

Quantitative Assessment of IP Service Quality in 802.11b Networks

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Introduction



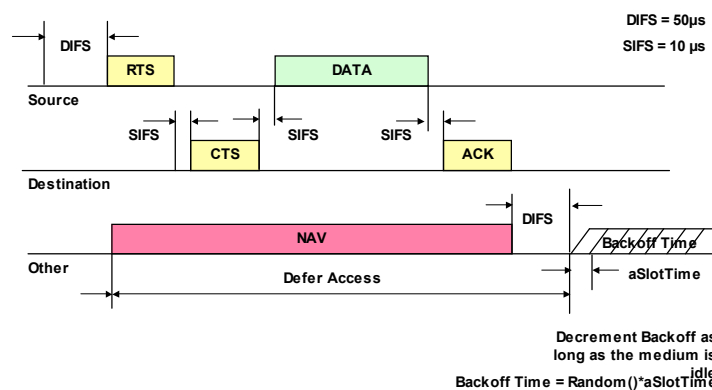
- Brief background on 802.11b networks
- Test Setup and Findings
 - Impact of Downstream being a bandwidth bottleneck
 - Impact of 802.11b's CSMA/CA scheme- a lower bound on TCP performance degradation in sharing medium
- Conclusions

Background on 802.11b networks - 1



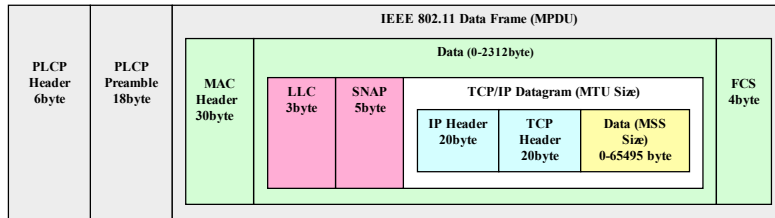
- ❑ Extension to 802.11 that applies to wireless LANs
- ❑ Provides 11 Mbps transmission in the 2.4 GHz band using Direct Sequence Spread Spectrum (DSSS)
- ❑ Uses CSMA/CA at MAC layer
- ❑ Operates in Adhoc/Infrastructure modes
- ❑ *Our study focuses on 802.11b Infrastructure mode & CSMA/CA with RTS/CTS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

Background on 802.11b networks - 2



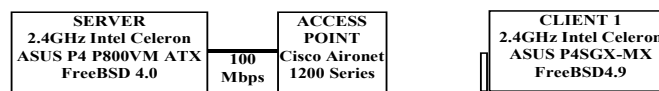
802.11b RTS/CTS Data Transaction

Background on 802.11b networks - 3



802.11b Frame Encapsulation

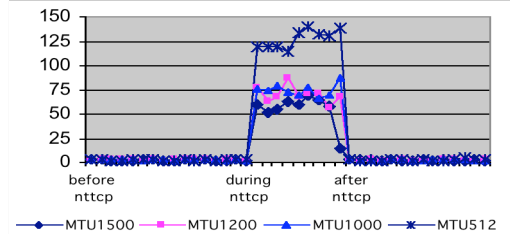
Impact of Downstream (DS) BW Bottleneck - 1



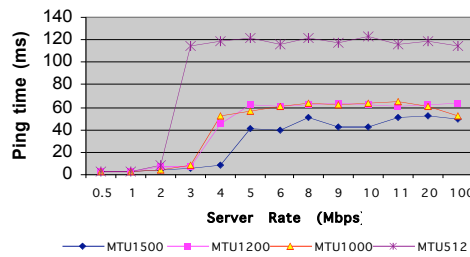
802.11b Wireless Netgear PC Card

- Nttcp transferring 8MByte with TCP client window 32KByte 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 Dumynet

Impact of Downstream (DS) BW Bottleneck - 2



No Server Side Rate Limit



Server Side Rate Limit using Dummynet



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Test Results Implications



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

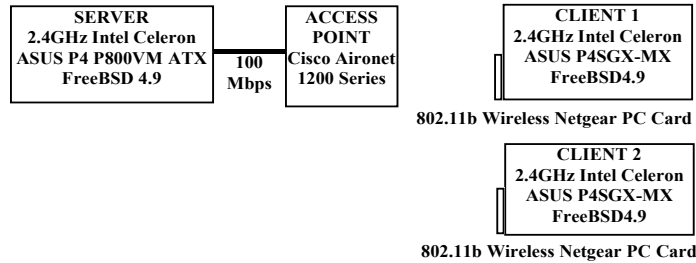


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Impact of CSMA/CA with RTS/CTS - 1



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

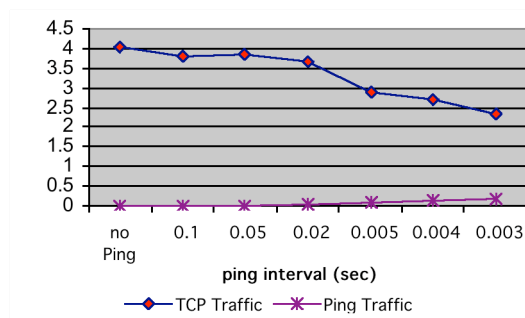


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Impact of CSMA/CA with RTS/CTS - 2



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



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Impact of CSMA/CA with RTS/CTS - 3



	1500-byte MTU TCP Data (μs)	TCP ACK (μs)
DIFS & SIFS	$50 + 10 \times 3 = 80$	$50 + 10 \times 3 = 80$
RTS & CTS	$192 \times 2 + (20+14)/0.125 = 656$	$192 \times 2 + (20+14)/0.125 = 656$
802.11 Data	$192 + (1500+42)/1.375 = 1,313.4$	$192 + (40+42)/1.375 = 251.6$
802.11 ACK	$192 + 14/(1.375) = 203$	$192 + 14/(1.375) = 203$
Frame exchange total	2252.4	1190.6
Total transaction	3443	

TCP Transaction Time

* Backoff Time is not included in the calculation



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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	269.1	315.6	408.7
802.11 ACK	203	203	203
Frame exchange total	1208.1	1254.6	1347.7
Total transaction *	2416.2	2509.2	2695.4

Ping Transaction Time

* Backoff time is not included in the calculation

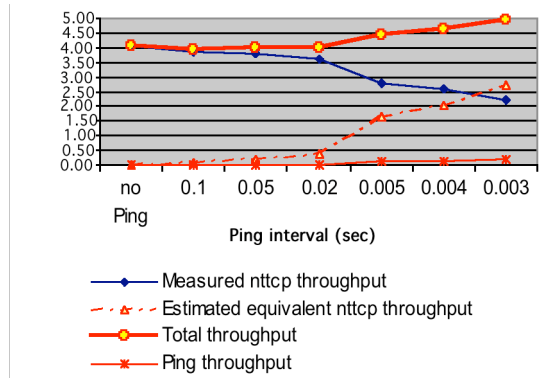


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Impact of CSMA/CA with RTS/CTS - 5

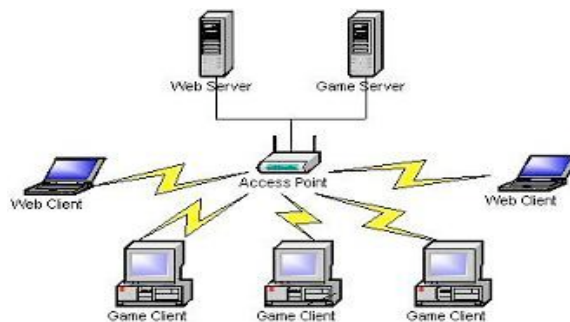


Nttcp Throughput of TCP traffic and "taken" by 64byte-ping traffic

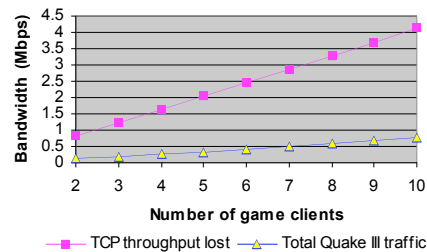
Impact of CSMA/CA with RTS/CTS - 6



802.11b and Networked Games



Impact of CSMA/CA with RTS/CTS - 7



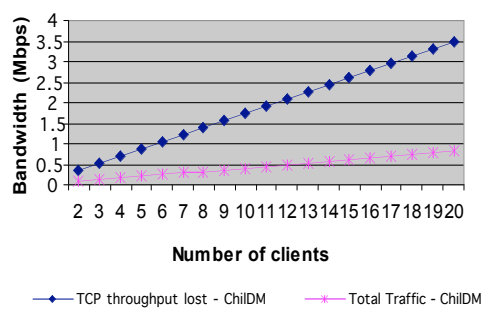
Estimated equivalent TCP capacity consumed by Quake III traffic



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Impact of CSMA/CA with RTS/CTS - 8



Estimated equivalent TCP capacity consumed by Half Life traffic for ChildDM map played



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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' game 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!



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