Understanding 802.11e Voice Behaviour via Testbed Measurements and Modeling

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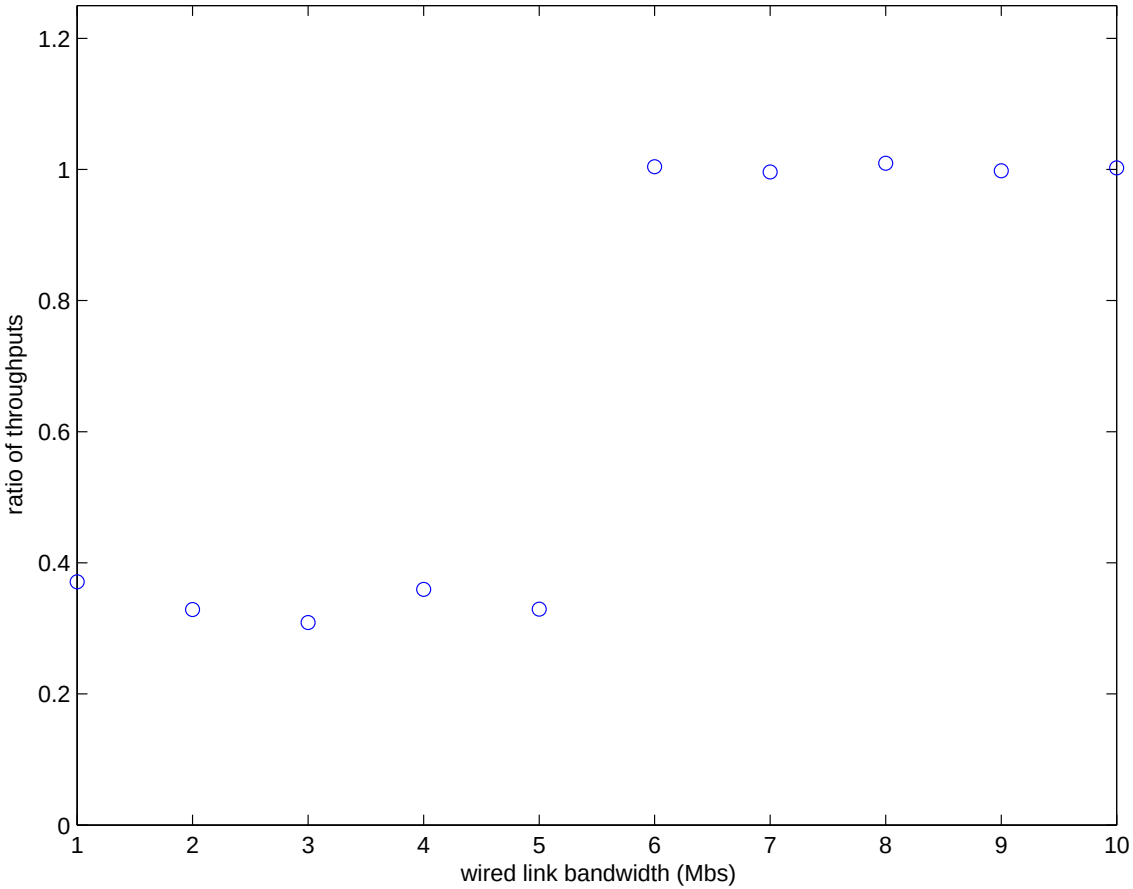
Voice over WiFi

- Behaviour of voice over WiFi.
- Infrastructure mode 802.11(e).
- AP known to constrain capacity.
- Modeling/Simulation suggests solution.
- Buffering also a question.
- Simple on-off traffic model.
- Use test-bed to understand problem and solution.

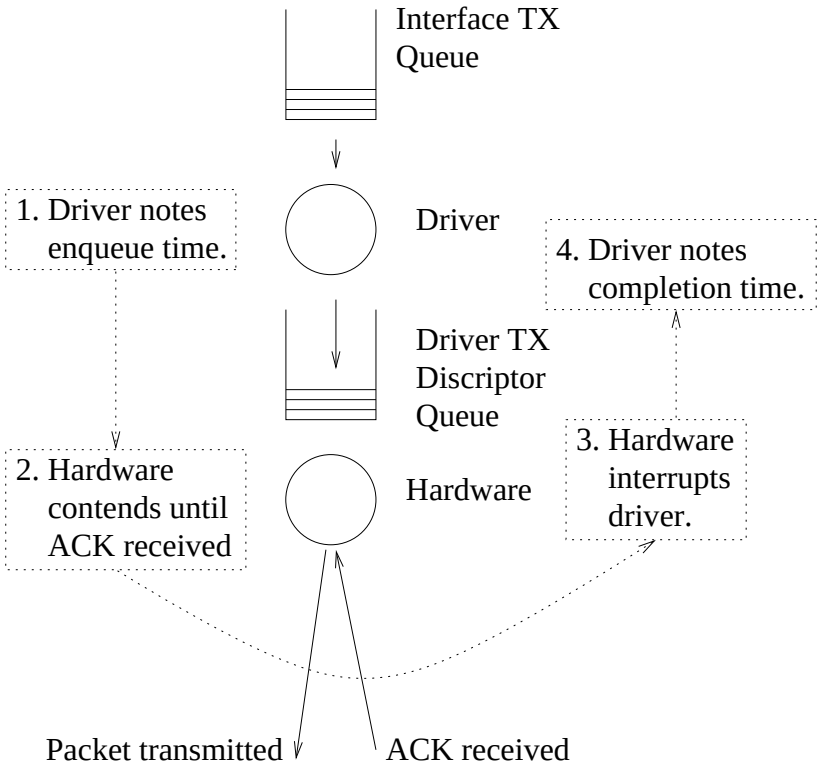
Problem: When busy MAC is per-packet 'fair'

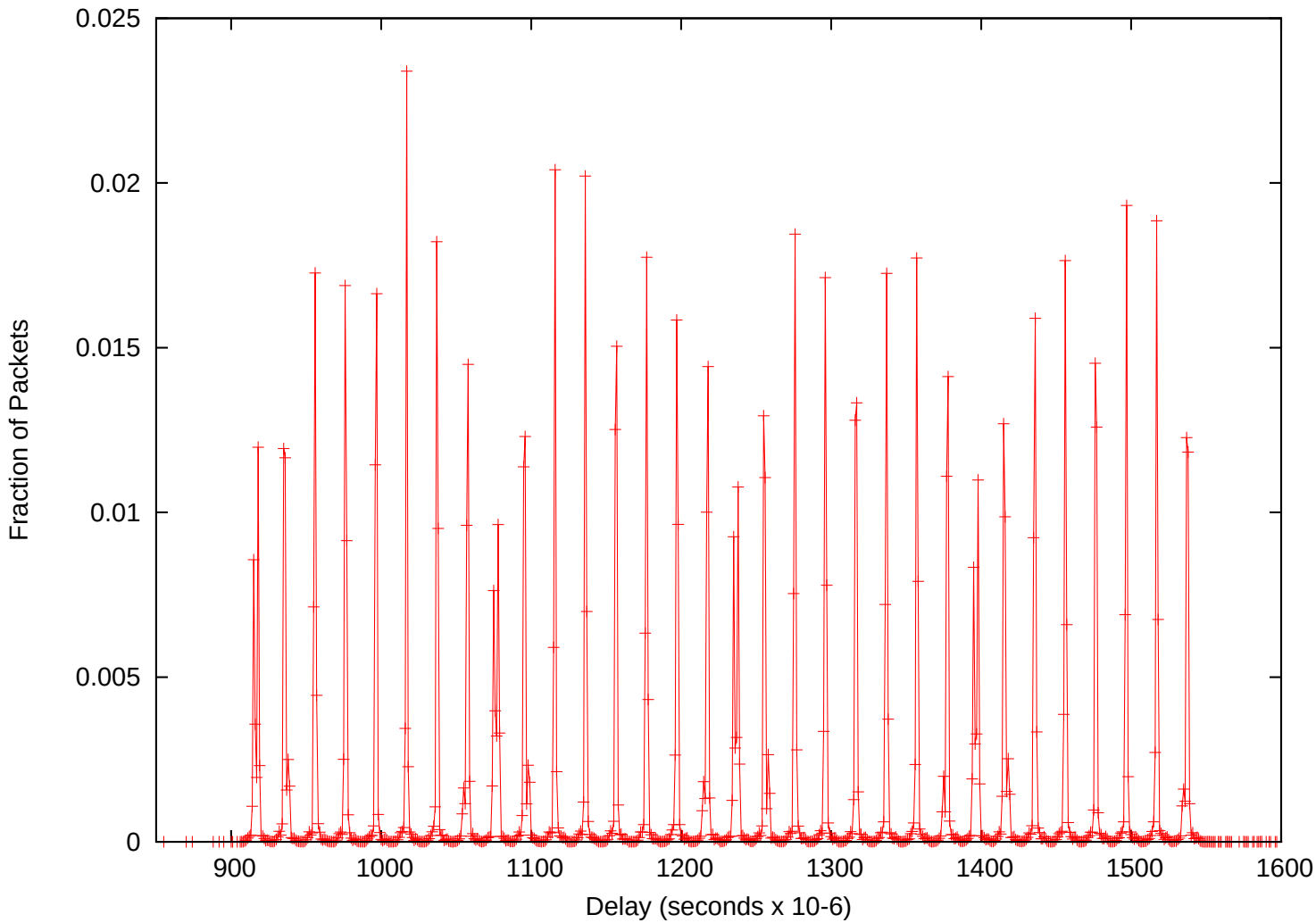



192.168.0.180&180
192.168.0.187
187
192.168.0.185
192.168.0.7&177

Delay Measurement

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




0.025
0.02
0.015
0.01
0.005
0
Fraction of Packets
900
1000
1100
1200
1300
1400
1500
1600
Delay (seconds x 10-6)

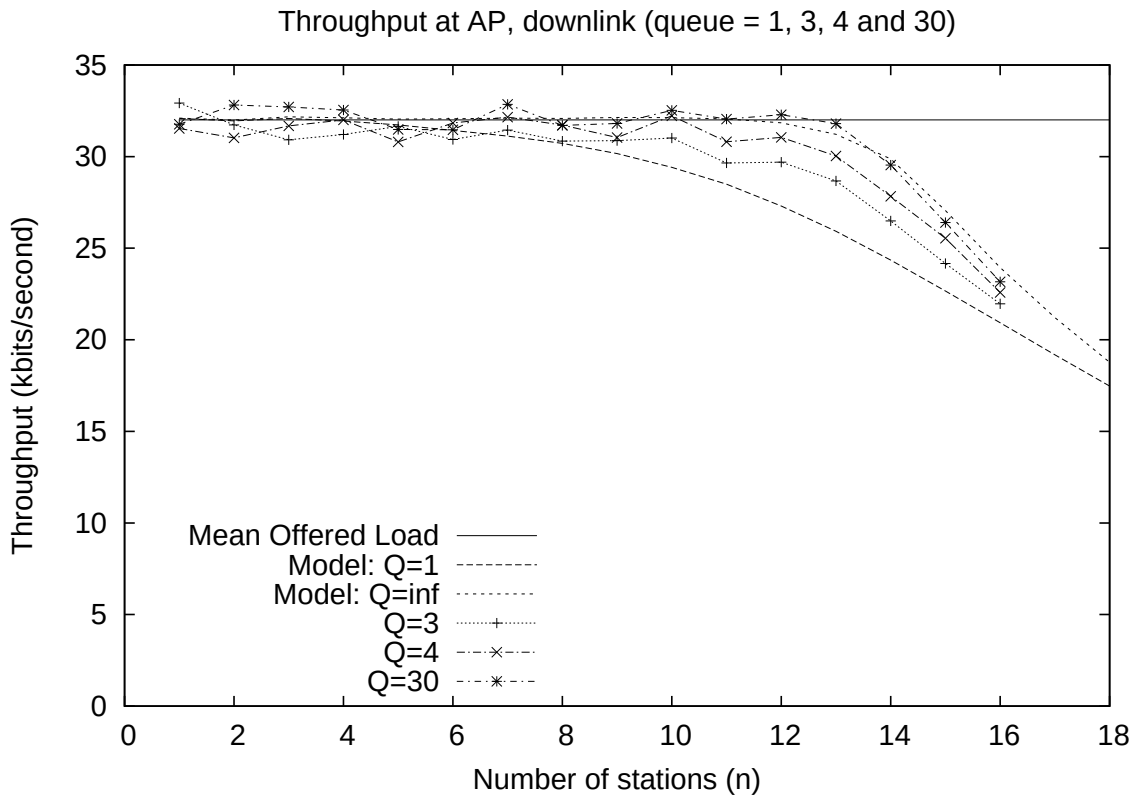


Figure 1: Measured and modelled throughput at the AP. Buffer size at the AP and the STAs is the same. Analytic model also shown.

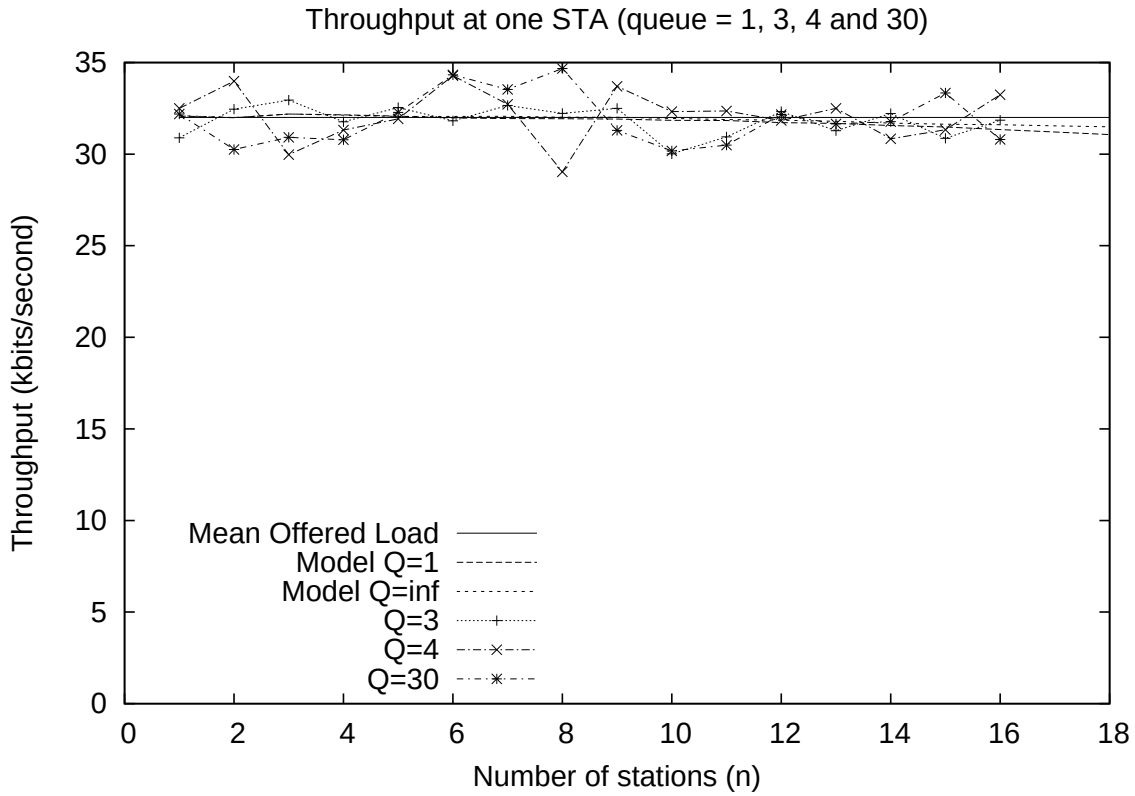


Figure 2: Measured and modelled throughput at a single STA. The buffer size at the AP and the STAs is the same.

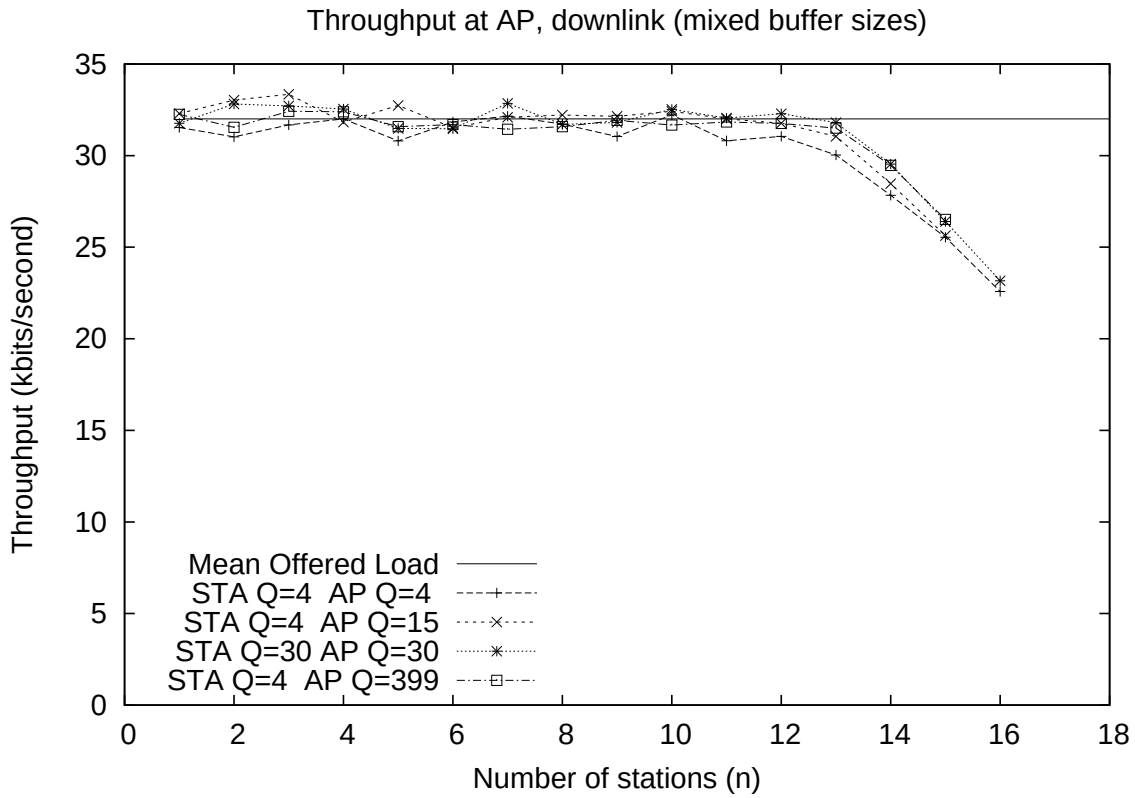


Figure 3: Measured throughput at the AP. Results are shown for various combinations of buffer sizes at the STAs and the AP.

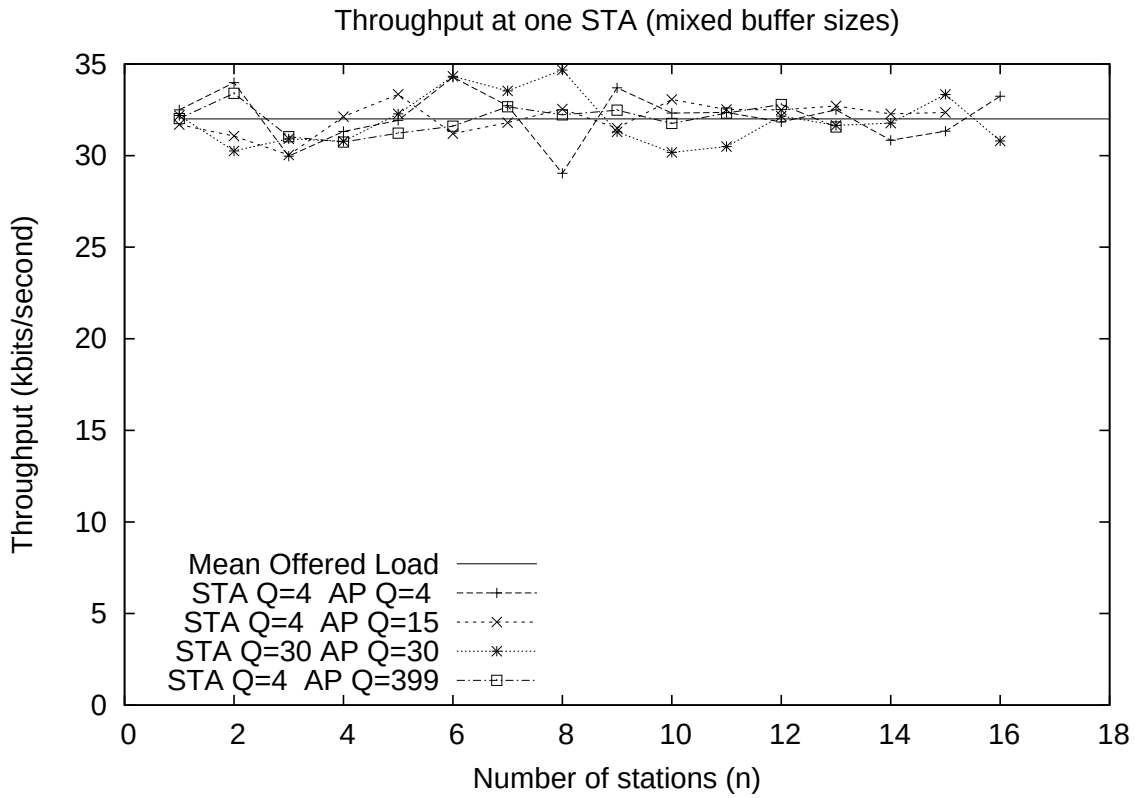


Figure 4: Measured throughput at a single STA. Results are shown for various combinations of buffer sizes at the STAs and the AP.

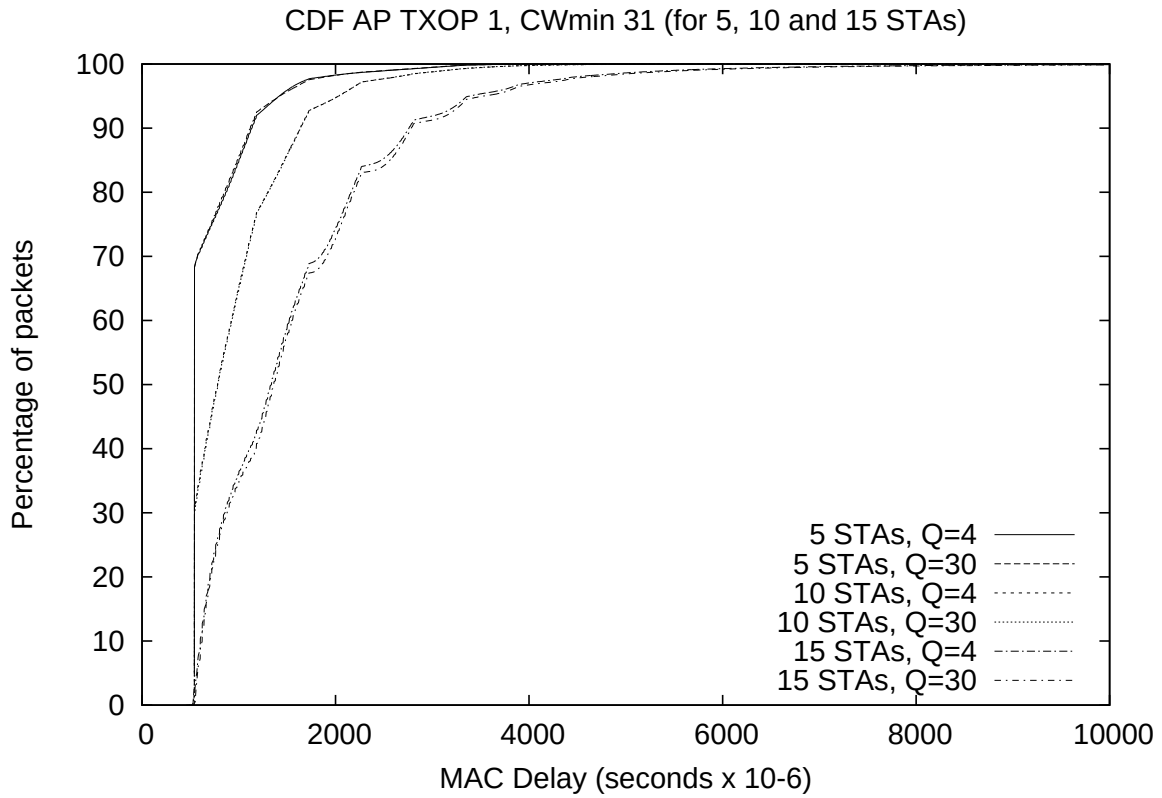


Figure 5: Cumulative distribution for delays at the access point when there are 5, 10 and 15 stations with standard MAC settings.

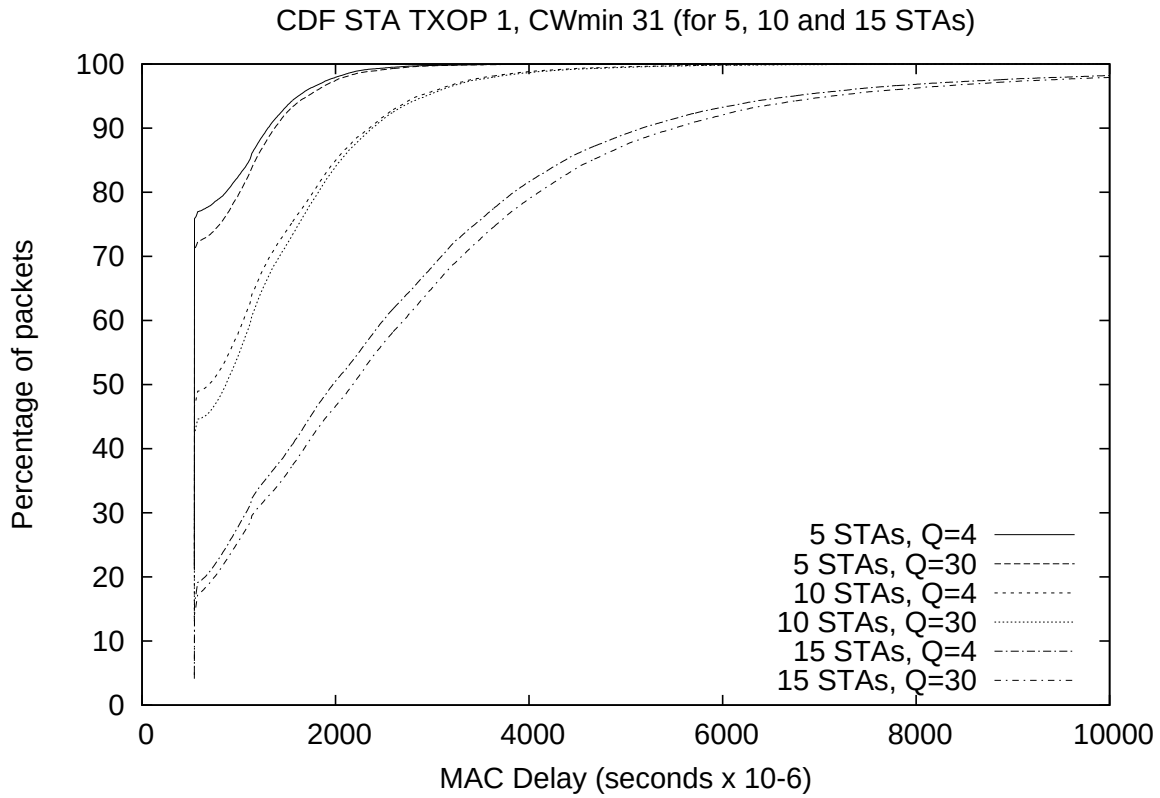
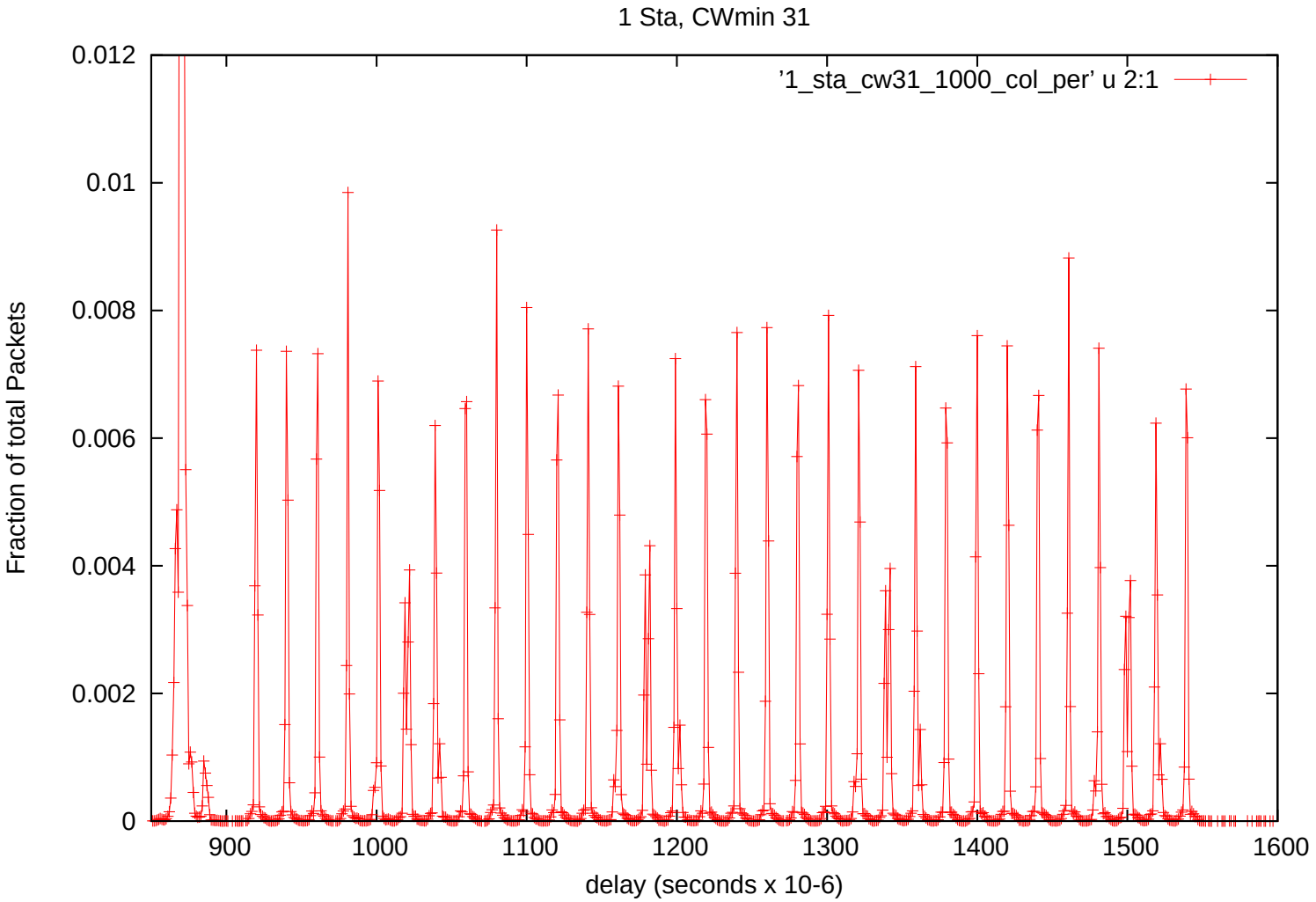


Figure 6: Cumulative distribution for delays at a station when there are 5, 10 and 15 stations with standard MAC settings.

Solution: 802.11e?

- 802.11e makes parameters tunable.
- CWmin: base range for backoff.
- TXOP: transmission duration.
- Simple solution: TXOP = n packets.
- Better solution: CWmin = 16, TXOP = $n/2$ packets?


1 Sta, CWmin 31
'1_sta_cw31_1000_col_per' u 2:1
Fraction of total Packets
0.012
0.01
0.008
0.006
0.004
0.002
0
900
1000
1100
1200
1300
1400
1500
1600
delay (seconds x 10-6)

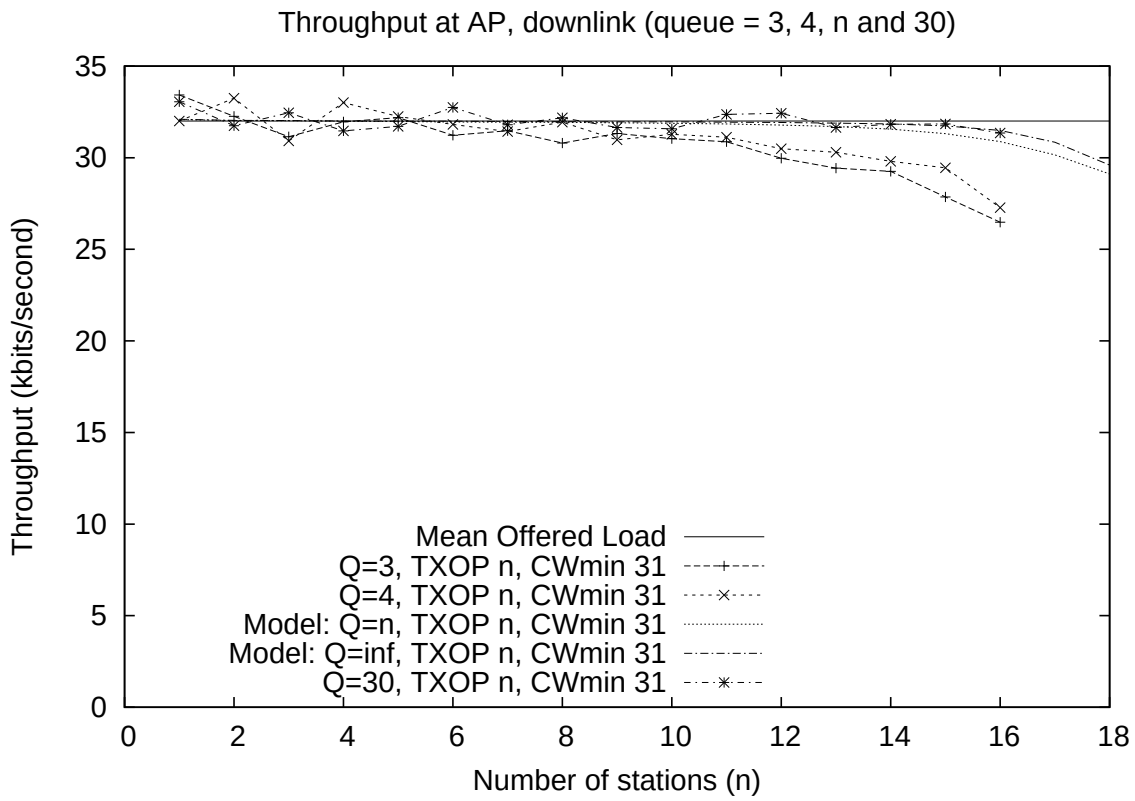


Figure 7: Throughput at the AP for prioritised voice, with $TXOP = n$ packets.

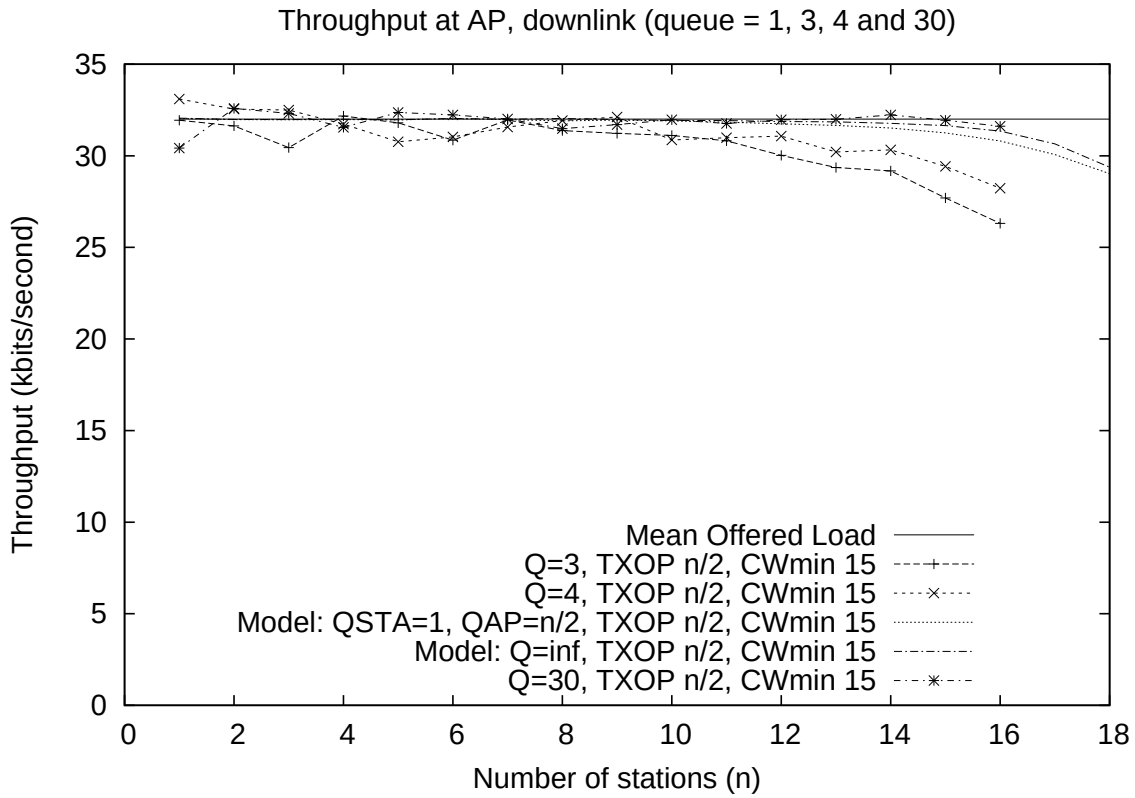


Figure 8: Throughput at the AP for prioritised voice, $TXOP = n/2$, $CW_{min} = 15$.

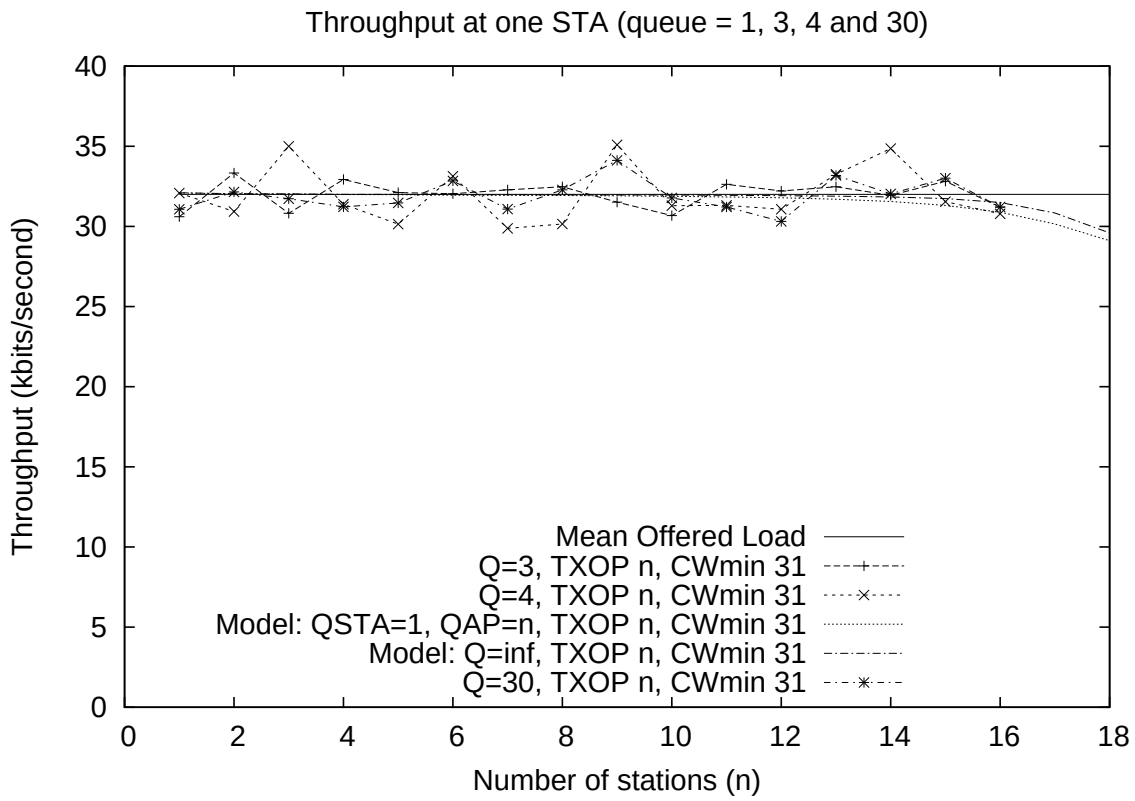


Figure 9: Throughput at a STA for prioritised voice, with $TXOP = n$ packets at the AP.

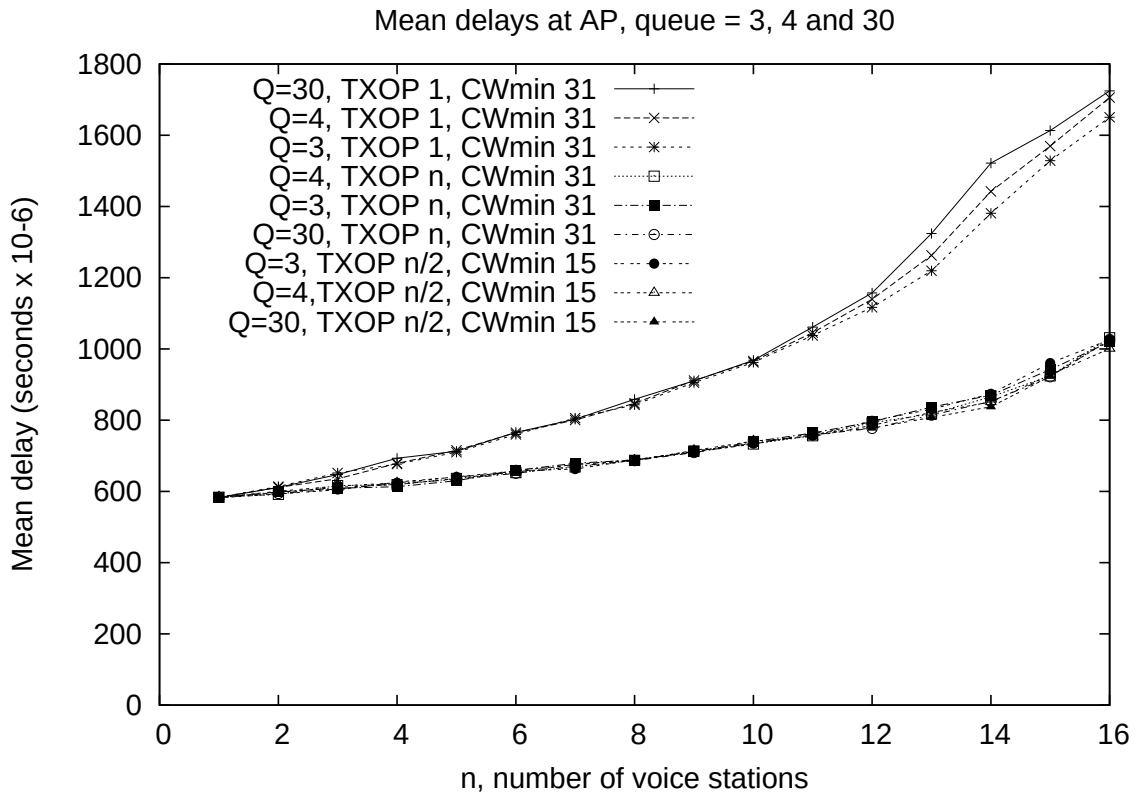


Figure 10: Mean MAC delay at the AP. The group with longer mean delays correspond to the experiments in which the AP is not prioritised.

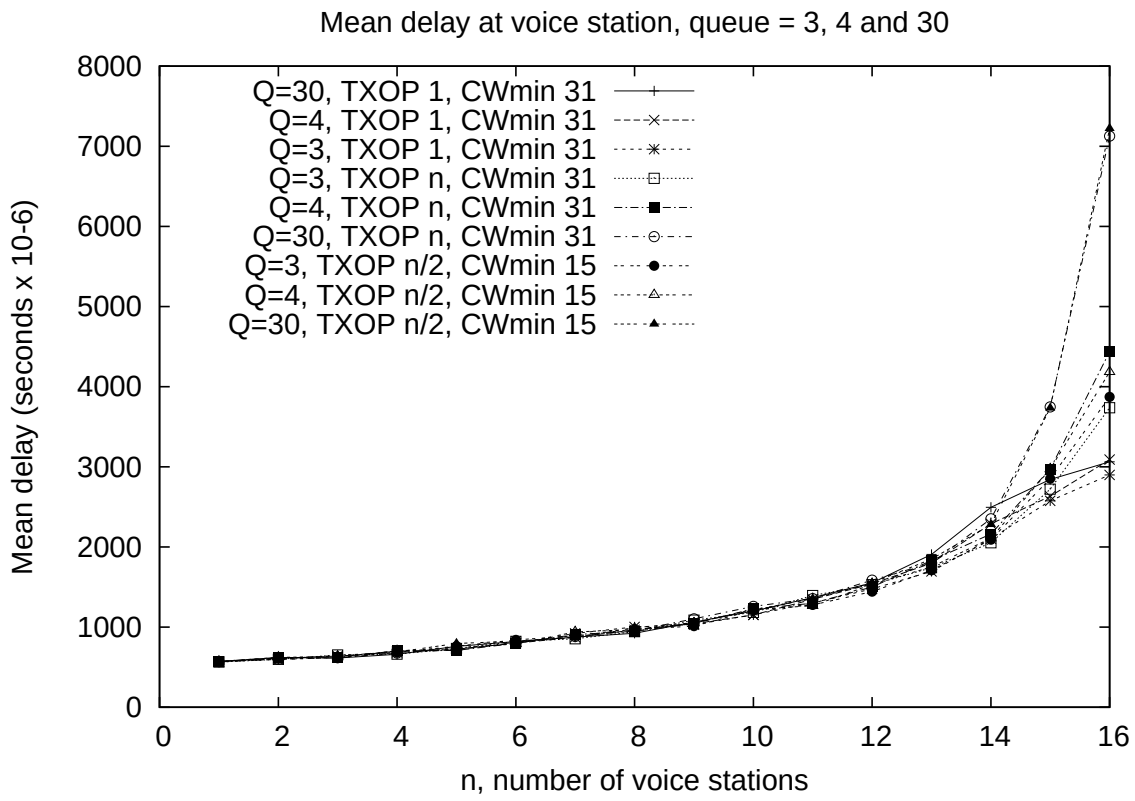


Figure 11: Mean MAC delay a station. The mean inter-packet arrival time at a STA is $10000\mu s$.

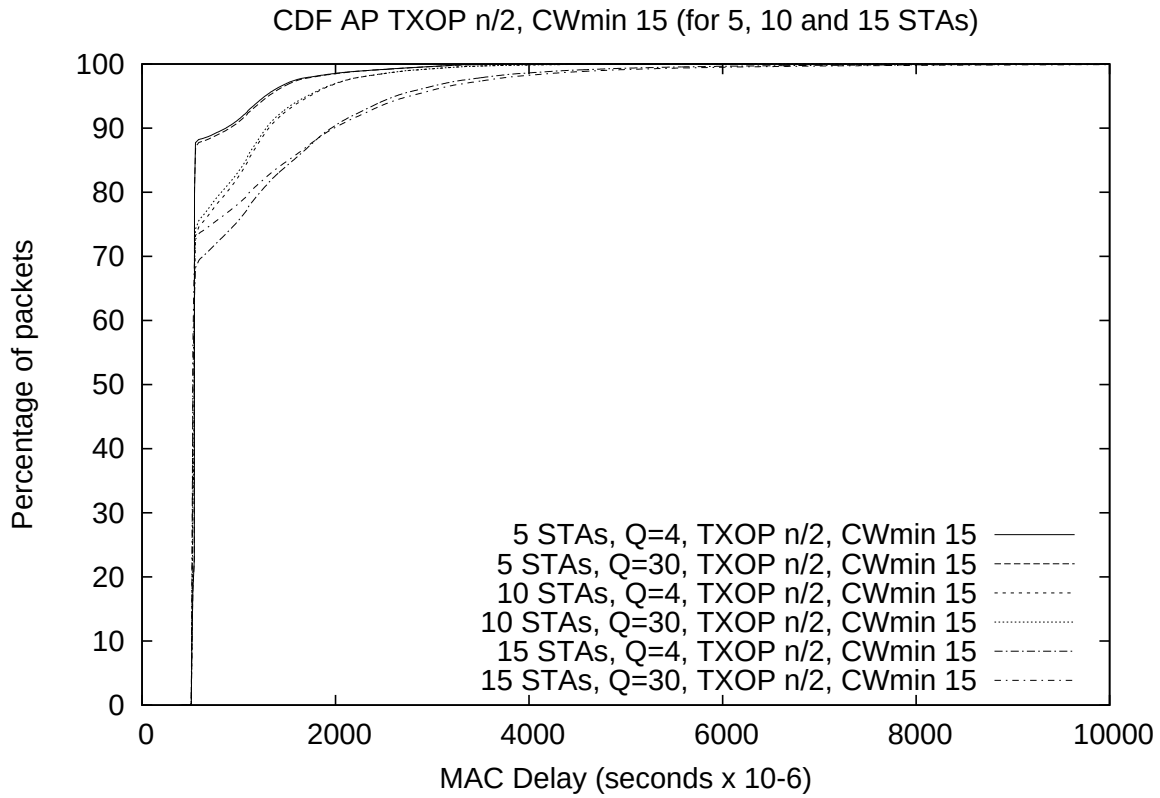


Figure 12: Cumulative distribution for delays at the AP when there are 5, 10 and 15 stations and the AP is prioritised using $TXOP = n/2$ and $CW_{min} = 15$.

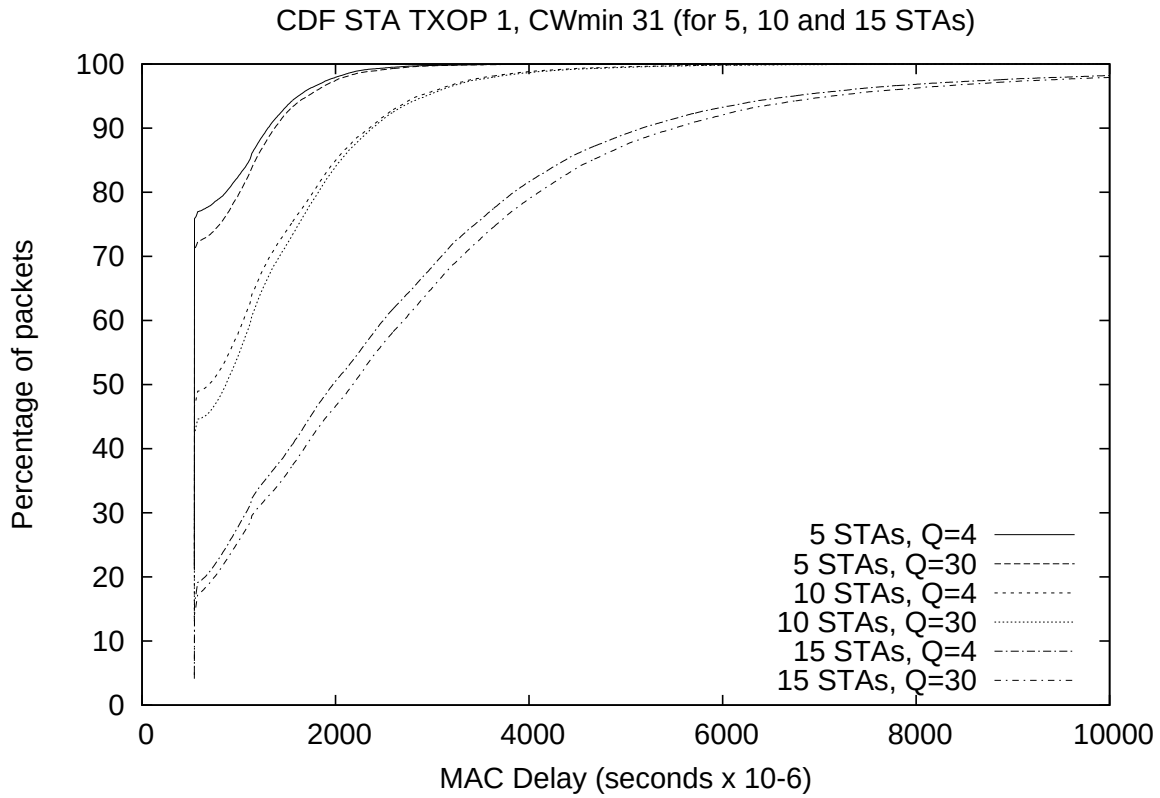


Figure 13: Cumulative distribution for delays at a station when there are 5, 10 and 15 stations with standard MAC settings.

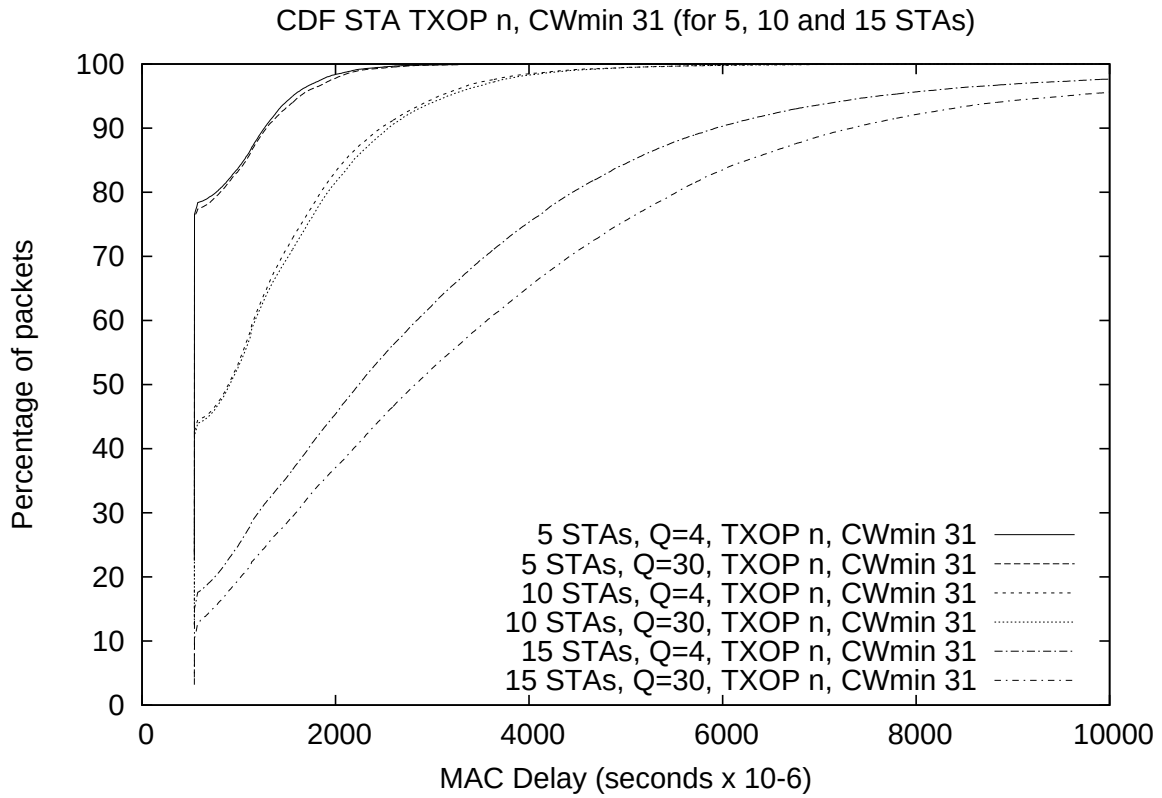


Figure 14: Cumulative distribution for delays at a station when there are 5, 10 and 15 stations and the AP is prioritised using $TXOP = n$.

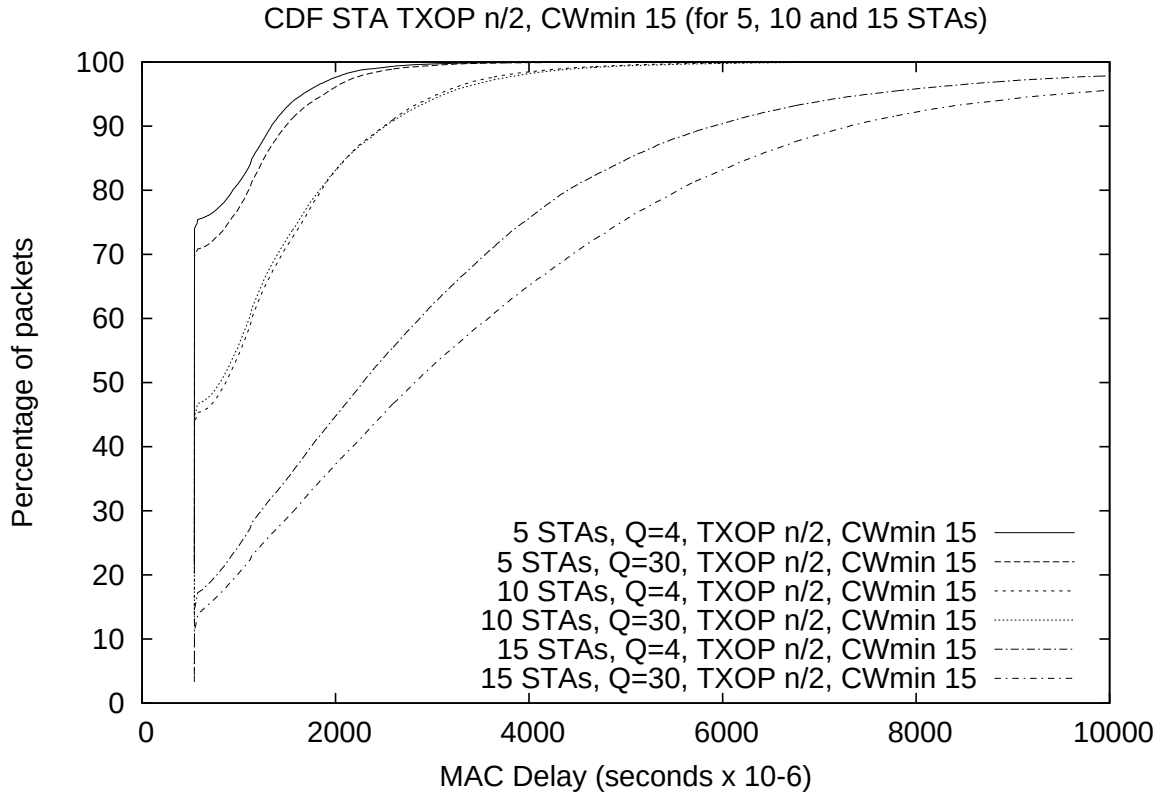


Figure 15: Cumulative distribution for delays at a station when there are 5, 10 and 15 stations when the AP is prioritised using $TXOP = n/2$ and $CW_{min} = 15$.

Conclusion

- Reproduced capacity problem.
- Buffering helps, TXOP helps more.
- Models are producing useful predictions.
- Burstiness for TXOP seems OK.
- Some interesting MAC/buffer tradeoffs.