Multihop Wireless Networks: What's Wrong With Min Hopcount?

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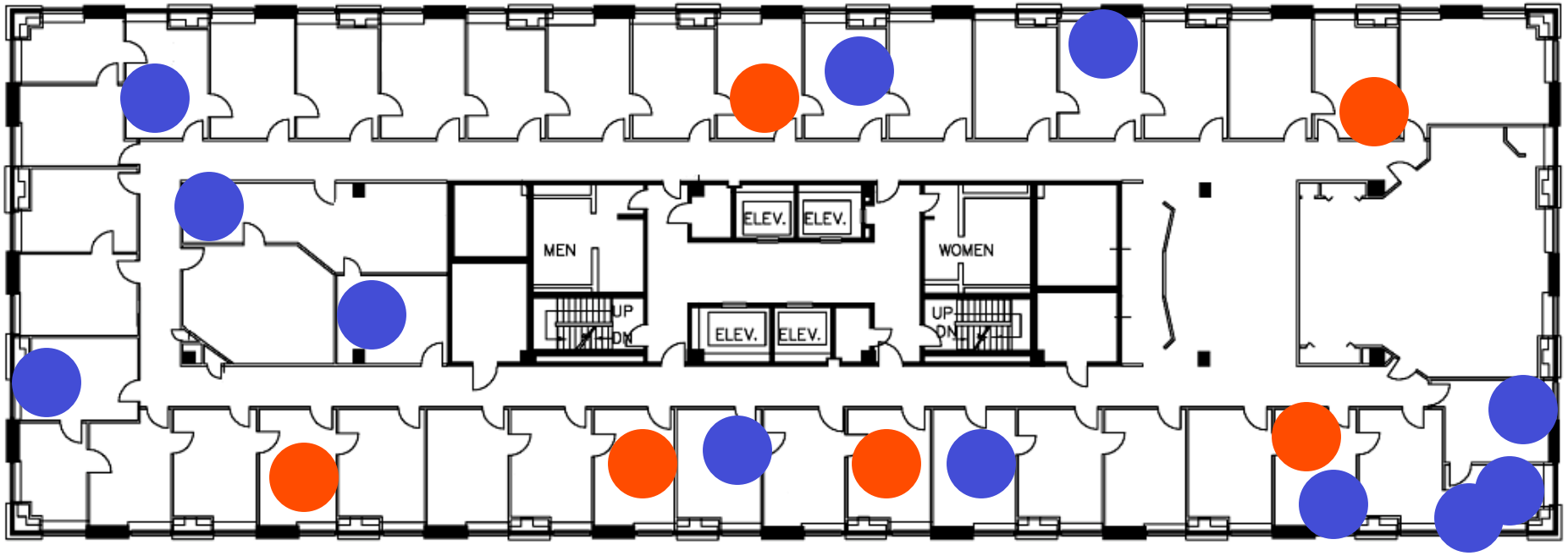
Wired Nets: Why Min Hopcount?

- Prefer route with fewest links (“hops”)
- Many more sophisticated alternatives
  - End-to-end latency, lowest congestion, etc.
- Min hopcount works in practice
  - Can engineer a decent network
  - Alternatives complex, less tested

Min Hopcount Assumption

- All important route state in hopcount
- Link quality is bimodal
  - Links are either “good”, or “bad”
- All “good” links are equivalent
  - Sufficient condition for success
- What about wireless?

Indoor Wireless Network

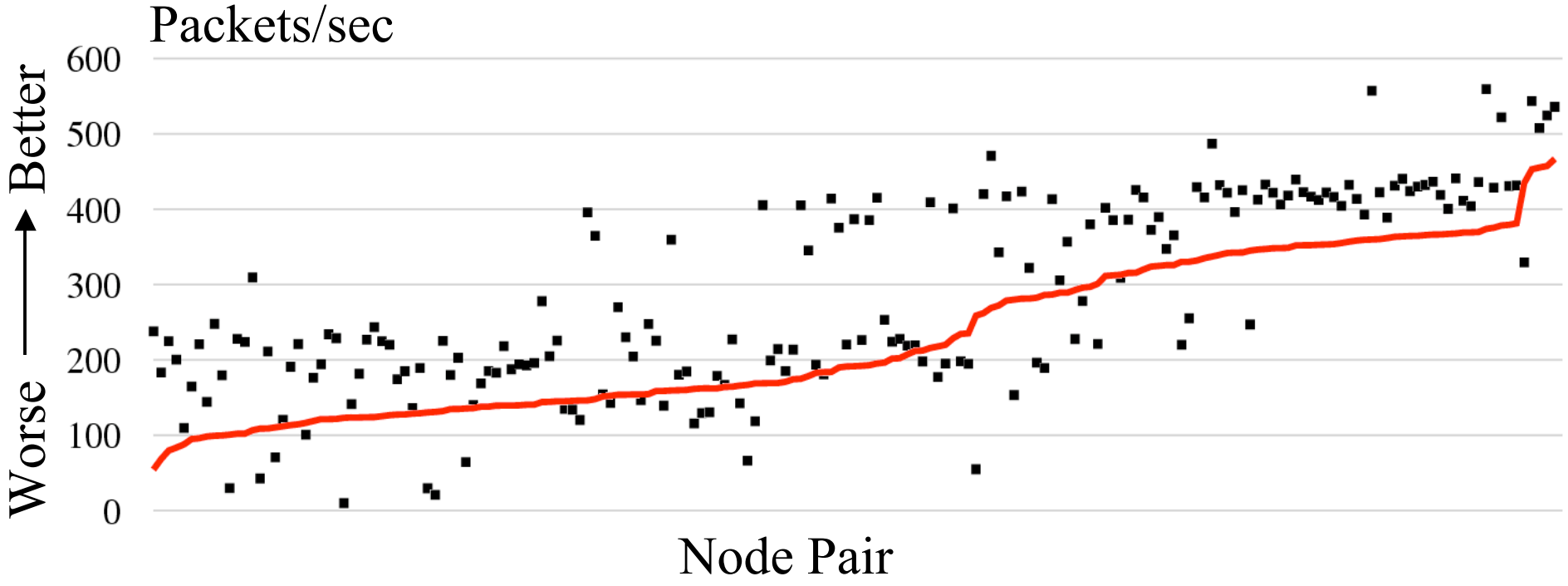


802.11b radios (fixed tx power), PCs, DSDV

5th floor

6th floor

Min Hopcount Underperforms

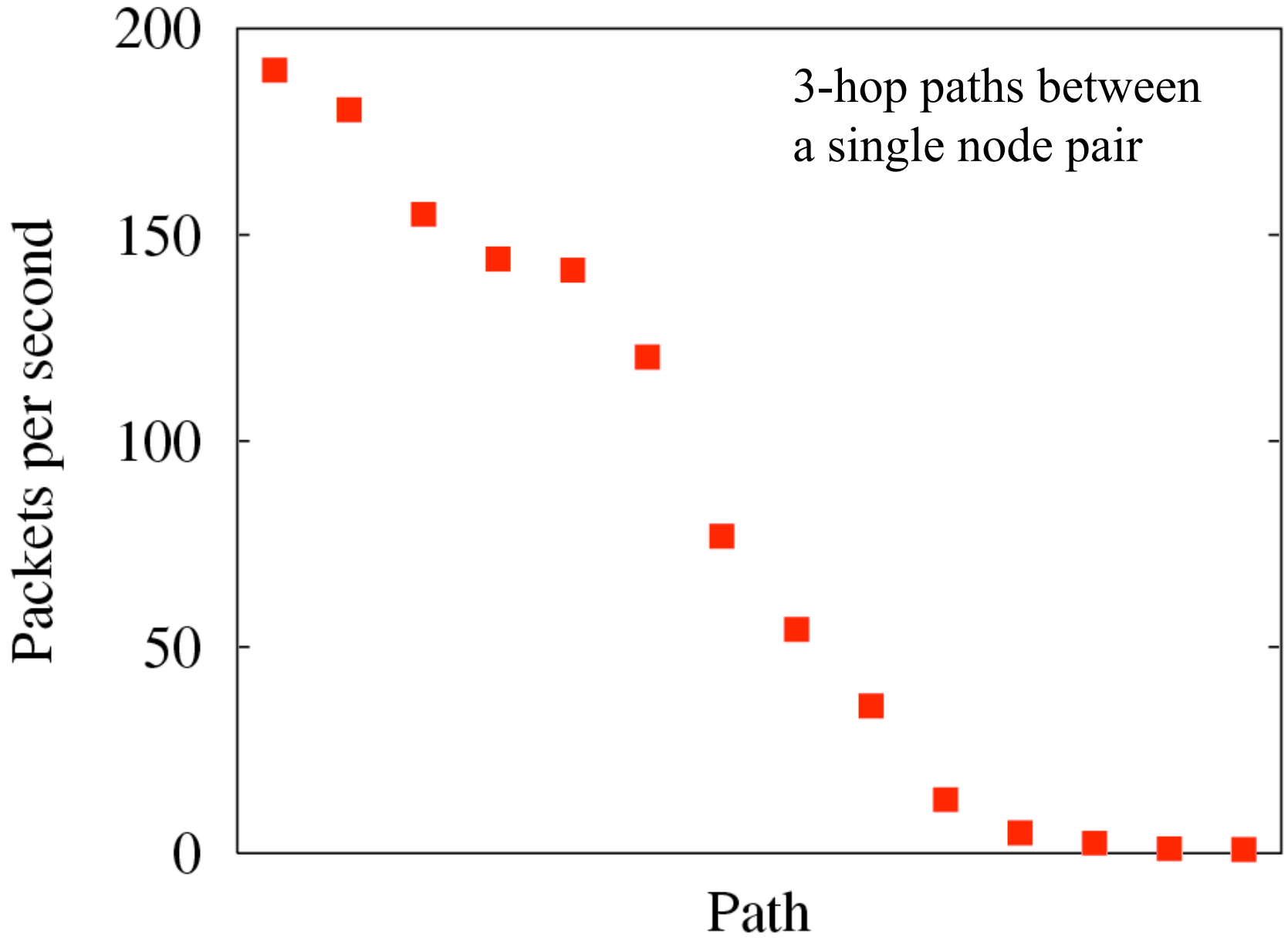


DSDV
"Best" static route

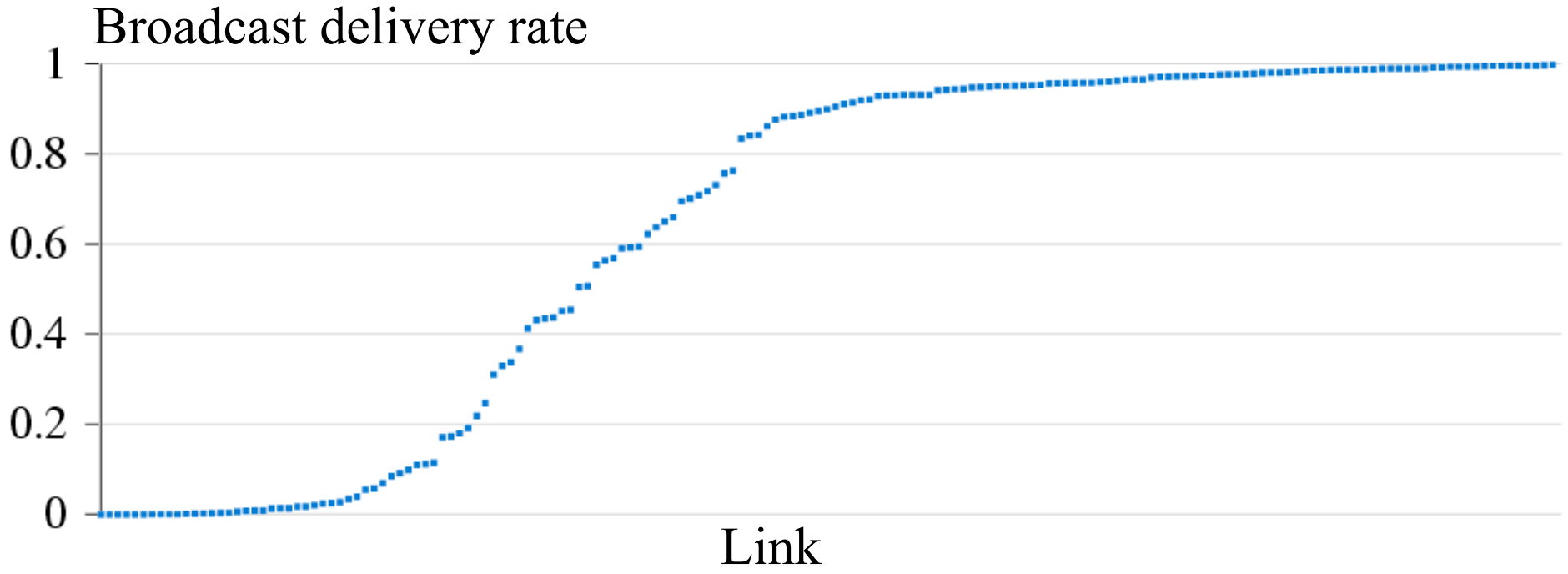
} 124-byte packets for 30 seconds

"Best" is maximum pkts/sec over multiple static source routes

Not All Min Hopcount Paths Are Equal

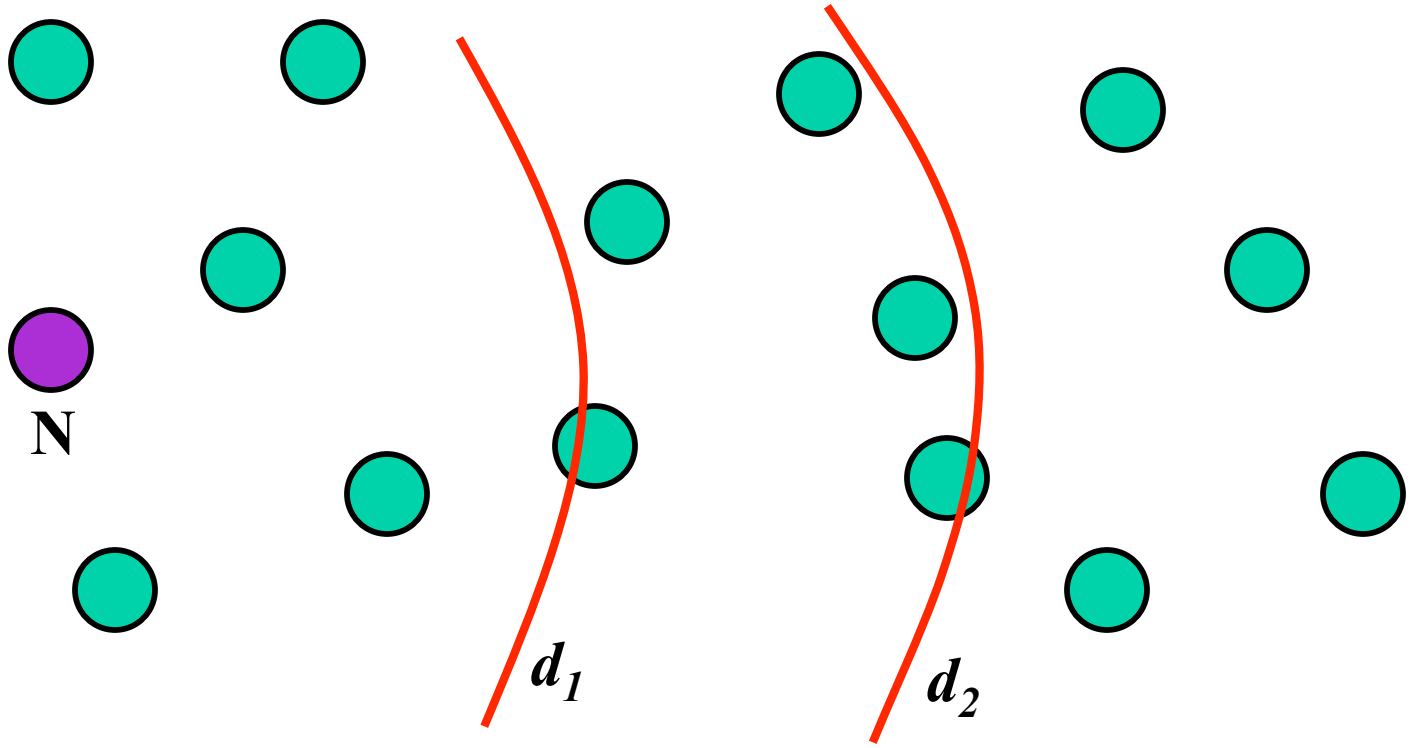


Not All Links Are Equal



- 171 non-zero links
- Links are not bimodal
- Min hopcount assumptions are **false**

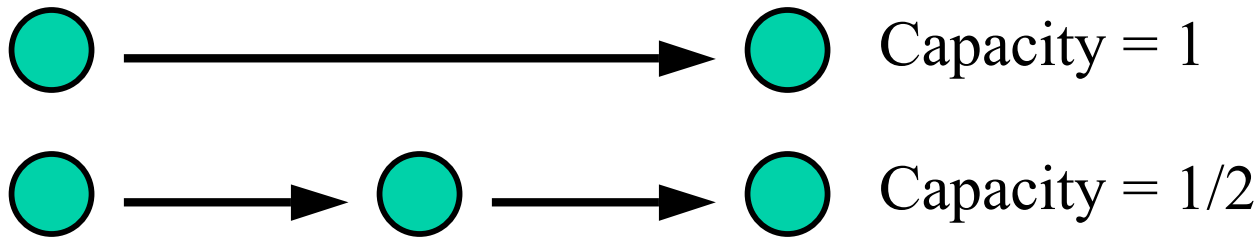
Intermediate Quality Wireless Links Always Exist



- There are nodes at every distance
- Link quality depends on signal strength (distance)
- Min hopcount maximizes link distance
  - Marginal links are more likely!

Should We Give Up Hopcount?

- Intuition from wired networks is wrong
  - Links share spectrum
  - Capacity penalty for more hops



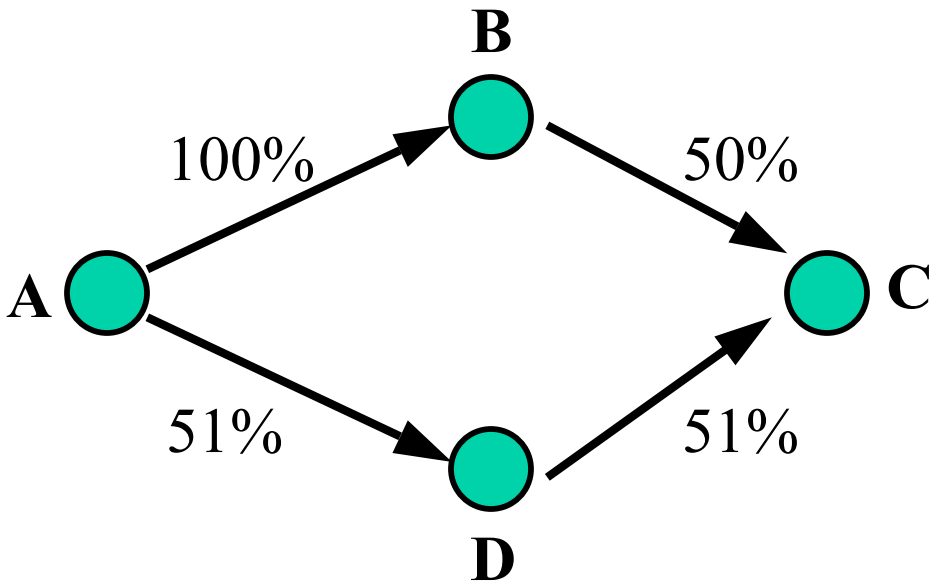
- What should we optimize?
  - Per-route throughput, **network capacity**, power?

Low Quality 802.11 Links

- 802.11 has link-level retransmissions
- Lossy links become narrow links
  - 0% effective loss rate
  - Good pings
  - But, low packet-per-second throughput
- Retransmissions waste capacity
  - Other nodes could have transmitted

A Reasonable (Wrong) Idea

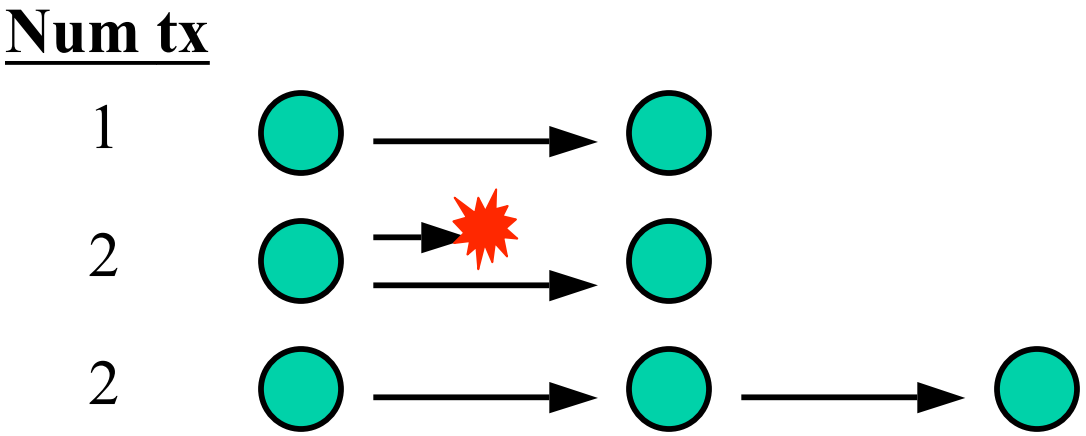
- Maximize bottleneck throughput: **A-D-C**



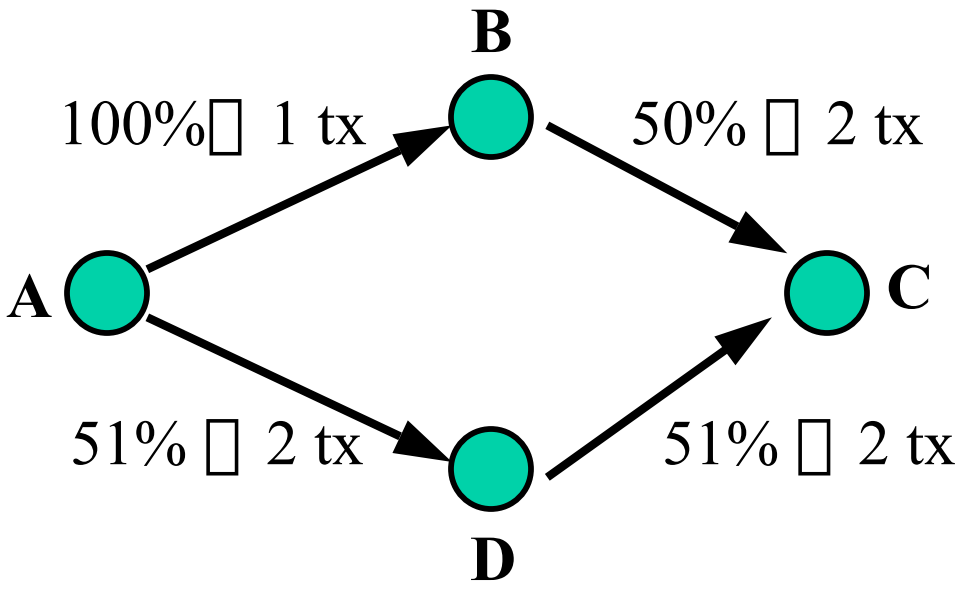
Actual throughput: { **A-B-C**: ABBABBABB = **1/3**
A-D-C: AADDAADD = 1/4

A Better Idea

- Insight: spectrum use is important!
- Idea: minimize transmissions per packet



Transmissions Per Packet



Transmissions per packet (**A-B-C**) = 3

Transmissions per packet (**A-D-C**) = 4

Research Agenda

- Explore performance of other protocols, e.g. DSR, AODV
- Explain route performance by underlying link performance
- Confirm usefulness of transmissions per packet as metric
- Handle link variation over time

Summary

- Minimum hopcount protocols are unlikely to achieve best performance
- Quality varies between links
- Transmissions per packet nicely quantifies link and path quality for routing