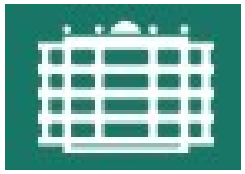
University of Würzburg
Informatik III (Distributed Systems)
Prof. Dr. P. Tran-Gia

Chemnitz
Technical University



Towards Dependable P2P Services
-
Case Studies for Mobile Network Control

Kurt Tutschku
tutschku@informatik.uni-wuerzburg.de

Workshop ”Dependability of all-IP Networks”
VTT, Espoo, Finland, May 18th-19th 2006.

Success Story of Peer-to-Peer

- cooperation of equal, autonomous and loosely connected entities (*peers*)
- simple but highly efficient mechanisms for **searching** and **exchanging** of resources/data (application architecture)
- forming of overlays
  - own namespace
  - sometimes: efficient routing due to application-specific self-organization
- fast and infrastructure-less
- fault tolerant; e.g.: download restarts automatically
- P2P mechanism are apparently suited for business/ commercial services and applications!
- if so, can I **rely on** them?

Is P2P reliable?

- in some sense:
  - I probably get the file (sooner or later)
  - however: ***peers are highly unreliable!***

→ how to build ***reliable*** or even ***dependable*** services on unreliable/low performance entities/peers?

- what is *dependability*
  - *similarities to "**carrier-gradeness**" (in telco speak)*
  - attributes: availability, reliability, **robustness**, safety, security and **efficiency/performance**

Project: Carrier-Grade Peer-to-Peer (CaPi)

SIEMENS

10/2004 – 10/2005

- aim:

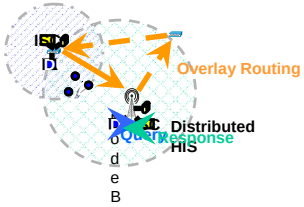
  Is P2P a dependable alternative for control tasks or services in future mobile networks?

  - dependable („carrier-grade“): efficiency and robustness
  - in particular: two applications for **mobile core network services**
    - support of vertical handovers
    - configuration of access points

- methodology:
  - **selection of a candidate P2P mechanism**
  - **performance analysis of initial solution**
  - **comparison with conventional approaches**
  - **modification of P2P**
  - cross-comparison with other P2P mechanisms
  - classification of P2P mechanisms

Applications to Support Dependability

- supporting vertical handover

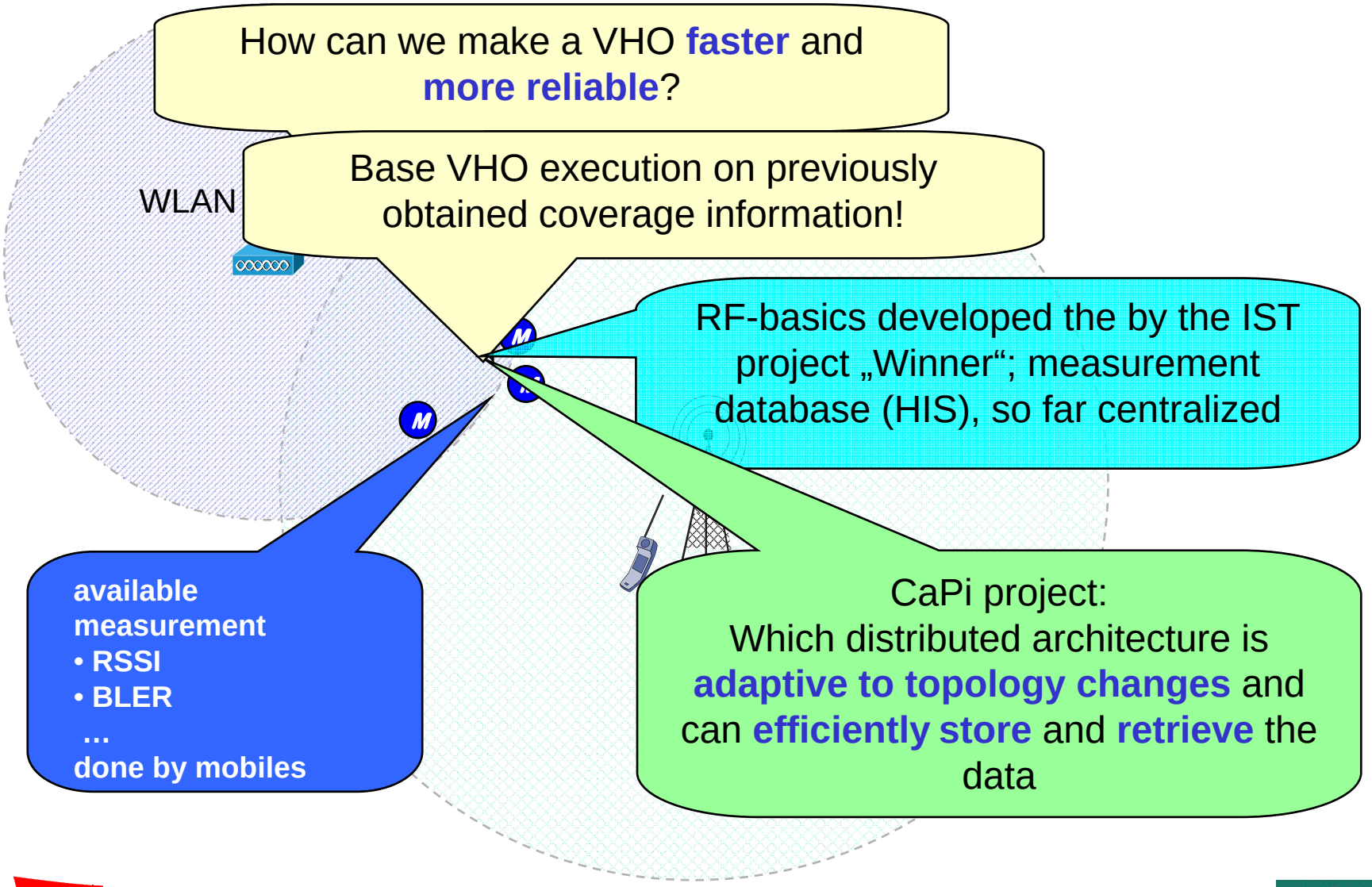


- main dependability/carrier-grade requirement: **efficiency**

- easy configuration of APs

- main dependability/carrier-grade requirement: **robustness**

CaPi-Project (I): Vertical Handover

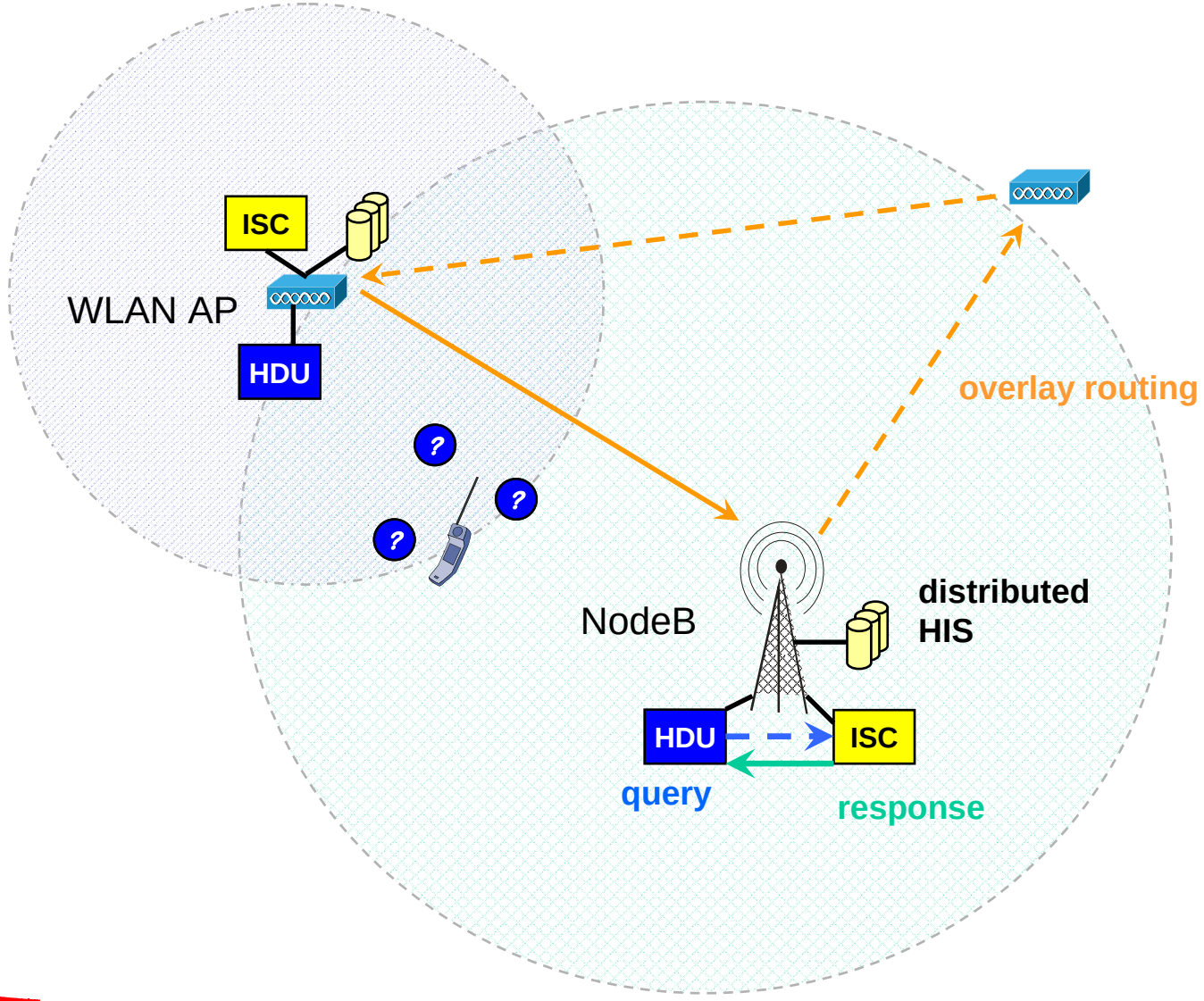


Solution

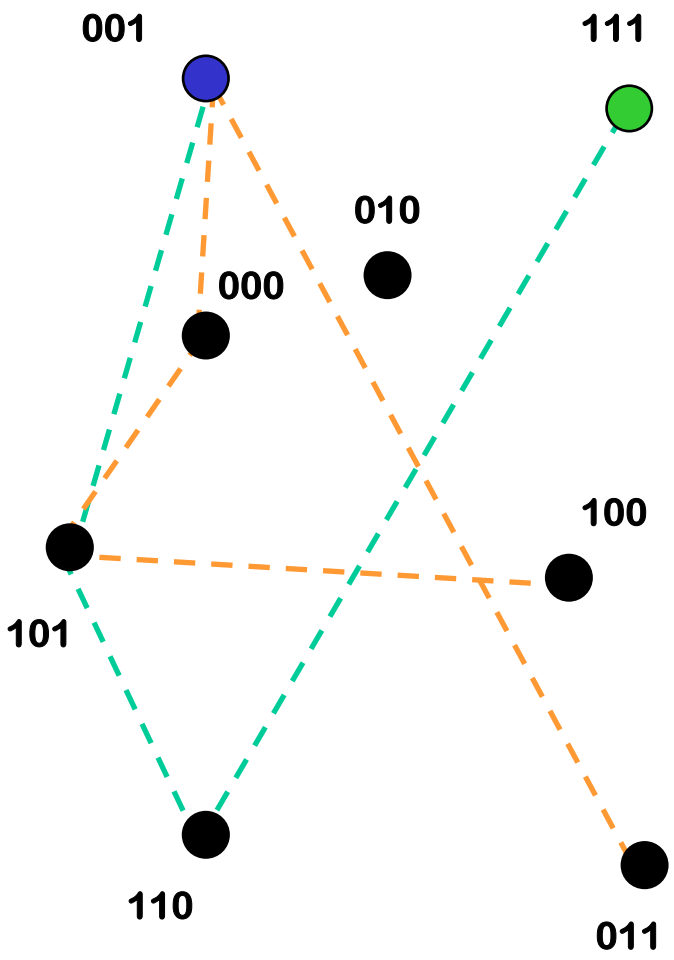
- **P2P overlay**
  - **Pastry algorithm** (DHT)
  - stores and retrieves data
  - access points, (AP) **= Peers**

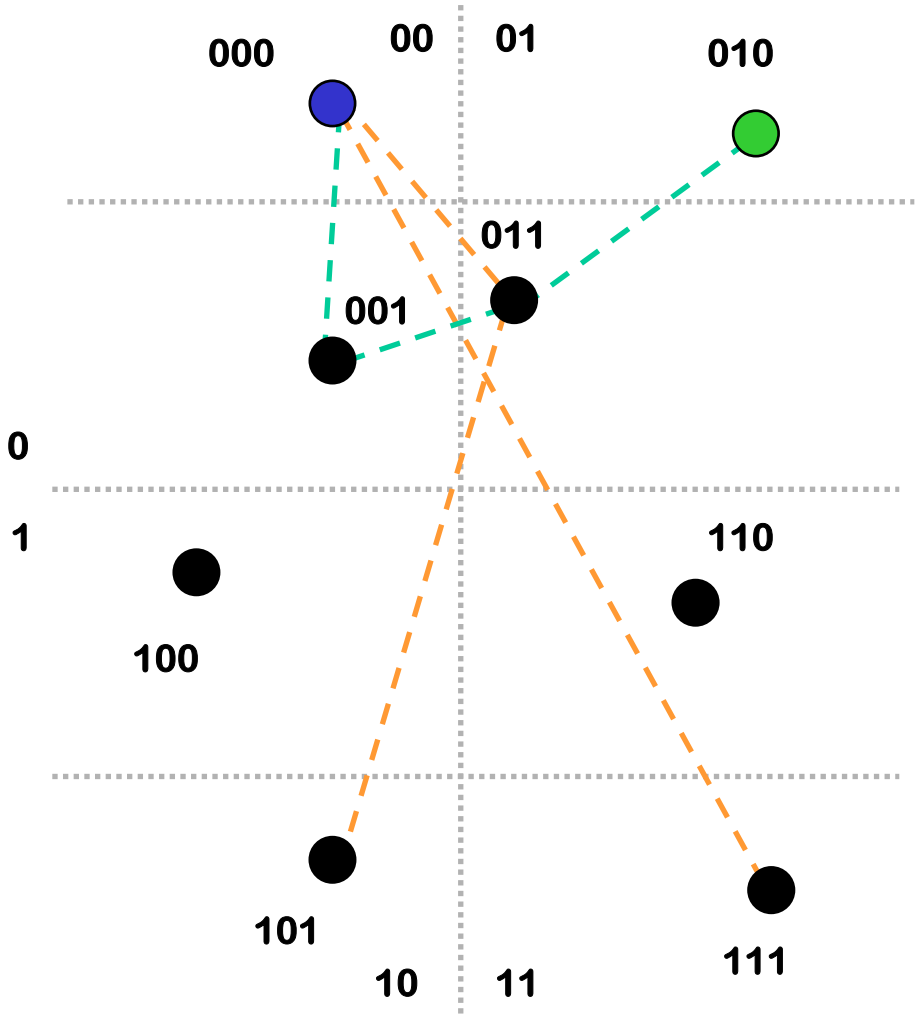
- constraints:
  - **fast** and successful **responses** are needed for reliable handover
  - high scalability in number of nodes (10^1 → 10^4-10^5)
  - support of **dynamic infrastructures**
    - no/small effort needed to add new APs
    - gradual extendibility
    - **self-organization**
  - huge number of requests (store/retrieve); time dependent information

CaPi Project (I): Distributed Measurement Database



Pastry and its Modifications

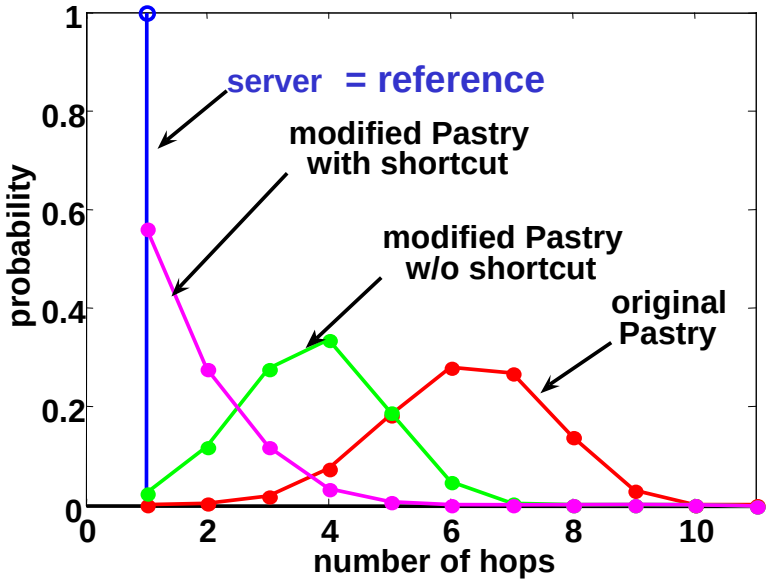




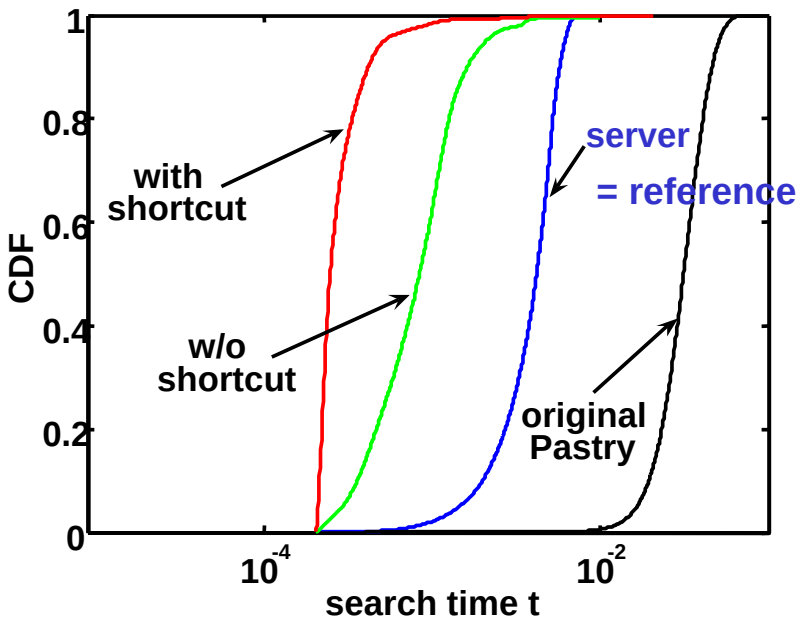
- random ID: $r_1r_2r_3r_4$…
- location-aware ID: $x_1y_1x_2y_2$…
- Pastry routing not changed

Efficiency/Performance

Hop Distribution



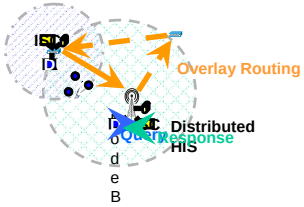
Search Time Distribution



- significant improvements due to local searches
- P2P can even beat client/server

Applications to Support Dependability

- supporting vertical handover

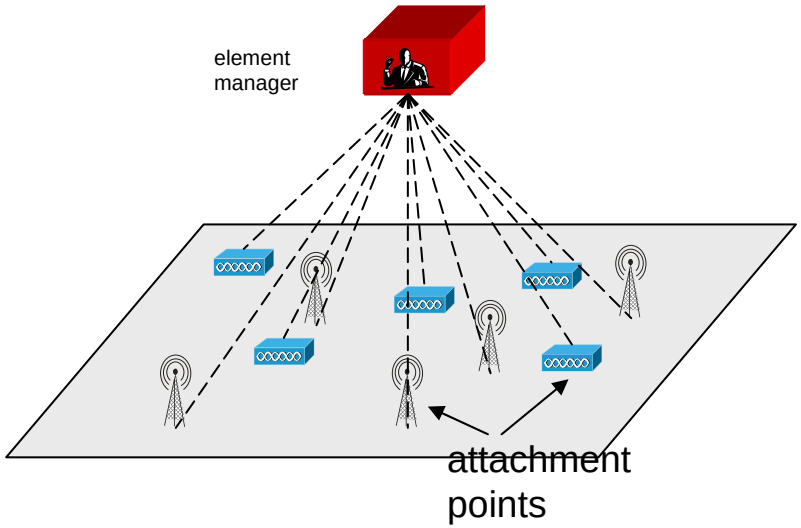


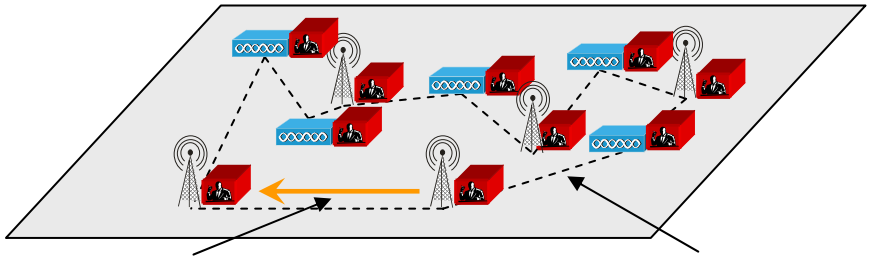
- main dependability/carrier-grade requirement: **efficiency**

- easy configuration of APs

- main dependability/carrier-grade requirement: **robustness**

CaPi-Project (II): Distributed Management



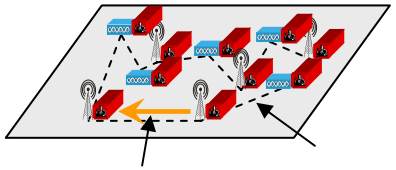


exchange of configu-
ration information (e.g.
SSIDs)

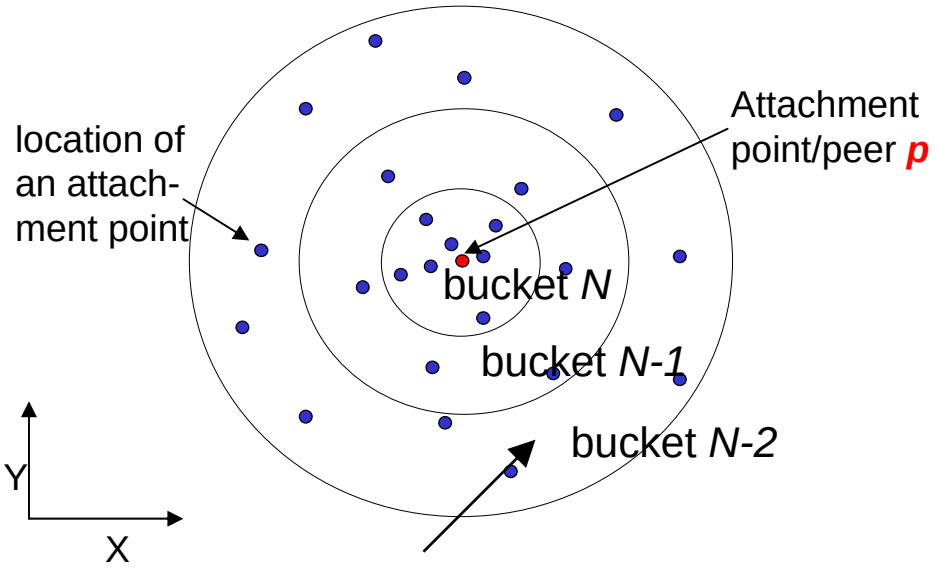
neighborhood
relationships (overlay
connection)

- centralized configuration management:
  - „single point of failures“
  - slow
  - depends on provider / no co-operation between providers
- self-organizing, distributed management:
  - fast setup of new access points
  - dynamic infrastructures
  - new modes of operation (single-access-point-ISP)

Solution



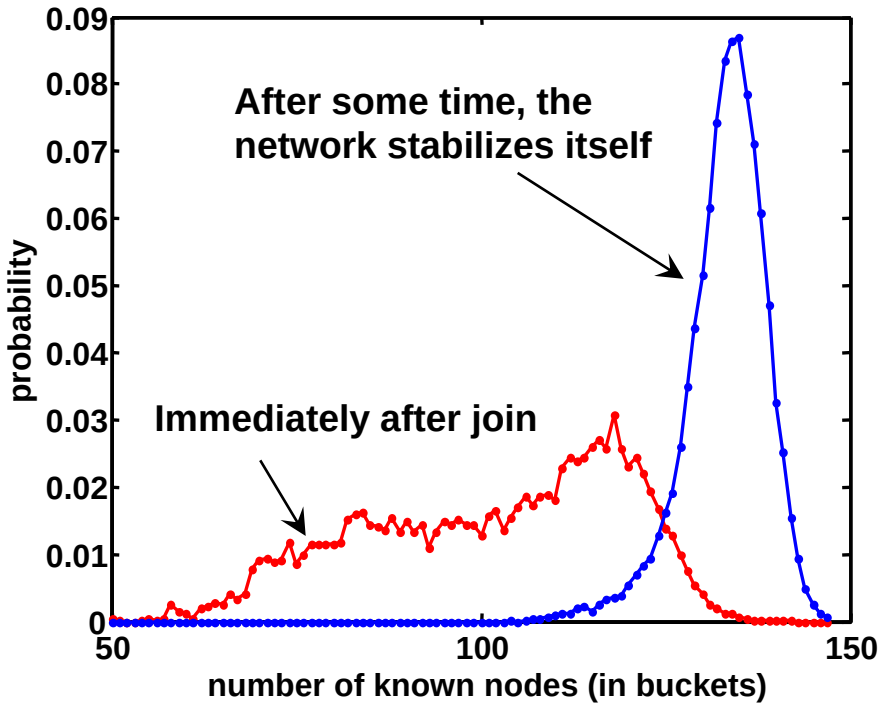
- **P2P overlay** for self-organization ofr APs
  - **Kademlia**-based DHT
  - AP = **peers**
  - geo-coding in ID permits identification of neighborhood relationships
  - Kademlia‘s **buckets** represent distance
  - search requests maintain overlay



bucket *i* of peer ***p*** consists of peers ***q*** with distance:

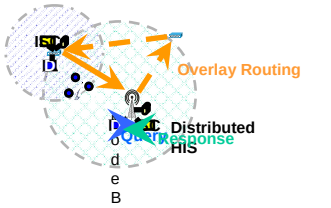
$$d(p,q) \in \left]2^{N-i}; 2^{N-i+1}\right]$$

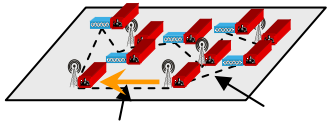
Results



- network organizes itself within reasonable time

Results





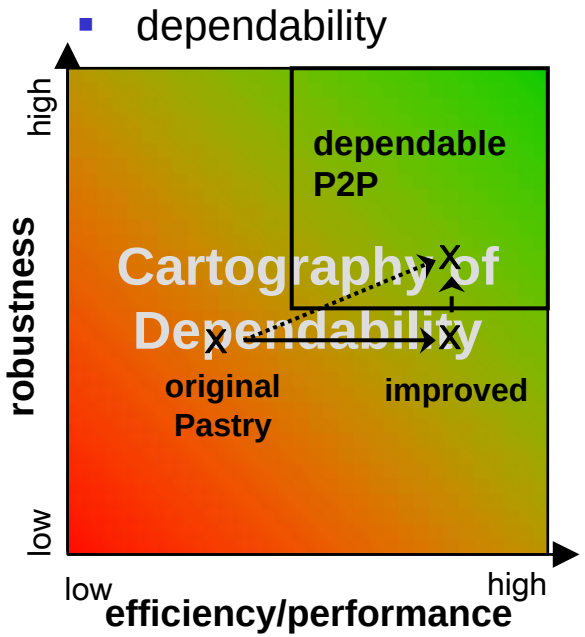
- P2P algorithms permit automatic mobile network control
- algorithms initially selected according to their apparent suitability
- **improved P2P algorithms can meet depend-ability requirements**

- to do:
  - **cross-validate algorithms:** compare different types on the same application
  - **classify their suitability**
  - **derive general engineering rules**

Towards Dependable P2P

- **Applications:** file swapping, locating of user/peer/resources, etc .
- **P2P platforms:** Gnutella, eDonkey, Chord, Pastry etc.

→ initial approach for a methodology, e.g.:



- even more to do: **combined (self-)optimization?**

  i.e. combine multiple dimensions of dependability into self-optimization

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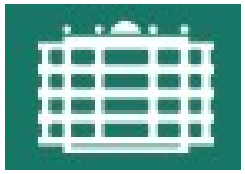

Thank you !

Any questions?

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