



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

# **Towards Dependable P2P Services**

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## **Case Studies for Mobile Network Control**

**Kurt Tutschku**

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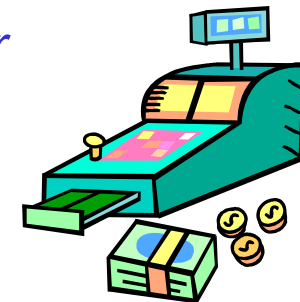
2nd Dagstuhl Seminar 06131 on "Peer-to-Peer Systems and  
Applications",  
March 29th 2006

# Success Story of P2P

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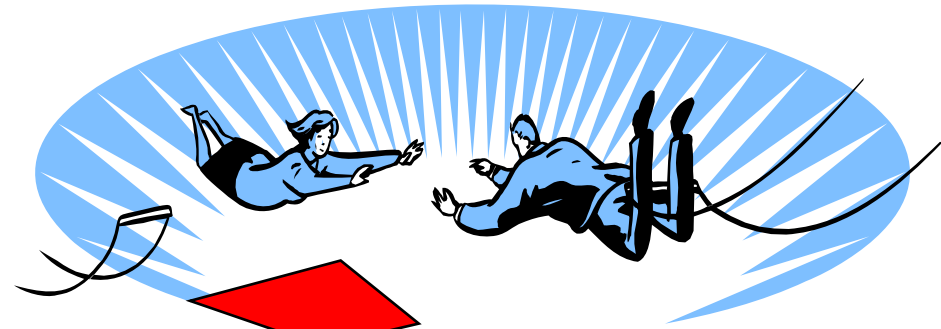


- ▶ user perspective: *content/file sharing*
  - community concept:
    - cooperative, sharing, free (even when grey scale), distributed
    - limited investment (no server)
  - high performance:
    - *short download times*
  - simplicity of use:
    - easy programming/configuration/set-up
    - *download restarts automatically*
- ▶ P2P application are (*apparently*) suited for *business 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!*

**contradiction?**

- how to build a **reliable** or even **dependable** service on unreliable/low performance entities/peers?

- ▶ what is *dependability* (“carrier-grade” in telco speak):
  - “... trustworthiness of a computing system which allows reliance to be justifiably placed on the service it delivers... „
  - attributes: availability, reliability, **robustness**, safety, security and **efficiency/performance**



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

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▶ from 10/2004 – 09/2005

**SIEMENS**

Siemens AG Com: *Frank-Uwe Andersen*



University of Würzburg, Department of Distributed Systems: *Prof. Dr. Phuoc Tran-Gia, Dr. Kurt Tutschku, Tobias Hoßfeld, Simon Oechsner*



University of Genova, D.I.S.T., Department of Communications, Computer and Systems Science: *Prof. Dr. F. Davoli, Luca Caviglione, Marco Perrando*

▶ **Does P2P offer carrier-grade/dependable solutions?**

▶ **approach: compare P2P with traditional solutions and modify P2P**



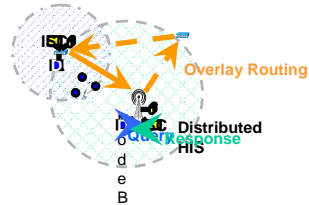
*University of Würzburg*  
*Distributed Systems*

*Kurt Tutschku*

# Applications to Support Dependability

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- ▶ supporting vertical handover



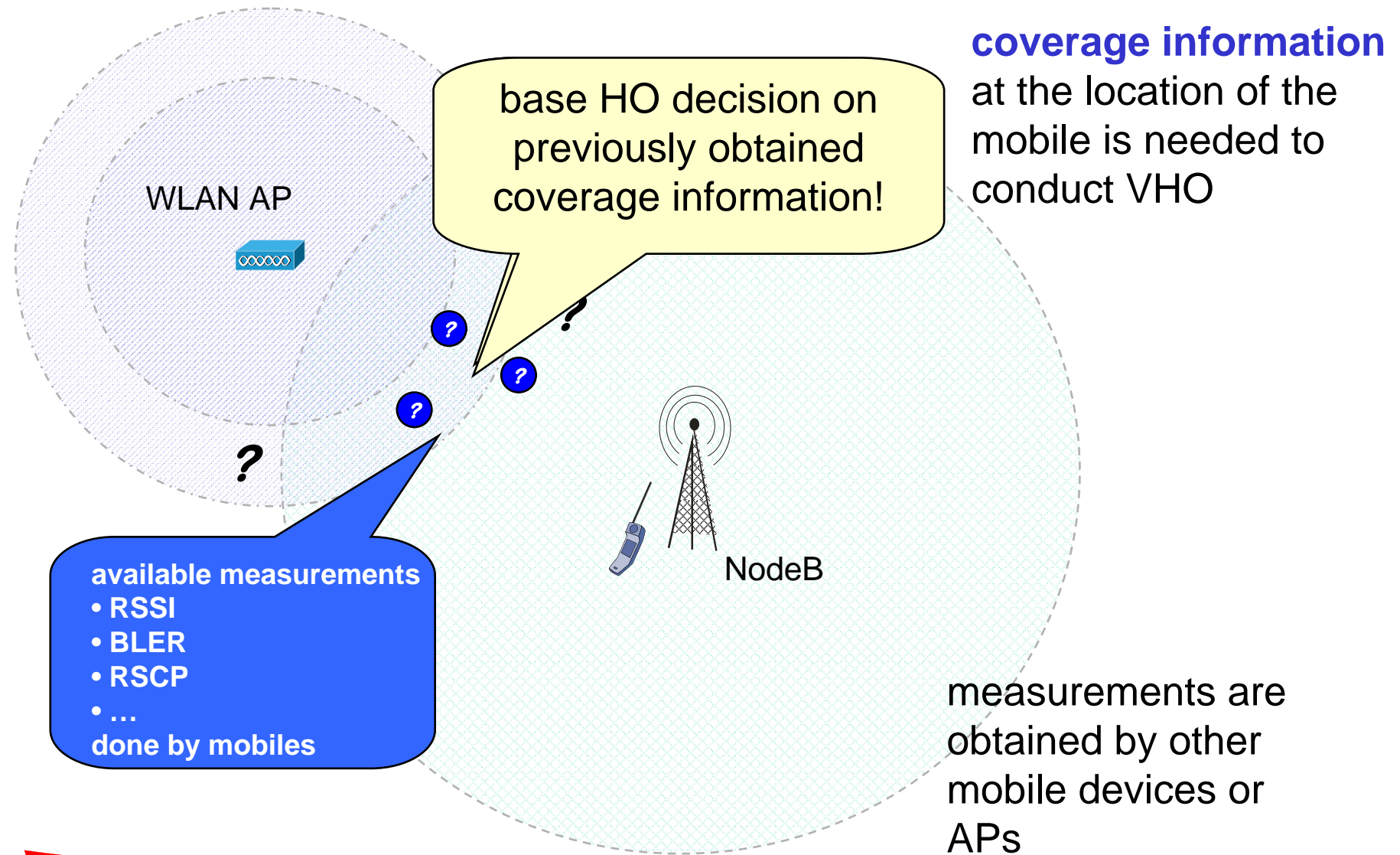
- ▶ main dependability/carrier-grade requirement: **efficiency**

- ▶ easy configuration of APs



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

# Vertical Handover



# Problem Formulation

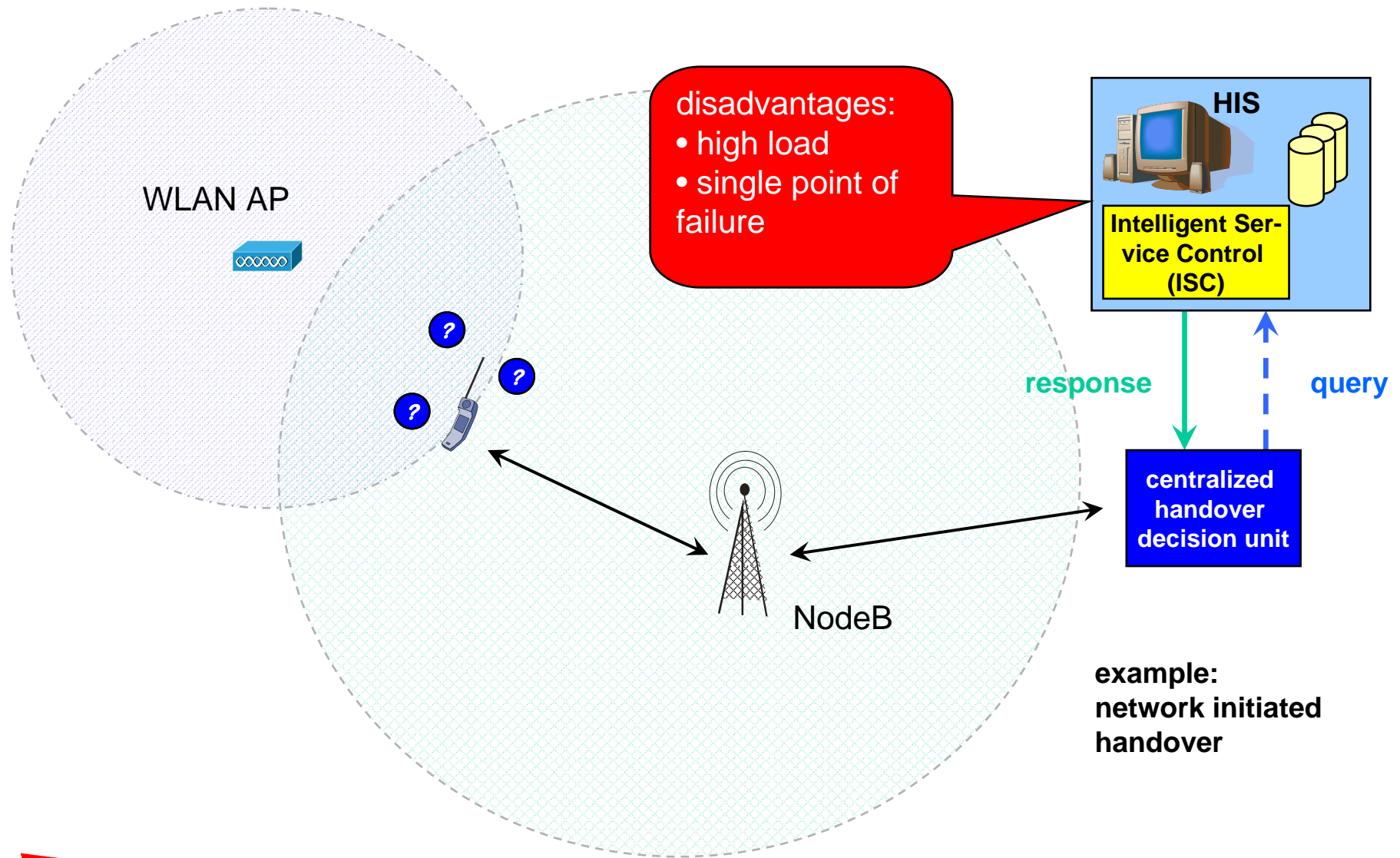
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- ▶ fast and successful responses are needed for viable handover
  - make locality-bound measurement information available (e.g. signal strength)
  - support of different access technologies
  - information is time-dependent (eg. changing RF conditions)
  - huge number of handover requests needs to be served

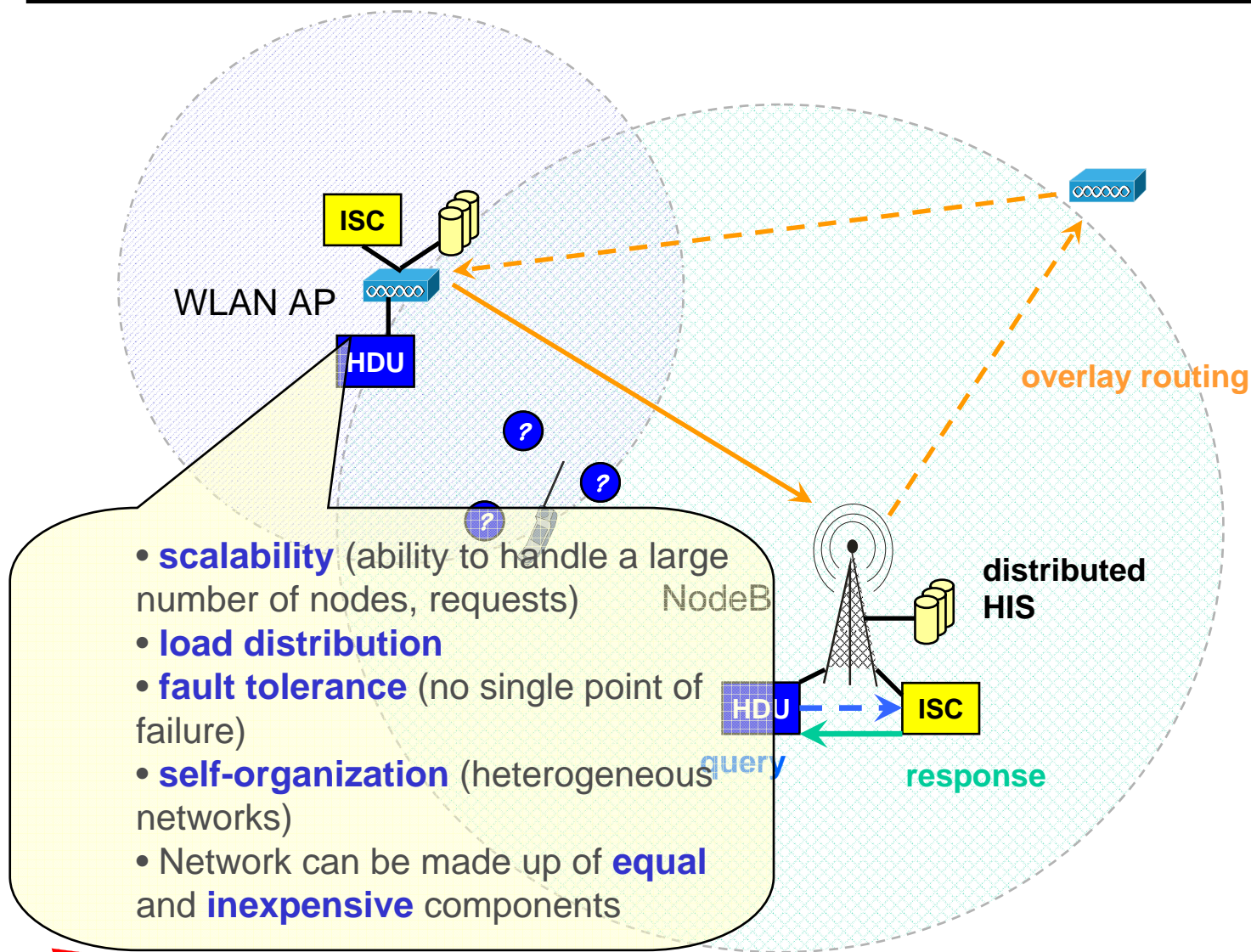
→ **VHO support system must be scalable, robust and efficient**



# Querying a Database for Information – HIS Concept



# Our Approach: Distribution of Database



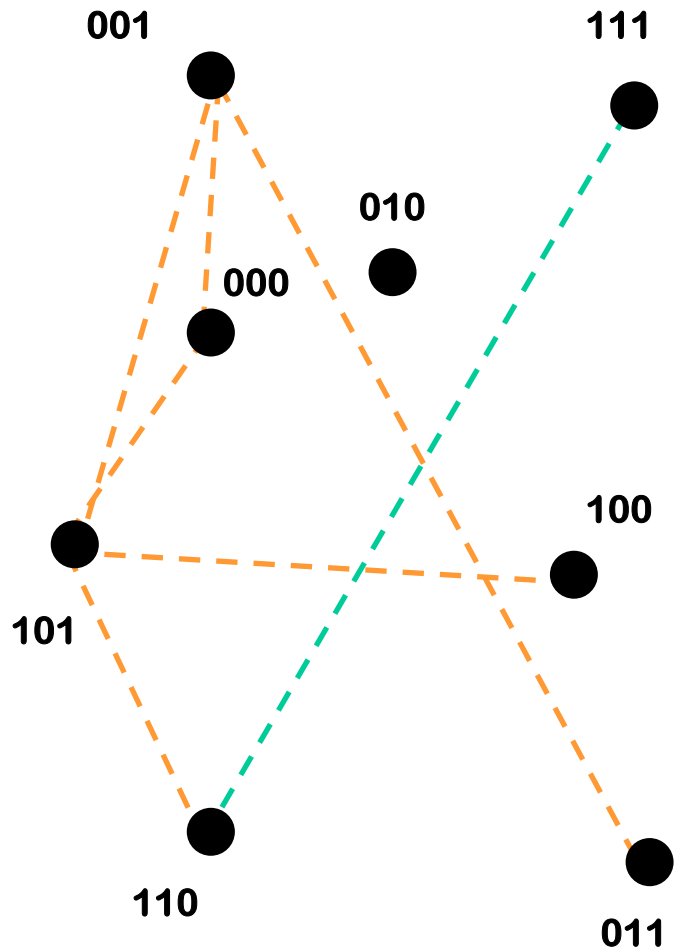
# How can we find the distributed coverage information?

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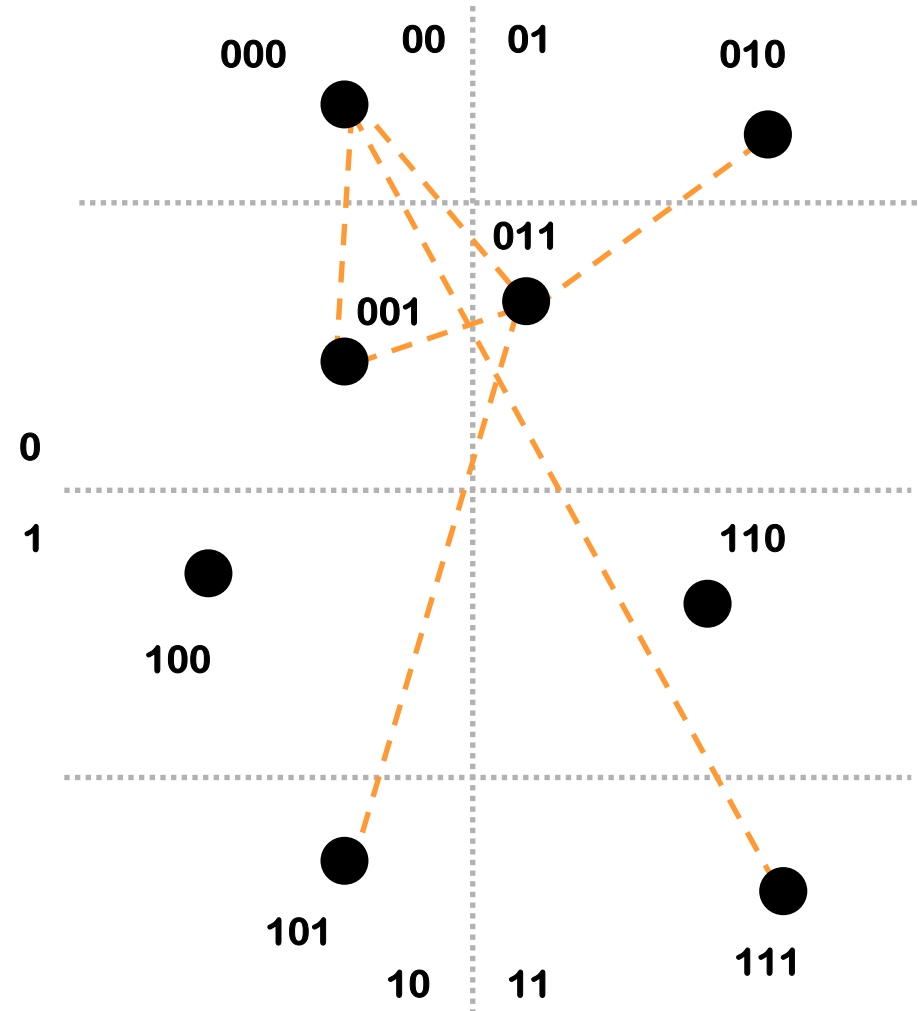
- ▶ dependability sub-criteria: **efficiency/search speed**
  - ▶ **geographically close** peers should be neighbors in the overlay
  - ▶ overlay metric has to be **symmetric** and **location-aware**
  - ▶ **structured P2P** used to locate and route data (scalability) but efficient?
- **Pastry can be enhanced to fulfill these requirements**



# Pastry and its Modifications



▶ random ID:  $r_1 r_2 r_3 r_4 \dots$



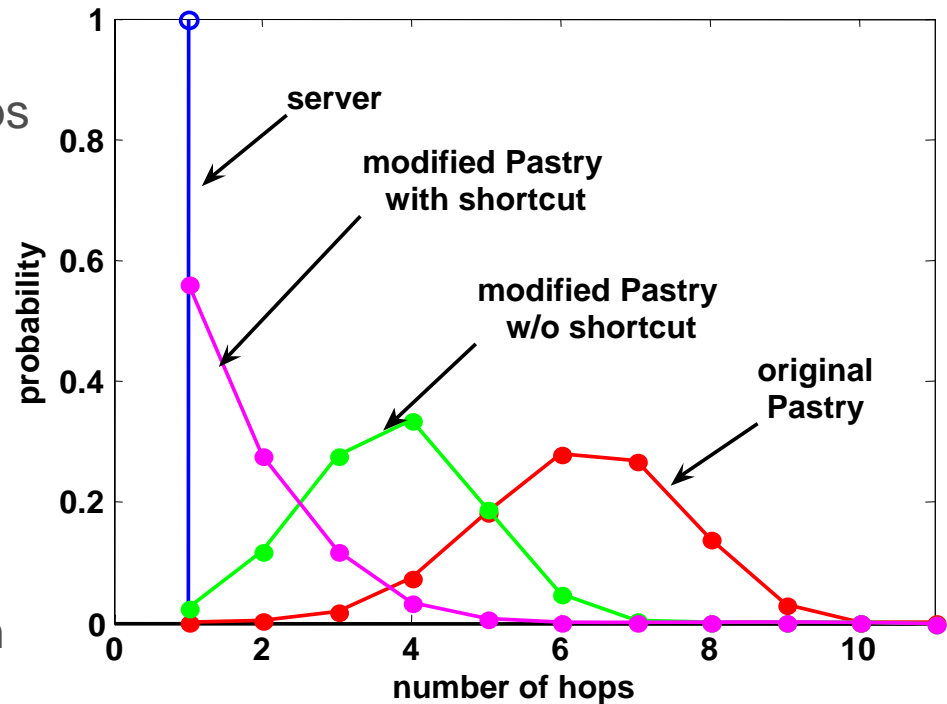
▶ location-aware ID:  $x_1 y_1 x_2 y_2 \dots$

▶ Pastry routing not changed



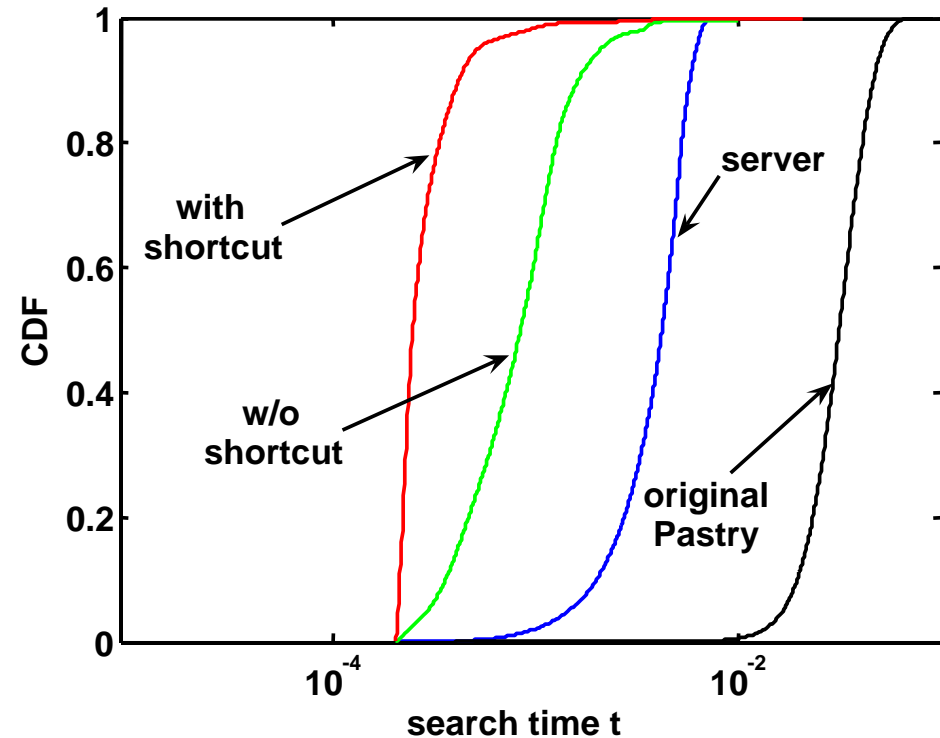
# Hop Distributions

- ▶ reference scenario: connection to server modeled as one hop
- ▶ ordinary Pastry takes  $\log(N)$  hops to route messages
- ▶ shortcut improvement cuts off the most ineffective part of the search
- ▶ our modifications improve the routing by shortening the search path **due to local searches**



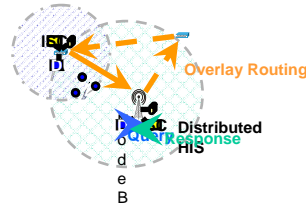
# Search Time Distributions

- ▶ standard Pastry performs not as good as classical client/server approach
- ▶ when improved with locality and shortcuts, search speed is increased
- ▶ modified algorithm is faster than a central server
- ▶ modifications are necessary to get **dependable systems**
- ▶ remark: neglecting per hop processing times and time in queues: **current work**



# Applications to Support Mobility

- ▶ Supporting vertical handover



- ▶ main dependability/carrier-grade requirement: **efficiency**
- ▶ coverage information is collected in a database
- ▶ on handover request coverage information has to be retrieved quickly
- ▶ Pastry P2P overlay used
  - information distributed among APs
  - application causes local searches
  - modified to our needs (IDs are location aware)
  - symmetric metric

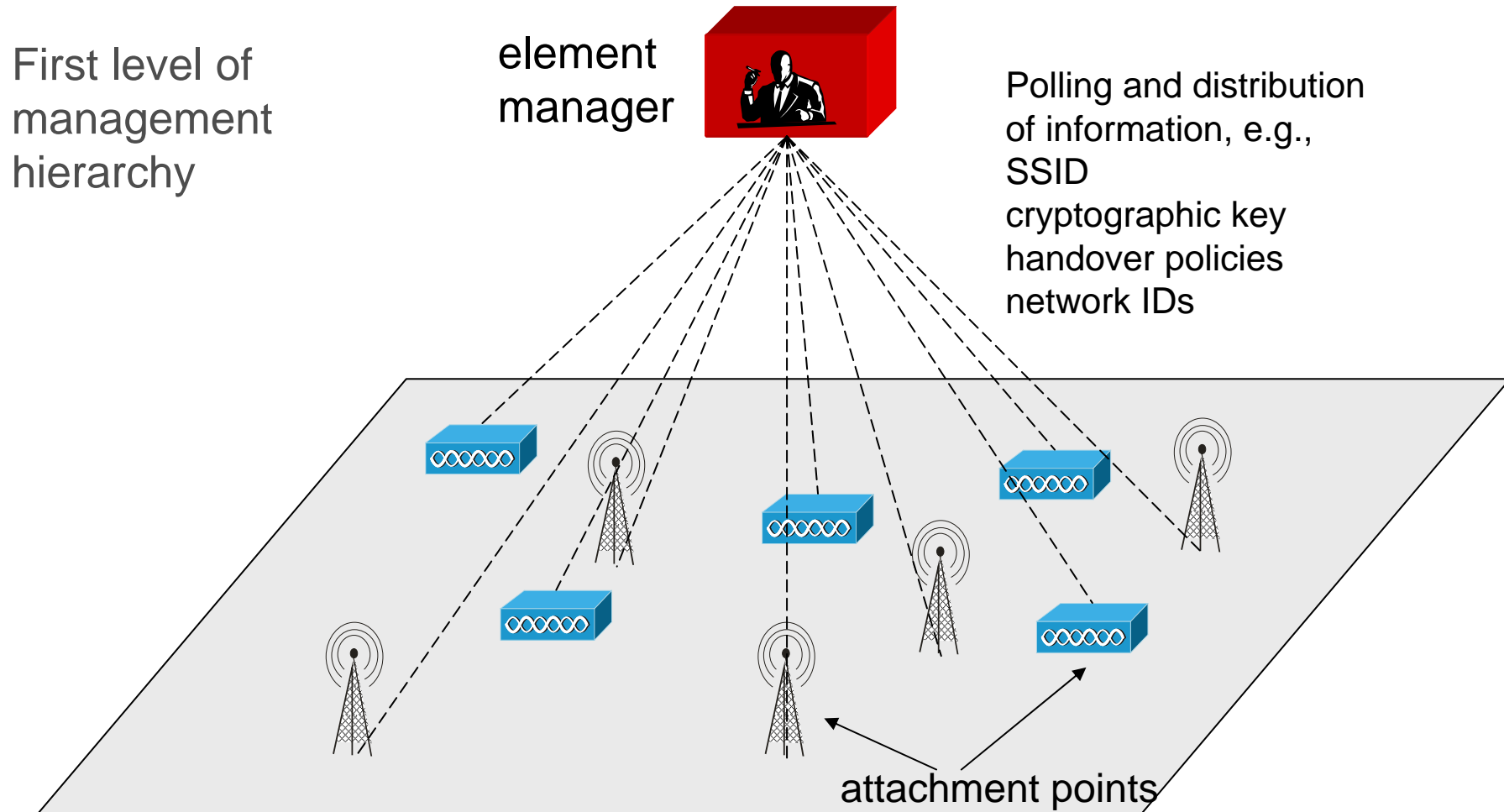
- ▶ Easy configuration of APs



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



# Current Network Management



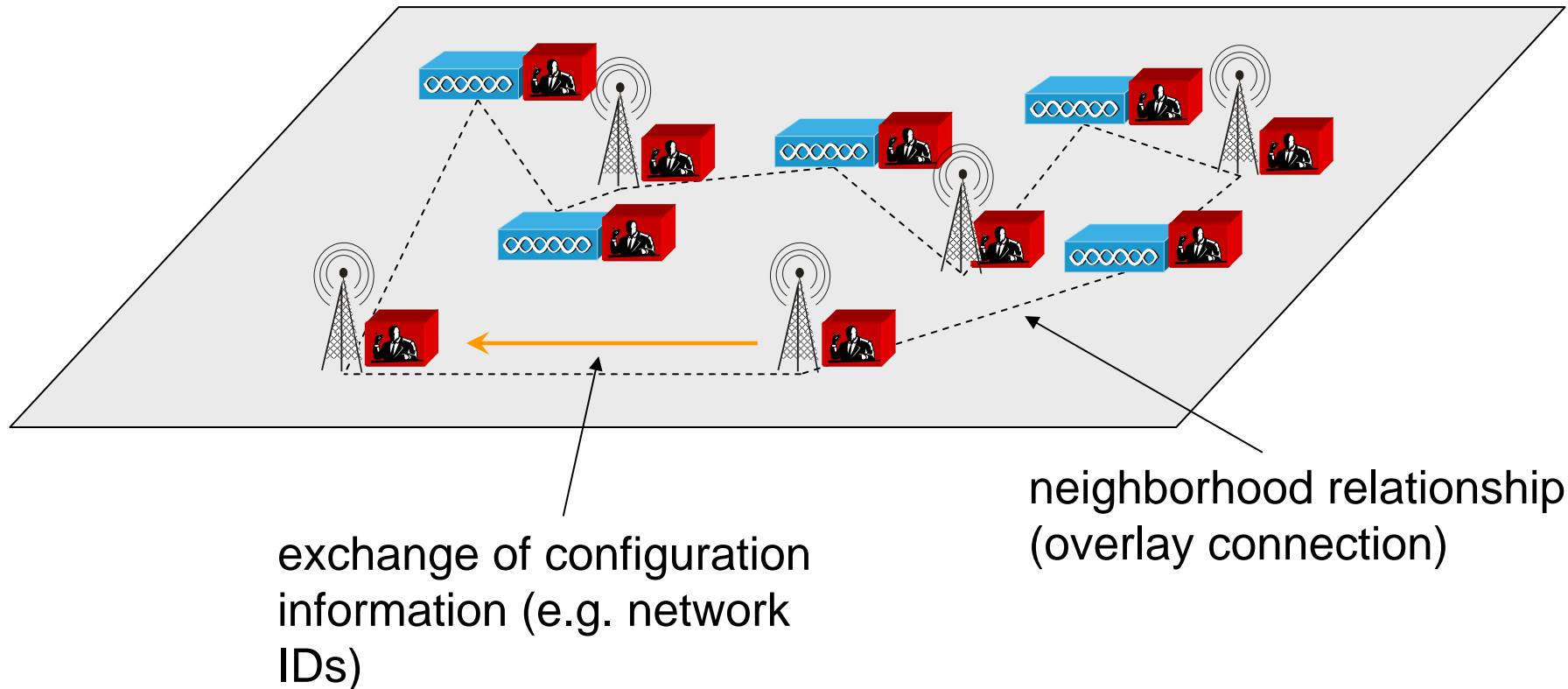
# Problem formulation

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- ▶ support **heterogeneous large-scale** networks with many cells
  - ▶ system must be flexible to react on changes in the network topology, i.e. **variable number of APs**
  - ▶ avoid central management
    - reliability (single point of failure, congestion)
    - split of responsibility and interoperability
  - ▶ **self-organization** of access networks required
- **application of P2P technology**
- attachment point are peers
  - distribute configuration data to suited nodes (i.e. cells that overlap)
  - neighboring cells/nodes have to be identified



# Distribution of Configuration Functions



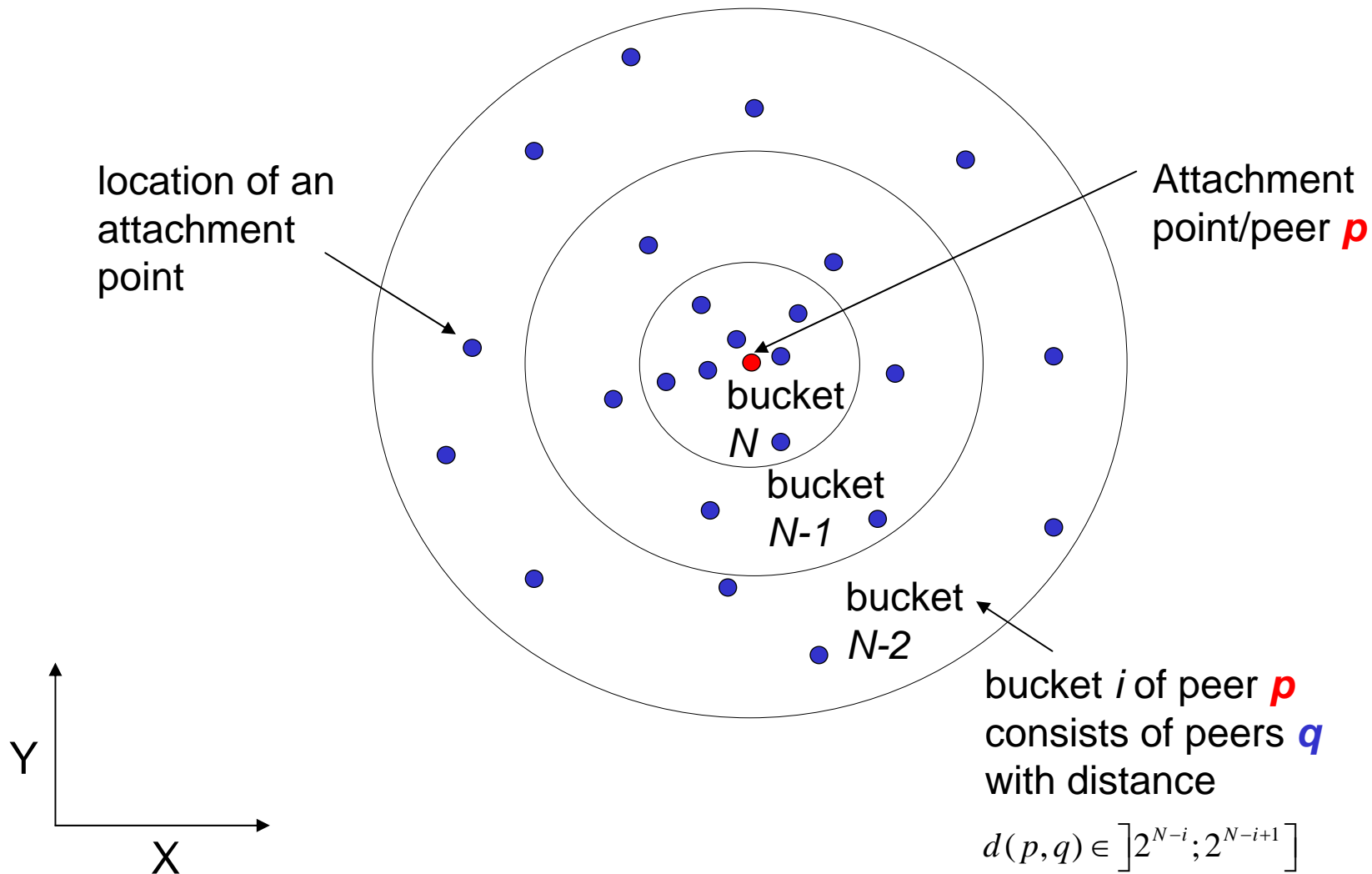
# eCAP (easy Configuration of Access Points)

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- ▶ dependability sub-criteria: **robustness/adaptivity**
- ▶ basic algorithm is based on **Kademlia**
- ▶ **geo-coding of node ID** and **spatial metric** is used to achieve adaptivity, i.e. automatic detection of close nodes
  - coordinates known via GPS
  - distance in the overlay is the Euclidean distance
  - symmetry of the metric is conserved

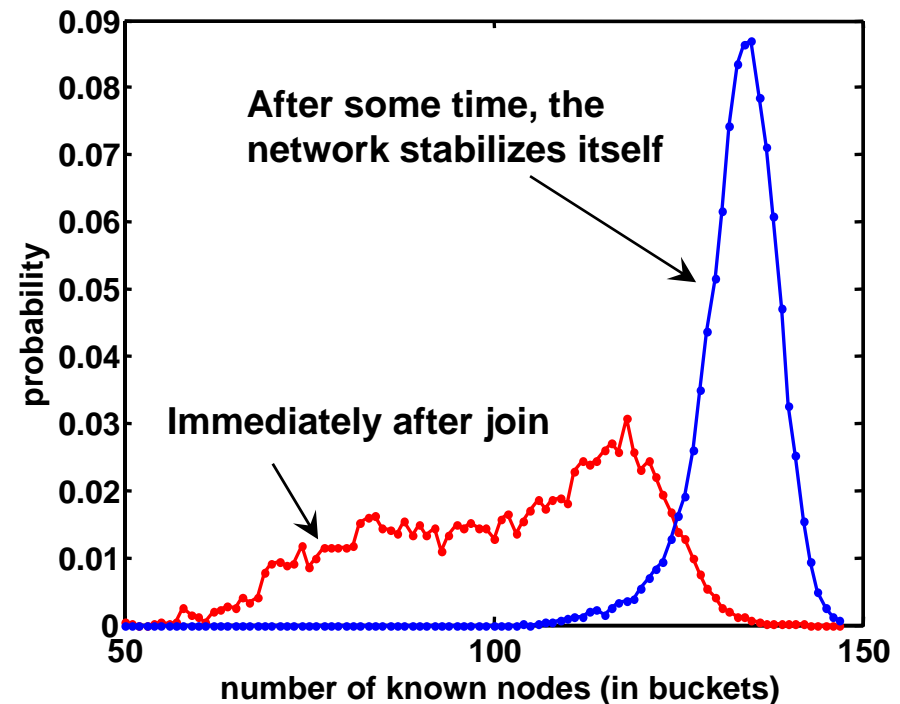


# Spatial metric



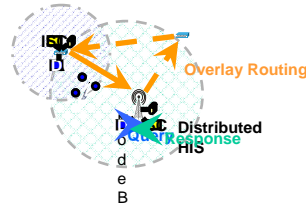
# Results

- ▶ network organizes itself
- ▶ high number of known nodes implies a high number of known neighbors
- ▶ time to stabilization depends on a number of parameters (e.g., network size)
- ▶ different methods for neighborhood detection have been tested



# Applications that rely on Dependability

- ▶ Supporting vertical handover



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

- ▶ coverage information is collected in a database
- ▶ on handover request coverage information has to be retrieved quickly

- ▶ Pastry P2P overlay used
  - information distributed among APs
  - application causes local searches
  - modified to our needs (IDs are location aware)
  - symmetric metric

- ▶ Easy configuration of APs



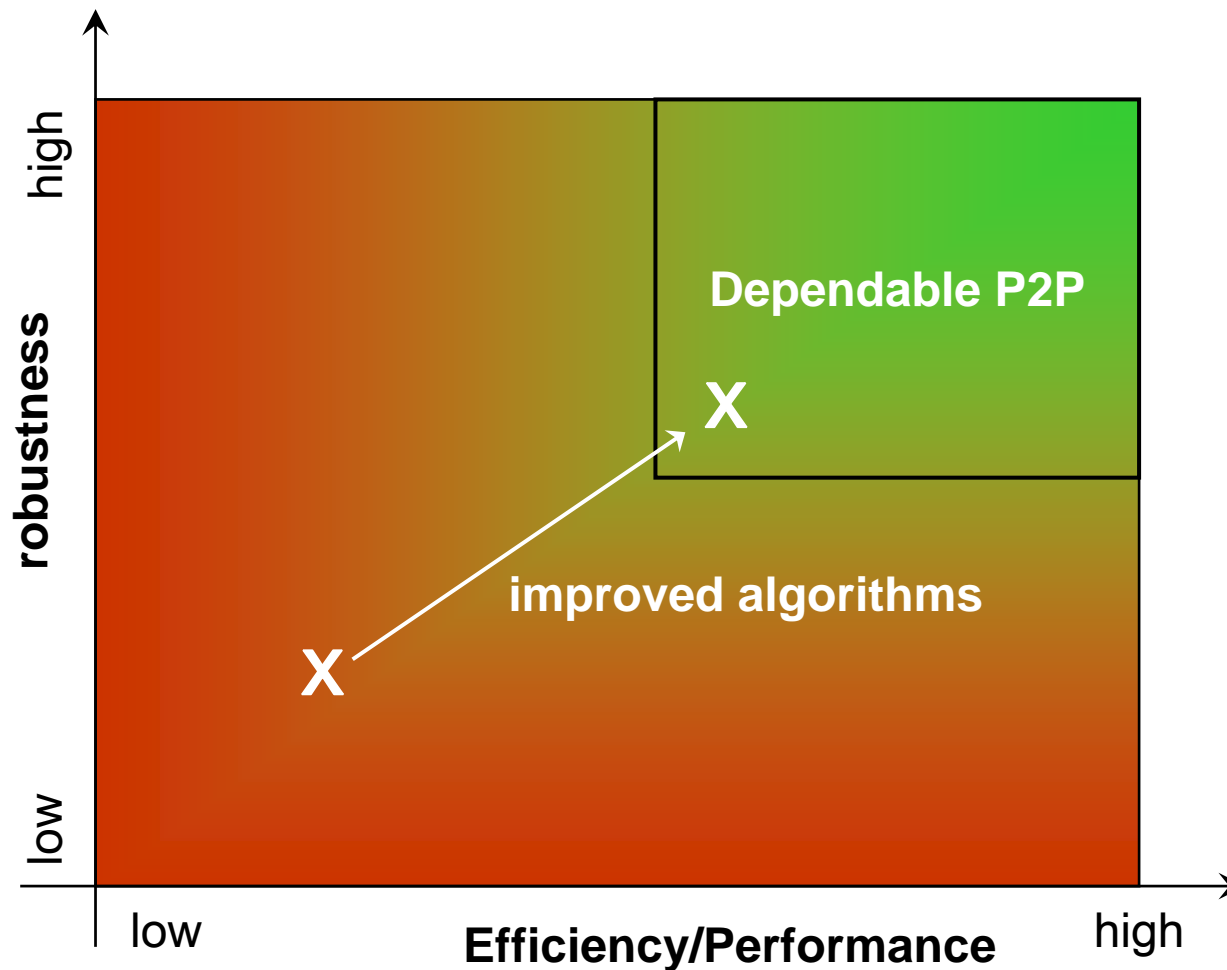
- ▶ main dependability/carrier-grade requirement: **robustness**

- ▶ knowledge of neighboring APs automatically collected and updated
- ▶ new APs can be easily inserted without human effort

- ▶ Kademia P2P overlay used
  - information of close APs implicitly in routing table
  - modified to our needs (proximity metric instead XOR)
  - search traffic utilizes to stabilize overlay



# Towards Dependable P2P



- ▶ still a lot of things to do: **combined (self-)optimization?**





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**Thank you !**

**Any questions?**

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