IPAC: IP-based Adaptive Packet Concatenation for Multihop Wireless Networks

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Scenario: Multihop Networks

- Packets are forwarded at each hop
- Each node contends for every packet
- As medium contention increases
  - Backoff
  - Retransmissions
  - Energy dissipation per node
- **Aggravated when medium highly utilized**

Solution

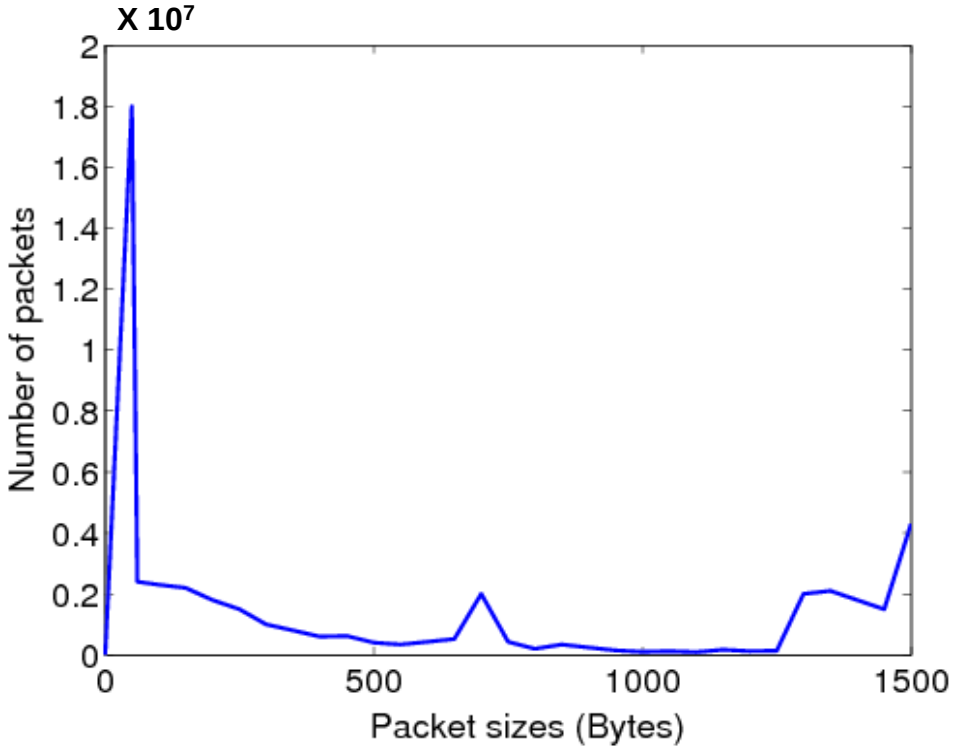
- Concatenate small packets into a large packet

- In this paper
  - Challenges
  - Design
  - Simulation results

Outline

- Wireless trace analysis
- Challenges
- IPAC protocol design
- Metrics and parameter selection
- Evaluation
- Conclusion

Case Study



- Traces from IETF 62, November 2004
- Goal: Study packet sizes from user applications
- Conclusion: Small packets abundant in wireless networks

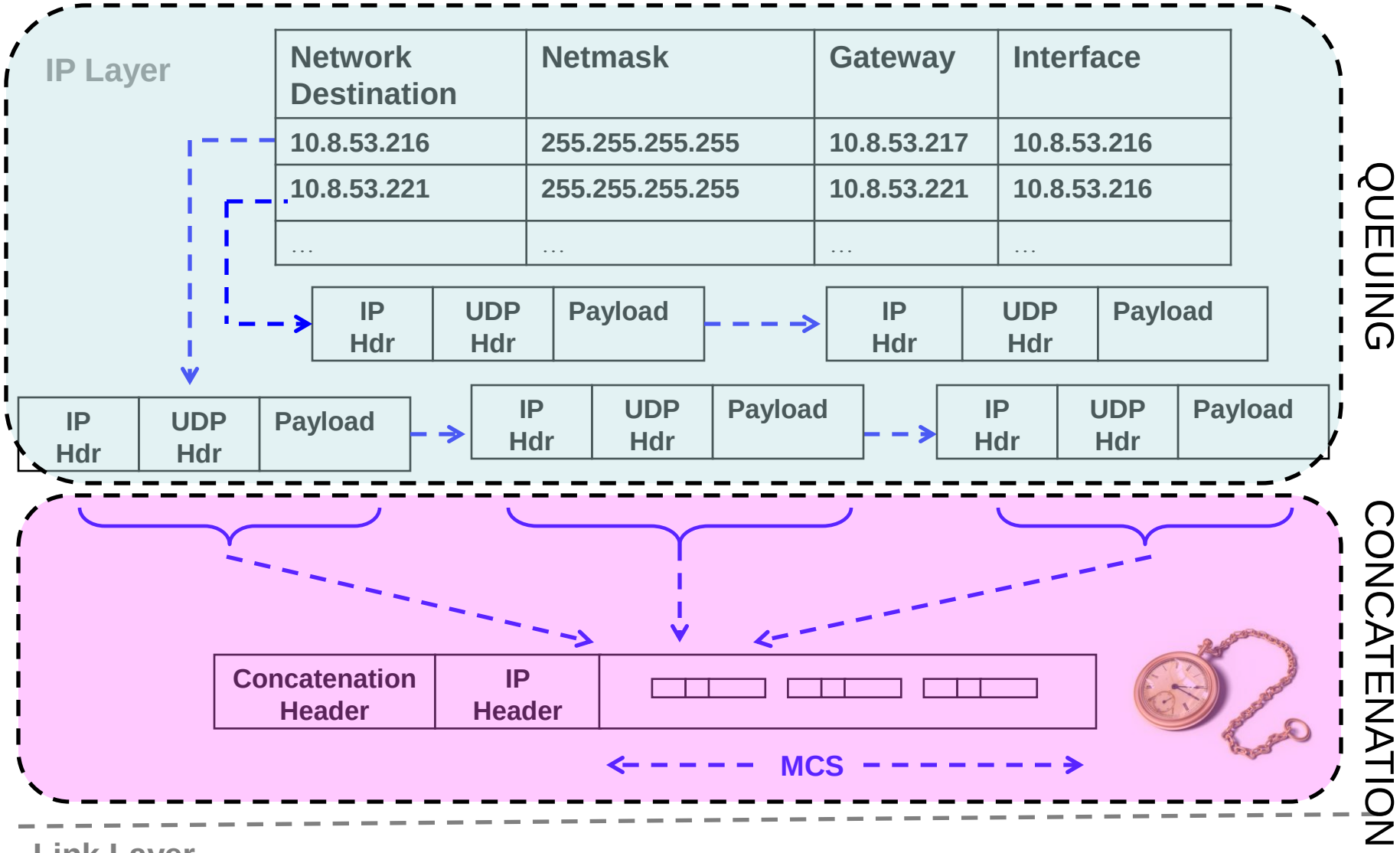
Protocol Design

- Basic Idea
  - Queue packets
  - Concatenate
  - Contend for the single large packet
- Challenges
  - What layer should we concatenate?
  - How long can we queue the packets?
  - What should be the length of the large packet?

IPAC: Challenges

- Layer
  - Latency, complexity
- Queuing interval
  - *As long as the applications do not suffer*
  - Parameter 1: Maximum Concatenation Interval
- Packet size
  - Large packets more prone to bit errors and loss
  - Parameter 2: Maximum Concatenation Size

IPAC: Protocol Description



IPAC: Adaptive MCS Determination

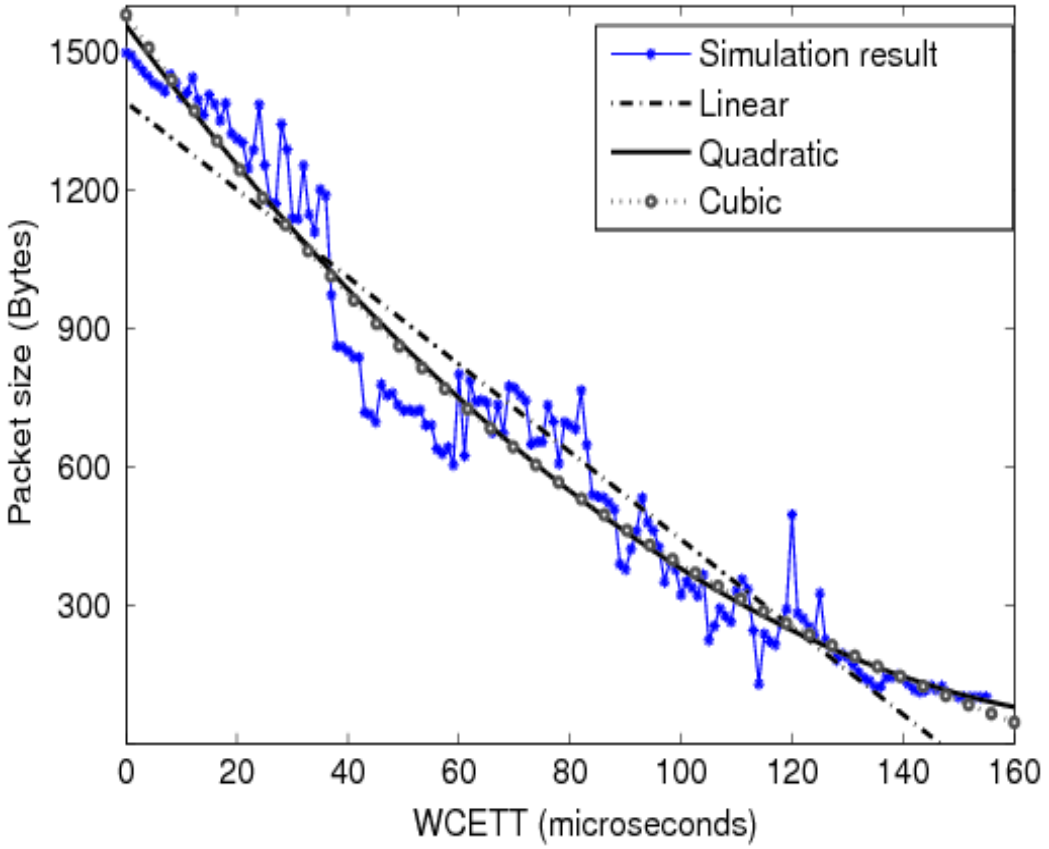
- How large is good?
  - Small packets increase contention
  - Large packets prone to error
- “Path Quality” to compute packet size
  - Routing metric **WCETT**
  - High WCETT => high packet loss => retransmissions => small packets better
  - Evaluations to determine exact mapping

Evaluation Methodology

- Qualnet 3.9 with OLSR-INRIA extension
- 100 nodes in 1000m X 1000m area
- 10 pairs of sender-receiver pairs
- Uniform random topology
- 200 second simulations

WCETT Mapping to Packet Sizes

- Each WCETT value maps to a “best” packet size
- Above this packet size, packet drop increases
- Quadratic curve fits our setup



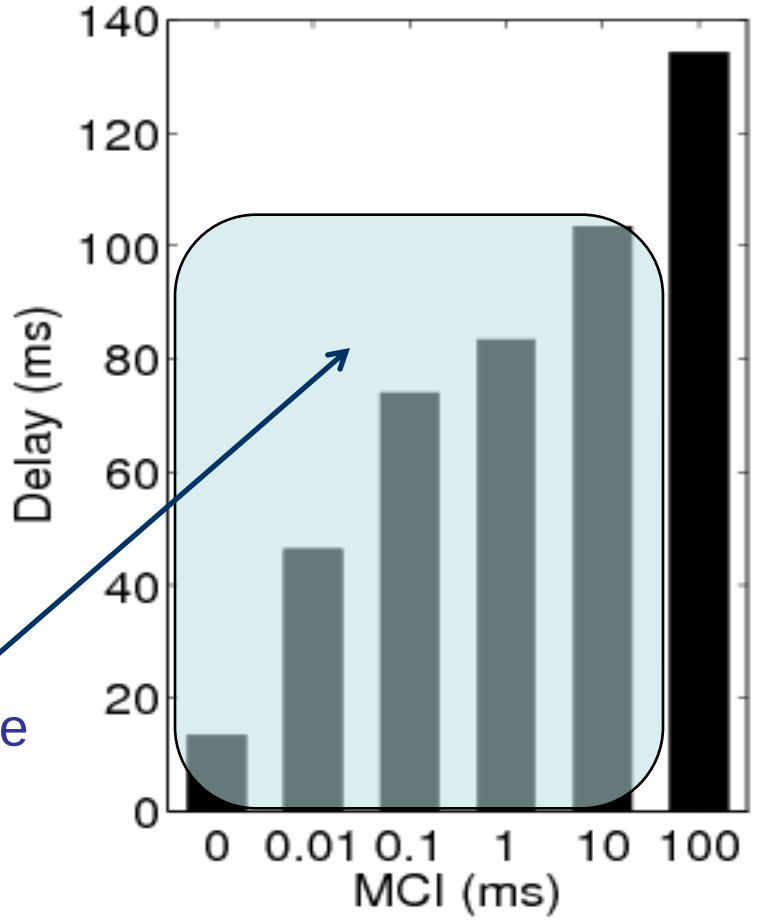
Linear $y = -9.5x + 1400$

Quadratic $y = 0.042x^2 - 16x + 1600$

Cubic $y = -0.00012x^3 + 0.071x^2 - 18x + 1600$

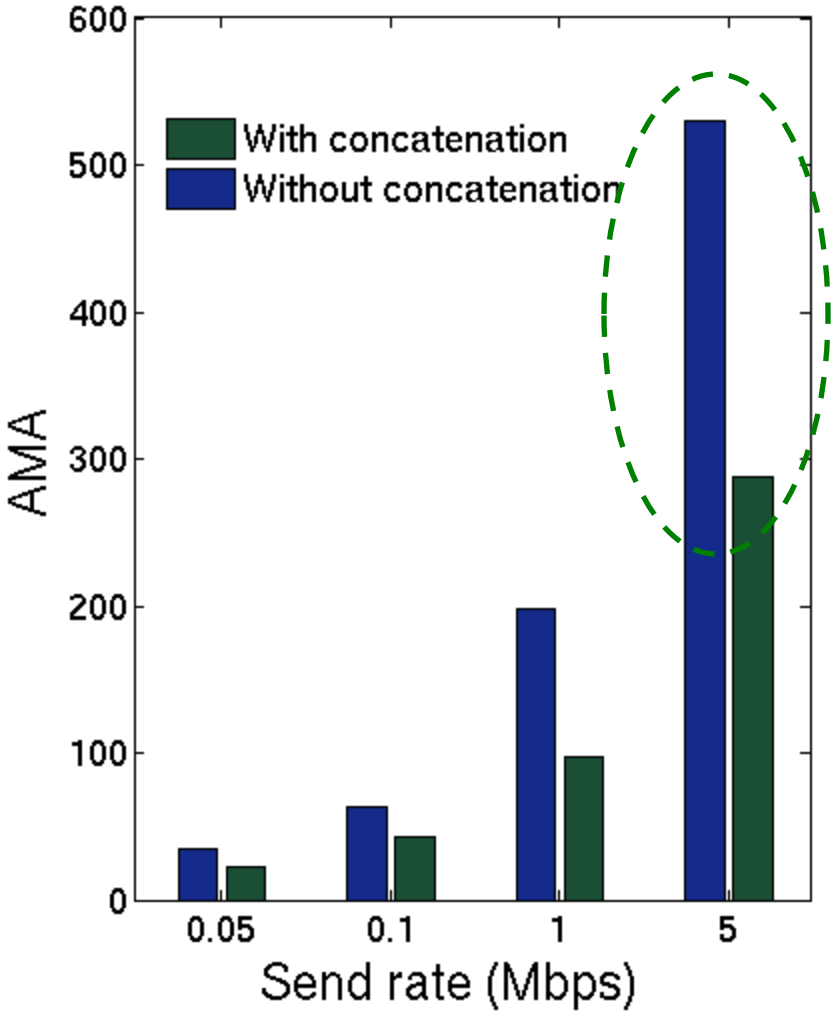
Delay Baseline: Characterizing MCI

- MCI is a tunable parameter
- Goals:
  - Select MCI for simulations
  - Understand effect on delay due to IPAC



Evaluation : Attempts to Medium Access

- **AMA**: Number of medium access attempts before transmission
- Estimate of backoff time
- IPAC reduces AMA

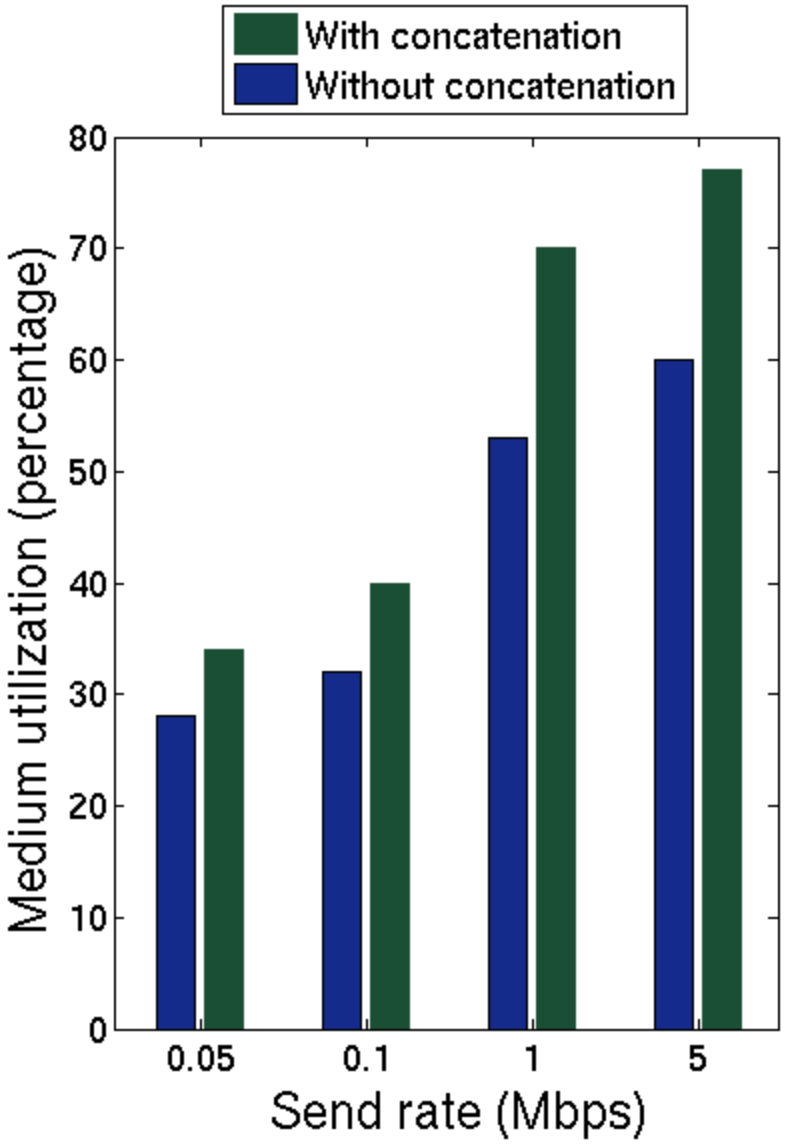


Medium Utilization

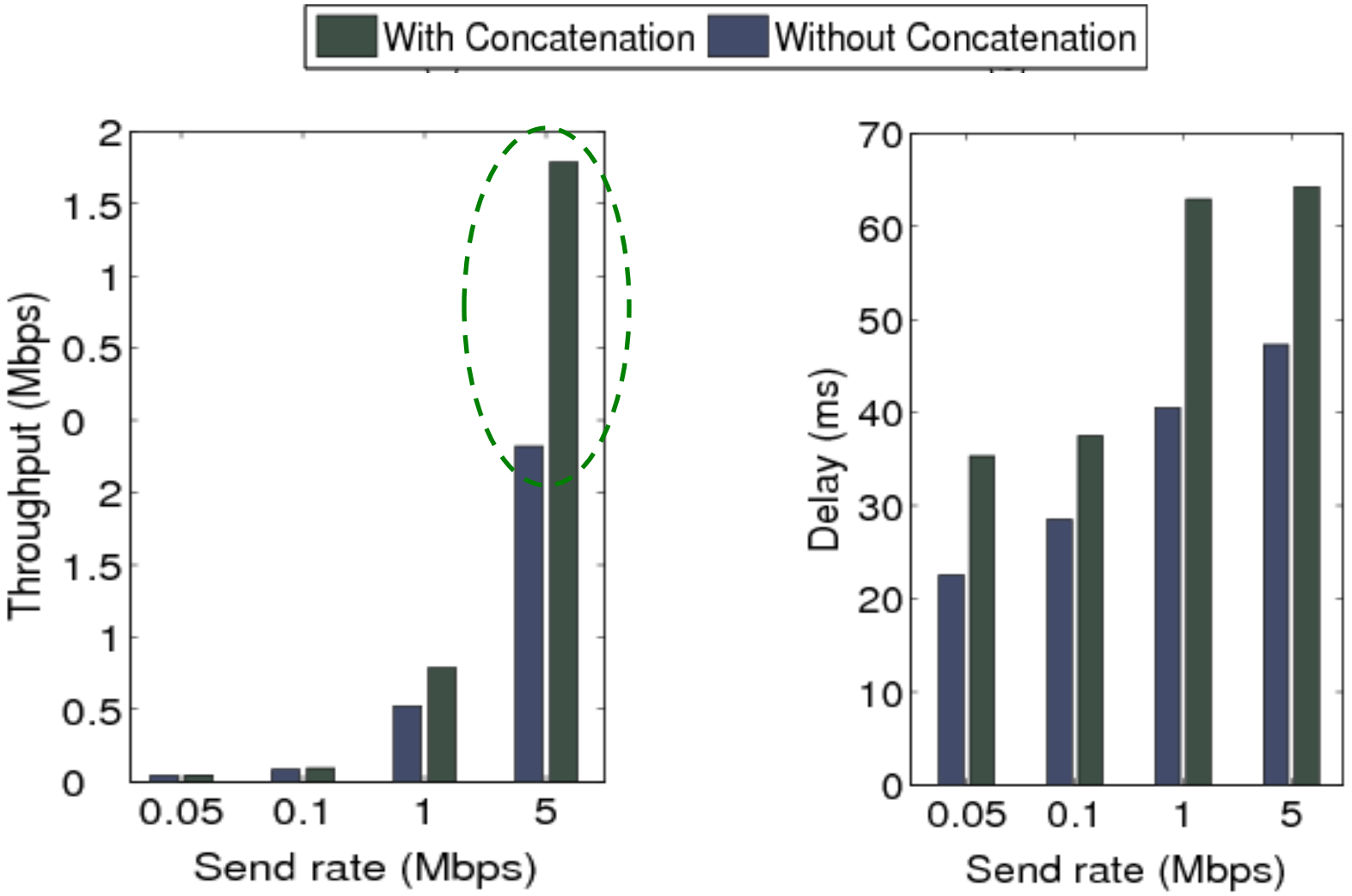
- transmit time /

(transmit + backoff time)

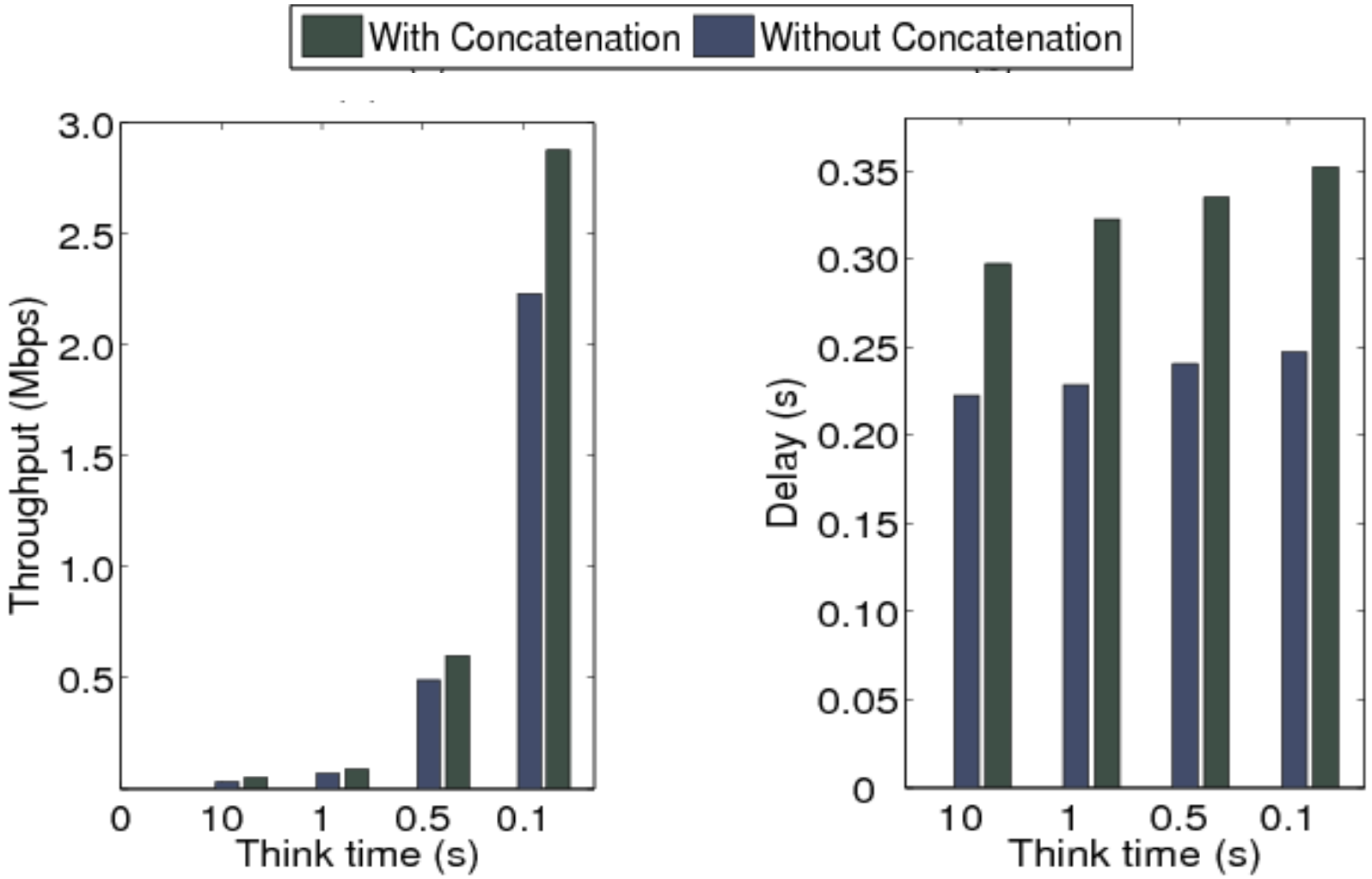
- Decrease in AMA => less backoff => higher utilization



IPAC: UDP Throughput and Delay



IPAC: TCP Throughput and Delay



Summary

- Large number of small increase contention
- Concatenating packets is beneficial
- Queuing interval and Concatenation size are important parameters
- IPAC results in increase in throughput and medium utilization by a factor of 2-3
- Improved benefits with increase in voice and video

Questions?

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Backup Slides

Overhead due to Concatenation Header