Simulation of IEEE 802.16h and IEEE 802.11y Coexistence

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Venue:

Joint meeting with 802.11/802.16/802.19 concerning 3.65GHz coexistence

Base Document:

IEEE C802.16h-07/017r1 <http://www.ieee802.org/16/le/contrib/C80216h-07_017r1.pdf>

Purpose:

To help resolve the coexistence issues between IEEE 802.11y and 802.16h systems

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Simulation of IEEE 802.16h and IEEE 802.11y Coexistence

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April 12, 2007

Simulation Assumptions

- Co-located Co-channel Systems
- All devices visible to each other…no hidden nodes
- Any 802.11y/802.16 packet overlap results in collision
- Same channel BW (5 MHz)
- Same modulation and code rate (1/2 QPSK)
- Same raw PHY bit-rate (~3 Mb/s)
- 802.16 Frame: DL:3ms, UL:2ms
- 802.11y PHY parameters: Table 147 of IEEE P802.11-REVma/D8.0 (5MHZ), RTS/CTS disabled

Simulation Scenarios

- Interference-free
- Baseline: fully interfering, no coexistence mechanisms
- Listen-before-Talk (LBT)
- Extended Quiet Periods (EQP)

Metrics of Interest: Average throughput and packet delay as a function of the total traffic offered to each system

Traffic Model

- Packet inter-arrival time exponentially distributed
- Packet size uniformly distributed in the range

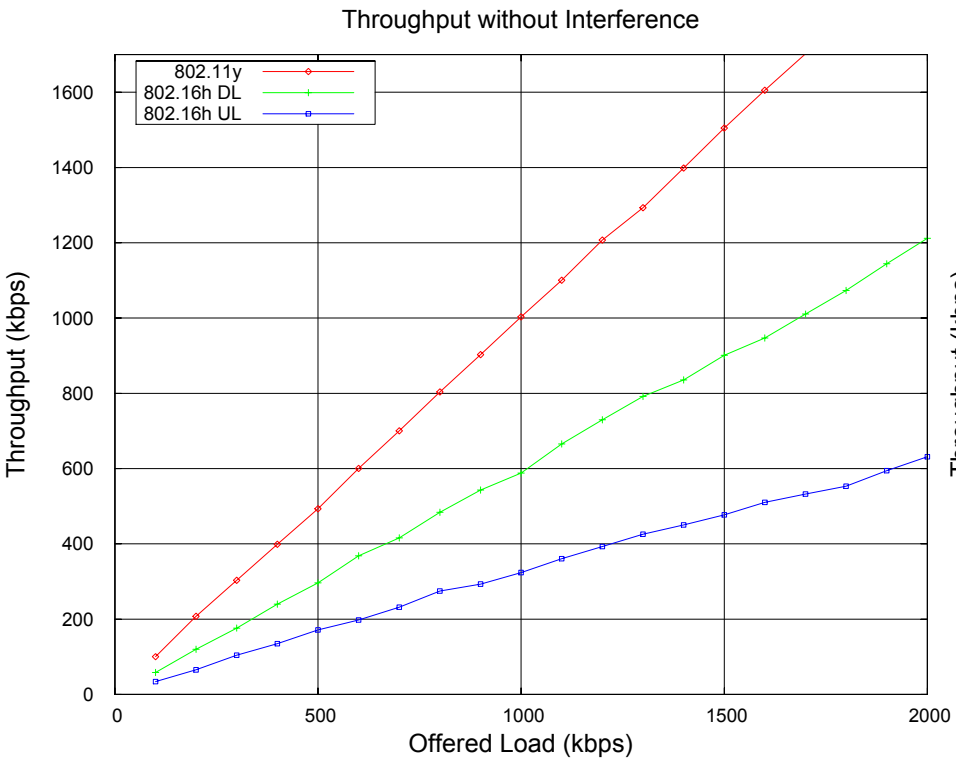
  0.1x1500 – 0.9x1500 bytes
- Both systems subject to UDP traffic with the same offered load

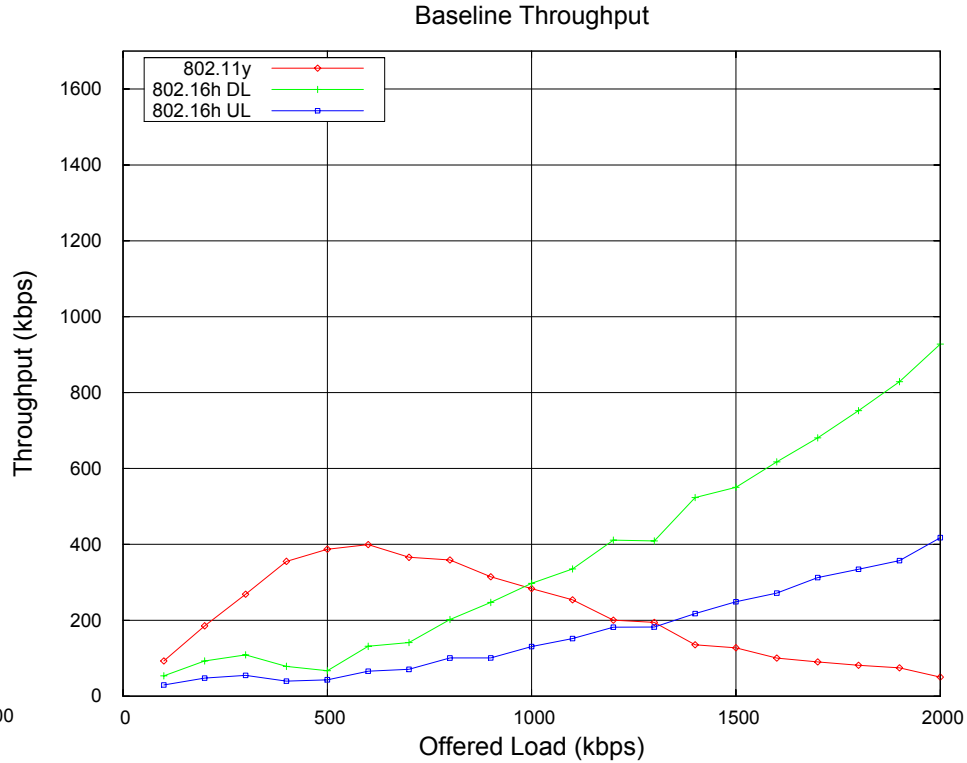
(varied from 100 kbps to 2.0 Mbps in 100kbps increments)

- DL/UL load ratio: 60/40

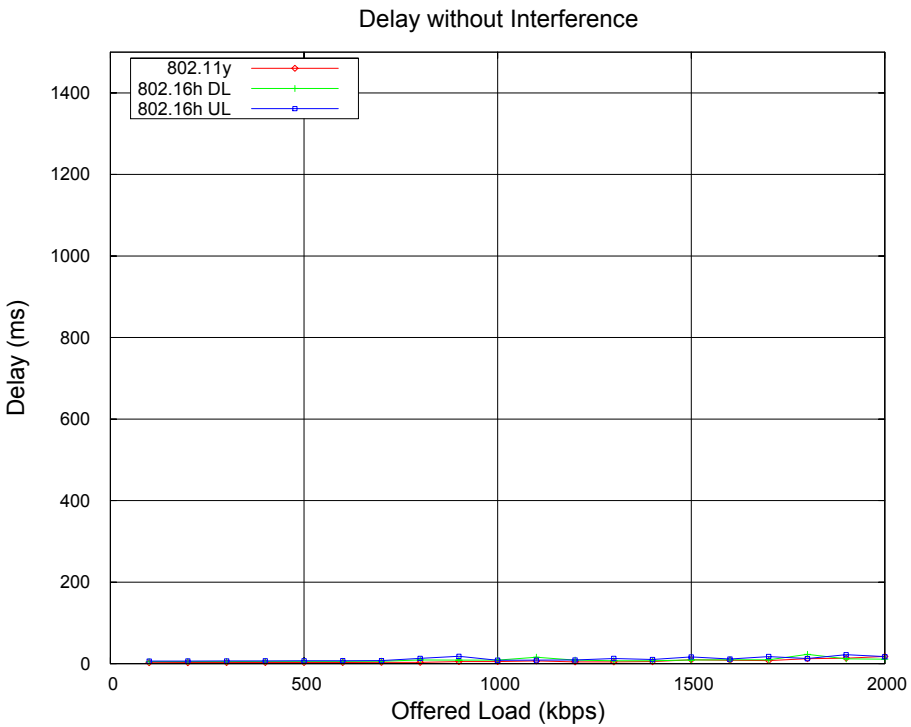
Simulation Setup

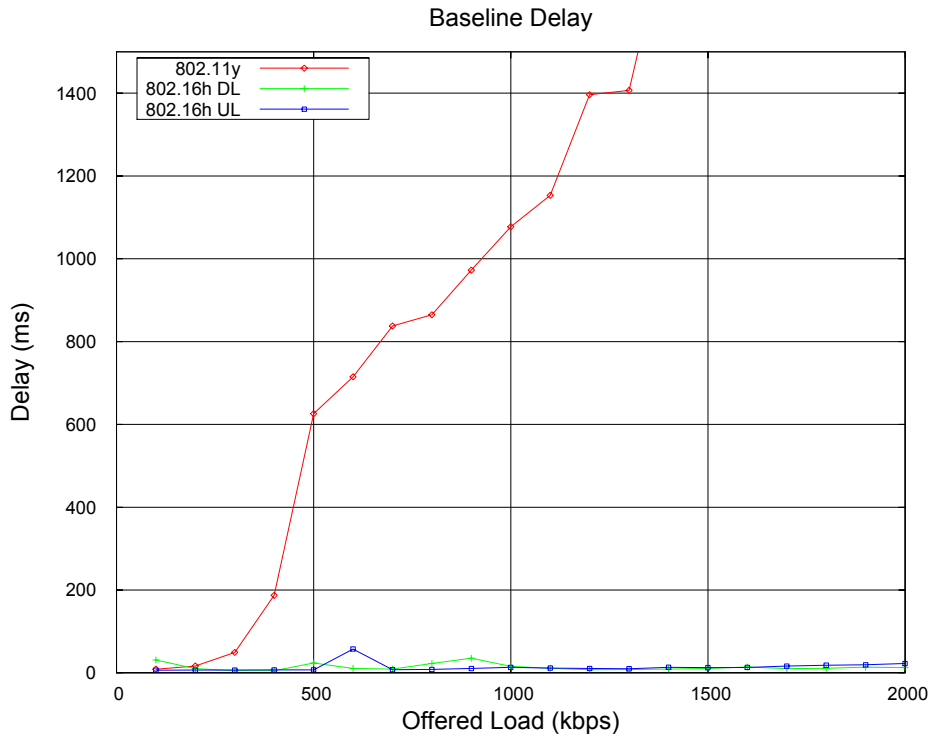
- Packet-level simulator
- 100s total simulation runtime, 20s warm-up period
- Each of the two systems simulated with 1 AP and 1 client node
- Multiple independent iterations of each coexistence scenario





Average throughput with no interference (left) and with baseline interference (right)





Average delay with no interference (left) and with baseline interference (right)

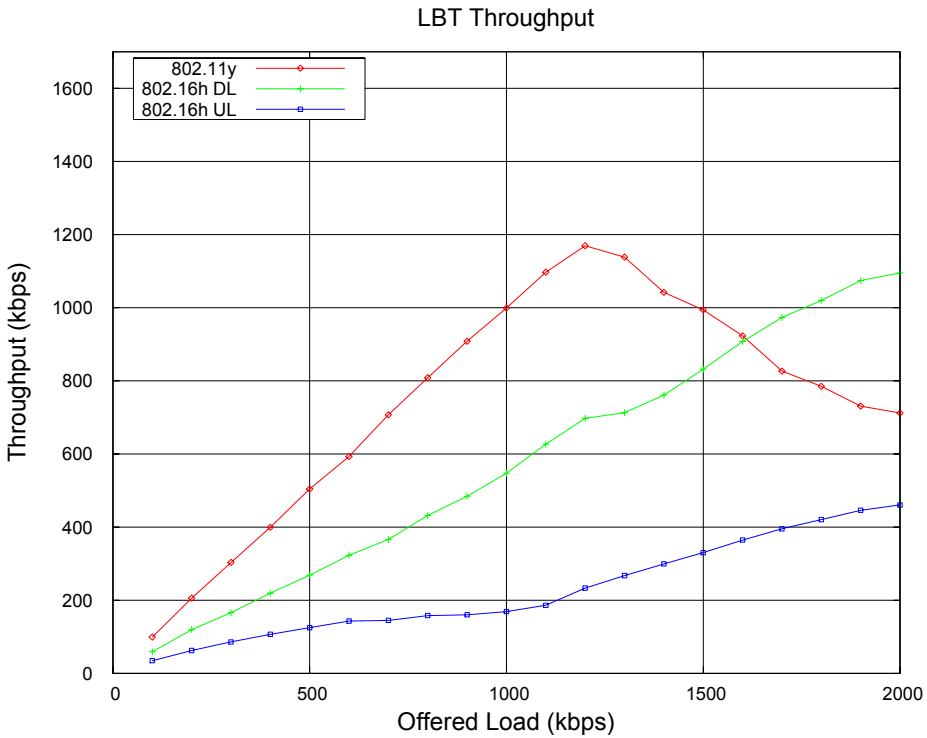
Listen-Before-Talk (LBT)

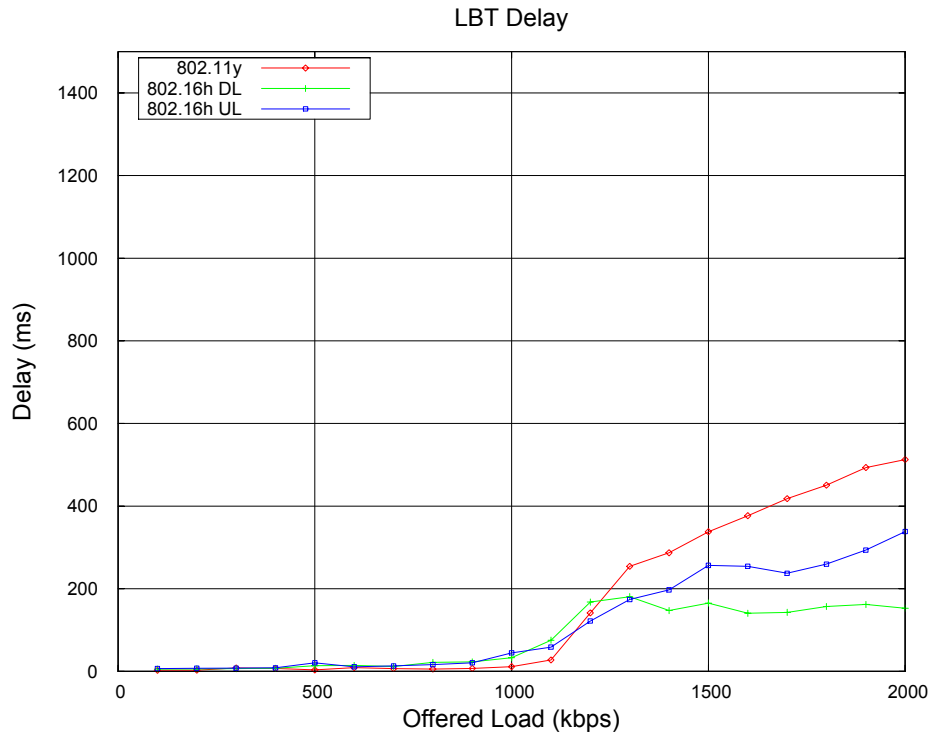
- Clear channel assessment undertaken by 802.16 system at the Transmit/Receive Gap of the TTD frame structure

- Applied independently to the IEEE 802.16 UL and DL

- Data deferred from tx due to 802.11y activity is buffered for next available frame

- The 802.11y operates in its regular CSMA/CA manner





Effect of LBT on Co-channel, Co-located IEEE 802.11y & 802.16 Throughput and Delay

Extended Quiet Period (EQP)

- Detailed in Clause 6.4.3.3. Of IEEE P802.16h/D2

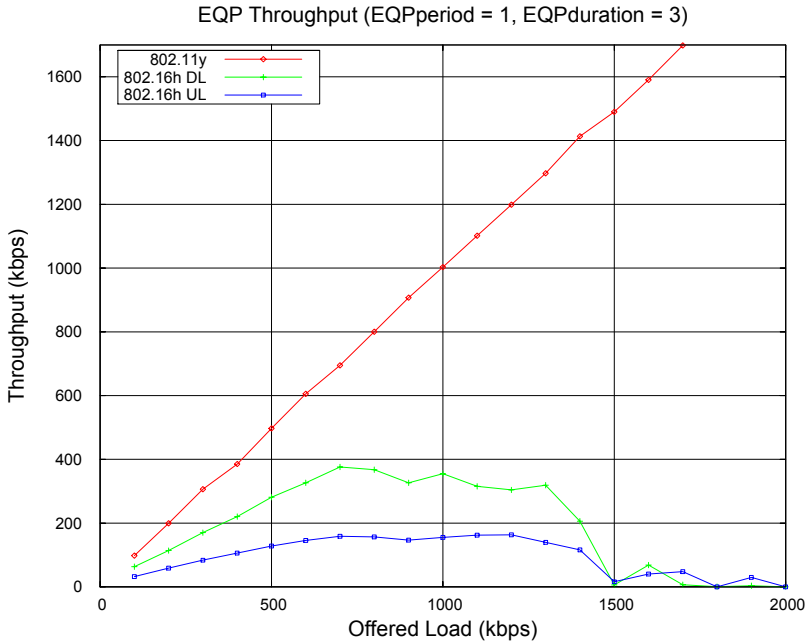
- IEEE 802.16 Frames are purposely not used so that IEEE 802.11y systems can use the created space without interference

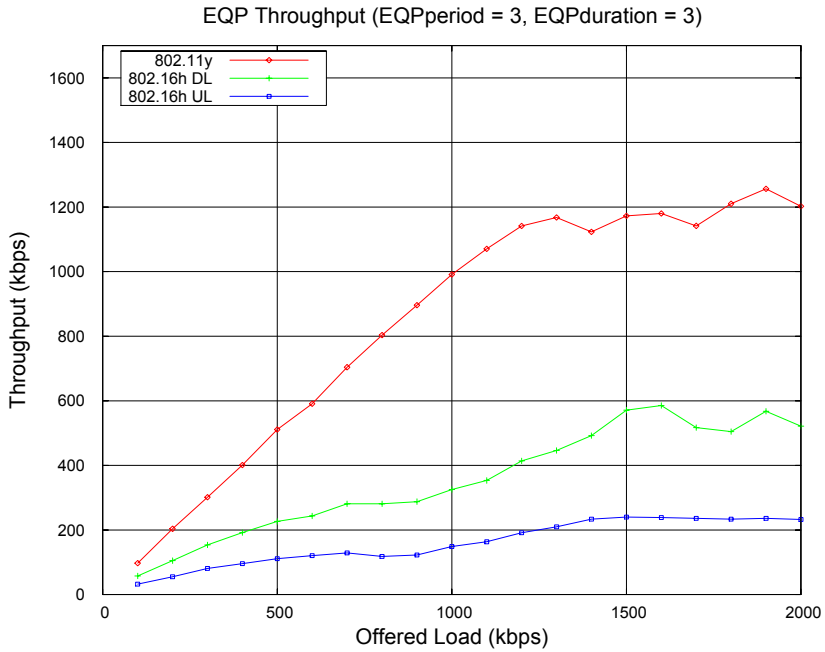
- The IEEE 802.11y operates without restrictions

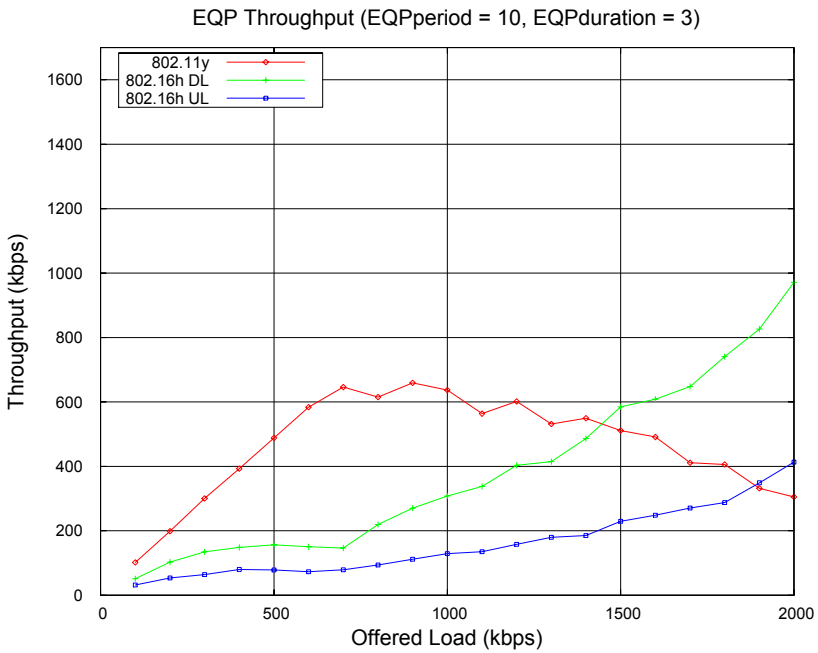
- EQP **Duration:** the number of integer 802.16 “quiet” frames

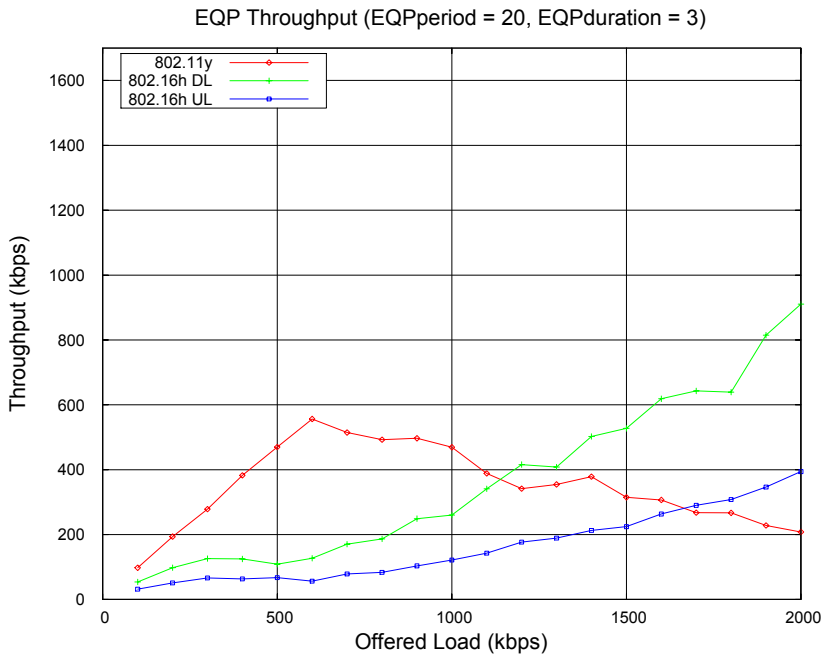
- EQP **Period**: the number of integer 802.16 “active” frames

Throughput Performance for Various EQP periods



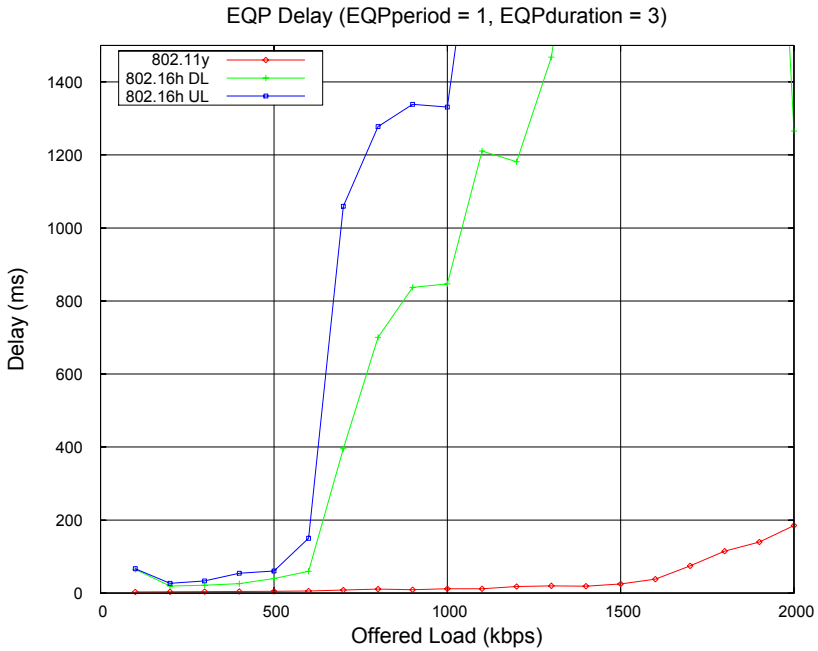


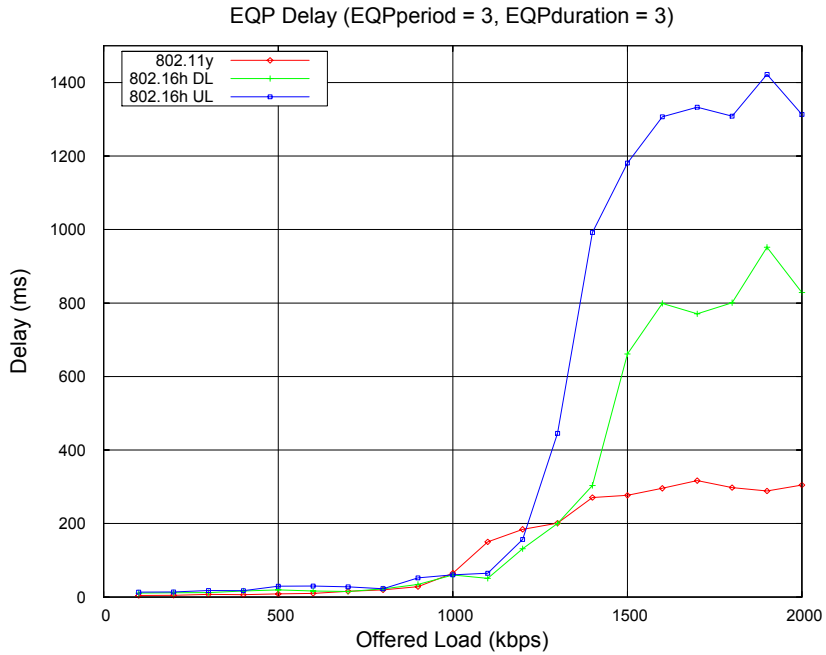


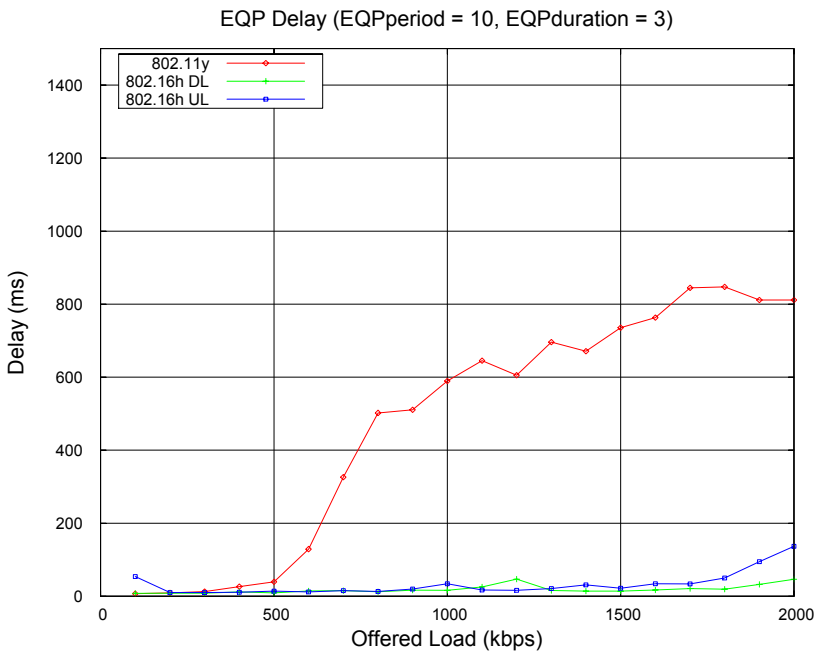


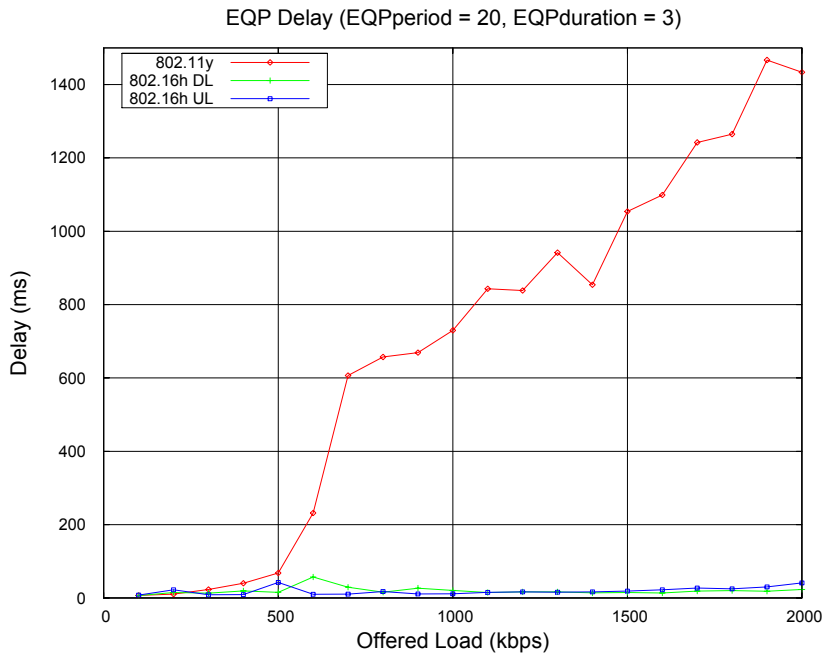
EQP Duration of 3=15 ms… and is the 802.16 “Quiet” time

Delay Performance for Various EQP periods









EQP Duration of 3=15 ms… and is the 802.16 “Quiet” time

Conclusions

As is and without refinements to the existing standards, IEEE 802.16 and 802.11y systems will severely affect each other's performance in common deployment environments (such as 3.65 GHz).

LBT provides a measure of performance improvement. To a lesser degree so does EQP.

The simulation scenarios are highly specific and simple….more complex scenarios will likely require most sophisticated avoidance, collaborative, and sensing measures by both standards.

More info: IEEEC802.16h-07/017r1