Experimental Evaluation of 802.11e EDCA for Enhanced Voice over WLAN Performance

Ian Dangerfield, David Malone, Douglas J. Leith

Hamilton Institute, NUI Maynooth, Ireland.

3 April 2006

802.11(e) MAC Summary

- After TX choose rand$(0, \mathrm{CW} - 1)$.
- Wait until medium idle for DIFS$(50\mu s)$,
- While idle count down in slots $(20\mu s)$.
- TX when counter gets to 0, ACK after SIFS $(10\mu s)$.
- If ACK then $\mathrm{CW} = \mathrm{CW}_{\mathrm{min}}$ else $\mathrm{CW}* = 2$.

Ideally produces even distribution of packet TX.

In 11e have multiple queues. Each has own $\mathrm{CW}_{\mathrm{min}}$, DIFS(aka AIFS) and can have TXOP.

Why use a testbed?

- Can we believe ns?
  Bugs: aCCATime, virtual collisions.
- Can we believe the standard?
- Can we believe models?
- What are the practical issues?

Testbed setup

Multiple STA (Linux) connected to AP (Linux hostap).

Hardware	model	spec
1× AP	Dell GX 260	2.66Ghz P4
18× STA	Soekris net4801	266Mhz 586
1× STA	Dell GX 270	2.8Ghz P4
WLAN NIC	D-Link DWL-G520	Atheros AR5212

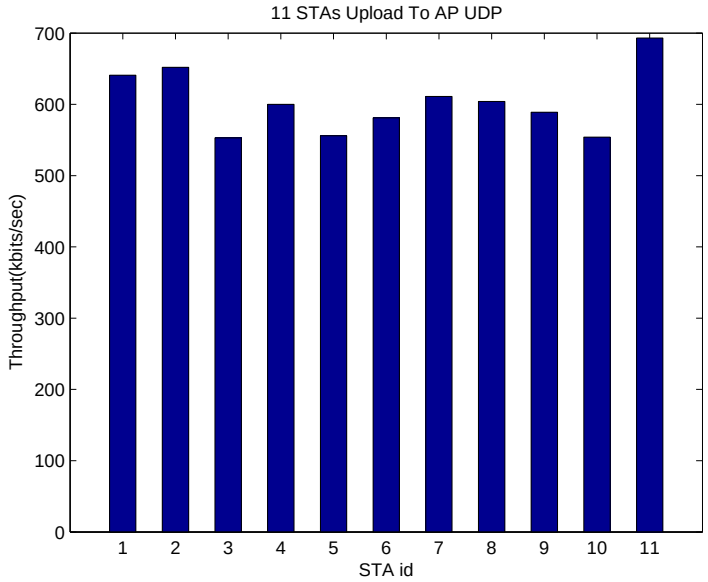
External antenna, PCI interface, Madwifi driver with local patches for 11e parameter setting.

MGEN and iperf used for traffic generation.

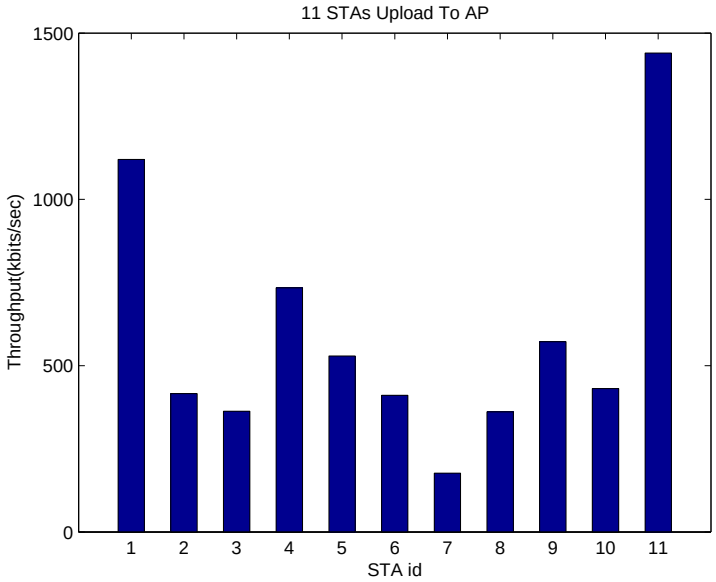

192.168.0.180&180
192.168.0.187
187
192.168.0.7&177

Practical Issue: Calibration

UDP up

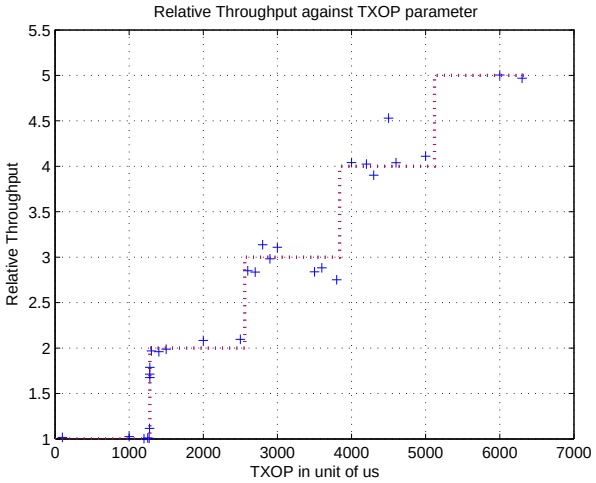


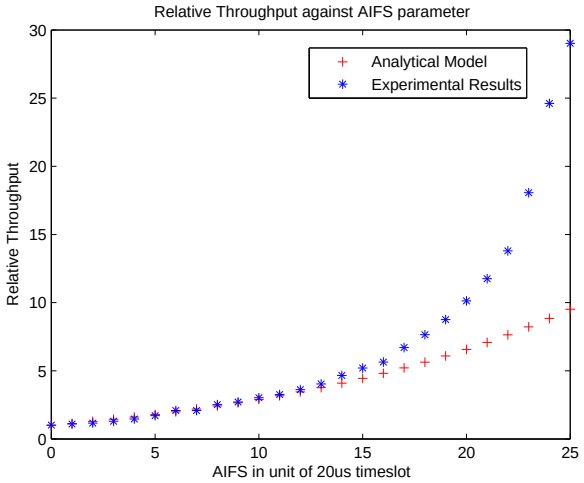
TCP up

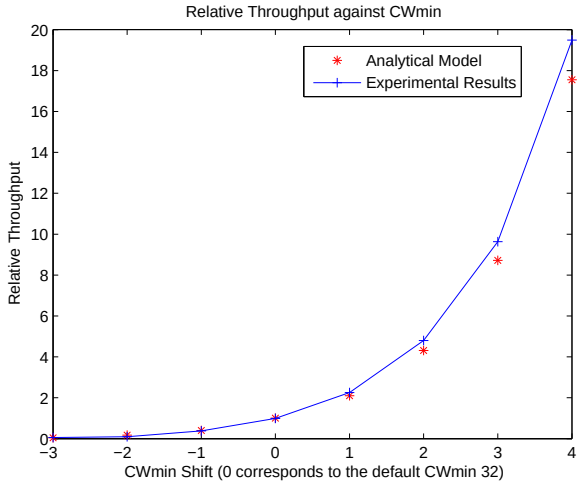


Small changes until well behaved.

Validation







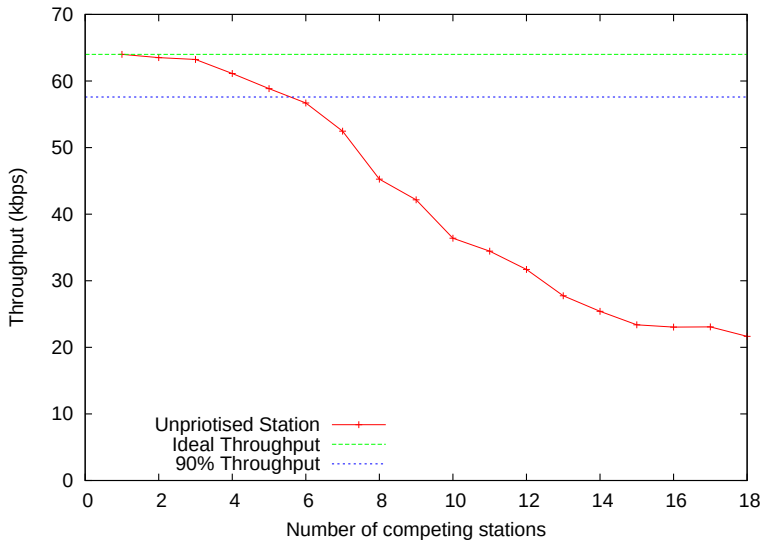
Measure relative performance of two saturated flows while varying TXOP, AIFS and CW_{min}. Compare to well-known models.

Voice

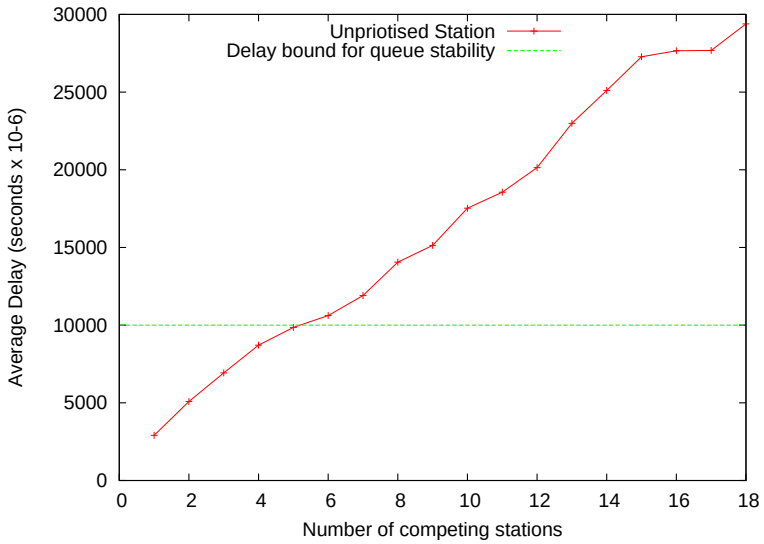
- Has a loss and delay requirement.
- Low rate vs. high rate.
- Aim to protect voice from saturated sources.
- AIFS is the obvious parameter.
- For sake of argument, target loss of 10%.
- (simulation says 4, model says 6 to be safe).

Unprioritised Voice

Throughput



Delay

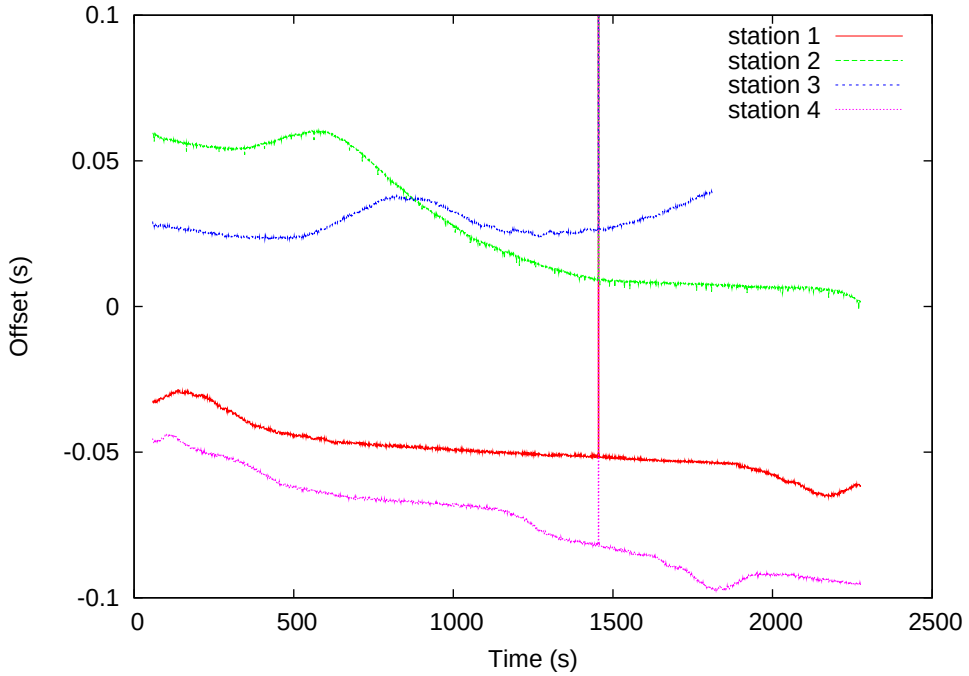


Rapid drop in throughput.

Linear growth in delay.

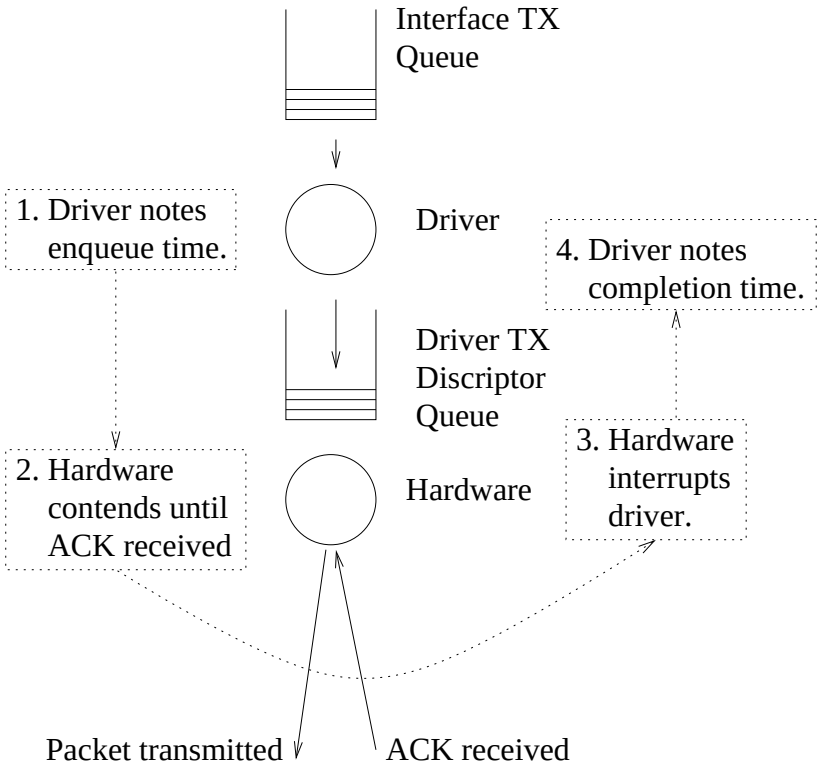
Measuring Delay

- Want to measure one-way MAC delay.
- NTP slow and insufficiently accurate.
- Simultaneously observable TX better, largish noise.

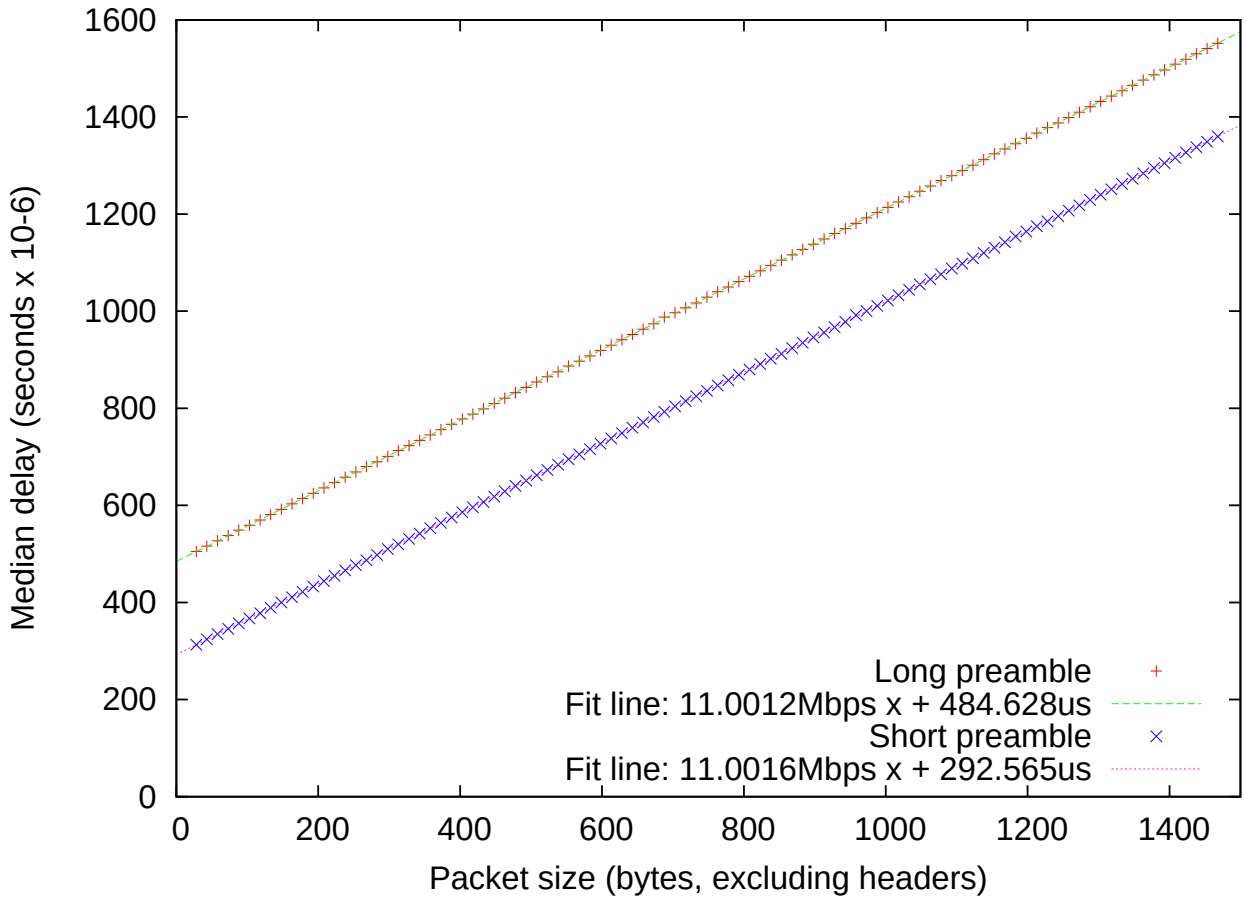


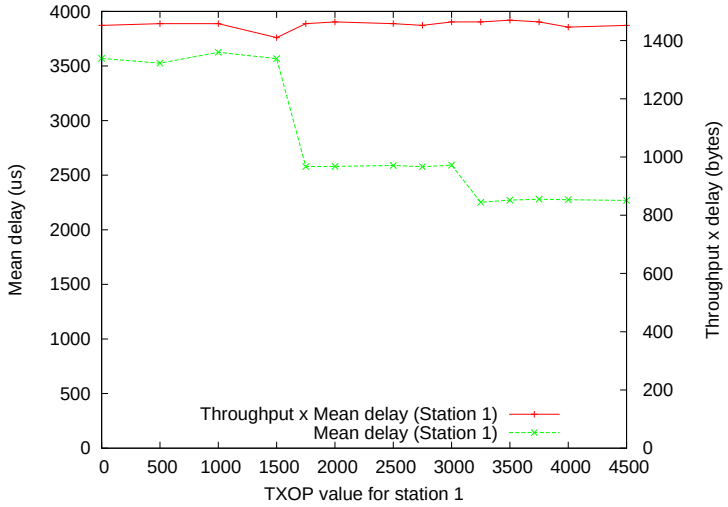
Delay Technique

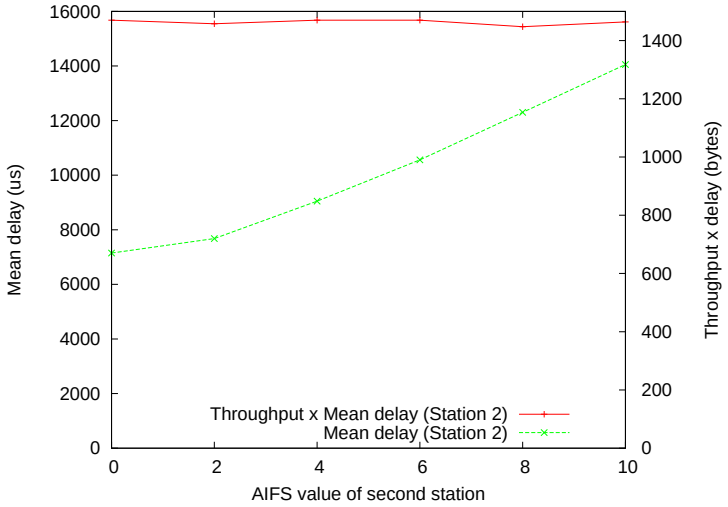
- Transmission not complete until MAC ACK.
- Hardware supports interrupt after ACK.

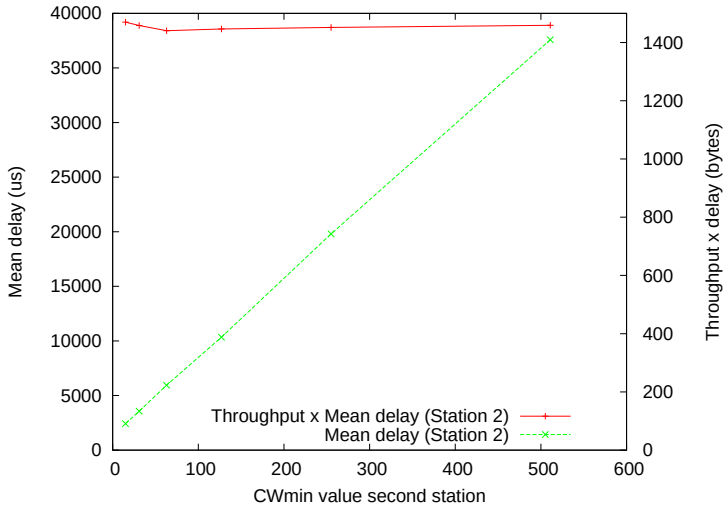


Validation


Median delay (seconds x 10-6)
Packet size (bytes, excluding headers)
0
200
400
600
800
1000
1200
1400
1600
Long preamble
Fit line: 11.0012Mbps x + 484.628us
Short preamble
Fit line: 11.0016Mbps x + 292.565us



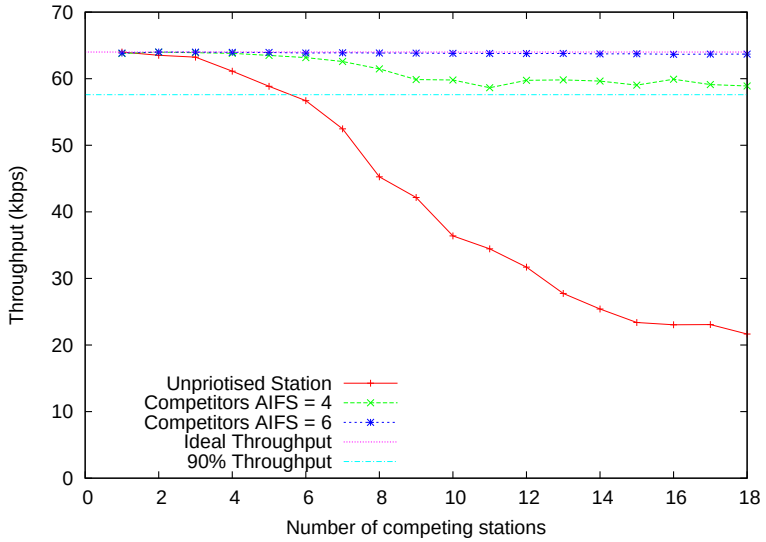




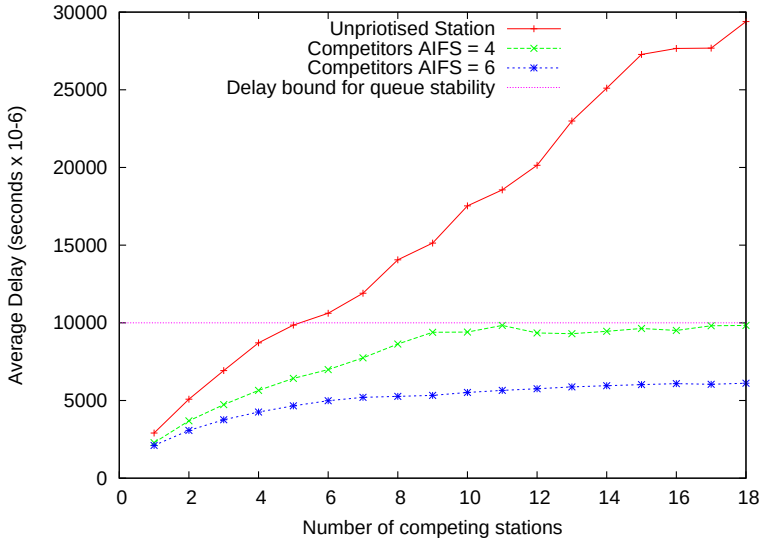
Measure relative performance of two saturated flows while varying TXOP, AIFS and CW_{min}. Check Throughput * delay has expected value.

AIFS Impact

Throughput



Delay

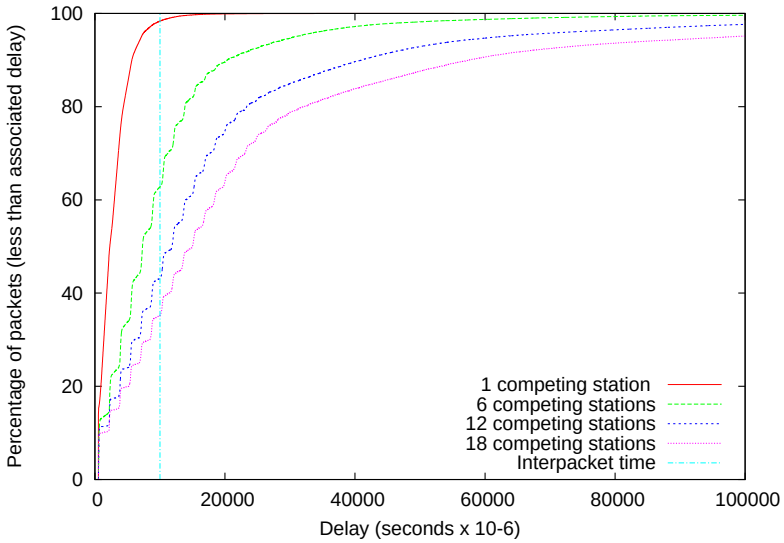


Delay now practically bounded.

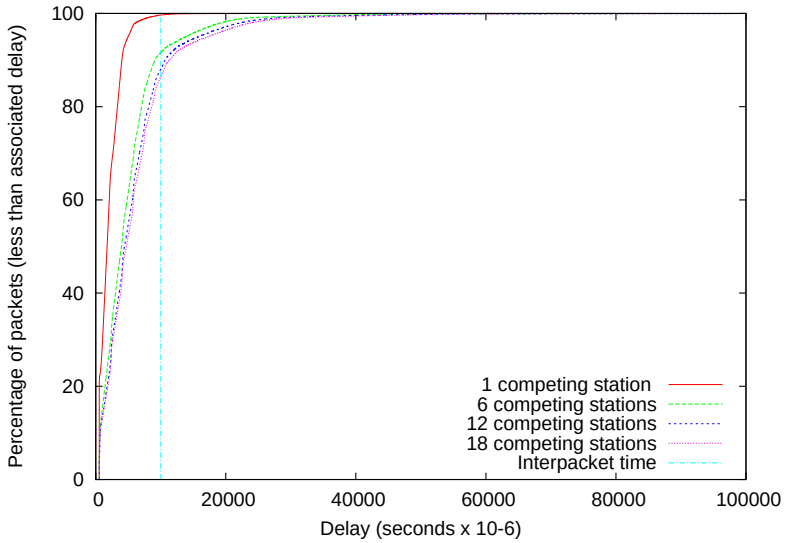
AIFS 4 is enough, but on boundary.

Delay Distribution

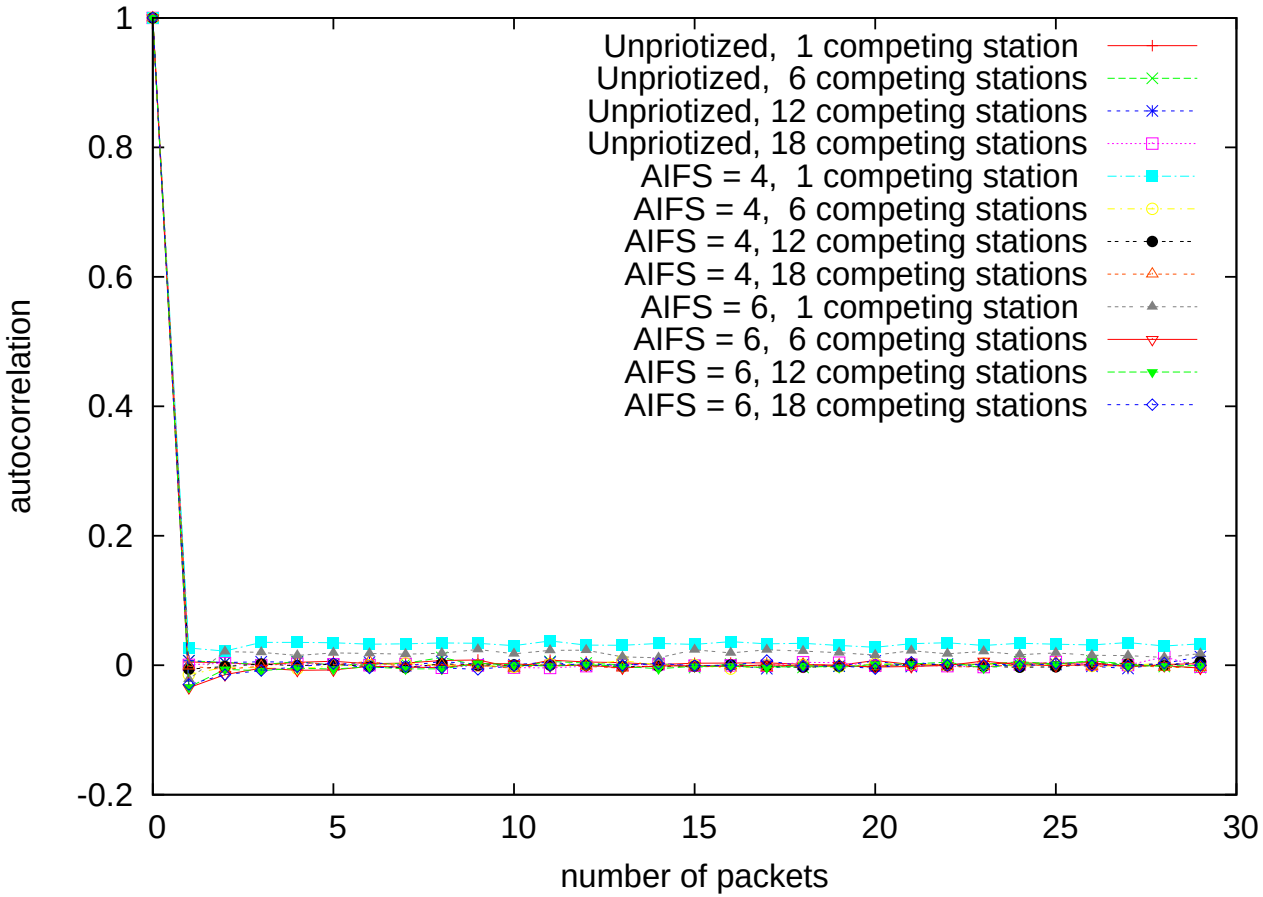
AIFS 0



AIFS 6



Autocorrelation



Conclusions

- Small 11e testbed.
- Hardware seems to behave as expected.
- Instrumented to fine-grained MAC delay.
- 11e can be used to help voice out.
- Look at mixed voice/data and voice only networks.

Thanks

David.Malone@nuim.ie
http://www.hamilton.ie/