TECHNISCHE UNIVERSITÄT DRESDEN

WELCOME TO DOS CLASS

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Senior Professor

Head of OS group 1994 - 2019

ORGANISATION

- Lecturer in charge of DOS:
  Dr. Carsten Weinhold, Barkhausen Institute TUD
- Several lectures presented by research-group members.
- register for mailing list !!!   see Website
  - only way to inform about short-term issues
  - for questions and discussions and lecturing methods
  - must use: “tu-dresden.de” mail-adresses

EXAMS

oral,

details to follow after COVID-19

may be similar as last years’ (see next slide)

LAST YEARS' EXAMS

- about 1 exam date per month
- for exam appointments:
  - email to angela.spehr@tu-dresden.de for exam date/time
  - provide paperwork (forms) at least **2 weeks before exam:**
    if you don't: appointment is automatically canceled
    you can cancel until 2 weeks before date
    after that, no more cancellation except for sickness
- Diplom/Master INF study programmes:
  can be combined with other classes in complex modules

- Name no more precise → Interesting/advanced Topics in Operating Systems
  - scalability
  - systems security
  - modeling
- Some overlap with „Distributed Systems“ (Prof Schill) and some classes by Prof Fetzer
- In some cases no written material (except slides)

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Faculty of Computer Science Institute of Systems Architecture, Operating Systems Group

1.0) DOS ORGANISATION

1.1) SCALABILITY IN COMPUTER SYSTEMS

1.2) EXAMPLE: DNS/BIND

HERMANN HÄRTIG, DISTRIBUTED OPERATING SYSTEMS, SS2020

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GOAL OF ALL LECTURES ON SCALABILITY

Topics:

- scalability: terminology, problems, principle approaches
- case studies, all layers of compute systems

Goal:

- understand (some of the) important principles how to build scalable systems

TODAY

Outline:

- scalability … and simple model to reason about 1 aspect
- names in Distributed Systems:
  purposes of naming, terminology. (DNS)
- application of scalability approaches on name resolution

Goal:

- understand some of the important principles how to build scalable systems … using DNS as example

MORE CASE STUDIES LATER IN THE CLASS

- memory consistency
- locks and advanced synchronization approaches
- file systems
- load balancing (MosiX) and HPC(MPI)

GENERAL DEFINITION: SCALABILITY

Scalability:

Scalability is the property of a system to handle a growing amount of work by adding resources to the system.

Wikipedia (2019) and many other sources

SCALABILITY: WEAK ./. STRONG

ability of a system to use growing resources ...

- weak:
  to handle growing load, larger problem, ...
- strong:
  accelerate existing work load, same problem

problems

THINK and PAUSE!

PAUSE THE VIDEO HERE
AND THINK before continuing

PROBLEMS

- performance bottlenecks / Amdahl's Law
- failures / abuse
- administration

RESOURCES AND PERFORMANCE

- processors
- communication
- memory (remember basic OS course: “thrashing”)

$$\text{Speedup:} \frac{\text{original execution time}}{\text{enhanced execution time}}$$

SIMPLE MODEL: AMDAHL'S LAW

$$\text{Speedup:} \frac{\text{original execution time}}{\text{enhanced execution time}}$$

Parallel Execution

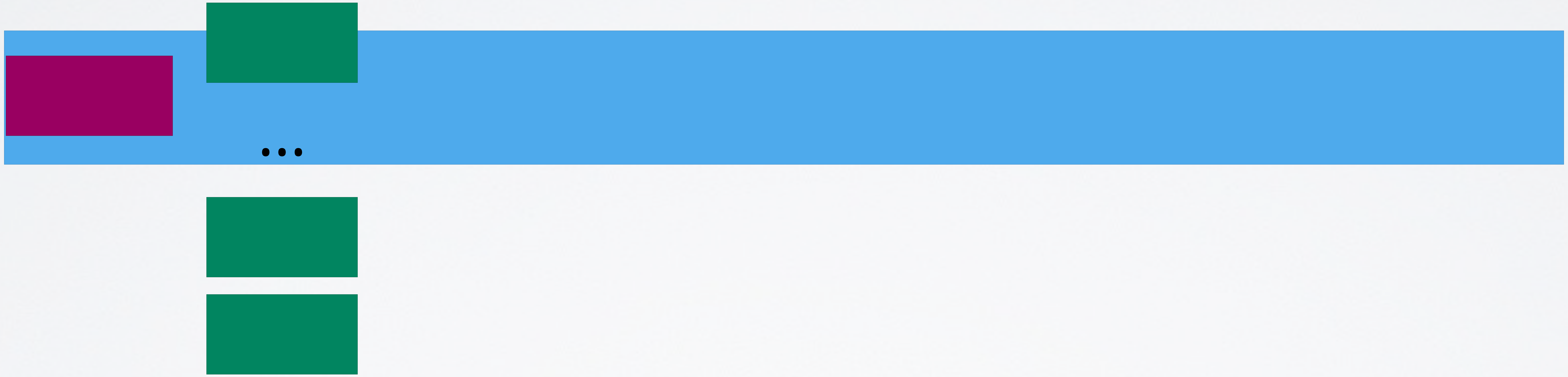
red: cannot run in Parallel

green: runs *perfectly* parallel

unlimited processors maximum speedup: blue/red

AMDAHL'S LAW

Parallel Execution, N processors



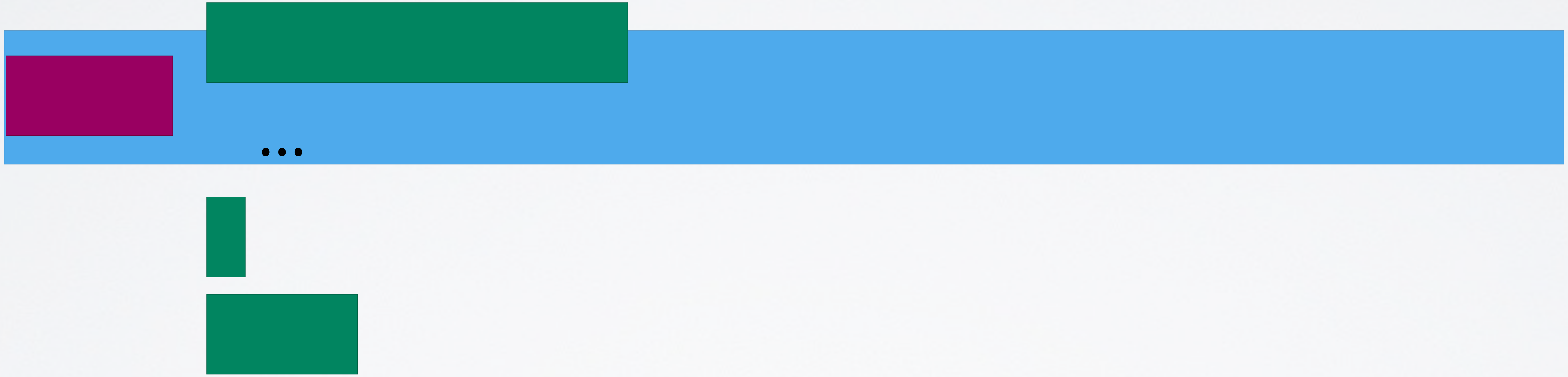
red: cannot run in Parallel

green: runs perfectly parallel

N processors maximum speedup: blue/(red+green/N)

AMDAHL'S LAW

Parallel Execution, N processors



red: cannot run in Parallel

green: runs perfectly parallel

maximum speedup: blue/(red+green/N)

AMDAHL'S LAW

$$\text{Speedup:} \frac{\text{original execution time}}{\text{enhanced execution time}}$$

- P: section that can be parallelized
- 1-P: serial section
- N: number of CPUs

$$\text{Speedup}(P,N) = \frac{1}{\left(1 - P + \frac{P}{N}\right)}$$

- if N becomes VERY large, speedup approaches: 1/(1-P) principle approaches

THINK and PAUSE!

PAUSE THE VIDEO HERE
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THE “RPC” PRINCIPLES

- partitioning
  split systems into parts that can operate independently/parallel to a large extent
- replication
  provide several copies of components
  - that are kept consistent eventually
  - that can be used in case of failure of copies
- locality (caching)
  maintain a copy of information that is nearer, cheaper/faster to access than the original

MORE PRINCIPLES

- identify and address bottlenecks
- specialize functionality/interfaces
- right level of consistency
  caches, replicates, … need not always be fully consistent
- lazy information dissemination
- balance load (make partitioning dynamic)

1.0) DOS ORGANISATION

1.1) SCALABILITY IN COMPUTER SYSTEMS

1.2) EXAMPLE: DNS/BIND

HERMANN HÄRTIG, DISTRIBUTED OPERATING SYSTEMS, SS2020

MY FIRST EMAIL

- UUCP/MMDF (cum grano salis):
  - ira!gmdzi!oldenburg!heinrich!user (path to destination)
  - user@ira!heinrich%gmdzi
    (mixing identifiers and path information)

A BIT OF HISTORY

- ARPA-Net at the beginning:
  - a single file: hosts.txt
  - maintained at Network Information Center of SRI (Stanford)
  - accessed via ftp
  - TCP/IP in BSD Unix
    => chaos name collisions, consistency, load
- DNS: Paul Mockapetries (84) ...

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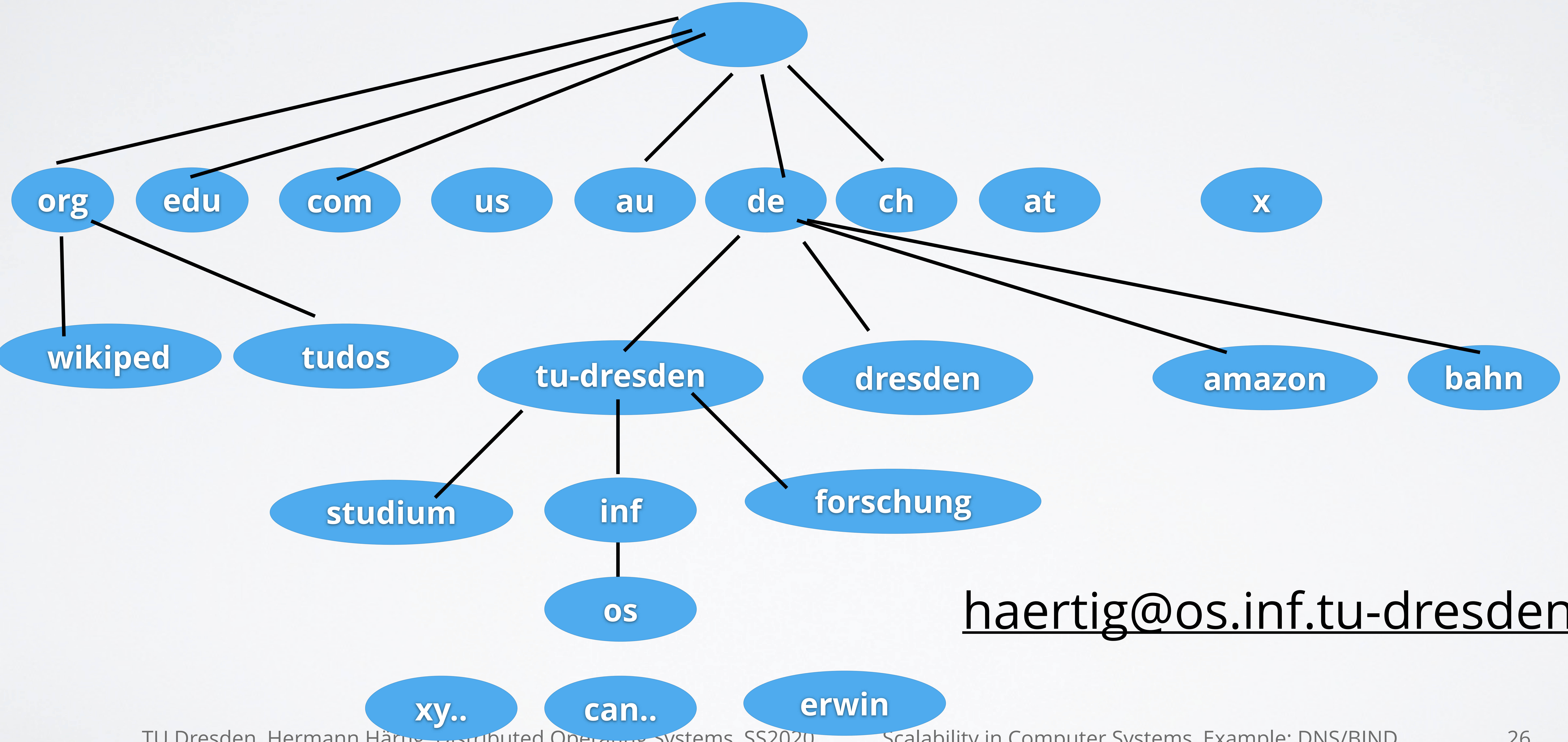
DOMAIN NAME SYSTEM



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NAMES, IDENTIFIERS, ADDRESSES

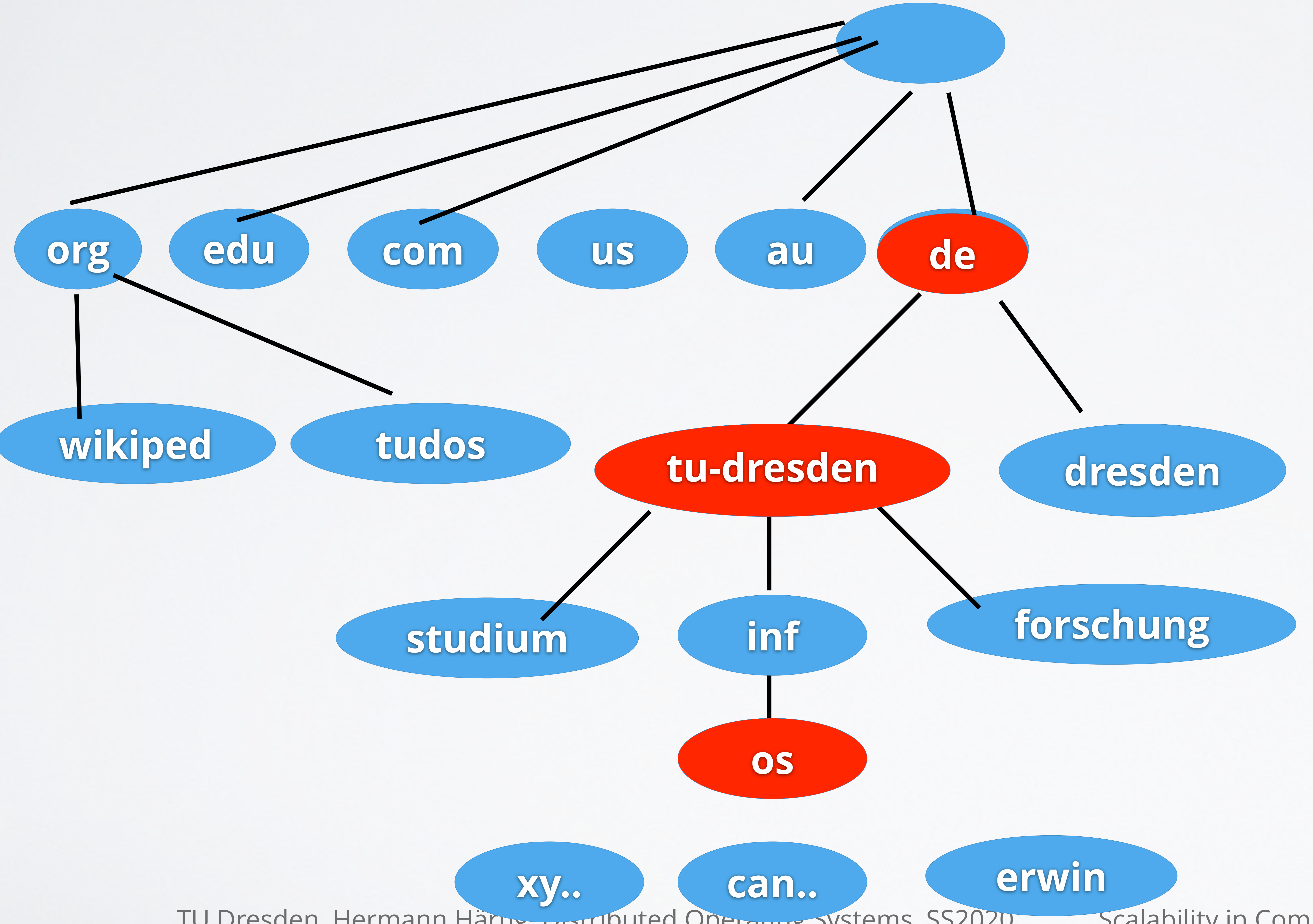
- names
  - symbolic, many names possible for 1 entity
  - have a meaning for people
- identifiers
  - identifies an entity uniquely
  - are used by programs
- addresses
  - locates an entity
  - changes occasionally (or frequently)

NAME RESOLUTION

- name resolution:
  map symbolic names to a set of attributes such as:
  identifiers, addresses, alias names, security properties
  encryption keys

- Principle interface:
  - Register (Context, Name, attributes, ...)
  - Lookup (Context, Name) -> attributes

DNS DOMAINS



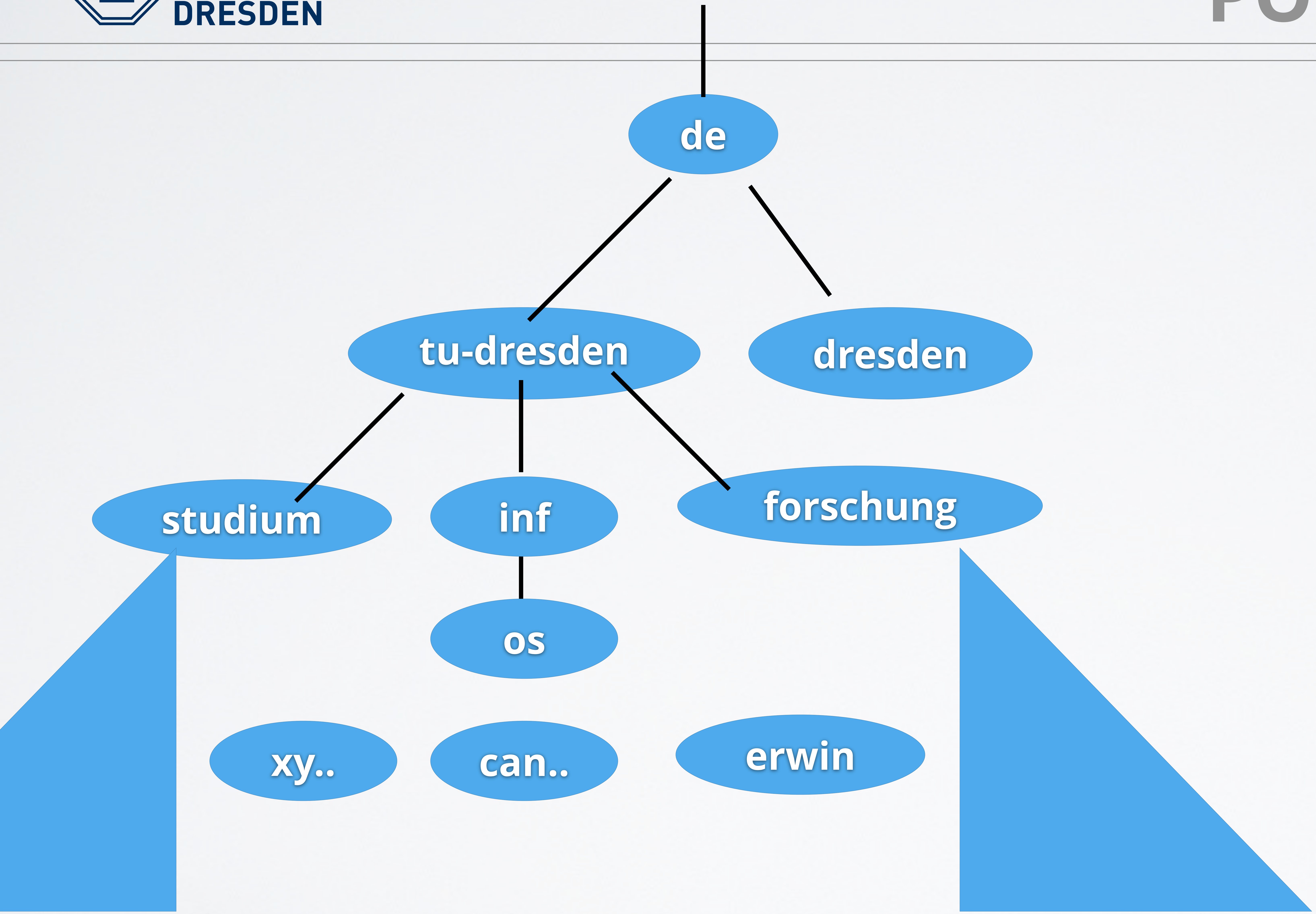
domain
subtree in DNS hierarchy:

- de
- tu-dresden.de
- os.inf.tu-dresden.de
- tudos.org and os.inf.tu-dresden.de are aliases

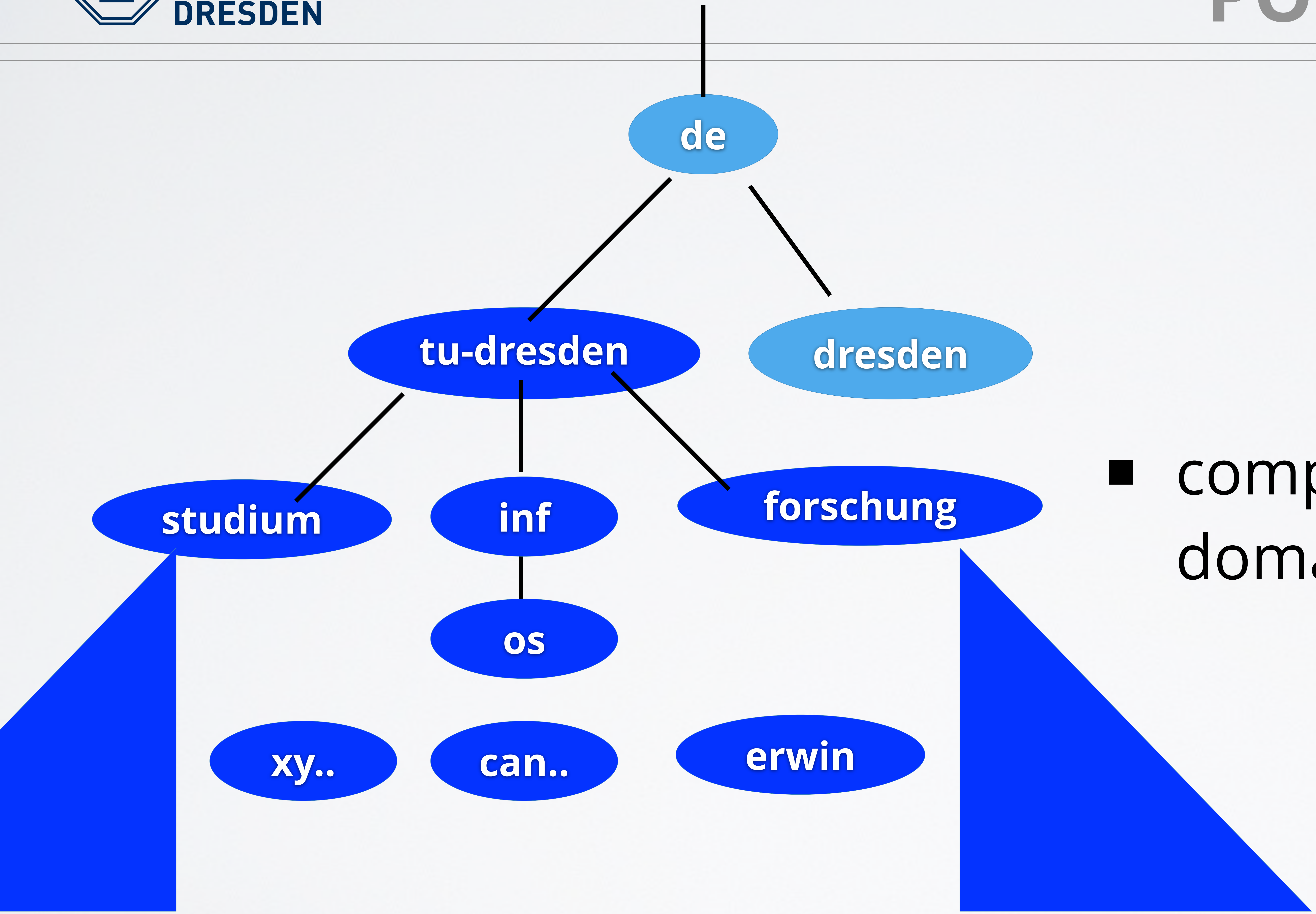
PARTITIONING: ZONE

- zone: Subset of a domain
  over which an authority has complete control.
  controlled by a name server.
  Subzones can be delegated to other authorities.
- navigation
  querying in a set of cooperating name servers

POTENTIAL ZONES

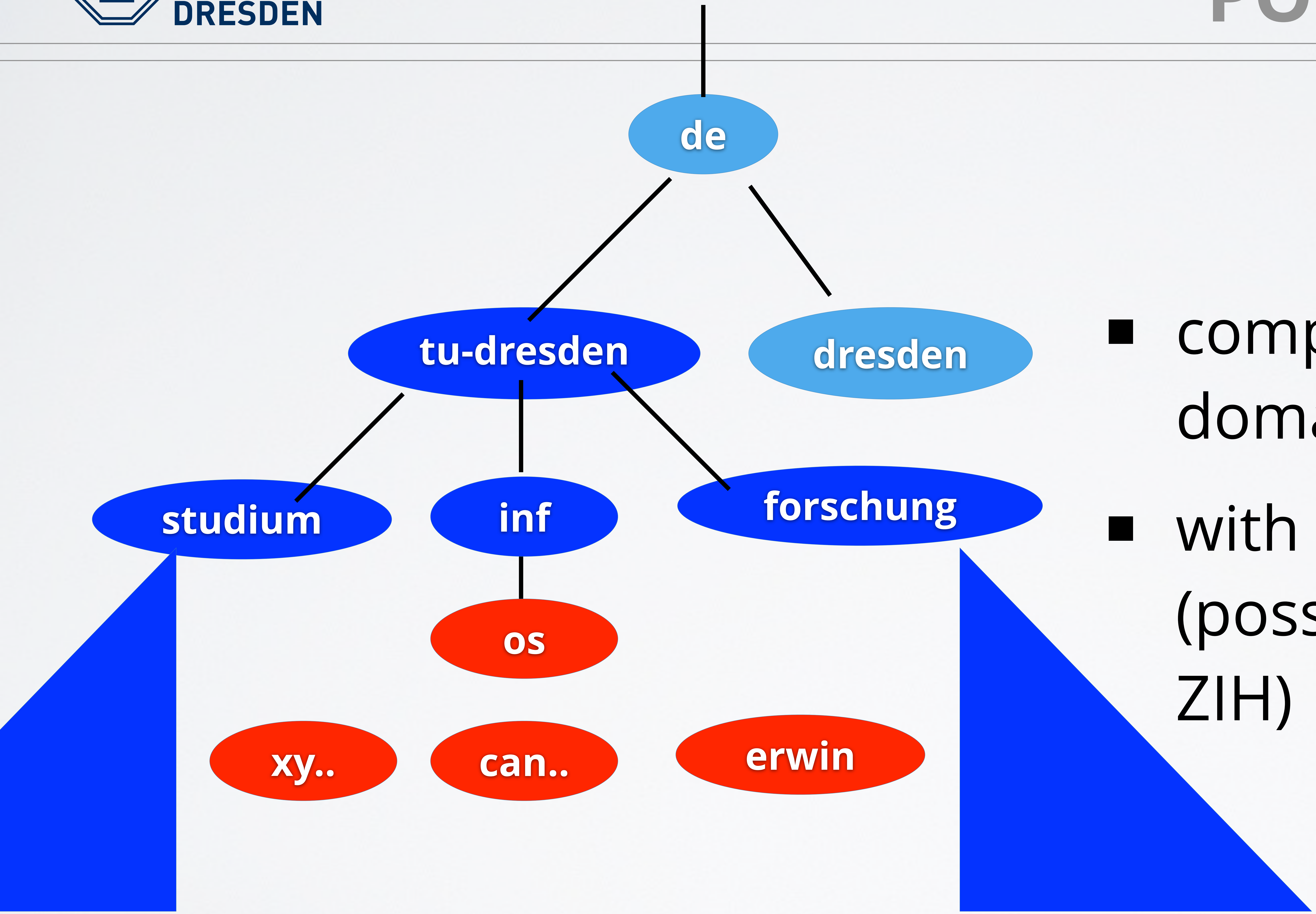


POTENTIAL ZONES

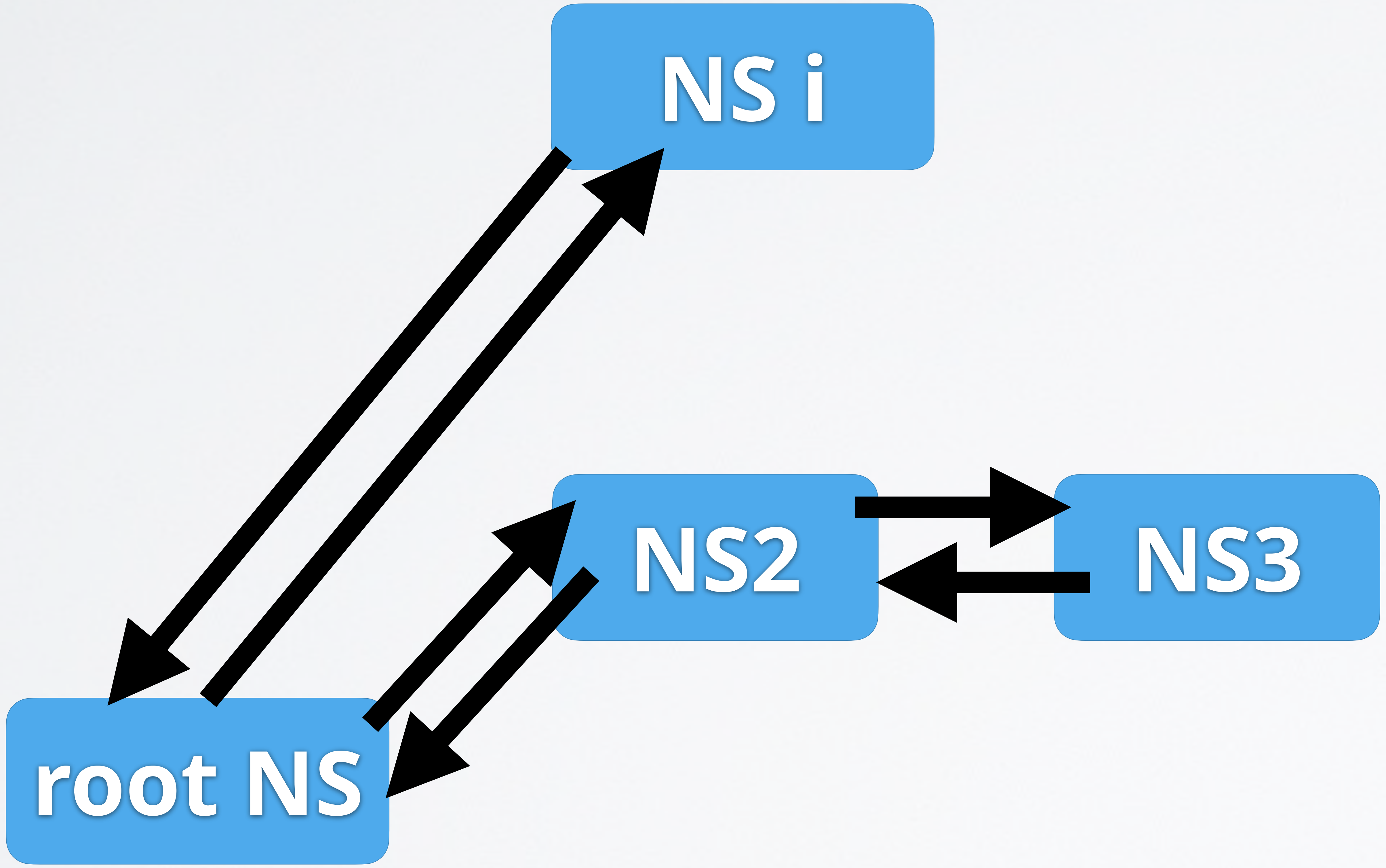


- complete tu-dresden domain

POTENTIAL ZONES



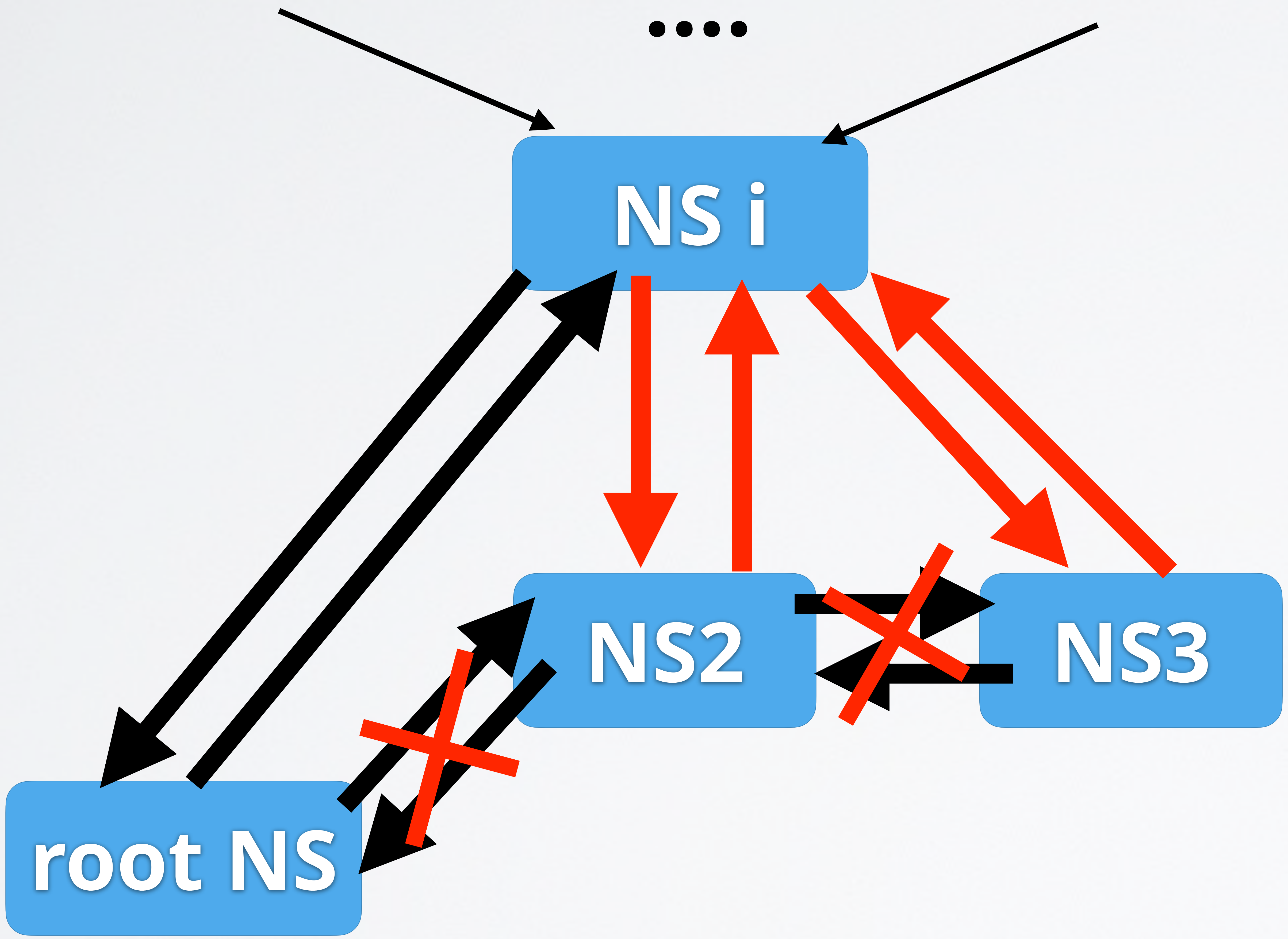
- complete tu-dresden domain
- with sub zone os (possible but unliked by ZIH)



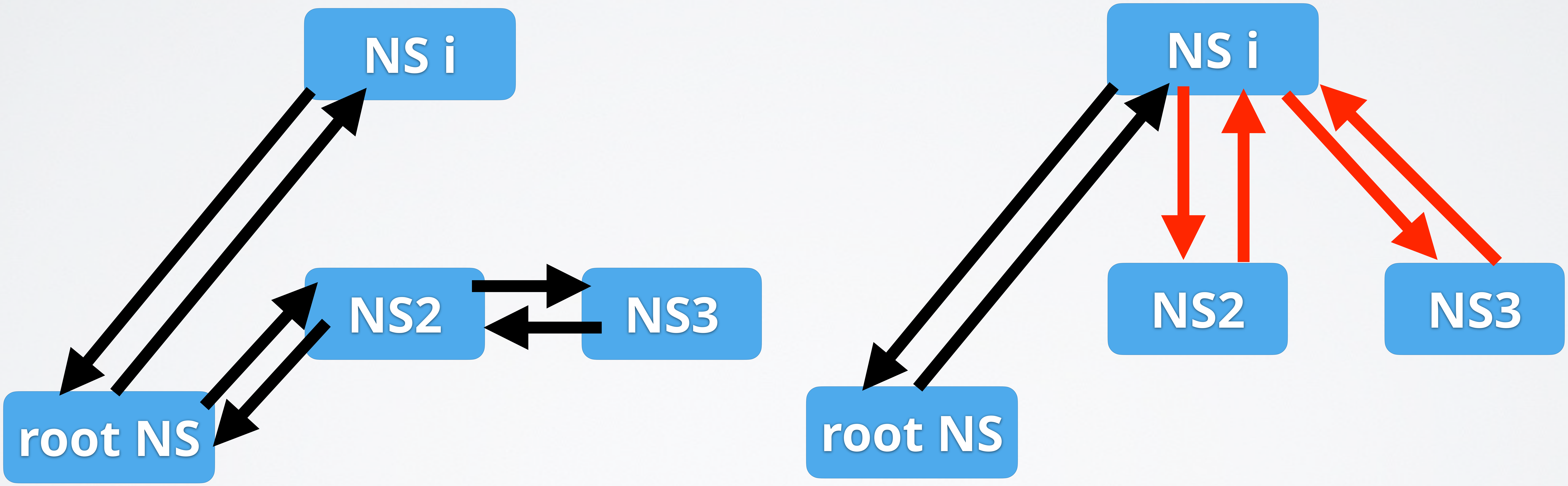
CACHING

- remember intermediate results
- @ root NS makes no sense! (overload)
- @ NS i !!!

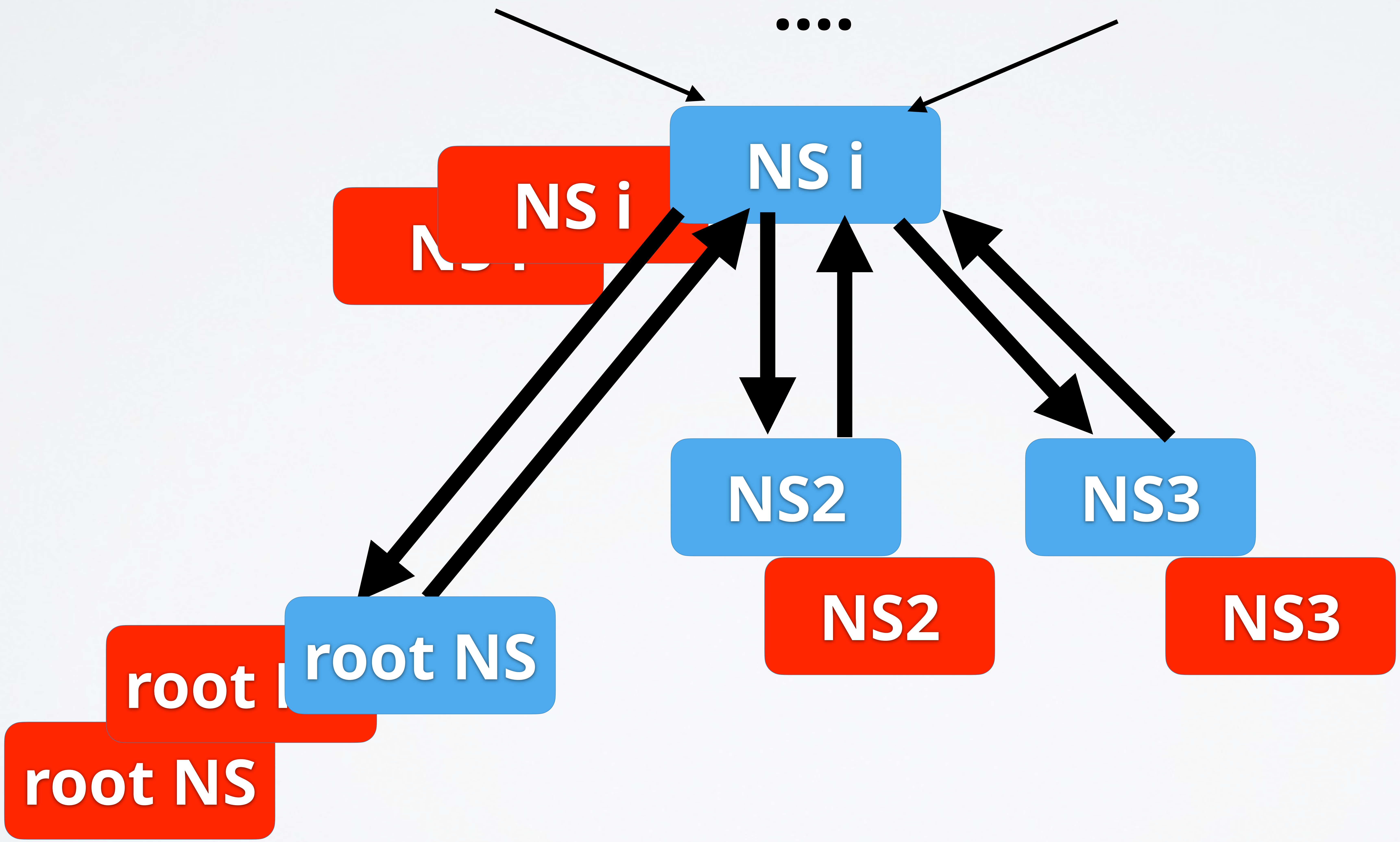
CACHING



RECURSIVE ./. ITERATIVE



REPLICATION



RPC: REPLICATION

- 2 techniques for replication:
  - several IPs/names
  - “any cast" (send packet to one of many servers with same IP)
- 13 root name server IPs, several hundreds of any cast
- each zone has at least
  one primary and one secondary IP

RESOURCE RECORDS

name =>

Record type	Interpretation	Content
A	address	IPv4 address
AAAA	address	IPv6 address
NS	Name server	DNS name
CNAME	Symbolic link	DNS name of canonical name
SOA	Start of authority	Zone-specific properties
PTR	IP reverse pointer	DNS name
HINFO	Host info	Text description of host OS
...	...	...

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- main problems for scalability ....
- simple model: Amdahl' law)
- few principle approaches ...
- DNS as fine example ... more examples to come
  study DNS it in your first exercise

- **register in mailing list**

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LITERATURE

- Paul Albitz & Cricket Liu
  DNS and BIND
  O´Reilly & Associates, Inc.
- Mark Hill, Michael Marty
  Amdahl's Law in the Multicore Era IEEE
- Couluris, Tollimore, Kindberg
  Distributed systems