_t umalloc_area_granularity;
00034
00047 void *umalloc_area_create(size_t area_size) L4_NOTHROW;
00048
00049 L4_END_DECLS
```

16.644 l4/sys/assert.h File Reference

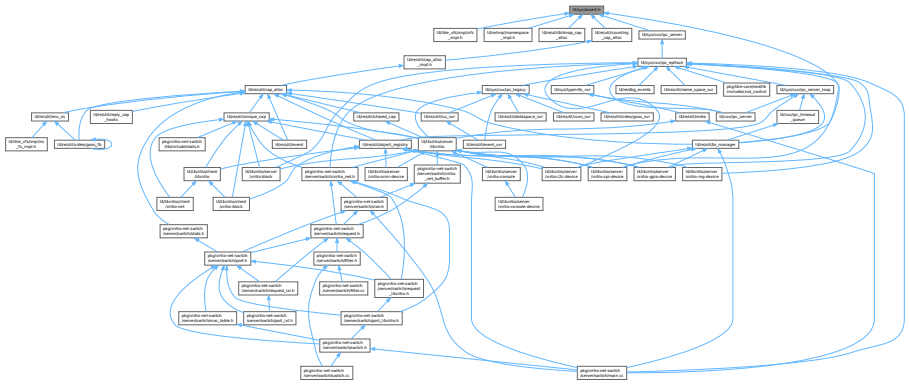
Low-level assert implementation.

```
#include <l4/sys/compiler.h>
#include <l4/sys/thread.h>
#include <l4/sys/vcon.h>
```

Include dependency graph for assert.h:



This graph shows which files directly or indirectly include this file:



Macros

- #define l4_assert(expr)

  Low-level assert.

16.644.1 Detailed Description

Low-level assert implementation.
Definition in file assert.h.

16.644.2 Macro Definition Documentation

16.644.2.1 l4_assert

```
#define l4_assert(
              expr)
```

Value:

```
l4_assert_fn(!!(expr), __FILE__ ":" L4_stringify(__LINE__) ": Assertion \"" \
                       L4_stringify(expr) "\" failed.\n")
```

Low-level assert.

Parameters

expr	Expression to be evaluated for the assertion.

This assertion is a low-level implementation that directly uses kernel primitives. Only use l4_assert() when the standard assert() functionality is not available.
Definition at line 32 of file assert.h.
Referenced by L4Re::Util::Cap_alloc_base::free(), L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::free(), L4Re::Util::Counting_cap_alloc< COUNTERTYPE, Dbg >::release(), and L4Re::Util::Br_manager::set_rcv_cap_flags().

16.645 assert.h

Go to the documentation of this file.

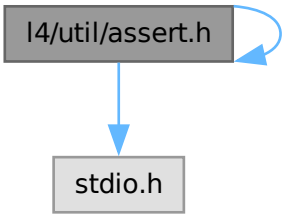
```
00001
00005 /*
00006  * (c) 2015 Adam Lackorzynski <adam@l4re.org>
00007  *
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #pragma once
00011
00012 #ifdef NDEBUG
00013
00014 #define l4_assert(x) do { } while (0)
00015 #define l4_check(x) do { (void)(x); } while (0)
00016
00017 #else
00018
00019 #include <l4/sys/compiler.h>
00020 #include <l4/sys/thread.h>
00021 #include <l4/sys/vcon.h>
00022
00032 #define l4_assert(expr) \
00033   l4_assert_fn(!!(expr), __FILE__ ":" L4_stringify(__LINE__) ": Assertion \"" \
00034                          L4_stringify(expr) "\" failed.\n")
00035
00036 #define l4_check(expr) l4_assert(expr)
00037
00041 L4_ALWAYS_INLINE
00042 void l4_assert_fn(unsigned expr, const char *text) L4_NOTHROW;
00043
00047 L4_INLINE L4_NORETURN
00048 void l4_assert_abort(const char *text) L4_NOTHROW;
00049
00050
00051 /* IMPLEMENTATION ----------------------------------------------------------*/
00052
00053 L4_INLINE L4_NORETURN
00054 void l4_assert_abort(const char *text) L4_NOTHROW
00055 {
00056   l4_vcon_write(L4_BASE_LOG_CAP, text, __builtin_strlen(text));
00057   for (;;)
00058     l4_thread_ex_regs(L4_INVALID_CAP, ~0UL, ~0UL,
00059                       L4_THREAD_EX_REGS_TRIGGER_EXCEPTION);
00060 }
00061
00062 L4_ALWAYS_INLINE
00063 void l4_assert_fn(unsigned expr, const char *text) L4_NOTHROW
00064 {
00065   if (L4_LIKELY(expr))
00066     return;
00067
00068   l4_assert_abort(text);
00069 }
00070
00071 #endif /* NDEBUG */
```

16.646 l4/util/assert.h File Reference

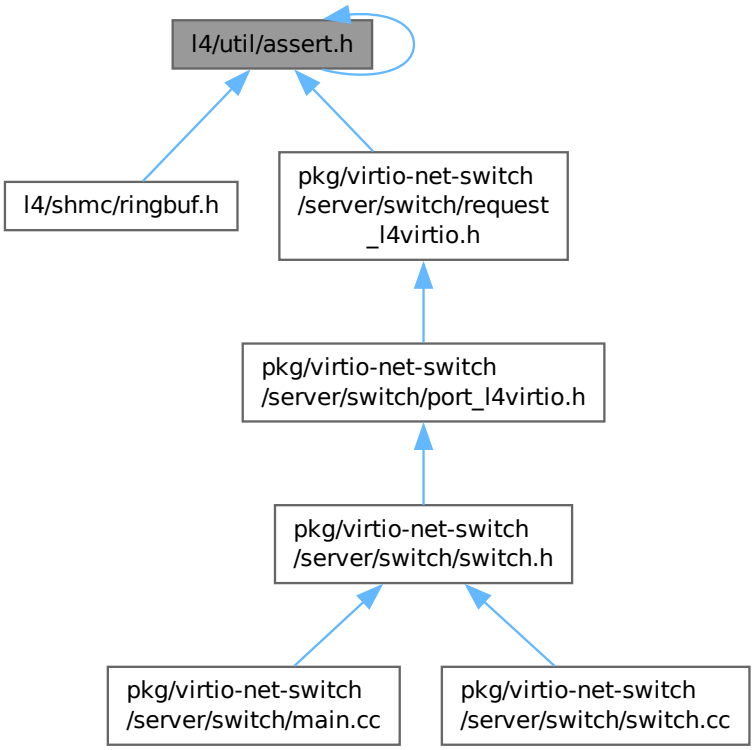
Some useful assert-style macros.

```
#include <stdio.h>
#include <assert.h>
```

Include dependency graph for assert.h:



This graph shows which files directly or indirectly include this file:



16.646.1 Detailed Description

Some useful assert-style macros.

Date

09/2009

Author

Bjoern Doebel doebel@tudos.org

Definition in file assert.h.

16.647 assert.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00009 /*
00010  * (c) 2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 /*****************************************************************************/
00016 #pragma once
00017
00018 #ifdef NDEBUG
00019
00020 #define DO_NOTHING              do {} while (0)
00021 #define ASSERT_ASSERT(x)        DO_NOTHING
00022 #define ASSERT_VALID(c)         DO_NOTHING
00023 #define ASSERT_EQUAL(a,b)       DO_NOTHING
00024 #define ASSERT_NOT_EQUAL(a,b)   DO_NOTHING
00025 #define ASSERT_LOWER_EQ(a,b)    DO_NOTHING
00026 #define ASSERT_GREATER_EQ(a,b)  DO_NOTHING
00027 #define ASSERT_BETWEEN(a,b,c)   DO_NOTHING
00028 #define ASSERT_IPC_OK(i)        DO_NOTHING
00029 #define ASSERT_OK(e)            do { (void)e; } while (0)
00030 #define ASSERT_NOT_NULL(p)      DO_NOTHING
00031 #ifndef assert
00032 #define assert(cond)            DO_NOTHING
00033 #endif
00034
00035 #else // NDEBUG
00036
00037 #ifndef ASSERT_PRINTF
00038 #include <stdio.h>
00039 #define ASSERT_PRINTF printf
00040 #endif
00041 #ifndef ASSERT_ASSERT
00042 #include <assert.h>
00043 #define ASSERT_ASSERT(x) assert(x)
00044 #endif
00045
00046 #define ASSERT_VALID(cap) \
00047   do { \
00048     typeof(cap) _cap = cap; \
00049     if (l4_is_invalid_cap(_cap)) { \
00050       ASSERT_PRINTF("%s: Cap invalid.\n", __func__); \
00051       ASSERT_ASSERT(!l4_is_invalid_cap(_cap)); \
00052     } \
00053   } while (0)
00054
00055
00056 #define ASSERT_EQUAL(a, b) \
00057   do { \
00058     typeof(a) _a = a; \
00059     typeof(b) _b = b; \
00060     if (_a != _b) { \
00061       ASSERT_PRINTF("%s:\n", __func__); \
00062       ASSERT_PRINTF("    "#a" (%lx) != "#b" (%lx)\n", (unsigned long)_a, (unsigned long)_b); \
00063       ASSERT_ASSERT(_a == _b); \
00064     } \
00065   } while (0)
00066
00067
00068 #define ASSERT_NOT_EQUAL(a, b) \
00069   do { \
00070     typeof(a) _a = a; \
00071     typeof(b) _b = b; \
00072     if (_a == _b) { \
00073       ASSERT_PRINTF("%s:\n", __func__); \
00074       ASSERT_PRINTF("    "#a" (%lx) == "#b" (%lx)\n", (unsigned long)_a, (unsigned long)_b); \
00075       ASSERT_ASSERT(_a != _b); \
00076     } \
```

```
00077   } while (0)
00078
00079
00080 #define ASSERT_LOWER_EQ(val, max) \
00081   do { \
00082     typeof(val) _val = val; \
00083     typeof(max) _max = max; \
00084     if (_val > _max) { \
00085       ASSERT_PRINTF("%s:\n", __func__); \
00086       ASSERT_PRINTF("    "#val" (%lx) > "#max" (%lx)\n", (unsigned long)_val, (unsigned long)_max); \
00087       ASSERT_ASSERT(_val <= _max); \
00088     } \
00089   } while (0)
00090
00091
00092 #define ASSERT_GREATER_EQ(val, min) \
00093   do { \
00094     typeof(val) _val = val; \
00095     typeof(min) _min = min; \
00096     if (_val < _min) { \
00097       ASSERT_PRINTF("%s:\n", __func__); \
00098       ASSERT_PRINTF("    "#val" (%lx) < "#min" (%lx)\n", (unsigned long)_val, (unsigned long)_min); \
00099       ASSERT_ASSERT(_val >= _min); \
00100     } \
00101   } while (0)
00102
00103
00104 #define ASSERT_BETWEEN(val, min, max) \
00105   ASSERT_LOWER_EQ((val), (max)); \
00106   ASSERT_GREATER_EQ((val), (min));
00107
00108
00109 #define ASSERT_IPC_OK(msgtag) \
00110   do { \
00111     int _r = l4_ipc_error(msgtag, l4_utcb()); \
00112     if (_r) { \
00113       ASSERT_PRINTF("%s: IPC Error: %lx\n", __func__, _r); \
00114       ASSERT_ASSERT(_r == 0); \
00115     } \
00116   } while (0)
00117
00118 #define ASSERT_OK(val)          ASSERT_EQUAL((val), 0)
00119 #define ASSERT_NOT_NULL(ptr)    ASSERT_NOT_EQUAL((ptr), (void *)0)
00120
00121 #endif // NDEBUG
```

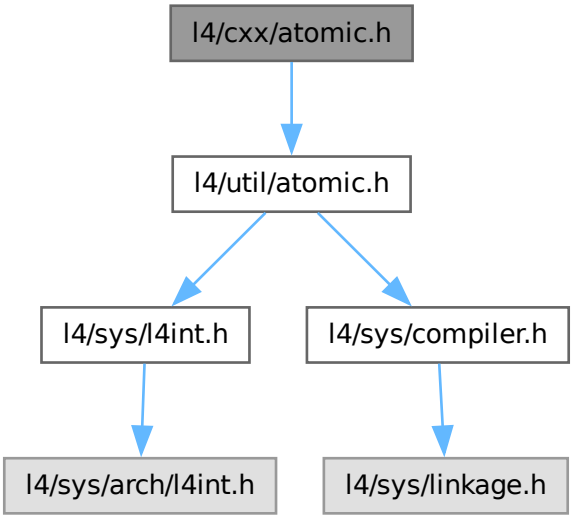
16.648 atomic.h

```
00001
00006 /*
00007  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/compiler.h>
00016
00017 L4_BEGIN_DECLS
00018
00019 long int
00020 l4_atomic_add(volatile long int* mem, long int offset) L4_NOTHROW L4_LONG_CALL;
00021
00022 long int
00023 l4_atomic_xchg(volatile long int* mem, long int newval) L4_NOTHROW L4_LONG_CALL;
00024
00025 long int
00026 l4_atomic_cmpxchg(volatile long int* mem, long int oldval, long int newval) L4_NOTHROW L4_LONG_CALL;
00027
00028 L4_END_DECLS
```

16.649 l4/cxx/atomic.h File Reference

Atomic template.

`#include <l4/util/atomic.h>`
Include dependency graph for atomic.h:



Namespaces

- namespace L4

  L4 low-level kernel interface.

16.649.1 Detailed Description

Atomic template.
Definition in file atomic.h.

16.650 atomic.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2004-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  *
00010  * License: see LICENSE.spdx (in this directory or the directories above)
00011  */
00012 #pragma once
00013
00014 #include <l4/util/atomic.h>
00015
00016 extern "C" void  ____error_compare_and_swap_does_not_support_3_bytes____();
00017 extern "C" void  ____error_compare_and_swap_does_not_support_more_than_4_bytes____();
00018
00019 namespace L4
00020 {
00021   template< typename X >
00022   inline int compare_and_swap(X volatile *dst, X old_val, X new_val)
00023   {
00024     switch (sizeof(X))
00025       {
00026       case 1:
00027   return l4util_cmpxchg8((l4_uint8_t volatile*)dst, old_val, new_val);
00028       case 2:
```

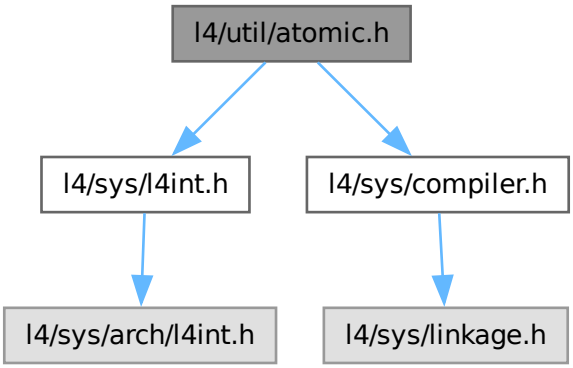
```
00029   return l4util_cmpxchg16((l4_uint16_t volatile *)dst, old_val, new_val);
00030       case 3: ____error_compare_and_swap_does_not_support_3_bytes____();
00031       case 4:
00032   return l4util_cmpxchg32((l4_uint32_t volatile*)dst, old_val, new_val);
00033       default:
00034         ____error_compare_and_swap_does_not_support_more_than_4_bytes____();
00035       }
00036     return 0;
00037   }
00038 }
```

16.651 l4/util/atomic.h File Reference

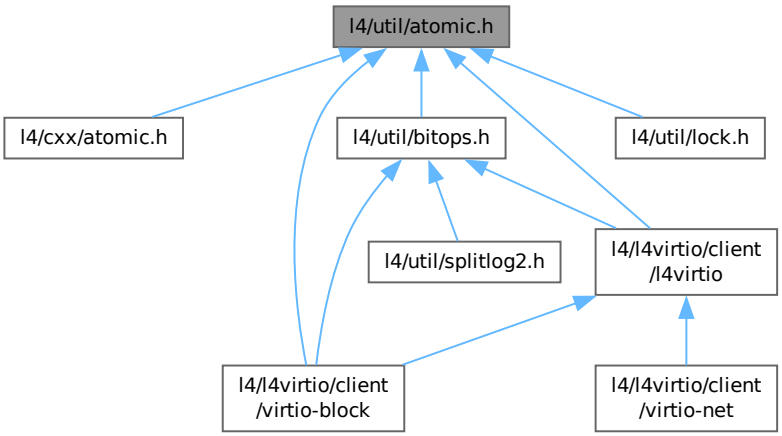
atomic operations header and generic implementations

```
#include <l4/sys/l4int.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for atomic.h:



This graph shows which files directly or indirectly include this file:



Functions

- int l4util_cmpxchg32 (volatile l4_uint32_t *dest, l4_uint32_t cmp_val, l4_uint32_t new_val)

  Atomic compare and exchange (32 bit version).
- int l4util_cmpxchg16 (volatile l4_uint16_t *dest, l4_uint16_t cmp_val, l4_uint16_t new_val)

  Atomic compare and exchange (16 bit version).
- int l4util_cmpxchg8 (volatile l4_uint8_t *dest, l4_uint8_t cmp_val, l4_uint8_t new_val)

  Atomic compare and exchange (8 bit version).
- int l4util_cmpxchg (volatile l4_umword_t *dest, l4_umword_t cmp_val, l4_umword_t new_val)

  Atomic compare and exchange (machine wide fields).
- l4_uint32_t l4util_xchg32 (volatile l4_uint32_t *dest, l4_uint32_t val)

  Atomic exchange (32 bit version).
- l4_uint16_t l4util_xchg16 (volatile l4_uint16_t *dest, l4_uint16_t val)

  Atomic exchange (16 bit version).
- l4_uint8_t l4util_xchg8 (volatile l4_uint8_t *dest, l4_uint8_t val)

  Atomic exchange (8 bit version).
- l4_umword_t l4util_xchg (volatile l4_umword_t *dest, l4_umword_t val)

  Atomic exchange (machine wide fields).
- void l4util_atomic_add (volatile long *dest, long val)

  Atomic add.
- void l4util_atomic_inc (volatile long *dest)

  Atomic increment.

Atomic add/sub/and/or (8,16,32 bit version) without result

- void l4util_add8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_add16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_add32 (volatile l4_uint32_t *dest, l4_uint32_t val)
- void l4util_sub8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_sub16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_sub32 (volatile l4_uint32_t *dest, l4_uint32_t val)
- void l4util_and8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_and16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_and32 (volatile l4_uint32_t *dest, l4_uint32_t val)
- void l4util_or8 (volatile l4_uint8_t *dest, l4_uint8_t val)
- void l4util_or16 (volatile l4_uint16_t *dest, l4_uint16_t val)
- void l4util_or32 (volatile l4_uint32_t *dest, l4_uint32_t val)

Atomic add/sub/and/or operations (8,16,32 bit) with result

- l4_uint8_t l4util_add8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_add16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_add32_res (volatile l4_uint32_t *dest, l4_uint32_t val)
- l4_uint8_t l4util_sub8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_sub16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_sub32_res (volatile l4_uint32_t *dest, l4_uint32_t val)
- l4_uint8_t l4util_and8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_and16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_and32_res (volatile l4_uint32_t *dest, l4_uint32_t val)
- l4_uint8_t l4util_or8_res (volatile l4_uint8_t *dest, l4_uint8_t val)
- l4_uint16_t l4util_or16_res (volatile l4_uint16_t *dest, l4_uint16_t val)
- l4_uint32_t l4util_or32_res (volatile l4_uint32_t *dest, l4_uint32_t val)

Atomic inc/dec (8,16,32 bit) without result

- void l4util_inc8 (volatile l4_uint8_t *dest)
- void l4util_inc16 (volatile l4_uint16_t *dest)
- void l4util_inc32 (volatile l4_uint32_t *dest)
- void l4util_dec8 (volatile l4_uint8_t *dest)
- void l4util_dec16 (volatile l4_uint16_t *dest)

- void l4util_dec32 (volatile l4_uint32_t *dest)

Atomic inc/dec (8,16,32 bit) with result

- l4_uint8_t l4util_inc8_res (volatile l4_uint8_t *dest)
- l4_uint16_t l4util_inc16_res (volatile l4_uint16_t *dest)
- l4_uint32_t l4util_inc32_res (volatile l4_uint32_t *dest)
- l4_uint8_t l4util_dec8_res (volatile l4_uint8_t *dest)
- l4_uint16_t l4util_dec16_res (volatile l4_uint16_t *dest)
- l4_uint32_t l4util_dec32_res (volatile l4_uint32_t *dest)

16.651.1 Detailed Description

atomic operations header and generic implementations

Date

10/20/2000

Author

Lars Reuther reuther@os.inf.tu-dresden.de, Jork Loeser jork@os.inf.tu-dresden.de

Definition in file atomic.h.

16.652 atomic.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00010 /*
00011  * (c) 2000-2009 Author(s)
00012  *     economic rights: Technische Universität Dresden (Germany)
00013  * License: see LICENSE.spdx (in this directory or the directories above)
00014  */
00015
00016 /*****************************************************************************/
00017 #ifndef __L4UTIL__INCLUDE__ATOMIC_H__
00018 #define __L4UTIL__INCLUDE__ATOMIC_H__
00019
00020 #include <l4/sys/l4int.h>
00021 #include <l4/sys/compiler.h>
00022
00023 /*****************************************************************************
00024  *** Prototypes
00025  *****************************************************************************/
00026
00027 L4_BEGIN_DECLS
00028
00033
00034 #if __SIZEOF_LONG__ == 8
00035
00055 L4_INLINE int
00056 l4util_cmpxchg64(volatile l4_uint64_t * dest,
00057                  l4_uint64_t cmp_val, l4_uint64_t new_val);
00058
00059 #endif
00060
00074 L4_INLINE int
00075 l4util_cmpxchg32(volatile l4_uint32_t * dest,
00076                  l4_uint32_t cmp_val, l4_uint32_t new_val);
00077
00091 L4_INLINE int
00092 l4util_cmpxchg16(volatile l4_uint16_t * dest,
00093                  l4_uint16_t cmp_val, l4_uint16_t new_val);
00094
00108 L4_INLINE int
00109 l4util_cmpxchg8(volatile l4_uint8_t * dest,
00110                 l4_uint8_t cmp_val, l4_uint8_t new_val);
00111
00125 L4_INLINE int
00126 l4util_cmpxchg(volatile l4_umword_t * dest,
00127                l4_umword_t cmp_val, l4_umword_t new_val);
00128
00138 L4_INLINE l4_uint32_t
00139 l4util_xchg32(volatile l4_uint32_t * dest, l4_uint32_t val);
00140
```

```
00150 L4_INLINE l4_uint16_t
00151 l4util_xchg16(volatile l4_uint16_t * dest, l4_uint16_t val);
00152
00162 L4_INLINE l4_uint8_t
00163 l4util_xchg8(volatile l4_uint8_t * dest, l4_uint8_t val);
00164
00174 L4_INLINE l4_umword_t
00175 l4util_xchg(volatile l4_umword_t * dest, l4_umword_t val);
00176
00178
00184 L4_INLINE void
00185 l4util_add8(volatile l4_uint8_t *dest, l4_uint8_t val);
00187 L4_INLINE void
00188 l4util_add16(volatile l4_uint16_t *dest, l4_uint16_t val);
00190 L4_INLINE void
00191 l4util_add32(volatile l4_uint32_t *dest, l4_uint32_t val);
00193 L4_INLINE void
00194 l4util_sub8(volatile l4_uint8_t *dest, l4_uint8_t val);
00196 L4_INLINE void
00197 l4util_sub16(volatile l4_uint16_t *dest, l4_uint16_t val);
00199 L4_INLINE void
00200 l4util_sub32(volatile l4_uint32_t *dest, l4_uint32_t val);
00202 L4_INLINE void
00203 l4util_and8(volatile l4_uint8_t *dest, l4_uint8_t val);
00205 L4_INLINE void
00206 l4util_and16(volatile l4_uint16_t *dest, l4_uint16_t val);
00208 L4_INLINE void
00209 l4util_and32(volatile l4_uint32_t *dest, l4_uint32_t val);
00211 L4_INLINE void
00212 l4util_or8(volatile l4_uint8_t *dest, l4_uint8_t val);
00214 L4_INLINE void
00215 l4util_or16(volatile l4_uint16_t *dest, l4_uint16_t val);
00217 L4_INLINE void
00218 l4util_or32(volatile l4_uint32_t *dest, l4_uint32_t val);
00220
00222
00229 L4_INLINE l4_uint8_t
00230 l4util_add8_res(volatile l4_uint8_t *dest, l4_uint8_t val);
00232 L4_INLINE l4_uint16_t
00233 l4util_add16_res(volatile l4_uint16_t *dest, l4_uint16_t val);
00235 L4_INLINE l4_uint32_t
00236 l4util_add32_res(volatile l4_uint32_t *dest, l4_uint32_t val);
00238 L4_INLINE l4_uint8_t
00239 l4util_sub8_res(volatile l4_uint8_t *dest, l4_uint8_t val);
00241 L4_INLINE l4_uint16_t
00242 l4util_sub16_res(volatile l4_uint16_t *dest, l4_uint16_t val);
00244 L4_INLINE l4_uint32_t
00245 l4util_sub32_res(volatile l4_uint32_t *dest, l4_uint32_t val);
00247 L4_INLINE l4_uint8_t
00248 l4util_and8_res(volatile l4_uint8_t *dest, l4_uint8_t val);
00250 L4_INLINE l4_uint16_t
00251 l4util_and16_res(volatile l4_uint16_t *dest, l4_uint16_t val);
00253 L4_INLINE l4_uint32_t
00254 l4util_and32_res(volatile l4_uint32_t *dest, l4_uint32_t val);
00256 L4_INLINE l4_uint8_t
00257 l4util_or8_res(volatile l4_uint8_t *dest, l4_uint8_t val);
00259 L4_INLINE l4_uint16_t
00260 l4util_or16_res(volatile l4_uint16_t *dest, l4_uint16_t val);
00262 L4_INLINE l4_uint32_t
00263 l4util_or32_res(volatile l4_uint32_t *dest, l4_uint32_t val);
00265
00267
00272 L4_INLINE void
00273 l4util_inc8(volatile l4_uint8_t *dest);
00275 L4_INLINE void
00276 l4util_inc16(volatile l4_uint16_t *dest);
00278 L4_INLINE void
00279 l4util_inc32(volatile l4_uint32_t *dest);
00281 L4_INLINE void
00282 l4util_dec8(volatile l4_uint8_t *dest);
00284 L4_INLINE void
00285 l4util_dec16(volatile l4_uint16_t *dest);
00287 L4_INLINE void
00288 l4util_dec32(volatile l4_uint32_t *dest);
00290
00292
00298 L4_INLINE l4_uint8_t
00299 l4util_inc8_res(volatile l4_uint8_t *dest);
00301 L4_INLINE l4_uint16_t
00302 l4util_inc16_res(volatile l4_uint16_t *dest);
00304 L4_INLINE l4_uint32_t
00305 l4util_inc32_res(volatile l4_uint32_t *dest);
00307 L4_INLINE l4_uint8_t
00308 l4util_dec8_res(volatile l4_uint8_t *dest);
00310 L4_INLINE l4_uint16_t
00311 l4util_dec16_res(volatile l4_uint16_t *dest);
00313 L4_INLINE l4_uint32_t
```

```
00314 l4util_dec32_res(volatile l4_uint32_t *dest);
00316
00324 L4_INLINE void
00325 l4util_atomic_add(volatile long *dest, long val);
00326
00333 L4_INLINE void
00334 l4util_atomic_inc(volatile long *dest);
00335
00336 L4_END_DECLS
00337
00338 /*****************
00339  * IMPLEMENTAION *
00340  *****************/
00341
00342 #if __SIZEOF_LONG__ == 8
00343
00344 L4_INLINE int
00345 l4util_cmpxchg64(volatile l4_uint64_t * dest,
00346                  l4_uint64_t cmp_val, l4_uint64_t new_val)
00347 {
00348   return __atomic_compare_exchange_n(dest, &cmp_val, new_val, 0,
00349                                      __ATOMIC_SEQ_CST, __ATOMIC_SEQ_CST);
00350 }
00351
00352 #endif
00353
00354 L4_INLINE int
00355 l4util_cmpxchg32(volatile l4_uint32_t * dest,
00356                  l4_uint32_t cmp_val, l4_uint32_t new_val)
00357 {
00358   return __atomic_compare_exchange_n(dest, &cmp_val, new_val, 0,
00359                                      __ATOMIC_SEQ_CST, __ATOMIC_SEQ_CST);
00360 }
00361
00362 L4_INLINE int
00363 l4util_cmpxchg16(volatile l4_uint16_t * dest,
00364                  l4_uint16_t cmp_val, l4_uint16_t new_val)
00365 {
00366   return __atomic_compare_exchange_n(dest, &cmp_val, new_val, 0,
00367                                      __ATOMIC_SEQ_CST, __ATOMIC_SEQ_CST);
00368 }
00369
00370 L4_INLINE int
00371 l4util_cmpxchg8(volatile l4_uint8_t * dest,
00372                 l4_uint8_t cmp_val, l4_uint8_t new_val)
00373 {
00374   return __atomic_compare_exchange_n(dest, &cmp_val, new_val, 0,
00375                                      __ATOMIC_SEQ_CST, __ATOMIC_SEQ_CST);
00376 }
00377
00378 L4_INLINE int
00379 l4util_cmpxchg(volatile l4_umword_t * dest,
00380                l4_umword_t cmp_val, l4_umword_t new_val)
00381 {
00382   return __atomic_compare_exchange_n(dest, &cmp_val, new_val, 0,
00383                                      __ATOMIC_SEQ_CST, __ATOMIC_SEQ_CST);
00384 }
00385
00386 L4_INLINE l4_uint32_t
00387 l4util_xchg32(volatile l4_uint32_t * dest, l4_uint32_t val)
00388 {
00389   return __atomic_exchange_n(dest, val, __ATOMIC_SEQ_CST);
00390 }
00391
00392 L4_INLINE l4_uint16_t
00393 l4util_xchg16(volatile l4_uint16_t * dest, l4_uint16_t val)
00394 {
00395   return __atomic_exchange_n(dest, val, __ATOMIC_SEQ_CST);
00396 }
00397
00398 L4_INLINE l4_uint8_t
00399 l4util_xchg8(volatile l4_uint8_t * dest, l4_uint8_t val)
00400 {
00401   return __atomic_exchange_n(dest, val, __ATOMIC_SEQ_CST);
00402 }
00403
00404 L4_INLINE l4_umword_t
00405 l4util_xchg(volatile l4_umword_t * dest, l4_umword_t val)
00406 {
00407   return __atomic_exchange_n(dest, val, __ATOMIC_SEQ_CST);
00408 }
00409
00410 L4_INLINE void
00411 l4util_inc8(volatile l4_uint8_t *dest)
00412 { __atomic_fetch_add(dest, 1, __ATOMIC_SEQ_CST); }
00413
00414 L4_INLINE void
```

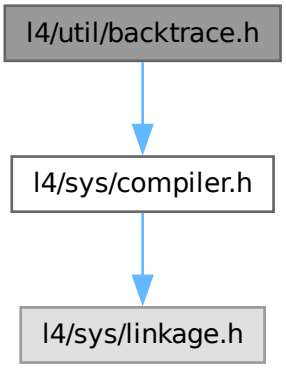
```
00415 l4util_inc16(volatile l4_uint16_t *dest)
00416 { __atomic_fetch_add(dest, 1, __ATOMIC_SEQ_CST); }
00417
00418 L4_INLINE void
00419 l4util_inc32(volatile l4_uint32_t *dest)
00420 { __atomic_fetch_add(dest, 1, __ATOMIC_SEQ_CST); }
00421
00422 L4_INLINE void
00423 l4util_atomic_inc(volatile long *dest)
00424 { __atomic_fetch_add(dest, 1, __ATOMIC_SEQ_CST); }
00425
00426 L4_INLINE void
00427 l4util_dec8(volatile l4_uint8_t *dest)
00428 { __atomic_fetch_sub(dest, 1, __ATOMIC_SEQ_CST); }
00429
00430 L4_INLINE void
00431 l4util_dec16(volatile l4_uint16_t *dest)
00432 { __atomic_fetch_sub(dest, 1, __ATOMIC_SEQ_CST); }
00433
00434 L4_INLINE void
00435 l4util_dec32(volatile l4_uint32_t *dest)
00436 { __atomic_fetch_sub(dest, 1, __ATOMIC_SEQ_CST); }
00437
00438
00439 L4_INLINE l4_uint8_t
00440 l4util_inc8_res(volatile l4_uint8_t *dest)
00441 { return __atomic_add_fetch(dest, 1, __ATOMIC_SEQ_CST); }
00442
00443 L4_INLINE l4_uint16_t
00444 l4util_inc16_res(volatile l4_uint16_t *dest)
00445 { return __atomic_add_fetch(dest, 1, __ATOMIC_SEQ_CST); }
00446
00447 L4_INLINE l4_uint32_t
00448 l4util_inc32_res(volatile l4_uint32_t *dest)
00449 { return __atomic_add_fetch(dest, 1, __ATOMIC_SEQ_CST); }
00450
00451 L4_INLINE l4_uint8_t
00452 l4util_dec8_res(volatile l4_uint8_t *dest)
00453 { return __atomic_sub_fetch(dest, 1, __ATOMIC_SEQ_CST); }
00454
00455 L4_INLINE l4_uint16_t
00456 l4util_dec16_res(volatile l4_uint16_t *dest)
00457 { return __atomic_sub_fetch(dest, 1, __ATOMIC_SEQ_CST); }
00458
00459 L4_INLINE l4_uint32_t
00460 l4util_dec32_res(volatile l4_uint32_t *dest)
00461 { return __atomic_sub_fetch(dest, 1, __ATOMIC_SEQ_CST); }
00462
00463 L4_INLINE l4_umword_t
00464 l4util_dec_res(volatile l4_umword_t *dest)
00465 { return __atomic_sub_fetch(dest, 1, __ATOMIC_SEQ_CST); }
00466
00467 L4_INLINE void
00468 l4util_add8(volatile l4_uint8_t *dest, l4_uint8_t val)
00469 { __atomic_fetch_add(dest, val, __ATOMIC_SEQ_CST); }
00470
00471 L4_INLINE void
00472 l4util_add16(volatile l4_uint16_t *dest, l4_uint16_t val)
00473 { __atomic_fetch_add(dest, val, __ATOMIC_SEQ_CST); }
00474
00475 L4_INLINE void
00476 l4util_add32(volatile l4_uint32_t *dest, l4_uint32_t val)
00477 { __atomic_fetch_add(dest, val, __ATOMIC_SEQ_CST); }
00478
00479 L4_INLINE void
00480 l4util_atomic_add(volatile long *dest, long val)
00481 { __atomic_fetch_add(dest, val, __ATOMIC_SEQ_CST); }
00482
00483 L4_INLINE void
00484 l4util_sub8(volatile l4_uint8_t *dest, l4_uint8_t val)
00485 { __atomic_fetch_sub(dest, val, __ATOMIC_SEQ_CST); }
00486
00487 L4_INLINE void
00488 l4util_sub16(volatile l4_uint16_t *dest, l4_uint16_t val)
00489 { __atomic_fetch_sub(dest, val, __ATOMIC_SEQ_CST); }
00490
00491 L4_INLINE void
00492 l4util_sub32(volatile l4_uint32_t *dest, l4_uint32_t val)
00493 { __atomic_fetch_sub(dest, val, __ATOMIC_SEQ_CST); }
00494
00495 L4_INLINE void
00496 l4util_and8(volatile l4_uint8_t *dest, l4_uint8_t val)
00497 { __atomic_fetch_and(dest, val, __ATOMIC_SEQ_CST); }
00498
00499 L4_INLINE void
00500 l4util_and16(volatile l4_uint16_t *dest, l4_uint16_t val)
00501 { __atomic_fetch_and(dest, val, __ATOMIC_SEQ_CST); }
```

```
00502
00503 L4_INLINE void
00504 l4util_and32(volatile l4_uint32_t *dest, l4_uint32_t val)
00505 { __atomic_fetch_and(dest, val, __ATOMIC_SEQ_CST); }
00506
00507 L4_INLINE void
00508 l4util_or8(volatile l4_uint8_t *dest, l4_uint8_t val)
00509 { __atomic_fetch_or(dest, val, __ATOMIC_SEQ_CST); }
00510
00511 L4_INLINE void
00512 l4util_or16(volatile l4_uint16_t *dest, l4_uint16_t val)
00513 { __atomic_fetch_or(dest, val, __ATOMIC_SEQ_CST); }
00514
00515 L4_INLINE void
00516 l4util_or32(volatile l4_uint32_t *dest, l4_uint32_t val)
00517 { __atomic_fetch_or(dest, val, __ATOMIC_SEQ_CST); }
00518
00519 L4_INLINE l4_uint8_t
00520 l4util_add8_res(volatile l4_uint8_t *dest, l4_uint8_t val)
00521 { return __atomic_add_fetch(dest, val, __ATOMIC_SEQ_CST); }
00522
00523 L4_INLINE l4_uint16_t
00524 l4util_add16_res(volatile l4_uint16_t *dest, l4_uint16_t val)
00525 { return __atomic_add_fetch(dest, val, __ATOMIC_SEQ_CST); }
00526
00527 L4_INLINE l4_uint32_t
00528 l4util_add32_res(volatile l4_uint32_t *dest, l4_uint32_t val)
00529 { return __atomic_add_fetch(dest, val, __ATOMIC_SEQ_CST); }
00530
00531 L4_INLINE l4_uint8_t
00532 l4util_sub8_res(volatile l4_uint8_t *dest, l4_uint8_t val)
00533 { return __atomic_sub_fetch(dest, val, __ATOMIC_SEQ_CST); }
00534
00535 L4_INLINE l4_uint16_t
00536 l4util_sub16_res(volatile l4_uint16_t *dest, l4_uint16_t val)
00537 { return __atomic_sub_fetch(dest, val, __ATOMIC_SEQ_CST); }
00538
00539 L4_INLINE l4_uint32_t
00540 l4util_sub32_res(volatile l4_uint32_t *dest, l4_uint32_t val)
00541 { return __atomic_sub_fetch(dest, val, __ATOMIC_SEQ_CST); }
00542
00543 L4_INLINE l4_uint8_t
00544 l4util_and8_res(volatile l4_uint8_t *dest, l4_uint8_t val)
00545 { return __atomic_and_fetch(dest, val, __ATOMIC_SEQ_CST); }
00546
00547 L4_INLINE l4_uint16_t
00548 l4util_and16_res(volatile l4_uint16_t *dest, l4_uint16_t val)
00549 { return __atomic_and_fetch(dest, val, __ATOMIC_SEQ_CST); }
00550
00551 L4_INLINE l4_uint32_t
00552 l4util_and32_res(volatile l4_uint32_t *dest, l4_uint32_t val)
00553 { return __atomic_and_fetch(dest, val, __ATOMIC_SEQ_CST); }
00554
00555 L4_INLINE l4_uint8_t
00556 l4util_or8_res(volatile l4_uint8_t *dest, l4_uint8_t val)
00557 { return __atomic_or_fetch(dest, val, __ATOMIC_SEQ_CST); }
00558
00559 L4_INLINE l4_uint16_t
00560 l4util_or16_res(volatile l4_uint16_t *dest, l4_uint16_t val)
00561 { return __atomic_or_fetch(dest, val, __ATOMIC_SEQ_CST); }
00562
00563 L4_INLINE l4_uint32_t
00564 l4util_or32_res(volatile l4_uint32_t *dest, l4_uint32_t val)
00565 { return __atomic_or_fetch(dest, val, __ATOMIC_SEQ_CST); }
00566
00567 #endif /* ! __L4UTIL__INCLUDE__ATOMIC_H__ */
```

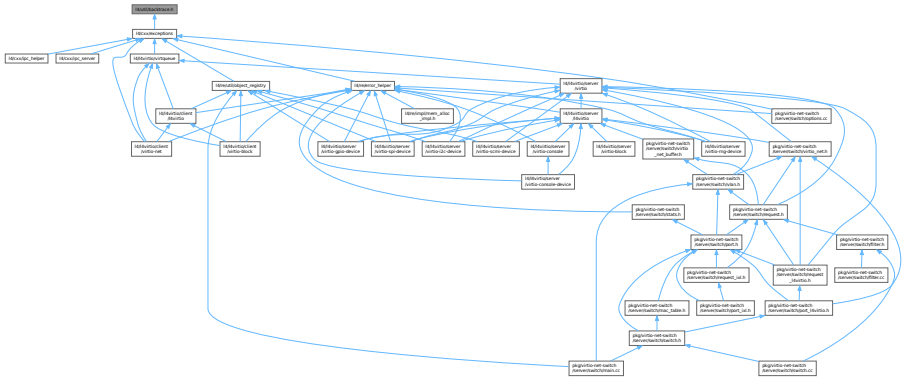
16.653 l4/util/backtrace.h File Reference

Backtrace.

```
#include <l4/sys/compiler.h>
```
Include dependency graph for backtrace.h:



This graph shows which files directly or indirectly include this file:



Functions

- L4_BEGIN_DECLS int l4util_backtrace (void **pc_array, int max_len)

  Fill backtrace structure.

16.653.1 Detailed Description

Backtrace.
Definition in file backtrace.h.

16.653.2 Function Documentation

16.653.2.1 l4util_backtrace()

```
L4_BEGIN_DECLS int l4util_backtrace (
            void ** pc_array,
            int max_len)
```
Fill backtrace structure.

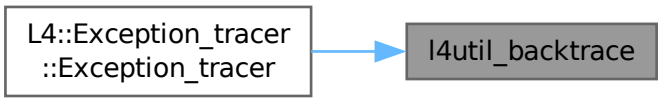
Parameters

pc_array	Array of instruction pointers.
max_len	Length of array.

Returns

Number of entries

References L4_END_DECLS.
Referenced by L4::Exception_tracer::Exception_tracer().
Here is the caller graph for this function:



16.654 backtrace.h

Go to the documentation of this file.

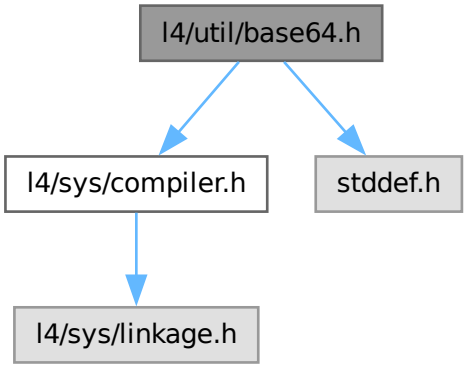
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #pragma once
00012
00013 #include <l4/sys/compiler.h>
00014
00015 L4_BEGIN_DECLS
00016
00024 int l4util_backtrace(void **pc_array, int max_len);
00025
00026 L4_END_DECLS
```

16.655 l4/util/base64.h File Reference

base 64 encoding and decoding functions adapted from Bob Trower 08/04/01

```
#include <l4/sys/compiler.h>
#include <stddef.h>
```

Include dependency graph for base64.h:



Functions

- void base64_encode (char const *in_data, size_t in_size, char **out_data, size_t *out_size)
- void base64_decode (char const *in_data, size_t in_size, char **out_data, size_t *out_size)

16.655.1 Detailed Description

base 64 encoding and decoding functions adapted from Bob Trower 08/04/01

Date

04/26/2002

Author

Joerg Nothnagel jn6@os.inf.tu-dresden.de

Definition in file base64.h.

16.656 base64.h

Go to the documentation of this file.

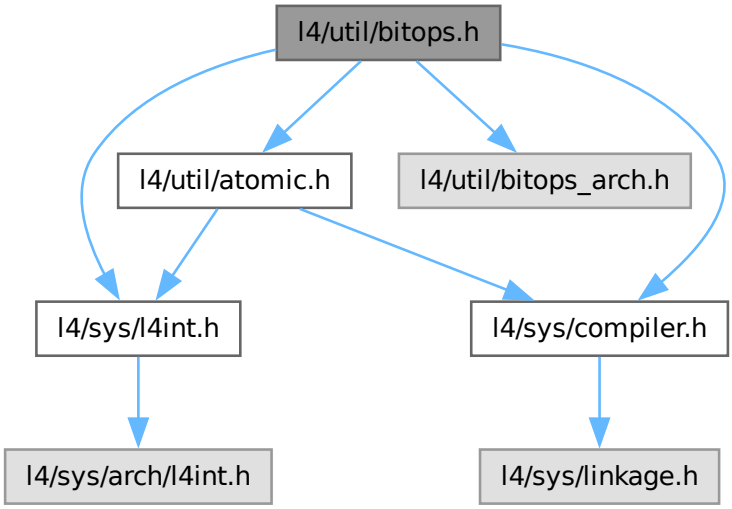
```
00001
00009 /*
00010  * (c) 2008-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #ifndef B64_EN_DECODE
00016 #define B64_EN_DECODE
00017
00018 #include <l4/sys/compiler.h>
00019 #include <stddef.h>
00020
00021 L4_BEGIN_DECLS
00022
00028
00040 L4_CV void base64_encode(char const *in_data, size_t in_size, char **out_data,
00041                          size_t *out_size);
00042
00054 L4_CV void base64_decode(char const *in_data, size_t in_size, char **out_data,
00055                          size_t *out_size);
00056
00057 L4_END_DECLS
00058
00060 #endif //B64_EN_DECODE
```

16.657 l4/util/bitops.h File Reference

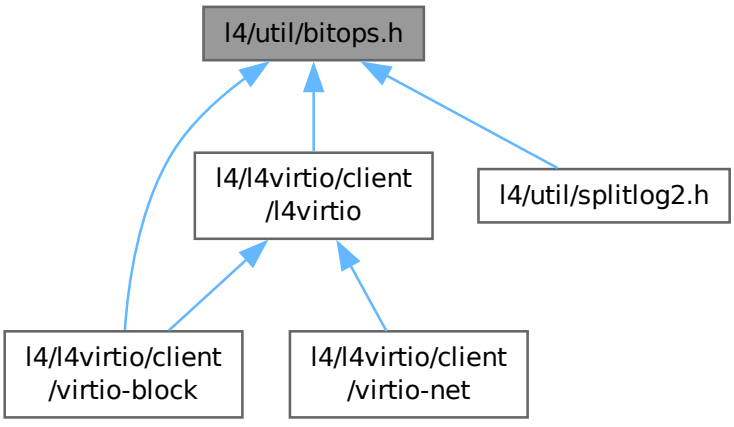
bit manipulation functions

```
#include <l4/sys/l4int.h>
#include <l4/sys/compiler.h>
#include <l4/util/bitops_arch.h>
#include <l4/util/atomic.h>
```

Include dependency graph for bitops.h:



This graph shows which files directly or indirectly include this file:



Macros

- #define **l4util_test_and_clear_bit**(b, dest)

  define some more usual names

Functions

- void l4util_set_bit (int b, volatile l4_umword_t *dest)

  Set bit in memory.
- void l4util_clear_bit (int b, volatile l4_umword_t *dest)

  Clear bit in memory.
- void l4util_complement_bit (int b, volatile l4_umword_t *dest)

  Complement bit in memory.
- int l4util_test_bit (int b, const volatile l4_umword_t *dest)

  Test bit (return value of bit).
- int l4util_bts (int b, volatile l4_umword_t *dest)

  Bit test and set.
- int l4util_btr (int b, volatile l4_umword_t *dest)

  Bit test and reset.
- int l4util_btc (int b, volatile l4_umword_t *dest)

  Bit test and complement.
- int l4util_bsr (l4_umword_t word)

  Bit scan reverse.
- int l4util_bsf (l4_umword_t word)

  Bit scan forward.
- int l4util_find_first_set_bit (const void *dest, l4_size_t size)

  Find the first set bit in a memory region.
- int l4util_find_first_zero_bit (const void *dest, l4_size_t size)

  Find the first zero bit in a memory region.
- unsigned long l4util_next_power2 (unsigned long val)

  Find the next power of 2 for a given number.

16.657.1 Detailed Description

bit manipulation functions

Date

07/03/2001

Author

Lars Reuther reuther@os.inf.tu-dresden.de

Definition in file bitops.h.

16.658 bitops.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00009 /*
00010  * (c) 2000-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 /*****************************************************************************/
00016 #ifndef __L4UTIL__INCLUDE__BITOPS_H__
00017 #define __L4UTIL__INCLUDE__BITOPS_H__
```

```
00018
00019 /* L4 includes */
00020 #include <l4/sys/l4int.h>
00021 #include <l4/sys/compiler.h>
00022
00024 #define l4util_test_and_clear_bit(b, dest)  l4util_btr(b, dest)
00025 #define l4util_test_and_set_bit(b, dest)  l4util_bts(b, dest)
00026 #define l4util_test_and_change_bit(b, dest) l4util_btc(b, dest)
00027 #define l4util_log2(word)     l4util_bsr(word)
00028
00029 /*****************************************************************************
00030  *** Prototypes
00031  *****************************************************************************/
00032
00033 L4_BEGIN_DECLS
00034
00039
00047 L4_INLINE void
00048 l4util_set_bit(int b, volatile l4_umword_t * dest);
00049
00057 L4_INLINE void
00058 l4util_clear_bit(int b, volatile l4_umword_t * dest);
00059
00067 L4_INLINE void
00068 l4util_complement_bit(int b, volatile l4_umword_t * dest);
00069
00079 L4_INLINE int
00080 l4util_test_bit(int b, const volatile l4_umword_t * dest);
00081
00093 L4_INLINE int
00094 l4util_bts(int b, volatile l4_umword_t * dest);
00095
00107 L4_INLINE int
00108 l4util_btr(int b, volatile l4_umword_t * dest);
00109
00121 L4_INLINE int
00122 l4util_btc(int b, volatile l4_umword_t * dest);
00123
00135 L4_INLINE int
00136 l4util_bsr(l4_umword_t word);
00137
00149 L4_INLINE int
00150 l4util_bsf(l4_umword_t word);
00151
00163 L4_INLINE int
00164 l4util_find_first_set_bit(const void * dest, l4_size_t size);
00165
00177 L4_INLINE int
00178 l4util_find_first_zero_bit(const void * dest, l4_size_t size);
00179
00180
00189 L4_INLINE unsigned long
00190 l4util_next_power2(unsigned long val);
00191
00192 L4_END_DECLS
00193
00194 /*****************************************************************************
00195  *** Implementation of specific version
00196  *****************************************************************************/
00197
00198 #include <l4/util/bitops_arch.h>
00199
00200 /*****************************************************************************
00201  *** Generic implementations
00202  *****************************************************************************/
00203
00204 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_SET_BIT
00205 #include <l4/util/atomic.h>
00206 L4_INLINE void
00207 l4util_set_bit(int b, volatile l4_umword_t * dest)
00208 {
00209   l4_umword_t oldval, newval;
00210
00211   dest += b / (sizeof(*dest) * 8); /* advance dest to the proper element */
00212   b    &= sizeof(*dest) * 8 - 1;   /* modulo; cut off all upper bits */
00213
00214   do
00215     {
00216       oldval = *dest;
00217       newval = oldval | (1UL << b);
00218     }
00219   while (!l4util_cmpxchg(dest, oldval, newval));
00220 }
00221 #endif
00222
00223 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_CLEAR_BIT
00224 #include <l4/util/atomic.h>
```

```
00225 L4_INLINE void
00226 l4util_clear_bit(int b, volatile l4_umword_t * dest)
00227 {
00228   l4_umword_t oldval, newval;
00229
00230   dest += b / (sizeof(*dest) * 8);
00231   b    &= sizeof(*dest) * 8 - 1;
00232
00233   do
00234     {
00235       oldval = *dest;
00236       newval = oldval & ~(1UL << b);
00237     }
00238   while (!l4util_cmpxchg(dest, oldval, newval));
00239 }
00240 #endif
00241
00242 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_TEST_BIT
00243 L4_INLINE int
00244 l4util_test_bit(int b, const volatile l4_umword_t * dest)
00245 {
00246   dest += b / (sizeof(*dest) * 8);
00247   b    &= sizeof(*dest) * 8 - 1;
00248
00249   return (*dest >> b) & 1;
00250 }
00251 #endif
00252
00253 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_SET
00254 #include <l4/util/atomic.h>
00255 L4_INLINE int
00256 l4util_bts(int b, volatile l4_umword_t * dest)
00257 {
00258   l4_umword_t oldval, newval;
00259
00260   dest += b / (sizeof(*dest) * 8);
00261   b    &= sizeof(*dest) * 8 - 1;
00262
00263   do
00264     {
00265       oldval = *dest;
00266       newval = oldval | (1UL << b);
00267     }
00268   while (!l4util_cmpxchg(dest, oldval, newval));
00269
00270   /* Return old bit */
00271   return (oldval >> b) & 1;
00272 }
00273 #endif
00274
00275 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_RESET
00276 #include <l4/util/atomic.h>
00277 L4_INLINE int
00278 l4util_btr(int b, volatile l4_umword_t * dest)
00279 {
00280   l4_umword_t oldval, newval;
00281
00282   dest += b / (sizeof(*dest) * 8);
00283   b    &= sizeof(*dest) * 8 - 1;
00284
00285   do
00286     {
00287       oldval = *dest;
00288       newval = oldval & ~(1UL << b);
00289     }
00290   while (!l4util_cmpxchg(dest, oldval, newval));
00291
00292   /* Return old bit */
00293   return (oldval >> b) & 1;
00294 }
00295 #endif
00296
00297 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_BIT_SCAN_REVERSE
00298 L4_INLINE int
00299 l4util_bsr(l4_umword_t word)
00300 {
00301   int i;
00302
00303   if (!word)
00304     return -1;
00305
00306   for (i = 8 * sizeof(word) - 1; i >= 0; i--)
00307     if ((1UL << i) & word)
00308       return i;
00309
00310   __builtin_unreachable();
00311 }
```

```
00312 #endif
00313
00314 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_BIT_SCAN_FORWARD
00315 L4_INLINE int
00316 l4util_bsf(l4_umword_t word)
00317 {
00318   unsigned int i;
00319
00320   if (!word)
00321     return -1;
00322
00323   for (i = 0; i < sizeof(word) * 8; i++)
00324     if ((1UL << i) & word)
00325       return i;
00326
00327   __builtin_unreachable();
00328 }
00329 #endif
00330
00331 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_FIND_FIRST_ZERO_BIT
00332 L4_INLINE int
00333 l4util_find_first_zero_bit(const void * dest, l4_size_t size)
00334 {
00335   l4_size_t i, j;
00336   unsigned long *v = (unsigned long*)dest;
00337
00338   if (!size)
00339     return 0;
00340
00341   size = (size + 31) & ~0x1f; /* Grmbl: adapt to x86 implementation... */
00342
00343   for (i = j = 0; i < size; i++, j++)
00344     {
00345       if (j >= sizeof(*v) * 8)
00346   {
00347     j = 0;
00348     v++;
00349   }
00350       if (!((1UL << j) & *v))
00351   return i;
00352     }
00353   return size + 1;
00354 }
00355 #endif
00356
00357 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_COMPLEMENT_BIT
00358 L4_INLINE void
00359 l4util_complement_bit(int b, volatile l4_umword_t * dest)
00360 {
00361   dest += b / (sizeof(*dest) * 8);
00362   b    &= sizeof(*dest) * 8 - 1;
00363
00364   *dest ^= 1UL << b;
00365 }
00366 #endif
00367
00368 /*
00369  * Adapted from:
00370  * http://en.wikipedia.org/wiki/Power_of_two#Algorithm_to_find_the_next-highest_power_of_two
00371  */
00372 L4_INLINE unsigned long
00373 l4util_next_power2(unsigned long val)
00374 {
00375   unsigned i;
00376
00377   if (val == 0)
00378     return 1;
00379
00380   val--;
00381   for (i=1; i < sizeof(unsigned long)*8; i<<=1)
00382     val = val | val >> i;
00383
00384   return val + 1;
00385 }
00386
00387
00388 /* Non-implemented version, catch with a linker warning */
00389
00390 extern int __this_l4util_bitops_function_is_not_implemented_for_this_arch__sorry(void);
00391
00392 #ifndef __L4UTIL_BITOPS_HAVE_ARCH_BIT_TEST_AND_COMPLEMENT
00393 L4_INLINE int
00394 l4util_btc(int b, volatile l4_umword_t * dest)
00395 { (void)b; (void)dest; __this_l4util_bitops_function_is_not_implemented_for_this_arch__sorry(); return
      0; }
00396 #endif
00397
```

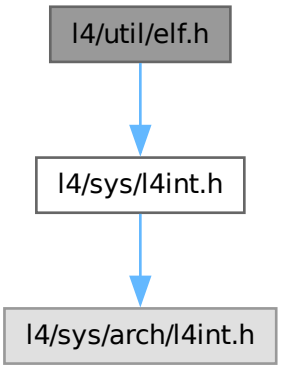
```
00398 #ifndef  __L4UTIL_BITOPS_HAVE_ARCH_FIND_FIRST_SET_BIT
00399 L4_INLINE int
00400 l4util_find_first_set_bit(const void * dest, l4_size_t size)
00401 { (void)dest; (void)size; __this_l4util_bitops_function_is_not_implemented_for_this_arch__sorry();
      return 0; }
00402 #endif
00403
00404 #endif /* ! __L4UTIL__INCLUDE__BITOPS_H__ */
```

16.659 l4/util/elf.h File Reference

ELF definition.

`#include <l4/sys/l4int.h>`

Include dependency graph for elf.h:



Data Structures

- struct Elf32_Ehdr

  ELF32 header.
- struct Elf64_Ehdr

  ELF64 header.
- struct Elf32_Shdr

  ELF32 section header.
- struct Elf64_Shdr

  ELF64 section header.
- struct Elf32_Phdr

  ELF32 program header.
- struct Elf64_Phdr

  ELF64 program header.
- struct Elf32_Dyn

  ELF32 dynamic entry.
- struct Elf64_Dyn

  ELF64 dynamic entry.
- struct Elf32_Rel

  ELF32 relocation entry w/o addend.
- struct Elf32_Rela

  ELF32 relocation entry w/ addend.

- struct Elf64_Rel

  ELF64 relocation entry w/o addend.
- struct Elf64_Rela

  ELF64 relocation entry w/ addend.
- struct Elf32_Sym

  ELF32 symbol table entry.
- struct Elf64_Sym

  ELF64 symbol table entry.
- struct Elf32_Auxv

  Auxiliary vector (32-bit).
- struct Elf64_Auxv

  Auxiliary vector (64-bit).

Macros

- #define **ElfW**(type)

  Use 64 or 32 bits types depending on the target architecture.
- #define **ELF32_R_SYM**(i)

  Symbol table index.
- #define ELF32_R_TYPE(i)
- #define **ELF32_R_INFO**(s, t)

  Create info from symbol table index + type.
- #define **ELF64_R_SYM**(i)

  Symbol table index.
- #define ELF64_R_TYPE(i)
- #define **ELF64_R_INFO**(s, t)

  Create info from symbol table index + type.
- #define ELF32_ST_BIND(i)
- #define ELF32_ST_TYPE(i)
- #define **ELF32_ST_INFO**(b, t)

  Make info from bind + type.
- #define ELF64_ST_BIND(i)
- #define ELF64_ST_TYPE(i)
- #define **ELF64_ST_INFO**(b, t)

  Make info from bind + type.

Typedefs

- typedef struct Elf32_Auxv **Elf32_Auxv**

  Auxiliary vector (32-bit).
- typedef struct Elf64_Auxv **Elf64_Auxv**

  Auxiliary vector (64-bit).

ELF types

- typedef l4_uint32_t **Elf32_Addr**

  size 4 align 4
- typedef l4_uint32_t **Elf32_Off**

  size 4 align 4
- typedef l4_uint16_t **Elf32_Half**

  size 2 align 2
- typedef l4_uint32_t **Elf32_Word**

  size 4 align 4
- typedef l4_int32_t **Elf32_Sword**

size 4 align 4

- typedef l4_uint64_t **Elf64_Addr**

  size 8 align 8
- typedef l4_uint64_t **Elf64_Off**

  size 8 align 8
- typedef l4_uint16_t **Elf64_Half**

  size 2 align 2
- typedef l4_uint32_t **Elf64_Word**

  size 4 align 4
- typedef l4_int32_t **Elf64_Sword**

  size 4 align 4
- typedef l4_uint64_t **Elf64_Xword**

  size 8 align 8
- typedef l4_int64_t **Elf64_Sxword**

  size 8 align 8

Enumerations

- enum { EI_NIDENT = 16 }
- enum Elf_ETs {
  ET_NONE = 0 , ET_REL = 1 , ET_EXEC = 2 , ET_DYN = 3 ,
  ET_CORE = 4 , ET_LOPROC = 0xff00 , ET_HIPROC = 0xffff }

  Object file type.
- enum Elf_EMs {
  EM_NONE = 0 , EM_M32 = 1 , EM_SPARC = 2 , EM_386 = 3 ,
  EM_68K = 4 , EM_88K = 5 , EM_860 = 7 , EM_MIPS = 8 ,
  EM_MIPS_RS4_BE = 10 , EM_SPARC64 = 11 , EM_PARISC = 15 , EM_VPP500 = 17 ,
  EM_SPARC32PLUS = 18 , EM_960 = 19 , EM_PPC = 20 , EM_V800 = 36 ,
  EM_FR20 = 37 , EM_RH32 = 38 , EM_RCE = 39 , EM_ARM = 40 ,
  EM_ALPHA = 41 , EM_SH = 42 , EM_SPARCV9 = 43 , EM_TRICORE = 44 ,
  EM_ARC = 45 , EM_H8_300 = 46 , EM_H8_300H = 47 , EM_H8S = 48 ,
  EM_H8_500 = 49 , EM_IA_64 = 50 , EM_MIPS_X = 51 , EM_COLDFIRE = 52 ,
  EM_68HC12 = 53 , EM_X86_64 = 62 , EM_PDSP = 63 , EM_FX66 = 66 ,
  EM_ST9PLUS = 67 , EM_ST7 = 68 , EM_68HC16 = 69 , EM_68HC11 = 70 ,
  EM_68HC08 = 71 , EM_68HC05 = 72 , EM_SVX = 73 , EM_ST19 = 74 ,
  EM_VAX = 75 , EM_CRIS = 76 , EM_JAVELIN = 77 , EM_FIREPATH = 78 ,
  EM_ZSP = 79 , EM_MMIX = 80 , EM_HUANY = 81 , EM_PRISM = 82 ,
  EM_AVR = 83 , EM_FR30 = 84 , EM_D10V = 85 , EM_D30V = 86 ,
  EM_V850 = 87 , EM_M32R = 88 , EM_MN10300 = 89 , EM_MN10200 = 90 ,
  EM_PJ = 91 , EM_OPENRISC = 92 , EM_ARC_A5 = 93 , EM_XTENSA = 94 ,
  EM_ALTERA_NIOS2 = 113 , EM_AARCH64 = 183 , EM_TILEPRO = 188 , EM_MICROBLAZE = 189 ,
  EM_TILEGX = 191 , EM_RISCV = 243 , **EM_NUM** = 244 }

  Required architecture.
- enum Elf_EVs { EV_NONE = 0 , EV_CURRENT = 1 }

  Object file version.
- enum Elf_EIs {
  EI_MAG0 = 0 , EI_MAG1 = 1 , EI_MAG2 = 2 , EI_MAG3 = 3 ,
  EI_CLASS = 4 , EI_DATA = 5 , EI_VERSION = 6 , EI_OSABI = 7 ,
  EI_ABIVERSION = 8 , EI_PAD = 9 }

  Identification Indices.
- enum Elf_MAGs { ELFMAG0 = 0x7f , ELFMAG1 = 'E' , ELFMAG2 = 'L' , ELFMAG3 = 'F' }

  Magic number.
- enum Elf_CIASSs { ELFCLASSNONE = 0 , ELFCLASS32 = 1 , ELFCLASS64 = 2 , ELFCLASSNUM = 3 }

  File class or capacity.
- enum Elf_DATAs { ELFDATANONE = 0 , ELFDATA2LSB = 1 , ELFDATA2MSB = 2 , ELFDATANUM = 3 }

  Data encoding.

- enum Elf_OSABIs {
  ELFOSABI_NONE = 0 , ELFOSABI_SYSV = 0 , ELFOSABI_HPUX = 1 , ELFOSABI_NETBSD = 2 ,
  ELFOSABI_LINUX = 3 , ELFOSABI_SOLARIS = 6 , ELFOSABI_AIX = 7 , ELFOSABI_IRIX = 8 ,
  ELFOSABI_FREEBSD = 9 , ELFOSABI_TRU64 = 10 , ELFOSABI_MODESTO = 11 , ELFOSABI_OPENBSD = 12 ,
  ELFOSABI_ARM = 97 , ELFOSABI_STANDALONE = 255 }

  Identify operating system and ABI to which the object is targeted.
- enum Elf_SHNs {
  SHN_UNDEF = 0 , SHN_LORESERVE = 0xff00 , SHN_LOPROC = 0xff00 , SHN_HIPROC = 0xff1f ,
  SHN_ABS = 0xfff1 , SHN_COMMON = 0xfff2 , SHN_HIRESERVE = 0xffff }

  Special section indexes.
- enum Elf_SHTs {
  SHT_NULL = 0 , SHT_PROGBITS = 1 , SHT_SYMTAB = 2 , SHT_STRTAB = 3 ,
  SHT_RELA = 4 , SHT_HASH = 5 , SHT_DYNAMIC = 6 , SHT_NOTE = 7 ,
  SHT_NOBITS = 8 , SHT_REL = 9 , SHT_SHLIB = 10 , SHT_DYNSYM = 11 ,
  SHT_INIT_ARRAY = 14 , SHT_FINI_ARRAY = 15 , SHT_PREINIT_ARRAY = 16 , SHT_GROUP = 17 ,
  SHT_SYMTAB_SHNDX = 18 , SHT_NUM = 19 , SHT_LOOS = 0x60000000 , SHT_HIOS = 0x6fffffff ,
  SHT_LOPROC = 0x70000000 , SHT_HIPROC = 0x7fffffff , SHT_LOUSER = 0x80000000 , SHT_HIUSER = 0xffffffff }

  Section type.
- enum Elf_SHFs {
  SHF_WRITE = 0x1 , SHF_ALLOC = 0x2 , SHF_EXECINSTR = 0x4 , SHF_MERGE = 0x10 ,
  SHF_STRINGS = 0x20 , SHF_INFO_LINK = 0x40 , SHF_LINK_ORDER = 0x80 , SHF_OS_NONCONFORMING = 0x100 ,
  SHF_GROUP = 0x200 , SHF_TLS = 0x400 , SHF_MASKOS = 0x0ff00000 , SHF_MASKPROC = 0xf0000000 }

  Section attribute flags.
- enum Elf_PTs {
  PT_NULL = 0 , PT_LOAD = 1 , PT_DYNAMIC = 2 , PT_INTERP = 3 ,
  PT_NOTE = 4 , PT_SHLIB = 5 , PT_PHDR = 6 , PT_TLS = 7 ,
  PT_NUM = 8 , PT_LOOS = 0x60000000 , PT_HIOS = 0x6fffffff , PT_LOPROC = 0x70000000 ,
  PT_HIPROC = 0x7fffffff , PT_GNU_EH_FRAME = PT_LOOS + 0x474e550 , PT_GNU_STACK = PT_LOOS + 0x474e551 , PT_GNU_RELRO = PT_LOOS + 0x474e552 ,
  PT_L4_STACK = PT_LOOS + 0x12 , PT_L4_AUX = PT_LOOS + 0x14 }

  Segment types.
- enum ELF_PFs {
  PF_X = 0x1 , PF_W = 0x2 , PF_R = 0x4 , PF_MASKOS = 0x0ff00000 ,
  PF_MASKPROC = 0x7fffffff }

  Segment permissions.
- enum Elf_NTs_core {
  NT_PRSTATUS = 1 , NT_FPREGSET = 2 , NT_PRPSINFO = 3 , NT_PRXREG = 4 ,
  NT_TASKSTRUCT = 4 , NT_PLATFORM = 5 , NT_AUXV = 6 , NT_GWINDOWS = 7 ,
  NT_ASRS = 8 , NT_PSTATUS = 10 , NT_PSINFO = 13 , NT_PRCRED = 14 ,
  NT_UTSNAME = 15 , NT_LWPSTATUS = 16 , NT_LWPSINFO = 17 , NT_PRFPXREG = 20 }

  Legal values for note segment descriptor types for core files.
- enum Elf_NTs_obj { NT_VERSION = 1 }

  Legal values for the note segment descriptor types for object files.
- enum Elf_DTs {
  DT_NULL = 0 , DT_NEEDED = 1 , DT_PLTRELSZ = 2 , DT_PLTGOT = 3 ,
  DT_HASH = 4 , DT_STRTAB = 5 , DT_SYMTAB = 6 , DT_RELA = 7 ,
  DT_RELASZ = 8 , DT_RELAENT = 9 , DT_STRSZ = 10 , DT_SYMENT = 11 ,
  DT_INIT = 12 , DT_FINI = 13 , DT_SONAME = 14 , DT_RPATH = 15 ,
  DT_SYMBOLIC = 16 , DT_REL = 17 , DT_RELSZ = 18 , DT_RELENT = 19 ,
  DT_PTRREL = 20 , DT_DEBUG = 21 , DT_TEXTREL = 22 , DT_JMPREL = 23 ,
  DT_BIND_NOW = 24 , DT_INIT_ARRAY = 25 , DT_FINI_ARRAY = 26 , DT_INIT_ARRAYSZ = 27 ,
  DT_FINI_ARRAYSZ = 28 , DT_RUNPATH = 29 , DT_FLAGS = 30 , DT_ENCODING = 32 ,

DT_PREINIT_ARRAY = 32 , DT_PREINIT_ARRAYSZ = 33 , DT_NUM = 34 , DT_LOOS = 0x6000000d , DT_HIOS = 0x6ffff000 , DT_LOPROC = 0x70000000 , DT_HIPROC = 0x7fffffff }

Dynamic Array Tags.

- enum Elf_DFs { DF_ORIGIN = 0x00000001 , DF_SYMBOLIC = 0x00000002 , DF_TEXTREL = 0x00000004 , DF_BIND_NOW = 0x00000008 , DF_STATIC_TLS = 0x00000010 }

  Values of Elf32_Dyn.d_un.d_val, Elf64_Dyn.d_un.d_val in the DT_FLAGS entry.
- enum Elf_DF_1s { DF_1_NOW = 0x00000001 , DF_1_GLOBAL = 0x00000002 , DF_1_GROUP = 0x00000004 , DF_1_NODELETE = 0x00000008 , DF_1_LOADFLTR = 0x00000010 , DF_1_INITFIRST = 0x00000020 , DF_1_NOOPEN = 0x00000040 , DF_1_ORIGIN = 0x00000080 , DF_1_DIRECT = 0x00000100 , **DF_1_TRANS** = 0x00000200 , DF_1_INTERPOSE = 0x00000400 , DF_1_NODEFLIB = 0x00000800 , DF_1_NODUMP = 0x00001000 , DF_1_CONFALT = 0x00002000 , DF_1_ENDFILTEE = 0x00004000 , DF_1_DISPRELDNE = 0x00008000 , DF_1_DISPRELPND = 0x00010000 }

  State flags selectable in the Elf32_Dyn.d_un.d_val / Elf64_Dyn.d_un.d_val element of the DT_FLAGS_1 entry in the dynamic section.
- enum Elf_DTF_1s

  Flags for the feature selection in DT_FEATURE_1.
- enum Elf_DF_P1s { DF_P1_LAZYLOAD = 0x00000001 , DF_P1_GROUPPERM = 0x00000002 }

  Flags in the DT_POSFLAG_1 entry effecting only the next DT_∗ entry.
- enum Elf_R_386_s { R_386_NONE = 0 , R_386_32 = 1 , R_386_PC32 = 2 , R_386_GOT32 = 3 , R_386_PLT32 = 4 , R_386_COPY = 5 , R_386_GLOB_DAT = 6 , R_386_JMP_SLOT = 7 , R_386_RELATIVE = 8 , R_386_GOTOFF = 9 , R_386_GOTPC = 10 , **R_386_32PLT** = 11 , R_386_TLS_TPOFF = 14 , R_386_TLS_IE = 15 , R_386_TLS_GOTIE = 16 , R_386_TLS_LE = 17 , R_386_TLS_GD = 18 , R_386_TLS_LDM = 19 , **R_386_16** = 20 , **R_386_PC16** = 21 , **R_386_8** = 22 , **R_386_PC8** = 23 , R_386_TLS_GD_32 = 24 , R_386_TLS_GD_PUSH = 25 , R_386_TLS_GD_CALL = 26 , R_386_TLS_GD_POP = 27 , R_386_TLS_LDM_32 = 28 , R_386_TLS_LDM_PUSH = 29 , R_386_TLS_LDM_CALL = 30 , R_386_TLS_LDM_POP = 31 , R_386_TLS_LDO_32 = 32 , R_386_TLS_IE_32 = 33 , R_386_TLS_LE_32 = 34 , R_386_TLS_DTPMOD32 = 35 , R_386_TLS_DTPOFF32 = 36 , R_386_TLS_TPOFF32 = 37 , R_386_NUM = 38 }

  Relocation types (processor specific).
- enum Elf_EF_ARM_s { }

  ARM specific declarations.
- enum Elf_STT_ARM_s

  Additional symbol types for Thumb.
- enum Elf_SHF_s_ARM { SHF_ARM_ENTRYSECT = 0x10000000 , SHF_ARM_COMDEF = 0x80000000 }

  ARM-specific values for Elf32_Shdr.sh_flags / Elf64_Shdr.sh_flags.
- enum Elf_ARM_SBs { PF_ARM_SB = 0x10000000 }

  ARM-specific program header flags.
- enum Elf_R_ARM_s { R_ARM_NONE = 0 , R_ARM_PC24 = 1 , R_ARM_ABS32 = 2 , R_ARM_REL32 = 3 , **R_ARM_PC13** = 4 , R_ARM_ABS16 = 5 , R_ARM_ABS12 = 6 , **R_ARM_THM_ABS5** = 7 , R_ARM_ABS8 = 8 , **R_ARM_SBREL32** = 9 , **R_ARM_THM_PC22** = 10 , **R_ARM_THM_PC8** = 11 , **R_ARM_AMP_VCALL9** = 12 , **R_ARM_SWI24** = 13 , **R_ARM_THM_SWI8** = 14 , **R_ARM_XPC25** = 15 , **R_ARM_THM_XPC22** = 16 , R_ARM_COPY = 20 , R_ARM_GLOB_DAT = 21 , R_ARM_JUMP_SLOT = 22 , R_ARM_RELATIVE = 23 , R_ARM_GOTOFF = 24 , R_ARM_GOTPC = 25 , R_ARM_GOT32 = 26 , R_ARM_PLT32 = 27 , **R_ARM_ALU_PCREL_7_0** = 32 , **R_ARM_ALU_PCREL_15_8** = 33 , **R_ARM_↩ ALU_PCREL_23_15** = 34 ,

R_ARM_LDR_SBREL_11_0 = 35 , **R_ARM_ALU_SBREL_19_12** = 36 , **R_ARM_ALU_SBREL_27_20** = 37 , **R_ARM_GNU_VTENTRY** = 100 ,
R_ARM_GNU_VTINHERIT = 101 , R_ARM_THM_PC11 = 102 , R_ARM_THM_PC9 = 103 , **R_ARM_RXPC25** = 249 ,
R_ARM_RSBREL32 = 250 , **R_ARM_THM_RPC22** = 251 , **R_ARM_RREL32** = 252 , **R_ARM_RABS22** = 253 ,
R_ARM_RPC24 = 254 , **R_ARM_RBASE** = 255 , R_ARM_NUM = 256 }

ARM relocations.

- enum Elf_R_AARCH64_s { R_AARCH64_NONE = 0 , **R_AARCH64_RELATIVE** = 1027 }

  AARCH64 relocations.

- enum Elf_R_X86_64_s {
  R_X86_64_NONE = 0 , R_X86_64_64 = 1 , R_X86_64_PC32 = 2 , R_X86_64_GOT32 = 3 ,
  R_X86_64_PLT32 = 4 , R_X86_64_COPY = 5 , R_X86_64_GLOB_DAT = 6 , R_X86_64_JUMP_SLOT = 7 ,
  R_X86_64_RELATIVE = 8 , R_X86_64_GOTPCREL = 9 , R_X86_64_32 = 10 , R_X86_64_32S = 11 ,
  R_X86_64_16 = 12 , R_X86_64_PC16 = 13 , R_X86_64_8 = 14 , R_X86_64_PC8 = 15 ,
  R_X86_64_DTPMOD64 = 16 , R_X86_64_DTPOFF64 = 17 , R_X86_64_TPOFF64 = 18 , R_X86_64_TLSGD = 19 ,
  R_X86_64_TLSLD = 20 , R_X86_64_DTPOFF32 = 21 , R_X86_64_GOTTPOFF = 22 , R_X86_64_TPOFF32 = 23 ,
  R_X86_64_NUM = 24 }

  AMD x86-64 relocations.

- enum Elf_STNs

  Symbol Table Entry.

- enum Elf_STBs {
  STB_LOCAL = 0 , STB_GLOBAL = 1 , STB_WEAK = 2 , STB_LOOS = 10 ,
  STB_HIOS = 12 , STB_LOPROC = 13 , STB_HIPROC = 15 }

  Symbol Binding.

- enum Elf_STTs {
  STT_NOTYPE = 0 , STT_OBJECT = 1 , STT_FUNC = 2 , STT_SECTION = 3 ,
  STT_FILE = 4 , STT_LOOS = 10 , STT_HIOS = 12 , STT_LOPROC = 13 ,
  STT_HIPROC = 15 }

  Symbol Types.

- enum Elf_ATs {
  AT_NULL = 0 , AT_IGNORE = 1 , AT_EXECFD = 2 , AT_PHDR = 3 ,
  AT_PHENT = 4 , AT_PHNUM = 5 , AT_PAGESZ = 6 , AT_BASE = 7 ,
  AT_FLAGS = 8 , AT_ENTRY = 9 , AT_NOTELF = 10 , AT_UID = 11 ,
  AT_EUID = 12 , AT_GID = 13 , AT_EGID = 14 , AT_L4_AUX = 0xf0 ,
  AT_L4_ENV = 0xf1 , AT_L4_KIP = 0xf2 }

  Legal values for Elf32_Auxv.atype / Elf64_Auxv.atype.

16.659.1 Detailed Description

ELF definition.

Date

08/18/2000

Author

Frank Mehnert fm3@os.inf.tu-dresden.de Alexander Warg aw11@os.inf.tu-dresden.de

Many structs from "Executable and Linkable Format (ELF)", Portable Formats Specification, Version 1.1 and "System V Application Binary Interface - DRAFT - April 29, 1998" The Santa Cruz Operation, Inc. (see http://www.sco.com/developer/gabi/contents.html)
Definition in file elf.h.

16.660 elf.h

Go to the documentation of this file.

```
00001
00019 /*
00020  * (c) 2008-2009 Author(s)
00021  *     economic rights: Technische Universität Dresden (Germany)
00022  * License: see LICENSE.spdx (in this directory or the directories above)
00023  */
00024
00025 /* (c) 2003-2006 Technische Universitaet Dresden
00026  * License: see LICENSE.spdx (in this directory or the directories above) */
00027
00028 #pragma once
00029
00030 #include <l4/sys/l4int.h>
00031
00037
00042 typedef l4_uint32_t     Elf32_Addr;
00043 typedef l4_uint32_t     Elf32_Off;
00044 typedef l4_uint16_t     Elf32_Half;
00045 typedef l4_uint32_t     Elf32_Word;
00046 typedef l4_int32_t      Elf32_Sword;
00047 typedef l4_uint64_t     Elf64_Addr;
00048 typedef l4_uint64_t     Elf64_Off;
00049 typedef l4_uint16_t     Elf64_Half;
00050 typedef l4_uint32_t     Elf64_Word;
00051 typedef l4_int32_t      Elf64_Sword;
00052 typedef l4_uint64_t     Elf64_Xword;
00053 typedef l4_int64_t      Elf64_Sxword;
00055
00060 #if L4_MWORD_BITS == 64
00061 # define ElfW(type)      _ElfW(Elf, 64, type)
00062 #else
00063 # define ElfW(type)      _ElfW(Elf, 32, type)
00064 #endif
00065 #define _ElfW(e,w,t)    __ElfW(e, w, _##t)
00066 #define __ElfW(e,w,t)   e##w##t
00067
00068 #if defined(ARCH_x86)
00069 # define L4_ARCH_EI_DATA      ELFDATA2LSB
00070 # define L4_ARCH_E_MACHINE    EM_386
00071 # define L4_ARCH_EI_CLASS     ELFCLASS32
00072 #elif defined(ARCH_amd64)
00073 # define L4_ARCH_EI_DATA      ELFDATA2LSB
00074 # define L4_ARCH_E_MACHINE    EM_X86_64
00075 # define L4_ARCH_EI_CLASS     ELFCLASS64
00076 #elif defined(ARCH_arm)
00077 # define L4_ARCH_EI_DATA      ELFDATA2LSB
00078 # define L4_ARCH_E_MACHINE    EM_ARM
00079 # define L4_ARCH_EI_CLASS     ELFCLASS32
00080 #elif defined(ARCH_arm64)
00081 # define L4_ARCH_EI_DATA      ELFDATA2LSB
00082 # define L4_ARCH_E_MACHINE    EM_AARCH64
00083 # define L4_ARCH_EI_CLASS     ELFCLASS64
00084 #elif defined(ARCH_ppc32)
00085 # define L4_ARCH_EI_DATA      ELFDATA2MSB
00086 # define L4_ARCH_E_MACHINE    EM_PPC
00087 # define L4_ARCH_EI_CLASS     ELFCLASS32
00088 #elif defined(ARCH_sparc)
00089 # define L4_ARCH_EI_DATA      ELFDATA2MSB
00090 # define L4_ARCH_E_MACHINE    EM_SPARC
00091 # define L4_ARCH_EI_CLASS     ELFCLASS32
00092 #elif defined(ARCH_mips)
00093 # define L4_ARCH_EI_DATA      ELFDATA2LSB
00094 # define L4_ARCH_E_MACHINE    EM_MIPS
00095 # ifdef __mips64
00096 #  define L4_ARCH_EI_CLASS     ELFCLASS64
00097 # else
00098 #  define L4_ARCH_EI_CLASS     ELFCLASS32
00099 # endif
00100 #elif defined(ARCH_riscv)
00101 # define L4_ARCH_EI_DATA      ELFDATA2LSB
00102 # define L4_ARCH_E_MACHINE    EM_RISCV
00103 # if __riscv_xlen == 64
00104 #  define L4_ARCH_EI_CLASS     ELFCLASS64
00105 # else
00106 #  define L4_ARCH_EI_CLASS     ELFCLASS32
00107 # endif
00108 #else
00109 # warning elf.h: Unsupported build architecture!
00110 #endif
00111
00112
00114
00116
```

```
00117 enum
00118 {
00119   EI_NIDENT             = 16,
00120 };
00121
00125 typedef struct
00126 {
00127   unsigned char e_ident[EI_NIDENT];
00128   Elf32_Half    e_type;
00129   Elf32_Half    e_machine;
00130   Elf32_Word    e_version;
00131   Elf32_Addr    e_entry;
00132   Elf32_Off     e_phoff;
00133   Elf32_Off     e_shoff;
00134   Elf32_Word    e_flags;
00135   Elf32_Half    e_ehsize;
00136   Elf32_Half    e_phentsize;
00137   Elf32_Half    e_phnum;
00138   Elf32_Half    e_shentsize;
00139   Elf32_Half    e_shnum;
00140   Elf32_Half    e_shstrndx;
00141 } Elf32_Ehdr;
00142
00146 typedef struct
00147 {
00148   unsigned char e_ident[EI_NIDENT];
00149   Elf64_Half     e_type;
00150   Elf64_Half     e_machine;
00151   Elf64_Word     e_version;
00152   Elf64_Addr     e_entry;
00153   Elf64_Off      e_phoff;
00154   Elf64_Off      e_shoff;
00155   Elf64_Word     e_flags;
00156   Elf64_Half     e_ehsize;
00157   Elf64_Half     e_phentsize;
00158   Elf64_Half     e_phnum;
00159   Elf64_Half     e_shentsize;
00160   Elf64_Half     e_shnum;
00161   Elf64_Half     e_shstrndx;
00162 } Elf64_Ehdr;
00163
00168 enum Elf_ETs
00169 {
00170   ET_NONE               = 0,
00171   ET_REL                = 1,
00172   ET_EXEC               = 2,
00173   ET_DYN                = 3,
00174   ET_CORE               = 4,
00175   ET_LOPROC             = 0xff00,
00176   ET_HIPROC             = 0xffff,
00177 };
00178
00183 enum Elf_EMs
00184 {
00185   EM_NONE               = 0,
00186   EM_M32                = 1,
00187   EM_SPARC              = 2,
00188   EM_386                = 3,
00189   EM_68K                = 4,
00190   EM_88K                = 5,
00191   EM_860                = 7,
00192   EM_MIPS               = 8,
00193   EM_MIPS_RS4_BE        = 10,
00194   EM_SPARC64            = 11,
00195   EM_PARISC             = 15,
00196   EM_VPP500             = 17,
00197   EM_SPARC32PLUS        = 18,
00198   EM_960                = 19,
00199   EM_PPC                = 20,
00200   EM_V800               = 36,
00201   EM_FR20               = 37,
00202   EM_RH32               = 38,
00203   EM_RCE                = 39,
00204   EM_ARM                = 40,
00205   EM_ALPHA              = 41,
00206   EM_SH                 = 42,
00207   EM_SPARCV9            = 43,
00208   EM_TRICORE            = 44,
00209   EM_ARC                = 45,
00210   EM_H8_300             = 46,
00211   EM_H8_300H            = 47,
00212   EM_H8S                = 48,
00213   EM_H8_500             = 49,
00214   EM_IA_64              = 50,
00215   EM_MIPS_X             = 51,
00216   EM_COLDFIRE           = 52,
00217   EM_68HC12             = 53,
```

```
00218   EM_X86_64             = 62,
00219   EM_PDSP               = 63,
00220   EM_FX66               = 66,
00221   EM_ST9PLUS            = 67,
00222   EM_ST7                = 68,
00223   EM_68HC16             = 69,
00224   EM_68HC11             = 70,
00225   EM_68HC08             = 71,
00226   EM_68HC05             = 72,
00227   EM_SVX                = 73,
00228   EM_ST19               = 74,
00229   EM_VAX                = 75,
00230   EM_CRIS               = 76,
00231   EM_JAVELIN            = 77,
00232   EM_FIREPATH           = 78,
00233   EM_ZSP                = 79,
00234   EM_MMIX               = 80,
00235   EM_HUANY              = 81,
00236   EM_PRISM              = 82,
00237   EM_AVR                = 83,
00238   EM_FR30               = 84,
00239   EM_D10V               = 85,
00240   EM_D30V               = 86,
00241   EM_V850               = 87,
00242   EM_M32R               = 88,
00243   EM_MN10300            = 89,
00244   EM_MN10200            = 90,
00245   EM_PJ                 = 91,
00246   EM_OPENRISC           = 92,
00247   EM_ARC_A5             = 93,
00248   EM_XTENSA             = 94,
00249   EM_ALTERA_NIOS2       = 113,
00250   EM_AARCH64            = 183,
00251   EM_TILEPRO            = 188,
00252   EM_MICROBLAZE         = 189,
00253   EM_TILEGX             = 191,
00254   EM_RISCV              = 243,
00255   EM_NUM                = 244,
00256 };
00257
00258 #if 0
00259 #define EM_ALPHA        0x9026  /* interium value used by Linux until the
00260                                    committee comes up with a final number */
00261 #define EM_S390         0xA390  /* interium value used for IBM S390 */
00262 #endif
00263
00266 enum Elf_EVs
00267 {
00268   EV_NONE               = 0,
00269   EV_CURRENT            = 1,
00270 };
00271
00274 enum Elf_EIs
00275 {
00276   EI_MAG0               = 0,
00277   EI_MAG1               = 1,
00278   EI_MAG2               = 2,
00279   EI_MAG3               = 3,
00280   EI_CLASS              = 4,
00281   EI_DATA               = 5,
00282   EI_VERSION            = 6,
00283   EI_OSABI              = 7,
00284   EI_ABIVERSION         = 8,
00285   EI_PAD                = 9,
00286 };
00287
00289 enum Elf_MAGs
00290 {
00291   ELFMAG0               = 0x7f,
00292   ELFMAG1               = 'E',
00293   ELFMAG2               = 'L',
00294   ELFMAG3               = 'F',
00295 };
00296
00298 enum Elf_ClASSs
00299 {
00300   ELFCLASSNONE          = 0,
00301   ELFCLASS32            = 1,
00302   ELFCLASS64            = 2,
00303   ELFCLASSNUM           = 3,
00304 };
00305
00307 enum Elf_DATAs
00308 {
00309   ELFDATANONE           = 0,
00310   ELFDATA2LSB           = 1,
00311   ELFDATA2MSB           = 2,
```

```
00312   ELFDATANUM            = 3,
00313 };
00314
00316 enum Elf_OSABIs
00317 {
00318   ELFOSABI_NONE         = 0,
00319   ELFOSABI_SYSV         = 0,
00320   ELFOSABI_HPUX         = 1,
00321   ELFOSABI_NETBSD       = 2,
00322   ELFOSABI_LINUX        = 3,
00323   ELFOSABI_SOLARIS      = 6,
00324   ELFOSABI_AIX          = 7,
00325   ELFOSABI_IRIX         = 8,
00326   ELFOSABI_FREEBSD      = 9,
00327   ELFOSABI_TRU64        = 10,
00328   ELFOSABI_MODESTO      = 11,
00329   ELFOSABI_OPENBSD      = 12,
00330   ELFOSABI_ARM          = 97,
00331   ELFOSABI_STANDALONE   = 255,
00332 };
00333
00335 enum Elf_SHNs
00336 {
00337   SHN_UNDEF             = 0,
00338   SHN_LORESERVE         = 0xff00,
00339   SHN_LOPROC            = 0xff00,
00340   SHN_HIPROC            = 0xff1f,
00341   SHN_ABS               = 0xfff1,
00342   SHN_COMMON            = 0xfff2,
00343   SHN_HIRESERVE         = 0xffff,
00344 };
00345
00347 typedef struct
00348 {
00349   Elf32_Word            sh_name;
00350   Elf32_Word            sh_type;
00351   Elf32_Word            sh_flags;
00352   Elf32_Addr            sh_addr;
00353   Elf32_Off             sh_offset;
00354   Elf32_Word            sh_size;
00355   Elf32_Word            sh_link;
00356   Elf32_Word            sh_info;
00357   Elf32_Word            sh_addralign;
00358   Elf32_Word            sh_entsize;
00359 } Elf32_Shdr;
00360
00362 typedef struct
00363 {
00364   Elf64_Word            sh_name;
00365   Elf64_Word            sh_type;
00366   Elf64_Xword           sh_flags;
00367   Elf64_Addr            sh_addr;
00368   Elf64_Off             sh_offset;
00369   Elf64_Xword           sh_size;
00370   Elf64_Word            sh_link;
00371   Elf64_Word            sh_info;
00372   Elf64_Xword           sh_addralign;
00373   Elf64_Xword           sh_entsize;
00374 } Elf64_Shdr;
00375
00377 enum Elf_SHTs
00378 {
00379   SHT_NULL              = 0,
00380   SHT_PROGBITS          = 1,
00381   SHT_SYMTAB            = 2,
00382   SHT_STRTAB            = 3,
00383   SHT_RELA              = 4,
00384   SHT_HASH              = 5,
00385   SHT_DYNAMIC           = 6,
00386   SHT_NOTE              = 7,
00387   SHT_NOBITS            = 8,
00388   SHT_REL               = 9,
00389   SHT_SHLIB             = 10,
00390   SHT_DYNSYM            = 11,
00391   SHT_INIT_ARRAY        = 14,
00392   SHT_FINI_ARRAY        = 15,
00393   SHT_PREINIT_ARRAY     = 16,
00394   SHT_GROUP             = 17,
00395   SHT_SYMTAB_SHNDX      = 18,
00396   SHT_NUM               = 19,
00397   SHT_LOOS              = 0x60000000,
00398   SHT_HIOS              = 0x6fffffff,
00399   SHT_LOPROC            = 0x70000000,
00400   SHT_HIPROC            = 0x7fffffff,
00401   SHT_LOUSER            = 0x80000000,
00402   SHT_HIUSER            = 0xffffffff,
00403 };
```

```
00404
00406 enum Elf_SHFs
00407 {
00408   SHF_WRITE             = 0x1,
00409   SHF_ALLOC             = 0x2,
00410   SHF_EXECINSTR         = 0x4,
00411   SHF_MERGE             = 0x10,
00412   SHF_STRINGS           = 0x20,
00413   SHF_INFO_LINK         = 0x40,
00414   SHF_LINK_ORDER        = 0x80,
00415   SHF_OS_NONCONFORMING  = 0x100,
00417   SHF_GROUP             = 0x200,
00418   SHF_TLS               = 0x400,
00419   SHF_MASKOS            = 0x0ff00000,
00420   SHF_MASKPROC          = 0xf0000000,
00421 };
00422
00423
00425 typedef struct
00426 {
00427   Elf32_Word    p_type;
00428   Elf32_Off     p_offset;
00429   Elf32_Addr    p_vaddr;
00430   Elf32_Addr    p_paddr;
00431   Elf32_Word    p_filesz;
00432   Elf32_Word    p_memsz;
00433   Elf32_Word    p_flags;
00434   Elf32_Word    p_align;
00435 } Elf32_Phdr;
00436
00438 typedef struct
00439 {
00440   Elf64_Word    p_type;
00441   Elf64_Word    p_flags;
00442   Elf64_Off     p_offset;
00443   Elf64_Addr    p_vaddr;
00444   Elf64_Addr    p_paddr;
00445   Elf64_Xword   p_filesz;
00446   Elf64_Xword   p_memsz;
00447   Elf64_Xword   p_align;
00448 } Elf64_Phdr;
00449
00451 enum Elf_PTs
00452 {
00453   PT_NULL               = 0,
00454   PT_LOAD               = 1,
00455   PT_DYNAMIC            = 2,
00456   PT_INTERP             = 3,
00457   PT_NOTE               = 4,
00458   PT_SHLIB              = 5,
00459   PT_PHDR               = 6,
00460   PT_TLS                = 7,
00461   PT_NUM                = 8,
00462   PT_LOOS               = 0x60000000,
00463   PT_HIOS               = 0x6fffffff,
00464   PT_LOPROC             = 0x70000000,
00465   PT_HIPROC             = 0x7fffffff,
00466
00467   PT_GNU_EH_FRAME       = PT_LOOS + 0x474e550,
00468   PT_GNU_STACK          = PT_LOOS + 0x474e551,
00469   PT_GNU_RELRO          = PT_LOOS + 0x474e552,
00470
00471   PT_L4_STACK           = PT_LOOS + 0x12,
00472   PT_L4_AUX             = PT_LOOS + 0x14,
00473 };
00474
00476 enum ELF_PFs
00477 {
00478   PF_X                  = 0x1,
00479   PF_W                  = 0x2,
00480   PF_R                  = 0x4,
00481   PF_MASKOS             = 0x0ff00000,
00482   PF_MASKPROC           = 0x7fffffff,
00483 };
00484
00486 enum Elf_NTs_core
00487 {
00488   NT_PRSTATUS           = 1,
00489   NT_FPREGSET           = 2,
00490   NT_PRPSINFO           = 3,
00491   NT_PRXREG             = 4,
00492   NT_TASKSTRUCT         = 4,
00493   NT_PLATFORM           = 5,
00494   NT_AUXV               = 6,
00495   NT_GWINDOWS           = 7,
00496   NT_ASRS               = 8,
00497   NT_PSTATUS            = 10,
```

```
00498   NT_PSINFO             = 13,
00499   NT_PRCRED             = 14,
00500   NT_UTSNAME            = 15,
00501   NT_LWPSTATUS          = 16,
00502   NT_LWPSINFO           = 17,
00503   NT_PRFPXREG           = 20,
00504 };
00505
00507 enum Elf_NTs_obj
00508 {
00509   NT_VERSION            = 1,
00510 };
00511
00513 typedef struct
00514 {
00515   Elf32_Sword   d_tag;
00516   union
00517   {
00518     Elf32_Word  d_val;
00519     Elf32_Addr  d_ptr;
00520   } d_un;
00521 } Elf32_Dyn;
00522
00524 typedef struct
00525 {
00526   Elf64_Sxword  d_tag;
00527   union
00528   {
00529     Elf64_Xword d_val;
00530     Elf64_Addr  d_ptr;
00531   } d_un;
00532 } Elf64_Dyn;
00533
00535 enum Elf_DTs
00536 {
00537   DT_NULL               = 0,
00538   DT_NEEDED             = 1,
00539   DT_PLTRELSZ           = 2,
00540   DT_PLTGOT             = 3,
00541   DT_HASH               = 4,
00542   DT_STRTAB             = 5,
00543   DT_SYMTAB             = 6,
00544   DT_RELA               = 7,
00545   DT_RELASZ             = 8,
00546   DT_RELAENT            = 9,
00547   DT_STRSZ              = 10,
00548   DT_SYMENT             = 11,
00549   DT_INIT               = 12,
00550   DT_FINI               = 13,
00551   DT_SONAME             = 14,
00552   DT_RPATH              = 15,
00553   DT_SYMBOLIC           = 16,
00554   DT_REL                = 17,
00555   DT_RELSZ              = 18,
00556   DT_RELENT             = 19,
00557   DT_PTRREL             = 20,
00558   DT_DEBUG              = 21,
00559   DT_TEXTREL            = 22,
00560   DT_JMPREL             = 23,
00561   DT_BIND_NOW           = 24,
00562   DT_INIT_ARRAY         = 25,
00563   DT_FINI_ARRAY         = 26,
00564   DT_INIT_ARRAYSZ       = 27,
00565   DT_FINI_ARRAYSZ       = 28,
00566   DT_RUNPATH            = 29,
00567   DT_FLAGS              = 30,
00568   DT_ENCODING           = 32,
00569   DT_PREINIT_ARRAY      = 32,
00570   DT_PREINIT_ARRAYSZ    = 33,
00571   DT_NUM                = 34,
00572   DT_LOOS               = 0x6000000d,
00573   DT_HIOS               = 0x6ffff000,
00574   DT_LOPROC             = 0x70000000,
00575   DT_HIPROC             = 0x7fffffff,
00576 };
00577
00581 enum Elf_DFs
00582 {
00583   DF_ORIGIN             = 0x00000001,
00584   DF_SYMBOLIC           = 0x00000002,
00585   DF_TEXTREL            = 0x00000004,
00586   DF_BIND_NOW           = 0x00000008,
00587   DF_STATIC_TLS         = 0x00000010,
00588 };
00589
00594 enum Elf_DF_1s
00595 {
```

```
00596   DF_1_NOW              = 0x00000001,
00597   DF_1_GLOBAL           = 0x00000002,
00598   DF_1_GROUP            = 0x00000004,
00599   DF_1_NODELETE         = 0x00000008,
00600   DF_1_LOADFLTR         = 0x00000010,
00601   DF_1_INITFIRST        = 0x00000020,
00602   DF_1_NOOPEN           = 0x00000040,
00603   DF_1_ORIGIN           = 0x00000080,
00604   DF_1_DIRECT           = 0x00000100,
00605   DF_1_TRANS            = 0x00000200,
00606   DF_1_INTERPOSE        = 0x00000400,
00607   DF_1_NODEFLIB         = 0x00000800,
00608   DF_1_NODUMP           = 0x00001000,
00609   DF_1_CONFALT          = 0x00002000,
00610   DF_1_ENDFILTEE        = 0x00004000,
00611   DF_1_DISPRELDNE       = 0x00008000,
00612   DF_1_DISPRELPND       = 0x00010000,
00613 };
00614
00616 enum Elf_DTF_1s
00617 {
00618   DTF_1_PARINIT         = 0x00000001,
00619   DTF_1_CONFEXP         = 0x00000002,
00620 };
00621
00623 enum Elf_DF_P1s
00624 {
00625   DF_P1_LAZYLOAD        = 0x00000001,
00626   DF_P1_GROUPPERM       = 0x00000002,
00628 };
00629
00631 typedef struct
00632 {
00633   Elf32_Addr          r_offset;
00634   Elf32_Word          r_info;
00635 } Elf32_Rel;
00636
00638 typedef struct
00639 {
00640   Elf32_Addr          r_offset;
00641   Elf32_Word          r_info;
00642   Elf32_Sword         r_addend;
00643 } Elf32_Rela;
00644
00646 typedef struct
00647 {
00648   Elf64_Addr          r_offset;
00649   Elf64_Xword         r_info;
00650 } Elf64_Rel;
00651
00653 typedef struct
00654 {
00655   Elf64_Addr          r_offset;
00656   Elf64_Xword         r_info;
00657   Elf64_Sxword        r_addend;
00658 } Elf64_Rela;
00659
00661 #define ELF32_R_SYM(i)    ((i)»8)
00663 #define ELF32_R_TYPE(i)   ((unsigned char)(i))
00665 #define ELF32_R_INFO(s,t) (((s)«8)+(unsigned char)(t))
00666
00668 #define ELF64_R_SYM(i)    ((i)»32)
00669
00671 #define ELF64_R_TYPE(i)   ((i)&0xffffffffL)
00672
00674 #define ELF64_R_INFO(s,t) (((s)«32)+(t)&0xffffffffL)
00675
00677 enum Elf_R_386_s
00678 {
00679  R_386_NONE             = 0,
00680  R_386_32               = 1,
00681  R_386_PC32             = 2,
00682  R_386_GOT32            = 3,
00683  R_386_PLT32            = 4,
00684  R_386_COPY             = 5,
00685  R_386_GLOB_DAT         = 6,
00686  R_386_JMP_SLOT         = 7,
00687  R_386_RELATIVE         = 8,
00688  R_386_GOTOFF           = 9,
00689  R_386_GOTPC            = 10,
00690  R_386_32PLT            = 11,
00691  R_386_TLS_TPOFF        = 14,
00692  R_386_TLS_IE           = 15,
00694  R_386_TLS_GOTIE        = 16,
00695  R_386_TLS_LE           = 17,
00696  R_386_TLS_GD           = 18,
00698  R_386_TLS_LDM          = 19,
```

```
00700   R_386_16                = 20,
00701   R_386_PC16              = 21,
00702   R_386_8                 = 22,
00703   R_386_PC8               = 23,
00704   R_386_TLS_GD_32         = 24,
00706   R_386_TLS_GD_PUSH       = 25,
00707   R_386_TLS_GD_CALL       = 26,
00709   R_386_TLS_GD_POP        = 27,
00710   R_386_TLS_LDM_32        = 28,
00712   R_386_TLS_LDM_PUSH      = 29,
00713   R_386_TLS_LDM_CALL      = 30,
00715   R_386_TLS_LDM_POP       = 31,
00716   R_386_TLS_LDO_32        = 32,
00717   R_386_TLS_IE_32         = 33,
00719   R_386_TLS_LE_32         = 34,
00721   R_386_TLS_DTPMOD32      = 35,
00722   R_386_TLS_DTPOFF32      = 36,
00723   R_386_TLS_TPOFF32       = 37,
00724   R_386_NUM               = 38,
00725 };
00726
00728
00730 enum Elf_EF_ARM_s
00731 {
00732   EF_ARM_RELEXEC          = 0x01,
00733   EF_ARM_HASENTRY         = 0x02,
00734   EF_ARM_INTERWORK        = 0x04,
00735   EF_ARM_APCS_26          = 0x08,
00736   EF_ARM_APCS_FLOAT       = 0x10,
00737   EF_ARM_PIC              = 0x20,
00738   EF_ARM_ALIGN8           = 0x40,
00739   EF_ARM_NEW_ABI          = 0x80,
00740   EF_ARM_OLD_ABI          = 0x100,
00741
00742 /* Other constants defined in the ARM ELF spec. version B-01.  */
00743 /* NB. These conflict with values defined above.  */
00744   EF_ARM_SYMSARESORTED    = 0x04,
00745   EF_ARM_DYNSYMSUSESEGIDX = 0x08,
00746   EF_ARM_MAPSYMSFIRST     = 0x10,
00747   EF_ARM_EABIMASK         = 0XFF000000,
00748
00749 #define EF_ARM_EABI_VERSION(flags) ((flags) & EF_ARM_EABIMASK)
00750   EF_ARM_EABI_UNKNOWN     = 0x00000000,
00751   EF_ARM_EABI_VER1        = 0x01000000,
00752   EF_ARM_EABI_VER2        = 0x02000000,
00753 };
00754
00756 enum Elf_STT_ARM_s
00757 {
00758   STT_ARM_TFUNC           = 0xd,
00759 };
00760
00762 enum Elf_SHF_s_ARM
00763 {
00764   SHF_ARM_ENTRYSECT       = 0x10000000,
00765   SHF_ARM_COMDEF          = 0x80000000,
00767 };
00768
00770 enum Elf_ARM_SBs
00771 {
00772   PF_ARM_SB               = 0x10000000,
00774 };
00775
00777 enum Elf_R_ARM_s
00778 {
00779   R_ARM_NONE              = 0,
00780   R_ARM_PC24              = 1,
00781   R_ARM_ABS32             = 2,
00782   R_ARM_REL32             = 3,
00783   R_ARM_PC13              = 4,
00784   R_ARM_ABS16             = 5,
00785   R_ARM_ABS12             = 6,
00786   R_ARM_THM_ABS5          = 7,
00787   R_ARM_ABS8              = 8,
00788   R_ARM_SBREL32           = 9,
00789   R_ARM_THM_PC22          = 10,
00790   R_ARM_THM_PC8           = 11,
00791   R_ARM_AMP_VCALL9        = 12,
00792   R_ARM_SWI24             = 13,
00793   R_ARM_THM_SWI8          = 14,
00794   R_ARM_XPC25             = 15,
00795   R_ARM_THM_XPC22         = 16,
00796   R_ARM_COPY              = 20,
00797   R_ARM_GLOB_DAT          = 21,
00798   R_ARM_JUMP_SLOT         = 22,
00799   R_ARM_RELATIVE          = 23,
00800   R_ARM_GOTOFF            = 24,
```

```
00801   R_ARM_GOTPC           = 25,
00802   R_ARM_GOT32           = 26,
00803   R_ARM_PLT32           = 27,
00804   R_ARM_ALU_PCREL_7_0   = 32,
00805   R_ARM_ALU_PCREL_15_8  = 33,
00806   R_ARM_ALU_PCREL_23_15 = 34,
00807   R_ARM_LDR_SBREL_11_0  = 35,
00808   R_ARM_ALU_SBREL_19_12 = 36,
00809   R_ARM_ALU_SBREL_27_20 = 37,
00810   R_ARM_GNU_VTENTRY     = 100,
00811   R_ARM_GNU_VTINHERIT   = 101,
00812   R_ARM_THM_PC11        = 102,
00813   R_ARM_THM_PC9         = 103,
00814   R_ARM_RXPC25          = 249,
00815   R_ARM_RSBREL32        = 250,
00816   R_ARM_THM_RPC22       = 251,
00817   R_ARM_RREL32          = 252,
00818   R_ARM_RABS22          = 253,
00819   R_ARM_RPC24           = 254,
00820   R_ARM_RBASE           = 255,
00821   R_ARM_NUM             = 256,
00822 };
00823
00825 enum Elf_R_AARCH64_s
00826 {
00827   R_AARCH64_NONE        = 0,
00828   R_AARCH64_RELATIVE    = 1027,
00829 };
00830
00832 enum Elf_R_X86_64_s
00833 {
00834   R_X86_64_NONE         = 0,
00835   R_X86_64_64           = 1,
00836   R_X86_64_PC32         = 2,
00837   R_X86_64_GOT32        = 3,
00838   R_X86_64_PLT32        = 4,
00839   R_X86_64_COPY         = 5,
00840   R_X86_64_GLOB_DAT     = 6,
00841   R_X86_64_JUMP_SLOT    = 7,
00842   R_X86_64_RELATIVE     = 8,
00843   R_X86_64_GOTPCREL     = 9,
00844   R_X86_64_32           = 10,
00845   R_X86_64_32S          = 11,
00846   R_X86_64_16           = 12,
00847   R_X86_64_PC16         = 13,
00848   R_X86_64_8            = 14,
00849   R_X86_64_PC8          = 15,
00850   R_X86_64_DTPMOD64     = 16,
00851   R_X86_64_DTPOFF64     = 17,
00852   R_X86_64_TPOFF64      = 18,
00853   R_X86_64_TLSGD        = 19,
00855   R_X86_64_TLSLD        = 20,
00857   R_X86_64_DTPOFF32     = 21,
00858   R_X86_64_GOTTPOFF     = 22,
00860   R_X86_64_TPOFF32      = 23,
00861   R_X86_64_NUM          = 24,
00862 };
00863
00865 enum Elf_STNs
00866 {
00867   STN_UNDEF             = 0,
00868 };
00869
00871 typedef struct
00872 {
00873   Elf32_Word            st_name;
00874   Elf32_Addr            st_value;
00875   Elf32_Word            st_size;
00876   unsigned char         st_info;
00877   unsigned char         st_other;
00878   Elf32_Half            st_shndx;
00879 } Elf32_Sym;
00880
00882 typedef struct
00883 {
00884   Elf64_Word            st_name;
00885   unsigned char         st_info;
00886   unsigned char         st_other;
00887   Elf64_Half            st_shndx;
00888   Elf64_Addr            st_value;
00889   Elf64_Xword           st_size;
00890 } Elf64_Sym;
00891
00893 #define ELF32_ST_BIND(i)    ((i)»4)
00894
00896 #define ELF32_ST_TYPE(i)    ((i)&0xf)
00897
```

```
00899 #define ELF32_ST_INFO(b,t)   (((b)«4)+((t)&0xf))
00900
00902 #define ELF64_ST_BIND(i)     ((i)»4)
00903
00905 #define ELF64_ST_TYPE(i)     ((i)&0xf)
00906
00908 #define ELF64_ST_INFO(b,t)   (((b)«4)+((t)&0xf))
00909
00912 enum Elf_STBs
00913 {
00914   STB_LOCAL      = 0,
00915   STB_GLOBAL     = 1,
00916   STB_WEAK       = 2,
00917   STB_LOOS       = 10,
00918   STB_HIOS       = 12,
00919   STB_LOPROC     = 13,
00920   STB_HIPROC     = 15,
00921 };
00922
00925 enum Elf_STTs
00926 {
00927   STT_NOTYPE     = 0,
00928   STT_OBJECT     = 1,
00929   STT_FUNC       = 2,
00930   STT_SECTION    = 3,
00931   STT_FILE       = 4,
00932   STT_LOOS       = 10,
00933   STT_HIOS       = 12,
00934   STT_LOPROC     = 13,
00935   STT_HIPROC     = 15,
00936 };
00937
00939 enum Elf_ATs
00940 {
00941   AT_NULL         = 0,
00942   AT_IGNORE       = 1,
00943   AT_EXECFD       = 2,
00944   AT_PHDR         = 3,
00945   AT_PHENT        = 4,
00946   AT_PHNUM        = 5,
00947   AT_PAGESZ       = 6,
00948   AT_BASE         = 7,
00949   AT_FLAGS        = 8,
00950   AT_ENTRY        = 9,
00951   AT_NOTELF       = 10,
00952   AT_UID          = 11,
00953   AT_EUID         = 12,
00954   AT_GID          = 13,
00955   AT_EGID         = 14,
00956
00957   AT_L4_AUX       = 0xf0,
00958   AT_L4_ENV       = 0xf1,
00959   AT_L4_KIP       = 0xf2,
00960 };
00961
00963 typedef struct Elf32_Auxv
00964 {
00965   Elf32_Word atype;
00966   Elf32_Word avalue;
00967 } Elf32_Auxv;
00968
00970 typedef struct Elf64_Auxv
00971 {
00972   Elf64_Word atype;
00973   Elf64_Word avalue;
00974 } Elf64_Auxv;
00975
00976 typedef struct
00977 {
00978   Elf32_Word n_namesz;
00979   Elf32_Word n_descsz;
00980   Elf32_Word n_type;
00981 } Elf32_Nhdr;
00982
00983 typedef struct
00984 {
00985   Elf64_Word n_namesz;
00986   Elf64_Word n_descsz;
00987   Elf64_Word n_type;
00988 } Elf64_Nhdr;
00989
00997 static inline int l4util_elf_check_magic(ElfW(Ehdr) const *hdr);
00998
01006 static inline int l4util_elf_check_arch(ElfW(Ehdr) const *hdr);
01007
01014 static inline ElfW(Phdr) *l4util_elf_phdr(ElfW(Ehdr) const *hdr);
01015
```

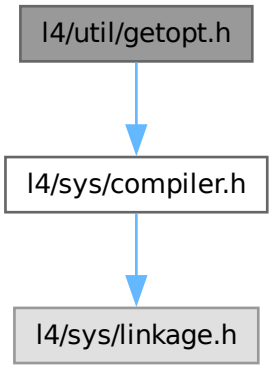
```
01016
01017 /* Implementations */
01018
01019 static inline
01020 int l4util_elf_check_magic(ElfW(Ehdr) const *hdr)
01021 {
01022   return    hdr->e_ident[EI_MAG0] == ELFMAG0
01023          && hdr->e_ident[EI_MAG1] == ELFMAG1
01024          && hdr->e_ident[EI_MAG2] == ELFMAG2
01025          && hdr->e_ident[EI_MAG3] == ELFMAG3;
01026 }
01027
01028 static inline
01029 int l4util_elf_check_arch(ElfW(Ehdr) const *hdr)
01030 {
01031   return    hdr->e_ident[EI_CLASS] == L4_ARCH_EI_CLASS
01032          && hdr->e_ident[EI_DATA]  == L4_ARCH_EI_DATA
01033          && hdr->e_machine         == L4_ARCH_E_MACHINE;
01034 }
01035
01036 static inline
01037 ElfW(Phdr) *l4util_elf_phdr(ElfW(Ehdr) const *hdr)
01038 {
01039   return (ElfW(Phdr) *)((char *)hdr + hdr->e_phoff);
01040 }
```

16.661 l4/util/getopt.h File Reference

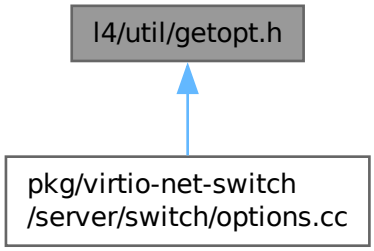
getopt

`#include <l4/sys/compiler.h>`

Include dependency graph for getopt.h:



This graph shows which files directly or indirectly include this file:



16.661.1 Detailed Description

getopt
Definition in file getopt.h.

16.662 getopt.h

Go to the documentation of this file.

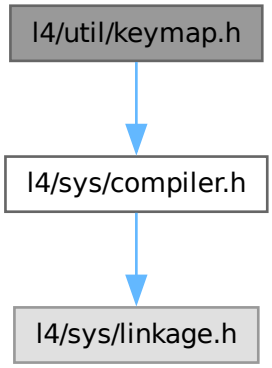
```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #ifndef _GETOPT_H
00012 #define _GETOPT_H
00013
00014 #ifndef NULL
00015 #define NULL 0
00016 #endif
00017
00018 #include <l4/sys/compiler.h>
00019
00020 L4_BEGIN_DECLS
00021
00022 /* For communication from `getopt' to the caller.
00023    When `getopt' finds an option that takes an argument,
00024    the argument value is returned here.
00025    Also, when `ordering' is RETURN_IN_ORDER,
00026    each non-option ARGV-element is returned here.  */
00027
00028 extern char *optarg;
00029
00030 /* Index in ARGV of the next element to be scanned.
00031    This is used for communication to and from the caller
00032    and for communication between successive calls to `getopt'.
00033
00034    On entry to `getopt', zero means this is the first call; initialize.
00035
00036    When `getopt' returns -1, this is the index of the first of the
00037    non-option elements that the caller should itself scan.
00038
00039    Otherwise, `optind' communicates from one call to the next
00040    how much of ARGV has been scanned so far.  */
00041
00042 extern int optind;
00043
00044 /* Callers store zero here to inhibit the error message `getopt' prints
00045    for unrecognized options.  */
00046
00047 extern int opterr;
00048
00049 /* Set to an option character which was unrecognized.  */
00050
```

```
00051 extern int optopt;
00052
00053 /* Describe the long-named options requested by the application.
00054    The LONG_OPTIONS argument to getopt_long or getopt_long_only is a vector
00055    of `struct option' terminated by an element containing a name which is
00056    zero.
00057
00058    The field `has_arg' is:
00059    no_argument    (or 0) if the option does not take an argument,
00060    required_argument  (or 1) if the option requires an argument,
00061    optional_argument  (or 2) if the option takes an optional argument.
00062
00063    If the field `flag' is not NULL, it points to a variable that is set
00064    to the value given in the field `val' when the option is found, but
00065    left unchanged if the option is not found.
00066
00067    To have a long-named option do something other than set an `int' to
00068    a compiled-in constant, such as set a value from `optarg', set the
00069    option's `flag' field to zero and its `val' field to a nonzero
00070    value (the equivalent single-letter option character, if there is
00071    one).  For long options that have a zero `flag' field, `getopt'
00072    returns the contents of the `val' field.  */
00073
00074 struct option
00075 {
00076   const char *name;
00077   /* has_arg can't be an enum because some compilers complain about
00078      type mismatches in all the code that assumes it is an int.  */
00079   int has_arg;
00080   int *flag;
00081   int val;
00082 };
00083
00084 /* Names for the values of the `has_arg' field of `struct option'.  */
00085
00086 #define no_argument   0
00087 #define required_argument 1
00088 #define optional_argument 2
00089
00090 L4_CV int getopt (int argc, char *const *argv, const char *shortopts);
00091
00092 L4_CV int getopt_long (int argc, char *const *argv, const char *shortopts,
00093            const struct option *longopts, int *longind);
00094 L4_CV int getopt_long_only (int argc, char *const *argv,
00095           const char *shortopts,
00096                 const struct option *longopts, int *longind);
00097
00098 L4_CV int _getopt_internal (int argc, char *const *argv,
00099           const char *shortopts,
00100                 const struct option *longopts, int *longind,
00101           int long_only);
00102
00103 L4_END_DECLS
00104
00105 #endif /* _GETOPT_H */
```

16.663 l4/util/keymap.h File Reference

Event to ASCII key mapping.

`#include <l4/sys/compiler.h>`
Include dependency graph for keymap.h:



16.663.1 Detailed Description

Event to ASCII key mapping.
Definition in file keymap.h.

16.664 keymap.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #ifndef __L4UTIL__KEYMAP_H__
00011 #define __L4UTIL__KEYMAP_H__
00012
00013 #include <l4/sys/compiler.h>
00014
00015 L4_BEGIN_DECLS
00016
00017 int l4util_map_event_to_keymap(unsigned value, unsigned shift);
00018
00019 L4_END_DECLS
00020
00021
00022 #endif /* __L4UTIL__KEYMAP_H__ */
```

16.665 kip.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.666 kip.h

```
00001 /*
```

```
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.667 kip.h

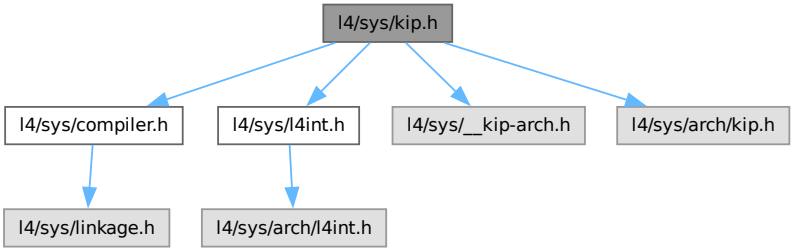
```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.668 l4/sys/kip.h File Reference

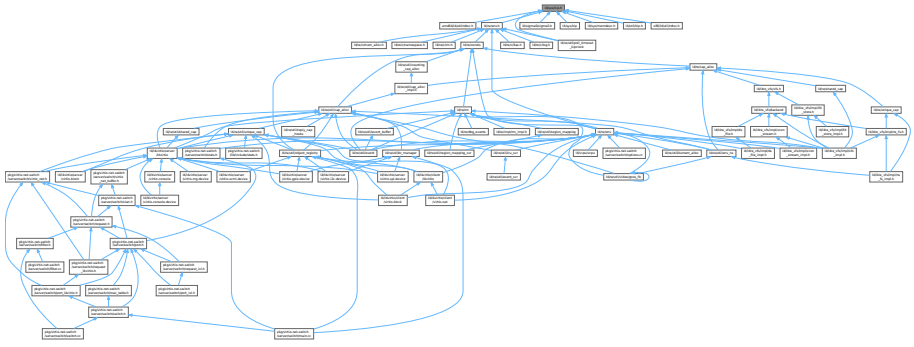
Kernel Info Page access functions.

```
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
#include <l4/sys/__kip-arch.h>
#include <l4/sys/arch/kip.h>
```

Include dependency graph for kip.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4_kernel_info_t

  L4 Kernel Interface Page.

Macros

- #define **L4_KERNEL_INFO_MAGIC** (0x4BE6344CL) /* "L4µK" */

  Kernel Info Page identifier ("L4µK").
- #define l4_kip_for_each_feature(s)

  Cycle through kernel features given in the KIP.

Typedefs

- typedef struct l4_kernel_info_t l4_kernel_info_t

  L4 Kernel Interface Page.

Enumerations

- enum { L4_KIP_OFFS_READ_US = 0x900 , L4_KIP_OFFS_READ_NS = 0x980 }

Functions

- l4_kernel_info_t const * l4_kip (void) L4_NOTHROW

  Get Kernel Info Page.
- l4_umword_t l4_kip_version (l4_kernel_info_t const *kip) L4_NOTHROW

  Get the kernel version.
- const char * l4_kip_version_string (l4_kernel_info_t const *kip) L4_NOTHROW

  Get the kernel version string.
- int l4_kernel_info_version_offset (l4_kernel_info_t const *kip) L4_NOTHROW

  Return offset in bytes of version_strings relative to the KIP base.
- l4_cpu_time_t l4_kip_clock (l4_kernel_info_t const *kip) L4_NOTHROW

  Return clock value from the KIP.
- l4_umword_t l4_kip_clock_lw (l4_kernel_info_t const *kip) L4_NOTHROW

  Return least significant machine word of clock value from the KIP.
- l4_uint64_t l4_kip_clock_ns (l4_kernel_info_t const *kip) L4_NOTHROW

  Return current clock using the KIP in nanoseconds.
- int l4_kip_kernel_has_feature (l4_kernel_info_t const *kip, char const *str)

  Check if kernel supports a feature.

16.668.1 Detailed Description

Kernel Info Page access functions.
Definition in file kip.h.

16.668.2 Macro Definition Documentation

16.668.2.1 l4_kip_for_each_feature

```
#define l4_kip_for_each_feature(
            s)
```

Value:

```
for (s += __builtin_strlen(s) + 1; *s; s += __builtin_strlen(s) + 1)
```

Cycle through kernel features given in the KIP.
Cycles through all KIP kernel feature strings. `s` must be a character pointer (`char const *`) initialized with l4_kip_version_string().
Definition at line 272 of file kip.h.
Referenced by l4_kip_kernel_has_feature().

16.668.3 Function Documentation

16.668.3.1 l4_kip_kernel_has_feature()

```
int l4_kip_kernel_has_feature (
             l4_kernel_info_t const * kip,
             char const * str)  [inline]
```

Check if kernel supports a feature.

Parameters

kip	Pointer to the kernel info page (KIP).
str	Feature name to check.

Returns

1 if the kernel supports the feature, 0 if not.

Checks the feature field in the KIP for the given string.
Definition at line 286 of file kip.h.
References l4_kip_for_each_feature, and l4_kip_version_string().
Here is the call graph for this function:



16.669 kip.h

Go to the documentation of this file.

```
00001
00006 /*
00007  * (c) 2008-2013 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00008  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00009  *     economic rights: Technische Universität Dresden (Germany)
00010  *
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013 #pragma once
00014
00015 #include <l4/sys/compiler.h>
00016 #include <l4/sys/l4int.h>
00017
00018 #include <l4/sys/__kip-arch.h>
00019
00023 struct l4_kip_platform_info
00024 {
00025   char                           name[16];
00026   l4_uint32_t                    is_mp;
00027   struct l4_kip_platform_info_arch arch;
00028 };
00029
00036 typedef struct l4_kernel_info_t
00037 {
00038   /* offset 0x00 */
00039   l4_uint32_t            magic;
00042   l4_uint32_t            version;
00043   l4_uint8_t             offset_version_strings;
00044   l4_uint8_t             _fill0[3];
00045   l4_uint8_t             kip_sys_calls;
00046   l4_uint8_t             node;
00047   l4_uint8_t             _fill1[2];
00048
00049   /* offset 0x10 */
```

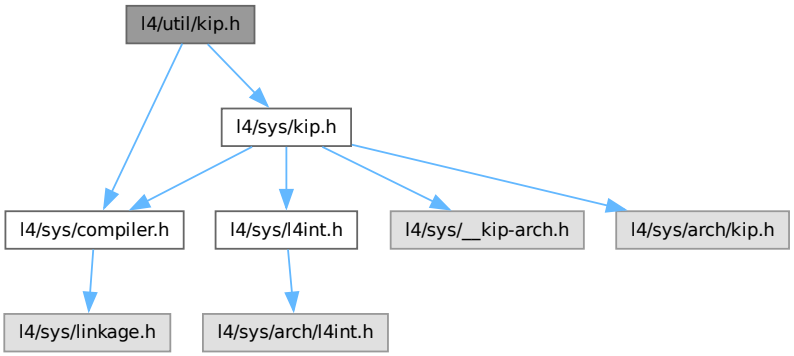
```
00050   l4_uint64_t            sigma0_ip;
00051   l4_uint64_t            root_ip;
00052
00053   /* offset 0x20 */
00054   volatile l4_cpu_time_t _clock_val;
00055   l4_uint64_t            frequency_cpu;
00056
00057   /* offset 0x30 */
00058   l4_uint64_t            acpi_rsdp_addr;
00059   l4_uint64_t            dt_addr;
00060
00061   /* offset 0x40 */
00062   l4_uint64_t            user_ptr;
00063   l4_uint64_t            _res0[1];
00064
00065   /* offset 0x50 */
00066   l4_uint32_t            scheduler_granularity;
00067   l4_uint32_t            mem_descs;
00068   l4_uint32_t            mem_descs_num;
00069   l4_uint32_t            _res1[1];
00070
00071   /* offset 0x60 */
00072   l4_uint64_t            _res2[2];
00073
00074   /* offset 0x70 */
00075   struct l4_kip_platform_info    platform_info;
00076 } l4_kernel_info_t;
00077
00085
00089 enum l4_kernel_info_consts_t
00090 {
00091   L4_KIP_VERSION_FIASCO      = 0x87004444,
00092   L4_KIP_VERSION_FIASCO_MASK = 0xff00ffff,
00093 };
00094
00095 enum
00096 {
00105   L4_KIP_OFFS_READ_US        = 0x900,
00106
00116   L4_KIP_OFFS_READ_NS        = 0x980,
00117 };
00118
00122 extern l4_kernel_info_t const *l4_global_kip;
00123
00127 #define L4_KERNEL_INFO_MAGIC (0x4BE6344CL) /* "L4µK" */
00128
00129
00135 L4_INLINE l4_kernel_info_t const *l4_kip(void) L4_NOTHROW;
00136
00137
00145 L4_INLINE l4_umword_t l4_kip_version(l4_kernel_info_t const *kip) L4_NOTHROW;
00146
00154 L4_INLINE const char *l4_kip_version_string(l4_kernel_info_t const *kip) L4_NOTHROW;
00155
00164 L4_INLINE int
00165 l4_kernel_info_version_offset(l4_kernel_info_t const *kip) L4_NOTHROW;
00166
00184 L4_INLINE l4_cpu_time_t
00185 l4_kip_clock(l4_kernel_info_t const *kip) L4_NOTHROW;
00186
00199 L4_INLINE l4_umword_t
00200 l4_kip_clock_lw(l4_kernel_info_t const *kip) L4_NOTHROW
00201   L4_DEPRECATED("Use l4_kip_clock() instead");
00202
00216 L4_INLINE l4_uint64_t
00217 l4_kip_clock_ns(l4_kernel_info_t const *kip) L4_NOTHROW;
00218
00220
00221 /*****************************************************************************
00222  * Implementations
00223  *****************************************************************************/
00224
00225 L4_INLINE l4_kernel_info_t const*
00226 l4_kip(void) L4_NOTHROW
00227 { return l4_global_kip; }
00228
00229 L4_INLINE l4_umword_t
00230 l4_kip_version(l4_kernel_info_t const *kip) L4_NOTHROW
00231 { return kip->version & L4_KIP_VERSION_FIASCO_MASK; }
00232
00233 L4_INLINE const char*
00234 l4_kip_version_string(l4_kernel_info_t const *k) L4_NOTHROW
00235 { return (const char *)k + l4_kernel_info_version_offset(k); }
00236
00237 L4_INLINE int
00238 l4_kernel_info_version_offset(l4_kernel_info_t const *kip) L4_NOTHROW
00239 { return kip->offset_version_strings « 4; }
```

```
00240
00241 L4_INLINE l4_cpu_time_t
00242 l4_kip_clock(l4_kernel_info_t const *kip) L4_NOTHROW
00243 {
00244   // Use kernel-provided code to determine the current clock.
00245   typedef l4_uint64_t (*kip_time_fn_read_us)(void);
00246   kip_time_fn_read_us read_us =
00247     (kip_time_fn_read_us)((l4_uint8_t const*)kip + L4_KIP_OFFS_READ_US);
00248   return read_us();
00249 }
00250
00251 L4_INLINE l4_cpu_time_t
00252 l4_kip_clock_ns(l4_kernel_info_t const *kip) L4_NOTHROW
00253 {
00254   typedef l4_uint64_t (*kip_time_fn_read_ns)(void);
00255   kip_time_fn_read_ns read_ns =
00256     (kip_time_fn_read_ns)((l4_uint8_t const*)kip + L4_KIP_OFFS_READ_NS);
00257   return read_ns();
00258 }
00259
00260 L4_INLINE l4_umword_t
00261 l4_kip_clock_lw(l4_kernel_info_t const *kip) L4_NOTHROW
00262 {
00263   return l4_kip_clock(kip);
00264 }
00265
00272 #define l4_kip_for_each_feature(s) \
00273         for (s += __builtin_strlen(s) + 1; *s; s += __builtin_strlen(s) + 1)
00274
00285 L4_INLINE int
00286 l4_kip_kernel_has_feature(l4_kernel_info_t const *kip, char const *str)
00287 {
00288   const char *s = l4_kip_version_string(kip);
00289   if (!s)
00290     return 0;
00291
00292   l4_kip_for_each_feature(s)
00293     {
00294       if (__builtin_strcmp(s, str) == 0)
00295         return 1;
00296     }
00297
00298   return 0;
00299 }
00300
00301 #include <l4/sys/arch/kip.h>
```

16.670 l4/util/kip.h File Reference

```
#include <l4/sys/kip.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for kip.h:



Macros

- #define l4util_kip_for_each_feature(s)

  Cycle through kernel features given in the KIP.

Functions

- L4_BEGIN_DECLS int l4util_kip_kernel_has_feature (l4_kernel_info_t const *k, char const *str)

  Check if kernel supports a feature.
- unsigned long l4util_kip_kernel_abi_version (l4_kernel_info_t const *k)

  Return kernel ABI version.

16.671 kip.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Alexander Warg <warg@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #pragma once
00013
00014 #include <l4/sys/kip.h>
00015 #include <l4/sys/compiler.h>
00016
00022
00023
00024 L4_BEGIN_DECLS
00025
00038 L4_CV int l4util_kip_kernel_has_feature(l4_kernel_info_t const *k, char const *str);
00039
00046 L4_CV unsigned long l4util_kip_kernel_abi_version(l4_kernel_info_t const *k);
00047
00048 L4_END_DECLS
00049
00058 #define l4util_kip_for_each_feature(s)  l4_kip_for_each_feature(s)
00059
00061
```

16.672 kip.h

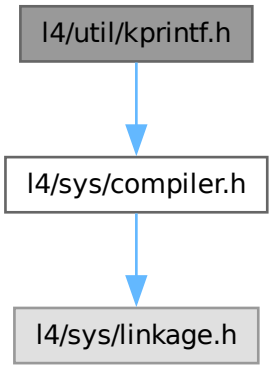
```
00001 /*
00002  * Copyright (C) 2024 Kernkonzept GmbH.
00003  * Author(s): Georg Kotheimer <georg.kotheimer@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00019 L4_INLINE int
00020 l4_kip_has_isa_ext(l4_kernel_info_t const *kip, L4_riscv_isa_ext ext) L4_NOTHROW
00021 {
00022   if (ext < 0 || ext >= L4_riscv_isa_ext_max)
00023     return 0;
00024
00025   return kip->platform_info.arch.isa_ext[ext / 32] & (1 << (ext % 32));
00026 }
```

16.673 kip.h

```
00001 /*
00002  * Copyright (C) 2026 Kernkonzept GmbH.
00003  * Author(s): Jan Klötzke <jan.kloetzke@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
```

16.674 l4/util/kprintf.h File Reference

printf using the kernel debugger
`#include <l4/sys/compiler.h>`
Include dependency graph for kprintf.h:



16.674.1 Detailed Description

printf using the kernel debugger

Date

04/05/2007

Author

Adam Lackorzynski adam@os.inf.tu-dresden.de,

Definition in file kprintf.h.

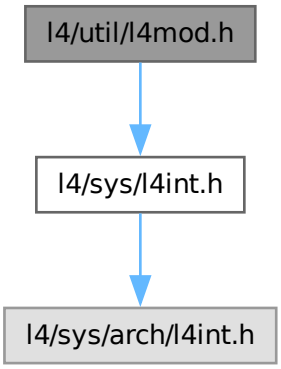
16.675 kprintf.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00009 /*
00010  * (c) 2007-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #ifndef __L4UTIL__INCLUDE__KPRINTF_H__
00016 #define __L4UTIL__INCLUDE__KPRINTF_H__
00017
00018 #include <l4/sys/compiler.h>
00019
00020 L4_BEGIN_DECLS
00021
00022 L4_CV int l4_kprintf(const char *fmt, ...)
00023                      __attribute__((format (printf, 1, 2)));
00024
00025 L4_END_DECLS
00026
00027 #endif /* ! __L4UTIL__INCLUDE__KPRINTF_H__ */
```

16.676 l4/util/l4mod.h File Reference

L4mod structures and constants.
`#include <l4/sys/l4int.h>`
Include dependency graph for l4mod.h:



Data Structures

- struct l4util_l4mod_mod
  A single module.
- struct l4util_l4mod_info
  Base module structure.

Enumerations

- enum l4util_l4mod_mod_info_flag {
  L4util_l4mod_mod_flag_unspec = 0 , L4util_l4mod_mod_flag_kernel = 1 , L4util_l4mod_mod_flag_sigma0 = 2 , L4util_l4mod_mod_flag_roottask = 3 ,
  L4util_l4mod_mod_flag_cpu_fw = 4 , L4util_l4mod_mod_flag_mask = 7 << 0 }
  Flags for l4util_l4mod_mod.flags.

16.676.1 Detailed Description

L4mod structures and constants.
Definition in file l4mod.h.

16.676.2 Enumeration Type Documentation

16.676.2.1 l4util_l4mod_mod_info_flag

`enum l4util_l4mod_mod_info_flag`
Flags for l4util_l4mod_mod.flags.

Enumerator

L4util_l4mod_mod_flag_unspec	A generic module.
L4util_l4mod_mod_flag_kernel	The kernel module.

L4util_l4mod_mod_flag_sigma0	The sigma0 module.
L4util_l4mod_mod_flag_roottask	The root task module.
L4util_l4mod_mod_flag_cpu_fw	A CPU firmware module containing one or several firmware update blobs. Such modules are announced via L4::Kip::Mem_desc::Arch regions. These regions are exclusively used by the kernel.
L4util_l4mod_mod_flag_mask	Mask for specified flags.

Definition at line 17 of file l4mod.h.

16.677 l4mod.h

Go to the documentation of this file.

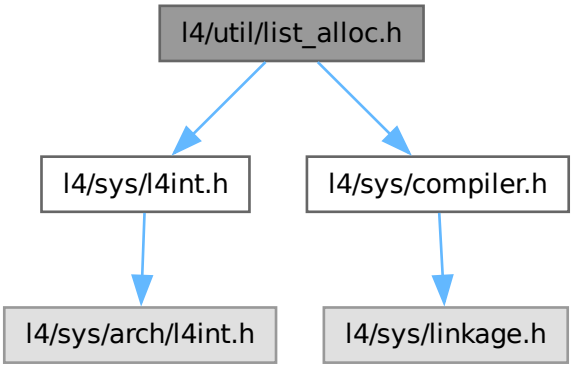
```
00001 /*
00002  * Copyright (C) 2021-2022, 2024 Kernkonzept GmbH.
00003  * Author(s): Adam Lackorzynski <adam@l4re.org>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00012 #pragma once
00013
00014 #include <l4/sys/l4int.h>
00015
00017 enum l4util_l4mod_mod_info_flag
00018 {
00019   L4util_l4mod_mod_flag_unspec    = 0,
00020   L4util_l4mod_mod_flag_kernel    = 1,
00021   L4util_l4mod_mod_flag_sigma0    = 2,
00022   L4util_l4mod_mod_flag_roottask  = 3,
00029   L4util_l4mod_mod_flag_cpu_fw    = 4,
00030   L4util_l4mod_mod_flag_mask      = 7 << 0,
00031 };
00032
00034 typedef struct
00035 {
00036   l4_uint64_t flags;
00037   l4_uint64_t mod_start;
00038   l4_uint64_t mod_end;
00039   l4_uint64_t cmdline;
00040 } l4util_l4mod_mod;
00041
00043 typedef struct
00044 {
00045   l4_uint64_t flags;
00046   l4_uint64_t cmdline;
00047   l4_uint64_t mods_addr;
00048   l4_uint32_t mods_count;
00049   l4_uint32_t _pad;
00050
00055   l4_uint64_t vbe_ctrl_info;
00056   l4_uint64_t vbe_mode_info;
00057 } l4util_l4mod_info;
```

16.678 l4/util/list_alloc.h File Reference

Simple list-based allocator.

```
#include <l4/sys/l4int.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for list_alloc.h:



Functions

- L4_BEGIN_DECLS void l4la_free (l4la_free_t **first, void *block, l4_size_t size)

  Add free memory to memory pool.
- void * l4la_alloc (l4la_free_t **first, l4_size_t size, unsigned align)

  Allocate memory from pool.
- void l4la_dump (l4la_free_t **first)

  Show all list members.
- void l4la_init (l4la_free_t **first)

  Init memory pool.
- l4_size_t l4la_avail (l4la_free_t **first)

  Show available memory in pool.

16.678.1 Detailed Description

Simple list-based allocator.
Taken from the Fiasco kernel.

Date

Alexander Warg <aw11os.inf.tu-dresden.de> Frank Mehnert fm3@os.inf.tu-dresden.de

Definition in file list_alloc.h.

16.678.2 Function Documentation

16.678.2.1 l4la_alloc()

```
void * l4la_alloc (
            l4la_free_t ** first,
            l4_size_t size,
            unsigned align)
```

Allocate memory from pool.

Parameters

first	list identifier
size	length of memory block to allocate
align	alignment

References L4_CV.

16.678.2.2 l4la_avail()

```
l4_size_t l4la_avail (
            l4la_free_t ** first)
```

Show available memory in pool.

Parameters

first	list identifier

References L4_CV, and L4_END_DECLS.

16.678.2.3 l4la_dump()

```
void l4la_dump (
            l4la_free_t ** first)
```

Show all list members.

Parameters

first	list identifier

References L4_CV.

16.678.2.4 l4la_free()

```
L4_BEGIN_DECLS void l4la_free (
            l4la_free_t ** first,
            void * block,
            l4_size_t size)
```

Add free memory to memory pool.

Parameters

first	list identifier
block	address of unused memory block
size	size of memory block

References L4_CV.

16.678.2.5 l4la_init()

```
void l4la_init (
            l4la_free_t ** first)
```

Init memory pool.

Parameters

first	list identifier

References L4_CV.

16.679 list_alloc.h

Go to the documentation of this file.

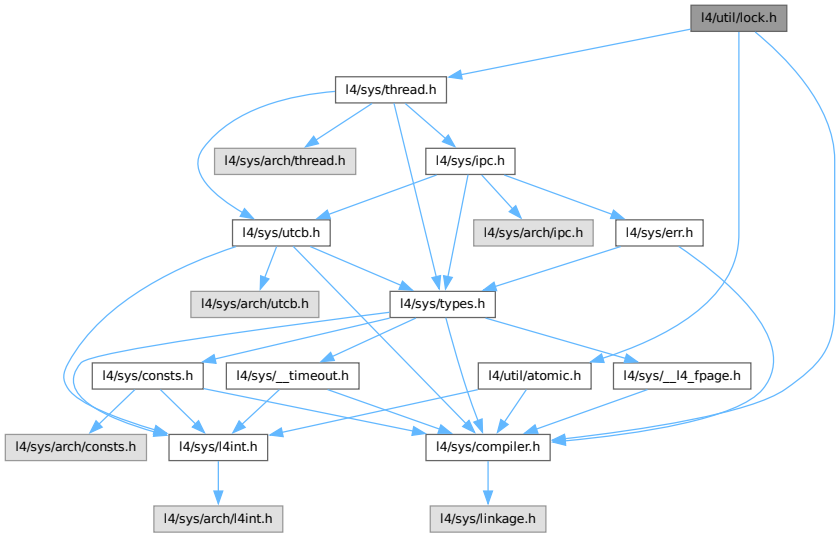
```
00001
00007
00008 /*
00009  * (c) 2003-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00010  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #ifndef L4UTIL_L4LA_H
00016 #define L4UTIL_L4LA_H
00017
00018 #include <l4/sys/l4int.h>
00019 #include <l4/sys/compiler.h>
00020
00021 typedef struct l4la_free_t_s
00022 {
00023   struct l4la_free_t_s *next;
00024   l4_size_t             size;
00025 } l4la_free_t;
00026
00027 #define L4LA_INITIALIZER  { 0 }
00028
00029 L4_BEGIN_DECLS
00030
00035 L4_CV void      l4la_free(l4la_free_t **first, void *block, l4_size_t size);
00036
00041 L4_CV void*     l4la_alloc(l4la_free_t **first, l4_size_t size, unsigned align);
00042
00045 L4_CV void      l4la_dump(l4la_free_t **first);
00046
00049 L4_CV void      l4la_init(l4la_free_t **first);
00050
00053 L4_CV l4_size_t l4la_avail(l4la_free_t **first);
00054
00055 L4_END_DECLS
00056
00057 #endif
```

16.680 l4/util/lock.h File Reference

Simple lock implementation.

```
#include <l4/sys/thread.h>
#include <l4/sys/compiler.h>
#include <l4/util/atomic.h>
```

Include dependency graph for lock.h:



16.680.1 Detailed Description

Simple lock implementation.
Does only work if all thread have the same priority!

Date

02/1997

Author

Michael Hohmuth hohmuth@os.inf.tu-dresden.de

Definition in file lock.h.

16.681 lock.h

Go to the documentation of this file.

```
00001 /*****************************************************************************/
00009 /*
00010  * (c) 2000-2009 Author(s)
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 /*****************************************************************************/
00016 #ifndef __L4UTIL_LOCK_H__
00017 #define __L4UTIL_LOCK_H__
00018
00019 #include <l4/sys/thread.h>
00020 #include <l4/sys/compiler.h>
00021 #include <l4/util/atomic.h>
00022
00023 L4_BEGIN_DECLS
00024
00025 typedef l4_uint32_t l4util_simple_lock_t;
00026
00027 L4_INLINE int  l4_simple_try_lock(l4util_simple_lock_t *lock);
00028 L4_INLINE void l4_simple_unlock(l4util_simple_lock_t *lock);
00029 L4_INLINE int  l4_simple_lock_locked(l4util_simple_lock_t *lock);
00030 L4_INLINE void l4_simple_lock_solid(register l4util_simple_lock_t *p);
00031 L4_INLINE void l4_simple_lock(l4util_simple_lock_t * lock);
00032
00033 L4_INLINE int
```

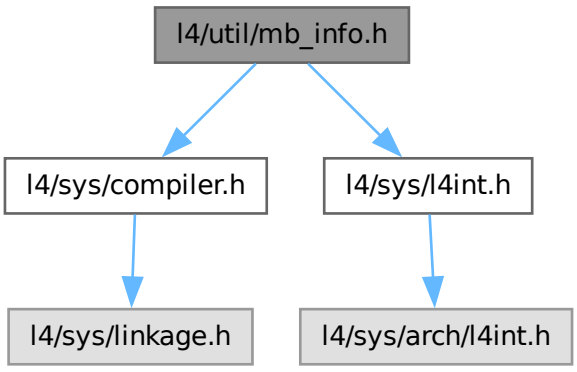
```
00034 l4_simple_try_lock(l4util_simple_lock_t *lock)
00035 {
00036   return __atomic_exchange_n(lock, 1, __ATOMIC_SEQ_CST) == 0;
00037 }
00038
00039 L4_INLINE void
00040 l4_simple_unlock(l4util_simple_lock_t *lock)
00041 {
00042   __atomic_store_n(lock, 0, __ATOMIC_RELEASE);
00043 }
00044
00045 L4_INLINE int
00046 l4_simple_lock_locked(l4util_simple_lock_t *lock)
00047 {
00048   return __atomic_load_n(lock, __ATOMIC_RELAXED) == 0 ? 0 : 1;
00049 }
00050
00051 L4_INLINE void
00052 l4_simple_lock_solid(register l4util_simple_lock_t *p)
00053 {
00054   while (l4_simple_lock_locked(p) || !l4_simple_try_lock(p))
00055     l4_thread_switch(L4_INVALID_CAP);
00056 }
00057
00058 L4_INLINE void
00059 l4_simple_lock(l4util_simple_lock_t * lock)
00060 {
00061   if (!l4_simple_try_lock(lock))
00062     l4_simple_lock_solid(lock);
00063 }
00064
00065 L4_END_DECLS
00066
00067 #endif
```

16.682 l4/util/mb_info.h File Reference

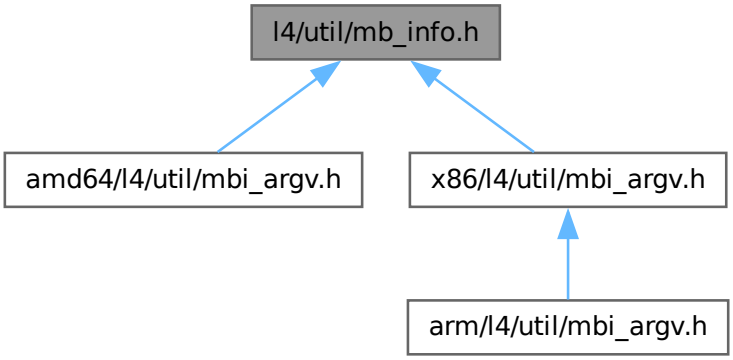
Multiboot info structure as defined by GRUB.

```
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
```

Include dependency graph for mb_info.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4util_mb_mod_t

  The structure type "mod_list" is used by the multiboot_info structure.
- struct l4util_mb_addr_range_t

  INT-15, AX=E820 style "AddressRangeDescriptor" ...with a "size" parameter on the front which is the structure size - 4, pointing to the next one, up until the full buffer length of the memory map has been reached.
- struct l4util_mb_drive_t

  Drive Info structure.
- struct l4util_mb_apm_t

  APM BIOS info.
- struct l4util_mb_vbe_ctrl_t

  VBE controller information.
- struct l4util_mb_vbe_mode_t

  VBE mode information.
- struct l4util_mb_info_t

  MultiBoot Info description.

Macros

- #define **MB_ARD_MEMORY** 1

  usable memory "Type", all others are reserved.
- #define MB_ART_MEMORY 1

  Address Range Types (ART) from "Advanced Configuration and Power Interface Specification" Rev3.0a (p.
- #define **MB_ART_RESERVED** 2

  in use or reserved by system
- #define **MB_ART_ACPI** 3

  ACPI Reclaim Memory (RAM that contains ACPI tables).
- #define **MB_ART_NVS** 4

  ACPI NVS Memory (must not be used by the OS.
- #define **MB_ART_UNUSABLE** 5

  memory in which errors have been detected
- #define l4util_mb_for_each_mmap_entry(i, mbi)

Iterate over a memory map provided in a Multiboot info.

- #define L4UTIL_MB_MEMORY 0x00000001

  Flags to be set in the 'flags' parameter above.
- #define **L4UTIL_MB_BOOTDEV** 0x00000002

  is there a boot device set?
- #define **L4UTIL_MB_CMDLINE** 0x00000004

  is the command-line defined?
- #define **L4UTIL_MB_MODS** 0x00000008

  are there modules to do something with?
- #define **L4UTIL_MB_AOUT_SYMS** 0x00000010

  is there a symbol table loaded?
- #define **L4UTIL_MB_ELF_SHDR** 0x00000020

  is there an ELF section header table?
- #define **L4UTIL_MB_MEM_MAP** 0x00000040

  is there a full memory map?
- #define **L4UTIL_MB_DRIVE_INFO** 0x00000080

  Is there drive info?
- #define **L4UTIL_MB_CONFIG_TABLE** 0x00000100

  Is there a config table?
- #define **L4UTIL_MB_BOOT_LOADER_NAME** 0x00000200

  Is there a boot loader name?
- #define **L4UTIL_MB_APM_TABLE** 0x00000400

  Is there a APM table?
- #define **L4UTIL_MB_VIDEO_INFO** 0x00000800

  Is there video information?
- #define **L4UTIL_MB_VALID** 0x2BADB002UL

  If we are multiboot-compliant, this value is present in the eax register.

16.682.1 Detailed Description

Multiboot info structure as defined by GRUB.
Definition in file mb_info.h.

16.682.2 Macro Definition Documentation

16.682.2.1 l4util_mb_for_each_mmap_entry

```
#define l4util_mb_for_each_mmap_entry(
              i,
              mbi)
```

Value:

```
  for (i = l4util_mb_first_mmap_entry(mbi);                                    \
       (unsigned long)i < (unsigned long)mbi->mmap_addr + mbi->mmap_length;    \
       i = l4util_mb_next_mmap_entry(i))
```

Iterate over a memory map provided in a Multiboot info.

Parameters

i	Name of a variable of type l4util_mb_addr_range_t * that is consecutively assigned pointers to the entries of the memory map.
mbi	Pointer to the l4util_mb_info_t where the memory map can be found.

Definition at line 332 of file mb_info.h.

16.682.2.2 L4UTIL_MB_MEMORY

```
#define L4UTIL_MB_MEMORY 0x00000001
```

Flags to be set in the 'flags' parameter above.
is there basic lower/upper memory information?
Definition at line 344 of file mb_info.h.

16.682.2.3 MB_ART_MEMORY

```
#define MB_ART_MEMORY 1
```

Address Range Types (ART) from "Advanced Configuration and Power Interface Specification" Rev3.0a (p. 390). Other values are undefined. available, usable RAM
Definition at line 64 of file mb_info.h.

16.683 mb_info.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00007  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011
00012 #ifndef L4UTIL_MB_INFO_H
00013 #define L4UTIL_MB_INFO_H
00014
00015 /*****************************************************************************
00016  * Multiboot (v1)
00017  *****************************************************************************/
00018
00019 #ifndef __ASSEMBLY__
00020
00021 #include <l4/sys/compiler.h>
00022 #include <l4/sys/l4int.h>
00023
00024 /*
00025  * \defgroup l4util_mb_mod Multiboot v1
00026  * \ingroup l4util_api
00027  */
00028
00033 typedef struct
00034 {
00035   l4_uint32_t mod_start;
00036   l4_uint32_t mod_end;
00037   l4_uint32_t cmdline;
00038   l4_uint32_t pad;
00039 } l4util_mb_mod_t;
00040
00041
00048 typedef struct __attribute__((packed))
00049 {
00050   l4_uint32_t struct_size;
00051   l4_uint64_t addr;
00052   l4_uint64_t size;
00053   l4_uint32_t type;
00054   /* unspecified optional padding... */
00055 } l4util_mb_addr_range_t;
00056
00058 #define MB_ARD_MEMORY   1
00059
00064 #define MB_ART_MEMORY   1
00065 #define MB_ART_RESERVED 2
00066 #define MB_ART_ACPI     3
00068 #define MB_ART_NVS      4
00069 #define MB_ART_UNUSABLE 5
00070
00071
00073 typedef struct
00074 {
00075   l4_uint32_t size;
00076   l4_uint8_t drive_number;
00077   l4_uint8_t drive_mode;
00078   l4_uint16_t drive_cylinders;
00079   l4_uint8_t drive_heads;
00080   l4_uint8_t drive_sectors;
00081   l4_uint16_t drive_ports[0];
```

```
00082 } l4util_mb_drive_t;
00083
00084 /* Drive Mode.  */
00085 #define MB_DI_CHS_MODE    0
00086 #define MB_DI_LBA_MODE    1
00087
00088
00090 typedef struct
00091 {
00092   l4_uint16_t version;
00093   l4_uint16_t cseg;
00094   l4_uint32_t offset;
00095   l4_uint16_t cseg_16;
00096   l4_uint16_t dseg_16;
00097   l4_uint16_t flags;
00098   l4_uint16_t cseg_len;
00099   l4_uint16_t cseg_16_len;
00100   l4_uint16_t dseg_16_len;
00101 } __attribute__((packed)) l4util_mb_apm_t;
00102 static_assert(sizeof(l4util_mb_apm_t) == 20, "Check l4util_mb_apm_t");
00103
00104
00106 typedef struct
00107 {
00108   l4_uint8_t signature[4];
00109   l4_uint16_t version;
00110   l4_uint32_t oem_string;
00111   l4_uint32_t capabilities;
00112   l4_uint32_t video_mode;
00113   l4_uint16_t total_memory;
00114   l4_uint16_t oem_software_rev;
00115   l4_uint32_t oem_vendor_name;
00116   l4_uint32_t oem_product_name;
00117   l4_uint32_t oem_product_rev;
00118   l4_uint8_t reserved[222];
00119   l4_uint8_t oem_data[256];
00120 } __attribute__((packed)) l4util_mb_vbe_ctrl_t;
00121 static_assert(sizeof(l4util_mb_vbe_ctrl_t) == 512, "Check l4util_mb_vbe_ctrl_t");
00122
00123
00125 typedef struct
00126 {
00130   l4_uint16_t mode_attributes;
00132   l4_uint8_t win_a_attributes;
00134   l4_uint8_t win_b_attributes;
00136   l4_uint16_t win_granularity;
00138   l4_uint16_t win_size;
00140   l4_uint16_t win_a_segment;
00142   l4_uint16_t win_b_segment;
00144   l4_uint32_t win_func;
00146   l4_uint16_t bytes_per_scanline;
00148
00152   l4_uint16_t x_resolution;
00154   l4_uint16_t y_resolution;
00156   l4_uint8_t x_char_size;
00158   l4_uint8_t y_char_size;
00160   l4_uint8_t number_of_planes;
00162   l4_uint8_t bits_per_pixel;
00164   l4_uint8_t number_of_banks;
00166   l4_uint8_t memory_model;
00168   l4_uint8_t bank_size;
00170   l4_uint8_t number_of_image_pages;
00172   l4_uint8_t reserved0;
00174
00178   l4_uint8_t red_mask_size;
00180   l4_uint8_t red_field_position;
00182   l4_uint8_t green_mask_size;
00184   l4_uint8_t green_field_position;
00186   l4_uint8_t blue_mask_size;
00188   l4_uint8_t blue_field_position;
00190   l4_uint8_t reserved_mask_size;
00192   l4_uint8_t reserved_field_position;
00194   l4_uint8_t direct_color_mode_info;
00196
00200   l4_uint32_t phys_base;
00202   l4_uint32_t reserved1;
00204   l4_uint16_t reversed2;
00206
00210   l4_uint16_t linear_bytes_per_scanline;
00212   l4_uint8_t banked_number_of_image_pages;
00214   l4_uint8_t linear_number_of_image_pages;
00216   l4_uint8_t linear_red_mask_size;
00218   l4_uint8_t linear_red_field_position;
00220   l4_uint8_t linear_green_mask_size;
00222   l4_uint8_t linear_green_field_position;
00224   l4_uint8_t linear_blue_mask_size;
00226   l4_uint8_t linear_blue_field_position;
```

```
00228   l4_uint8_t linear_reserved_mask_size;
00230   l4_uint8_t linear_reserved_field_position;
00232   l4_uint32_t max_pixel_clock;
00234   l4_uint8_t reserved3[190];
00236 } __attribute__ ((packed)) l4util_mb_vbe_mode_t;
00237 static_assert(sizeof(l4util_mb_vbe_mode_t) == 256, "Check l4util_mb_vbe_mode_t");
00238
00239
00246
00247 typedef struct
00248 {
00249   l4_uint32_t flags;
00250   l4_uint32_t mem_lower;
00251   l4_uint32_t mem_upper;
00252   l4_uint32_t boot_device;
00253   l4_uint32_t cmdline;
00254   l4_uint32_t mods_count;
00255   l4_uint32_t mods_addr;
00256
00257   union
00258   {
00259     struct
00260     {
00262       l4_uint32_t tabsize;
00263       l4_uint32_t strsize;
00264       l4_uint32_t addr;
00265       l4_uint32_t pad;
00266     }
00267     a;
00268
00269     struct
00270     {
00272       l4_uint32_t num;
00273       l4_uint32_t size;
00274       l4_uint32_t addr;
00275       l4_uint32_t shndx;
00276     }
00277     e;
00278   }
00279   syms;
00280
00281   l4_uint32_t mmap_length;
00282   l4_uint32_t mmap_addr;
00283   l4_uint32_t drives_length;
00284   l4_uint32_t drives_addr;
00285   l4_uint32_t config_table;
00286   l4_uint32_t boot_loader_name;
00287   l4_uint32_t apm_table;
00288   l4_uint32_t vbe_ctrl_info;
00289   l4_uint32_t vbe_mode_info;
00290   l4_uint16_t vbe_mode;
00291   l4_uint16_t vbe_interface_seg;
00292   l4_uint16_t vbe_interface_off;
00293   l4_uint16_t vbe_interface_len;
00294 } l4util_mb_info_t;
00295 static_assert(sizeof(l4util_mb_info_t) == 88, "Check l4util_mb_info_t");
00296
00303 static inline l4util_mb_addr_range_t *
00304 l4util_mb_first_mmap_entry(l4util_mb_info_t *mbi)
00305 {
00306   return (l4util_mb_addr_range_t *)(l4_addr_t)mbi->mmap_addr;
00307 }
00308
00318 static inline l4util_mb_addr_range_t *
00319 l4util_mb_next_mmap_entry(l4util_mb_addr_range_t *e)
00320 {
00321   return (l4util_mb_addr_range_t *)((l4_addr_t)e + e->struct_size
00322                                     + sizeof(e->struct_size));
00323 }
00324
00332 #define l4util_mb_for_each_mmap_entry(i, mbi)                                  \
00333   for (i = l4util_mb_first_mmap_entry(mbi);                                    \
00334        (unsigned long)i < (unsigned long)mbi->mmap_addr + mbi->mmap_length;    \
00335        i = l4util_mb_next_mmap_entry(i))
00336
00337 #endif /* ! __ASSEMBLY__ */
00338
00342
00344 #define L4UTIL_MB_MEMORY    0x00000001
00345
00347 #define L4UTIL_MB_BOOTDEV   0x00000002
00348
00350 #define L4UTIL_MB_CMDLINE   0x00000004
00351
00353 #define L4UTIL_MB_MODS      0x00000008
00354
00355 /* These next two are mutually exclusive */
```

```
00357 #define L4UTIL_MB_AOUT_SYMS   0x00000010
00358
00360 #define L4UTIL_MB_ELF_SHDR    0x00000020
00361
00363 #define L4UTIL_MB_MEM_MAP   0x00000040
00364
00366 #define L4UTIL_MB_DRIVE_INFO    0x00000080
00367
00369 #define L4UTIL_MB_CONFIG_TABLE    0x00000100
00370
00372 #define L4UTIL_MB_BOOT_LOADER_NAME  0x00000200
00373
00375 #define L4UTIL_MB_APM_TABLE   0x00000400
00376
00378 #define L4UTIL_MB_VIDEO_INFO    0x00000800
00379
00380
00382 #define L4UTIL_MB_VALID     0x2BADB002UL
00383 #define L4UTIL_MB_VALID_ASM   0x2BADB002
00384
00385
00386 /*****************************************************************************
00387  * Multiboot2
00388  *****************************************************************************/
00389
00390 #ifndef __ASSEMBLY__
00391
00392 typedef struct
00393 {
00394   l4_uint32_t total_size;
00395   l4_uint32_t reserved;
00396 }  __attribute__((packed)) l4util_mb2_info_t;
00397
00398 typedef struct
00399 {
00400   char string[0];
00401 }  __attribute__((packed)) l4util_mb2_cmdline_tag_t;
00402
00403 typedef struct
00404 {
00405   l4_uint32_t mod_start;
00406   l4_uint32_t mod_end;
00407   char string[];
00408 }  __attribute__((packed)) l4util_mb2_module_tag_t;
00409
00410 typedef struct
00411 {
00412   l4_uint64_t base_addr;
00413   l4_uint64_t length;
00414   l4_uint32_t type;
00415   l4_uint32_t reserved;
00416 }  __attribute__((packed)) l4util_mb2_memmap_entry_t;
00417
00418 typedef struct
00419 {
00420   l4_uint32_t entry_size;
00421   l4_uint32_t entry_version;
00422   l4util_mb2_memmap_entry_t entries[];
00423 }  __attribute__((packed)) l4util_mb2_memmap_tag_t;
00424
00425 typedef struct
00426 {
00427   char data[0];
00428 } __attribute__((packed)) l4util_mb2_rsdp_tag_t;
00429
00430
00431 struct color_info_rgb_t
00432 {
00433   l4_uint8_t framebuffer_red_field_position;
00434   l4_uint8_t framebuffer_red_mask_size;
00435   l4_uint8_t framebuffer_green_field_position;
00436   l4_uint8_t framebuffer_green_mask_size;
00437   l4_uint8_t framebuffer_blue_field_position;
00438   l4_uint8_t framebuffer_blue_mask_size;
00439 } __attribute__((packed));
00440
00441 typedef struct
00442 {
00443   l4_uint64_t framebuffer_addr;
00444   l4_uint32_t framebuffer_pitch;
00445   l4_uint32_t framebuffer_width;
00446   l4_uint32_t framebuffer_height;
00447   l4_uint8_t  framebuffer_bpp;
00448   l4_uint8_t  framebuffer_type;
00449   l4_uint8_t  reserved;
00450
00451   // color_info;
```

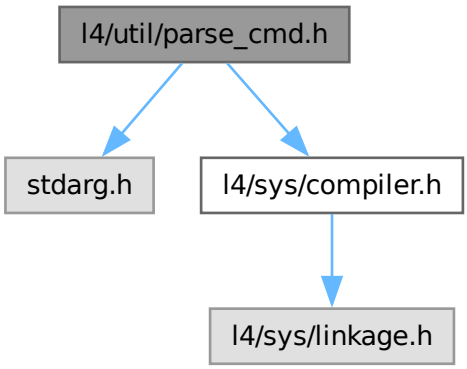
```
00452   union
00453   {
00454     struct color_info_rgb_t color_info_rgb;
00455   };
00456 } __attribute__((packed)) l4util_mb2_framebuffer_tag_t;
00457
00458 typedef struct
00459 {
00460   l4_uint32_t type;
00461   l4_uint32_t size;
00462
00463   union
00464   {
00465     l4util_mb2_cmdline_tag_t cmdline;
00466     l4util_mb2_module_tag_t module;
00467     l4util_mb2_memmap_tag_t memmap;
00468     l4util_mb2_framebuffer_tag_t fb;
00469     l4util_mb2_rsdp_tag_t rsdp;
00470   };
00471 }  __attribute__((packed)) l4util_mb2_tag_t;
00472
00473 #endif  /* ! __ASSEMBLY__ */
00474
00475
00476 #define L4UTIL_MB2_MAGIC    0xE85250D6
00477 #define L4UTIL_MB2_ARCH_I386    0x0
00478
00479 #define L4UTIL_MB2_TERMINATOR_HEADER_TAG  0
00480 #define L4UTIL_MB2_INFO_REQUEST_HEADER_TAG  1
00481 #define L4UTIL_MB2_ENTRY_ADDRESS_HEADER_TAG 3
00482 #define L4UTIL_MB2_FRAMEBUFFER_HEADER_TAG 5
00483 #define L4UTIL_MB2_RELOCATABLE_HEADER_TAG 10
00484
00485 #define L4UTIL_MB2_TAG_FLAG_REQUIRED    0
00486
00487 #define L4UTIL_MB2_TAG_ALIGN_SHIFT    3
00488 #define L4UTIL_MB2_TAG_ALIGN      8
00489
00490 #define L4UTIL_MB2_TERMINATOR_INFO_TAG            0
00491 #define L4UTIL_MB2_BOOT_CMDLINE_INFO_TAG          1
00492 #define L4UTIL_MB2_MODULE_INFO_TAG                3
00493 #define L4UTIL_MB2_MEMORY_MAP_INFO_TAG            6
00494 #define L4UTIL_MB2_FRAMEBUFFER_INFO_TAG           8
00495 #define L4UTIL_MB2_RSDP_OLD_INFO_TAG             14
00496 #define L4UTIL_MB2_RSDP_NEW_INFO_TAG             15
00497 #define L4UTIL_MB2_IMAGE_LOAD_BASE_PHYS_INFO_TAG 21
00498
00499 #define L4UTIL_MB2_RELO_PREFERED_NONE 0
00500 #define L4UTIL_MB2_RELO_PREFERED_MIN  1
00501 #define L4UTIL_MB2_RELO_PREFERED_MAX  2
00502
00503 #endif
```

16.684 l4/util/parse_cmd.h File Reference

comfortable command-line parsing

```
#include <stdarg.h>
#include <l4/sys/compiler.h>
```

Include dependency graph for parse_cmd.h:



Typedefs

- typedef void(∗ **parse_cmd_fn_t**) (int)
  Function type for PARSE_CMD_FN.
- typedef void(∗ **parse_cmd_fn_arg_t**) (int, const char ∗, int)
  Function type for PARSE_CMD_FN_ARG.

Enumerations

- enum parse_cmd_type
  Types for parsing.

Functions

- L4_BEGIN_DECLS int parse_cmdline (int ∗argc, const char ∗∗∗argv, int arg0,...)
  Parse the command-line for specified arguments and store the values into variables.

16.684.1 Detailed Description

comfortable command-line parsing

Date

2002

Author

Jork Loeser jork.loeser@inf.tu-dresden.de

Definition in file parse_cmd.h.

16.685 parse_cmd.h

Go to the documentation of this file.

```
00001
00008
00009 /*
00010  * (c) 2003-2009 Author(s)
```

```
00011  *     economic rights: Technische Universität Dresden (Germany)
00012  * License: see LICENSE.spdx (in this directory or the directories above)
00013  */
00014
00015 #ifndef __PARSE_CMD_H
00016 #define __PARSE_CMD_H
00017
00018 #include <stdarg.h>
00019 #include <l4/sys/compiler.h>
00020
00026
00030 enum parse_cmd_type {
00031     PARSE_CMD_INT,
00032     PARSE_CMD_SWITCH,
00033     PARSE_CMD_STRING,
00034     PARSE_CMD_FN,
00035     PARSE_CMD_FN_ARG,
00036     PARSE_CMD_INC,
00037     PARSE_CMD_DEC,
00038 };
00039
00043 typedef L4_CV void (*parse_cmd_fn_t)(int);
00044
00048 typedef L4_CV void (*parse_cmd_fn_arg_t)(int, const char*, int);
00049
00050 L4_BEGIN_DECLS
00051
00138 L4_CV int parse_cmdline(int *argc, const char***argv, int arg0, ...);
00139 L4_CV int parse_cmdlinev(int *argc, const char***argv, int arg0, va_list va);
00140 L4_CV int parse_cmdline_extra(const char*argv0, const char*line, char delim,
00141             int arg0,...);
00142
00143 L4_END_DECLS
00145
00146 #endif
00147
```

16.686 printf_helpers.h

```
00001 /*
00002  * Copyright (C) 2025 Kernkonzept GmbH.
00003  * Author(s): Frank Mehnert <frank.mehnert@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <stddef.h>
00011 #include <stdio.h>
00012 #include <l4/sys/compiler.h>
00013
00031 L4_INLINE int l4util_human_readable_size(char *outstr, size_t outsize,
00032                                          unsigned long long bytes)
00033 {
00034   static char const unitstr[7] = { 'B', 'K', 'M', 'G', 'T', 'P', 'E' };
00035
00036   int idx = sizeof(unitstr) - 1;
00037   int order;
00038
00039   for (order = idx * 10; order >= 10; order -= 10, --idx)
00040     if (bytes > (1ULL << order))
00041       break;
00042
00043   unsigned long long value = bytes >> order;
00044   unsigned long long fract = (bytes - (value << order))
00045                              / ((1ULL << order) / 10 + 1);
00046
00047   if (idx > 0)
00048     return snprintf(outstr, outsize, "%llu.%1llu %ciB",
00049                     value, fract, unitstr[idx]);
00050   else
00051     return snprintf(outstr, outsize, "%llu B  ", value);
00052 }
00053
00075 L4_INLINE int l4util_human_readable_size_region(char *outstr, size_t outsize,
00076                                                 unsigned long long begin,
00077                                                 unsigned long long end)
00078 {
00079   if (end - begin == ~0UL)
00080     return snprintf(outstr, outsize, "%s",
00081                     sizeof(long) == 4 ? "4.0 GiB" : "16.0 EiB");
00082   else
00083     return l4util_human_readable_size(outstr, outsize, end - begin + 1);
```

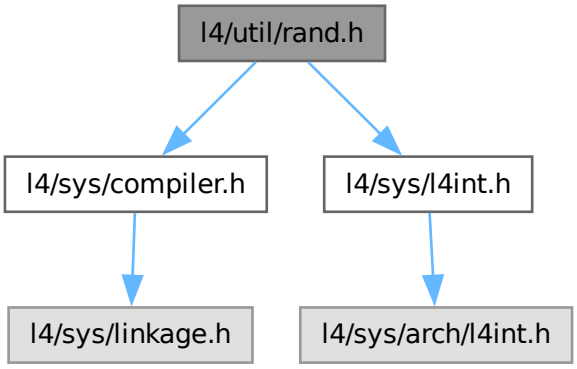
```
00084 }
```

16.687 l4/util/rand.h File Reference

Simple Pseudo-Random Number Generator.

```
#include <l4/sys/compiler.h>
#include <l4/sys/l4int.h>
```

Include dependency graph for rand.h:



Functions

- l4_uint32_t l4util_rand (void)

  Deliver next random number.
- void l4util_srand (l4_uint32_t seed)

  Initialize random number generator.

16.687.1 Detailed Description

Simple Pseudo-Random Number Generator.

Date

1998

Author

Lars Reuther reuther@os.inf.tu-dresden.de

Definition in file rand.h.

16.688 rand.h

Go to the documentation of this file.

```
00001
00008 /*
00009  * (c) 2008-2009 Author(s)
00010  *     economic rights: Technische Universität Dresden (Germany)
00011  * License: see LICENSE.spdx (in this directory or the directories above)
00012  */
00013
```

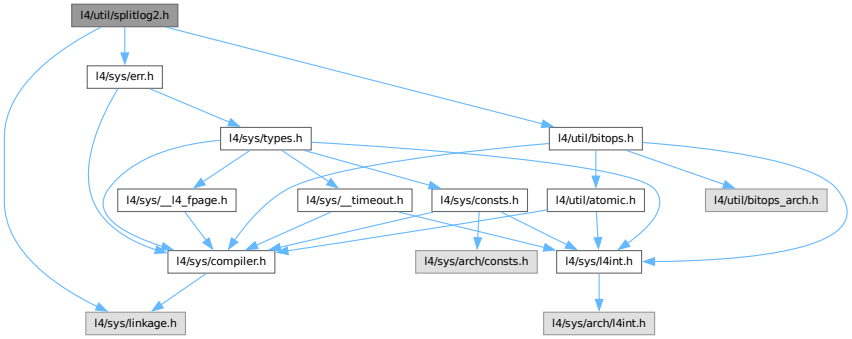
```
00014 #ifndef __L4UTIL_RAND_H
00015 #define __L4UTIL_RAND_H
00016
00017 #define L4_RAND_MAX 65535
00018
00019 #include <l4/sys/compiler.h>
00020 #include <l4/sys/l4int.h>
00021
00022 L4_BEGIN_DECLS
00023
00028
00035 L4_CV l4_uint32_t
00036 l4util_rand(void);
00037
00044 L4_CV void
00045 l4util_srand (l4_uint32_t seed);
00046
00047 L4_END_DECLS
00048
00049 #endif /* __L4UTIL_RAND_H */
```

16.689 l4/util/splitlog2.h File Reference

Split a range in log2 aligned and size-aligned chunks.

```
#include <l4/sys/linkage.h>
#include <l4/sys/err.h>
#include <l4/util/bitops.h>
```

Include dependency graph for splitlog2.h:



Functions

- L4_BEGIN_DECLS long l4util_splitlog2_hdl (l4_addr_t start, l4_addr_t end, long(∗handler)(l4_addr_t s, l4_addr_t e, int log2size))

  Split a range into log2 base and size aligned chunks.
- l4_addr_t l4util_splitlog2_size (l4_addr_t start, l4_addr_t end)

  Return log2 base and size aligned length of a range.

16.689.1 Detailed Description

Split a range in log2 aligned and size-aligned chunks.
Definition in file splitlog2.h.

16.690 splitlog2.h

Go to the documentation of this file.

```
00001
00005 /*
00006  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00007  *     economic rights: Technische Universität Dresden (Germany)
```

```
00008  * License: see LICENSE.spdx (in this directory or the directories above)
00009  */
00010 #ifndef __L4UTIL__INCLUDE__SPLITLOG2_H__
00011 #define __L4UTIL__INCLUDE__SPLITLOG2_H__
00012
00013 #include <l4/sys/linkage.h>
00014 #include <l4/sys/err.h>
00015 #include <l4/util/bitops.h>
00016
00017 L4_BEGIN_DECLS
00018
00031 L4_INLINE long
00032 l4util_splitlog2_hdl(l4_addr_t start, l4_addr_t end,
00033                      long (*handler)(l4_addr_t s, l4_addr_t e, int log2size));
00034
00043 L4_INLINE l4_addr_t
00044 l4util_splitlog2_size(l4_addr_t start, l4_addr_t end);
00045
00046 L4_END_DECLS
00047
00048 /* Implementation */
00049
00050 L4_INLINE long
00051 l4util_splitlog2_hdl(l4_addr_t start, l4_addr_t end,
00052                      long (*handler)(l4_addr_t s, l4_addr_t e, int log2size))
00053 {
00054   if (end < start)
00055     return -L4_EINVAL;
00056
00057   for (;;)
00058     {
00059       long retval;
00060       int len2 = l4util_splitlog2_size(start, end);
00061       l4_addr_t len = 1UL << len2;
00062       l4_addr_t chunk_end = start + len - 1;
00063       if ((retval = handler(start, chunk_end, len2)))
00064         return retval;
00065       if (chunk_end >= end)
00066         return 0;
00067       start = chunk_end + 1;
00068     }
00069 }
00070
00071 L4_INLINE l4_addr_t
00072 l4util_splitlog2_size(l4_addr_t start, l4_addr_t end)
00073 {
00074   int start_bits = l4util_bsf(start);
00075   l4_addr_t len = end - start + 1; // == 0 for entire address space
00076   int len_bits = len ? l4util_bsr(len) : (int)(sizeof(l4_addr_t) * 8 - 1);
00077   if (start_bits != -1 && len_bits > start_bits)
00078     len_bits = start_bits;
00079
00080   return len_bits;
00081 }
00082
00083 #endif /* ! __L4UTIL__INCLUDE__SPLITLOG2_H__ */
```

16.691 util.h

```
00001
00004 /*
00005  * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00006  *               Alexander Warg <warg@os.inf.tu-dresden.de>,
00007  *               Frank Mehnert <fm3@os.inf.tu-dresden.de>
00008  *     economic rights: Technische Universität Dresden (Germany)
00009  * License: see LICENSE.spdx (in this directory or the directories above)
00010  */
00011 #ifndef __L4UTIL__UTIL_H__
00012 #define __L4UTIL__UTIL_H__
00013
00014 #include <l4/sys/types.h>
00015 #include <l4/sys/compiler.h>
00016 #include <l4/sys/ipc.h>
00017
00021
00022 L4_BEGIN_DECLS
00023
00034 L4_CV l4_timeout_s l4util_micros2l4to(l4_uint64_t us) L4_NOTHROW;
00035
00041 L4_CV void l4_sleep(l4_uint32_t ms) L4_NOTHROW;
00042
00049 L4_CV void l4_usleep(l4_uint64_t us) L4_NOTHROW;
00050
00056 L4_INLINE void l4_sleep_forever(void) L4_NOTHROW L4_NORETURN;
```

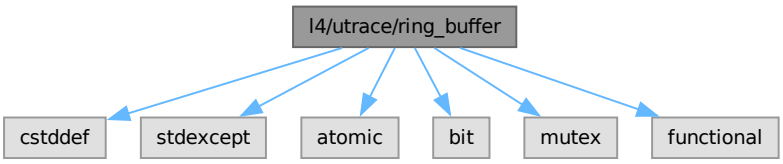
```
00057
00065 L4_INLINE void
00066 l4_touch_ro(const void *addr, unsigned size) L4_NOTHROW;
00067
00075 L4_INLINE void
00076 l4_touch_rw(const void *addr, unsigned size) L4_NOTHROW;
00077
00078
00079
00080 /*
00081  * Implementations
00082  */
00083
00084 L4_INLINE void
00085 l4_sleep_forever(void) L4_NOTHROW
00086 {
00087   for (;;)
00088     l4_ipc_sleep(L4_IPC_NEVER);
00089 }
00090
00091 L4_INLINE void
00092 l4_touch_ro(const void *addr, unsigned size) L4_NOTHROW
00093 {
00094   l4_addr_t b, e;
00095
00096   b = l4_trunc_page((l4_addr_t)addr);
00097   e = l4_trunc_page((l4_addr_t)addr + size - 1);
00098
00099   for (; b <= e; b += L4_PAGESIZE)
00100     (void)(*(volatile char *)b);
00101 }
00102
00103
00104 L4_INLINE void
00105 l4_touch_rw(const void *addr, unsigned size) L4_NOTHROW
00106 {
00107   l4_addr_t b, e;
00108
00109   b = l4_trunc_page((l4_addr_t)addr);
00110   e = l4_trunc_page((l4_addr_t)addr + size - 1);
00111
00112   for (; b <= e; b += L4_PAGESIZE)
00113     *(volatile char *)b |= 0;
00114 }
00115
00116 L4_END_DECLS
00117
00118 #endif /* __L4UTIL__UTIL_H__ */
```

16.692 l4/utrace/ring_buffer File Reference

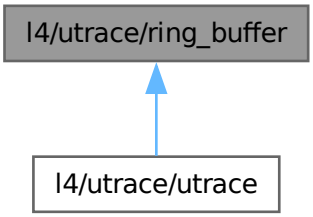
Shared-memory multiple-producer multiple-consumer head-drop ring buffer implementation.

```
#include <cstddef>
#include <stdexcept>
#include <atomic>
#include <bit>
#include <mutex>
#include <functional>
```

Include dependency graph for ring_buffer:



This graph shows which files directly or indirectly include this file:



Data Structures

- class utrace::Ring_buffer< SEQUENCE_TYPE >
  Ring buffer.
- class utrace::Ring_status< SEQUENCE_TYPE >
  Ring buffer status area.
- class utrace::Ring_slot< ITEM_TYPE, GENERATION_PTR >
  Ring buffer slot.
- class utrace::Ring_buffer_producer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >
  Ring buffer producer.
- class utrace::Ring_buffer_consumer_raw< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >
  Polling ring buffer consumer.
- class utrace::Ring_buffer_consumer< SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR >
  Blocking ring buffer consumer.

16.692.1 Detailed Description

Shared-memory multiple-producer multiple-consumer head-drop ring buffer implementation.
This implements a generic ring buffer for transferring fixed-sized items in shared memory between producers and consumers without coupling. This means that the pace of producers is never affected by the pace of consumers (producers never block and never wait for the consumers).
When consumers are unable to dequeue items from the ring buffer quickly enough, they lose access to the oldest items (head-drop policy), but this condition is always detected.
When there are more producers than the total number of items actively enqueuing items into the ring buffer, the state of the ring buffer is undefined. When the sequence/generation counter of the items in the ring buffer overflow, the state of the ring buffer is undefined.
Definition in file ring_buffer.

16.693 ring_buffer

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2026 Kernkonzept GmbH.
00004  * Author(s): Martin Decky <martin.decky@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00028
00029 #pragma once
00030
```

```
00031 #include <cstddef>
00032 #include <stdexcept>
00033 #include <atomic>
00034 #include <bit>
00035 #include <mutex>
00036 #include <functional>
00037
00038 namespace utrace {
00039
00041 #if defined(ARCH_arm64)
00042   static constexpr size_t stable_cache_alignment = 256U;
00043 #elif defined(ARCH_ppc32)
00044   static constexpr size_t stable_cache_alignment = 128U;
00045 #else
00046   static constexpr size_t stable_cache_alignment = 64U;
00047 #endif
00048
00049 #ifdef __GCC_DESTRUCTIVE_SIZE
00050 static_assert(stable_cache_alignment >= __GCC_DESTRUCTIVE_SIZE,
00051               "Stable cache alignment not sufficient");
00052 #endif // __GCC_DESTRUCTIVE_SIZE
00053
00062 template<typename SEQUENCE_TYPE>
00063 class Ring_buffer
00064 {
00065 public:
00066   using Sequence = SEQUENCE_TYPE;
00067   using Generation = std::atomic<Sequence>;
00068
00070   static constexpr Sequence const nil = 0U;
00071
00083   static void check_items(size_t const items)
00084   {
00085     if (items == 0)
00086       throw std::invalid_argument("Zero items not supported.");
00087
00088     if (items != std::bit_ceil(items))
00089       throw std::invalid_argument("Number of items must be power of two.");
00090   }
00091
00103   static void check_mask(size_t const mask)
00104   {
00105     auto items = mask + 1;
00106     if (items != std::bit_ceil(items))
00107       throw std::length_error("Invalid mask.");
00108   }
00109 };
00110
00124 template<typename SEQUENCE_TYPE>
00125 class Ring_status
00126 {
00127 public:
00128   using Sequence = SEQUENCE_TYPE;
00129   using Generation = typename Ring_buffer<Sequence>::Generation;
00130
00131   template<typename S, typename T, auto G> friend class Ring_buffer_producer;
00132   template<typename S, typename T, auto G>
00133   friend class Ring_buffer_consumer_raw;
00134
00142   unsigned version() const
00143   { return _version; }
00144
00152   size_t alignment() const
00153   { return _alignment; }
00154
00156   size_t mask() const
00157   { return _mask; }
00158
00160   size_t items() const
00161   { return _mask + 1; }
00162
00163 private:
00165   unsigned _version;
00166
00168   size_t _alignment;
00169
00171   alignas(stable_cache_alignment) size_t _mask;
00172
00174   alignas(stable_cache_alignment) Generation _tail;
00175 };
00176
00186 template<typename ITEM_TYPE>
00187 static constexpr size_t ring_slot_alignment = std::bit_ceil(sizeof(ITEM_TYPE));
00188
00203 template<typename ITEM_TYPE, auto GENERATION_PTR>
00204 class alignas(ring_slot_alignment<ITEM_TYPE>) Ring_slot
00205 {
```

```
00206 public:
00207   using This = Ring_slot;
00208   using Item = ITEM_TYPE;
00209
00210   template<typename S, typename T, auto G> friend class Ring_buffer_producer;
00211   template<typename S, typename T, auto G>
00212   friend class Ring_buffer_consumer_raw;
00213
00221   static size_t size(size_t const items)
00222   { return items * sizeof(This); }
00223
00224 private:
00227   auto generation() const noexcept
00228   { return std::atomic_ref(_data.*GENERATION_PTR); }
00229
00231   Item _data;
00232 };
00233
00244 template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
00245 class Ring_buffer_producer : public Ring_buffer<SEQUENCE_TYPE>
00246 {
00247 public:
00248   using This = Ring_buffer_producer;
00249   using Super = Ring_buffer<SEQUENCE_TYPE>;
00250
00251   using Item = ITEM_TYPE;
00252
00253   using Status = Ring_status<SEQUENCE_TYPE>;
00254   using Slot = Ring_slot<Item, GENERATION_PTR>;
00255
00271   Ring_buffer_producer(Status &status, Slot &slots, unsigned const version,
00272                        size_t const items) : _status(status), _slots(slots)
00273   {
00274     This::check_items(items);
00275
00276     _status._version = version;
00277     _status._alignment = stable_cache_alignment;
00278     _status._mask = items - 1;
00279     _status._tail = Super::nil;
00280
00281     for (size_t i = 0; i < items; ++i)
00282       _slots[i].generation() = Super::nil;
00283   }
00284
00286   size_t items() const
00287   { return _status.items(); }
00288
00297   void enqueue(Item const &item) const
00298   {
00299     auto next = ++_status._tail;
00300     auto index = next & _status._mask;
00301
00302     auto &generation = _slots[index].generation();
00303     auto &slot = _slots[index]._data;
00304
00305     generation.store(Super::nil, std::memory_order_release);
00306     slot = item;
00307     generation.store(next, std::memory_order_release);
00308   }
00309
00310 private:
00311   Ring_buffer_producer() = delete;
00312
00313   Status &_status;
00314   Slot &_slots;
00315 };
00316
00330 template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
00331 class Ring_buffer_consumer_raw : public Ring_buffer<SEQUENCE_TYPE>
00332 {
00333 public:
00334   using This = Ring_buffer_consumer_raw;
00335   using Super = Ring_buffer<SEQUENCE_TYPE>;
00336
00337   using Sequence = SEQUENCE_TYPE;
00338   using Item = ITEM_TYPE;
00339
00340   using Status = Ring_status<Sequence>;
00341   using Slot = Ring_slot<Item, GENERATION_PTR>;
00342
00350   enum class Drop_policy
00351   {
00361     Conservative = 0,
00362
00371     Minimal
00372   };
00373
```

```
00375   enum class State
00376   {
00377     Idle = 0,  //< No item dequeued.
00378     Ready,     //< An item has been dequeued.
00379     Dropped    //< Some items have been dropped.
00380   };
00381
00391   Ring_buffer_consumer_raw(Status const &status, Slot const *slots)
00392     : _status(status), _slots(slots)
00393   { This::check_mask(_status._mask); }
00394
00396   size_t items() const
00397   { return _status.items(); }
00398
00432   State peek(Item &item, Drop_policy policy, Sequence &current,
00433              Sequence *drops = nullptr) const
00434   {
00435     if (drops)
00436       *drops = 0;
00437
00438     // First access to the ring buffer.
00439     if (current == Super::nil)
00440       current = 1;
00441
00442     auto index = current & _status._mask;
00443
00444     auto const &generation = _slots[index].generation();
00445     auto const &slot = _slots[index]._data;
00446
00447     auto seen = generation.load();
00448     if (seen < current)
00449       {
00450         // Expected item not produced yet.
00451         return State::Idle;
00452       }
00453
00454     if (seen > current)
00455       goto drop;
00456
00457     item = slot;
00458     seen = generation.load();
00459
00460     // Make sure the item has not been overwritten while we have been copying
00461     // the data.
00462     if (seen == current)
00463       {
00464         // Consume item.
00465         ++current;
00466         return State::Ready;
00467       }
00468
00469   drop:
00470     // Seen > current -> drop detected.
00471     Sequence head = _status._tail;
00472
00473     // Conservative drop policy continues at the tail.
00474     // Minimal drop policy continues at the head.
00475     if (policy == Drop_policy::Minimal)
00476       head -= _status._mask;
00477
00478     // How many items have been dropped.
00479     if (drops)
00480       *drops = head - current;
00481
00482     current = head;
00483     return State::Dropped;
00484   }
00485
00486 private:
00487   Ring_buffer_consumer_raw() = delete;
00488
00489   Status const &_status;
00490   Slot const *_slots;
00491 };
00492
00506 template<typename SEQUENCE_TYPE, typename ITEM_TYPE, auto GENERATION_PTR>
00507 class Ring_buffer_consumer
00508   : public Ring_buffer_consumer_raw<SEQUENCE_TYPE, ITEM_TYPE, GENERATION_PTR>
00509 {
00510 public:
00511   using Sequence = SEQUENCE_TYPE;
00512   using Item = ITEM_TYPE;
00513
00514   using Super = Ring_buffer_consumer_raw<Sequence, Item, GENERATION_PTR>;
00515
00516   using Drop_policy = Super::Drop_policy;
00517   using State = Super::State;
```

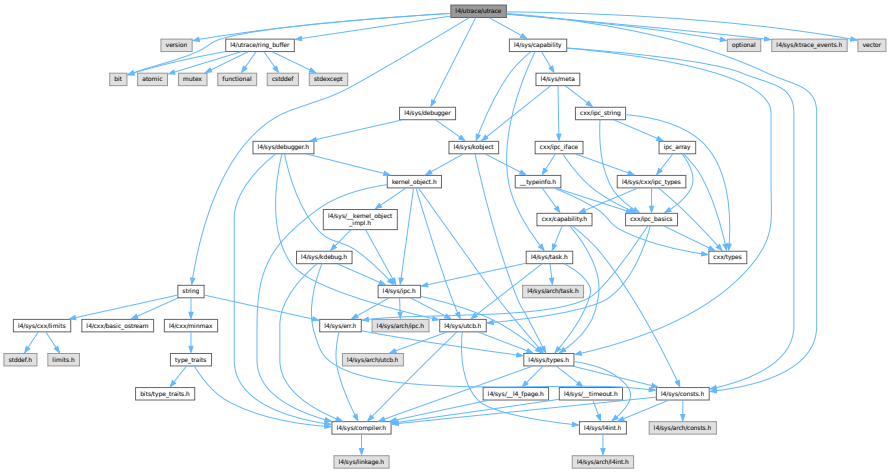
```
00518   using Status = Ring_status<Sequence>;
00519   using Slot = Ring_slot<Item, GENERATION_PTR>;
00520
00521   using Yield = std::function<bool (Sequence)>;
00522
00532   Ring_buffer_consumer(Status const &status, Slot const *slots)
00533     : Super(status, slots)
00534   {}
00535
00557   State peek(Item &item, Drop_policy policy, Sequence *drops = nullptr)
00558   {
00559     const std::lock_guard guard(_lock);
00560     return Super::peek(item, policy, _current, drops);
00561   }
00562
00592   size_t dequeue(Item items[], size_t capacity, size_t burst,
00593                  Drop_policy policy, Yield const &yield,
00594                  Sequence *drops = nullptr)
00595   {
00596     if (drops)
00597       *drops = 0;
00598
00599     size_t count = 0;
00600     size_t idle_cycles = 0;
00601
00602     for (;;)
00603       {
00604         Sequence current_drops;
00605         auto status = peek(items[count], policy, &current_drops);
00606
00607         if (status == State::Dropped)
00608           {
00609             // Some items have been dropped. We need to notify the caller
00610             // about it. Thus return with the items already dequeued.
00611
00612             if (drops)
00613               *drops = current_drops;
00614
00615             break;
00616           }
00617
00618         if (status == State::Ready)
00619           {
00620             // Next item dequeued. Return if there is no space for more items
00621             // in the array.
00622
00623             ++count;
00624             if (count == capacity)
00625               break;
00626
00627             continue;
00628           }
00629
00630         if (status == State::Idle)
00631           {
00632             // No next item has been produced yet. Return if we have already
00633             // dequeued enough items. Otherwise just spin, but allow the yield
00634             // function to implement passive waiting.
00635
00636             if (count >= burst)
00637               break;
00638
00639             ++idle_cycles;
00640             if (yield(idle_cycles))
00641               idle_cycles = 0;
00642           }
00643       }
00644
00645     return count;
00646   }
00647
00648 private:
00649   Ring_buffer_consumer() = delete;
00650   State peek(Item &, Drop_policy, Sequence &, Sequence *) const = delete;
00651
00653   std::mutex _lock;
00654
00656   Sequence _current = 0;
00657 };
00658
00659 } // namespace utrace
```

16.694 l4/utrace/utrace File Reference

L4Re tracebuffer access.

```
#include <version>
#include <bit>
#include <string>
#include <optional>
#include <l4/sys/ktrace_events.h>
#include <l4/sys/consts.h>
#include <l4/sys/capability>
#include <l4/sys/debugger>
#include <l4/utrace/ring_buffer>
#include <vector>
```

Include dependency graph for utrace:



Data Structures

- class utrace::Tracebuffer

  Tracebuffer abstraction.
- struct utrace::Tracebuffer::Index_desc

  Mapping of the dynamic tracebuffer log indexes to names.

16.694.1 Detailed Description

L4Re tracebuffer access.

This is an abstraction for processing the L4Re tracebuffer events. In the current implementation, there is only a single global tracebuffer available via the base debugger (JDB) capability.

Definition in file utrace.

16.695 utrace

Go to the documentation of this file.

```
00001 // vim:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * Copyright (C) 2026 Kernkonzept GmbH.
00004  * Author(s): Martin Decky <martin.decky@kernkonzept.com>
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008
00017
00018 #pragma once
```

```
00019
00020 #include <version>
00021 #include <bit>
00022 #include <string>
00023 #include <optional>
00024 #include <l4/sys/ktrace_events.h>
00025 #include <l4/sys/consts.h>
00026 #include <l4/sys/capability>
00027 #include <l4/sys/debugger>
00028 #include <l4/utrace/ring_buffer>
00029
00030 #if defined(__cpp_lib_generator)
00031 #include <generator>
00032 #else
00033 #include <vector>
00034 #endif
00035
00036 namespace utrace {
00037
00039 static constexpr size_t log_name_buffer_size = 64U;
00040
00042 static constexpr size_t object_name_buffer_size = 16U;
00043
00050 class Tracebuffer
00051 {
00052 public:
00053   using Sequence = L4_ktrace_t__Mword;
00054   using Item = l4_tracebuffer_entry_t;
00055
00056   using Buffer = Ring_buffer_consumer<Sequence, Item, &Item::_number>;
00057   using Drop_policy = Buffer::Drop_policy;
00058   using Status = Buffer::Status;
00059   using Slot = Buffer::Slot;
00060
00061   using Id = unsigned long;
00062
00063   static_assert(sizeof(Status) <= L4_PAGESIZE);
00064
00066   struct Index_desc
00067   {
00068     unsigned index;
00069     std::string name;
00070     std::string shortname;
00071   };
00072
00082   static void validate();
00083
00085   static unsigned version();
00086
00088   static std::endian endianness();
00089
00098   static std::optional<Index_desc> index(unsigned idx);
00099
00106 #if defined(__cpp_lib_generator)
00107   static std::generator<Index_desc> indexes();
00108 #else
00109   static std::vector<Index_desc> indexes();
00110 #endif
00111
00113   static Tracebuffer &instance();
00114
00116   size_t items() const;
00117
00137   size_t dequeue(Item *items, size_t capacity, size_t burst, Drop_policy policy,
00138                  Sequence *drops = nullptr);
00139
00151   static std::optional<Id> ptr_to_id(void *const ptr);
00152
00164   static std::optional<std::string> id_to_name(Id const id);
00165
00166 private:
00167   static constexpr unsigned tracebuffer_version = 0;
00168   static constexpr size_t yield_cycles = 100;
00169
00174   class Factory
00175   {
00176   public:
00178     static Factory &instance();
00179
00181     Status &status();
00182
00184     Slot *slots();
00185
00186   private:
00197     Factory();
00198
00205     ~Factory();
```

```
00206
00220     static l4_fpage_t reserve(size_t size);
00221
00232     static Status *map_status(l4_fpage_t fpage);
00233
00245     static Slot *map_slots(l4_fpage_t fpage, size_t items);
00246
00247     l4_fpage_t _fpage_status;
00248     l4_fpage_t _fpage_slots;
00249
00250     Status *_status;
00251     Slot *_slots;
00252   };
00253
00254   Tracebuffer() = delete;
00255
00261   Tracebuffer(Factory &factory);
00262
00263   static L4::Cap<L4::Debugger> _jdb;
00264   Buffer _buffer;
00265 };
00266
00267 }; // namespace utrace
```

16.696 vbus

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2011 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/vbus/vbus.h>
00011 #include <l4/vbus/vbus_pm.h>
00012 #include <l4/sys/icu>
00013
00014 #include <l4/re/dataspace>
00015 #include <l4/re/dma_space>
00016 #include <l4/re/event>
00017 #include <l4/re/inhibitor>
00018
00036
00040 namespace L4vbus {
00041
00042 class Vbus;
00043
00049 template<typename DEC>
00050 class Pm
00051 {
00052 private:
00053   DEC const *self() const { return static_cast<DEC const *>(this); }
00054   DEC *self() { return static_cast<DEC *>(this); }
00055 public:
00063   int pm_suspend() const
00064   { return l4vbus_pm_suspend(self()->bus_cap().cap(), self()->dev_handle()); }
00065
00074   int pm_resume() const
00075   { return l4vbus_pm_resume(self()->bus_cap().cap(), self()->dev_handle()); }
00076 };
00077
00078
00083 class Device : public Pm<Device>
00084 {
00085 public:
00089   Device() : _dev(L4VBUS_NULL) {}
00090
00100   Device(L4::Cap<Vbus> bus, l4vbus_device_handle_t dev)
00101   : _bus(bus), _dev(dev) {}
00102
00107   L4::Cap<Vbus> bus_cap() const { return _bus; }
00108
00116   l4vbus_device_handle_t dev_handle() const { return _dev; }
00117
00118
00148   int device_by_hid(Device *child, char const *hid,
00149                     int depth = L4VBUS_MAX_DEPTH,
00150                     l4vbus_device_t *devinfo = 0) const
00151   {
00152     child->_bus = _bus;
00153     return l4vbus_get_device_by_hid(_bus.cap(), _dev, &child->_dev, hid,
00154                                     depth, devinfo);
```

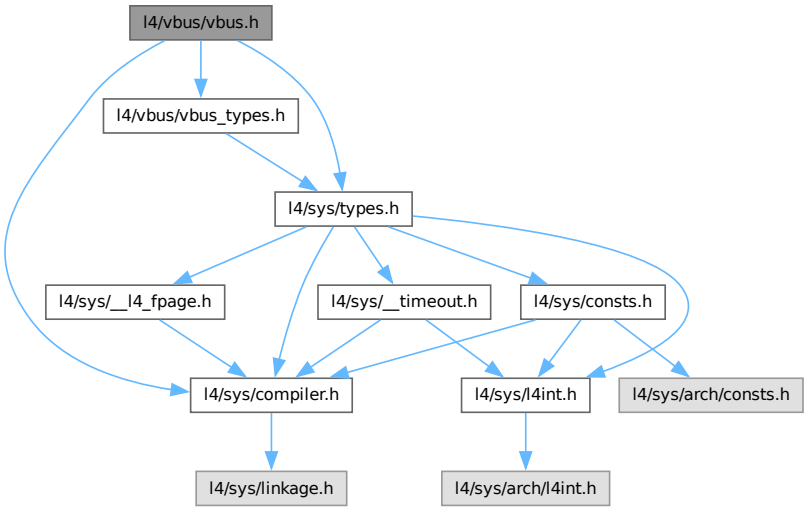
```
00155   }
00156
00171   int next_device(Device *child, int depth = L4VBUS_MAX_DEPTH,
00172                   l4vbus_device_t *devinfo = 0) const
00173   {
00174     child->_bus = _bus;
00175     return l4vbus_get_next_device(_bus.cap(), _dev, &child->_dev, depth,
00176                                   devinfo);
00177   }
00178
00189   int device(l4vbus_device_t *devinfo) const
00190   { return l4vbus_get_device(_bus.cap(), _dev, devinfo); }
00191
00209   int get_resource(unsigned res_idx, l4vbus_resource_t *res) const
00210   {
00211     return l4vbus_get_resource(_bus.cap(), _dev, res_idx, res);
00212   }
00213
00223   int is_compatible(char const *cid) const
00224   { return l4vbus_is_compatible(_bus.cap(), _dev, cid); }
00225
00230   bool operator == (Device const &o) const
00231   {
00232     return _bus == o._bus && _dev == o._dev;
00233   }
00234
00239   bool operator != (Device const &o) const
00240   {
00241     return _bus != o._bus || _dev != o._dev;
00242   }
00243
00244 protected:
00245   L4::Cap<Vbus> _bus;
00247   l4vbus_device_handle_t _dev;
00248 };
00249
00260 class Icu : public Device
00261 {
00262 public:
00264   enum Src_types
00265   {
00273     Src_dev_handle = L4VBUS_ICU_SRC_DEV_HANDLE
00274   };
00275
00285   int vicu(L4::Cap<L4::Icu> icu) const
00286   {
00287     return l4vbus_vicu_get_cap(_bus.cap(), _dev, icu.cap());
00288   }
00289 };
00290
00298 class Vbus : public L4::Kobject_3t<Vbus, L4Re::Dataspace, L4Re::Inhibitor, L4Re::Event>
00299 {
00300 public:
00301
00311   int request_ioport(l4vbus_resource_t *res) const
00312   {
00313     return l4vbus_request_ioport(cap(), res);
00314   }
00315
00323   int release_ioport(l4vbus_resource_t *res) const
00324   {
00325     return l4vbus_release_ioport(cap(), res);
00326   }
00327
00336   Device root() const
00337   {
00338     return Device(L4::Cap<Vbus>(cap()), L4VBUS_ROOT_BUS);
00339   }
00340
00358   int assign_dma_domain(unsigned domain_id, unsigned flags,
00359                         L4::Cap<L4Re::Dma_space> dma_space) const
00360   {
00361     return l4vbus_assign_dma_domain(cap(), domain_id, flags, dma_space.cap());
00362   }
00363
00364   typedef L4::Typeid::Raw_ipc<Vbus> Rpcs;
00365 };
00366
00367 } // namespace L4vbus
```

16.697 l4/vbus/vbus.h File Reference

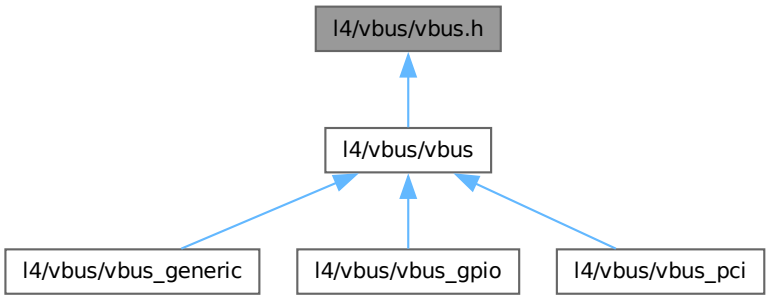
Description of the vbus C API.

```
#include <l4/sys/compiler.h>
#include <l4/vbus/vbus_types.h>
#include <l4/sys/types.h>
```

Include dependency graph for vbus.h:



This graph shows which files directly or indirectly include this file:



Enumerations

- enum { L4VBUS_NULL = -1L , L4VBUS_ROOT_BUS = 0 }

  Constants for device nodes.
- enum l4vbus_icu_src_types { L4VBUS_ICU_SRC_DEV_HANDLE = 1ULL << 63 }

  Flags that can be used with the ICU on a vbus device.
- enum L4vbus_dma_domain_assign_flags { L4VBUS_DMAD_UNBIND = 0 , L4VBUS_DMAD_BIND = 1 , L4VBUS_DMAD_L4RE_DMA_SPACE = 0 }

  Flags for l4vbus_assign_dma_domain().

Functions

- L4_BEGIN_DECLS int l4vbus_get_device_by_hid (l4_cap_idx_t vbus, l4vbus_device_handle_t parent, l4vbus_device_handle_t *child, char const *hid, int depth, l4vbus_device_t *devinfo)

  Find a device by the hardware interface identifier (HID).
- int l4vbus_get_next_device (l4_cap_idx_t vbus, l4vbus_device_handle_t parent, l4vbus_device_handle_t *child, int depth, l4vbus_device_t *devinfo)

  Find next child following `child`.
- int l4vbus_get_device (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, l4vbus_device_t *devinfo)

  Obtain detailed information about a Vbus device.
- int l4vbus_get_resource (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, unsigned res_idx, l4vbus_resource_t *res)

  Obtain the resource description of an individual device resource.
- int l4vbus_is_compatible (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, char const *cid)

  Check if the given device has a compatibility ID (CID) or HID that matches cid.
- int l4vbus_get_hid (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, char *hid, unsigned long max_len)

  Get the HID (hardware identifier) of a device.
- int l4vbus_get_adr (l4_cap_idx_t vbus, l4vbus_device_handle_t dev, l4_uint32_t *adr)

  Get the bus-specific address of a device.
- int l4vbus_request_ioport (l4_cap_idx_t vbus, l4vbus_resource_t const *res)

  Request an IO port resource.
- int l4vbus_assign_dma_domain (l4_cap_idx_t vbus, unsigned domain_id, unsigned flags, l4_cap_idx_t dma_space)

  Bind or unbind a kernel DMA space or a L4Re::Dma_space to a DMA domain.
- int l4vbus_release_ioport (l4_cap_idx_t vbus, l4vbus_resource_t const *res)

  Release a previously requested IO port resource.
- int l4vbus_vicu_get_cap (l4_cap_idx_t vbus, l4vbus_device_handle_t icu, l4_cap_idx_t cap)

  Get capability of ICU.

16.697.1 Detailed Description

Description of the vbus C API.
Definition in file vbus.h.

16.697.2 Enumeration Type Documentation

16.697.2.1 anonymous enum

`anonymous enum`
Constants for device nodes.

Enumerator

L4VBUS_NULL	NULL device.
L4VBUS_ROOT_BUS	Root device on the vbus.

Definition at line 20 of file vbus.h.

16.697.2.2 l4vbus_icu_src_types

`enum l4vbus_icu_src_types`
Flags that can be used with the ICU on a vbus device.

Enumerator

L4VBUS_ICU_SRC_DEV_HANDLE	Flag to denote that the value should be interpreted as a device handle. This flag may be used in the `source` parameter in l4_icu_msi_info() to denote that the ICU should interpret the source ID as a device handle.

Definition at line 26 of file vbus.h.

16.698 vbus.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *          Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00013 #pragma once
00014
00015 #include <l4/sys/compiler.h>
00016 #include <l4/vbus/vbus_types.h>
00017 #include <l4/sys/types.h>
00018
00020 enum {
00021   L4VBUS_NULL = -1L,
00022   L4VBUS_ROOT_BUS = 0,
00023 };
00024
00026 enum l4vbus_icu_src_types {
00033     L4VBUS_ICU_SRC_DEV_HANDLE = 1ULL << 63
00034 };
00035
00053
00054 L4_BEGIN_DECLS
00055
00063 int L4_CV
00064 l4vbus_get_device_by_hid(l4_cap_idx_t vbus, l4vbus_device_handle_t parent,
00065                          l4vbus_device_handle_t *child, char const *hid,
00066                          int depth, l4vbus_device_t *devinfo);
00067
00083 int L4_CV
00084 l4vbus_get_next_device(l4_cap_idx_t vbus, l4vbus_device_handle_t parent,
00085                        l4vbus_device_handle_t *child, int depth,
00086                        l4vbus_device_t *devinfo);
00087
00101 int L4_CV
00102 l4vbus_get_device(l4_cap_idx_t vbus, l4vbus_device_handle_t dev,
00103                   l4vbus_device_t *devinfo);
00104
00113 int L4_CV
00114 l4vbus_get_resource(l4_cap_idx_t vbus, l4vbus_device_handle_t dev,
00115                     unsigned res_idx, l4vbus_resource_t *res);
00116
00117
00124 int L4_CV
00125 l4vbus_is_compatible(l4_cap_idx_t vbus, l4vbus_device_handle_t dev,
00126                      char const *cid);
00127
00138 int L4_CV
00139 l4vbus_get_hid(l4_cap_idx_t vbus, l4vbus_device_handle_t dev, char *hid,
00140                unsigned long max_len);
00141
00152 int L4_CV
00153 l4vbus_get_adr(l4_cap_idx_t vbus, l4vbus_device_handle_t dev, l4_uint32_t *adr);
00154
00168 int L4_CV
00169 l4vbus_request_ioport(l4_cap_idx_t vbus, l4vbus_resource_t const *res);
00170
00174 enum L4vbus_dma_domain_assign_flags
00175 {
00177   L4VBUS_DMAD_UNBIND = 0,
00179   L4VBUS_DMAD_BIND   = 1,
00181   L4VBUS_DMAD_L4RE_DMA_SPACE = 0,
00182 };
00183
00203 int L4_CV
00204 l4vbus_assign_dma_domain(l4_cap_idx_t vbus, unsigned domain_id,
00205                          unsigned flags, l4_cap_idx_t dma_space);
```

```
00206
00215 int L4_CV
00216 l4vbus_release_ioport(l4_cap_idx_t vbus, l4vbus_resource_t const *res);
00217
00227 int L4_CV
00228 l4vbus_vicu_get_cap(l4_cap_idx_t vbus, l4vbus_device_handle_t icu,
00229                     l4_cap_idx_t cap);
00230
00231 L4_END_DECLS
00232
```

16.699 vbus_generic

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2009 Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *          Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009
00010 #pragma once
00011
00012 #include <l4/cxx/ipc_stream>
00013 #include <l4/vbus/vbus_types.h>
00014 #include <l4/vbus/vbus>
00015
00016 inline void
00017 l4vbus_device_msg(l4vbus_device_handle_t handle, l4_uint32_t op,
00018                   L4::Ipc::Iostream &s)
00019 {
00020   s « handle « op;
00021 }
```

16.700 vbus_gpio

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2011 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/vbus/vbus>
00011 #include <l4/vbus/vbus_gpio.h>
00012
00018
00019 namespace L4vbus {
00020
00026 class Gpio_pin : public Device
00027 {
00028 public:
00029   Gpio_pin(Device const &dev, unsigned pin)
00030   : Device(dev), _pin(pin)
00031   {}
00032
00038   int get() const
00039   {
00040     return l4vbus_gpio_get(_bus.cap(), _dev, _pin);
00041   }
00042
00049   int set(int value) const
00050   {
00051     return l4vbus_gpio_set(_bus.cap(), _dev, _pin, value);
00052   }
00053
00064   int setup(unsigned mode, unsigned value) const
00065   {
00066     return l4vbus_gpio_setup(_bus.cap(), _dev, _pin, mode, value);
00067   }
00068
00075   int config_pull(unsigned mode) const
00076   {
00077     return l4vbus_gpio_config_pull(_bus.cap(), _dev, _pin, mode);
00078   }
00079
00089   int config_pad(unsigned func, unsigned value) const
00090   {
```

```
00091     return l4vbus_gpio_config_pad(_bus.cap(), _dev, _pin, func, value);
00092   }
00093
00102   int config_get(unsigned func, unsigned *value) const
00103   {
00104     return l4vbus_gpio_config_get(_bus.cap(), _dev, _pin, func, value);
00105   }
00106
00112   int to_irq() const
00113   {
00114     return l4vbus_gpio_to_irq(_bus.cap(), _dev, _pin);
00115   }
00116
00122   unsigned pin() const { return _pin; }
00123
00124 protected:
00125   Gpio_pin() {}
00126   unsigned _pin;
00127 };
00128
00133 class Gpio_module : public Device
00134 {
00135 public:
00136   Gpio_module(Device dev)
00137   : Device(dev)
00138   {}
00139
00146   struct Pin_slice
00147   {
00148     Pin_slice(unsigned offset, unsigned mask) : offset(offset), mask(mask) {}
00149     unsigned offset, mask;
00150   };
00151
00166   int setup(Pin_slice const &mask, unsigned mode, unsigned value) const
00167   {
00168     return l4vbus_gpio_multi_setup(_bus.cap(), _dev, mask.offset, mask.mask,
00169                                    mode, value);
00170   }
00171
00185   int config_pad(Pin_slice const &mask, unsigned func, unsigned value) const
00186   {
00187     return l4vbus_gpio_multi_config_pad(_bus.cap(), _dev, mask.offset,
00188                                         mask.mask, func, value);
00189   }
00190
00201   int get(unsigned offset, unsigned *data) const
00202   {
00203     return l4vbus_gpio_multi_get(_bus.cap(), _dev, offset, data);
00204   }
00205
00217   int set(Pin_slice const &mask, unsigned data)
00218   {
00219     return l4vbus_gpio_multi_set(_bus.cap(), _dev, mask.offset,
00220                                  mask.mask, data);
00221   }
00222
00229   Gpio_pin pin(unsigned pin) const
00230   {
00231     return Gpio_pin(*this, pin);
00232   }
00233
00234 protected:
00235   Gpio_module() {}
00236 };
00237
00238 }
```

16.701 vbus_gpio-ops.h

```
00001 /*
00002  * (c) 2011 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/vbus/vbus_interfaces.h>
00011
00012 enum L4vbus_gpio_op
00013 {
00014   L4VBUS_GPIO_OP_SETUP = L4VBUS_INTERFACE_GPIO << L4VBUS_IFACE_SHIFT,
00015   L4VBUS_GPIO_OP_CONFIG_PAD,
```

```
00016   L4VBUS_GPIO_OP_CONFIG_GET,
00017   L4VBUS_GPIO_OP_GET,
00018   L4VBUS_GPIO_OP_SET,
00019   L4VBUS_GPIO_OP_MULTI_SETUP,
00020   L4VBUS_GPIO_OP_MULTI_CONFIG_PAD,
00021   L4VBUS_GPIO_OP_MULTI_GET,
00022   L4VBUS_GPIO_OP_MULTI_SET,
00023   L4VBUS_GPIO_OP_TO_IRQ,
00024   L4VBUS_GPIO_OP_CONFIG_PULL
00025 };
```

16.702 vbus_gpio.h

```
00001 /*
00002  * (c) 2011 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/compiler.h>
00010 #include <l4/sys/types.h>
00011 #include <l4/vbus/vbus_types.h>
00012
00018
00019 L4_BEGIN_DECLS
00020
00024 enum L4vbus_gpio_generic_func
00025 {
00026   L4VBUS_GPIO_SETUP_INPUT  = 0x100,
00027   L4VBUS_GPIO_SETUP_OUTPUT = 0x200,
00028   L4VBUS_GPIO_SETUP_IRQ    = 0x300,
00029 };
00030
00034 enum L4vbus_gpio_pull_modes
00035 {
00036   L4VBUS_GPIO_PIN_PULL_NONE = 0x100,
00037   L4VBUS_GPIO_PIN_PULL_UP   = 0x200,
00038   L4VBUS_GPIO_PIN_PULL_DOWN = 0x300,
00039 };
00040
00048 int L4_CV
00049 l4vbus_gpio_setup(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00050                   unsigned pin, unsigned mode, int value);
00051
00059 int L4_CV
00060 l4vbus_gpio_config_pull(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00061                         unsigned pin, unsigned mode);
00062
00070 int L4_CV
00071 l4vbus_gpio_config_pad(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00072                        unsigned pin, unsigned func, unsigned value);
00073
00081 int L4_CV
00082 l4vbus_gpio_config_get(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00083                        unsigned pin, unsigned func, unsigned *value);
00084
00092 int L4_CV
00093 l4vbus_gpio_get(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00094                 unsigned pin);
00095
00103 int L4_CV
00104 l4vbus_gpio_set(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00105                 unsigned pin, int value);
00106
00115 int L4_CV
00116 l4vbus_gpio_multi_setup(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00117                         unsigned offset, unsigned mask,
00118                         unsigned mode, unsigned value);
00119
00128 int L4_CV
00129 l4vbus_gpio_multi_config_pad(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00130                              unsigned offset, unsigned mask,
00131                              unsigned func, unsigned value);
00132
00139 int L4_CV
00140 l4vbus_gpio_multi_get(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00141                       unsigned offset, unsigned *data);
00142
00151 int L4_CV
00152 l4vbus_gpio_multi_set(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00153                       unsigned offset, unsigned mask, unsigned data);
00154
```

```
00162 int L4_CV
00163 l4vbus_gpio_to_irq(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00164                     unsigned pin);
00165
00167
00168 L4_END_DECLS
```

16.703 vbus_i2c.h

```
00001 /*
00002  * (c) 2009 Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/compiler.h>
00010 #include <l4/sys/types.h>
00011 #include <l4/vbus/vbus_types.h>
00012
00013 L4_BEGIN_DECLS
00014
00015 int L4_CV
00016 l4vbus_i2c_write(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00017                  l4_uint16_t addr, l4_uint8_t sub_addr,
00018                  l4_uint8_t *buffer, unsigned long size);
00019
00020 int L4_CV
00021 l4vbus_i2c_read(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00022                 l4_uint16_t addr, l4_uint8_t sub_addr,
00023                 l4_uint8_t *buffer, unsigned long *size);
00024
00025 L4_END_DECLS
```

16.704 vbus_inhibitor.h

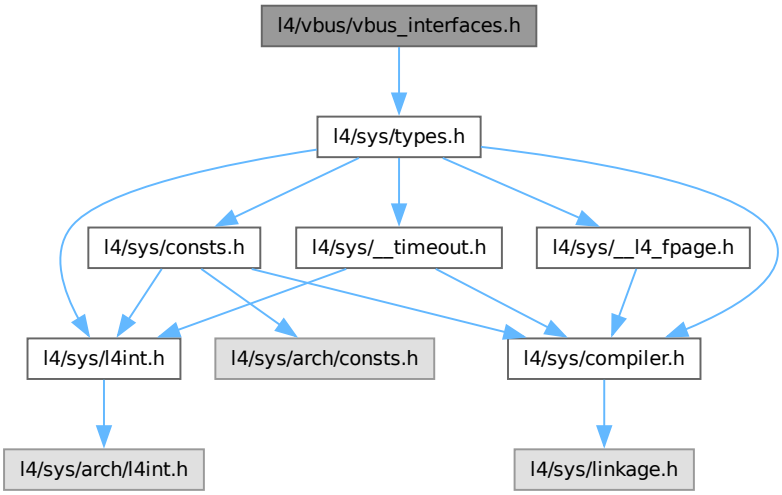
```
00001
00006 #pragma once
00007
00008 enum Vbus_inhibitor
00009 {
00010   L4VBUS_INHIBITOR_SUSPEND  = 0,
00011   L4VBUS_INHIBITOR_SHUTDOWN = 1,
00012   L4VBUS_INHIBITOR_REBOOT   = L4VBUS_INHIBITOR_SHUTDOWN,
00013   L4VBUS_INHIBITOR_WAKEUP   = 2,
00014   L4VBUS_INHIBITOR_MAX
00015 };
00016
```

16.705 l4/vbus/vbus_interfaces.h File Reference

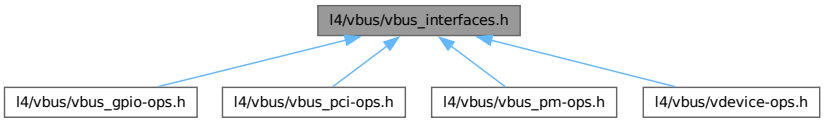
This header contains the definition of VBUS sub-interfaces and convenience functions to work with the interface IDs.

```
#include <l4/sys/types.h>
```

Include dependency graph for vbus_interfaces.h:



This graph shows which files directly or indirectly include this file:



Typedefs

- typedef enum l4vbus_iface_type_t l4vbus_iface_type_t

  Different sub-interfaces a vbus device may support.

Enumerations

- enum l4vbus_iface_type_t {
  L4VBUS_INTERFACE_ICU = 0 , L4VBUS_INTERFACE_GPIO , L4VBUS_INTERFACE_PCI , L4VBUS_INTERFACE_PCIDEV
  ,
  L4VBUS_INTERFACE_PM , L4VBUS_INTERFACE_BUS , L4VBUS_INTERFACE_GENERIC = 0x20 }

  Different sub-interfaces a vbus device may support.
- enum { L4VBUS_IFACE_SHIFT = 26 }

Functions

- unsigned **l4vbus_subinterface** (unsigned opcode)

  Return the ID of the vbus sub-interface.
- unsigned **l4vbus_interface_opcode** (unsigned opcode)

  Return the function opcode within the sub-interface of the vbus command.
- int l4vbus_subinterface_supported (l4_uint32_t dev_type, l4vbus_iface_type_t iface_type)

  Check if a vbus device supports a given sub-interface.

16.705.1 Detailed Description

This header contains the definition of VBUS sub-interfaces and convenience functions to work with the interface IDs.
Definition in file vbus_interfaces.h.

16.705.2 Typedef Documentation

16.705.2.1 l4vbus_iface_type_t

```
typedef enum l4vbus_iface_type_t l4vbus_iface_type_t
```

Different sub-interfaces a vbus device may support.
The IPC interface of vbus devices is divided into functional groups of sub-interfaces. Every device must implement the generic interface which provides general device information. According to the type of device, additional functionality may be supported.
The sub-interface constants are first of all used to divide the function opcode space of the interface into these functional groups (see L4VBUS_IFACE_SHIFT). They also make up a bitmask that specify the type of the device, i.e. from the point of view of the client a device is defined by the kinds of sub-interfaces it supports.

16.705.3 Enumeration Type Documentation

16.705.3.1 anonymous enum

```
anonymous enum
```

Enumerator

L4VBUS_IFACE_SHIFT	Sub-interface ID shift. Divides the function opcode sent via IPC into a sub-interface ID and the actual function opcode within the sub-interface.

Definition at line 48 of file vbus_interfaces.h.

16.705.3.2 l4vbus_iface_type_t

```
enum l4vbus_iface_type_t
```

Different sub-interfaces a vbus device may support.
The IPC interface of vbus devices is divided into functional groups of sub-interfaces. Every device must implement the generic interface which provides general device information. According to the type of device, additional functionality may be supported.
The sub-interface constants are first of all used to divide the function opcode space of the interface into these functional groups (see L4VBUS_IFACE_SHIFT). They also make up a bitmask that specify the type of the device, i.e. from the point of view of the client a device is defined by the kinds of sub-interfaces it supports.

Enumerator

L4VBUS_INTERFACE_ICU	Interrupt Controller.
L4VBUS_INTERFACE_GPIO	GPIO.
L4VBUS_INTERFACE_PCI	PCI.
L4VBUS_INTERFACE_PCIDEV	PCI Device.
L4VBUS_INTERFACE_PM	Power Management.
L4VBUS_INTERFACE_BUS	VBus.
L4VBUS_INTERFACE_GENERIC	No specific sub interface.

Definition at line 29 of file vbus_interfaces.h.

16.705.4 Function Documentation

16.705.4.1 l4vbus_subinterface_supported()

```
int l4vbus_subinterface_supported (
            l4_uint32_t dev_type,
            l4vbus_iface_type_t iface_type)  [inline]
```

Check if a vbus device supports a given sub-interface.

Parameters

dev_type	Device type as reported in l4vbus_device_t.
iface_type	Sub-interface type to check for.

Returns

True if the device supports the sub-interface.

Definition at line 99 of file vbus_interfaces.h.
References L4_INLINE, and L4VBUS_INTERFACE_GENERIC.

16.706 vbus_interfaces.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2014 Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00011 #pragma once
00012
00013 #include <l4/sys/types.h>
00014
00029 typedef enum l4vbus_iface_type_t
00030 {
00032   L4VBUS_INTERFACE_ICU = 0,
00034   L4VBUS_INTERFACE_GPIO,
00036   L4VBUS_INTERFACE_PCI,
00038   L4VBUS_INTERFACE_PCIDEV,
00040   L4VBUS_INTERFACE_PM,
00042   L4VBUS_INTERFACE_BUS,
00044   L4VBUS_INTERFACE_GENERIC = 0x20
00045 } l4vbus_iface_type_t;
00046
00047
00048 enum {
00056   L4VBUS_IFACE_SHIFT = 26
00057 };
00058
00070 L4_INLINE unsigned l4vbus_subinterface(unsigned opcode)
00071 {
00072   return opcode » L4VBUS_IFACE_SHIFT;
00073 }
00074
00086 L4_INLINE unsigned l4vbus_interface_opcode(unsigned opcode)
00087 {
00088   return opcode & ((1 « L4VBUS_IFACE_SHIFT) - 1);
00089 }
00090
00099 L4_INLINE int l4vbus_subinterface_supported(l4_uint32_t dev_type,
00100                                             l4vbus_iface_type_t iface_type)
00101 {
00102   if (iface_type == L4VBUS_INTERFACE_GENERIC)
00103     return 1;
00104
00105   return (dev_type & (1 « iface_type)) ? 1 : 0;
00106 }
```

16.707 vbus_mcspi.h

```
00001 /*
```

```
00002  * (c) 2009 Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/compiler.h>
00010 #include <l4/sys/types.h>
00011 #include <l4/vbus/vbus_types.h>
00012
00013 L4_BEGIN_DECLS
00014
00015 int L4_CV
00016 l4vbus_mcspi_read(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00017                   unsigned channel, l4_umword_t *value);
00018
00019 int L4_CV
00020 l4vbus_mcspi_write(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00021                    unsigned channel, l4_umword_t value);
00022
00023 L4_END_DECLS
```

16.708 vbus_pci

```
00001 // vi:set ft=cpp: -*- Mode: C++ -*-
00002 /*
00003  * (c) 2014 Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include <l4/vbus/vbus>
00011 #include <l4/vbus/vbus_pci.h>
00012
00018
00019 namespace L4vbus {
00020
00025 class Pci_host_bridge : public Device
00026 {
00027 public:
00039   int cfg_read(l4_uint32_t bus, l4_uint32_t devfn, l4_uint32_t reg,
00040                l4_uint32_t *value, l4_uint32_t width) const
00041   {
00042     return l4vbus_pci_cfg_read(bus_cap().cap(), _dev, bus,
00043                                devfn, reg, value, width);
00044   }
00045
00046
00058   int cfg_write(l4_uint32_t bus, l4_uint32_t devfn, l4_uint32_t reg,
00059                 l4_uint32_t value, l4_uint32_t width) const
00060   {
00061     return l4vbus_pci_cfg_write(bus_cap().cap(), _dev, bus,
00062                                 devfn, reg, value, width);
00063   }
00064
00065
00079   int irq_enable(l4_uint32_t bus, l4_uint32_t devfn, int pin,
00080                  unsigned char *trigger, unsigned char *polarity) const
00081   {
00082     return l4vbus_pci_irq_enable(bus_cap().cap(), _dev, bus,
00083                                  devfn, pin, trigger, polarity);
00084   }
00085
00086 };
00087
00088
00093 class Pci_dev : public Device
00094 {
00095 public:
00105   int cfg_read(l4_uint32_t reg, l4_uint32_t *value,
00106                l4_uint32_t width) const
00107   {
00108     return l4vbus_pcidev_cfg_read(bus_cap().cap(), _dev, reg, value, width);
00109   }
00110
00111
00121   int cfg_write(l4_uint32_t reg, l4_uint32_t value,
00122                 l4_uint32_t width) const
00123   {
00124     return l4vbus_pcidev_cfg_write(bus_cap().cap(), _dev, reg, value, width);
00125   }
```

```
00126
00127
00137   int irq_enable(unsigned char *trigger, unsigned char *polarity) const
00138   {
00139     return l4vbus_pcidev_irq_enable(bus_cap().cap(), _dev, trigger, polarity);
00140   }
00141
00142 };
00143
00144 }
```

16.709 vbus_pci-ops.h

```
00001 /*
00002  * (c) 2014 Sarah Hoffmann <sarah.hoffmann@kernkonzept.com>
00003  *
00004  * License: see LICENSE.spdx (in this directory or the directories above)
00005  */
00006 #pragma once
00007
00008 #include <l4/vbus/vbus_interfaces.h>
00009
00010 enum
00011 {
00012   L4vbus_pciroot_cfg_read = L4VBUS_INTERFACE_PCI « L4VBUS_IFACE_SHIFT,
00013   L4vbus_pciroot_cfg_write,
00014   L4vbus_pciroot_cfg_irq_enable
00015 };
00016
00017 enum
00018 {
00019   L4vbus_pcidev_cfg_read = L4VBUS_INTERFACE_PCIDEV « L4VBUS_IFACE_SHIFT,
00020   L4vbus_pcidev_cfg_write,
00021   L4vbus_pcidev_cfg_irq_enable
00022 };
```

16.710 vbus_pci.h

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00008 #pragma once
00009
00010 #include <l4/sys/compiler.h>
00011 #include <l4/vbus/vbus_types.h>
00012 #include <l4/sys/types.h>
00013
00019
00020
00021 L4_BEGIN_DECLS
00022
00029 int L4_CV
00030 l4vbus_pci_cfg_read(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00031                     l4_uint32_t bus, l4_uint32_t devfn,
00032                     l4_uint32_t reg, l4_uint32_t *value, l4_uint32_t width);
00033
00040 int L4_CV
00041 l4vbus_pci_cfg_write(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00042                      l4_uint32_t bus, l4_uint32_t devfn,
00043                      l4_uint32_t reg, l4_uint32_t value, l4_uint32_t width);
00044
00051 int L4_CV
00052 l4vbus_pci_irq_enable(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00053                       l4_uint32_t bus, l4_uint32_t devfn,
00054                       int pin, unsigned char *trigger,
00055                       unsigned char *polarity);
00056
00057
00064 int L4_CV
00065 l4vbus_pcidev_cfg_read(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00066                        l4_uint32_t reg, l4_uint32_t *value, l4_uint32_t width);
00067
00074 int L4_CV
00075 l4vbus_pcidev_cfg_write(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00076                         l4_uint32_t reg, l4_uint32_t value, l4_uint32_t width);
00077
00084 int L4_CV
```

```
00085 l4vbus_pcidev_irq_enable(l4_cap_idx_t vbus, l4vbus_device_handle_t handle,
00086                          unsigned char *trigger,
00087                          unsigned char *polarity);
00088
00089
00090
00092 L4_END_DECLS
```

16.711 vbus_pm-ops.h

```
00001 /*
00002  * (c) 2013 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007
00008 #pragma once
00009
00010 #include "vbus_interfaces.h"
00011
00012 enum L4vbus_pm_op
00013 {
00014   L4VBUS_PM_OP_SUSPEND = L4VBUS_INTERFACE_PM « L4VBUS_IFACE_SHIFT,
00015   L4VBUS_PM_OP_RESUME,
00016 };
00017
```

16.712 vbus_pm.h

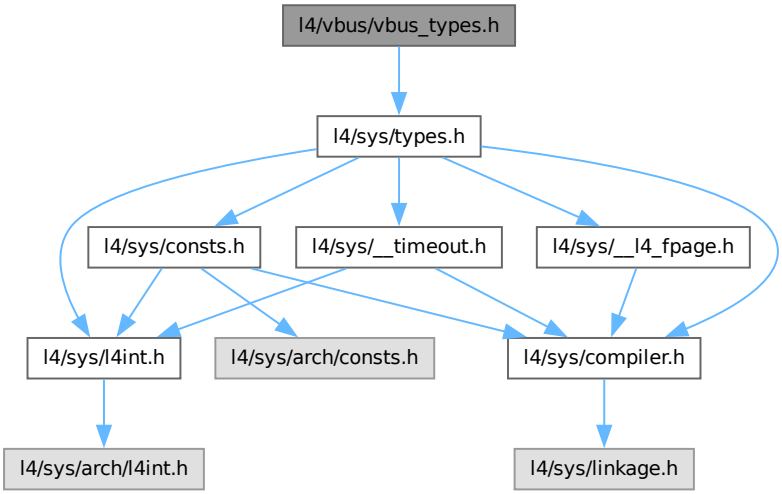
```
00001 /*
00002  * (c) 2013 Alexander Warg <warg@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00007 #pragma once
00008
00009 #include <l4/sys/compiler.h>
00010 #include <l4/vbus/vbus_types.h>
00011 #include <l4/sys/types.h>
00012
00018
00019 L4_BEGIN_DECLS
00020
00027 int L4_CV
00028 l4vbus_pm_suspend(l4_cap_idx_t vbus, l4vbus_device_handle_t handle);
00029
00036 int L4_CV
00037 l4vbus_pm_resume(l4_cap_idx_t vbus, l4vbus_device_handle_t handle);
00038
00040
00041 L4_END_DECLS
```

16.713 l4/vbus/vbus_types.h File Reference

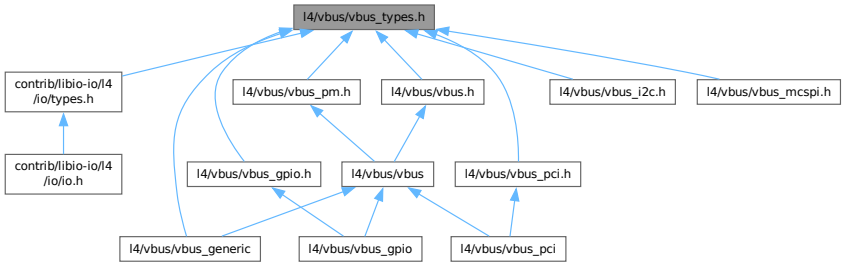
This header file contains descriptions of vbus related data types and constants.

```
#include <l4/sys/types.h>
```

Include dependency graph for vbus_types.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4vbus_resource_t

  Description of a single vbus resource.
- struct l4vbus_device_t

  Detailed information about a vbus device.

Typedefs

- typedef l4_mword_t **l4vbus_device_handle_t**

  Device handle for a device on the vbus.
- typedef l4_addr_t **l4vbus_paddr_t**

  Address of resources on the vbus.

Enumerations

- enum l4vbus_resource_type_t {
  L4VBUS_RESOURCE_INVALID = 0 , L4VBUS_RESOURCE_IRQ , L4VBUS_RESOURCE_MEM ,

L4VBUS_RESOURCE_PORT ,
L4VBUS_RESOURCE_BUS , L4VBUS_RESOURCE_GPIO , L4VBUS_RESOURCE_DMA_DOMAIN ,
L4VBUS_RESOURCE_CLOCK ,
L4VBUS_RESOURCE_MAX }

Description of vbus resource types.

- enum l4vbus_resource_flags_t {
L4VBUS_RESOURCE_F_MEM_R = 0x1 , L4VBUS_RESOURCE_F_MEM_W = 0x2 , L4VBUS_RESOURCE_F_MEM_PREFE
= 0x10 , L4VBUS_RESOURCE_F_MEM_CACHEABLE = 0x20 ,
L4VBUS_RESOURCE_F_MEM_MMIO_READ = 0x2000 , L4VBUS_RESOURCE_F_MEM_MMIO_WRITE
= 0x4000 }

  Description of vbus resource flags.

- enum l4vbus_device_flags_t { L4VBUS_DEVICE_F_CHILDREN = 0x10 }

  Flags describing device properties, see l4vbus_device_t.

16.713.1 Detailed Description

This header file contains descriptions of vbus related data types and constants.
Definition in file vbus_types.h.

16.713.2 Enumeration Type Documentation

16.713.2.1 l4vbus_device_flags_t

`enum l4vbus_device_flags_t`
Flags describing device properties, see l4vbus_device_t.

Enumerator

L4VBUS_DEVICE_F_CHILDREN	Device has child devices.

Definition at line 93 of file vbus_types.h.

16.713.2.2 l4vbus_resource_flags_t

`enum l4vbus_resource_flags_t`
Description of vbus resource flags.

Enumerator

L4VBUS_RESOURCE_F_MEM_R	Memory resource is readable.
L4VBUS_RESOURCE_F_MEM_W	Memory resource is writeable.
L4VBUS_RESOURCE_F_MEM_PREFETCHABLE	Memory resource is prefetchable. Clients may map it buffered or non-cached.
L4VBUS_RESOURCE_F_MEM_CACHEABLE	Memory resource is cacheable. This implies that the memory resource is prefetchable. If not set, clients must not map it cached. If the resource is neither cacheable nor prefetchable, clients must map it non-cached!
L4VBUS_RESOURCE_F_MEM_MMIO_READ	Reading needs to be performed using the MMIO space protocol.
L4VBUS_RESOURCE_F_MEM_MMIO_WRITE	Writing needs to be performed using the MMIO space protocol.

Definition at line 52 of file vbus_types.h.

16.713.2.3 l4vbus_resource_type_t

enum l4vbus_resource_type_t
Description of vbus resource types.

Enumerator

L4VBUS_RESOURCE_INVALID	Invalid type.
L4VBUS_RESOURCE_IRQ	Interrupt resource.
L4VBUS_RESOURCE_MEM	I/O memory resource.
L4VBUS_RESOURCE_PORT	I/O port resource (x86 only).
L4VBUS_RESOURCE_BUS	Bus resource.
L4VBUS_RESOURCE_GPIO	Gpio resource.
L4VBUS_RESOURCE_DMA_DOMAIN	DMA domain.
L4VBUS_RESOURCE_CLOCK	Clock with dedicated frequency.
L4VBUS_RESOURCE_MAX	Maximum resource id.

Definition at line 39 of file vbus_types.h.

16.714 vbus_types.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00013 #pragma once
00014
00015 #include <l4/sys/types.h>
00016
00018 typedef l4_mword_t l4vbus_device_handle_t;
00020 typedef l4_addr_t l4vbus_paddr_t;
00021
00023 typedef struct {
00025   l4_uint16_t    type;
00027   l4_uint16_t    flags;
00029   l4vbus_paddr_t start;
00031   l4vbus_paddr_t end;
00033   l4vbus_device_handle_t provider;
00035   l4_uint32_t id;
00036 } l4vbus_resource_t;
00037
00039 enum l4vbus_resource_type_t {
00040   L4VBUS_RESOURCE_INVALID = 0,
00041   L4VBUS_RESOURCE_IRQ,
00042   L4VBUS_RESOURCE_MEM,
00043   L4VBUS_RESOURCE_PORT,
00044   L4VBUS_RESOURCE_BUS,
00045   L4VBUS_RESOURCE_GPIO,
00046   L4VBUS_RESOURCE_DMA_DOMAIN,
00047   L4VBUS_RESOURCE_CLOCK,
00048   L4VBUS_RESOURCE_MAX,
00049 };
00050
00052 enum l4vbus_resource_flags_t {
00054   L4VBUS_RESOURCE_F_MEM_R = 0x1,
00056   L4VBUS_RESOURCE_F_MEM_W = 0x2,
00061   L4VBUS_RESOURCE_F_MEM_PREFETCHABLE = 0x10,
00068   L4VBUS_RESOURCE_F_MEM_CACHEABLE = 0x20,
00070   L4VBUS_RESOURCE_F_MEM_MMIO_READ = 0x2000,
00072   L4VBUS_RESOURCE_F_MEM_MMIO_WRITE = 0x4000,
00073 };
00074
00075 enum l4vbus_consts_t {
00076   L4VBUS_DEV_NAME_LEN = 64,
00077   L4VBUS_MAX_DEPTH = 100,
00078 };
```

```
00079
00081 typedef struct {
00083   l4_uint32_t   type;
00085   char          name[L4VBUS_DEV_NAME_LEN];
00087   unsigned      num_resources;
00089   unsigned      flags;
00090 } l4vbus_device_t;
00091
00093 enum l4vbus_device_flags_t {
00094   L4VBUS_DEVICE_F_CHILDREN = 0x10,
00095 };
```

16.715 vdevice-ops.h

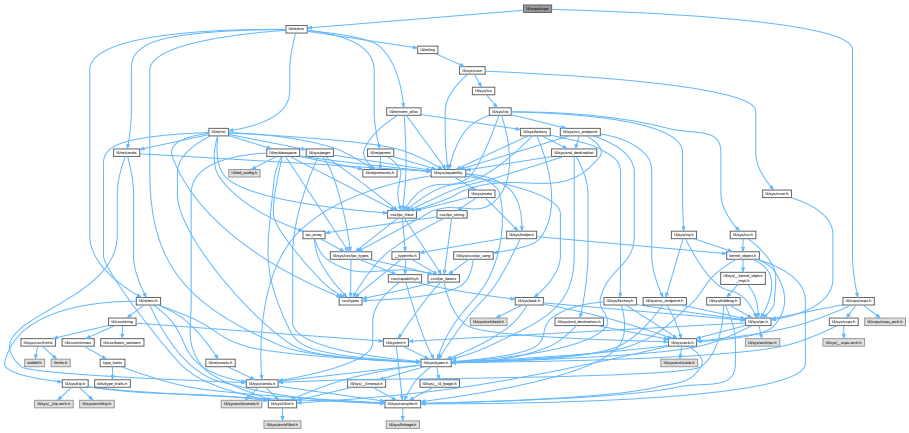
```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>,
00004  *          Torsten Frenzel <frenzel@os.inf.tu-dresden.de>
00005  *     economic rights: Technische Universität Dresden (Germany)
00006  *
00007  * License: see LICENSE.spdx (in this directory or the directories above)
00008  */
00009 #pragma once
00010
00011 #include "vbus_interfaces.h"
00012
00013 enum L4vbus_vdevice_op
00014 {
00015   L4vbus_vdevice_hid = L4VBUS_INTERFACE_GENERIC << L4VBUS_IFACE_SHIFT,
00016   L4vbus_vdevice_adr,
00017   L4vbus_vdevice_get_by_hid,
00018   L4vbus_vdevice_get_next,
00019   L4vbus_vdevice_get_resource,
00020   L4vbus_vdevice_get_hid,
00021   L4vbus_vdevice_is_compatible,
00022   L4vbus_vdevice_get,
00023 };
00024
00025 enum {
00026   L4vbus_vbus_request_resource = L4VBUS_INTERFACE_BUS << L4VBUS_IFACE_SHIFT,
00027   L4vbus_vbus_release_resource,
00028   L4vbus_vbus_assign_dma_domain,
00029 };
00030
00031 enum
00032 {
00033   L4vbus_vicu_get_cap = L4VBUS_INTERFACE_ICU << L4VBUS_IFACE_SHIFT
00034 };
00035
```

16.716 l4/vcpu/vcpu File Reference

vCPU support library (C++ interface).

```
#include <l4/re/env>
#include <l4/vcpu/vcpu.h>
```

Include dependency graph for vcpu:



Data Structures

- class L4vcpu::State

  C++ implementation of state word in the vCPU area.
- class L4vcpu::Vcpu

  C++ implementation of the vCPU save state area.

16.716.1 Detailed Description

vCPU support library (C++ interface).
Definition in file vcpu.

16.717 vcpu

Go to the documentation of this file.

```
00001 // vi:se ft=cpp:
00002 /*
00003  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012
00013 #pragma once
00014
00015 #include <l4/re/env>
00016 #include <l4/vcpu/vcpu.h>
00017
00018 namespace L4vcpu {
00019
00024 class State
00025 {
00026 public:
00027   State() {}
00028
00034   explicit State(unsigned v) : _s(v) {}
00035
00041   void add(unsigned bits) throw()    { _s |= bits; }
00042
00048   void clear(unsigned bits) throw()  { _s &= ~bits; }
00049
00055   void set(unsigned v) throw() { _s = v; }
00056
00057 private:
00058   __typeof__(((l4_vcpu_state_t *)0)->state) _s;
00059 };
00060
00065 class Vcpu : private l4_vcpu_state_t
00066 {
00067 public:
00071   void irq_disable() throw()
```

```
00072   { l4vcpu_irq_disable(this); }
00073
00078   unsigned irq_disable_save() throw()
00079   { return l4vcpu_irq_disable_save(this); }
00080
00081   l4_vcpu_state_t *s() { return this; }
00082   l4_vcpu_state_t const *s() const { return this; }
00083
00088   State *state() throw()
00089   {
00090     static_assert(sizeof(State) == sizeof(l4_vcpu_state_t::state),
00091                   "size mismatch");
00092     return reinterpret_cast<State *>(&(l4_vcpu_state_t::state));
00093   }
00094
00099   State state() const throw()
00100   { return static_cast<State>(l4_vcpu_state_t::state); }
00101
00106   State *saved_state() throw()
00107   {
00108     static_assert(sizeof(State) == sizeof(l4_vcpu_state_t::saved_state),
00109                   "size mismatch");
00110     return reinterpret_cast<State *>(&(l4_vcpu_state_t::saved_state));
00111   }
00116   State saved_state() const throw()
00117   { return static_cast<State>(l4_vcpu_state_t::saved_state); }
00118
00122   l4_uint16_t sticky_flags() const throw()
00123   { return l4_vcpu_state_t::sticky_flags; }
00124
00135   void irq_enable(l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb,
00136                   l4vcpu_setup_ipc_t setup_ipc) throw()
00137   { l4vcpu_irq_enable(this, utcb, do_event_work_cb, setup_ipc); }
00138
00150   void irq_restore(unsigned s, l4_utcb_t *utcb,
00151                    l4vcpu_event_hndl_t do_event_work_cb,
00152                    l4vcpu_setup_ipc_t setup_ipc) throw()
00153   { l4vcpu_irq_restore(this, s, utcb, do_event_work_cb, setup_ipc); }
00154
00166   void wait_for_event(l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb,
00167                       l4vcpu_setup_ipc_t setup_ipc) throw()
00168   { l4vcpu_wait_for_event(this, utcb, do_event_work_cb, setup_ipc); }
00169
00174   void task(L4::Cap<L4::Task> const task = L4::Cap<L4::Task>::Invalid) throw()
00175   { user_task = task.cap(); }
00176
00181   int is_page_fault_entry() const
00182   { return l4vcpu_is_page_fault_entry(this); }
00183
00188   int is_irq_entry() const
00189   { return l4vcpu_is_irq_entry(this); }
00190
00195   l4_vcpu_regs_t *r() throw()
00196   { return &(l4_vcpu_state_t::r); }
00197
00202   l4_vcpu_regs_t const *r() const throw()
00203   { return &(l4_vcpu_state_t::r); }
00204
00209   l4_vcpu_ipc_regs_t *i() throw()
00210   { return &(l4_vcpu_state_t::i); }
00211
00216   l4_vcpu_ipc_regs_t const *i() const throw()
00217   { return &(l4_vcpu_state_t::i); }
00218
00225   void entry_sp(l4_umword_t sp)
00226   { l4_vcpu_state_t::entry_sp = sp; }
00227
00232   void entry_ip(l4_umword_t ip)
00233   { l4_vcpu_state_t::entry_ip = ip; }
00234
00246   L4_CV static int
00247   ext_alloc(Vcpu **vcpu,
00248             l4_addr_t *ext_state,
00249             L4::Cap<L4::Task> task = L4Re::Env::env()->task(),
00250             L4::Cap<L4Re::Rm> rm = L4Re::Env::env()->rm()) throw();
00251
00259   static inline Vcpu *cast(void *x) throw()
00260   { return reinterpret_cast<Vcpu *>(x); }
00261
00269   static inline Vcpu *cast(l4_addr_t x) throw()
00270   { return reinterpret_cast<Vcpu *>(x); }
00271
00275   void print_state(const char *prefix = "") const throw()
00276   { l4vcpu_print_state(this, prefix); }
00277 };
00278
00279
```

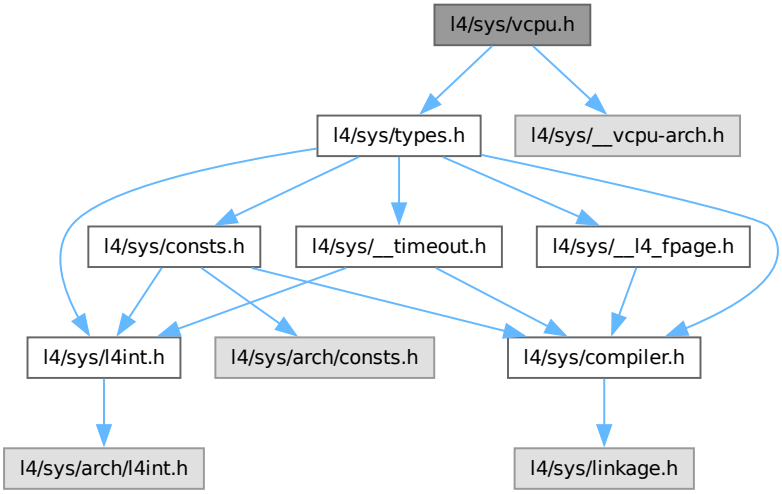
```
00280 }
```

16.718 l4/sys/vcpu.h File Reference

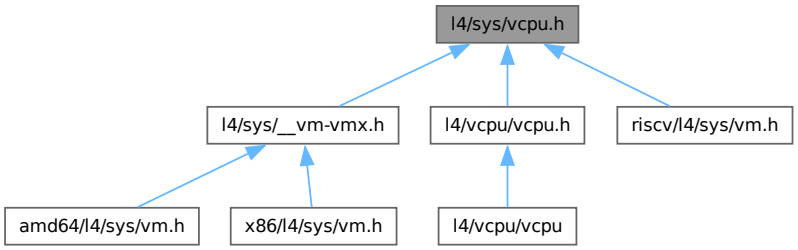
vCPU API

```
#include <l4/sys/types.h>
#include <l4/sys/__vcpu-arch.h>
```

Include dependency graph for vcpu.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct l4_vcpu_state_t

  State of a vCPU.

Typedefs

- typedef struct l4_vcpu_state_t **l4_vcpu_state_t**

  State of a vCPU.

Enumerations

- enum L4_vcpu_state_flags {
  L4_VCPU_F_IRQ = 0x01 , L4_VCPU_F_PAGE_FAULTS = 0x02 , L4_VCPU_F_EXCEPTIONS = 0x04 ,
  L4_VCPU_F_USER_MODE = 0x20 ,
  L4_VCPU_F_FPU_ENABLED = 0x80 }

  State flags of a vCPU.
- enum L4_vcpu_sticky_flags { L4_VCPU_SF_IRQ_PENDING = 0x01 }

  Sticky flags of a vCPU.

Functions

- int l4_vcpu_check_version (l4_vcpu_state_t const *vcpu) L4_NOTHROW

  Check if a vCPU state has the right version.

16.718.1 Detailed Description

vCPU API
Definition in file vcpu.h.

16.718.2 Function Documentation

16.718.2.1 l4_vcpu_check_version()

```
int l4_vcpu_check_version (
            l4_vcpu_state_t const * vcpu)  [inline]
```

Check if a vCPU state has the right version.

Parameters

vcpu	A pointer to an initialized vCPU state.

Return values

1	If the vCPU state has a matching version ID for the current vCPU user-level structures.
0	If the vCPU state has a different (incompatible) version ID than the current vCPU user-level structures.

Definition at line 191 of file vcpu.h.
References L4_NOTHROW, and L4_VCPU_STATE_VERSION.

16.719 vcpu.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
00003  *          Alexander Warg <warg@os.inf.tu-dresden.de>
00004  *     economic rights: Technische Universität Dresden (Germany)
00005  *
00006  * License: see LICENSE.spdx (in this directory or the directories above)
00007  */
00012 #pragma once
00013
00014 #include <l4/sys/types.h>
00015 #include <l4/sys/__vcpu-arch.h>
00016
00070
00075 typedef struct l4_vcpu_state_t
00076 {
00077   l4_umword_t          version;
00080   l4_umword_t          user_data[7];
```

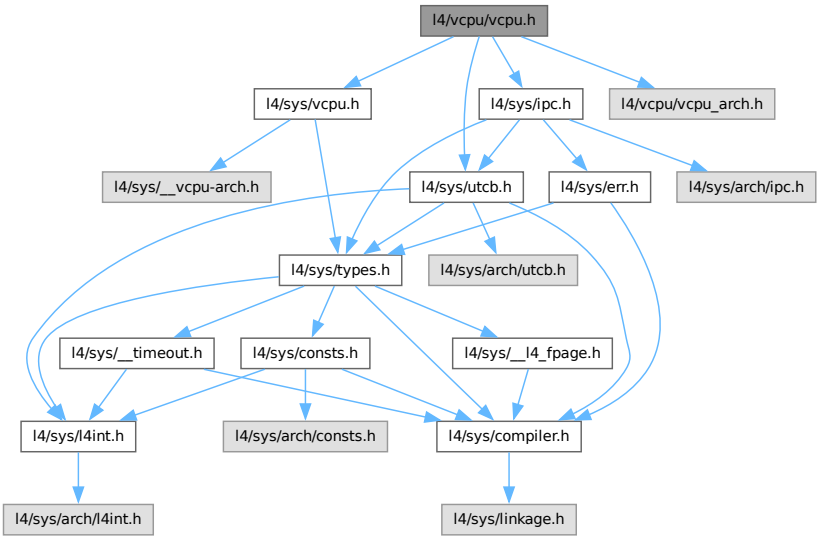
```
00081   l4_vcpu_regs_t       r;
00082   l4_vcpu_ipc_regs_t   i;
00083
00084   l4_uint16_t          state;
00085   l4_uint16_t          saved_state;
00086   l4_uint16_t          sticky_flags;
00087   l4_uint16_t          _reserved;
00088
00089   l4_cap_idx_t         user_task;
00090
00091   l4_umword_t          entry_sp;
00092   l4_umword_t          entry_ip;
00093   l4_umword_t          reserved_sp;
00094   l4_vcpu_arch_state_t arch_state;
00095 } l4_vcpu_state_t;
00096
00101 enum L4_vcpu_state_flags
00102 {
00114   L4_VCPU_F_IRQ         = 0x01,
00115
00129   L4_VCPU_F_PAGE_FAULTS = 0x02,
00130
00142   L4_VCPU_F_EXCEPTIONS  = 0x04,
00143
00152   L4_VCPU_F_USER_MODE   = 0x20,
00153
00160   L4_VCPU_F_FPU_ENABLED = 0x80,
00161 };
00162
00167 enum L4_vcpu_sticky_flags
00168 {
00171   L4_VCPU_SF_IRQ_PENDING = 0x01,
00172 };
00173
00185 L4_INLINE int
00186 l4_vcpu_check_version(l4_vcpu_state_t const *vcpu) L4_NOTHROW;
00187
00188 /* IMPLEMENTATION: ----------------------------------------------*/
00189
00190 L4_INLINE int
00191 l4_vcpu_check_version(l4_vcpu_state_t const *vcpu) L4_NOTHROW
00192 {
00193   return vcpu->version == L4_VCPU_STATE_VERSION;
00194 }
```

16.720 l4/vcpu/vcpu.h File Reference

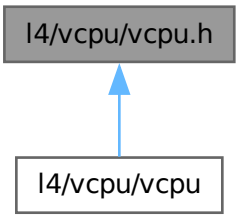
vCPU support library (C interface).

```
#include <l4/sys/vcpu.h>
#include <l4/sys/utcb.h>
#include <l4/sys/ipc.h>
#include <l4/vcpu/vcpu_arch.h>
```

Include dependency graph for vcpu.h:



This graph shows which files directly or indirectly include this file:



Functions

- void l4vcpu_irq_disable (l4_vcpu_state_t *vcpu) L4_NOTHROW

  Disable a vCPU for event delivery.
- unsigned l4vcpu_irq_disable_save (l4_vcpu_state_t *vcpu) L4_NOTHROW

  Disable a vCPU for event delivery and return previous state.
- void l4vcpu_irq_enable (l4_vcpu_state_t *vcpu, l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work_cb, l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW

  Enable a vCPU for event delivery.
- void l4vcpu_irq_restore (l4_vcpu_state_t *vcpu, unsigned s, l4_utcb_t *utcb, l4vcpu_event_hndl_t do_↩ event_work_cb, l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW

  Restore a previously saved IRQ/event state.
- void l4vcpu_wait_for_event (l4_vcpu_state_t *vcpu, l4_utcb_t *utcb, l4vcpu_event_hndl_t do_event_work↩ _cb, l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW

  Wait for event.
- void l4vcpu_print_state (const l4_vcpu_state_t *vcpu, const char *prefix) L4_NOTHROW

Print the state of a vCPU.

- int l4vcpu_is_irq_entry (l4_vcpu_state_t const *vcpu) L4_NOTHROW

  Return whether the entry reason was an IRQ/IPC message.

- int l4vcpu_is_page_fault_entry (l4_vcpu_state_t const *vcpu) L4_NOTHROW

  Return whether the entry reason was a page fault.

- int l4vcpu_ext_alloc (l4_vcpu_state_t **vcpu, l4_addr_t *ext_state, l4_cap_idx_t task, l4_cap_idx_t regmgr) L4_NOTHROW

  Allocate state area for an extended vCPU.

16.720.1 Detailed Description

vCPU support library (C interface).
Definition in file vcpu.h.

16.721 vcpu.h

Go to the documentation of this file.

```
00001 /*
00002  * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
00003  *     economic rights: Technische Universität Dresden (Germany)
00004  *
00005  * License: see LICENSE.spdx (in this directory or the directories above)
00006  */
00011 #pragma once
00012
00013 #include <l4/sys/vcpu.h>
00014 #include <l4/sys/utcb.h>
00015
00016 __BEGIN_DECLS
00017
00026
00032
00033 typedef void (*l4vcpu_event_hndl_t)(l4_vcpu_state_t *vcpu);
00034 typedef void (*l4vcpu_setup_ipc_t)(l4_utcb_t *utcb);
00035
00042 L4_CV L4_INLINE
00043 void
00044 l4vcpu_irq_disable(l4_vcpu_state_t *vcpu) L4_NOTHROW;
00045
00054 L4_CV L4_INLINE
00055 unsigned
00056 l4vcpu_irq_disable_save(l4_vcpu_state_t *vcpu) L4_NOTHROW;
00057
00070 L4_CV L4_INLINE
00071 void
00072 l4vcpu_irq_enable(l4_vcpu_state_t *vcpu, l4_utcb_t *utcb,
00073                   l4vcpu_event_hndl_t do_event_work_cb,
00074                   l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW;
00075
00090 L4_CV L4_INLINE
00091 void
00092 l4vcpu_irq_restore(l4_vcpu_state_t *vcpu, unsigned s,
00093                    l4_utcb_t *utcb,
00094                    l4vcpu_event_hndl_t do_event_work_cb,
00095                    l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW;
00096
00110 L4_CV L4_INLINE
00111 void
00112 l4vcpu_wait(l4_vcpu_state_t *vcpu, l4_utcb_t *utcb,
00113             l4_timeout_t to,
00114             l4vcpu_event_hndl_t do_event_work_cb,
00115             l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW;
00116
00130 L4_CV L4_INLINE
00131 void
00132 l4vcpu_wait_for_event(l4_vcpu_state_t *vcpu, l4_utcb_t *utcb,
00133                       l4vcpu_event_hndl_t do_event_work_cb,
00134                       l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW;
00135
00136
00144 L4_CV void
00145 l4vcpu_print_state(const l4_vcpu_state_t *vcpu, const char *prefix) L4_NOTHROW;
00146
00150 L4_CV void
00151 l4vcpu_print_state_arch(const l4_vcpu_state_t *vcpu, const char *prefix) L4_NOTHROW;
00152
```

```
00153
00162 L4_CV L4_INLINE
00163 int
00164 l4vcpu_is_irq_entry(l4_vcpu_state_t const *vcpu) L4_NOTHROW;
00165
00174 L4_CV L4_INLINE
00175 int
00176 l4vcpu_is_page_fault_entry(l4_vcpu_state_t const *vcpu) L4_NOTHROW;
00177
00189 L4_CV int
00190 l4vcpu_ext_alloc(l4_vcpu_state_t **vcpu, l4_addr_t *ext_state,
00191                  l4_cap_idx_t task, l4_cap_idx_t regmgr) L4_NOTHROW;
00192
00193 /* ================================================================== */
00194 /* Implementations */
00195
00196 #include <l4/sys/ipc.h>
00197 #include <l4/vcpu/vcpu_arch.h>
00198
00199 L4_CV L4_INLINE
00200 void
00201 l4vcpu_irq_disable(l4_vcpu_state_t *vcpu) L4_NOTHROW
00202 {
00203   vcpu->state &= ~L4_VCPU_F_IRQ;
00204   l4_barrier();
00205 }
00206
00207 L4_CV L4_INLINE
00208 unsigned
00209 l4vcpu_irq_disable_save(l4_vcpu_state_t *vcpu) L4_NOTHROW
00210 {
00211   unsigned s = vcpu->state;
00212   l4vcpu_irq_disable(vcpu);
00213   return s;
00214 }
00215
00216 L4_CV L4_INLINE
00217 void
00218 l4vcpu_wait(l4_vcpu_state_t *vcpu, l4_utcb_t *utcb,
00219             l4_timeout_t to,
00220             l4vcpu_event_hndl_t do_event_work_cb,
00221             l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW
00222 {
00223   l4vcpu_irq_disable(vcpu);
00224   setup_ipc(utcb);
00225   vcpu->i.tag = l4_ipc_wait(utcb, &vcpu->i.label, to);
00226   if (L4_LIKELY(!l4_msgtag_has_error(vcpu->i.tag)))
00227     do_event_work_cb(vcpu);
00228 }
00229
00230 L4_CV L4_INLINE
00231 void
00232 l4vcpu_irq_enable(l4_vcpu_state_t *vcpu, l4_utcb_t *utcb,
00233                   l4vcpu_event_hndl_t do_event_work_cb,
00234                   l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW
00235 {
00236   if (!(vcpu->state & L4_VCPU_F_IRQ))
00237     {
00238       setup_ipc(utcb);
00239       l4_barrier();
00240     }
00241
00242   while (1)
00243     {
00244       vcpu->state |= L4_VCPU_F_IRQ;
00245       l4_barrier();
00246
00247       if (L4_LIKELY(!(vcpu->sticky_flags & L4_VCPU_SF_IRQ_PENDING)))
00248         break;
00249
00250       l4vcpu_wait(vcpu, utcb, L4_IPC_BOTH_TIMEOUT_0,
00251                   do_event_work_cb, setup_ipc);
00252     }
00253 }
00254
00255 L4_CV L4_INLINE
00256 void
00257 l4vcpu_irq_restore(l4_vcpu_state_t *vcpu, unsigned s,
00258                    l4_utcb_t *utcb,
00259                    l4vcpu_event_hndl_t do_event_work_cb,
00260                    l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW
00261 {
00262   if (s & L4_VCPU_F_IRQ)
00263     l4vcpu_irq_enable(vcpu, utcb, do_event_work_cb, setup_ipc);
00264   else if (vcpu->state & L4_VCPU_F_IRQ)
00265     l4vcpu_irq_disable(vcpu);
00266 }
```

```
00267
00268 L4_CV L4_INLINE
00269 void
00270 l4vcpu_wait_for_event(l4_vcpu_state_t *vcpu, l4_utcb_t *utcb,
00271                       l4vcpu_event_hndl_t do_event_work_cb,
00272                       l4vcpu_setup_ipc_t setup_ipc) L4_NOTHROW
00273 {
00274   l4vcpu_wait(vcpu, utcb, L4_IPC_NEVER, do_event_work_cb, setup_ipc);
00275 }
00276
00277 __END_DECLS
```

Chapter 17

Examples

17.1 hello/server/src/main.c

This is the famous "Hello World!" program.
This is the famous "Hello World!" program.

```
/* SPDX-License-Identifier: MIT */

#include <stdio.h>
#include <unistd.h>

int main(void)
{
  for (;;)
    {
      puts("Hello World!");
      sleep(1);
    }
}
```

17.2 examples/sys/ipc/ipc_example.c

This example shows how two threads can exchange data using the L4 IPC mechanism.
This example shows how two threads can exchange data using the L4 IPC mechanism. One thread is sending an integer to the other thread which is returning the square of the integer. Both values are printed.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
 */
#include <pthread-l4.h>
#include <unistd.h>
#include <stdio.h>

#include <l4/sys/ipc.h>

static pthread_t t2;

/* Thread1 is the initiator thread, i.e. it initiates the IPC calls. In
 * other words, it takes the client role. It uses L4 IPC mechanisms to send
 * an integer value to thread2 and received a calculation result back. */
static void *thread1_fn(void *arg)
{
  l4_msgtag_t tag;
  int ipc_error;
  unsigned long value = 1;
  (void)arg;

  while (1)
    {
      printf("Sending:  %ld\n", value);

      /* Store the value which we want to have squared in the first message
       * register of our UTCB. */
      l4_utcb_mr()->mr[0] = value;

      /* To an L4 IPC call, i.e. send a message to thread2 and wait for a
       * reply from thread2. The '1' in the msgtag denotes that we want to
       * transfer one word of our message registers (i.e. MR0). No timeout. */
      tag = l4_ipc_call(pthread_l4_cap(t2), l4_utcb(),
                        l4_msgtag(0, 1, 0, 0), L4_IPC_NEVER);
```

```
      /* Check for IPC error, if yes, print out the IPC error code, if not,
       * print the received result. */
      ipc_error = l4_ipc_error(tag, l4_utcb());
      if (ipc_error)
        fprintf(stderr, "thread1: IPC error: %x\n", ipc_error);
      else
        printf("Received: %ld\n", l4_utcb_mr()->mr[0]);

      /* Wait some time and increment our value. */
      sleep(1);
      value++;
    }
  return NULL;
}

/* Thread2 is in the server role, i.e. it waits for requests from others and
 * sends back the calculation results. */
static void *thread2_fn(void *arg)
{
  l4_msgtag_t tag;
  l4_umword_t label;
  int ipc_error;
  (void)arg;

  /* Wait for requests from any thread. No timeout, i.e. wait forever. */
  tag = l4_ipc_wait(l4_utcb(), &label, L4_IPC_NEVER);
  while (1)
    {
      /* Check if we had any IPC failure, if yes, print the error code
       * and just wait again. */
      ipc_error = l4_ipc_error(tag, l4_utcb());
      if (ipc_error)
        {
          fprintf(stderr, "thread2: IPC error: %x\n", ipc_error);
          tag = l4_ipc_wait(l4_utcb(), &label, L4_IPC_NEVER);
          continue;
        }

      /* So, the IPC was ok, now take the value out of message register 0
       * of the UTCB and store the square of it back to it. */
      l4_utcb_mr()->mr[0] = l4_utcb_mr()->mr[0] * l4_utcb_mr()->mr[0];

      /* Send the reply and wait again for new messages.
       * The '1' in the msgtag indicated that we want to transfer 1 word in
       * the message registers (i.e. MR0) */
      tag = l4_ipc_reply_and_wait(l4_utcb(), l4_msgtag(0, 1, 0, 0),
                                  &label, L4_IPC_NEVER);
    }
  return NULL;
}

int main(void)
{
  // We will have two threads, one is already running the main function, the
  // other (thread2) will be created using pthread_create.

  if (pthread_create(&t2, NULL, thread2_fn, NULL))
    {
      fprintf(stderr, "Thread creation failed\n");
      return 1;
    }

  // Just run thread1 in the main thread
  thread1_fn(NULL);
  return 0;
}
```

17.3 examples/sys/ipc/ipc.cfg

Sample configuration file for the IPC example.
Sample configuration file for the IPC example.

```
# vim:se ft=lua:

local L4 = require("L4");

L4.default_loader:start({}, "rom/ex_ipc1");
```

17.4 examples/sys/start-with-exc/main.c

This example shows how to start a newly created thread with a defined set of CPU registers.

This example shows how to start a newly created thread with a defined set of CPU registers.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>,
 *               Björn Döbel <doebel@os.inf.tu-dresden.de>,
 *               Frank Mehnert <fm3@os.inf.tu-dresden.de>
 */
/*
 * Start a thread with an exception reply. This example does only work on
 * the x86-32 and ARM architectures.
 */

#include <l4/sys/thread.h>
#include <l4/sys/factory.h>
#include <l4/sys/ipc.h>
#include <l4/sys/scheduler.h>
#include <l4/sys/utcb.h>
#include <l4/util/util.h>
#include <l4/re/env.h>
#include <l4/re/c/util/cap_alloc.h>

#include <stdlib.h>
#include <stdio.h>

/* Stack for the thread to be created. 8kB are enough. */
static char thread_stack[8 << 10];

/* The thread to be created. For illustration it will print out its
 * register set.
 */
static void L4_STICKY(thread_func(l4_umword_t *d))
{
  while (1)
    {
      printf("hey, I'm a thread\n");
      printf("got register values: %ld %ld %ld %ld %ld %ld %ld %ld\n",
             d[7], d[6], d[5], d[4], d[2], d[1], d[0]);
      l4_sleep(800);
    }
}

/* Startup trick for this example. Put all the CPU registers on the stack so
 * that the C function above can get it on the stack. */
asm(
".global thread     \n"
"thread:      \n"
#ifdef ARCH_x86
" pusha     \n"
" push %esp   \n"
" call thread_func  \n"
#endif
#ifdef ARCH_arm
"       push {r0-r7}            \n"
"       mov r0, sp              \n"
"       bl thread_func          \n"
#endif
#ifdef ARCH_arm64
"       stp x0, x1, [sp, #0]!   \n"
"       stp x2, x3, [sp, #0]!   \n"
"       stp x4, x5, [sp, #0]!   \n"
"       stp x6, x7, [sp, #0]!   \n"
"       mov x0, sp              \n"
"       bl thread_func          \n"
#endif
);
extern void thread(void);

/* Our main function */
int main(void)
{
  /* Get a capability slot for our new thread. */
  l4_cap_idx_t t1 = l4re_util_cap_alloc();
  l4_utcb_t *u = l4_utcb();
  l4_exc_regs_t *e = l4_utcb_exc_u(u);
  l4_msgtag_t tag;
  int err;

  printf("Example showing how to start a thread with an exception.\n");
  /* We do not want to implement a pager here, take the shortcut. */
  printf("Make sure to start this program with ldr-flags=eager_map\n");

  if (l4_is_invalid_cap(t1))
    return 1;

  /* Create the thread using our default factory */
  tag = l4_factory_create_thread(l4re_env()->factory, t1);
```

```
  if (l4_error(tag))
    return 1;

  /* Setup the thread by setting the pager and task. */
  l4_thread_control_start();
  l4_thread_control_pager(l4re_env()->main_thread);
  l4_thread_control_exc_handler(l4re_env()->main_thread);
  l4_thread_control_bind((l4_utcb_t *)l4re_env()->first_free_utcb,
                         L4RE_THIS_TASK_CAP);
  tag = l4_thread_control_commit(t1);
  if (l4_error(tag))
    return 2;

  /* Start the thread by finally setting instruction and stack pointer */
  tag = l4_thread_ex_regs(t1,
                          (l4_umword_t)thread,
                          (l4_umword_t)thread_stack + sizeof(thread_stack),
                          L4_THREAD_EX_REGS_TRIGGER_EXCEPTION);
  if (l4_error(tag))
    return 3;

  l4_sched_param_t sp = l4_sched_param(1, 0);
  tag = l4_scheduler_run_thread(l4re_env()->scheduler, t1, &sp);
  if (l4_error(tag))
    return 4;


  /* Receive initial exception from just started thread */
  tag = l4_ipc_receive(t1, u, L4_IPC_NEVER);
  if ((err = l4_ipc_error(tag, u)))
    {
      printf("Umm, ipc error: %x\n", err);
      return 1;
    }
  /* We expect an exception IPC */
  if (!l4_msgtag_is_exception(tag))
    {
      printf("PF?: %lx %lx (not prepared to handle this) %ld\n",
             l4_utcb_mr_u(u)->mr[0], l4_utcb_mr_u(u)->mr[1], l4_msgtag_label(tag));
      return 1;
    }

  /* Fill out the complete register set of the new thread */
  e->sp = (l4_umword_t)(thread_stack + sizeof(thread_stack));
#ifdef ARCH_x86
  e->ip = (l4_umword_t)thread;
  e->edi = 0;
  e->esi = 1;
  e->ebp = 2;
  e->ebx = 4;
  e->edx = 5;
  e->ecx = 6;
  e->eax = 7;
#endif
#ifdef ARCH_arm
  e->pc = (l4_umword_t)thread;
  e->r[0] = 0;
  e->r[1] = 1;
  e->r[2] = 2;
  e->r[3] = 3;
  e->r[4] = 4;
  e->r[5] = 5;
  e->r[6] = 6;
  e->r[7] = 7;
#endif
#ifdef ARCH_arm64
  e->pc = (l4_umword_t)thread;
  e->r[0] = 0;
  e->r[1] = 1;
  e->r[2] = 2;
  e->r[3] = 3;
  e->r[4] = 4;
  e->r[5] = 5;
  e->r[6] = 6;
  e->r[7] = 7;
#endif
  /* Send a complete exception */
  tag = l4_msgtag(0, L4_UTCB_EXCEPTION_REGS_SIZE, 0, 0);

  /* Send reply and start the thread with the defined CPU register set */
  tag = l4_ipc_send(t1, u, tag, L4_IPC_NEVER);
  if ((err = l4_ipc_error(tag, u)))
    printf("Error sending IPC: %x\n", err);

  /* Idle around */
  while (1)
```

```
    l4_sleep(10000);

  return 0;
}
```

17.5 examples/sys/singlestep/main.c

This example shows how a thread can be single stepped on the x86 architecture.
This example shows how a thread can be single stepped on the x86 architecture.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>,
 *               Björn Döbel <doebel@os.inf.tu-dresden.de>
 */
/*
 * Single stepping example for the x86-32 architecture.
 */
#include <l4/sys/ipc.h>
#include <l4/sys/factory.h>
#include <l4/sys/thread.h>
#include <l4/sys/scheduler.h>
#include <l4/sys/utcb.h>
#include <l4/sys/kdebug.h>

#include <l4/util/util.h>
#include <l4/re/env.h>
#include <l4/re/c/util/cap_alloc.h>

#include <stdlib.h>
#include <stdio.h>
#include <string.h>

static char thread_stack[8 « 10];

static void thread_func(void)
{
  while (1)
    {
      unsigned long d = 0;

      /* Enable single stepping  */
      asm volatile("pushf; pop %0; or $256,%0; push %0; popf\n"
                   : "=r" (d) : "r" (d));

      /* Some instructions */
      asm volatile("nop");
      asm volatile("nop");
      asm volatile("nop");
      asm volatile("mov $0x12345000, %%edx" : : : "edx"); // a non-existent cap
      asm volatile("int $0x30\n");
      asm volatile("nop");
      asm volatile("nop");
      asm volatile("nop");

      /* Disabled single stepping */
      asm volatile("pushf; pop %0; and $~256,%0; push %0; popf\n"
                   : "=r" (d) : "r" (d));

      /* You won't see those */
      asm volatile("nop");
      asm volatile("nop");
      asm volatile("nop");
    }
}

int main(void)
{
  l4_msgtag_t tag;
  int ipc_stat = 0;
  l4_cap_idx_t th = l4re_util_cap_alloc();
  l4_exc_regs_t exc;
  l4_umword_t mr0, mr1;
  l4_utcb_t *u = l4_utcb();

  printf("Singlestep testing\n");

  if (l4_is_invalid_cap(th))
    return 1;

  l4_touch_rw(thread_stack, sizeof(thread_stack));
```

```
  l4_touch_ro(thread_func, 1);

  tag = l4_factory_create_thread(l4re_env()->factory, th);
  if (l4_error(tag))
    return 1;

  l4_thread_control_start();
  l4_thread_control_pager(l4re_env()->main_thread);
  l4_thread_control_exc_handler(l4re_env()->main_thread);
  l4_thread_control_bind((l4_utcb_t *)l4re_env()->first_free_utcb,
                         L4RE_THIS_TASK_CAP);
  l4_thread_control_alien(1);
  tag = l4_thread_control_commit(th);
  if (l4_error(tag))
    return 2;

  tag = l4_thread_ex_regs(th, (l4_umword_t)thread_func,
                          (l4_umword_t)thread_stack + sizeof(thread_stack),
                          0);
  if (l4_error(tag))
    return 3;

  l4_sched_param_t sp = l4_sched_param(1, 0);
  tag = l4_scheduler_run_thread(l4re_env()->scheduler, th, &sp);
  if (l4_error(tag))
    return 4;

  /* Pager/Exception loop */
  if (l4_msgtag_has_error(tag = l4_ipc_receive(th, u, L4_IPC_NEVER)))
    {
      printf("l4_ipc_receive failed");
      return 5;
    }
  memcpy(&exc, l4_utcb_exc(), sizeof(exc));
  mr0 = l4_utcb_mr()->mr[0];
  mr1 = l4_utcb_mr()->mr[1];

  for (;;)
    {
      if (l4_msgtag_is_exception(tag))
        {
          printf("PC = %08lx Trap = %08lx Err = %08lx, SP = %08lx SC-Nr: %lx\n",
                 l4_utcb_exc_pc(&exc), exc.trapno, exc.err,
                 exc.sp, exc.err » 3);
          if (exc.err » 3)
            {
              if (!(exc.err & 4))
                {
                  tag = l4_msgtag(L4_PROTO_ALLOW_SYSCALL,
                                  L4_UTCB_EXCEPTION_REGS_SIZE, 0, 0);
                  if (ipc_stat)
                    l4_kd_enter("Should not be 1");
                }
              else
                {
                  tag = l4_msgtag(L4_PROTO_NONE,
                                  L4_UTCB_EXCEPTION_REGS_SIZE, 0, 0);
                  if (!ipc_stat)
                    l4_kd_enter("Should not be 0");
                }
              ipc_stat = !ipc_stat;
            }
          l4_sleep(100);
        }
      else
        printf("Umm, non-handled request: %ld, %08lx %08lx\n",
               l4_msgtag_label(tag), mr0, mr1);

      memcpy(l4_utcb_exc(), &exc, sizeof(exc));

      /* Reply and wait */
      if (l4_msgtag_has_error(tag = l4_ipc_call(th, u, tag, L4_IPC_NEVER)))
        {
          printf("l4_ipc_call failed\n");
          return 5;
        }
      memcpy(&exc, l4_utcb_exc(), sizeof(exc));
      mr0 = l4_utcb_mr()->mr[0];
      mr1 = l4_utcb_mr()->mr[1];
    }

  return 0;
}
```

17.6 examples/sys/aliens/main.c

This example shows how system call tracing can be done.
This example shows how system call tracing can be done.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>,
 *               Björn Döbel <doebel@os.inf.tu-dresden.de>
 */
/*
 * Example to show syscall tracing.
 */
#if defined(ARCH_x86) || defined(ARCH_amd64)
// MEASURE only works on x86/amd64
//#define MEASURE
#endif

#include <l4/sys/ipc.h>
#include <l4/sys/thread.h>
#include <l4/sys/factory.h>
#include <l4/sys/scheduler.h>
#include <l4/sys/utcb.h>
#include <l4/util/util.h>
#include <l4/re/env.h>
#include <l4/re/c/util/cap_alloc.h>
#include <l4/re/c/util/kumem_alloc.h>
#include <l4/sys/debugger.h>

#include <stdlib.h>
#include <stdio.h>
#include <string.h>

/* Architecture specifics */
#if defined(ARCH_x86) || defined(ARCH_amd64)

static int
is_alien_after_call(l4_exc_regs_t const *exc)
{
#if defined(ARCH_x86)
  return exc->err & 4;
#else
  return exc->err == 1;
#endif
}

static inline void
_print_exc_state(l4_exc_regs_t const *exc)
{
  printf("PC=%08lx SP=%08lx Err=%08lx Trap=%lx, %s syscall, SC-Nr: %lx\n",
         l4_utcb_exc_pc(exc), exc->sp, exc->err,
         exc->trapno, is_alien_after_call(exc) ? " after" : "before",
         exc->err >> 3);
}

#elif defined(ARCH_arm)

static int
is_alien_after_call(l4_exc_regs_t const *exc)
{ return exc->err & 0x40; } // TODO: Should change this to (1 << 16)

static inline void
_print_exc_state(l4_exc_regs_t const *exc)
{
  printf("PC=%08lx SP=%08lx ULR=%08lx CPSR=%08lx Err=%lx/%lx, %s syscall\n",
         l4_utcb_exc_pc(exc), exc->sp, exc->ulr, exc->cpsr,
         exc->err, exc->err >> 26,
         is_alien_after_call(exc) ? " after" : "before");
}

#elif defined(ARCH_arm64)

static int
is_alien_after_call(l4_exc_regs_t const *exc)
{ return exc->err & (1ul << 16); }

static inline void
_print_exc_state(l4_exc_regs_t const *exc)
{
  printf("PC=%08lx SP=%08lx PSTATE=%08lx Err=%lx/%lx, %s syscall\n",
         l4_utcb_exc_pc(exc), exc->sp, exc->pstate,
         exc->err, exc->err >> 26,
         is_alien_after_call(exc) ? " after" : "before");
```

```
}

#elif defined(ARCH_mips)

static int
is_alien_after_call(l4_exc_regs_t const *exc)
{ return 0; }

static inline void
_print_exc_state(l4_exc_regs_t const *exc)
{
  printf("PC=%08lx SP=%08lx Cause=%lx, %s syscall\n",
         l4_utcb_exc_pc(exc), exc->sp, exc->cause,
         is_alien_after_call(exc) ? " after" : "before");
}

#elif defined(ARCH_riscv)

static int
is_alien_after_call(l4_exc_regs_t const *exc)
{ return exc->cause == L4_riscv_ec_l4_alien_after_syscall; }

static inline void
_print_exc_state(l4_exc_regs_t const *exc)
{
  printf("PC=%08lx SP=%08lx Cause=%lx, %s syscall\n",
         l4_utcb_exc_pc(exc), exc->sp, exc->cause,
         is_alien_after_call(exc) ? " after" : "before");
}

#else

static int
is_alien_after_call(l4_exc_regs_t const *exc)
{ return exc->err & 1; }

static inline void
_print_exc_state(l4_exc_regs_t const *exc)
{
  printf("PC=%08lx SP=%08lx, %s syscall\n",
         l4_utcb_exc_pc(exc), exc->sp,
         is_alien_after_call(exc) ? " after" : "before");
}

#endif

/* Measurement mode specifics.
 *
 * In measurement mode the code is less verbose and uses RDTSC for alient exception
 * performance measurement.
 */
#ifdef MEASURE

#include <l4/util/rdtsc.h>

static inline void
calibrate_timer(void)
{
  l4_calibrate_tsc(l4re_kip());
}

static inline void
print_timediff(l4_cpu_time_t start)
{
  e = l4_rdtsc();
  printf("time %lld\n", l4_tsc_to_ns(e - start));
}

static inline void
alien_sleep(void)
{
  l4_sleep(0);
}

static inline void
print_exc_state(l4_exc_regs_t const *exc)
{
  if (0)
    _print_exc_state(exc);
}

#else

static inline void
calibrate_timer(void)
{
```

```
}

static inline void
print_timediff(l4_cpu_time_t start)
{
  (void)start;
}

static inline l4_cpu_time_t
l4_rdtsc(void)
{
  return 0;
}

static inline void
alien_sleep(void)
{
  l4_sleep(1000);
}

static inline void
print_exc_state(l4_exc_regs_t const *exc)
{
  _print_exc_state(exc);
}

#endif


static char alien_thread_stack[8 « 10];
static l4_cap_idx_t alien;

static void alien_thread(void)
{
  while (1)
    {
      l4_ipc_call(0x1234 « L4_CAP_SHIFT, l4_utcb(),
                  l4_msgtag(0, 0, 0, 0), L4_IPC_NEVER);
      alien_sleep();
    }
}

int main(void)
{
  l4_msgtag_t tag;
  l4_cpu_time_t s;
  l4_utcb_t *u = l4_utcb();
  l4_exc_regs_t exc;
  l4_umword_t mr0, mr1;

  printf("Alien feature testing\n");

  l4_debugger_set_object_name(l4re_env()->main_thread, "alientest");

  /* Start alien thread */
  if (l4_is_invalid_cap(alien = l4re_util_cap_alloc()))
    return 1;

  l4_touch_rw(alien_thread_stack, sizeof(alien_thread_stack));

  tag = l4_factory_create_thread(l4re_env()->factory, alien);
  if (l4_error(tag))
    return 2;

  l4_debugger_set_object_name(alien, "alienth");

  l4_addr_t kumem;
  if (l4re_util_kumem_alloc(&kumem, 0, L4RE_THIS_TASK_CAP, l4re_env()->rm))
    return 3;

  l4_thread_control_start();
  l4_thread_control_pager(l4re_env()->main_thread);
  l4_thread_control_exc_handler(l4re_env()->main_thread);
  l4_thread_control_bind((l4_utcb_t *)kumem, L4RE_THIS_TASK_CAP);
  l4_thread_control_alien(1);
  tag = l4_thread_control_commit(alien);
  if (l4_error(tag))
    return 4;

  tag = l4_thread_ex_regs(alien,
                          (l4_umword_t)alien_thread,
                          (l4_umword_t)alien_thread_stack + sizeof(alien_thread_stack),
                          0);
  if (l4_error(tag))
    return 5;

  l4_sched_param_t sp = l4_sched_param(1, 0);
```

```
  tag = l4_scheduler_run_thread(l4re_env()->scheduler, alien, &sp);
  if (l4_error(tag))
    return 6;

  calibrate_timer();

  /* Pager/Exception loop */
  if (l4_msgtag_has_error(tag = l4_ipc_receive(alien, u, L4_IPC_NEVER)))
    {
      printf("l4_ipc_receive failed");
      return 7;
    }

  memcpy(&exc, l4_utcb_exc(), sizeof(exc));
  mr0 = l4_utcb_mr()->mr[0];
  mr1 = l4_utcb_mr()->mr[1];

  for (;;)
    {
      s = l4_rdtsc();

      if (l4_msgtag_is_exception(tag))
        {
          print_exc_state(&exc);
          tag = l4_msgtag(is_alien_after_call(&exc)
                          ? 0 : L4_PROTO_ALLOW_SYSCALL,
                        L4_UTCB_EXCEPTION_REGS_SIZE, 0, 0);
        }
      else
        printf("Umm, non-handled request (like PF): %lx %lx\n", mr0, mr1);

      memcpy(l4_utcb_exc(), &exc, sizeof(exc));

      /* Reply and wait */
      if (l4_msgtag_has_error(tag = l4_ipc_call(alien, u, tag, L4_IPC_NEVER)))
        {
          printf("l4_ipc_call failed\n");
          return 8;
        }
      memcpy(&exc, l4_utcb_exc(), sizeof(exc));
      mr0 = l4_utcb_mr()->mr[0];
      mr1 = l4_utcb_mr()->mr[1];
      print_timediff(s);
    }

  return 0;
}
```

17.7 examples/sys/utcb-ipc/main.c

This example shows how to send IPC using the UTCB to store payload.
This example shows how to send IPC using the UTCB to store payload.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>,
 *               Björn Döbel <doebel@os.inf.tu-dresden.de>
 */
#include <l4/sys/ipc.h>
#include <l4/sys/thread.h>
#include <l4/sys/factory.h>
#include <l4/sys/utcb.h>
#include <l4/sys/task.h>
#include <l4/sys/vcon.h>
#include <l4/re/env.h>
#include <l4/re/c/util/cap_alloc.h>
#include <l4/re/c/util/kumem_alloc.h>
#include <l4/util/thread.h>

#include <stdio.h>
#include <string.h>

static unsigned char stack2[8 « 10] __attribute__((aligned(8)));
static l4_cap_idx_t thread1_cap, thread2_cap;

static void vlogprintn(const char *s, int l)
{
  if (l > L4_VCON_WRITE_SIZE)
    l = L4_VCON_WRITE_SIZE;

  l4_vcon_send(L4_BASE_LOG_CAP, s, l);
```

```
}

static void vlogprint(const char *s)
{
  vlogprintn(s, strlen(s));
}

static void vlogprintc(const char c)
{
  vlogprintn(&c, 1);
}

static void thread1(void)
{
  l4_msg_regs_t *mr = l4_utcb_mr();
  l4_msgtag_t tag;
  int i, j;

  printf("Thread1 up (%p)\n", l4_utcb());

  for (i = 0; i < 10; i++)
    {
      for (j = 0; j < L4_UTCB_GENERIC_DATA_SIZE; j++)
        mr->mr[j] = 'A' + (i + j) % ('~' - 'A' + 1);
      tag = l4_msgtag(0, L4_UTCB_GENERIC_DATA_SIZE, 0, 0);
      if (l4_msgtag_has_error(l4_ipc_send(thread2_cap, l4_utcb(), tag, L4_IPC_NEVER)))
  printf("IPC-send error\n");
    }

  mr->mr[0] = 1;
  if (l4_msgtag_has_error(l4_ipc_send(thread2_cap, l4_utcb(), tag, L4_IPC_NEVER)))
    printf("IPC-send error\n");

  printf("Thread1 done\n");
}

L4UTIL_THREAD_STATIC_FUNC(thread2)
{
  l4_msgtag_t tag;
  l4_msg_regs_t mr;
  unsigned i;

  // No printf() here because this would require a working pthread environment!
  vlogprint("Thread2 up\n");

  while (1)
    {
      if (l4_msgtag_has_error(tag = l4_ipc_receive(thread1_cap, l4_utcb(), L4_IPC_NEVER)))
        vlogprint("IPC receive error\n");
      memcpy(&mr, l4_utcb_mr(), sizeof(mr));
      if (mr.mr[0] == 1) // exit notification
        break;
      vlogprint("Thread2 receive: ");
      for (i = 0; i < l4_msgtag_words(tag); i++)
        vlogprintc((char)mr.mr[i]);
      vlogprint("\n");
    }

  vlogprint("Thread2 done, switching to thread1\n");
  if (l4_msgtag_has_error(l4_ipc_send(thread1_cap, l4_utcb(),
                                      tag, L4_IPC_NEVER)))
    vlogprint("IPC-send error\n");

  // In theory this could hit if the above IPC send operation doesn't switch
  // to the other thread.
  __builtin_trap();
}

int main(void)
{
  l4_msgtag_t tag;

  thread1_cap = l4re_env()->main_thread;
  thread2_cap = l4re_util_cap_alloc();

  if (l4_is_invalid_cap(thread2_cap))
    {
      printf("Cannot allocate thread2 capability\n");
      return 1;
    }

  tag = l4_factory_create_thread(l4re_env()->factory, thread2_cap);
  if (l4_error(tag))
    {
      printf("Cannot create thread2\n");
      return 2;
```

```
    }

  l4_addr_t kumem;
  if (l4re_util_kumem_alloc(&kumem, 0, L4RE_THIS_TASK_CAP, l4re_env()->rm))
    {
      printf("Cannot allocate UTCB for thread2\n");
      return 3;
    }

  l4_thread_control_start();
  l4_thread_control_pager(l4re_env()->rm);
  l4_thread_control_exc_handler(l4re_env()->rm);
  l4_thread_control_bind((l4_utcb_t *)kumem, L4RE_THIS_TASK_CAP);
  tag = l4_thread_control_commit(thread2_cap);
  if (l4_error(tag))
    {
      printf("Cannot set thread2 thread parameters\n");
      return 4;
    }

  tag = l4_thread_ex_regs(thread2_cap,
                          (l4_umword_t)thread2,
                          (l4_umword_t)(stack2 + sizeof(stack2)), 0);
  if (l4_error(tag))
    {
      printf("Cannot set thread2 IP/SP\n");
      return 5;
    }

  l4_sched_param_t sp = l4_sched_param(1, 0);
  tag = l4_scheduler_run_thread(l4re_env()->scheduler, thread2_cap, &sp);
  if (l4_error(tag))
    {
      printf("Cannot start thread2\n");
      return 6;
    }

  thread1();

  if (l4_msgtag_has_error(l4_ipc_receive(thread2_cap, l4_utcb(),
                                         L4_IPC_NEVER)))
    printf("IPC-receive error\n");

  l4_task_unmap(L4RE_THIS_TASK_CAP,
                l4_obj_fpage(thread2_cap, 0, L4_FPAGE_RWX),
                L4_FP_ALL_SPACES);

  printf("Terminated thread2. Terminating.\n");
  return 0;
}
```

17.8 examples/sys/isr/main.c

Example of an interrupt service routine.
Example of an interrupt service routine.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>,
 *               Björn Döbel <doebel@os.inf.tu-dresden.de>
 */
/*
 * This example shall show how to connect to an interrupt, receive interrupt
 * events and detach again. As the interrupt source we'll use the virtual
 * key interrupt -- pin 0 of the log capability.
 */

#include <l4/re/c/util/cap_alloc.h>
#include <l4/re/c/namespace.h>
#include <l4/sys/factory.h>
#include <l4/sys/icu.h>
#include <l4/sys/irq.h>
#include <l4/sys/vcon.h>
#include <l4/sys/utcb.h>

#include <stdio.h>

int main(void)
{
  int const irqno = 0;
  l4_cap_idx_t irqcap, icucap;
  l4_vcon_attr_t attr;
```

```
  long err;

  icucap = l4re_env()->log;

  /* Get a free capability slot for the ICU capability. */
  if (l4_is_invalid_cap(icucap))
    {
      printf("Did not find the Vlog ICU.\n");
      return 1;
    }

  /* Get another free capability slot for the corresponding IRQ object. */
  if (l4_is_invalid_cap(irqcap = l4re_util_cap_alloc()))
    {
      printf("Cannot allocate capability slot.\n");
      return 1;
    }

  /* Create IRQ object. */
  if ((err = l4_error(l4_factory_create_irq(l4re_env()->factory, irqcap))))
    {
      printf("Could not create IRQ object: %ld (%s).\n", err, l4sys_errtostr(err));
      return 1;
    }

  /*
   * Bind the recently allocated IRQ object to the IRQ number irqno as provided
   * by the ICU.
   */
  if ((err = l4_error(l4_icu_bind(icucap, irqno, irqcap))))
    {
      printf("Could not bind IRQ%d to ICU: %ld (%s).\n", irqno, err, l4sys_errtostr(err));
      return 1;
    }

  if ((err = l4_error(l4_vcon_get_attr(icucap, &attr))))
    {
      printf("Could not get Vcon attributes: %ld (%s).\n", err, l4sys_errtostr(err));
      return 1;
    }

  /* Disable echo at Vcon console. */
  attr.l_flags &= ~L4_VCON_ECHO;

  if ((err = l4_error(l4_vcon_set_attr(icucap, &attr))))
    {
      printf("Could not set Vcon attributes: %ld (%s).\n", err, l4sys_errtostr(err));
      return 1;
    }

  printf("Vcon echo disabled.\n");

  /* Bind ourselves to the IRQ. Define the IPC label which is sent if an IRQ
   * IPC arrives. */
  if ((err = l4_error(l4_rcv_ep_bind_thread(irqcap, l4re_env()->main_thread, 0x1234))))
    {
      printf("Could not bind to IRQ%d: %ld (%s).\n", irqno, err, l4sys_errtostr(err));
      return 1;
    }

  printf("Attached to key IRQ %d.\nPress keys now, Shift-Q to exit.\n", irqno);

  /* IRQ receive loop. */
  while (1)
    {
      /* Wait for the interrupt to happen. If we received an IRQ, the label
       * return code is set to 0. If we didn't receive an IRQ, the error flag
       * in the message tag is set and l4_error() reads the IPC error code from
       * the UTCB. */
      l4_umword_t label;
      if ((err = l4_error(l4_irq_wait(irqcap, &label, L4_IPC_NEVER))))
        printf("Could not receive IRQ: %ld (%s).\n", err, l4sys_errtostr(err));
      else
        {
          char buf[128];
          int n;

          if (label != 0x1234)
            {
              printf("Unexpected label %0lx -- ignoring interrupt.\n", label);
              continue;
            }

          /* Process the interrupt -- may do a 'break' */
          printf("Got IRQ with expected label 0x%lX.\n", label);
          n = l4_vcon_read(icucap, buf, sizeof(buf));
          if (n < 0)
```

```
            printf("Could not read from Vcon interface: %d (%s).\n", n, l4sys_errtostr(n));
          else
            {
              unsigned i;
              int terminate = 0;
              for (i = 0; i < (unsigned)n && i < sizeof(buf); ++i)
                {
                  int c = (unsigned char)buf[i];
                  if (c >= 32 && c < 128) // Filter UTF-8 encodings.
                    printf("Got key '%c'.\n", c);
                  else
                    printf("Got keycode %d.\n", c);
                  if (buf[i] == 'Q')
                    terminate = 1;
                }

              if (terminate)
                break;
            }
        }
    }

  /* We're done, detach from the interrupt. */
  if ((err = l4_error(l4_irq_detach(irqcap))))
    printf("Could not detach from IRQ: %ld (%s).\n", err, l4sys_errtostr(err));

  printf("Application terminated.\n");
  return 0;
}
```

17.9 examples/clntsrv/src/server.cc

Client/Server example using C++ infrastructure – Server implementation.
Client/Server example using C++ infrastructure – Server implementation.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>
 */
#include <stdio.h>
#include <l4/re/env>
#include <l4/re/util/cap_alloc>
#include <l4/re/util/object_registry>
#include <l4/re/util/br_manager>
#include <l4/sys/cxx/ipc_epiface>

#include "shared.h"

static L4Re::Util::Registry_server<> server;

class Calculation_server : public L4::Epiface_t<Calculation_server, Calc>
{
public:
  int op_sub(Calc::Rights, l4_uint32_t a, l4_uint32_t b, l4_uint32_t &res)
  {
    res = a - b;
    return 0;
  }

  int op_neg(Calc::Rights, l4_uint32_t a, l4_uint32_t &res)
  {
    res = -a;
    return 0;
  }
};


int
main()
{
  static Calculation_server calc;

  // Register calculation server
  if (!server.registry()->register_obj(&calc, "calc_server").is_valid())
    {
      printf("Could not register my service, is there a 'calc_server' in the caps table?\n");
      return 1;
    }

  printf("Welcome to the calculation server!\n"
         "I can do subtractions and negations.\n");

  // Wait for client requests
```

```
  server.loop();

  return 0;
}
```

17.10 examples/clntsrv/src/client.cc

Client/Server example using C++ infrastructure – Client implementation.
Client/Server example using C++ infrastructure – Client implementation.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>
 */
#include <l4/sys/err.h>
#include <l4/sys/types.h>
#include <l4/re/env>
#include <l4/re/util/cap_alloc>

#include <stdio.h>
#include "shared.h"

int
main()
{
  L4::Cap<Calc> server = L4Re::Env::env()->get_cap<Calc>("calc_server");
  if (!server.is_valid())
    {
      printf("Could not get server capability!\n");
      return 1;
    }

  l4_uint32_t val1 = 8;
  l4_uint32_t val2 = 5;

  printf("Asking for %d - %d\n", val1, val2);
  if (server->sub(val1, val2, &val1))
    {
      printf("Error talking to server\n");
      return 1;
    }
  printf("Result of subtract call: %d\n", val1);

  printf("Asking for -%d\n", val1);
  if (server->neg(val1, &val1))
    {
      printf("Error talking to server\n");
      return 1;
    }
  printf("Result of negate call: %d\n", val1);

  return 0;
}
```

17.11 examples/clntsrv/src/shared.h

Client/Server example using C++ infrastructure – Shared header file.
Client/Server example using C++ infrastructure – Shared header file.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
 */

#pragma once

#include <l4/sys/capability>
#include <l4/sys/cxx/ipc_iface>

struct Calc : L4::Kobject_t<Calc, L4::Kobject, 0x44>
{
  L4_INLINE_RPC(int, sub, (l4_uint32_t a, l4_uint32_t b, l4_uint32_t *res));
  L4_INLINE_RPC(int, neg, (l4_uint32_t a, l4_uint32_t *res));
  typedef L4::Typeid::Rpcs<sub_t, neg_t> Rpcs;
};
```

17.12 examples/clntsrv/configs/clntsrv.cfg

Sample configuration file for the client/server example.
Sample configuration file for the client/server example.

```
-- vim:set ft=lua:

-- Include L4 functionality
local L4 = require("L4");

-- Some shortcut for less typing
local ld = L4.default_loader;

-- Channel for the two programs to talk to each other.
local calc_server = ld:new_channel();

-- The server program, getting the channel in server mode.
ld:start({ caps = { calc_server = calc_server:svr() },
           log = { "server", "blue" } },
         "rom/ex_clntsrv-server");

-- The client program, getting the 'calc_server' channel to be able to talk
-- to the server. The client will be started with a green log output.
ld:start({ caps = { calc_server = calc_server },
           log = { "client", "green" } },
         "rom/ex_clntsrv-client");
```

17.13 examples/libs/l4re/c/ma+rm.c

Coarse grained memory allocation, in C.
Coarse grained memory allocation, in C.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
 */

#include <l4/re/c/mem_alloc.h>
#include <l4/re/c/rm.h>
#include <l4/re/c/util/cap_alloc.h>
#include <l4/sys/err.h>
#include <stdio.h>
#include <string.h>

static int allocate_mem(unsigned long size_in_bytes, unsigned long flags,
                        void **virt_addr)
{
  int r;
  l4re_ds_t ds;

  /* Allocate a free capability index for our data space */
  ds = l4re_util_cap_alloc();
  if (l4_is_invalid_cap(ds))
    return -L4_ENOMEM;

  size_in_bytes = l4_trunc_page(size_in_bytes);

  /* Allocate memory via a dataspace */
  if ((r = l4re_ma_alloc(size_in_bytes, ds, flags)))
    return r;

  /* Make the dataspace visible in our address space */
  *virt_addr = 0;
  if ((r = l4re_rm_attach(virt_addr, size_in_bytes,
                          L4RE_RM_F_SEARCH_ADDR | L4RE_RM_F_RWX, ds, 0,
                          flags & L4RE_MA_SUPER_PAGES
                             ? L4_SUPERPAGESHIFT : L4_PAGESHIFT)))
    {
      /* Free dataspace again */
      l4re_util_cap_free_um(ds);
      return r;
    }

  /* Done, virtual address is in virt_addr */
  return 0;
}

static int free_mem(void *virt_addr)
{
  int r;
  l4re_ds_t ds;

  /* Detach memory from our address space */
```

```
  if ((r = l4re_rm_detach_ds(virt_addr, &ds)))
    return r;

  /* Free memory at our memory allocator */
  l4re_util_cap_free_um(ds);

  /* All went ok */
  return 0;
}

int main(void)
{
  void *virt;

  /* Allocate memory: 16k Bytes (usually) */
  if (allocate_mem(4 * L4_PAGESIZE, 0, &virt))
    return 1;

  printf("Allocated memory.\n");

  /* Do something with the memory */
  memset(virt, 0x12, 4 * L4_PAGESIZE);

  printf("Touched memory.\n");

  /* Free memory */
  if (free_mem(virt))
    return 2;

  printf("Freed and done. Bye.\n");

  return 0;
}
```

17.14 examples/libs/l4re/c++/mem_alloc/ma+rm.cc

Coarse grained memory allocation, in C++.
Coarse grained memory allocation, in C++.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
 */

#include <l4/re/mem_alloc>
#include <l4/re/rm>
#include <l4/re/env>
#include <l4/re/dataspace>
#include <l4/re/util/cap_alloc>
#include <l4/sys/err.h>
#include <cstdio>
#include <cstring>

static int allocate_mem(unsigned long size_in_bytes, unsigned long flags,
                        void **virt_addr)
{
  int r;
  L4::Cap<L4Re::Dataspace> d;

  /* Allocate a free capability index for our data space */
  d = L4Re::Util::cap_alloc.alloc<L4Re::Dataspace>();
  if (!d.is_valid())
    return -L4_ENOMEM;

  size_in_bytes = l4_trunc_page(size_in_bytes);

  /* Allocate memory via a dataspace */
  if ((r = L4Re::Env::env()->mem_alloc()->alloc(size_in_bytes, d, flags)))
    return r;

  /* Make the dataspace visible in our address space */
  *virt_addr = 0;
  if ((r = L4Re::Env::env()->rm()->attach(virt_addr, size_in_bytes,
                                          L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
                                          L4::Ipc::make_cap_rw(d), 0,
                                          flags & L4Re::Mem_alloc::Super_pages
                                            ? L4_SUPERPAGESHIFT : L4_PAGESHIFT)))
    return r;

  /* Done, virtual address is in virt_addr */
  return 0;
}

static int free_mem(void *virt_addr)
```

```
{
  int r;
  L4::Cap<L4Re::Dataspace> ds;

  /* Detach memory from our address space */
  if ((r = L4Re::Env::env()->rm()->detach(virt_addr, &ds)))
    return r;

  /* Release and return capability slot to allocator */
  L4Re::Util::cap_alloc.free(ds, L4Re::Env::env()->task().cap());

  /* All went ok */
  return 0;
}

int main(void)
{
  void *virt;

  /* Allocate memory: 16k Bytes (usually) */
  if (allocate_mem(4 * L4_PAGESIZE, 0, &virt))
    return 1;

  printf("Allocated memory.\n");

  /* Do something with the memory */
  memset(virt, 0x12, 4 * L4_PAGESIZE);

  printf("Touched memory.\n");

  /* Free memory */
  if (free_mem(virt))
    return 2;

  printf("Freed and done. Bye.\n");

  return 0;
}
```

17.15 examples/libs/l4re/c++/shared_ds/ds_clnt.cc

Sharing memory between applications, client side.
Sharing memory between applications, client side.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *          Alexander Warg <warg@os.inf.tu-dresden.de>
 */

#include <l4/re/util/cap_alloc> // L4::Cap
#include <l4/re/dataspace>      // L4Re::Dataspace
#include <l4/re/rm>             // L4::Rm
#include <l4/re/env>            // L4::Env
#include <l4/sys/cache.h>

#include <cstring>
#include <cstdio>
#include <unistd.h>

#include "interface.h"

int main()
{
  /*
   * Try to get server interface cap.
   */

  L4::Cap<My_interface> svr = L4Re::Env::env()->get_cap<My_interface>("shm");
  if (!svr.is_valid())
    {
      printf("Could not get the server capability\n");
      return 1;
    }

  /*
   * Alloc data space cap slot
   */
  L4::Cap<L4Re::Dataspace> ds = L4Re::Util::cap_alloc.alloc<L4Re::Dataspace>();
  if (!ds.is_valid())
    {
      printf("Could not get capability slot!\n");
      return 1;
```

```
    }

  /*
   * Alloc server notifier IRQ cap slot
   */
  L4::Cap<L4::Irq> irq = L4Re::Util::cap_alloc.alloc<L4::Irq>();
  if (!irq.is_valid())
    {
      printf("Could not get capability slot!\n");
      return 1;
    }

  /*
   * Request shared data-space cap.
   */
  if (svr->get_shared_buffer(ds, irq))
    {
      printf("Could not get shared memory dataspace!\n");
      return 1;
    }

  /*
   * Attach to arbitrary region
   */
  char *addr = 0;
  int err = L4Re::Env::env()->rm()->attach(&addr, ds->size(),
                                           L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
                                           L4::Ipc::make_cap_rw(ds));
  if (err < 0)
    {
      printf("Error attaching data space: %s\n", l4sys_errtostr(err));
      return 1;
    }

  printf("Content: %s\n", addr);

  // wait a bit for the demo effect
  printf("Sleeping a bit...\n");
  sleep(1);

  /*
   * Fill in new stuff
   */
  memset(addr, 0, ds->size());
  char const * const msg = "Hello from client, too!";
  printf("Setting new content in shared memory\n");
  snprintf(addr, strlen(msg)+1, msg);
  l4_cache_clean_data((unsigned long)addr,
                      (unsigned long)addr + strlen(msg) + 1);

  // notify the server
  irq->trigger();

  /*
   * Detach region containing addr, result should be Detached_ds (other results
   * only apply if we split regions etc.).
   */
  err = L4Re::Env::env()->rm()->detach(addr, 0);
  if (err)
    printf("Failed to detach region\n");

  /* Free objects and capabilties, just for completeness. */
  L4Re::Util::cap_alloc.free(ds, L4Re::This_task);
  L4Re::Util::cap_alloc.free(irq, L4Re::This_task);

  return 0;
}
```

17.16 examples/libs/l4re/c++/shared_ds/ds_srv.cc

Sharing memory between applications, server/creator side.

Sharing memory between applications, server/creator side.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *          Alexander Warg <warg@os.inf.tu-dresden.de>
 */

#include <l4/re/env>
#include <l4/re/error_helper>
#include <l4/re/namespace>
#include <l4/re/util/cap_alloc>
#include <l4/re/util/object_registry>
```

```
#include <l4/re/dataspace>
#include <l4/cxx/ipc_server>
#include <l4/util/util.h>

#include <l4/sys/typeinfo_svr>

#include <cstring>
#include <cstdio>
#include <unistd.h>
#include <pthread.h>
#include <pthread-l4.h>
#include <thread>

#include "interface.h"

class My_server_obj : public L4::Server_object_t<L4::Kobject>
{
private:
  L4::Cap<L4Re::Dataspace> _shm;
  L4::Cap<L4::Irq> _irq;

public:
  explicit My_server_obj(L4::Cap<L4Re::Dataspace> shm, L4::Cap<L4::Irq> irq)
  : _shm(shm), _irq(irq)
  {}

  int dispatch(l4_umword_t obj, L4::Ipc::Iostream &ios);
};


int My_server_obj::dispatch(l4_umword_t obj, L4::Ipc::Iostream &ios)
{
  // we don't care about the original object reference, however
  // we could read out the access rights from the lowest 2 bits
  (void) obj;

  l4_msgtag_t t;
  ios >> t; // extract the tag

  switch (t.label())
    {
    case L4::Meta::Protocol:
      // handle the meta protocol requests, implementing the
      // runtime dynamic type system for L4 objects.
      return L4::Util::handle_meta_request<My_interface>(ios);
    case 0:
      // since we have just one operation we have no opcode dispatch,
      // and just return the data-space and the notifier IRQ capabilities
      ios << _shm << _irq;
      return 0;
    default:
      // every other protocol is not supported.
      return -L4_EBADPROTO;
    }
}


class Shm_observer : public L4::Irq_handler_object
{
private:
  char *_shm;

public:
  explicit Shm_observer(char *shm)
  : _shm(shm)
  {}

  int dispatch(l4_umword_t obj, L4::Ipc::Iostream &ios);
};

int Shm_observer::dispatch(l4_umword_t obj, L4::Ipc::Iostream &ios)
{
  // We don't care about the original object reference, however
  // we could read out the access rights from the lowest 2 bits
  (void)obj;

  // Since we end up here in this function, we got a 'message' from the IRQ
  // that is bound to us. The 'ios' stream won't contain any valuable info.
  (void)ios;

  printf("Client sent us: %s\n", _shm);

  return 0;
}

enum
{
```

```
  DS_SIZE = 4 << 12,
};

static char *get_ds(L4::Cap<L4Re::Dataspace> *_ds)
{
  *_ds = L4Re::Util::cap_alloc.alloc<L4Re::Dataspace>();
  if (!(*_ds).is_valid())
    {
      printf("Dataspace allocation failed.\n");
      return 0;
    }

  int err =  L4Re::Env::env()->mem_alloc()->alloc(DS_SIZE, *_ds, 0);
  if (err < 0)
    {
      printf("mem_alloc->alloc() failed.\n");
      L4Re::Util::cap_alloc.free(*_ds);
      return 0;
    }

  /*
   * Attach DS to local address space
   */
  char *_addr = 0;
  err =  L4Re::Env::env()->rm()->attach(&_addr, (*_ds)->size(),
                                        L4Re::Rm::F::Search_addr | L4Re::Rm::F::RW,
                                        L4::Ipc::make_cap_rw(*_ds));
  if (err < 0)
    {
      printf("Error attaching data space: %s\n", l4sys_errtostr(err));
      L4Re::Util::cap_alloc.free(*_ds);
      return 0;
    }

  /*
   * Success! Write something to DS.
   */
  printf("Attached DS\n");
  static char const * const msg = "[DS] Hello from server!";
  snprintf(_addr, strlen(msg) + 1, msg);

  return _addr;
}

static void *server_thread(void *)
{
  L4::Cap<L4::Thread> l4_thread = Pthread::L4::cap(pthread_self());
  L4Re::Util::Registry_server<> server(l4_thread, L4Re::Env::env()->factory());

  L4::Cap<L4Re::Dataspace> ds;
  char *addr;

  if (!(addr = get_ds(&ds)))
    return nullptr;

  // First the IRQ handler, because we need it in the My_server_obj object
  Shm_observer observer(addr);

  // Registering the observer as an IRQ handler, this allocates an
  // IRQ object using the factory of our server.
  L4::Cap<L4::Irq> irq = server.registry()->register_irq_obj(&observer);

  // Now the initial server object shared with the client via our parent.
  // it provides the data-space and the IRQ capabilities to a client.
  My_server_obj server_obj(ds, irq);

  // Registering the server object to the capability 'shm' in our the L4Re::Env.
  // This capability must be provided by the parent. (see the shared_ds.lua)
  server.registry()->register_obj(&server_obj, "shm");

  // Run our server loop.
  server.loop();
}

int main()
{
  pthread_attr_t pattr;

  if (pthread_attr_init(&pattr))
    L4Re::throw_error(-L4_ENOMEM, "Initialize pthread attributes");

  pthread_t thr;
  L4Re::chksys(pthread_create(&thr, &pattr, server_thread, nullptr),
               "Create server thread");
```

```
  L4Re::chksys(pthread_attr_destroy(&pattr), "Destroy pthread attributes");

  l4_sleep_forever();

  return 0;
}
```

17.17 examples/libs/l4re/c++/shared_ds/shared_ds.cfg

Sharing memory between applications, configuration file.
Sharing memory between applications, configuration file.

```
-- Include L4 functionality
local L4 = require("L4");

-- Create a channel from the client to the server
local channel = L4.default_loader:new_channel();

-- Start the server, giving the channel with full server rights.
-- The server will have a yellow log output.
L4.default_loader:start(
  {
    caps = { shm = channel:svr() },
    log  = { "server", "yellow" }
  },
  "rom/ex_l4re_ds_srv"
);

-- Start the client, giving it the channel with read only rights. The
-- log output will be green.
L4.default_loader:start(
  {
    caps = { shm = channel },
    log  = { "client", "green"  },
    l4re_dbg = L4.Dbg.Warn
  },
  "rom/ex_l4re_ds_clnt"
);
```

17.18 examples/libs/l4re/streammap/server.cc

Client/Server example showing how to map a page to another task – Server implementation.
Client/Server example showing how to map a page to another task – Server implementation. Note that there's also a shared memory library that supplies this functionality in more convenient way.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>
 */
#include <stdio.h>
#include <l4/re/env>
#include <l4/re/util/cap_alloc>
#include <l4/re/util/object_registry>
#include <l4/cxx/ipc_server>

#include "shared.h"

static char page_to_map[L4_PAGESIZE] __attribute__((aligned(L4_PAGESIZE)));

static L4Re::Util::Registry_server<> server;

class Smap_server : public L4::Server_object_t<Mapper>
{
public:
  int dispatch(l4_umword_t obj, L4::Ipc::Iostream &ios);
};

int
Smap_server::dispatch(l4_umword_t, L4::Ipc::Iostream &ios)
{
  l4_msgtag_t t;
  ios >> t;

  // We're only talking the Map_example protocol
  if (t.label() != Mapper::Protocol)
    return -L4_EBADPROTO;

  L4::Opcode opcode;
```

```
  ios » opcode;

  switch (opcode)
    {
    case Mapper::Do_map:
      l4_addr_t snd_base;
      ios » snd_base;
      // put something into the page to read it out at the other side
      snprintf(page_to_map, sizeof(page_to_map), "Hello from the server!");
      printf("Sending to client\n");
      // send page
      ios « L4::Ipc::Snd_fpage::mem((l4_addr_t)page_to_map, L4_PAGESHIFT,
                                    L4_FPAGE_RO, snd_base);
      return L4_EOK;
    default:
      return -L4_ENOSYS;
    }
}

int
main()
{
  static Smap_server smap;

  // Register server
  if (!server.registry()->register_obj(&smap, "smap").is_valid())
    {
      printf("Could not register my service, read-only namespace?\n");
      return 1;
    }

  printf("Welcome to the memory map example server!\n");

  // Wait for client requests
  server.loop();

  return 0;
}
```

17.19 examples/libs/l4re/streammap/client.cc

Client/Server example showing how to map a page to another task – Client implementation.
Client/Server example showing how to map a page to another task – Client implementation. Note that there's also a shared memory library that supplies this functionality in more convenient way.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *               Alexander Warg <warg@os.inf.tu-dresden.de>
 */
#include <l4/sys/err.h>
#include <l4/sys/types.h>
#include <l4/re/env>
#include <l4/re/util/cap_alloc>
#include <l4/cxx/ipc_stream>

#include <stdio.h>

#include "shared.h"

static int
func_smap_call(L4::Cap<void> const &server)
{
  L4::Ipc::Iostream s(l4_utcb());
  l4_addr_t addr = 0;
  int err;

  if ((err = L4Re::Env::env()->rm()->reserve_area(&addr, L4_PAGESIZE,
                                                  L4Re::Rm::F::Search_addr)))
    {
      printf("The reservation of one page within our virtual memory failed with %d\n", err);
      return 1;
    }

  s « L4::Opcode(Mapper::Do_map)
    « (l4_addr_t)addr;
  s « L4::Ipc::Rcv_fpage::mem((l4_addr_t)addr, L4_PAGESHIFT, 0);
  int r = l4_error(s.call(server.cap(), Mapper::Protocol));
  if (r)
    return r; // failure

  printf("String sent by server: %s\n", (char *)addr);

  return 0; // ok
```

```
}

int
main()
{

  L4::Cap<void> server = L4Re::Env::env()->get_cap<void>("smap");
  if (!server.is_valid())
    {
      printf("Could not get capability slot!\n");
      return 1;
    }


  printf("Asking for page from server\n");

  if (func_smap_call(server))
    {
      printf("Error talking to server\n");
      return 1;
    }
  printf("It worked!\n");

  L4Re::Util::cap_alloc.free(server, L4Re::This_task);

  return 0;
}
```

17.20 examples/libs/l4re/streammap/streammap.cfg

Sample configuration file for the client/server map example.
Sample configuration file for the client/server map example.

```
-- vim:set ft=lua:

-- Include L4 functionality
local L4 = require("L4");

-- Channel for the communication between the server and the client.
local smap_channel = L4.default_loader:new_channel();

-- The server program, using the 'smap' channel in server
-- mode. The log prefix will be 'server', colored yellow.
L4.default_loader:start({ caps = { smap = smap_channel:svr() },
                          log = { "server", "yellow" }},
                        "rom/ex_smap-server");


-- The client program.
-- It is given the 'smap' channel to be able to talk to the server.
-- The log prefix will be 'client', colored green.
L4.default_loader:start({ caps = { smap = smap_channel },
                          log = { "client", "green" } },
                        "rom/ex_smap-client");
```

17.21 examples/libs/libirq/loop.c

libirq usage example using a self-created thread.
libirq usage example using a self-created thread.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
 */

#include <l4/irq/irq.h>
#include <l4/util/util.h>
#include <stdio.h>
#include <pthread.h>

enum { IRQ_NO = 17 };

static void isr_handler(void)
{
  printf("Got IRQ %d\n", IRQ_NO);
}

static void *isr_thread(void *data)
{
  l4irq_t *irq;
```

```
  (void)data;

  if (!(irq = l4irq_attach(IRQ_NO)))
    return NULL;

  while (1)
    {
      if (l4irq_wait(irq))
        continue;
      isr_handler();
    }

  return NULL;
}


int main(void)
{
  pthread_t thread;

  if (pthread_create(&thread, NULL, isr_thread, NULL))
    return 1;

  l4_sleep_forever();
  return 0;
}
```

17.22 examples/libs/libirq/async_isr.c

libirq usage example using asynchronous ISR handler functionality.
libirq usage example using asynchronous ISR handler functionality.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
 */
/*
 * This example shall show how to use the libirq.
 */

#include <l4/irq/irq.h>
#include <l4/util/util.h>

#include <stdio.h>

enum { IRQ_NO = 17 };

static void isr_handler(void *data)
{
  (void)data;
  printf("Got IRQ %d\n", IRQ_NO);
}

int main(void)
{
  const int seconds = 5;
  l4irq_t *irqdesc;

  if (!(irqdesc = l4irq_request(IRQ_NO, isr_handler, 0, 0xff, 0)))
    {
      printf("Requesting IRQ %d failed\n", IRQ_NO);
      return 1;
    }

  printf("Attached to key IRQ %d\nPress keys now, will terminate in %d seconds\n",
         IRQ_NO, seconds);

  l4_sleep(seconds * 1000);

  if (l4irq_release(irqdesc))
    {
      printf("Failed to release IRQ\n");
      return 1;
    }

  printf("Bye\n");
  return 0;
}
```

17.23 examples/sys/migrate/thread_migrate.cc

Thread migration example.
Thread migration example.

```
/* SPDX-License-Identifier: MIT */
/*
 * (c) 2008-2009 Author(s)
 */
#include <l4/sys/scheduler>
#include <l4/re/env>
#include <l4/re/util/cap_alloc>

#include <pthread-l4.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

enum { NR_THREADS = 12 };
static L4::Cap<L4::Thread> threads[NR_THREADS];
static l4_umword_t         cpu_map, cpu_nrs;

/* Function for the threads. The content is not really relevant, so lets
 * just sleep around a bit. */
static void *thread_fn(void *)
{
  while (1)
    sleep(1);

  return 0;
}

/* Check how many CPUs we have available.
 */
static int check_cpus(void)
{
  l4_sched_cpu_set_t cs = l4_sched_cpu_set(0, 0);

  if (l4_error(L4Re::Env::env()->scheduler()->info(&cpu_nrs, &cs)) < 0)
    return 1;

  cpu_map = cs.map;

  printf("%ld maximal supported CPUs.\n", cpu_nrs);
  if (cpu_nrs >= L4_MWORD_BITS)
    {
      printf("Will only handle %ld CPUs.\n", cpu_nrs);
      cpu_nrs = L4_MWORD_BITS;
    }
  else if (cpu_nrs == 1)
    printf("Only found 1 CPU.\n");

  return cpu_nrs < 2;
}

/* Create a couple of threads and store their capabilities in an array */
static int create_threads(void)
{
  unsigned i;

  for (i = 0; i < NR_THREADS; ++i)
    {
      pthread_t t;

      if (pthread_create(&t, NULL, thread_fn, NULL))
        return 1;

      threads[i] = L4::Cap<L4::Thread>(pthread_l4_cap(t));
    }
  printf("Created %d threads.\n", NR_THREADS);
  return 0;
}

/* Helper function to get the next CPU */
static unsigned get_next_cpu(unsigned c)
{
  unsigned x = c;
  for (;;)
    {
      x = (x + 1) % cpu_nrs;
      if (L4Re::Env::env()->scheduler()->is_online(x))
        return x;
      if (x == c)
        return c;
    }
```

```
}

/* Function that shuffles the threads on the available CPUs */
static void shuffle(void)
{
  unsigned start = 0;
  while (1)
    {
      unsigned t;
      unsigned c = start;
      for (t = 0; t < NR_THREADS; ++t)
        {
          l4_sched_param_t sp = l4_sched_param(20);
          c = get_next_cpu(c);
          sp.affinity = l4_sched_cpu_set(c, 0);
          if (l4_error(L4Re::Env::env()->scheduler()->run_thread(threads[t], sp)))
            printf("Error migrating thread%02d to CPU%02d\n", t, c);
          printf("Migrated Thread%02d -> CPU%02d\n", t, c);
        }

      start++;
      if (start == cpu_nrs)
        start = 0;
      sleep(1);
    }
}

int main(void)
{
  if (check_cpus())
    return 1;

  if (create_threads())
    return 1;

  shuffle();

  return 0;
}
```

17.24 examples/sys/migrate/thread_migrate.cfg

Sample configuration file for the thread migration example.
Sample configuration file for the thread migration example.

```
-- vim:set ft=lua:

local L4 = require("L4");

-- The log prefix will be 'migrate', colored green.
L4.default_loader:start({ log = { "migrate", "green" } },
                        "rom/ex_thread_migrate");
```

17.25 tmpfs/lib/src/fs.cc

Example file system for L4Re::Vfs.
Example file system for L4Re::Vfs.

```
/*
 * (c) 2010 Adam Lackorzynski <adam@os.inf.tu-dresden.de>,
 *          Alexander Warg <warg@os.inf.tu-dresden.de>
 *     economic rights: Technische Universität Dresden (Germany)
 * This file is part of TUD:OS and distributed under the terms of the
 * GNU Lesser General Public License 2.1.
 * Please see the COPYING-LGPL-2.1 file for details.
 */

#include <l4/l4re_vfs/backend>
#include <l4/cxx/string>
#include <l4/cxx/avl_tree>

#include <sys/stat.h>
#include <sys/ioctl.h>
#include <dirent.h>

#include <cstdio>
#include <cstdlib>
```

```
#include <cstring>

namespace {

using namespace L4Re::Vfs;
using cxx::Ref_ptr;

class File_data
{
public:
  File_data() : _buf(0), _size(0) {}

  unsigned long put(unsigned long offset,
                    unsigned long bufsize, void *srcbuf);
  unsigned long get(unsigned long offset,
                    unsigned long bufsize, void *dstbuf);

  unsigned long size(unsigned long offset);
  unsigned long size() const { return _size; }

  ~File_data() noexcept { free(_buf); }

private:
  void *_buf;
  unsigned long _size;
};

unsigned long
File_data::put(unsigned long offset, unsigned long bufsize, void *srcbuf)
{
  if (offset + bufsize > _size)
    size(offset + bufsize);

  if (!_buf)
    return 0;

  memcpy((char *)_buf + offset, srcbuf, bufsize);
  return bufsize;
}

unsigned long
File_data::get(unsigned long offset, unsigned long bufsize, void *dstbuf)
{
  unsigned long s = bufsize;

  if (offset > _size)
    return 0;

  if (offset + bufsize > _size)
    s = _size - offset;

  memcpy(dstbuf, (char *)_buf + offset, s);
  return s;
}

unsigned long
File_data::size(unsigned long offset)
{
  if (offset != _size)
    {
      _size = offset;
      _buf = realloc(_buf, _size);
    }

  if (_buf)
    return 0;
  return -ENOSPC;
}


class Node : public cxx::Avl_tree_node
{
public:
  Node(const char *path, mode_t mode)
    : _ref_cnt(0), _path(strdup(path))
  {
    memset(&_info, 0, sizeof(_info));
    _info.st_mode = mode;
  }

  const char *path() const { return _path; }
  struct stat64 *info() { return &_info; }

  void add_ref() noexcept { ++_ref_cnt; }
```

```
  int remove_ref() noexcept { return --_ref_cnt; }

  bool is_dir() const { return S_ISDIR(_info.st_mode); }

  virtual ~Node() { free(_path); }

private:
  int           _ref_cnt;
  char         *_path;
  struct stat64 _info;
};

struct Node_get_key
{
  typedef cxx::String Key_type;
  static Key_type key_of(Node const *n)
  { return n->path(); }
};

struct Path_avl_tree_compare
{
  bool operator () (const char *l, const char *r) const
  { return strcmp(l, r) < 0; }
  bool operator () (const cxx::String l, const cxx::String r) const
  {
    int v = strncmp(l.start(), r.start(), cxx::min(l.len(), r.len()));
    return v < 0 || (v == 0 && l.len() < r.len());
  }
};

class Pers_file : public Node
{
public:
  Pers_file(const char *name, mode_t mode)
    : Node(name, (mode & 0777) | S_IFREG) {}
  File_data const &data() const { return _data; }
  File_data &data() { return _data; }
private:
  File_data     _data;
};

class Pers_dir : public Node
{
private:
  typedef cxx::Avl_tree<Node, Node_get_key, Path_avl_tree_compare> Tree;
  Tree _tree;

public:
  Pers_dir(const char *name, mode_t mode)
    : Node(name, (mode & 0777) | S_IFDIR) {}
  Ref_ptr<Node> find_path(cxx::String);
  bool add_node(Ref_ptr<Node> const &);

  typedef Tree::Const_iterator Const_iterator;
  Const_iterator begin() const { return _tree.begin(); }
  Const_iterator end() const { return _tree.end(); }
};

Ref_ptr<Node> Pers_dir::find_path(cxx::String path)
{
  return cxx::ref_ptr(_tree.find_node(path));
}

bool Pers_dir::add_node(Ref_ptr<Node> const &n)
{
  bool e = _tree.insert(n.ptr()).second;
  if (e)
    n->add_ref();
  return e;
}

class Tmpfs_dir : public Be_file
{
public:
  explicit Tmpfs_dir(Ref_ptr<Pers_dir> const &d) noexcept
    : _dir(d), _getdents_state(false) {}
  int get_entry(const char *, int, mode_t, Ref_ptr<File> *) noexcept override;
  ssize_t getdents(char *, size_t) noexcept override;
  int fstat(struct stat64 *buf) const noexcept override;
  int utime(const struct utimbuf *) noexcept override;
  int fchmod(mode_t) noexcept override;
  int mkdir(const char *, mode_t) noexcept override;
  int unlink(const char *) noexcept override;
  int rename(const char *, const char *) noexcept override;
  int faccessat(const char *, int, int) noexcept override;

private:
```

```
  int walk_path(cxx::String const &_s,
                Ref_ptr<Node> *ret, cxx::String *remaining = 0);

  Ref_ptr<Pers_dir> _dir;
  bool _getdents_state;
  Pers_dir::Const_iterator _getdents_iter;
};

class Tmpfs_file : public Be_file_pos
{
public:
  explicit Tmpfs_file(Ref_ptr<Pers_file> const &f) noexcept
    : Be_file_pos(), _file(f) {}

  off64_t size() const noexcept;
  int fstat(struct stat64 *buf) const noexcept override;
  int ftruncate(off64_t p) noexcept override;
  int ioctl(unsigned long, va_list) noexcept override;
  int utime(const struct utimbuf *) noexcept override;
  int fchmod(mode_t) noexcept override;

private:
  ssize_t preadv(const struct iovec *v, int iovcnt, off64_t p) noexcept
          override;
  ssize_t pwritev(const struct iovec *v, int iovcnt, off64_t p) noexcept
          override;
  Ref_ptr<Pers_file> _file;
};

ssize_t Tmpfs_file::preadv(const struct iovec *v, int iovcnt, off64_t p)
        noexcept
{
  if (iovcnt < 0)
    return -EINVAL;

  ssize_t sum = 0;
  for (int i = 0; i < iovcnt; ++i)
    {
      sum  += _file->data().get(p, v[i].iov_len, v[i].iov_base);
      p += v[i].iov_len;
    }
  return sum;
}

ssize_t Tmpfs_file::pwritev(const struct iovec *v, int iovcnt, off64_t p)
        noexcept
{
  if (iovcnt < 0)
    return -EINVAL;

  ssize_t sum = 0;
  for (int i = 0; i < iovcnt; ++i)
    {
      sum  += _file->data().put(p, v[i].iov_len, v[i].iov_base);
      p += v[i].iov_len;
    }
  return sum;
}

int Tmpfs_file::fstat(struct stat64 *buf) const noexcept
{
  _file->info()->st_size = _file->data().size();
  memcpy(buf, _file->info(), sizeof(*buf));
  return 0;
}

int Tmpfs_file::ftruncate(off64_t p) noexcept
{
  if (p < 0)
      return -EINVAL;

  if (_file->data().size(p) == 0)
      return 0;

  return -EIO; // most likely ENOSPC, but can't report that
}

off64_t Tmpfs_file::size() const noexcept
{ return _file->data().size(); }

int
Tmpfs_file::ioctl(unsigned long v, va_list args) noexcept
{
  switch (v)
    {
    case FIONREAD: // return amount of data still available
      int *available = va_arg(args, int *);
```

```
      *available = _file->data().size() - pos();
      return 0;
    };
  return -EINVAL;
}

int
Tmpfs_file::utime(const struct utimbuf *times) noexcept
{
  _file->info()->st_atime = times->actime;
  _file->info()->st_mtime = times->modtime;
  return 0;
}

int
Tmpfs_file::fchmod(mode_t m) noexcept
{
  _file->info()->st_mode = m;
  return 0;
}

int
Tmpfs_dir::faccessat(const char *path, int mode, int) noexcept
{
  Ref_ptr<Node> node;
  cxx::String name = path;

  int err = walk_path(name, &node, &name);
  if (err < 0)
    return err;

  if (mode == F_OK) // existence check
    return 0;

  struct stat64 *stats = node->info();

  if ((mode & R_OK) && !(stats->st_mode & S_IRUSR))
    return -EACCES;

  if ((mode & W_OK) && !(stats->st_mode & S_IWUSR))
    return -EACCES;

  if ((mode & X_OK) && !(stats->st_mode & S_IXUSR))
    return -EACCES;

  return 0;
}

int
Tmpfs_dir::get_entry(const char *name, int flags, mode_t mode,
                     Ref_ptr<File> *file) noexcept
{
  Ref_ptr<Node> path;
  if (!*name)
    {
      *file = cxx::ref_ptr(this);
      return 0;
    }

  cxx::String n = name;

  int e = walk_path(n, &path, &n);

  if (e == -ENOTDIR)
    return e;

  if (!(flags & O_CREAT) && e < 0)
    return e;

  if ((flags & O_CREAT) && e == -ENOENT)
    {
      Ref_ptr<Node> node(new Pers_file(n.start(), mode));
      // when ENOENT is return, path is always a directory
      bool e = cxx::ref_ptr_static_cast<Pers_dir>(path)->add_node(node);
      if (!e)
        return -ENOMEM;
      path = node;
    }

  if (path->is_dir())
    *file = cxx::ref_ptr(new Tmpfs_dir(cxx::ref_ptr_static_cast<Pers_dir>(path)));
  else
    *file = cxx::ref_ptr(new Tmpfs_file(cxx::ref_ptr_static_cast<Pers_file>(path)));

  if (!*file)
```

```
    return -ENOMEM;


  return 0;
}

ssize_t
Tmpfs_dir::getdents(char *buf, size_t sz) noexcept
{
  struct dirent64 *d = (struct dirent64 *)buf;
  ssize_t ret = 0;

  if (!_getdents_state)
    {
      _getdents_iter = _dir->begin();
      _getdents_state = true;
    }
  else if (_getdents_iter == _dir->end())
    {
      _getdents_state = false;
      return 0;
    }

  for (; _getdents_iter != _dir->end(); ++_getdents_iter)
    {
      unsigned l = strlen(_getdents_iter->path()) + 1;
      if (l > sizeof(d->d_name))
        l = sizeof(d->d_name);

      unsigned n = offsetof (struct dirent64, d_name) + l;
      n = (n + sizeof(long) - 1) & ~(sizeof(long) - 1);

      if (n > sz)
        break;

      d->d_ino = 1;
      d->d_off = 0;
      memcpy(d->d_name, _getdents_iter->path(), l);
      d->d_reclen = n;
      d->d_type   = DT_REG;
      ret += n;
      sz  -= n;
      d    = (struct dirent64 *)((unsigned long)d + n);
    }

  return ret;
}

int
Tmpfs_dir::fstat(struct stat64 *buf) const noexcept
{
  memcpy(buf, _dir->info(), sizeof(*buf));
  return 0;
}

int
Tmpfs_dir::utime(const struct utimbuf *times) noexcept
{
  _dir->info()->st_atime = times->actime;
  _dir->info()->st_mtime = times->modtime;
  return 0;
}

int
Tmpfs_dir::fchmod(mode_t m) noexcept
{
  _dir->info()->st_mode = m;
  return 0;
}

int
Tmpfs_dir::walk_path(cxx::String const &_s,
                     Ref_ptr<Node> *ret, cxx::String *remaining)
{
  Ref_ptr<Pers_dir> p = _dir;
  cxx::String s = _s;
  Ref_ptr<Node> n;

  while (1)
    {
      if (s.len() == 0)
        {
          *ret = p;
          return 0;
```

```
        }

      cxx::String::Index sep = s.find("/");

      if (sep - s.start() == 1 && *s.start() == '.')
        {
          s = s.substr(s.start() + 2);
          continue;
        }

      n = p->find_path(s.head(sep - s.start()));

      if (!n)
        {
          *ret = p;
          if (remaining)
            *remaining = s.head(sep - s.start());
          return -ENOENT;
        }


      if (sep == s.end())
        {
          *ret = n;
          return 0;
        }

      if (!n->is_dir())
        return -ENOTDIR;

      s = s.substr(sep + 1);

      p = cxx::ref_ptr_static_cast<Pers_dir>(n);
    }

  *ret = n;

  return 0;
}

int
Tmpfs_dir::mkdir(const char *name, mode_t mode) noexcept
{
  Ref_ptr<Node> node = _dir;
  cxx::String p = cxx::String(name);
  cxx::String path, last = p;
  cxx::String::Index s = p.rfind("/");

  // trim /'s at the end
  while (p.len() && s == p.end() - 1)
    {
      p.len(p.len() - 1);
      s = p.rfind("/");
    }

  //printf("MKDIR '%s' p=%p %p\n", name, p.start(), s);

  if (s != p.end())
    {
      path = p.head(s);
      last = p.substr(s + 1, p.end() - s);

      int e = walk_path(path, &node);
      if (e < 0)
        return e;
    }

  if (!node->is_dir())
    return -ENOTDIR;

  // due to path walking we can end up with an empty name
  if (p.len() == 0 || p == cxx::String("."))
    return 0;

  Ref_ptr<Pers_dir> dnode = cxx::ref_ptr_static_cast<Pers_dir>(node);

  Ref_ptr<Pers_dir> dir(new Pers_dir(last.start(), mode));
  return dnode->add_node(dir) ? 0 : -EEXIST;
}

int
Tmpfs_dir::unlink(const char *name) noexcept
{
  cxx::Ref_ptr<Node> n;

  int e = walk_path(name, &n);
  if (e < 0)
```

```
    return -ENOENT;

  printf("Unimplemented (if file exists): %s(%s)\n", __func__, name);
  return -ENOMEM;
}

int
Tmpfs_dir::rename(const char *old, const char *newn) noexcept
{
  printf("Unimplemented: %s(%s, %s)\n", __func__, old, newn);
  return -ENOMEM;
}



class Tmpfs_fs : public Be_file_system
{
public:
  Tmpfs_fs() : Be_file_system("tmpfs") {}
  int mount(char const *source, unsigned long mountflags,
            void const *data, cxx::Ref_ptr<File> *dir) noexcept override
  {
    (void)mountflags;
    (void)source;
    (void)data;
    *dir = cxx::ref_ptr(new Tmpfs_dir(cxx::ref_ptr(new Pers_dir("root", 0777))));
    if (!*dir)
      return -ENOMEM;
    return 0;
  }
};

static Tmpfs_fs _tmpfs L4RE_VFS_FILE_SYSTEM_ATTRIBUTE;

}
```

17.26 examples/libs/shmc/prodcons.c

Simple shared memory example.
Simple shared memory example.

```
/*
 * (c) 2008-2009 Adam Lackorzynski <adam@os.inf.tu-dresden.de>
 *     economic rights: Technische Universität Dresden (Germany)
 *
 * This file is part of TUD:OS and distributed under the terms of the
 * GNU General Public License 2.
 * Please see the COPYING-GPL-2 file for details.
 */

/*
 * This example uses shared memory between two threads, one producer, one
 * consumer.
 */

#include <l4/shmc/shmc.h>

#include <l4/util/util.h>

#include <stdio.h>
#include <string.h>
#include <pthread-l4.h>

#include <l4/sys/thread.h>
#include <l4/sys/debugger.h>
#include <l4/sys/kip.h>
#include <l4/re/env.h>

#define LOG(args...)            printf(NAME ": " args)
#define CHK(func)                                                       \
  do                                                                    \
    {                                                                   \
      long r = (func);                                                  \
      if (r)                                                            \
        {                                                               \
          printf(NAME ": Failure %ld (%s) at line %d.\n",               \
                 r, l4sys_errtostr(r), __LINE__);                       \
          return (void *)-1;                                            \
        }                                                               \
```

```
    } while (0)

static const char some_data[] = "Hi consumer!";

static inline l4_cap_idx_t self(void) { return pthread_l4_cap(pthread_self()); }

#define NAME "PRODUCER"
static void *thread_producer(void *d)
{
  (void)d;
  l4shmc_chunk_t p_one;
  l4shmc_signal_t s_one, s_done;
  l4shmc_area_t shmarea;
  l4_kernel_clock_t try_until;

  l4_debugger_set_object_name(self(), "producer");

  // attach this thread to the shm object
  CHK(l4shmc_attach("testshm", &shmarea));

  // add a chunk
  CHK(l4shmc_add_chunk(&shmarea, "one", 1024, &p_one));

  // add a signal
  CHK(l4shmc_add_signal(&shmarea, "testshm_prod", &s_one));

  CHK(l4shmc_attach_signal(&shmarea, "testshm_done", self(), &s_done));

  // connect chunk and signal
  CHK(l4shmc_connect_chunk_signal(&p_one, &s_one));

  CHK(l4shmc_mark_client_initialized(&shmarea));

  try_until = l4_kip_clock(l4re_kip()) + 10 * 1000000;

  for (;;)
    {
      l4_umword_t clients;
      l4shmc_get_initialized_clients(&shmarea, &clients);
      if (clients == 3UL)
        break;
      if (l4_kip_clock(l4re_kip()) >= try_until)
        {
          LOG("consumer not initialized within time\n");
          return (void *)-1;
        }
    }

  LOG("Ready.\n");

  while (1)
    {
      while (l4shmc_chunk_try_to_take(&p_one))
        printf("Uh, should not happen!\n"); //l4_thread_yield();

      memcpy(l4shmc_chunk_ptr(&p_one), some_data, sizeof(some_data));

      CHK(l4shmc_chunk_ready_sig(&p_one, sizeof(some_data)));

      LOG("Sent data.\n");

      CHK(l4shmc_wait_signal(&s_done));
    }

  l4_sleep_forever();
  return NULL;
}


#undef NAME
#define NAME "CONSUMER"
static void *thread_consumer(void *d)
{
  (void)d;
  l4shmc_area_t shmarea;
  l4shmc_chunk_t p_one;
  l4shmc_signal_t s_one, s_done;
  l4_kernel_clock_t try_until;

  l4_debugger_set_object_name(self(), "consumer");

  // attach to shared memory area
  CHK(l4shmc_attach("testshm", &shmarea));

  // get chunk 'one'
```

```
  CHK(l4shmc_get_chunk(&shmarea, "one", &p_one));

  // add a signal
  CHK(l4shmc_add_signal(&shmarea, "testshm_done", &s_done));

  // attach signal to this thread
  CHK(l4shmc_attach_signal(&shmarea, "testshm_prod", self(), &s_one));

  // connect chunk and signal
  CHK(l4shmc_connect_chunk_signal(&p_one, &s_one));

  CHK(l4shmc_mark_client_initialized(&shmarea));

  try_until = l4_kip_clock(l4re_kip()) + 10 * 1000000;

  for (;;)
    {
      l4_umword_t clients;
      l4shmc_get_initialized_clients(&shmarea, &clients);
      if (clients == 3UL)
        break;
      if (l4_kip_clock(l4re_kip()) >= try_until)
        {
          LOG("producer not initialized within time\n");
          return (void *)-1;
        }
    }

  LOG("Ready.\n");

  while (1)
    {
      CHK(l4shmc_wait_chunk(&p_one));

      LOG("Received from chunk one: '%s'.\n",
          (char *)l4shmc_chunk_ptr(&p_one));
      memset(l4shmc_chunk_ptr(&p_one), 0, l4shmc_chunk_size(&p_one));

      CHK(l4shmc_chunk_consumed(&p_one));

      CHK(l4shmc_trigger(&s_done));
    }

  return NULL;
}


int main(void)
{
  pthread_t one, two;
  long r;

  // create shared memory area
  if ((r = l4shmc_create("testshm")) < 0)
    {
      printf("Error %ld (%s) creating shared memory area\n",
             r, l4sys_errtostr(r));
      return 1;
    }

  // create two threads, one for producer, one for consumer
  pthread_create(&one, 0, thread_producer, 0);
  pthread_create(&two, 0, thread_consumer, 0);

  // now sleep, the two threads are doing the work
  l4_sleep_forever();

  return 0;
}
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