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USC

Resource Discovery, Query Resolution & Rendezvous in Large-Scale Wireless Networks: Architectural Design & Analysis

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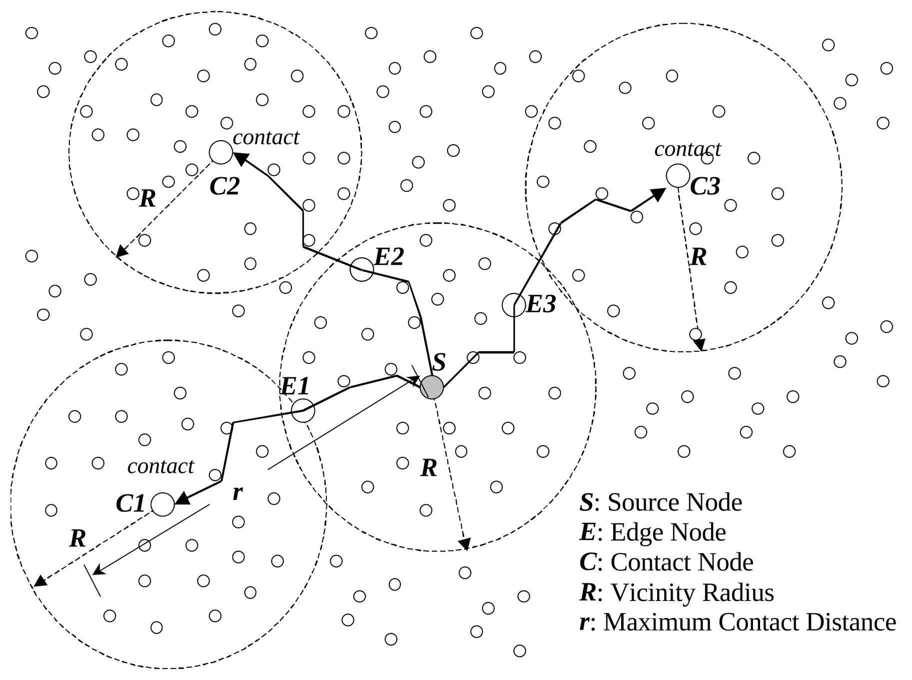
Objective

- Provide efficient power-aware routing of *small transfers*; e.g., resource discovery and queries, in ad hoc and sensor networks
- Design rendezvous and bootstrap architectures for data-centric storage applications
- Introduce a framework for *mobility-rich* analysis of wireless networking protocols

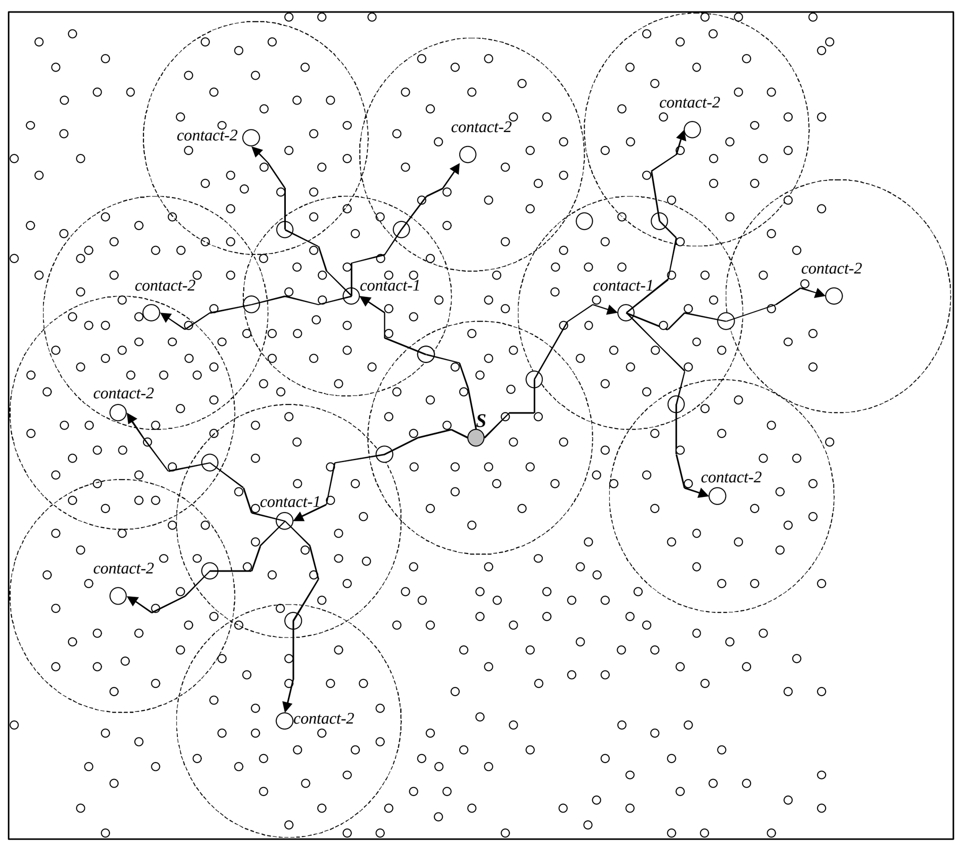
Motivation

- Small transfers likely to constitute large portion of traffic in wireless networks
- Lack of infrastructure necessitates self-configuration and efficient rendezvous
- Network dynamics; due to mobility and errors may greatly affect protocol performance and correctness.

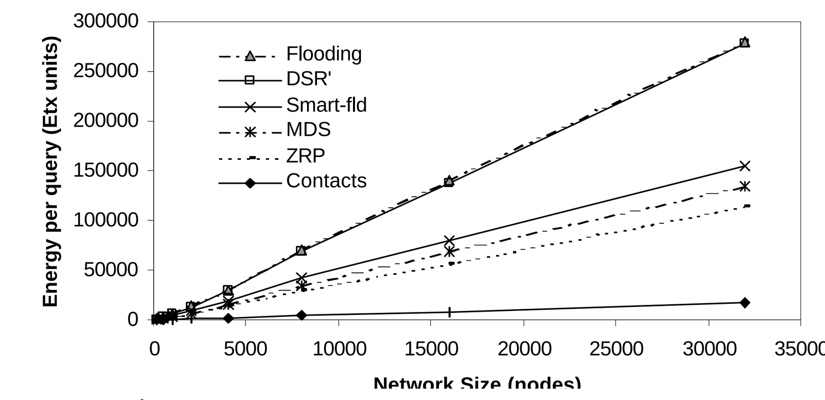
Contact-based Resource Discovery and Query Resolution

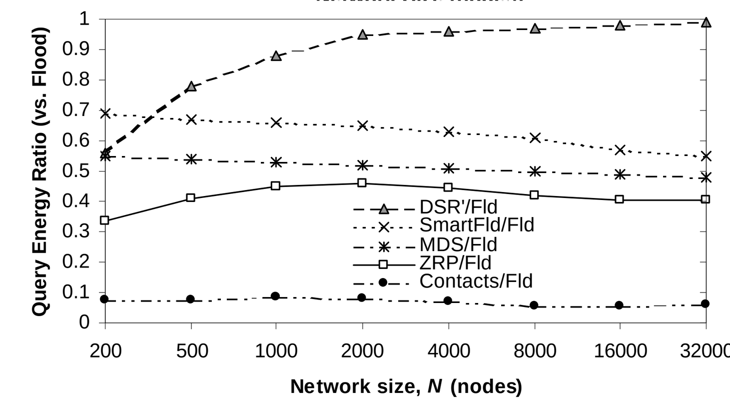


- Zone-based loosely-coupled simple hierarchy
- Contacts act as *short cuts* between zones to reduce *degrees of separation* between source and target
- Design parameters: *r, R, #contacts (NoC), search depth (D), search policy*



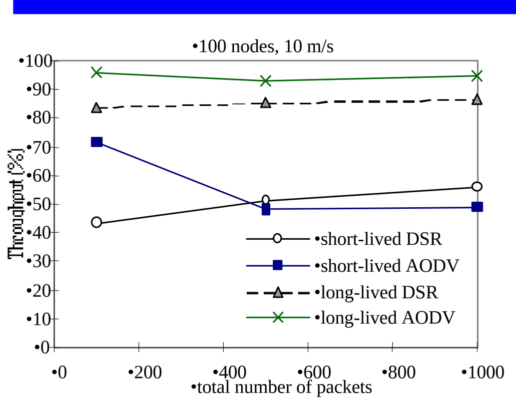
- Hierarchy organized in terms of *levels* of contacts
- Queries sent in single-shot or expanding rings

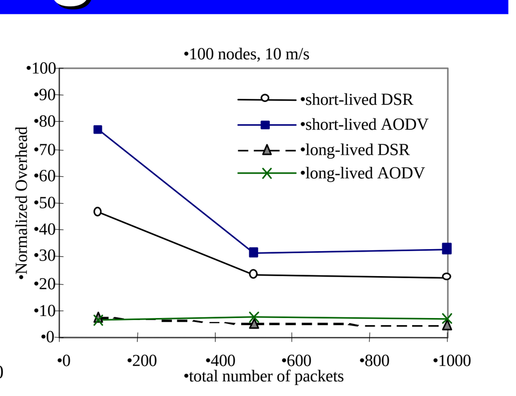




- Contact-based scheme attains significant power savings
- Parameter settings: *exponential expanding ring*, *r=R=NoC=3, D=33*, work well for wide range of networks

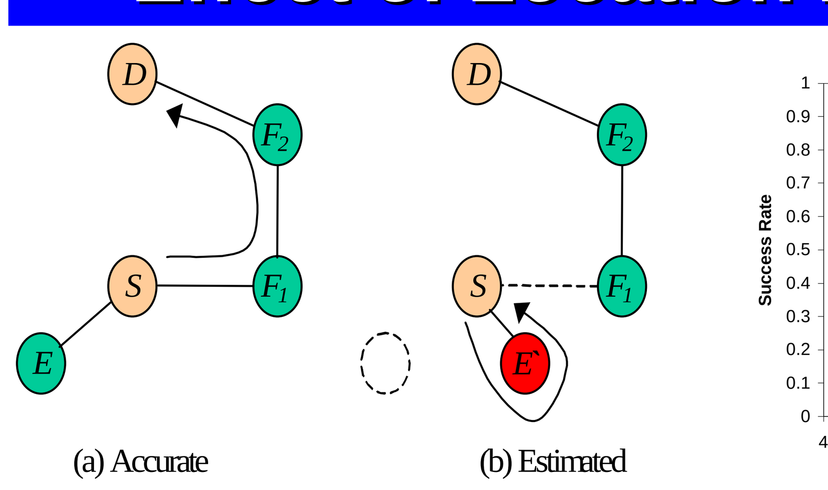
Short vs. Long Transfers





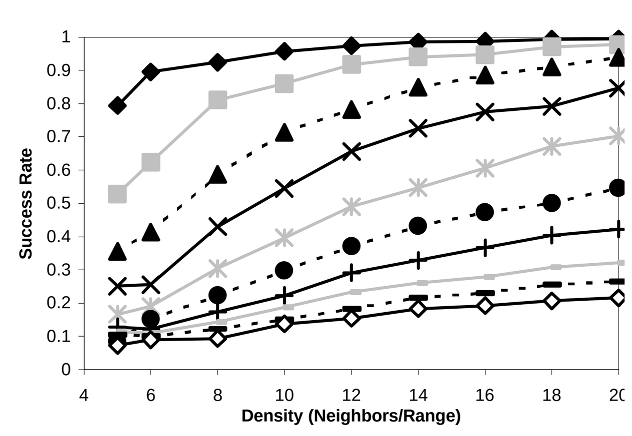
Failure of on-demand routing
- Significant drop in performance for small transfers due to drop in cache validity

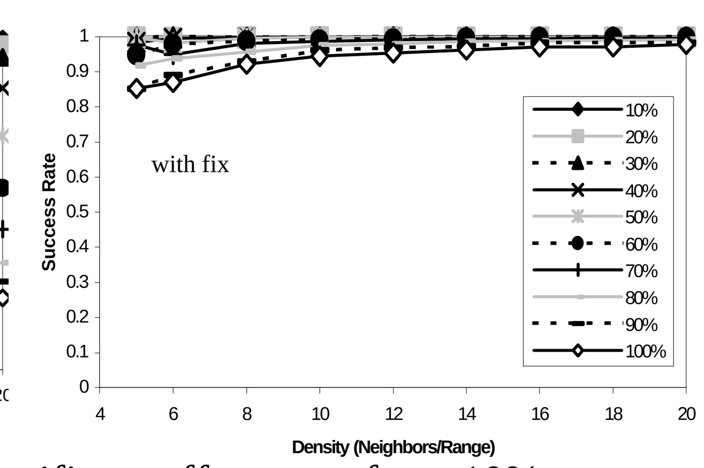
Effect of Location Errors on Geographic Routing



Disconnection due to incorrect edge removal by planarization

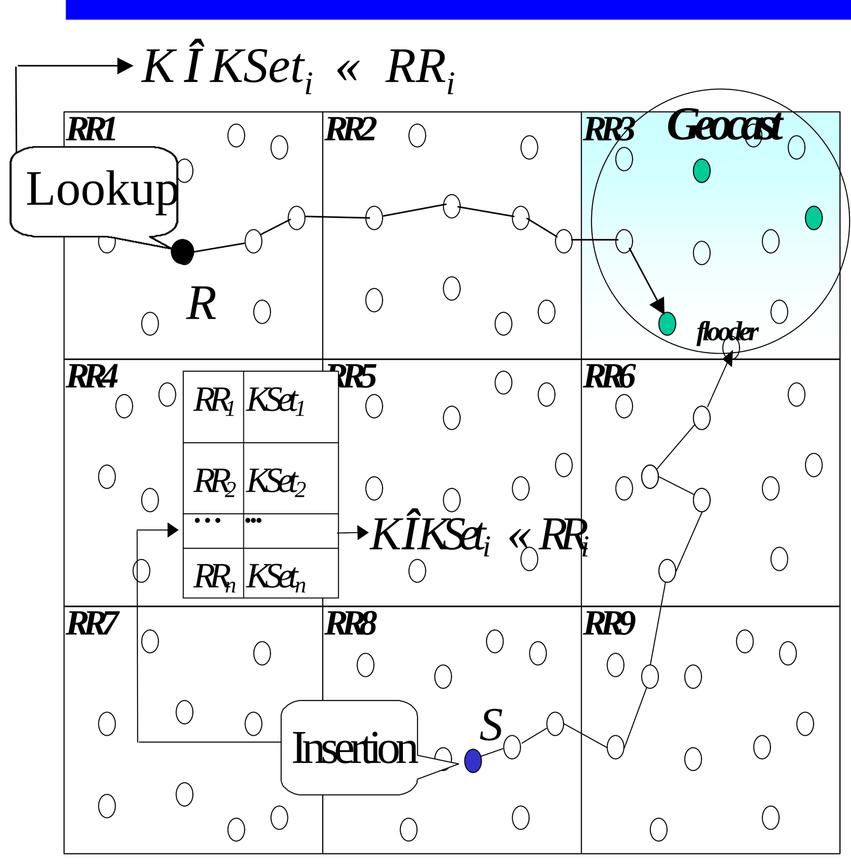
Fix: Allow only mutual witness removal





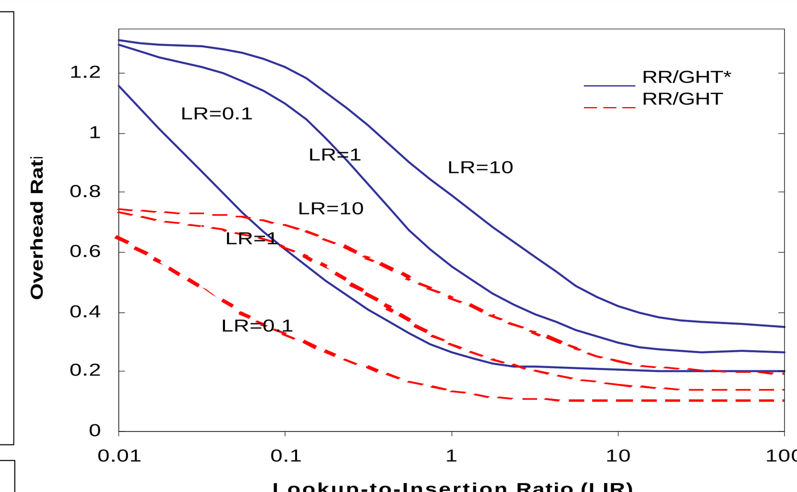
GHT & GPSR analysis: - Significant effect even for < 10% error
- With fix success rate is near-perfect even for large errors
- To study: effects of inconsistency and mobility

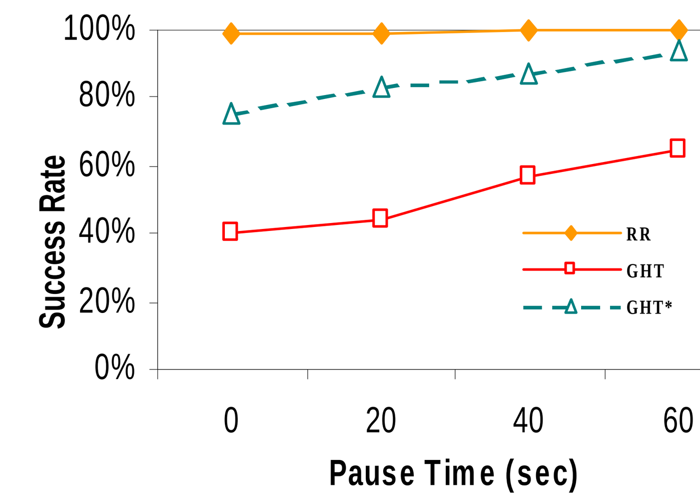
Rendezvous Regions for Data-centric Storage



Insertion: Node *S* wishing to insert resource key *K* that belongs to $KSet_i$ gets the corresponding *RR* (in this case *RR3*) through the mapping ($KSet_i \rightarrow RR_i$). Then sends the resource data towards *RR3*, where it is geocast by the flooder and stored by the servers.

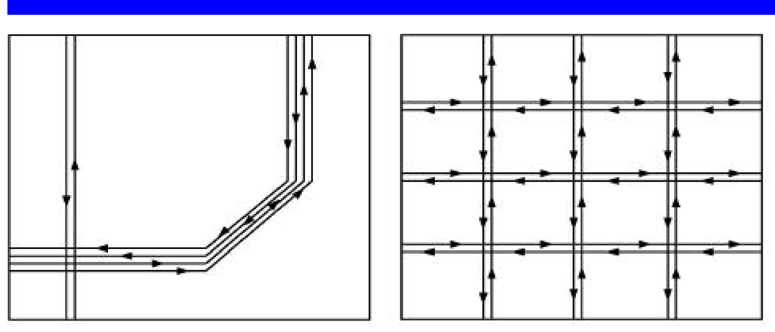
Lookup: Node *R* looking for a resource key *K*, that belongs to $KSet_i$, gets the corresponding *RR* (*RR3*) through the mapping ($KSet_i \rightarrow RR_i$). It sends the resource lookup to *RR3*, where it is anycast to any server holding the data



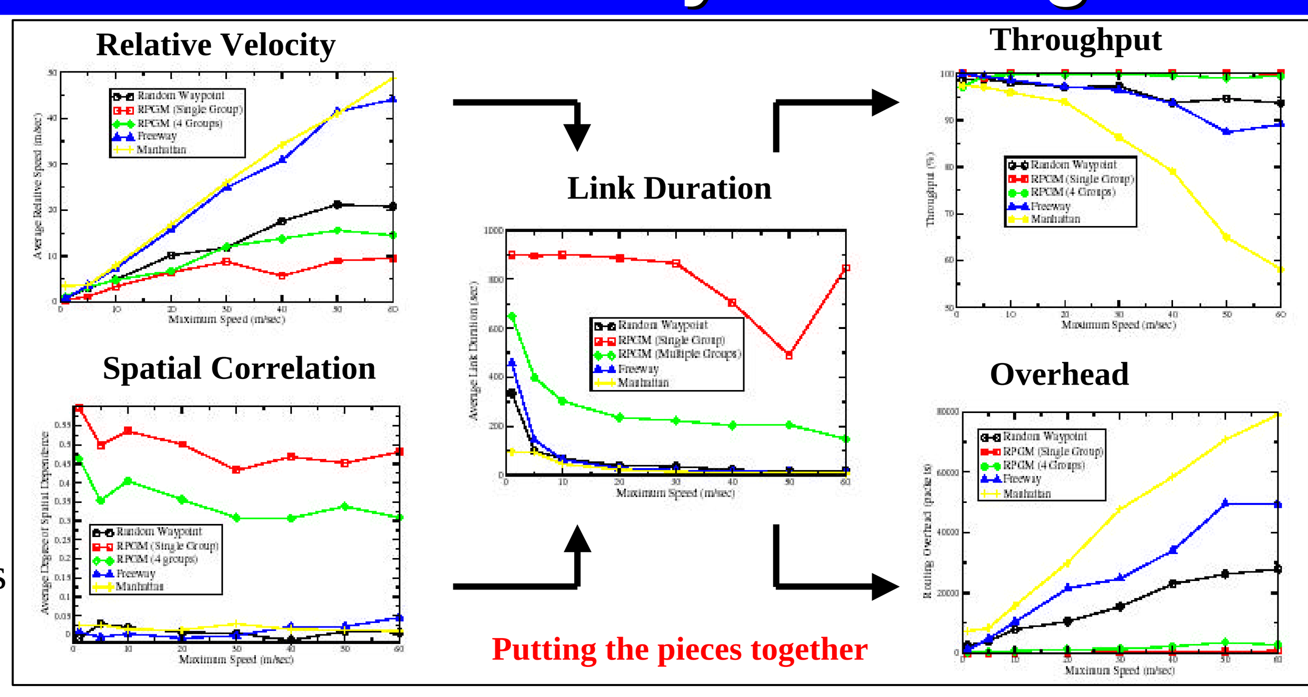


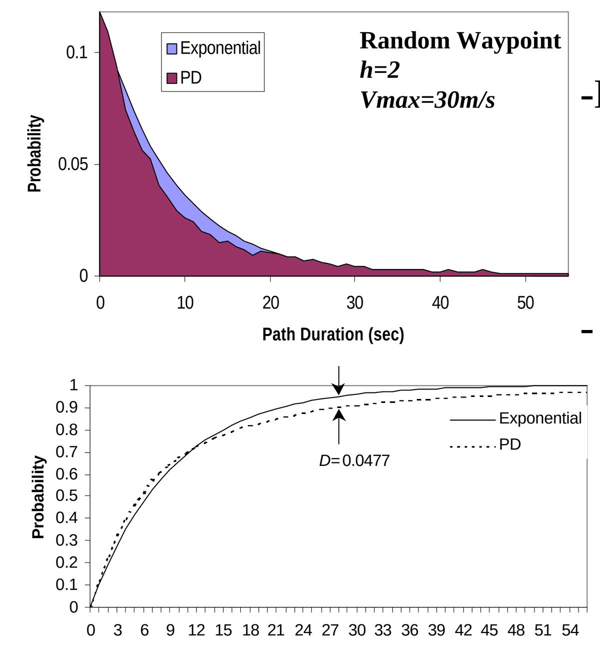
- Low lookup overhead. Efficient in applications with high LIR
- Regions provide a dampening factor to the effects of mobility.
- Robust to failures using low frequency low overhead checking mechanism
- Scalable with high number of nodes. Low hotspot overhead
- Robust to location errors. Relaxes assumptions of accurate locations

'IMPORTANT': Mobility Modeling and Analysis



- Incorporate a *rich* set of mobility models; freeway, mahattan, group, contraction, rand
- Introduce set of metric to measure mobility effects; spatio-temporal correlation, rel. vel.
- Relate mobility to performance via link stats
- Obtain models for link and path statistics





- Link duration distribution
  - *not* exponential
  - bi-modal for manhattan, freeway, group for low velocities
- Path duration distribution
  - multi-hop paths exponential for > 10m/s
  - bi/multi-modal for low velocities

Future Research Directions

- Integrating Contact-based and Rendezvous Regions architectures
- Dynamic configuration of Rendezvous Regions
- Investigate *short cut* associations and building *small worlds* (in wired/wireless nets)
- Study other mobility models: hybrid, trace-based, scenario based