Zone-based Peer-to-Peer

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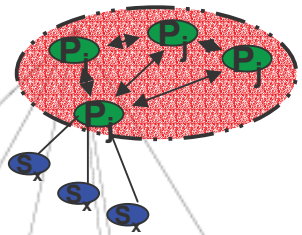
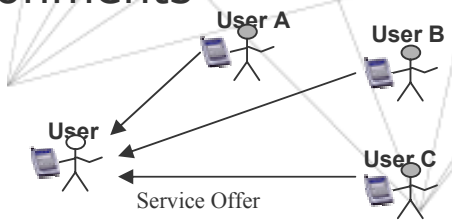
Motivation



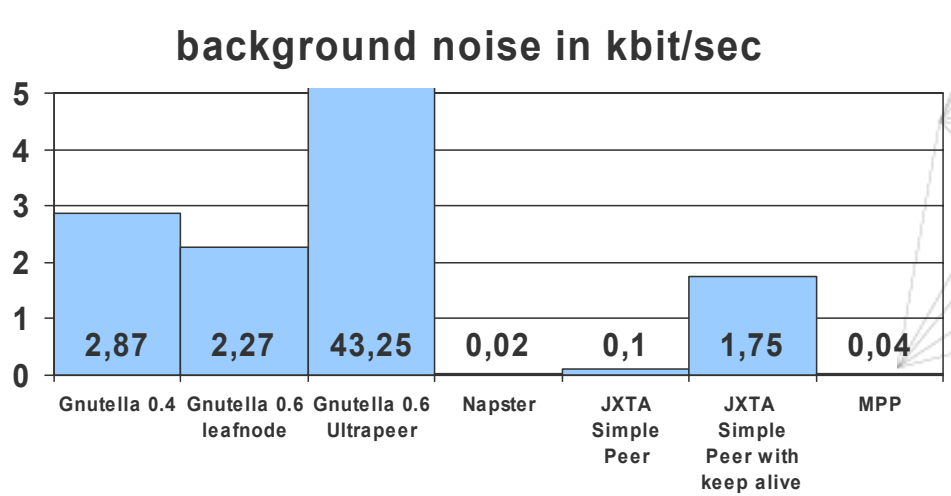
- Peer-to-Peer (P2P):
  self-organizing overlay networks to offer distributed resources (e.g., files) of its nodes to user applications
- P2P overlays can accomodate changes of the node availability → support ubiquitous environments
- P2P supports user-provided services

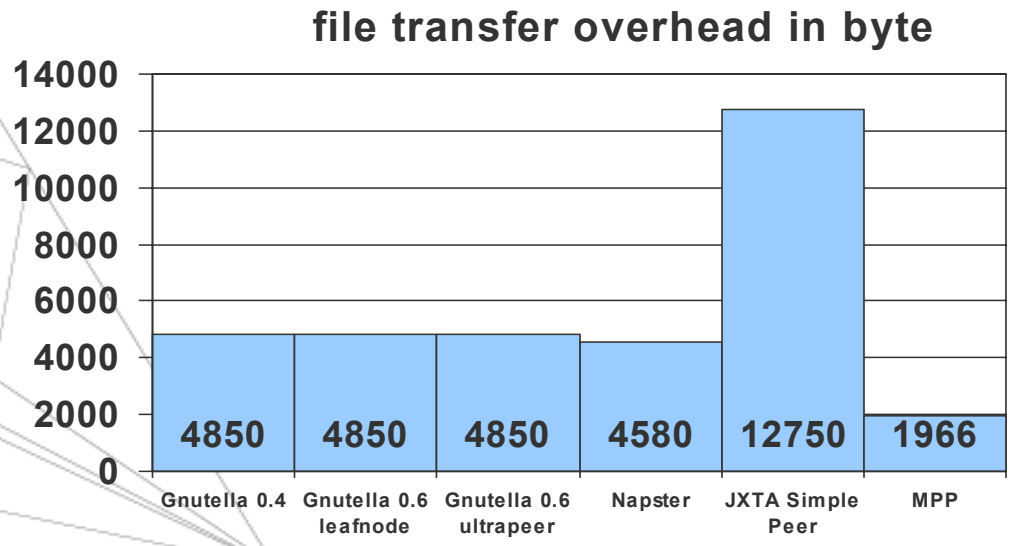


- Design goal:
  High success probability with **efficient search**

- But (in pure P2P)
  - Search means flooding ←→ scarce wireless resources
  - P2P overlay networks not aware of underlying physical infrastructure or TCP/IP connections between nodes

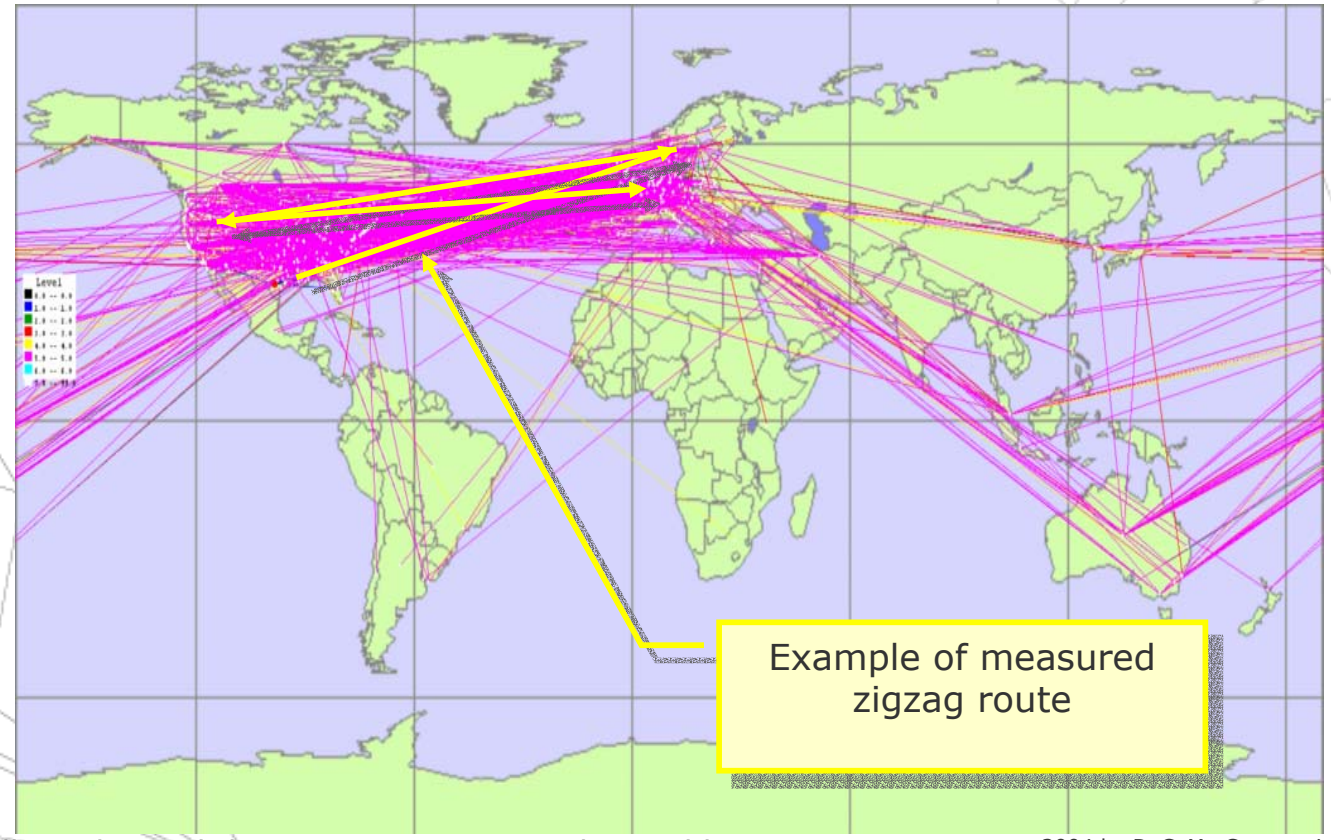
P2P Signaling Efficiency





P2P Overlay Establishment

- Random Establishment of connections in the virtual overlay, resulting in zigzag routes.



Distribution of Gnutella nodes and their connections over the world
Measurements taken at TUM in May 2002

Problems & Objective

- High signaling overhead for search in P2P networks due to simple flooding-based mechanisms
- No knowledge about topology
- Reactive search schemes rather than proactive search schemes cause long search

- Target: mobile environment
  - Low data rates → low overhead required
  - Frequent join and leaves of nodes
  - Number of hops (e.g., ad hoc networks) should be minimized

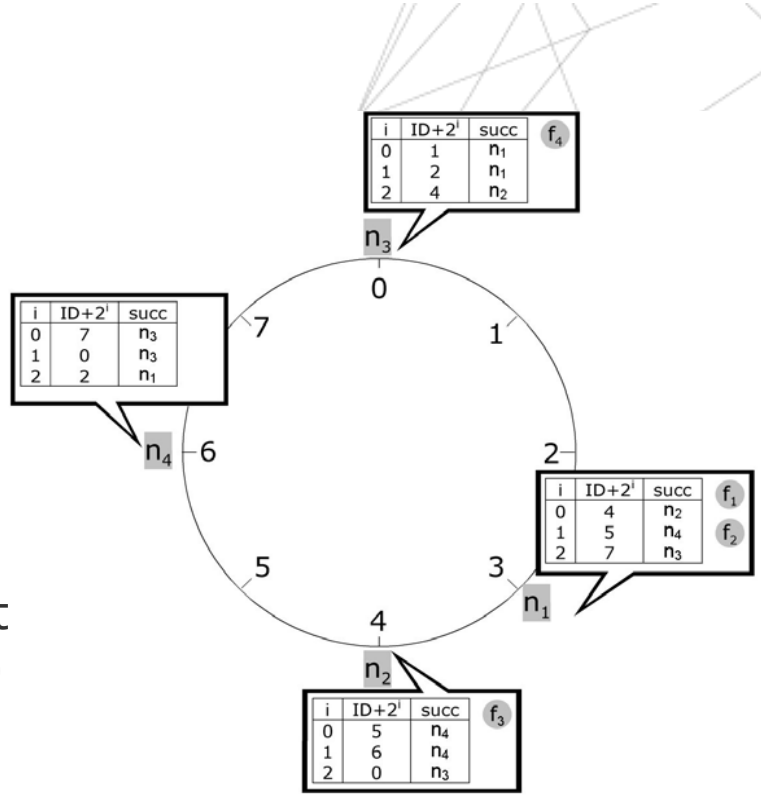
Objective: Optimize peer-to-peer search for resource constrained systems using proactive search

Proactive Request Routing

- Unstructured P2P
  - Gnutella 0.4 → simple flooding
  - Gnutella 0.6, JXTA → hierarchies, still flooding
  - *Reactive* request routing, no a priori knowledge of resources
- Structured P2P
  - Dynamic Hash Table (DHT) based approaches
  - Chord, CAN → request routing path is determined before a request is issued
  - Towards *proactive* request routing

DHT-based Overlay Approaches – Chord

- Nodes form a Chord ring based on address hashing
- Content is hashed and shifted to the node with respective hash key



- Problems for unstable, mobile environments:
  - Unstability causes frequent shift of content (overhead)
  - No exploration of local proximity
  - Load on nodes is not balanced

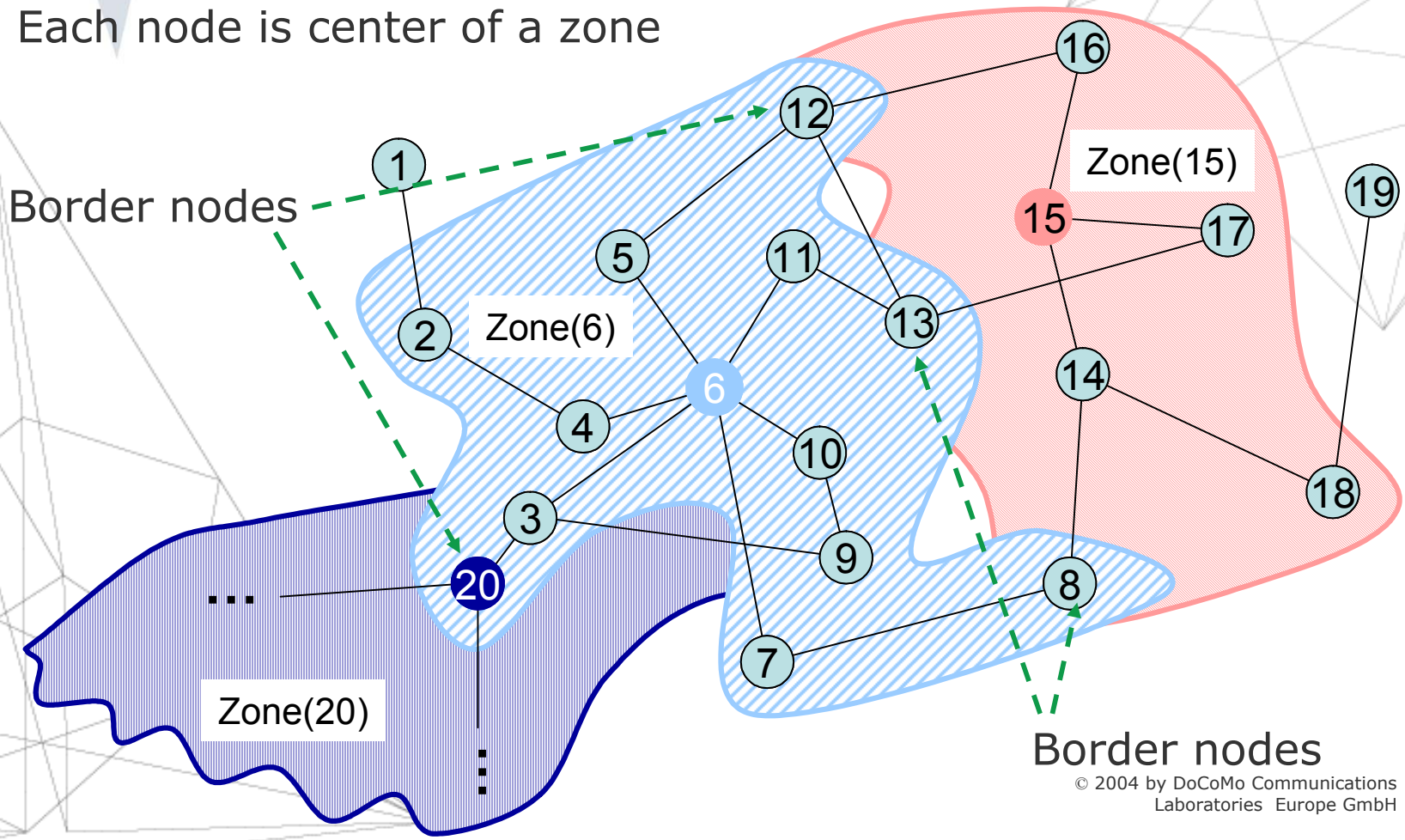
Zone-based Peer-to-Peer

- Employing proactive routing schemes in overlay (from ad hoc networks: DSDV, AODV, ZRP)
- Establishment of zones as special peer groups
- Zone setup could be based on local proximity
- In zones, knowledge about available content is shared among the peers
- Requested content could be found with less effort

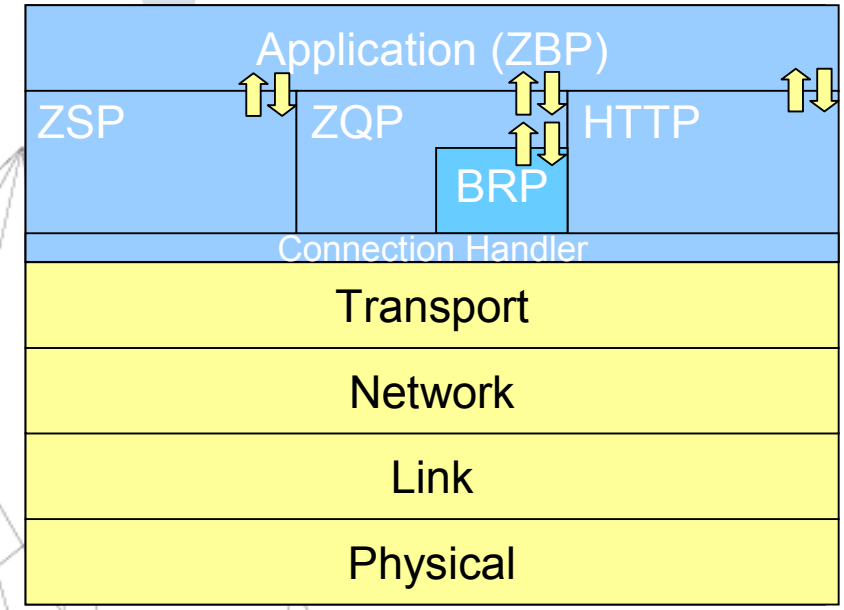
DSDV Destination sequenced distance vector protocol
AODV Ad-hoc on-demand distance vector routing
ZRP Zone Routing Protocol

Zone-based Peer-to-Peer (ZBP)

- Examples of Zones established (zone radius 2)
- Each node is center of a zone



ZPB: Protocol Stack



Connection Handler (CH)

- Interface to transport layer
- Creates connections according to physical topology or other relationship

ZBP – layered model

ZBP Application:

– application, controls other protocols

ZSP: Zone Setup Protocol

– Zone establishment and advertisement handling

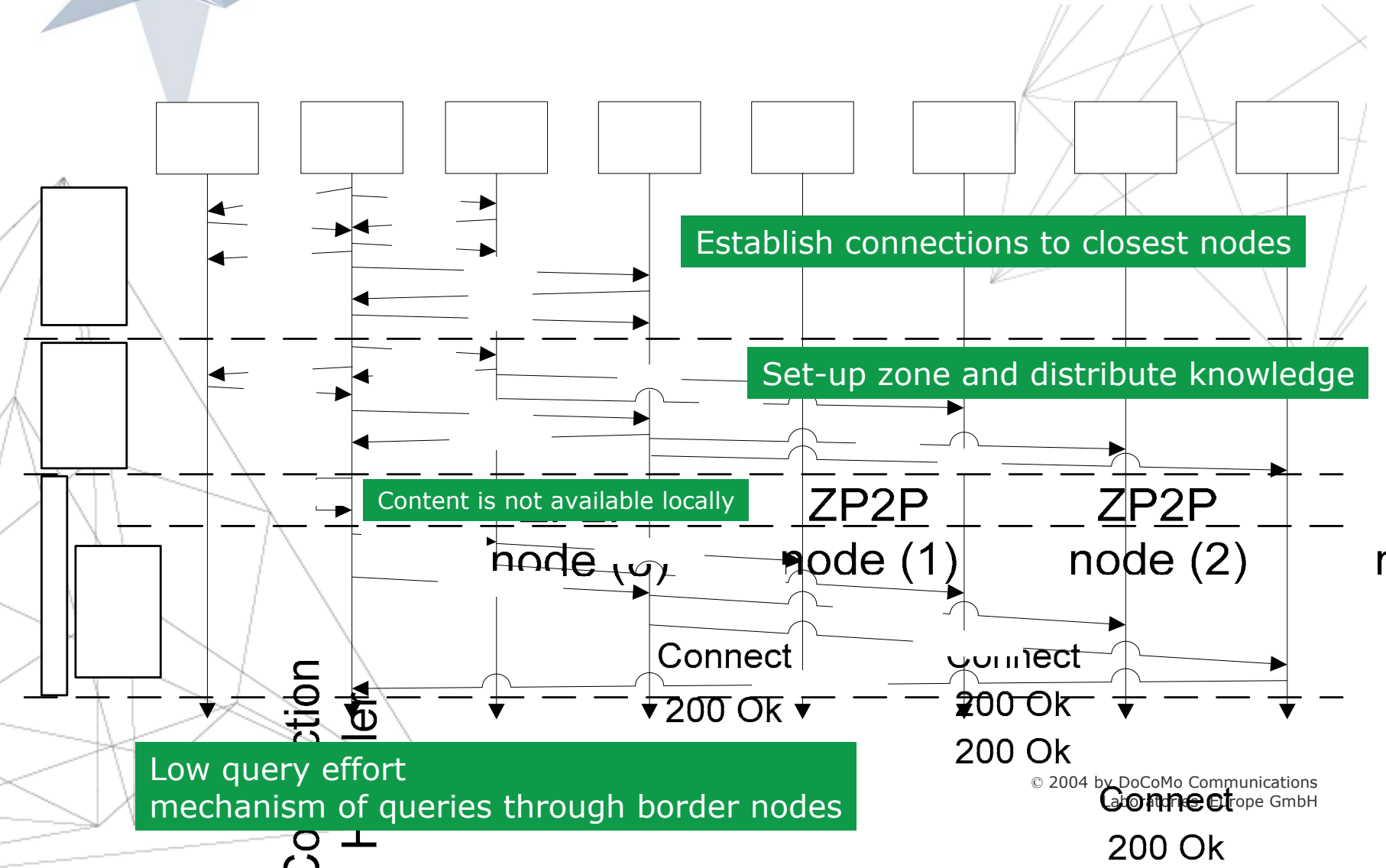
ZQP: Zone Query Protocol

– Search within zone and through border nodes

BRP: Bordercast Resolution Protocol

HTTP

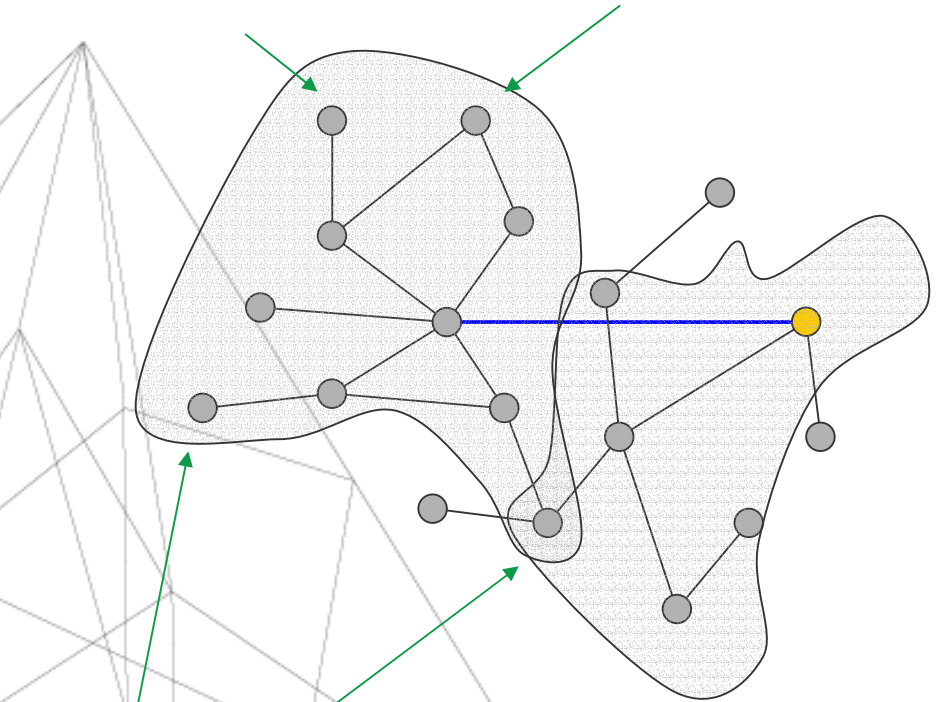
Sample Signaling Flow



Example search

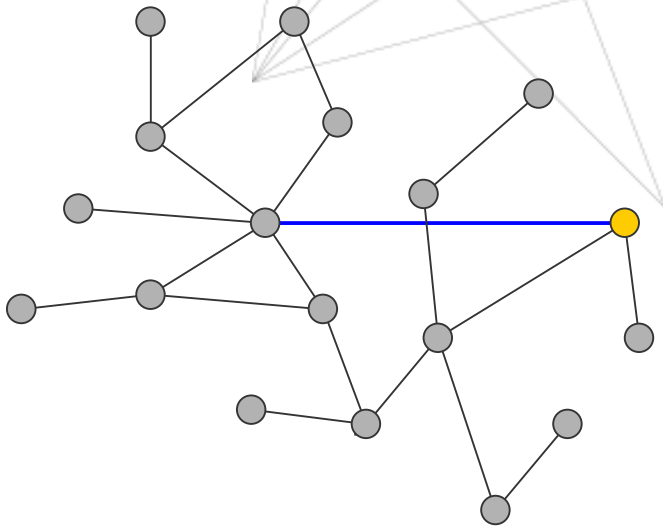
Query-Routing by bordercasting: Routing not flooding

ZBP



Border nodes of this zone

Gnutella



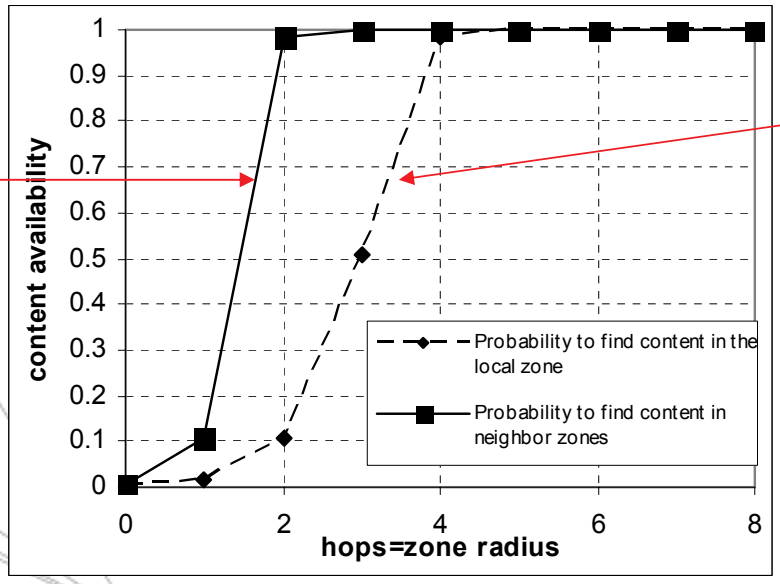
Evaluation

- Analysis
  - Connectivity model based on random graph theory
  - Assumptions (from previous measurement):
    - 3 connections per node
    - Uptime 900 sec
    - 100 files shared by each peer
    - 2 downloads per session
    - Replication rate: 0,55%
- Simulation

Analytical Evaluation

- Availability of specific content against zone radius
  - Availability increases fast with zone radius
  - Radius of 2 → 100% success rate incl. neighbor zones

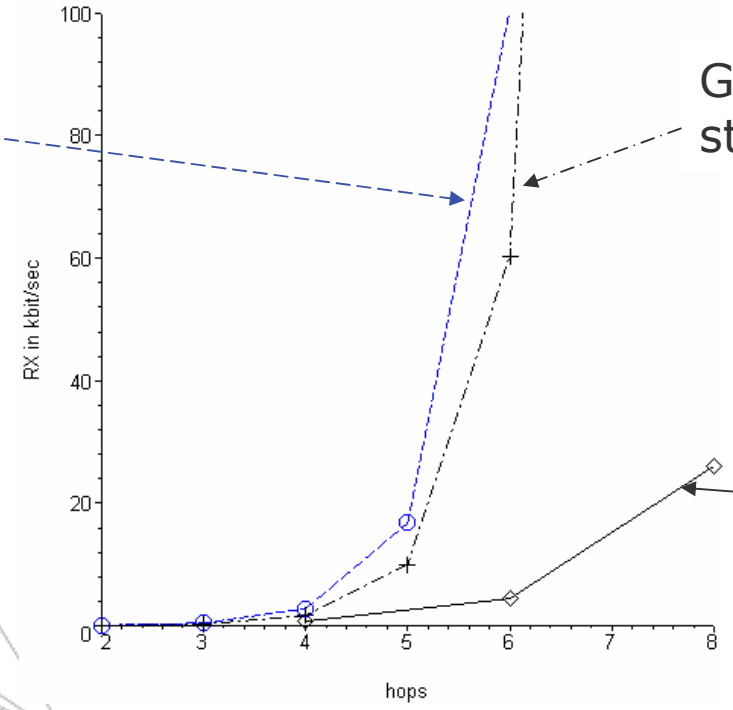
availability of the content in the inner and all neighbor-zones



availability of the content within the zone

Analytical Evaluation

- Signaling traffic compared to Gnutella 0.4 and compressed Gnutella 0.4
  - Overhead can be reduced significantly



Gnutella

Gnutella with string compression

Received traffic in kbit/s

ZBP

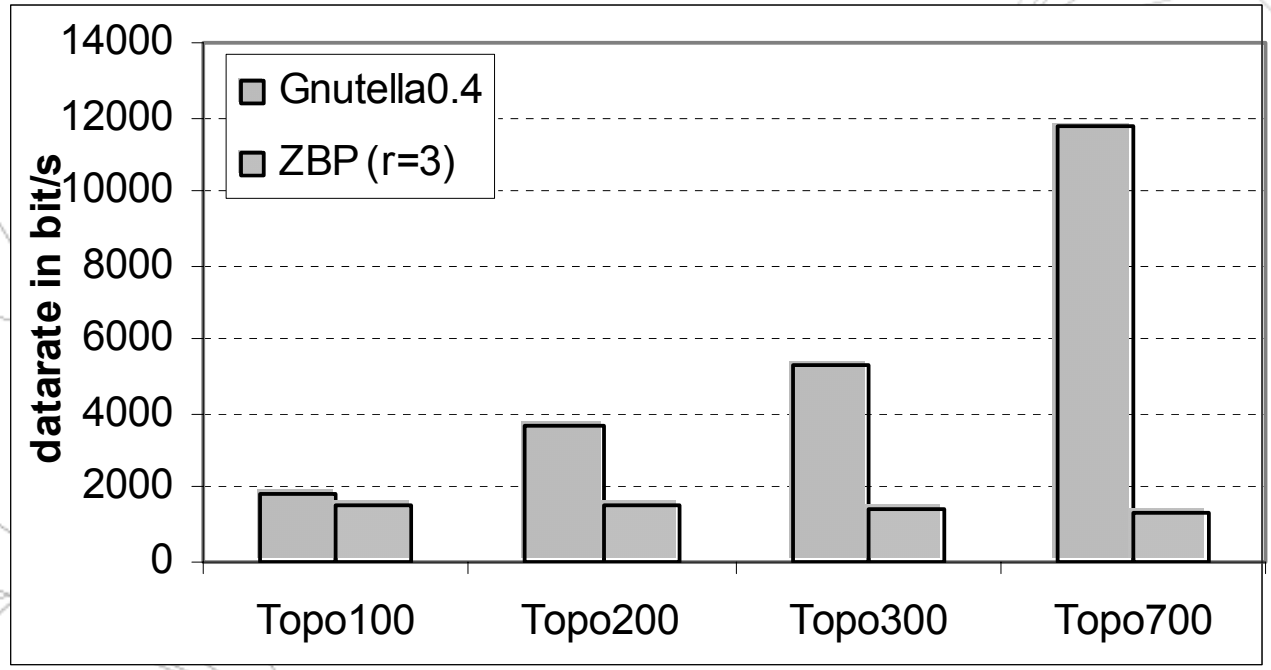
hops (= 2* zoneradius)

Evaluation

- Analysis
- Simulation
  - Assumptions (from previous measurement):
    - Topologies with 100, 200, 300, 700 nodes
    - 3 connections per node
    - Uptime 900 sec
    - 100 files shared by each peer
    - Replication rate: 0,55%

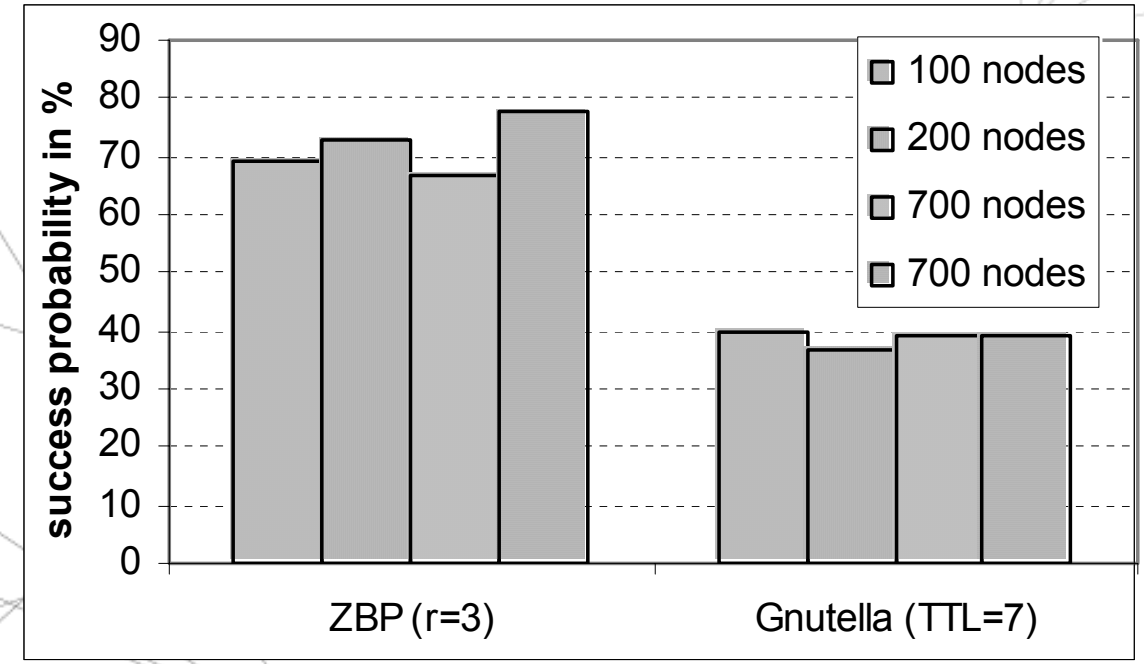
Simulation results

- Average total traffic simulated for one ZBP- and one Gnutella-node
  - ZBP traffic does not grow with network size
  - ZBP node only sends packets within zone



Simulation results

- Success probabilities for different network sizes in a ZBP network and a Gnutella network
  - In ZBP less query hit messages are in vain



Summary

- **Problem**: High signaling overhead for content search in P2P networks due to flooding-based mechanisms

- **Zone-based Peer-to-Peer**
  - Establishment of zones as special peer groups
  - In zones, knowledge about available content is shared among peers
  - Requested content could be found with less effort

- **Advantages**
  - reduced signalling load
    - Important for resource-limited mobile networks
    - Faster search → better acceptance of P2P applications by users
    - Decrease of cost
  - Mapping of zones to physical or logical topologies
    - Mapping to physical network avoids 'long' links
    - Support of semantic 'peer groups'

- P2P as a building block for next generation **mobile service platforms**
    - http://www.saint2005.org/workshops/wk-cfp-6.txt