Applying Peer-to-peer Mechanisms to Sensor Networks: Opportunities and Threats
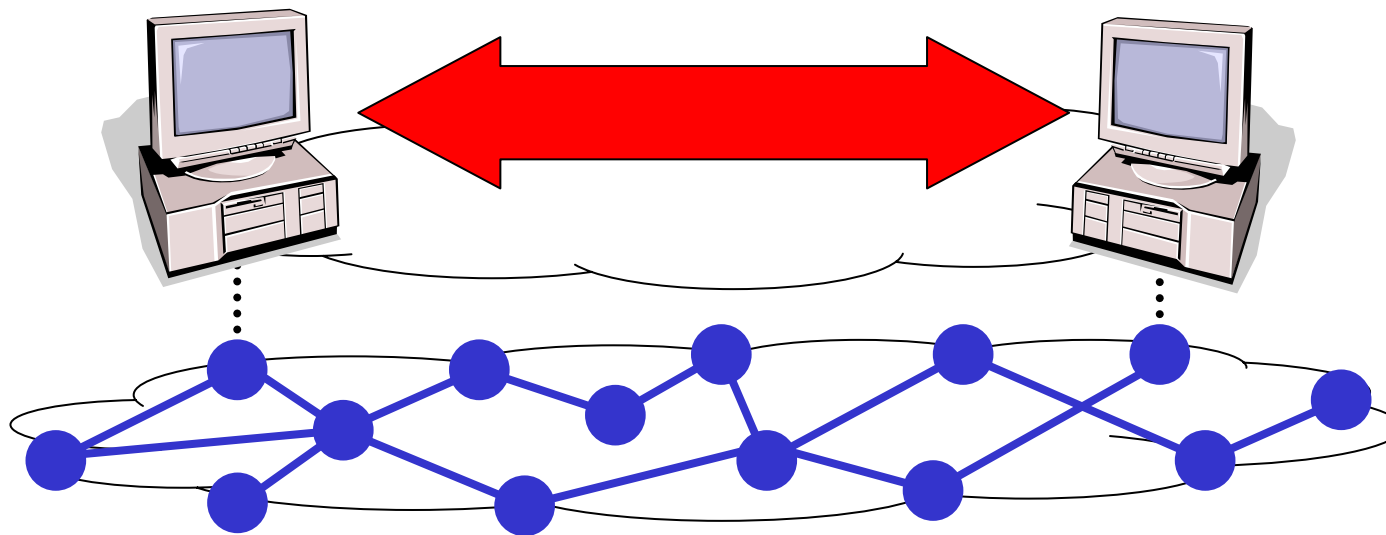
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The Peer-to-Peer Principle

Peer-to-Peer establishes an overlay-network on top of an existing communication infrastructure:
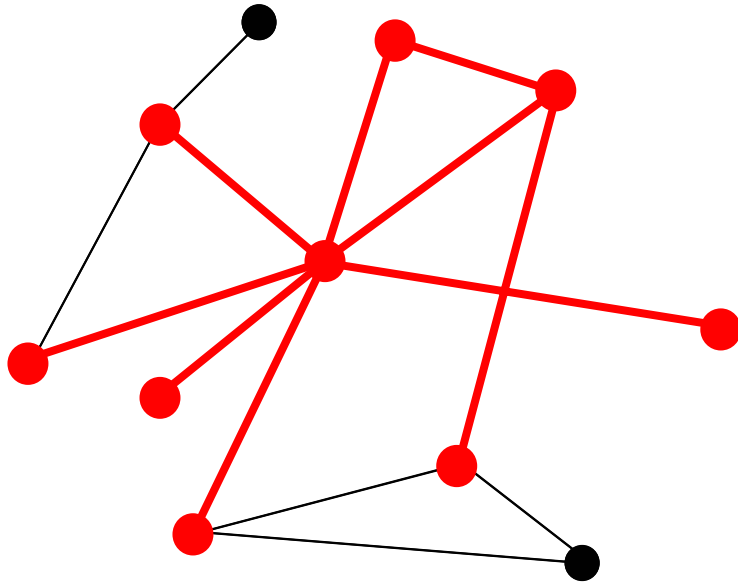

P2P lets you forget about the wires (or radio links) and gives rise to a new view on distributed systems …
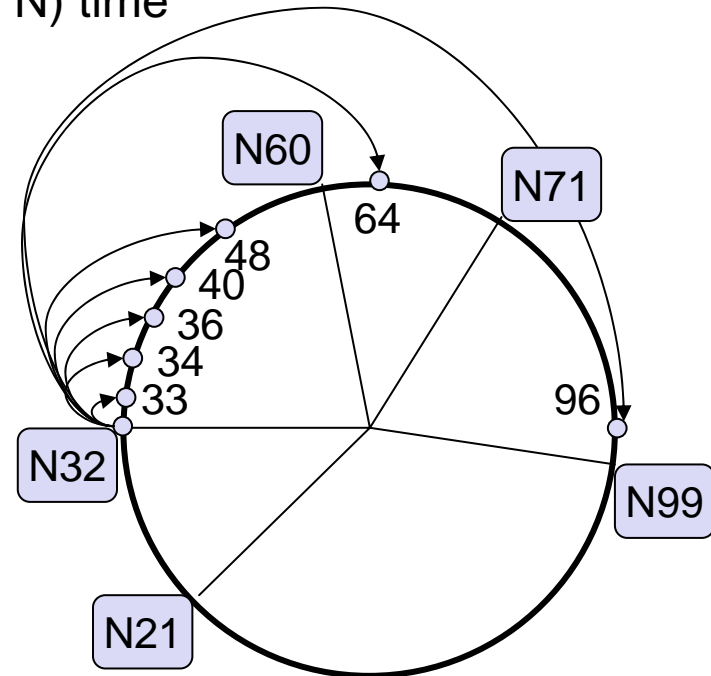
Peer-to-Peer Examples

Unstructured P2P Systems

- E.g. Gnutella: Store data where it is stored anyway, and share it

Distributed Hash Tables

- Flat key-space: Lookup in O(log N) time
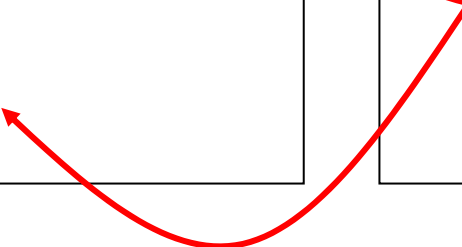
N60, N71, 64, 48, 40, 36, 34, 33, N32, 96, N99, N21

P2P systems can be fully decentralized and self-organizing …

Opportunities & Threats

| Opportunities	Threats
• Fully decentralized • No infrastructure required • Heterogeneity reflected • Application requirements can be reflected in the system structure	• Traffic overhead • Node Churn • Security hard to achieve without infrastructure or centralized component • Reliability!?!

- Chord-Graph is *directed*, i.e. always searching towards increasing keys.

- Guaranteed worst-case success in O(log N) steps, if structure is correctly maintained.

- Maintaining the structure requires considerable effort.

- Overlay hops can be adjusted to structure of underlying network topology.
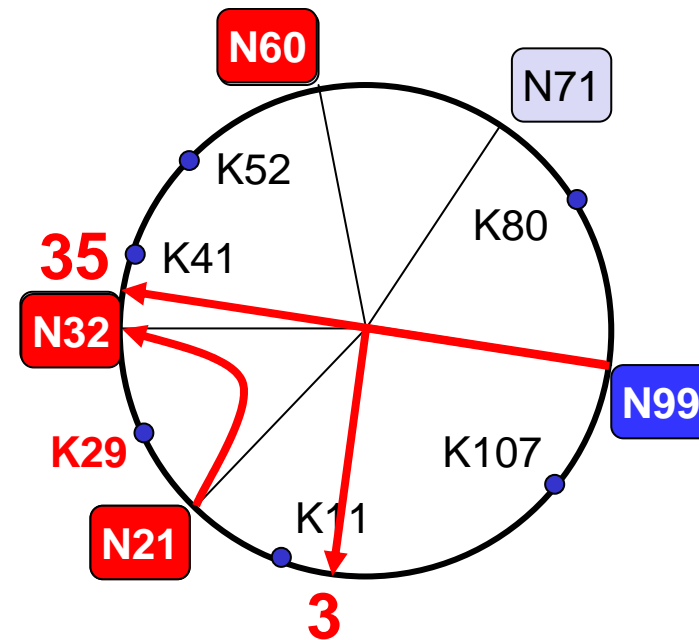
State of the art solution for wired networks' fully distributed lookup.

Improvements to Chord
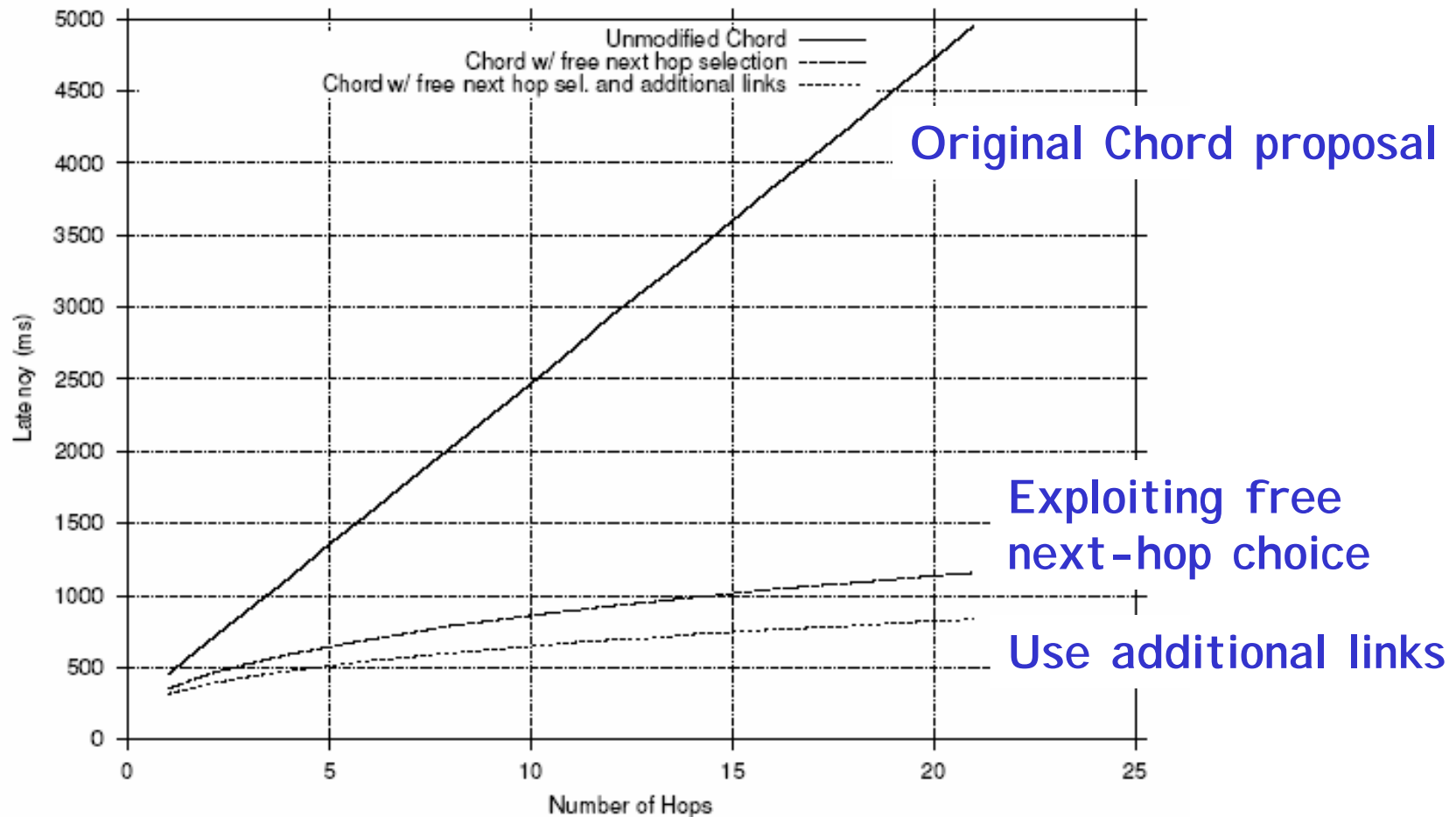
Kutzner et al., Adaptive Improvement Methods for the Chord DHT, 2004 (submitted)

- Requests are routed with „geographic routing" in the overlay.

- Allows fuzzy search.

- Non-flat key-space can be mapped to application-specific structure, e.g. text retrieval.

- Mapping between overlay and underlying network topology difficult.

TeleMatics
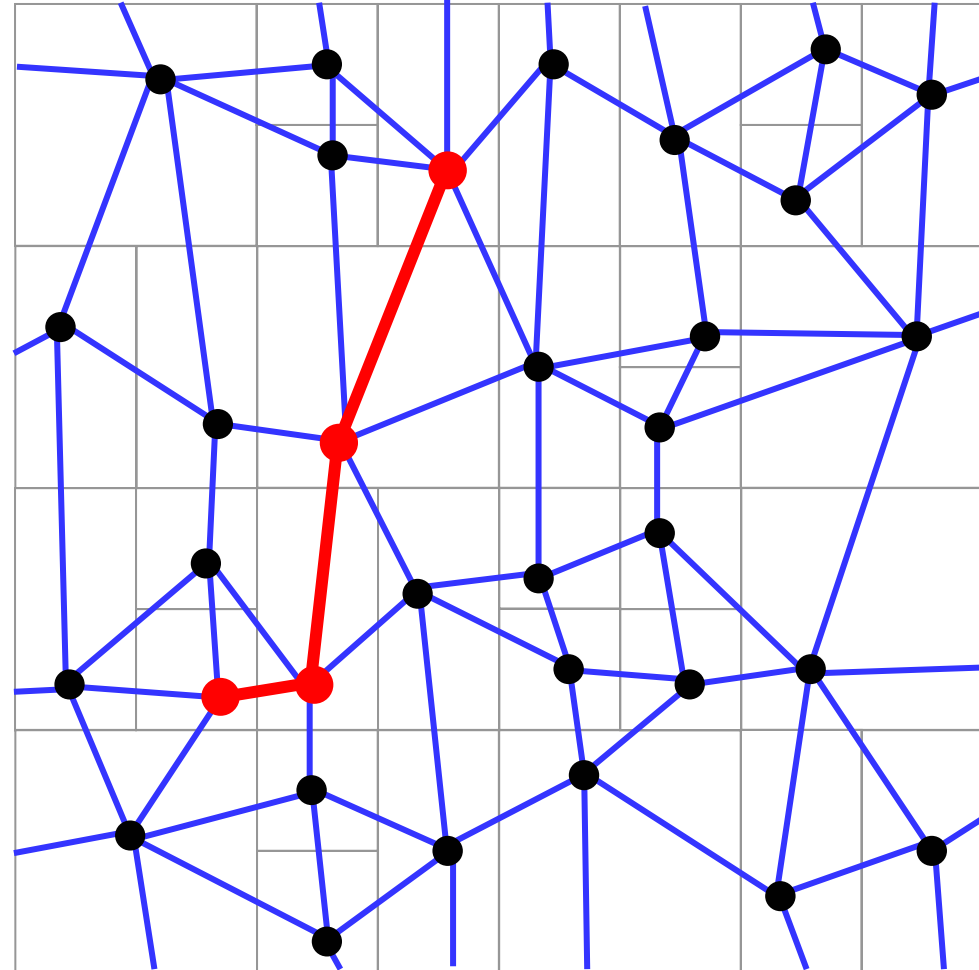
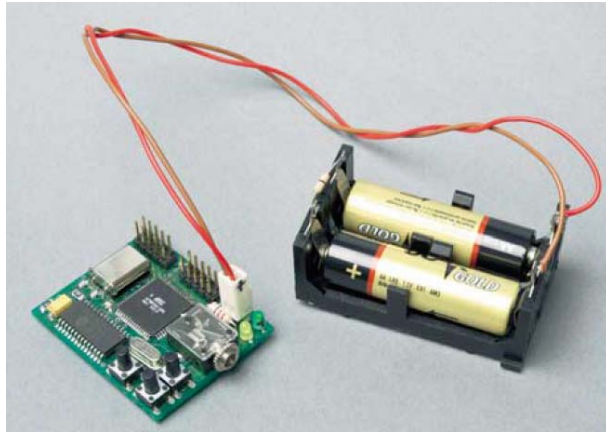Example: Start exploring the earth's surface from the pole. Number of nodes found increases like R^2

$$N \sim \sin^d(r/R)$$

Reachable Nodes

$d = 4.8$

Distance [Hops]
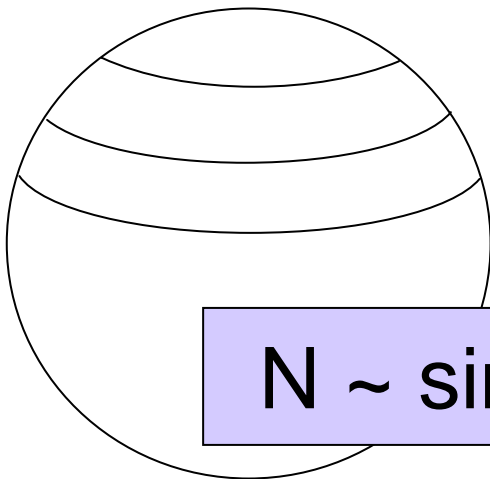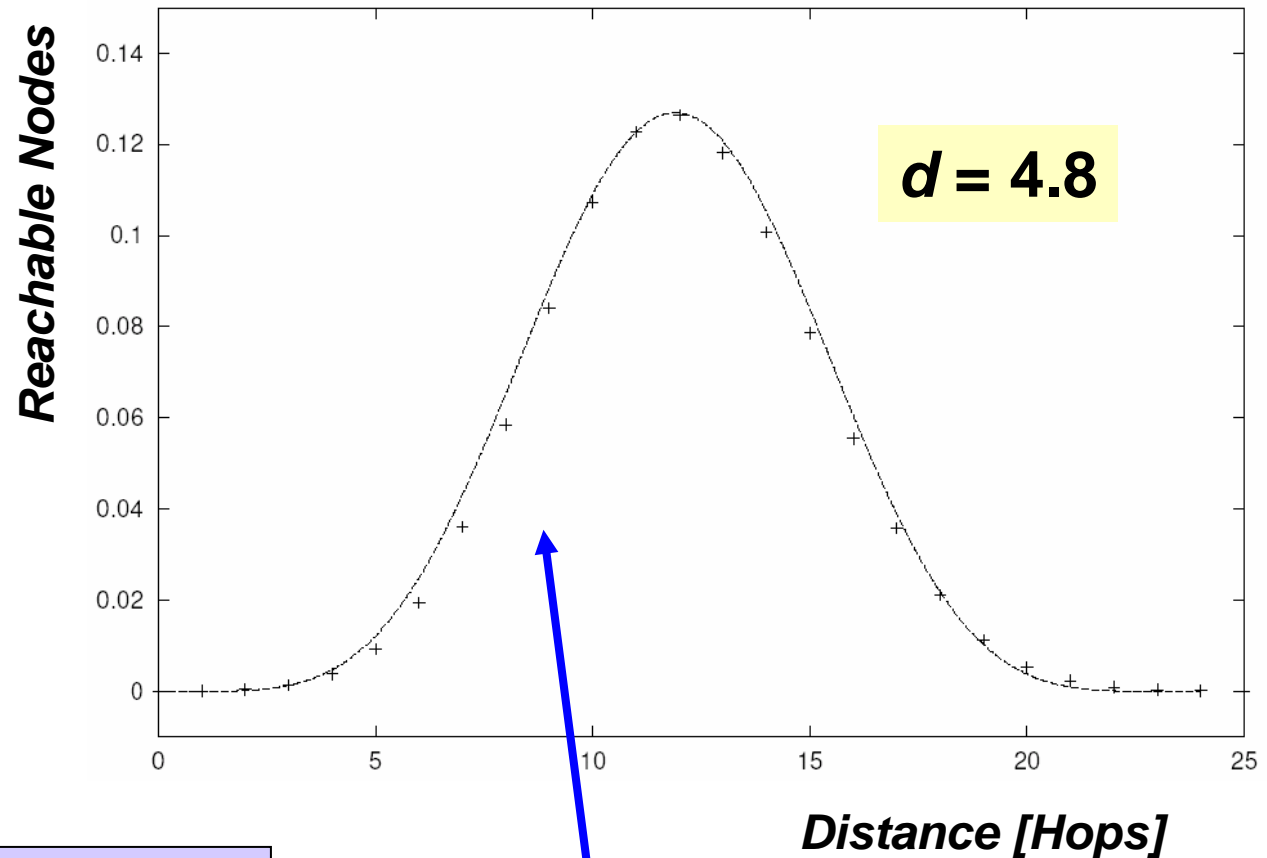
Same observation in the unstructured Gnutella network. – Exploit that „hidden" structure!

Fuhrmann, On the Topology of Overlay-Networks, ICON 2003

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