Plug-and-Play Routers and Base Stations

Simon Schütz, Lars Eggert, Marcus Brunner, Kai Zimmermann

NEC Europe Ltd., Network Laboratories,
Heidelberg, Germany
{schuetz|eggert|brunner|zimmermann}@netlab.nec.de

Outline

- Plug-and-play base stations
  - Problems
  - Assumptions
  - Concept
  - Performance analysis
- Plug-and-play routers
  - Problems
  - Concept: management hierarchy
  - Merging existing hierarchies
- Conclusion

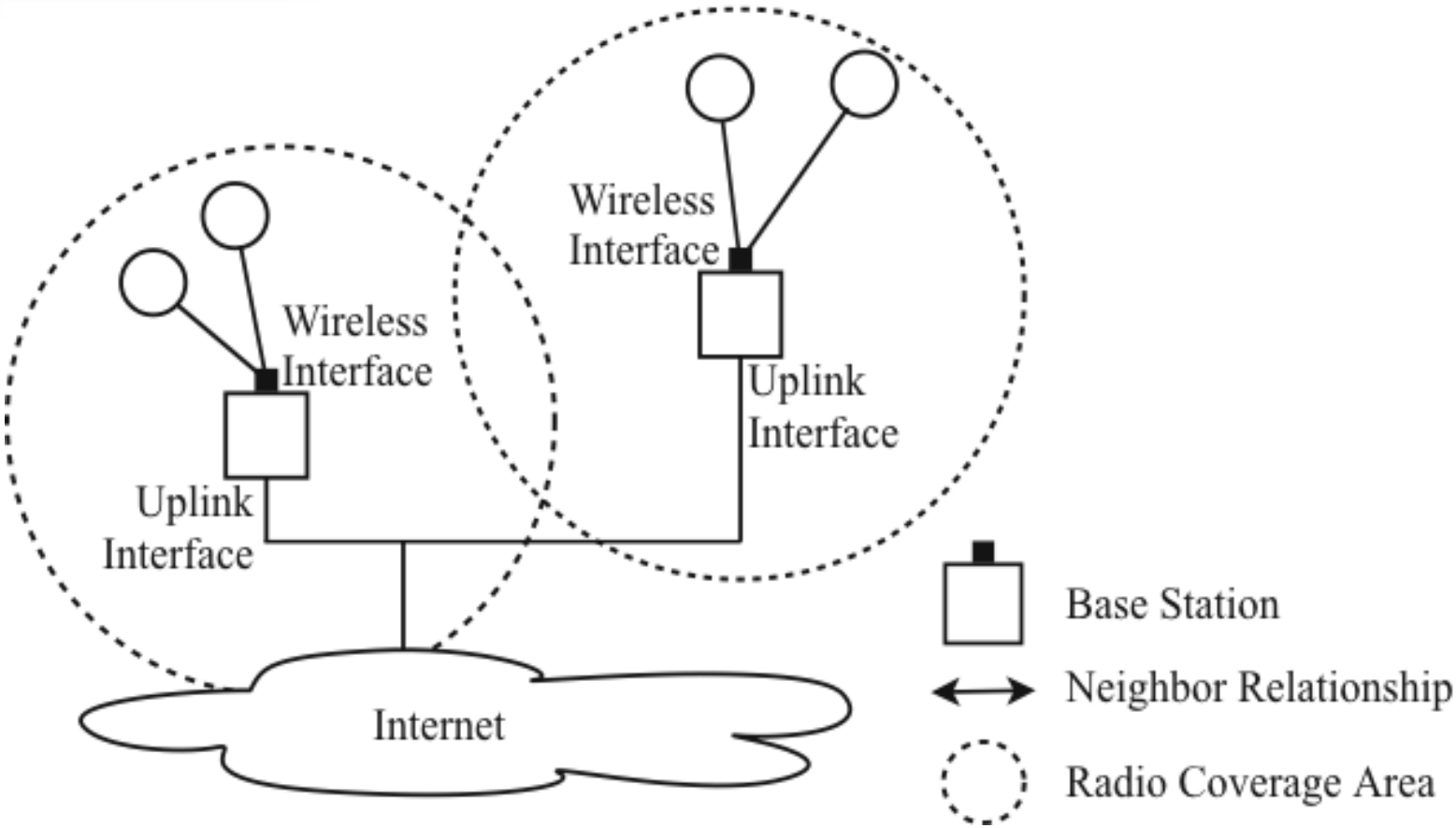
Plug-and-Play Base Stations

- bootstrapping base stations
- configure wireless properties
  - ESSID, channel, protocol, TX power, etc.
- coordinate configuration with
  - neighbored stations
  - complete access network

Assumptions

- each base station has at least two network interfaces
  - one to provide wireless services to its mobile clients
  - one for uplink connectivity (wired or wireless)
- each base station has a X.509 certificate
- each base station has a (statistically) unique identifier

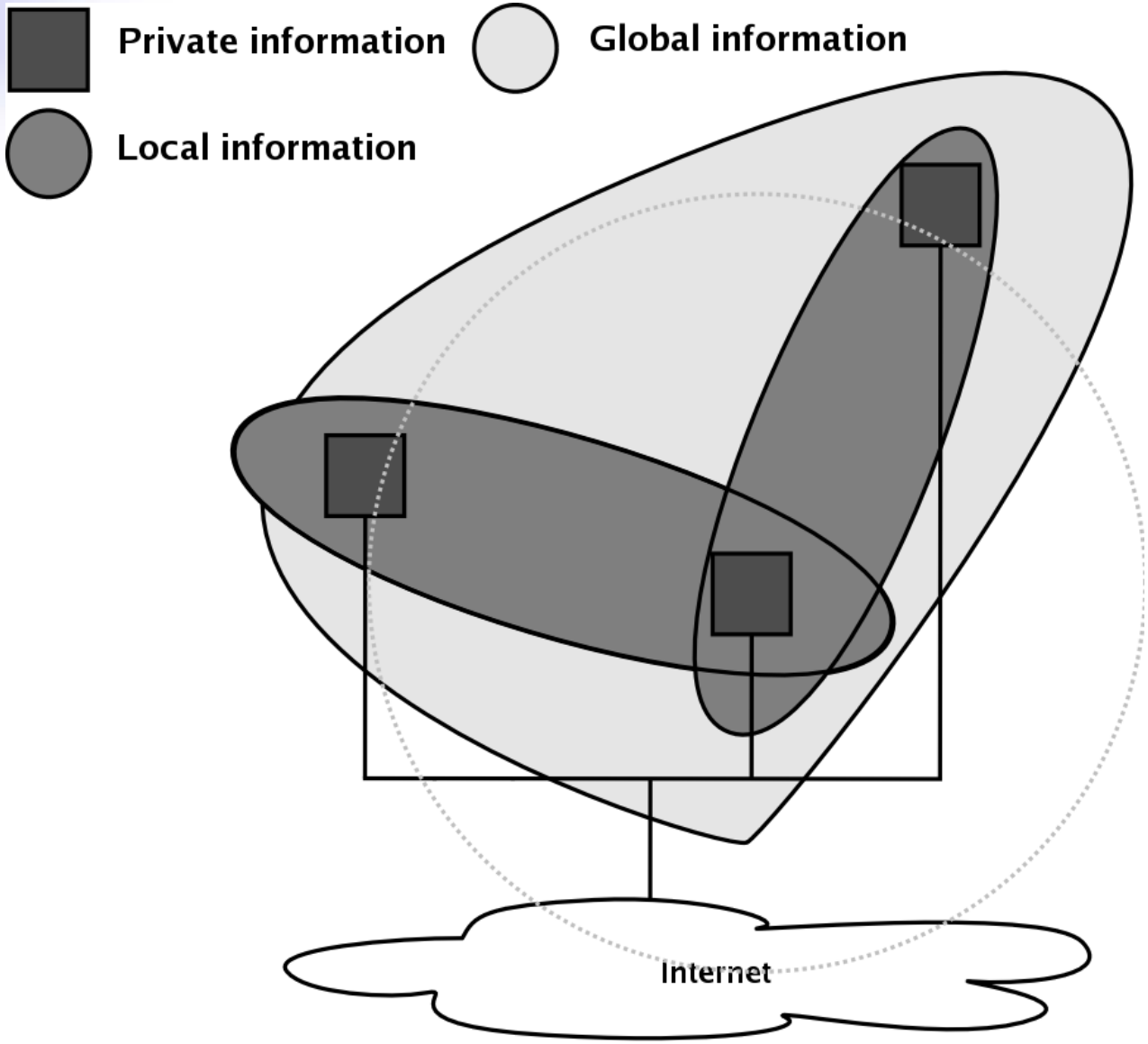
System Overview



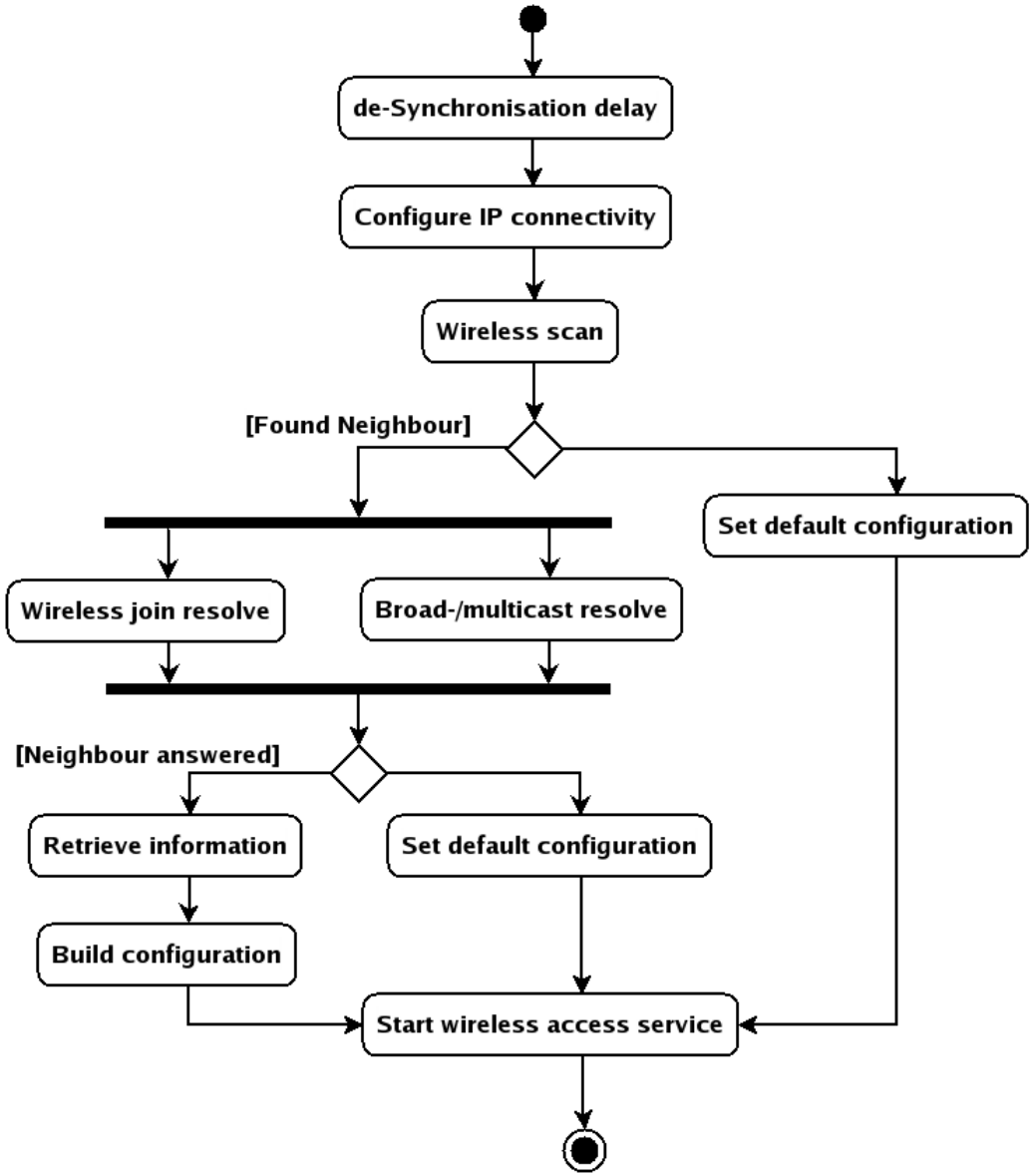
Basic Concept

- management functionality is entirely distributed
- base stations request/collect management information and but act autonomous
- neighbored base stations exchange management information
- epidemic replication for information that needs to be network-wide consistent
- management information is categorized into global, local and private

Information Categories

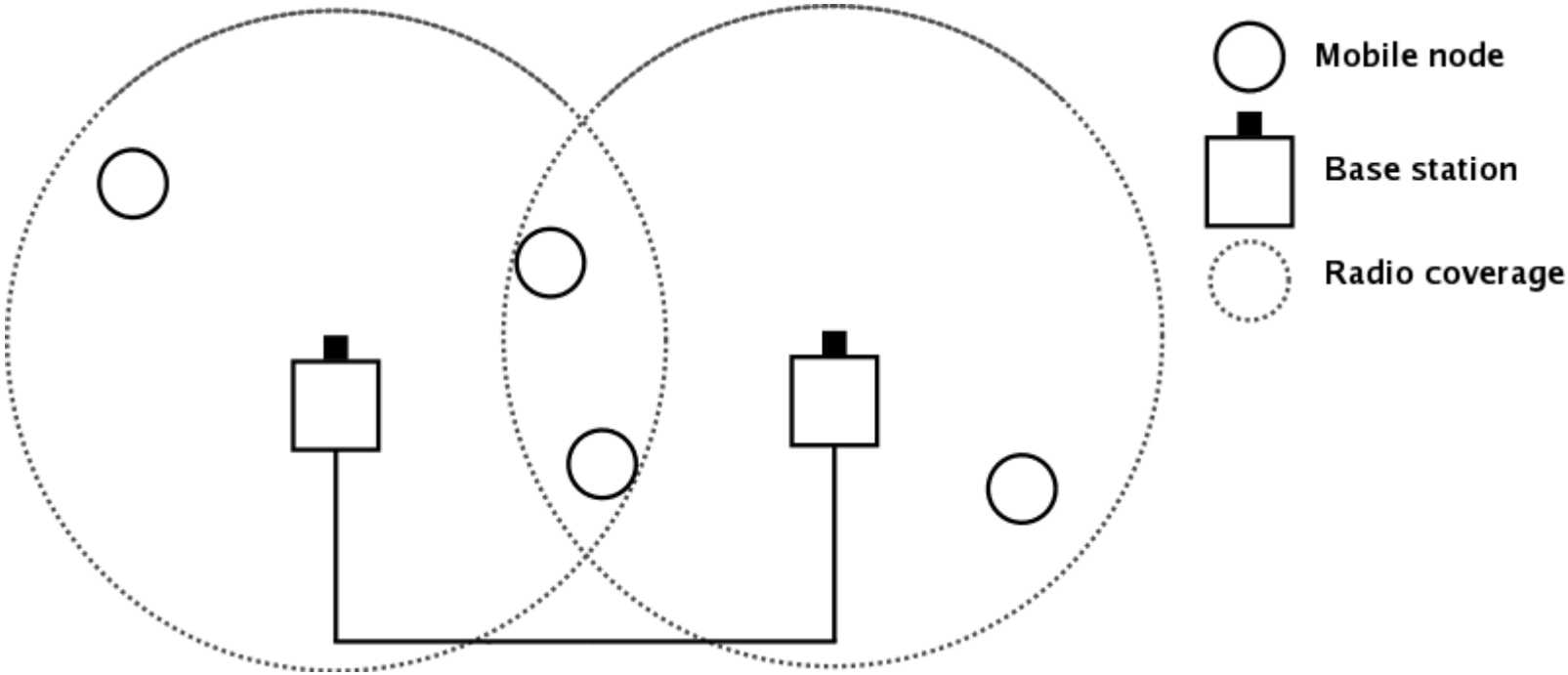


Bootstrapping New Base Stations



Integration of External Information

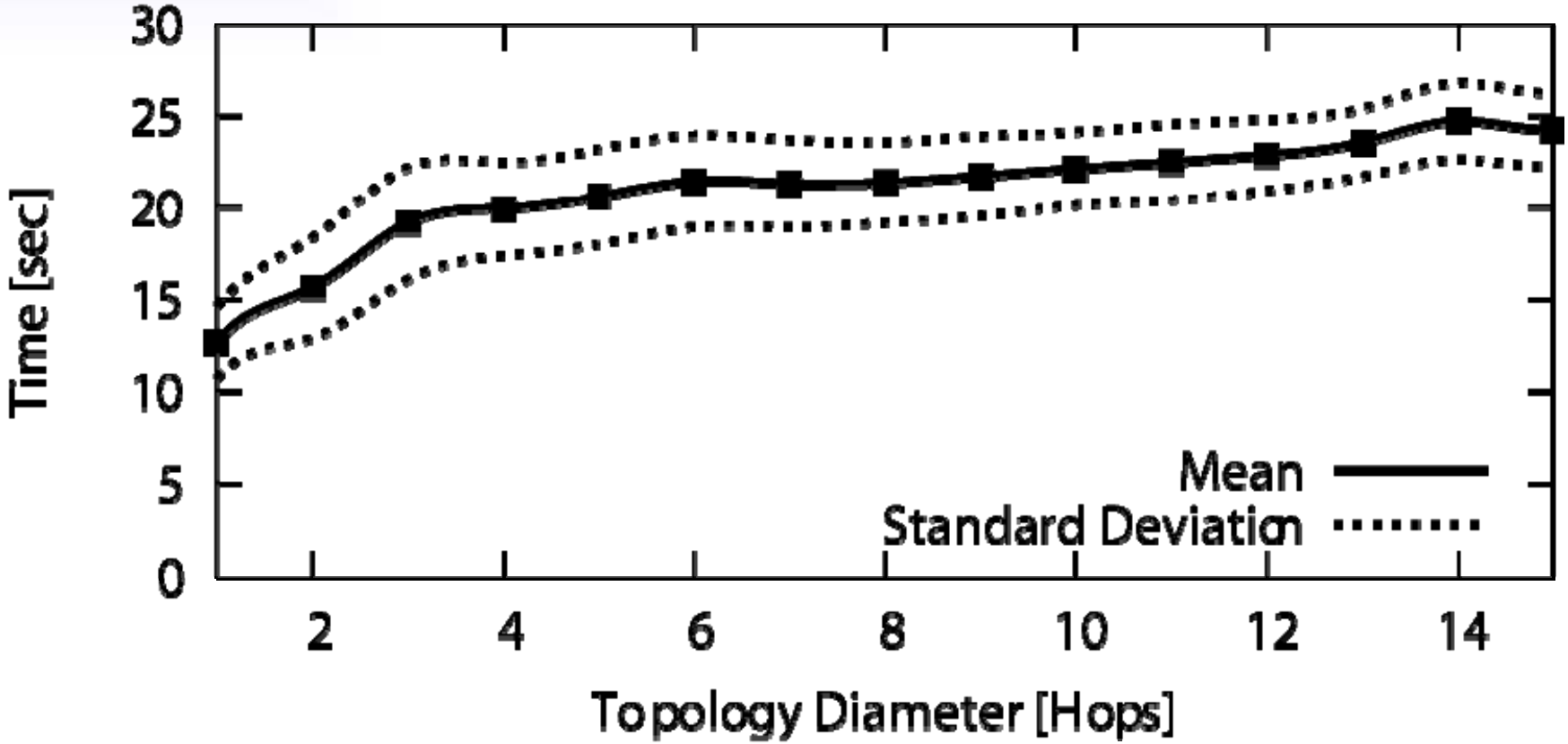
- user-controlled mobile nodes inform base stations
- specialized measurement nodes inform base stations
- can improve the self-healing and self-organization functions



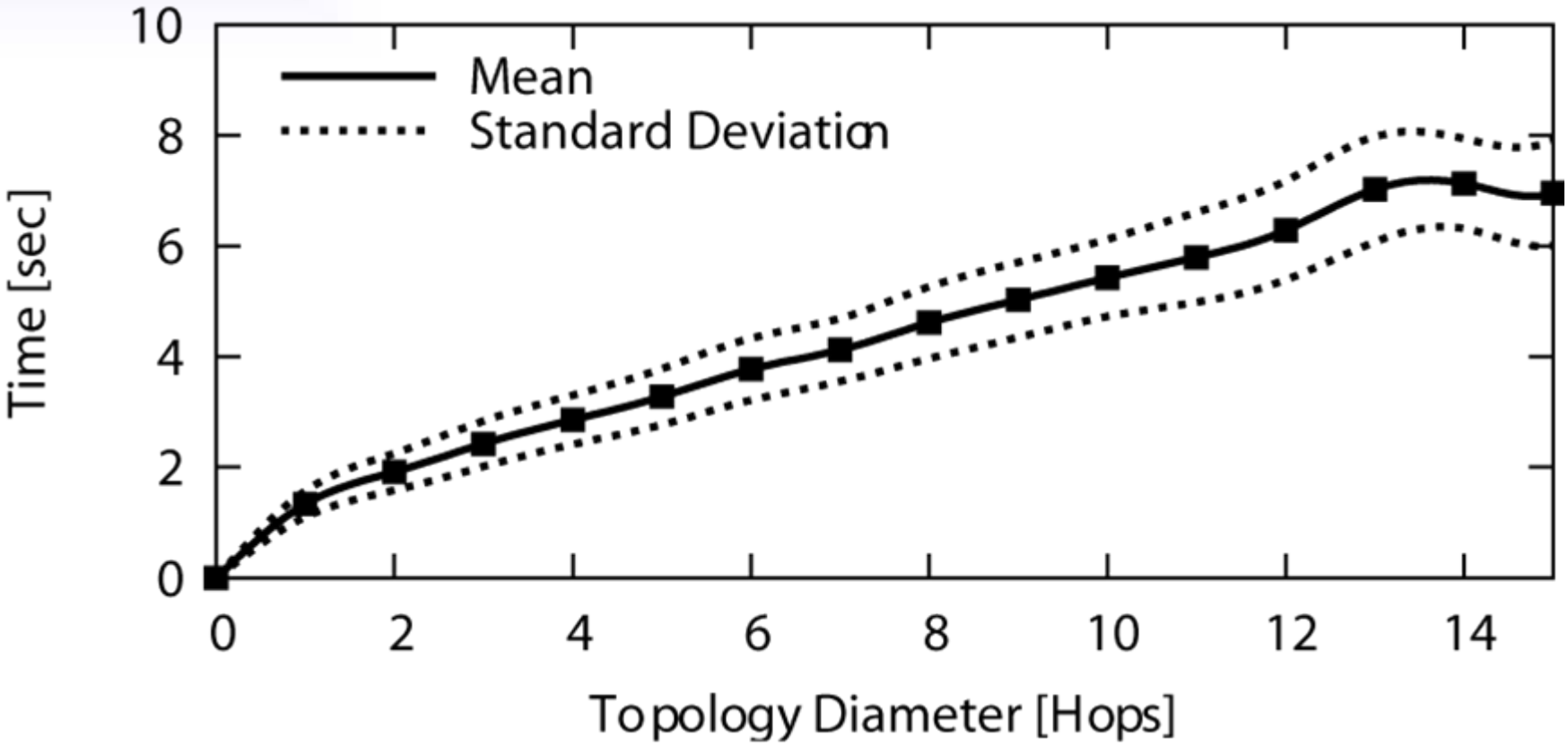
Quantitative Evaluation

- prototype is a Perl implementation on a Linux host
- supports a real mode and a simulation mode
- simulation mode runs the prototype in parallel on one host
- topologies generated at random

Convergence Time for Initial Self-Organization



Spread Time of new Global Information

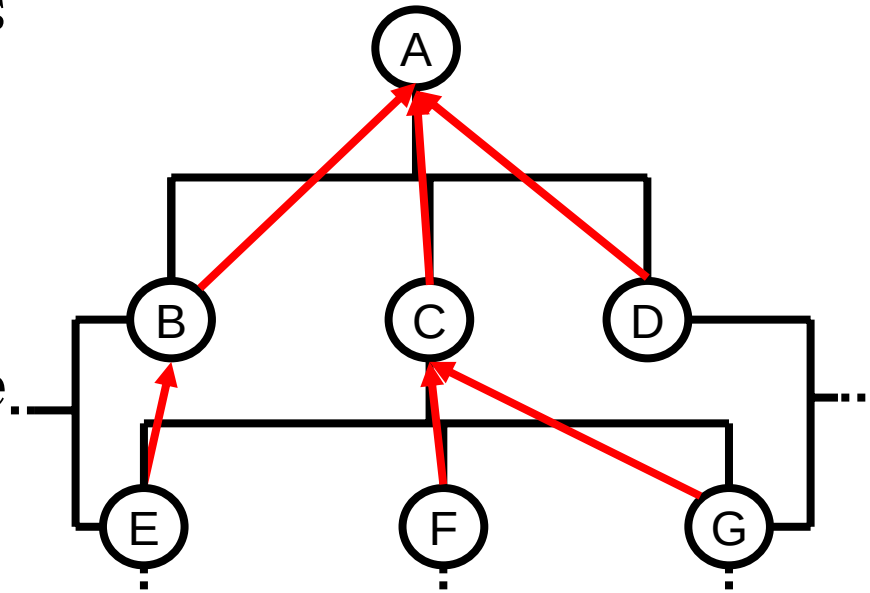


Plug-and-Play Routers: Problems

- router interfaces can run in two modes:
  - IP client mode: the interface receives it IP either statically or from a remote server
  - IP server mode: the IP is pre-defined and the router provides IPs to clients (e.g. through DHCP)
- nowadays: IP address spaces for routers are statically defined
- plug-and-play: need automatic assignment/distribution of IP address spaces

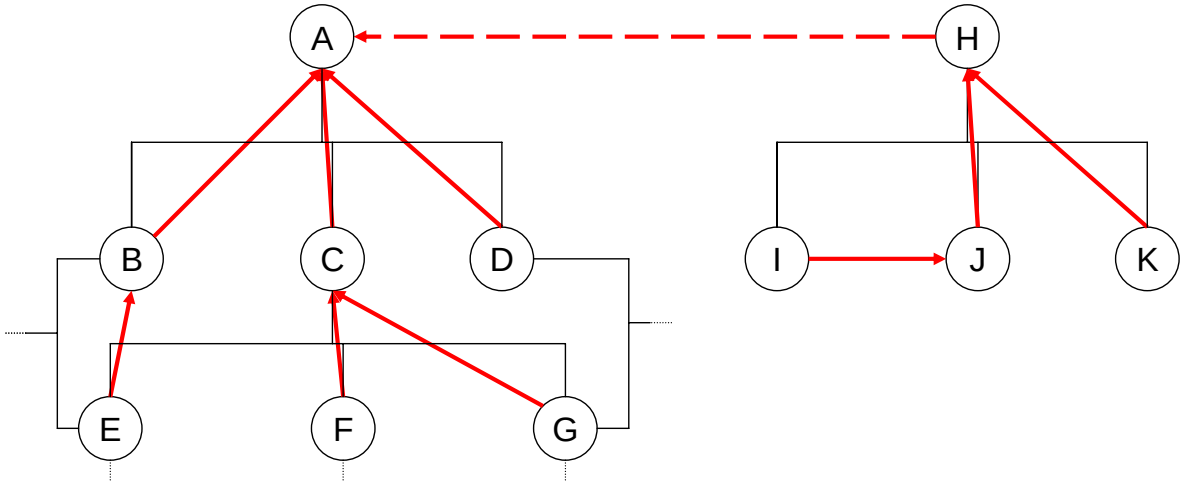
Concept: Management Hierarchy

- management hierarchy to prevent bottlenecks and single point-of-failures
- tree-root manages complete address space
- delegate sub-spaces lower-level routers
- minimize interaction with parent routers



Merging Different Hierarchies

- no address space conflicts:
  - one of the root-nodes becomes overall root
  - the other one attaches
- with address conflicts:
  - same as before, but
  - need to reconfigure parts of the tree
  - might run out of address space



Conclusion

- PnP base stations
  - fully decentralized approach
  - current state
    - protoype available
    - prototype implementation scales well
  - what is the future?
    - need more management applications
    - merge with IP self-configuration
    - more extensive evaluation
- PnP routers
  - partially distributed approach using hierarchy tree
  - preliminary prototype available
  - prototype needs to be refined
  - evaluation has to be carried out

Thanks!

Questions?