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Quantitative Assessment of IP Service Quality in 802.11b Networks

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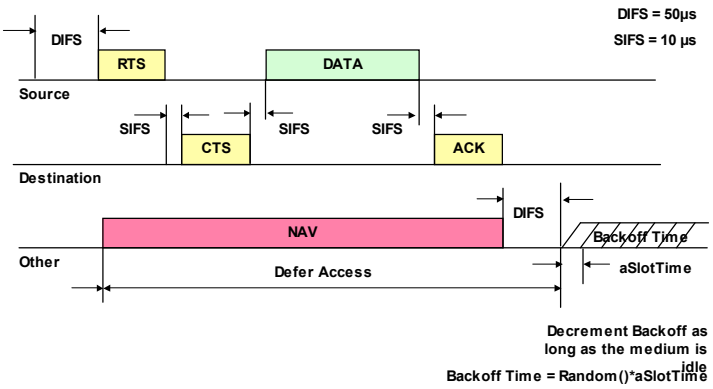
Introduction

- Brief background on 802.11b networks
- Test Setup and Findings
  - Impact of wireless link being a bandwidth bottleneck
  - Impact of 802.11b's CSMA/CA scheme- a lower bound on TCP performance degradation in sharing medium
- Conclusions

Background on 802.11b networks - 1

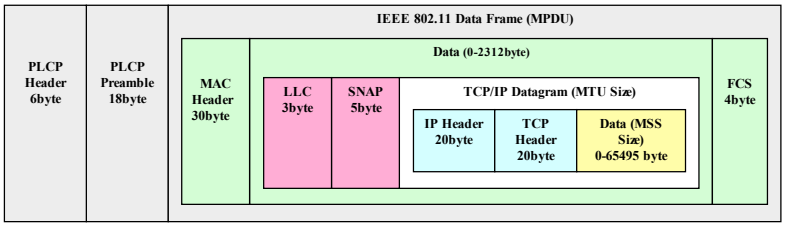
- Extension to 802.11 that applies to wireless LANs
- Provides 11 Mbps transmission in the 2.4 GHz band using Direct Sequence Spread Spectrum (DSSS)
- Uses CSMA/CA at MAC layer
- Operates in Adhoc/Infrastructure modes
- *Our study focuses on 802.11b Infrastructure mode & CSMA/CA with RTS/CTS and positive ACK mechanism*

Background on 802.11b networks - 2



802.11b RTS/CTS Data Transaction

Background on 802.11b networks - 3

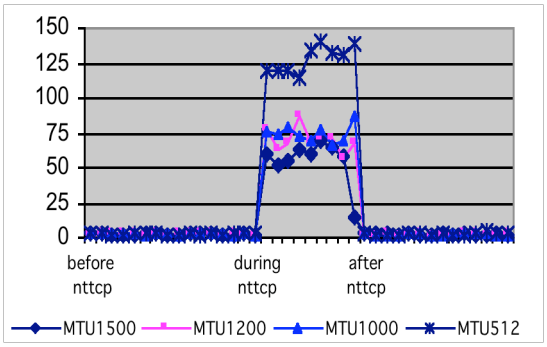


802.11b Frame Encapsulation

Impact of Wireless Link BW Bottleneck - 1

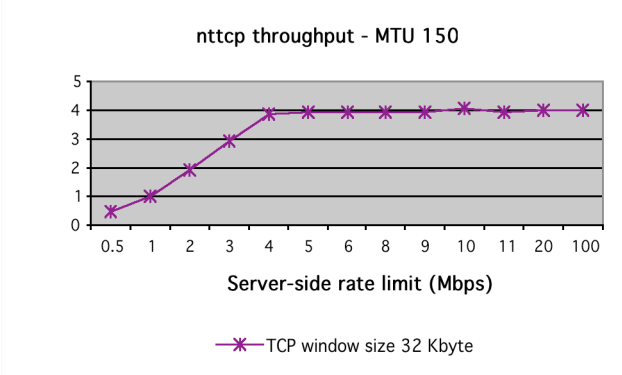
- Nttcp transferring 8MByte with TCP client window 32KBbyte from Server to Client
- ICMP ping from Client to Server to estimate RTT
- MTU sizes of 1500, 1200, 1000 and 512 bytes
- Repeat test with and without Server side BW limit using Dummynet

Impact of Wireless Link BW Bottleneck - 2

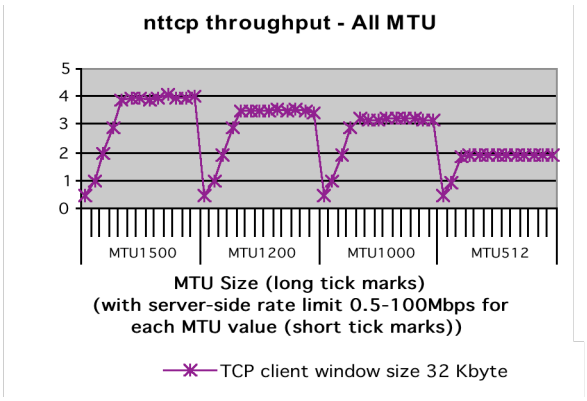


No Server Side Rate Limit

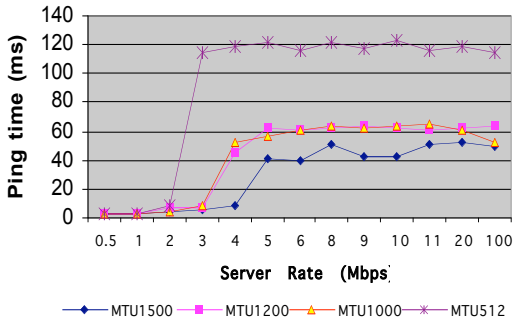
Impact of Wireless Link BW Bottleneck - 2



Impact of Wireless Link BW Bottleneck - 2



Impact of Wireless Link BW Bottleneck - 2

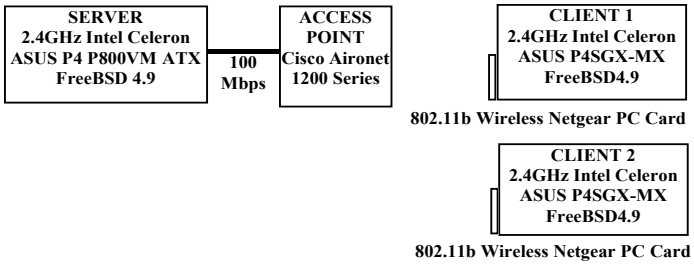


Server Side Rate Limit using Dummynet

Test Results Implications

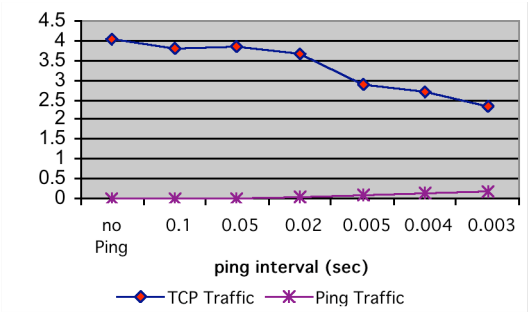
- Spike in RTT over the loaded DS link affects all traffic sharing the AP
- Implications for ISPs who wish to support interactive applications yet concurrently hosting local content
- Configuring the optimal window size based on idle link's RTT might lead to highly sub-optimal result

Impact of CSMA/CA with RTS/CTS - 1



- Nttcp from Server to Client 1
- Pinging Server from Client 2 with Different Ping Intervals and Packet Sizes

Impact of CSMA/CA with RTS/CTS - 2



Nttcp Throughput vs. Ping Rate (64byte ping packets)

Impact of CSMA/CA with RTS/CTS - 3

	1500-byte MTU TCP Data (µs)	TCP ACK (µs)
DIFS & SIFS	50 + 10*3 = 80	50 + 10*3 = 80
RTS & CTS	192*2 + (20 +14)/0.125 = 656	192*2 + (20 +14)/0.125 = 656
80211 Data	192 + 1542/(1375) = 1,313.4	192 + 82/(1375) = 251.6
80211 ACK	192 + 14/(1375) = 203	192 + 14/(1375) = 203
Frame exchange total	2252.4	1190.6
Total Transaction	3443 *	

*Backoff Time is not included in the calculation

TCP Transaction Time

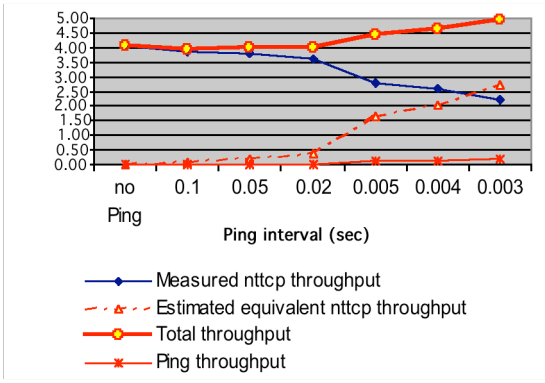
Impact of CSMA/CA with RTS/CTS - 4

	64-byte Echo Request & Reply (µs)	128-byte Echo Request & Reply (µs)	256-byte Echo Request & Reply (µs)
DIFS + RTS +CTS + SIFS	736	736	736
802.11 Data	192 + (64+42)/(1.375) = 269.1	192 + (128+42)/(1.375) = 315.6	192 + (256+42)/(1.375) = 408.7
802.11 ACK	192 + 14/(1.375) = 203	192 + 14/(1.375) = 203	192 + 14/(1.375) = 203
Frame exchange total	1208.1	1254.6	1347.7
Total Transaction*	1208.1*2 = 2416.2	1254.6*2= 2509.2	1347.7*2 = 2695.4

*Backoff Time is not included in the calculation

Ping Transaction Time

Impact of CSMA/CA with RTS/CTS - 5



Nttcp Throughput of TCP traffic and "taken" by 64byte-ping traffic

Conclusions

Experimentally characterise:

- Impacts of limited DS link capacity on wireless clients and ISPs
- Negative effects of CSMA/CA scheme in 802.11b networks on TCP performance in the presence of non-reactive flows from other interactive applications

Future Work

- Expanding our experiments with 802.11b 'hotspot' with mixed applications and multiple stations scenarios
- Considering other factors, e.g. backoff time in the CSMA/CA scheme, collision rate, and transmission probability
- Motivate further work on load balancing among different APs, optimising media access algorithm, application classification, priority queuing, and packet scheduling in 802.11b networks

THANK YOU!