Evaluating the communication performance of an ad hoc wireless network

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Po Yu Chen 2002.09.27

Goal

- Several media access and routing protocols adaptive and self-organizing wireless networks and the performance of such protocols were evaluated based on simulations.
- The author evaluates the practicality of realizing an ad hoc wireless network and investigate on performance

Goal

- These performance information can be used for some applications
  - QoS considerations
  - Route paths selection
    - Internet paths vs. local paths

Outline

- Introduction
- System component
- Communication performance
- Discussion
- Conclusion

Introduction

- Media access and Routing
  - Media access is concerned with channel access
  - Routing concerns how packets can be sent toward to their intended destination
- Simulation
  - Simulation can't account for all of factors affect connectivity and performance
  - On a large scale

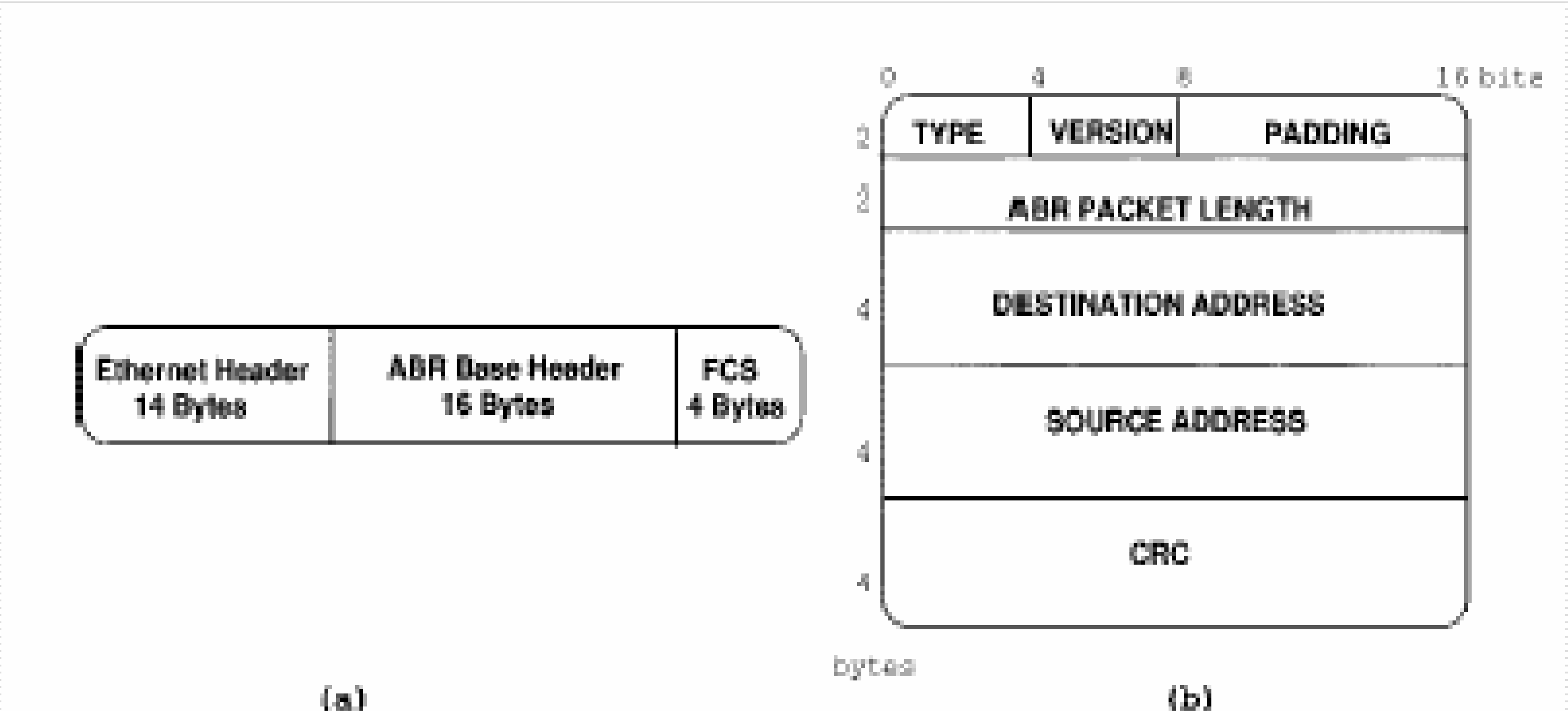
ABR (Associated-based routing)

- Source-initiated, On-demand routing
- Selects the **long-lived** path rather than shortest-path
- How to know the longevity of a route?
  - **Beacons**, **power life** and **signal strength**
- ABR copes with mobility by performing **local route repair**

ABR (Associated-based routing) (cont'd)

- ABR is implemented within IP
- ABR beacon
- Beaconing interval is an important issue
  - the amount of BW and power consumed
  - The accuracy of longevity information gathered
  - The time to detect a link failure and initiate route repair

ABR beacon & base header



System components

- 4 laptop computers located in an outdoor environment
- 2.4GHz PCMCIA cards
- Software tool
  - Ping utility (100 times)

Wireless adapter SPEC

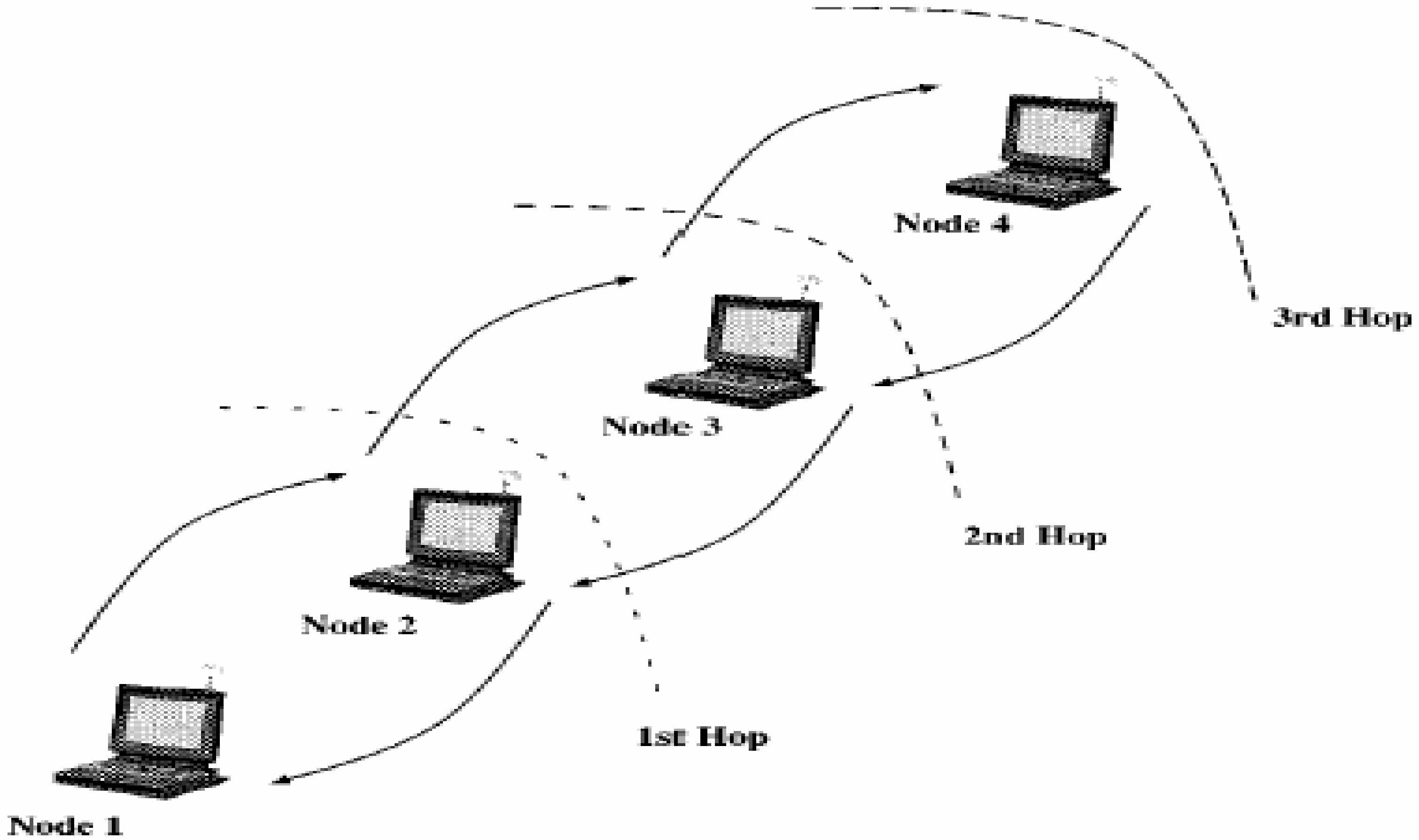
TABLE I
DATA SPECIFICATIONS OF WAVELAN PCMCIA WIRELESS ADAPTER

Data Communications	Performance
Data Rate	2 Mbps
Media Access	Ethernet CSMA/CA
Bit Error Rate	Better than 10^{-8}

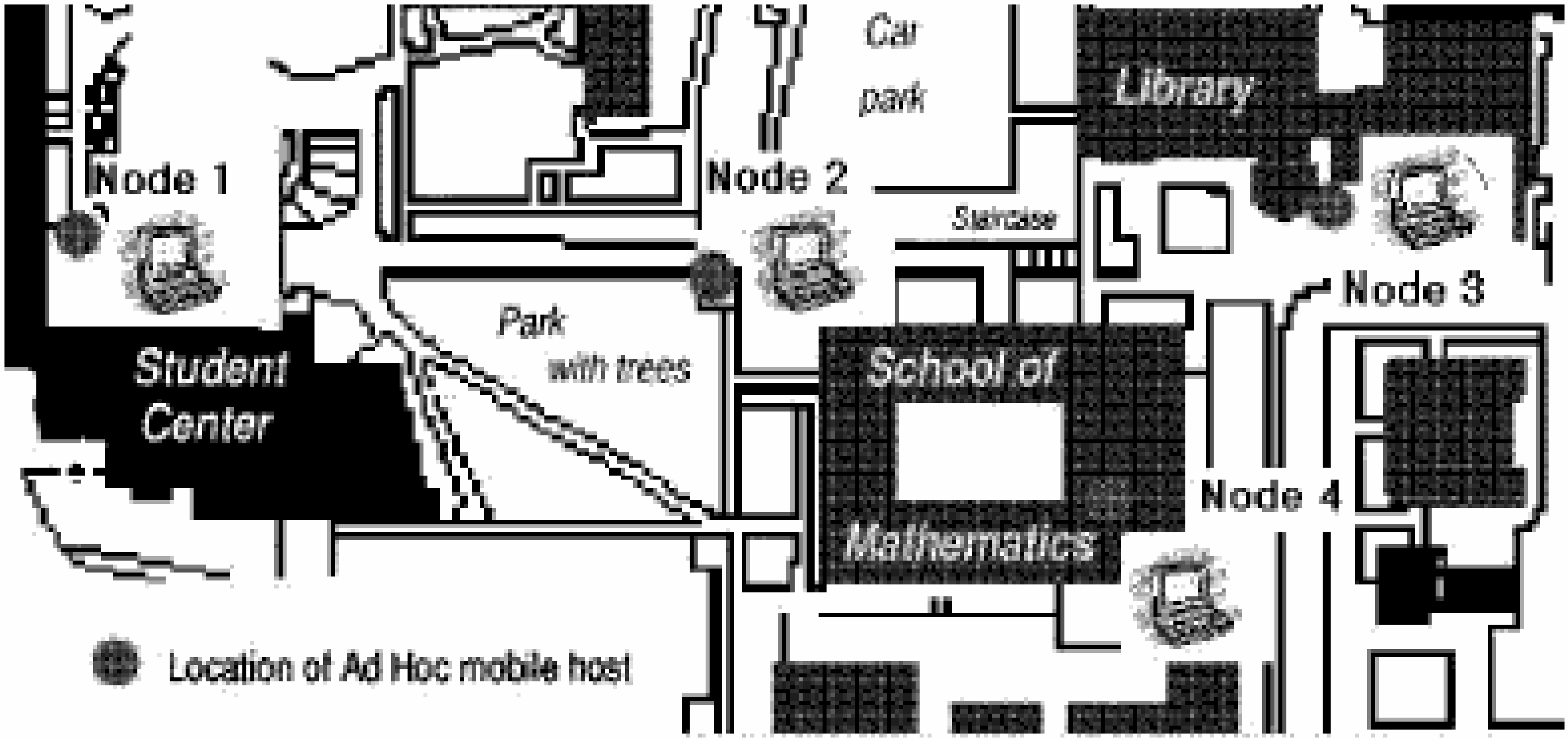
TABLE II
RF SPECIFICATION OF WAVELAN PCMCIA WIRELESS ADAPTER

Radio Specifications	915 MHz	2.4GHz
Receiver Sensitivity	-80dBm	-82 dBm
Modulation Technique	Spread Spectrum (DQPSK)	Spread Spectrum (DQPSK)
Output Power	-80 dBm	-82 dBm
Range (open office)	250m	200m
Range (semi-open office)	60m	50m
Range (Closed office)	30m	30m

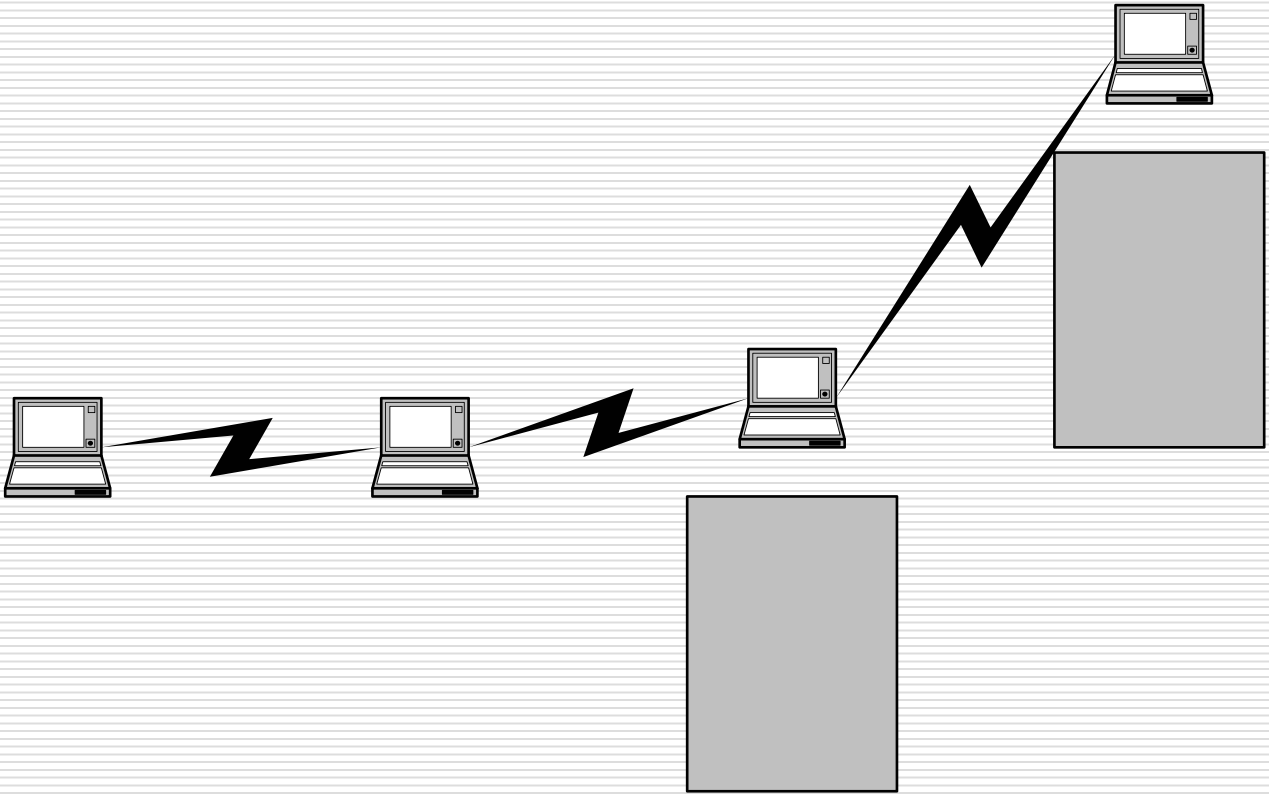
Network setup (1/2)



Network setup (1/2)



Network setup (2/2)



Communication performance

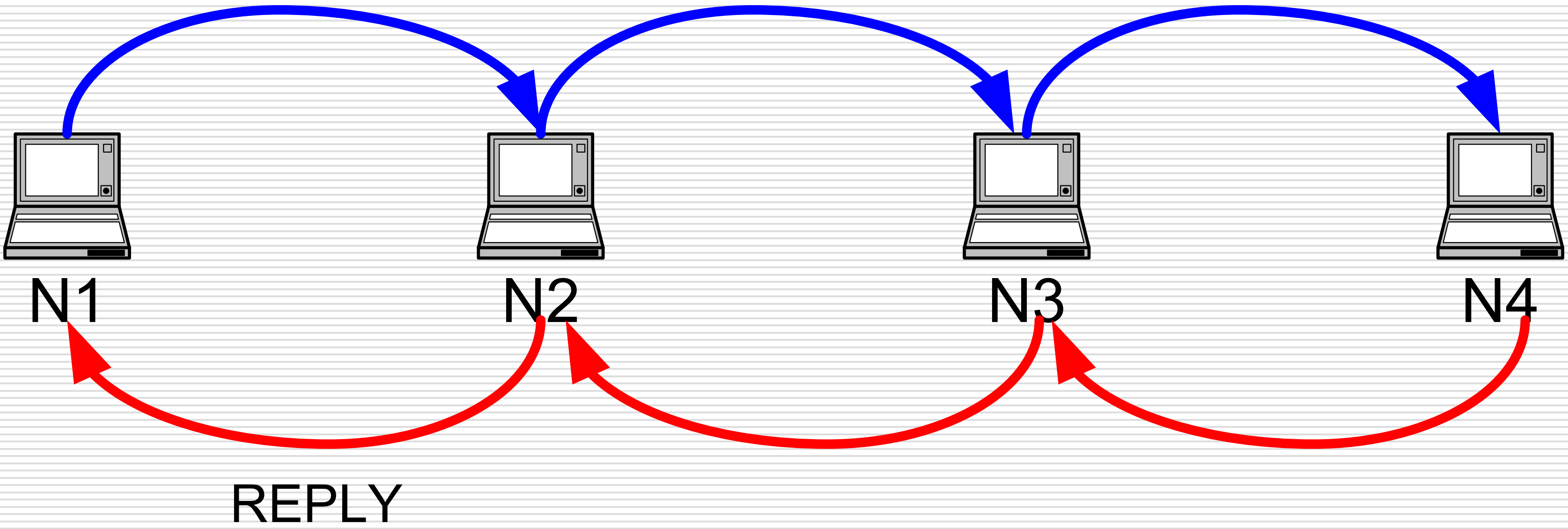
- There factors that can affect communication performance
  - Beaconing interval
  - Packet size
  - Number of route (route length)

Parameters

- RDT: Route Discovery Time
- EED: End-to-End Delay
- Communication throughput (bits/sec)
- Packet loss
- Route reconstruction time
- FTP file transfer time

Route Discovery

BQ: Broadcast Query

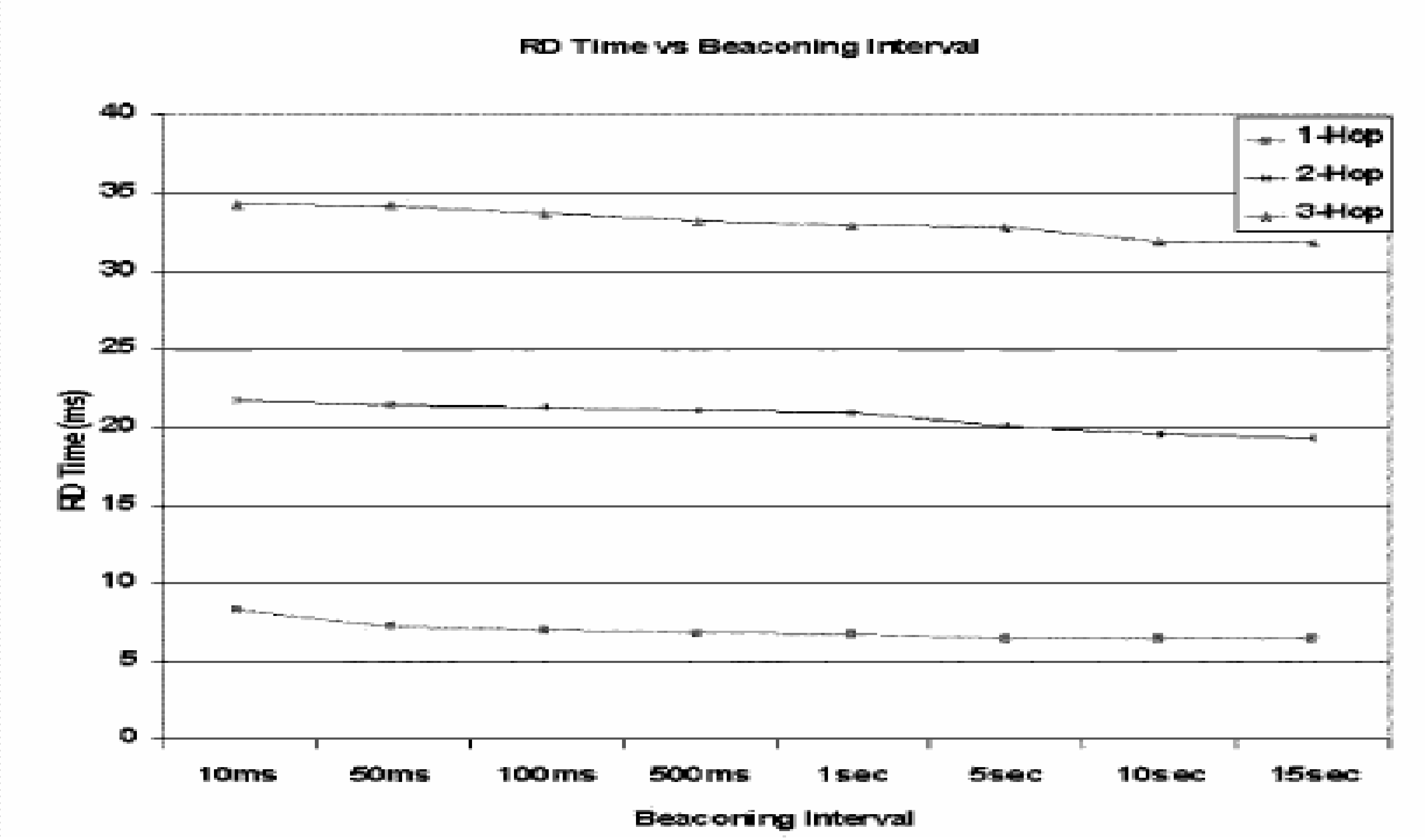


A route selection algorithm is executed at the destination

RDT—Beaconing interval (1/2)

- Two beacon frequency
  - Low: (15, 10, 5, 1 s)
  - High: (10, 50, 100, 500 ms)
- The relationship is almost linear
- High freq. has greater impact on RTT
  - The additional delay is due to channel contention

RDT—Beaconing interval (2/2)



RDT—Route length (1/2)

- With increasing route length, the total propagation delay is increased
- The relationship is non-linear
  - The BQ packet becomes larger as it forwarded
  - The REPLY packet is larger when the route is longer

RDT—Route length (2/2)

End-to-End Delay (EED)

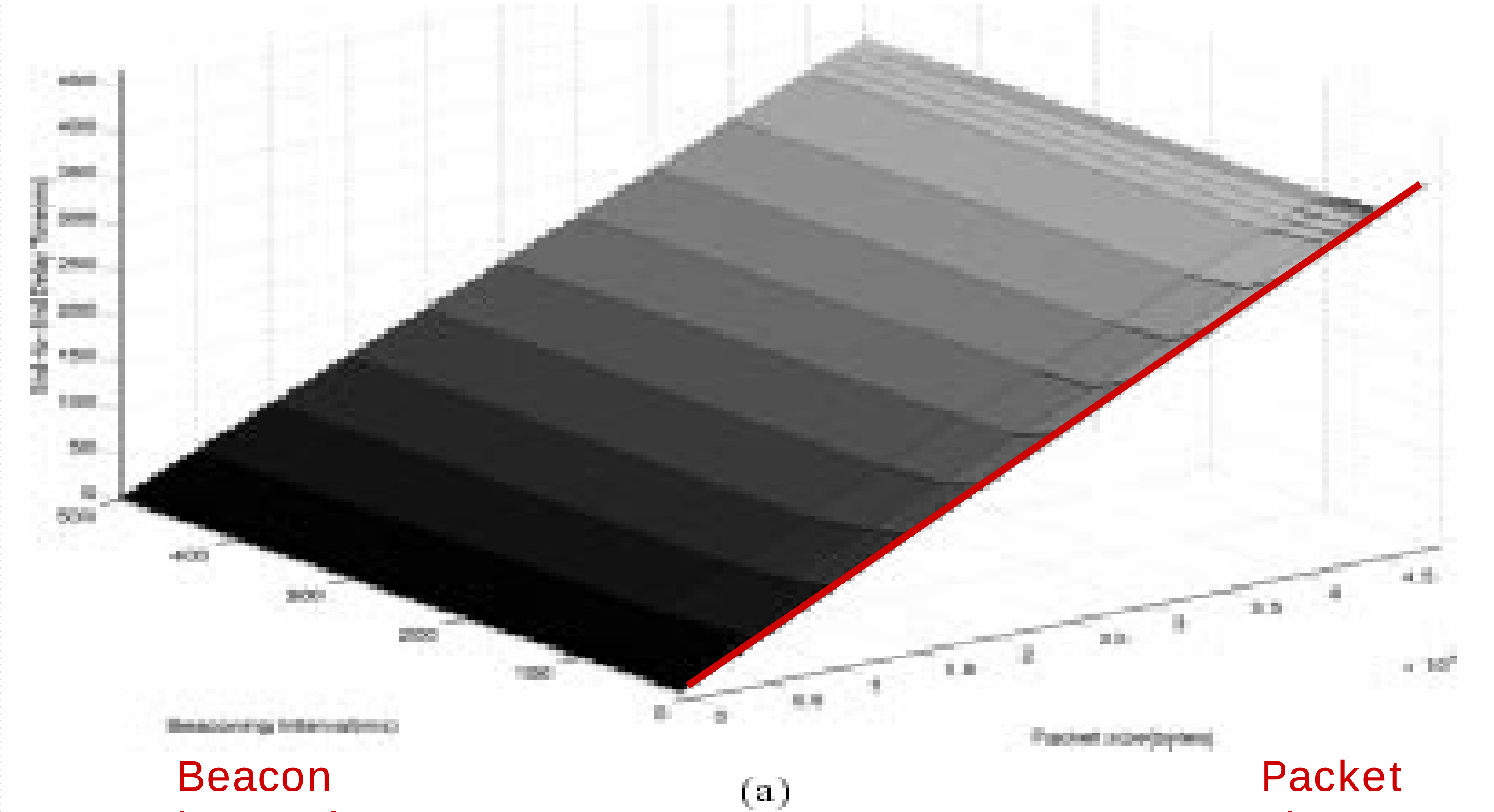
- EED includes:
  - Transmission delay
  - Processing delay
  - Queuing delay
- EED is taken as half the RTT

EED—Packet size (1/2)

- Varying packet size has a direct influence on EED
- The longer packet size will increase
  - Transmission time
  - Processing time

Average EED			
Hop Count	Min Size	1000 bytes	Max Size
One hop	3.25ms	10.40ms	340.00ms
Two hops	6.20ms	19.70ms	26.20ms
Three hops	8.80ms	29.20ms	38.30ms

EED—Packet size (2/2)



(a)

End-To-End Delay Time data for 1 hop - Low Frequency

EED—Beaconing interval

- Varying beaconing frequency does not have a significant impact on EED
- An increase in EED is observed due to the presence of severe contention over wireless media
- We also can see page. 17

EED—Route length (1/2)

- Ad hoc networks are multi-hop networks
- It is important to evaluate EED for different route length

Average EED			
Hop Count	Min Size	1000 bytes	Max Size
One hop	3.25ms	10.40ms	340.00ms
Two hops	6.20ms	19.70ms	26.20ms
Three hops	8.80ms	29.20ms	38.30ms

EED—Route length (2/2)

- We can observe that
  - The **per hop delay** is relatively constant
    - 64 bytes: 3ms/per hop
    - 1000 bytes: 10ms/per hop
- We evaluate the EED from the hop counts of the selected path

Throughput—Packet size (1/2)

- For the same beaconing interval, the use of large packet size can increase the throughput performance

Throughput—Packet size (2/2)

- At very large packet size, there is high probability that a packet is corrupted
- Contention can be a problem when the traffic load is high
- The optimal packet size cannot be determined easily

Throughput—Route length (1/2)

- Transiting data packets over multiple wireless links results in a greater delay, hence, affecting throughput
- At a packet size of 1000 bytes

Throughput—Route length (2/2)

- In light load environment, the throughput is expected to decrease to approximately

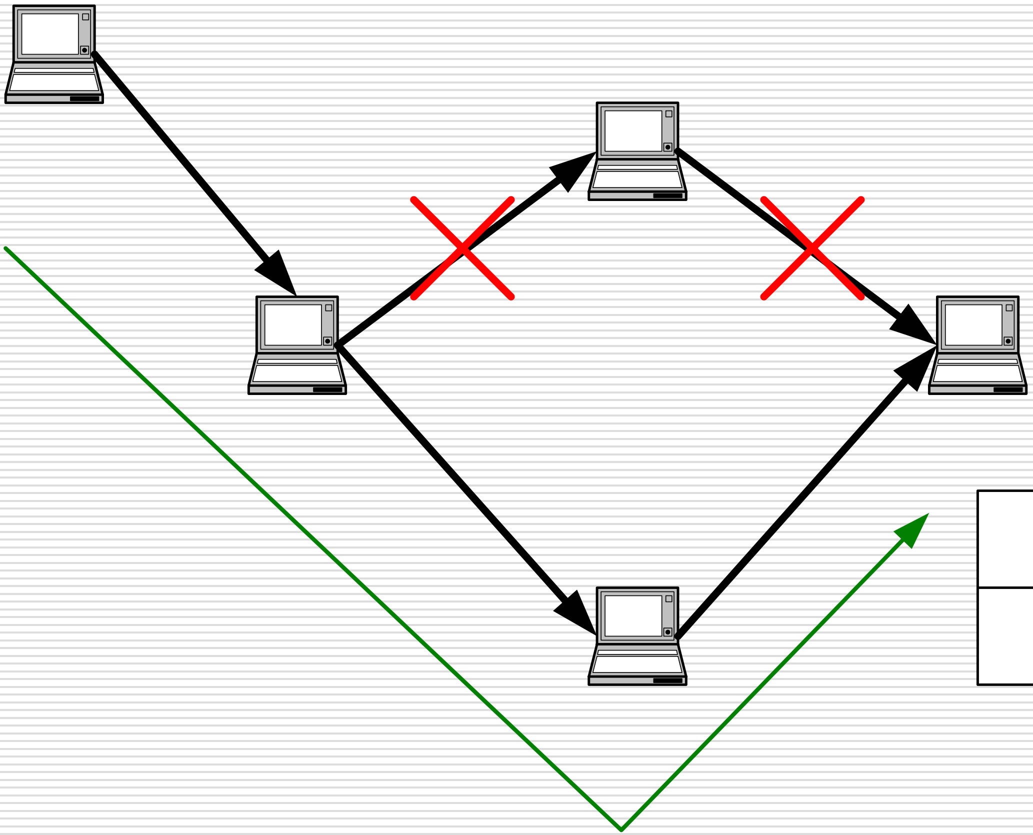
  1/N of one-hop throughput

  Where N is the route hop counts

Packet loss performance

- From observation, increasing the beaconing frequency or packet size of data does not have linear impact on the percentage of packet loss

Route Reconstruction Time



FTP

- FTP relies on TCP to send information reliably
- At a large route hop count and file size, beaconing at low freq., can significantly enhance FTP transfer rate

Discussion

- Performing Low- and High-beaconing freq. experiments in the presence of more neighbors
- Examining impact of beaconing on the power consumption of each node
- Compare with the internet path

Conclusion

- The author examines the impact of
  - varying beaconing interval
  - Packet loss
  - Route length

  On communication performance

Conclusion

			✓
	✓ ↑		✓ ↓
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