Routing over Bursty Wireless Links

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Distributed Systems

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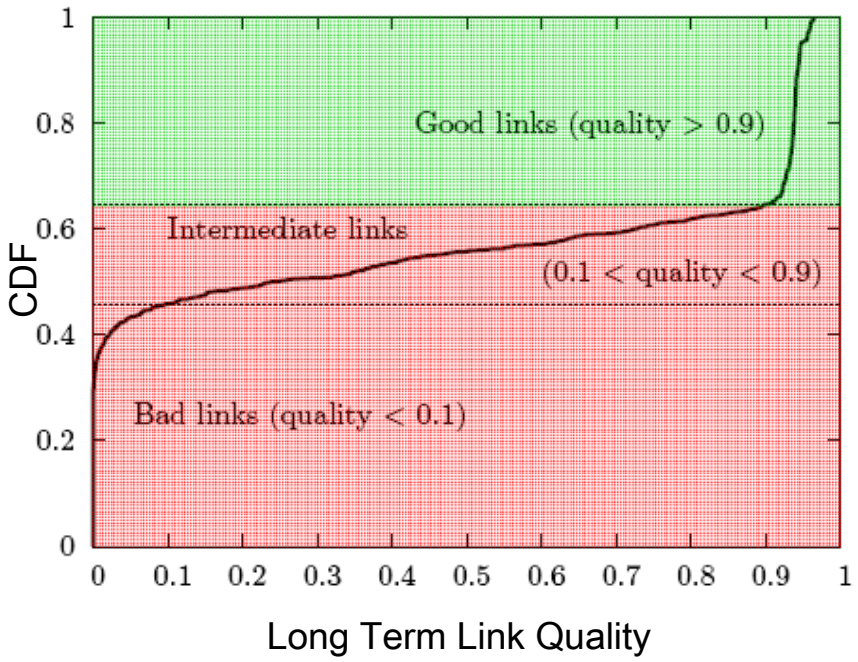
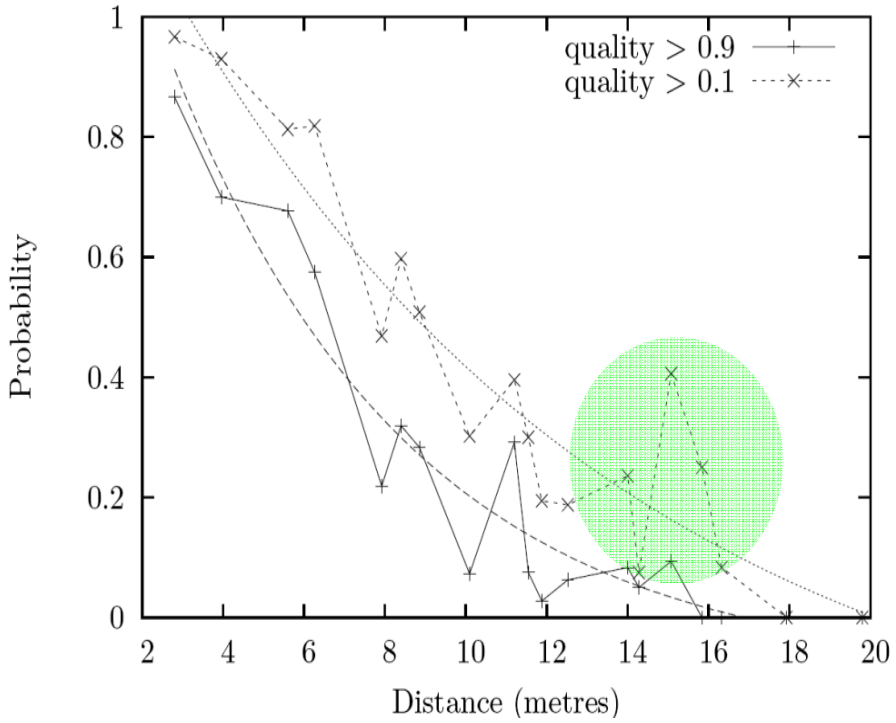
Motivation



- **Accurate link estimation – a prerequisite for efficient routing**
- **Existing approaches**
  - Link estimation based on Long Term Link Quality
  - Routing protocols **only** utilize good links for packet forwarding
- **Intermediate links are Bursty**
  - Stable in the short term

Intermediate links can be used for packet forwarding

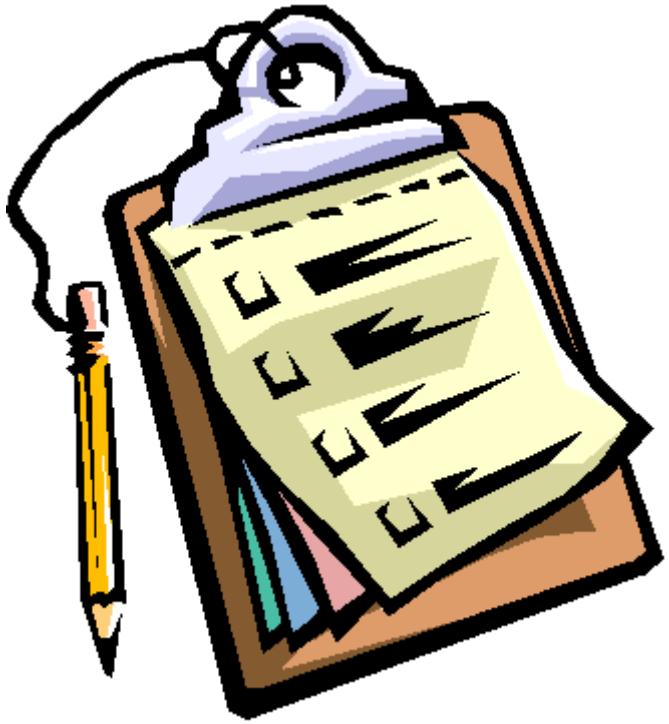
Motivation



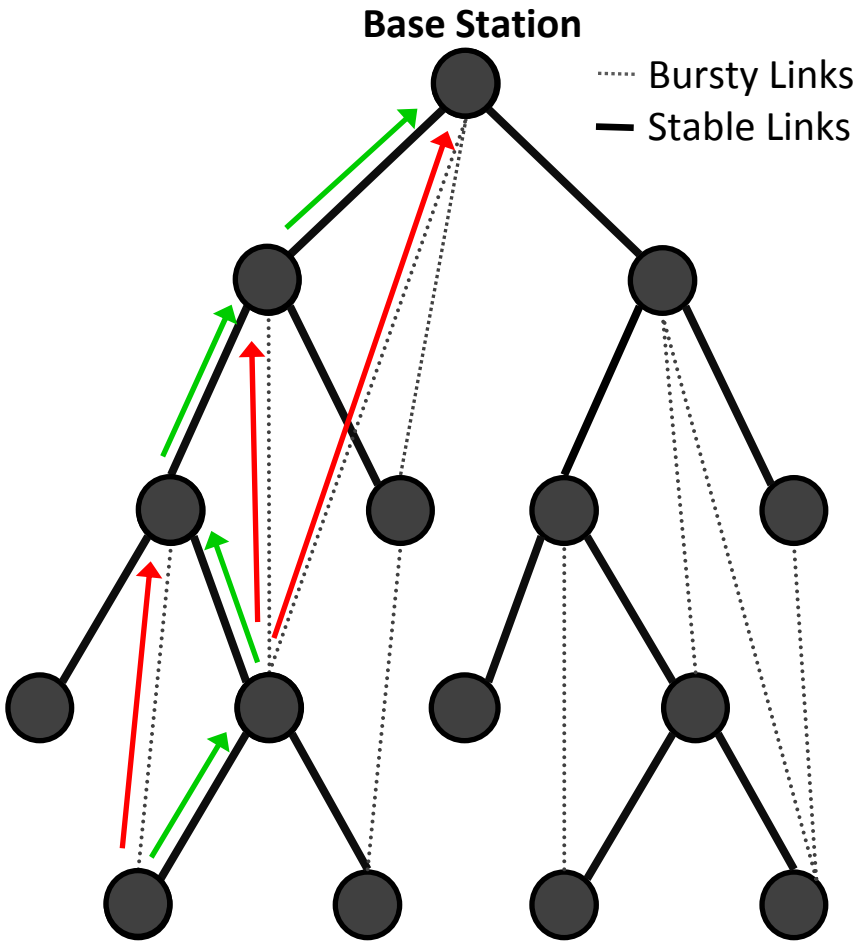
- **Why intermediate links**
  - Often long distance
  - Reduce routing hop count
  - Save transmission energy
  - Increase routing throughput
  - Anologous traffic patterns and link characteristics
- **Our Contribution**
  - Bursty traffic over bursty links
  - A mechanism to deal with unstable connectivity
- **Challenges**
  - How to identify reliable / stable periods of transmission?

Outline

- Motivation
- **Basic Concept**
- **Bursty Routing Extensions**
  - Short Term Link Estimation
  - Adaptive Routing Strategy
- **Evaluation**
- **Conclusion**



Basic Concept

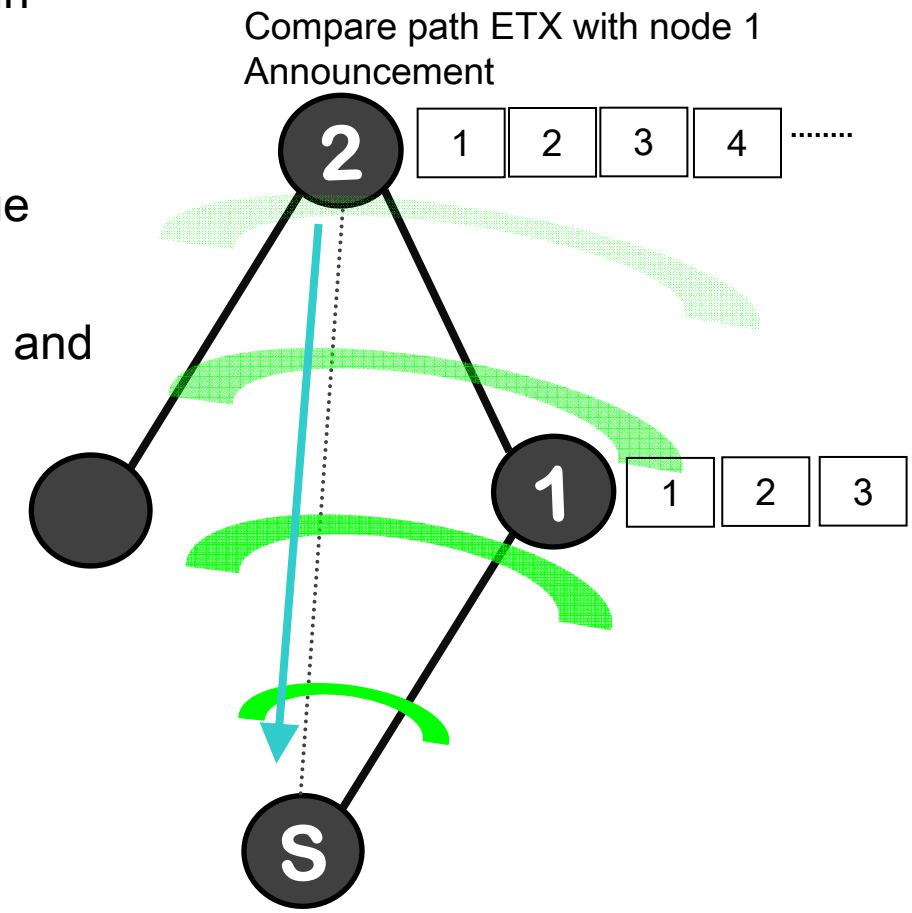


- **Routing Protocols in WSNs**
  - Collection trees based on ETX
  - S→1→2→3→D = min. 4 Tx
- **What if S→2 or 1→3 or 1→D becomes temporarily reliable?**
  - S→2→3→D or S→1→D
    - Save up to 2 transmissions per packet
  - Traditional routing schemes do not use such opportunities

We need Short Term Link Estimation for intermediate links

Bursty Routing Extensions - BRE

- **Short Term Link Estimation - STLE**
  - Identify reliable transmission periods in intermediate links
  - Based on data-packet overhearing
  - Quality proportionate to data exchange rates
  - Receiver determines successful burst and notify sender
- **Adaptive Routing Strategy**
  - Change parent temporarily
  - Do not inform descendent nodes
    - Ensures stability
  - Regress to traditional routing
    - Bursty link becomes unreliable
    - Ensures reliability

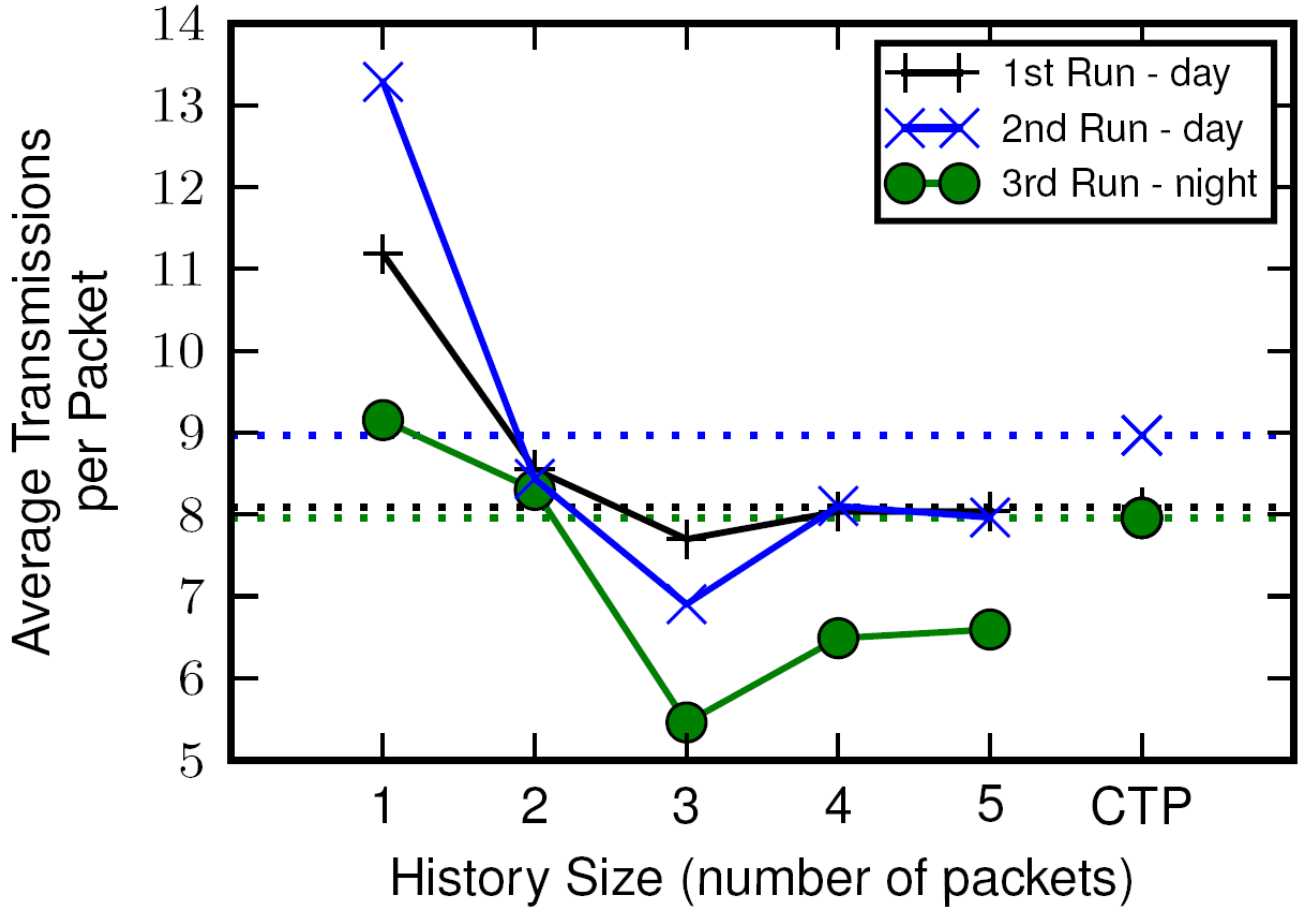


Evaluation

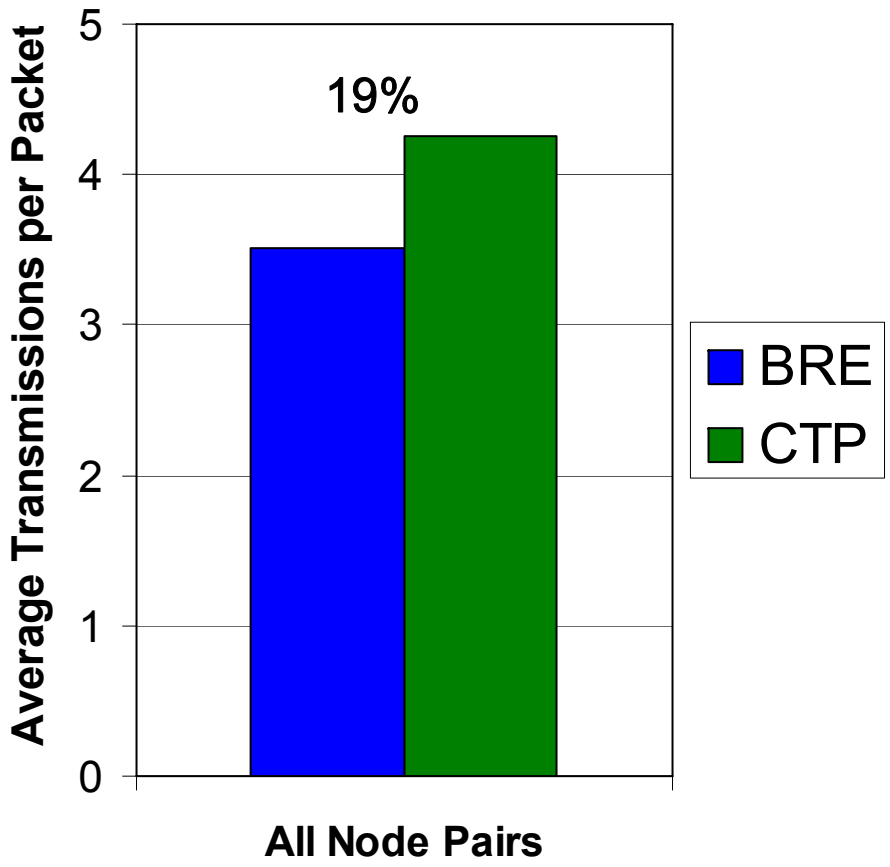
- **Implementation and Integration of BRE with CTP**
- **Outline**
  - STLE thresholds
  - Transmission cost
  - Burst lengths
- **Testbeds: MoteLab, TWIST, Customary**
  - Node Density: 10 to 30
  - Network size: 21 to 138
- **Some Initial Results**
  - Lower path ETX than original *parent* : > 50% neighbors
  - Overhearing nodes: 90%

STLE Thresholds

- **When to declare a bursty link as active**
  - Corresponding transmission *history*

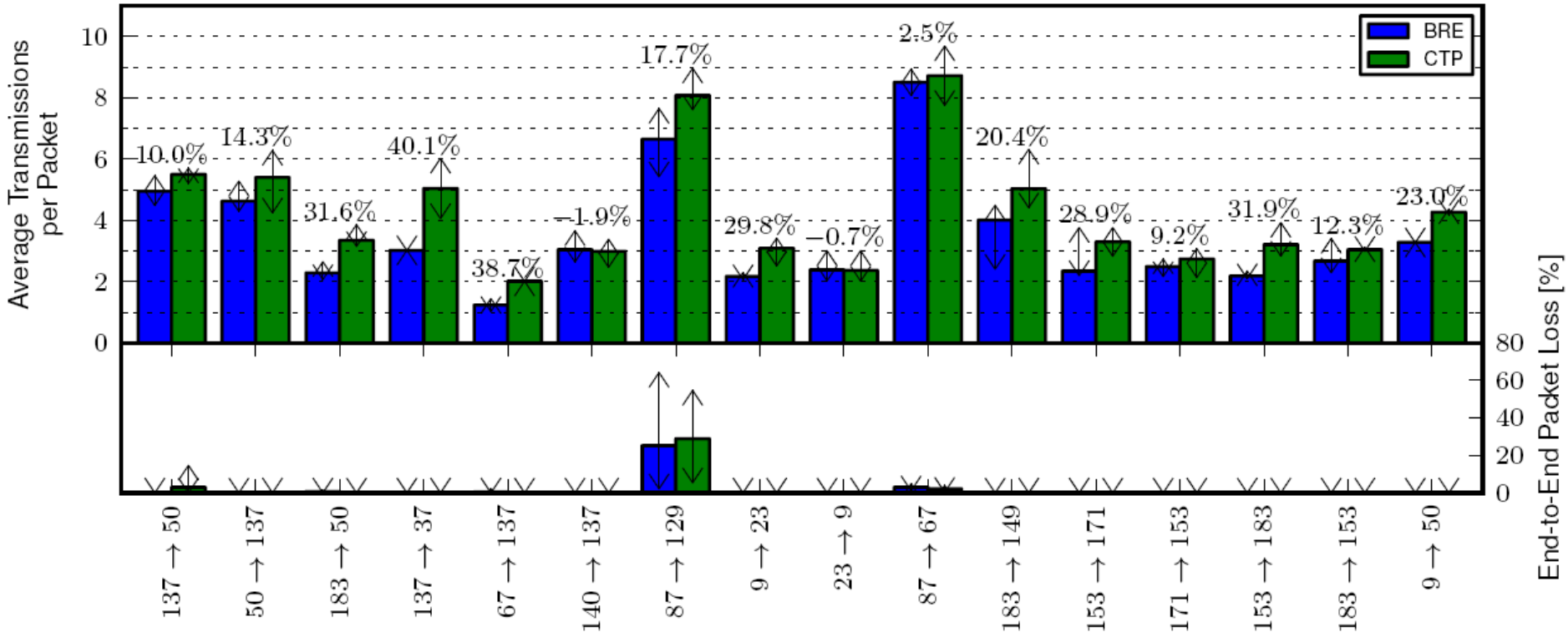


Transmission Cost and Reliability



- State: 30 neighbor entries
- Inter packet interval = 250 ms
- Transmission power = 0 dBm
- Each experiment repeated five times
- Throughput increase: ~10%

Transmission Cost and Reliability



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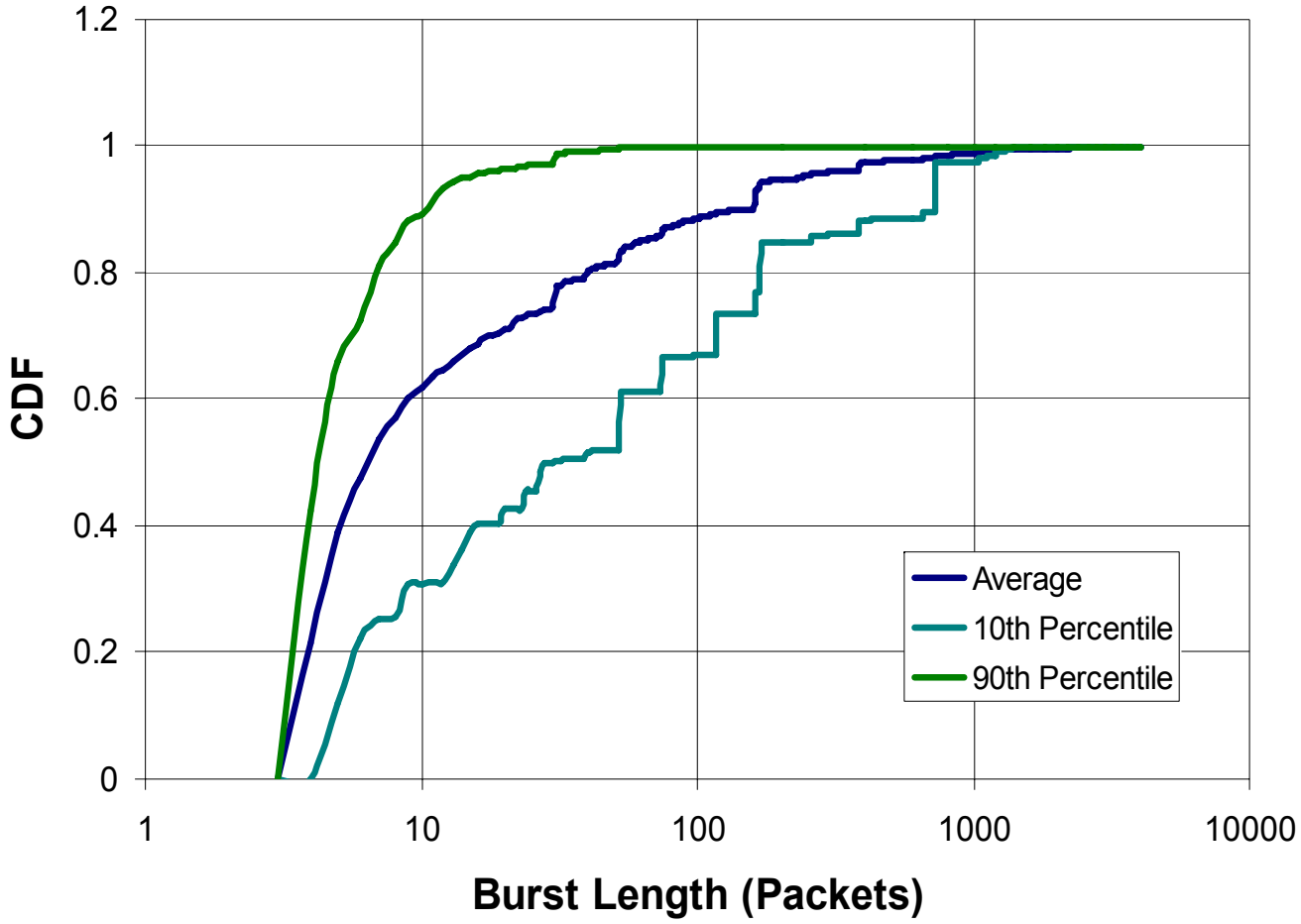
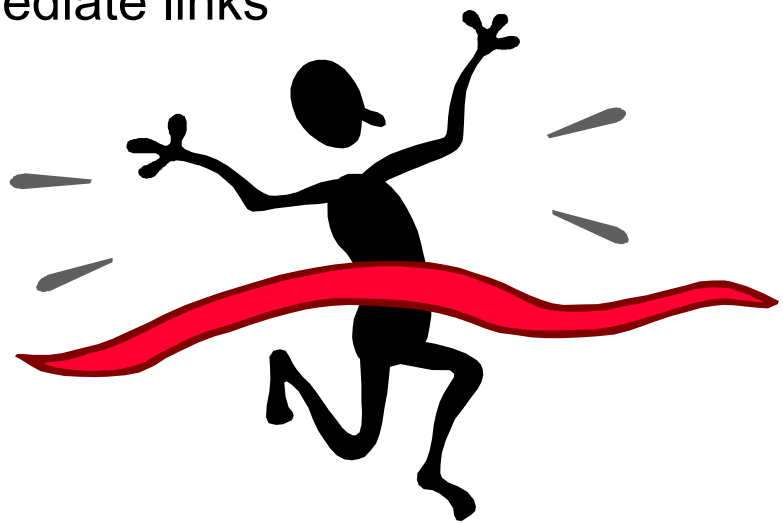
CDF – Burst Lengths



Conclusion

- **Contribution**
  - Intermediate links can be used for packet forwarding
  - BRE - a simple approach for utilizing Intermediate Links
  - Generalizes across most existing routing protocols
- **Results**
  - Significant Improvements – yet not tremendous
  - Considering high loss rates in intermediate links
- **Future Work**
  - Classifying overhearing nodes
  - Extension towards 802.11
  - Integration with low power listening



Questions … ?

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