Probabilistic Multi-path vs. Deterministic Single-path Protocols for Dynamic Ad-Hoc Network Scenarios

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Introduction

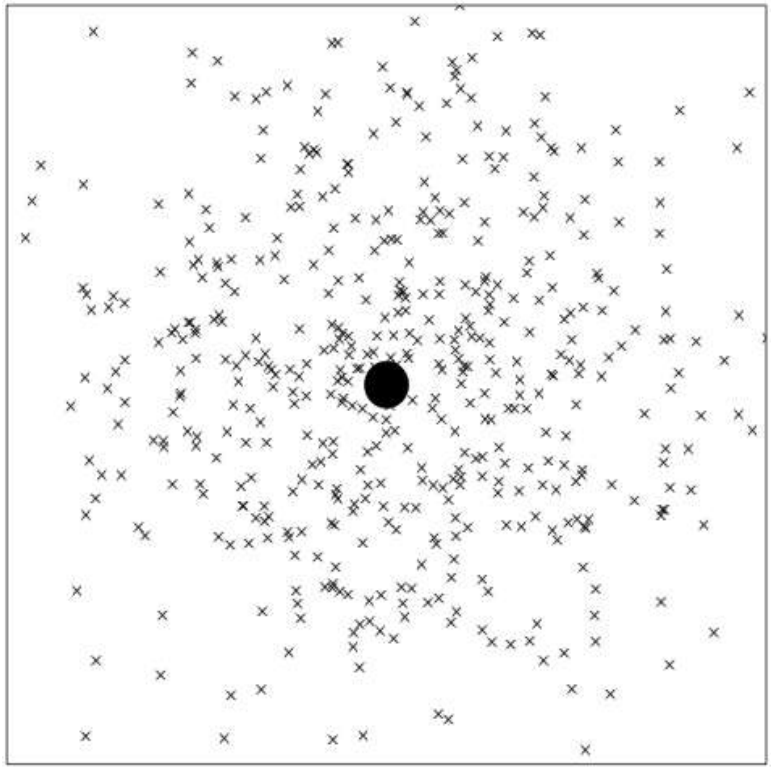
- Ad-hoc network scenario factors
  - Topology changes
  - Network load
  - Sessions
- Goal
  - Show strengths and weaknesses of protocols in various scenarios via simulation
  - Introduce Parametric Probabilistic Routing scheme

Outline

- Scenarios
- Protocols
  - Overview
  - Parametric Probabilistic Routing
- Experimental Design
- Results
- Discussion of Results

Scenarios

- Any-to-one
  - Sensor networks
- Any-to-any
  - Ad-hoc networks
- Any-to-many
  - Multiple equivalent base stations



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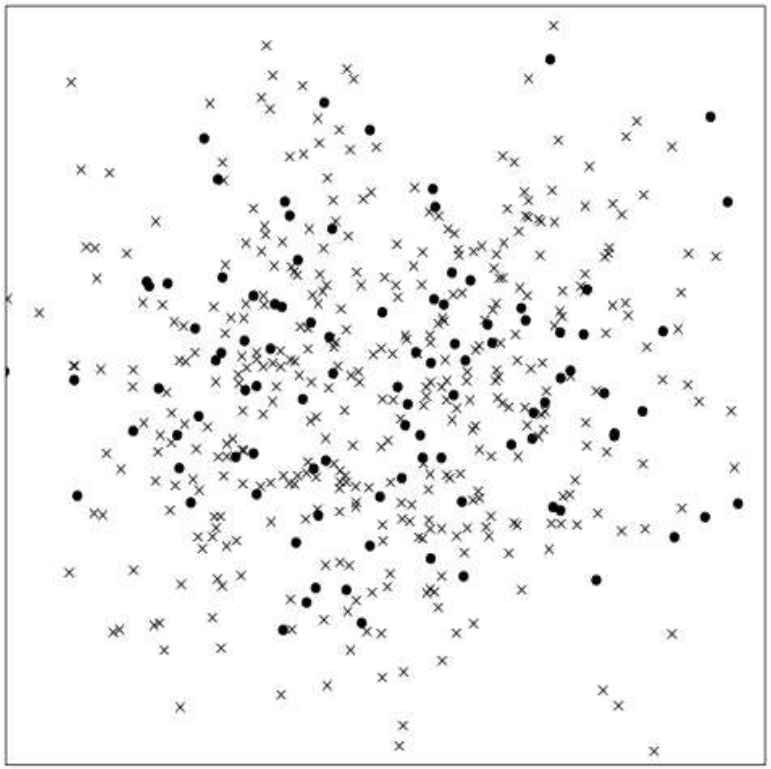

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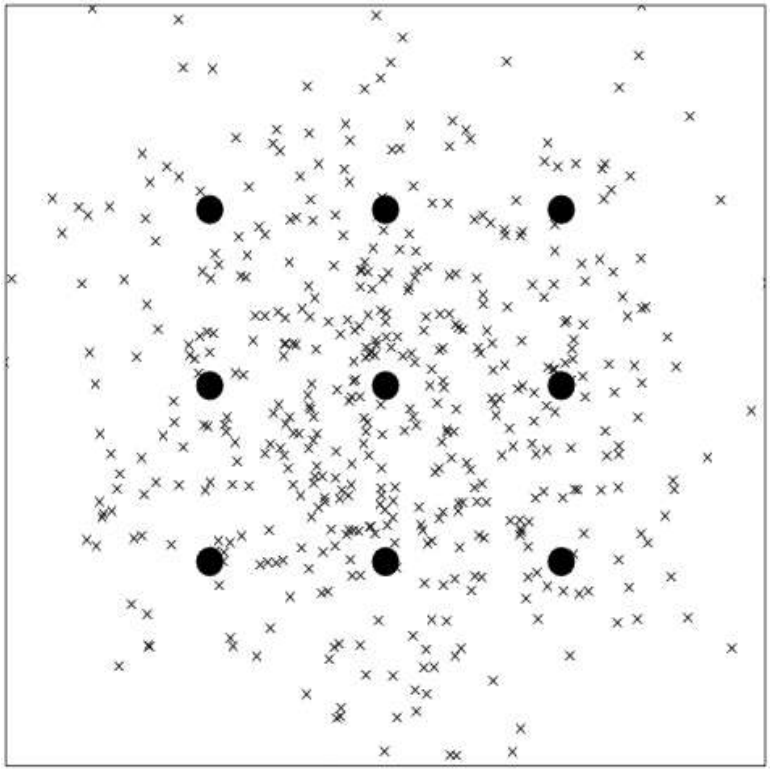

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Protocols

- Optimizing both datalink and network layer simultaneously
- Routing protocols:
  - Gossiping, Flooding, Parametric Probabilistic Routing, Shortest Path, AODV
- Datalink protocols:
  - CSMA, 802.11

Routing Protocols

- Multiple packet copies
  - Gossiping, Flooding, Param. Prob. Routing
- Single packet copy
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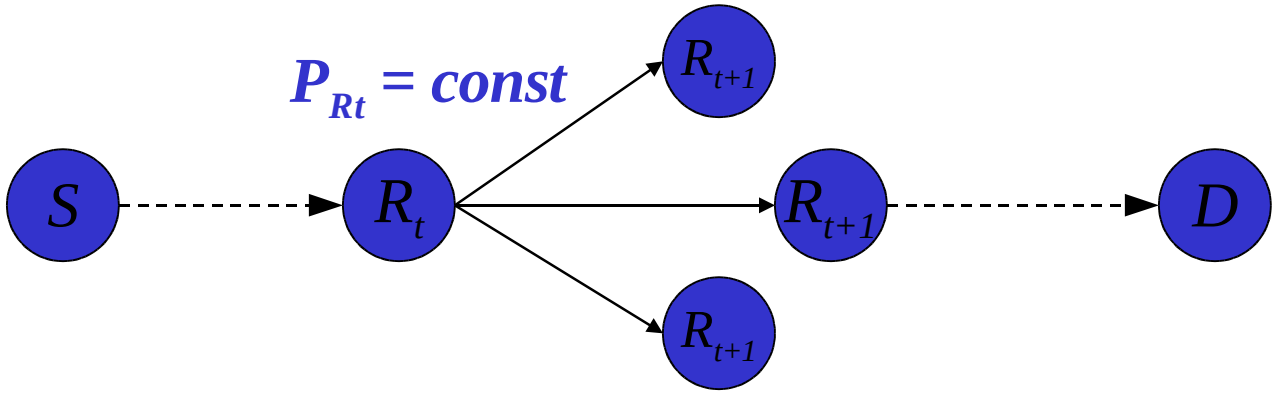

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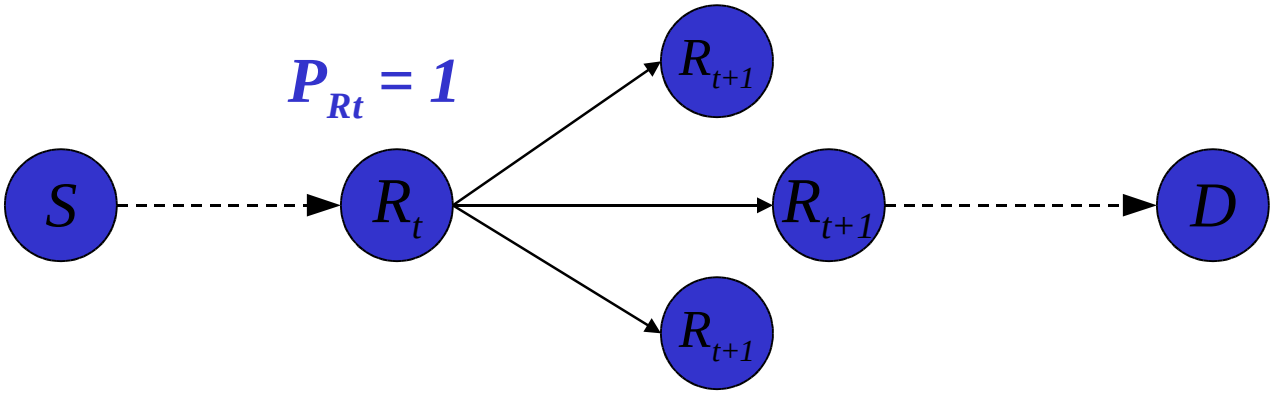

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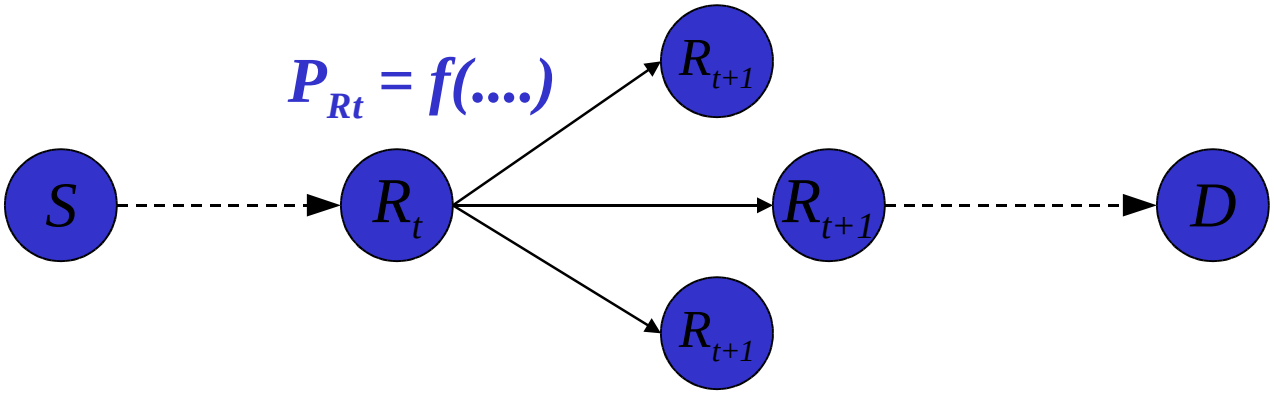

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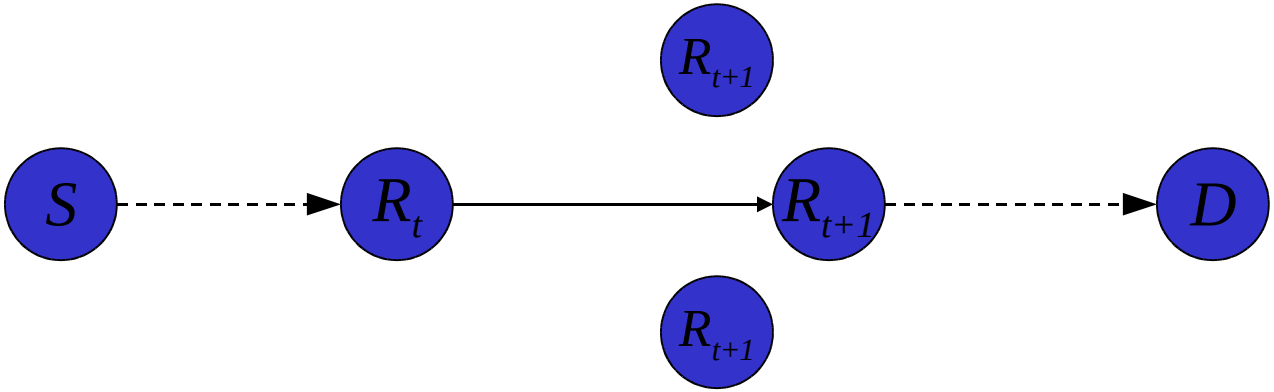

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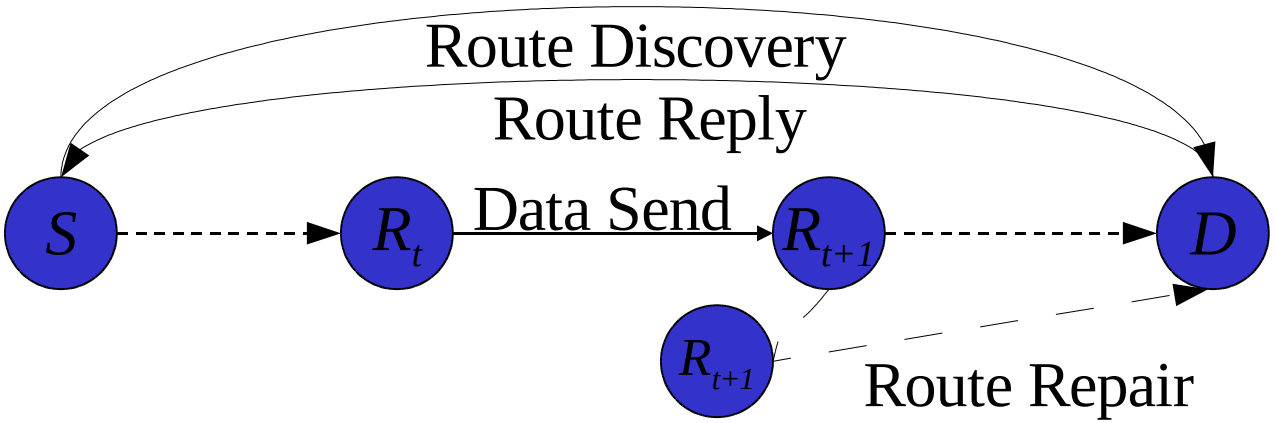

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Routing Protocols: Control Information

- Gossiping, Flooding
  - Do not need any
- AODV
  - On-demand, included in the specification
- Param. Prob. Routing, Shortest Path
  - Periodic beaconing from base stations
  - Beacon frequency: cost/quality trade-off

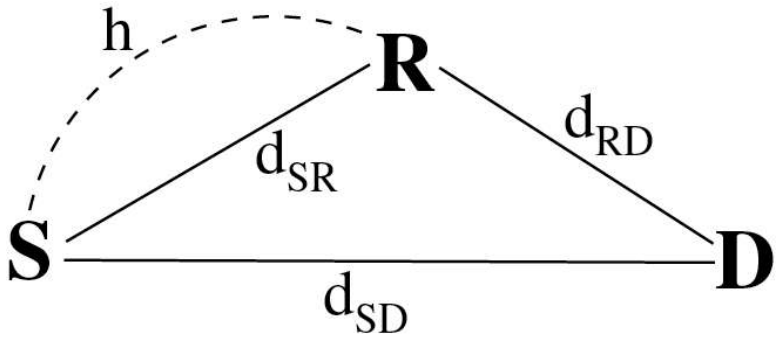
Datalink Protocols

- CSMA
  - Unreliable / Fast / Cheap
  - Senses the medium, and sends data if free
- 802.11
  - Reliable / Slow / Costly
  - RTS/CTS/ACK negotiation mechanism

Parametric Probabilistic Routing

- Retransmission probability:

$$P = \exp[\, -k_1(d_{RD} - d_{SD} + k_2 \cdot h) - k_3 \cdot c\,]$$



- Other types of information could be used
  - e.g. remaining energy of the node

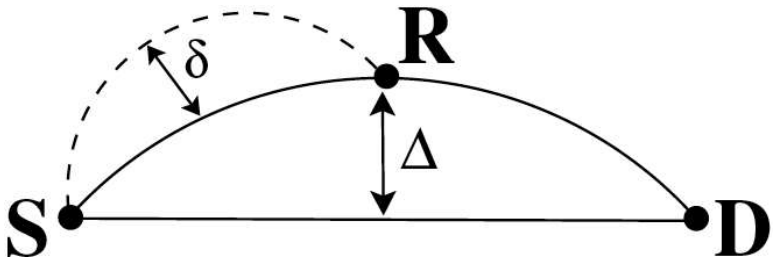
Parametric Probabilistic Routing: Directed Transmission

- An instance of PPR

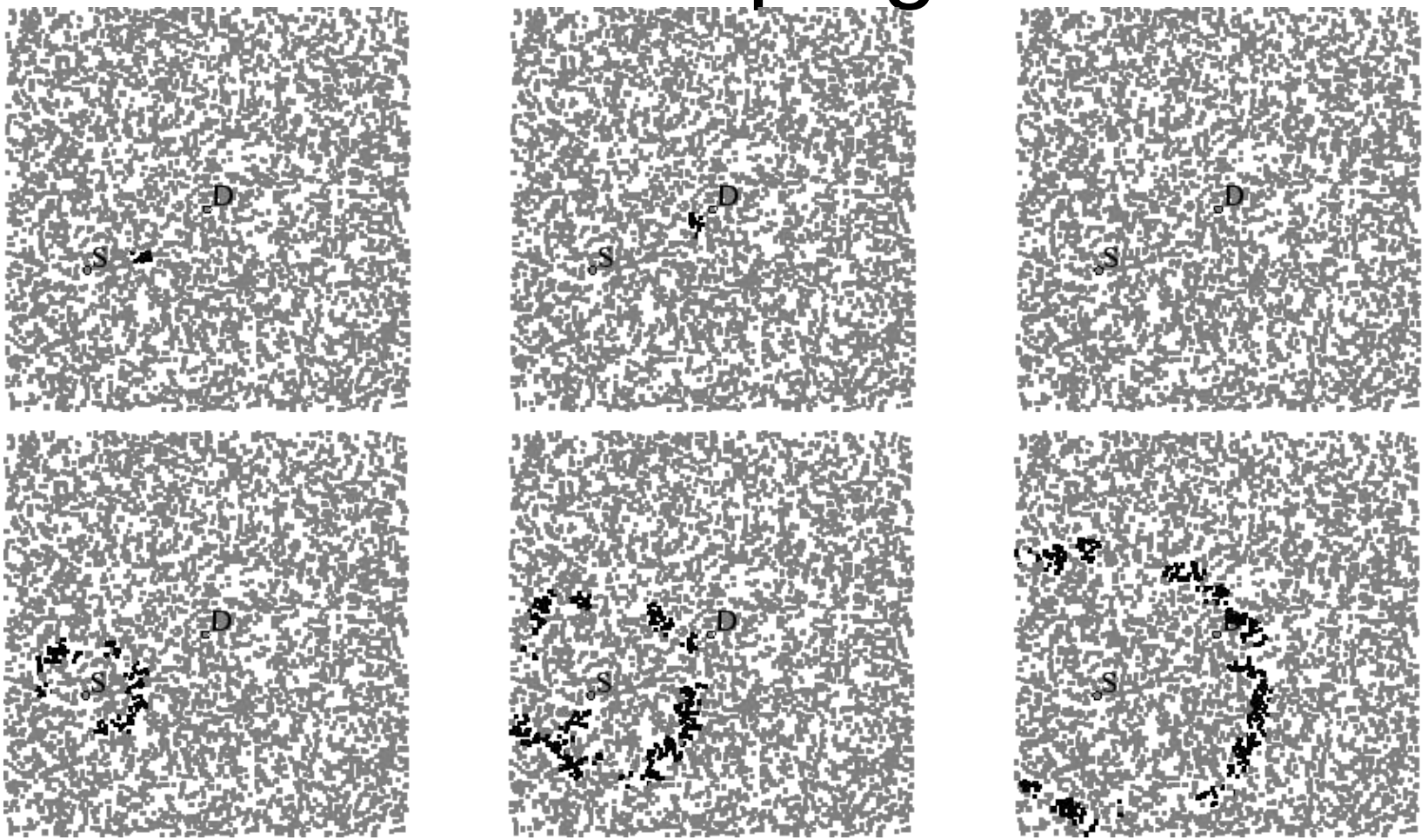
$$\Delta = d_{SR} + d_{RD} - d_{SD}$$

$$\delta = h - d_{SR}$$

$$P = \exp[\, -k_1(\Delta + \delta)\,]$$



Directed Transmission vs. Gossiping



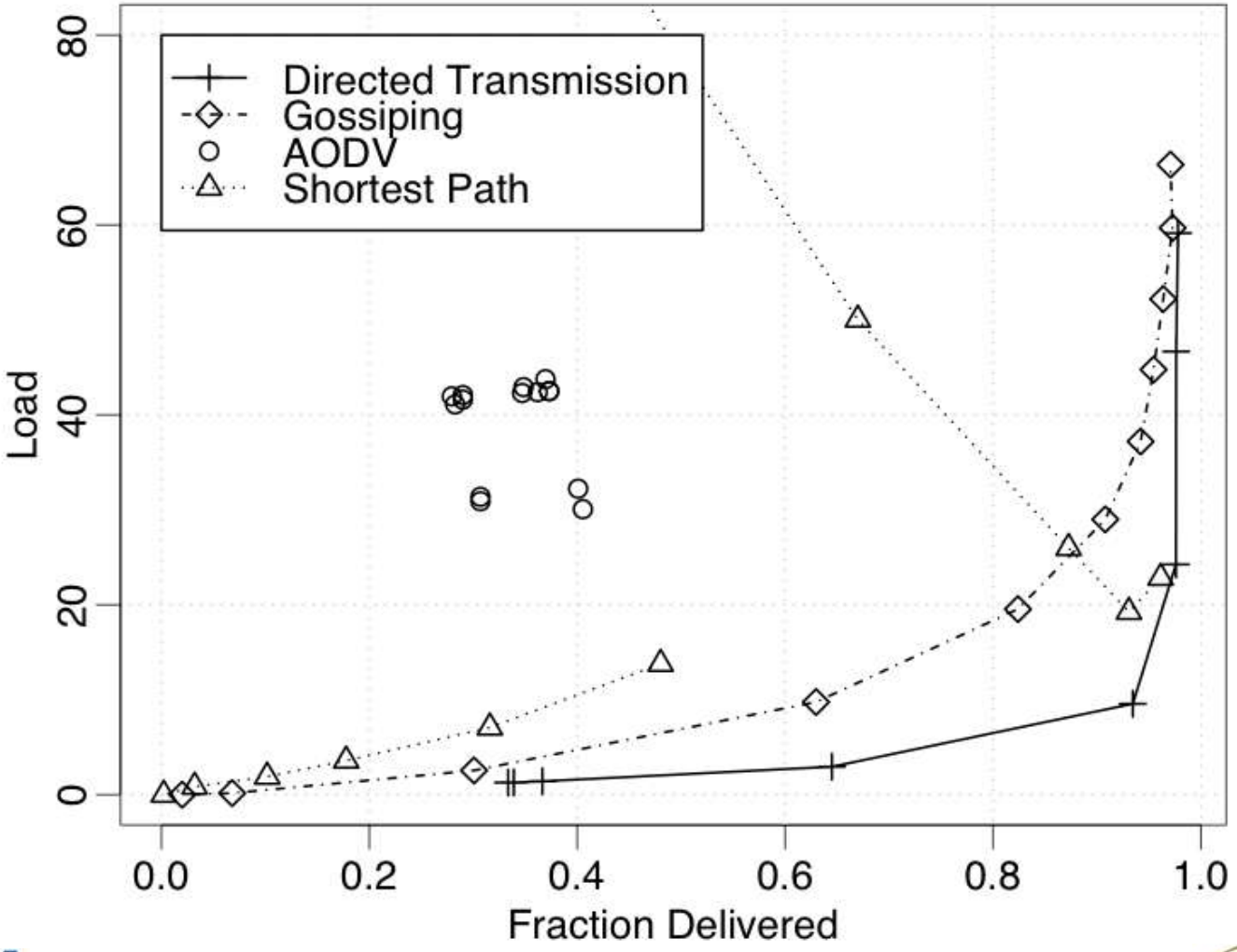
$t = 10$ $t = 20$ $t = 30$

Experimental Design

- QualNet network simulator
  - including detail signal propagation model
- 1000 nodes, average connectivity 10
- Random-waypoint mobility model
- Measures of performance:
  - Load
  - Fraction Delivered, reliability
  - Goodness = (reliability) – (relative load)

Results

Any-to-one scenario, medium mobility



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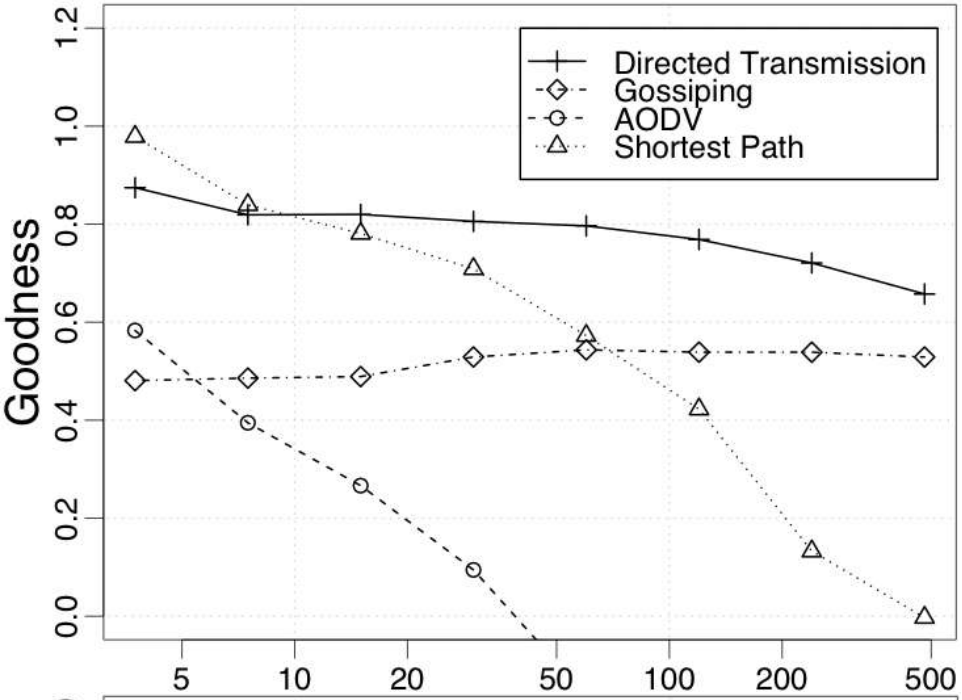

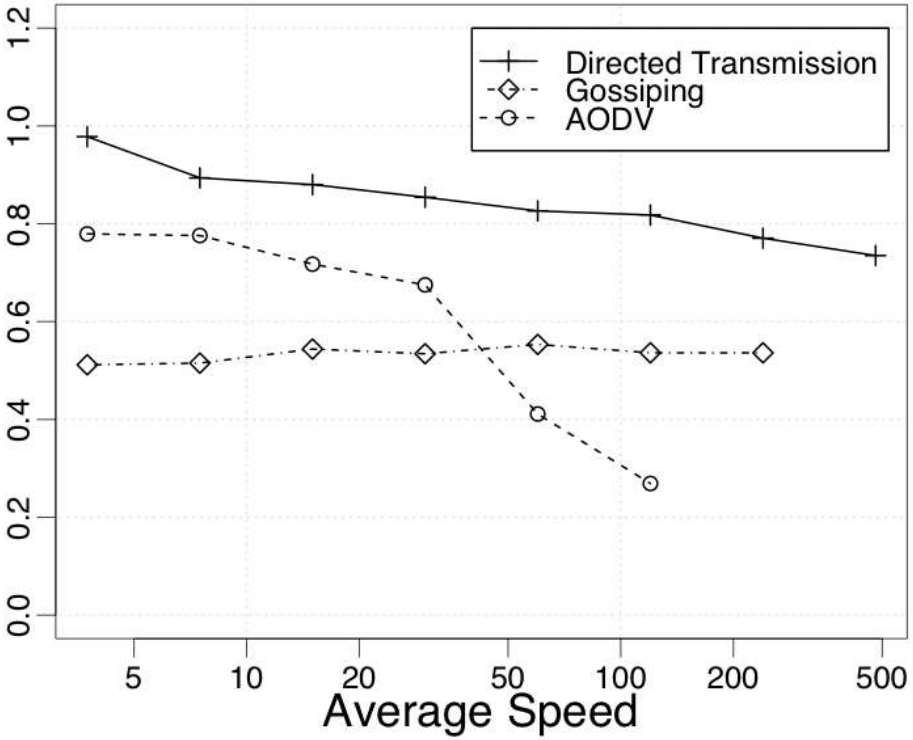

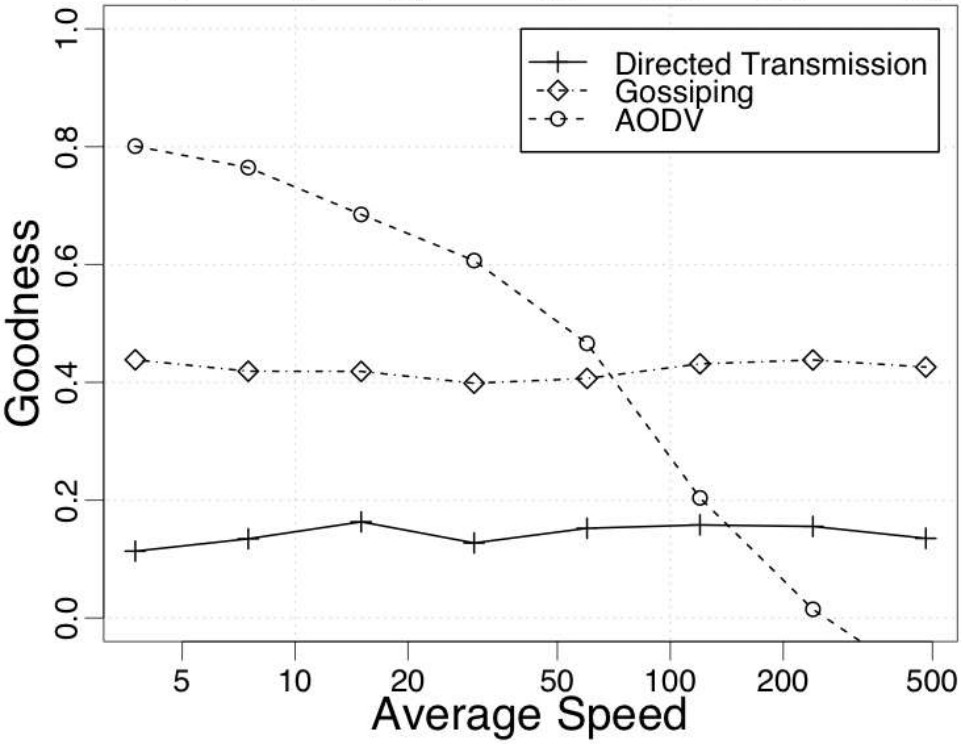

Any-to-one	Any-to-many
Any-to-any	

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Discussion of Results

- High mobility => multiple packet copy
  - Few destinations => informed (PPR)
  - Many destinations => blind (Gossiping)

- Long sessions => single packet copy
  - Few destinations => proactive (Shortest Path)
  - Many destination => reactive (AODV)

Conclusions

- Thorough comparison between different routing approaches performed
  - Protocol of choice strongly depends on application scenario
  - Lack of real-world applications prohibits natural selection of winners
- Parametric Probabilistic Routing introduced
  - Promising scheme for few destinations scenarios