UCP simulation: Approach and Initial Results

IEEE 802.16 Presentation Submission Template (Rev. 8.3)

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Paul Piggin	Voice:	**1 858 480 3100**
NextWave Broadband Inc.	Fax:	**1 858 480 3105**
12670 High Bluff Drive	E-mail:	**ppiggin @ nextwave.com**
San Diego CA 92130 USA		

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    Session #47

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Purpose:

UCP simulation: Approach and Initial Results

Paul Piggin

NextWave Broadband

Presentation Overview

- Present a simulation environment for proof of concept of UCP (Uncoordinated Coexistence Protocol) – sub clause *6.4.2.4* in P802.16h/D1
- Considering 3.65GHz, looking to demonstrate coexistence with 802.11y and supporting a solution based on UCP
- Simulation overview:
  - Equipment
  - Environment
- LBT and EQP/aEQP features and simulation results
- Further work

Definition of the *Simulation Space*
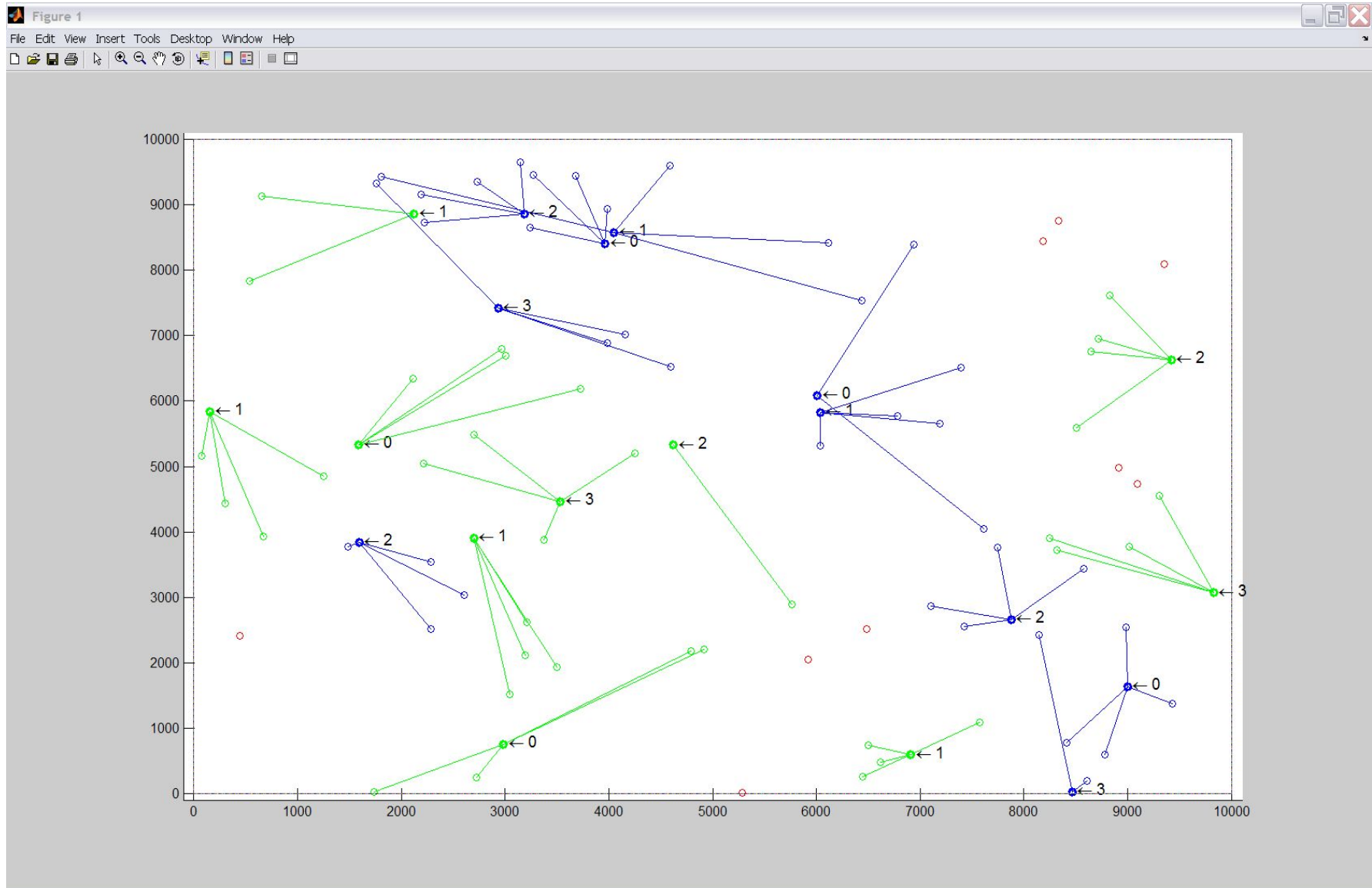
High-level simulation model

- Current traffic model – full buffer
- 802.16h initial assumptions for equipment are similar to *WiMAX Forum Release 1* certification parameters
- 802.11 model (under development) but based on 802.11a 5GHz OFDM with some modifications defined by 802.11 TGy
- Simulation 1-10secs averaged n times to generate a data point in the results that follow

Simulation assumptions: Equipment I

- 5ms frames
- 47 symbols per frame
  - 26 in the downlink (1 for preamble)
  - 21 in the uplink
- 102μs symbol duration
- RTG=60μs, SSTTG=SSRTG=50μs (WiMAX Forum parameters), TTG >50μs

Simulation assumptions: Equipment II

- 0 dBi antenna BS and MS (omni)
- 10MHz channels (5 channels in the simulation)
- 3 modulation schemes supported:
  - CTC QPSK ¾ (sensitivity -85.1dBm, Pwr = 20dBm)
  - CTC 16QAM ½ (sensitivity -82.8dBm , Pwr = 17dBm)
  - CTC 16QAM ¾ (sensitivity -78.7dBm, , Pwr = 17dBm)
  - (NB AWGN from WiMAX Forum RCT v1.0.0)
- Noise Figure = 6dB (BS & SS)
- Adjacent channel rejection (all modulation schemes):
  - $n \pm 1 = 10$dB
  - $n \pm 2 = 30$dB
  - $> n \pm 2 = 40$dB

Simulation assumptions: Environment

- 1km square simulation area
- Free space path loss model ($n=2$)
- No height variation in devices
- Specify x 802.16h BS and y 802.11y APs
- Up to z SS/STA associated with each BS/AP, respectively
- UCP:
  - DCS (undertaken once at the beginning of the simulation to distribute frequency allocation)
  - EQP/aEQP
  - LBT

Interference geometry calculation

SS$_{1,1}$

BS$_1$

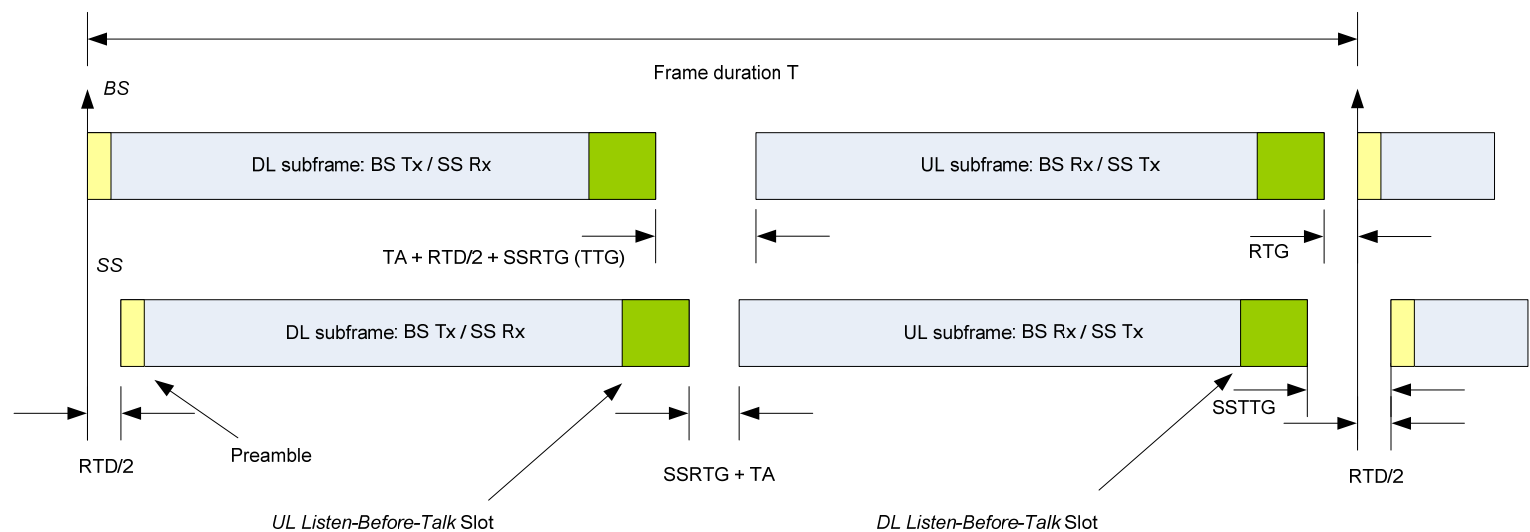Pathloss(1,2)$_{2,1}$
TxPwr(1,2)$_{2,1}$
Time of flight(1,2)$_{2,1}$

SS$_{2,1}$

SS$_{1,2}$

BS$_2$

SS$_{1,3}$

Pathloss(1,2)$_{2,2}$
TxPwr(1,2)$_{2,2}$
Time of flight(1,2)$_{2,2}$

SS$_{2,2}$

SS$_{2,3}$
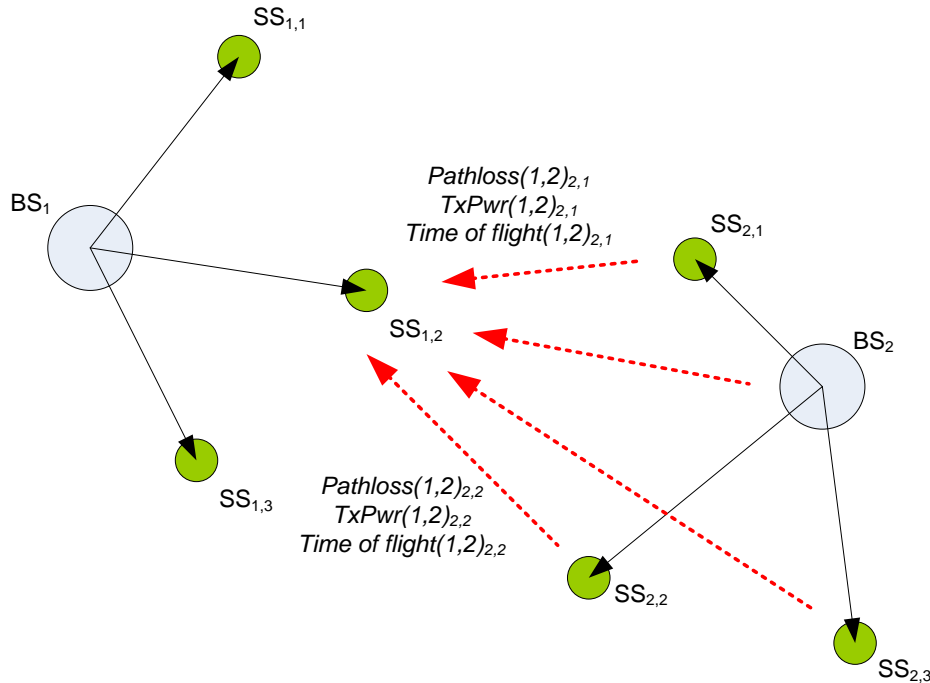
- Evaluation of link budget to calculate interference
- Compensation for *time of flight* given the microsecond resolution in the simulation
- -> Provides a decision on whether or not a device is transmitting at a given simulation instant

Frame duration T

BS

DL subframe: BS Tx / SS Rx

UL subframe: BS Rx / SS Tx

TA + RTD/2 + SSRTG (TTG)

RTG

SS

DL subframe: BS Tx / SS Rx

UL subframe: BS Rx / SS Tx

RTD/2

Preamble

SSRTG + TA

SSTTG

RTD/2

UL Listen-Before-Talk Slot

DL Listen-Before-Talk Slot

Listen Before Talk (LBT)

- Configuration:
  - DL LBT
  - UL LBT
  - DL&UL LBT
- First realisation: measured in a dedicated OFDM slot (102µs) just prior to respective DL and UL sub-frame
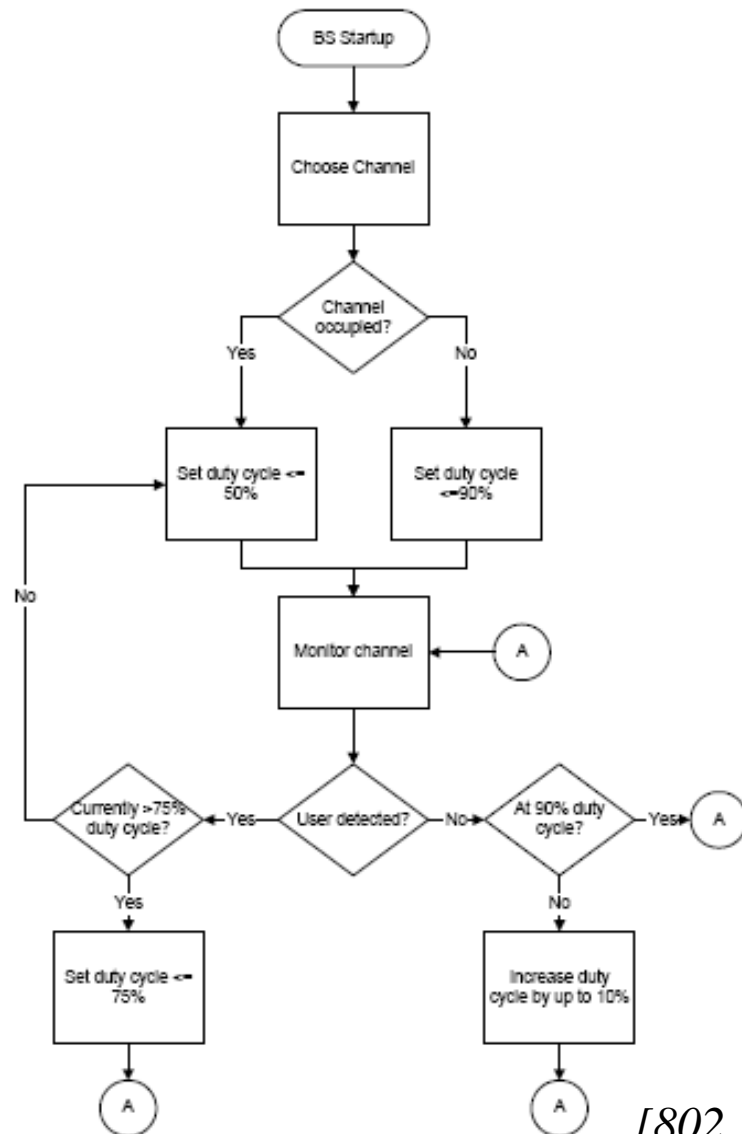- Controlled at BS and associated SS - act independently

Frame duration T

BS

| DL subframe: BS Tx / SS Rx | | UL subframe: BS Rx / SS Tx | |

TA + RTD/2 + SSRTG (TTG)

RTG

SS

| DL subframe: BS Tx / SS Rx | | UL subframe: BS Rx / SS Tx | |

SSTTG

RTD/2

Preamble

SSRTG + TA

RTD/2

UL Listen-Before-Talk Slot

DL Listen-Before-Talk Slot
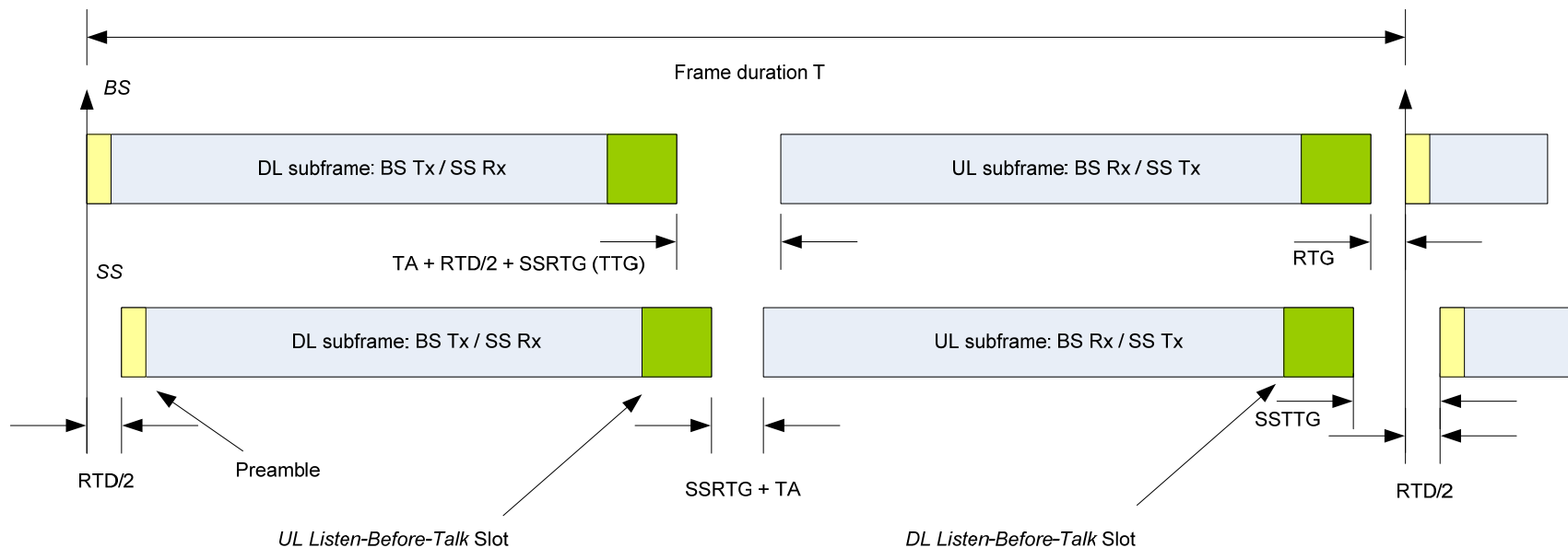
Adaptive Extended Quiet Period (EQP/aEQP)

- As implemented in 802.16h/D1
- Threshold 1 = -80dBm
- Threshold 2 = -75dBm
- Controlled at the BS
- Driven by interference calculations in the entire EQP UL sub-frame
- Measured at 50µs intervals

[802.16h/D1 sub clause 6.4.3.4]

Results summary

- 16h BS with a maximum of 4 SS per BS
- Specification of the number of channels based on bandwidth
- Frame sync. and/or EQP sync.

- What *system wide* results are produced?

  devices_active

  general_int_level

- What *user specific* results are produced?

  dl_lbt_interference_power_per_lbt_slot

  ul_lbt_interference_power_per_lbt_slot

  failed_dl_lbt_ratio

  failed_ul_lbt_ratio

  eqp_ratio

  dl_aeqp_interference_assessment

  dl_dot16_activity

  ul_dot16_activity

  dl_dot11_activity

  ul_dot11_activity

  dl_dot16_transmit_delay

  ul_dot16_transmit_delay

  dl_dot11_transmit_delay
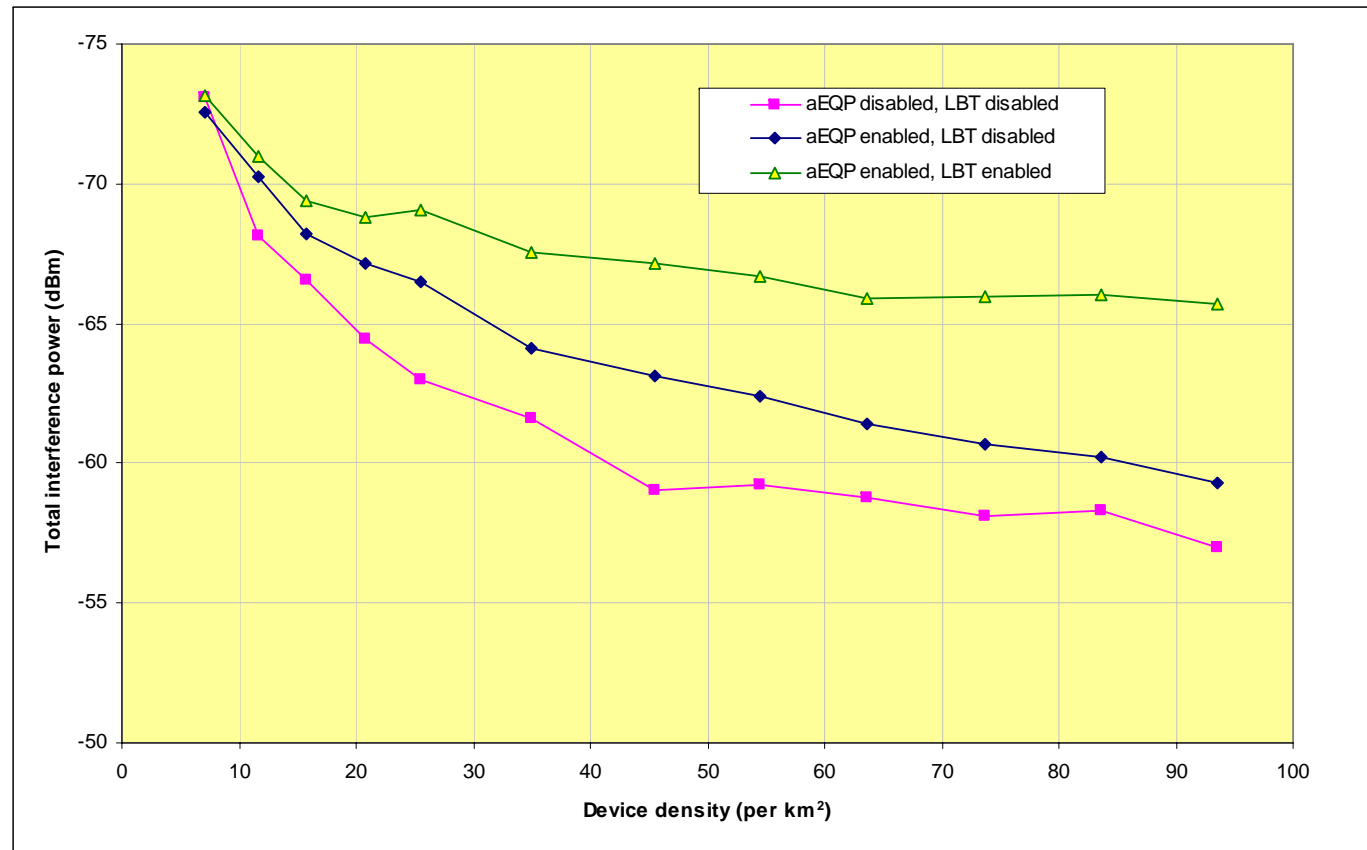
  ul_dot11_transmit_delay

Simulation results I

- 5 channels
- No BS sync.
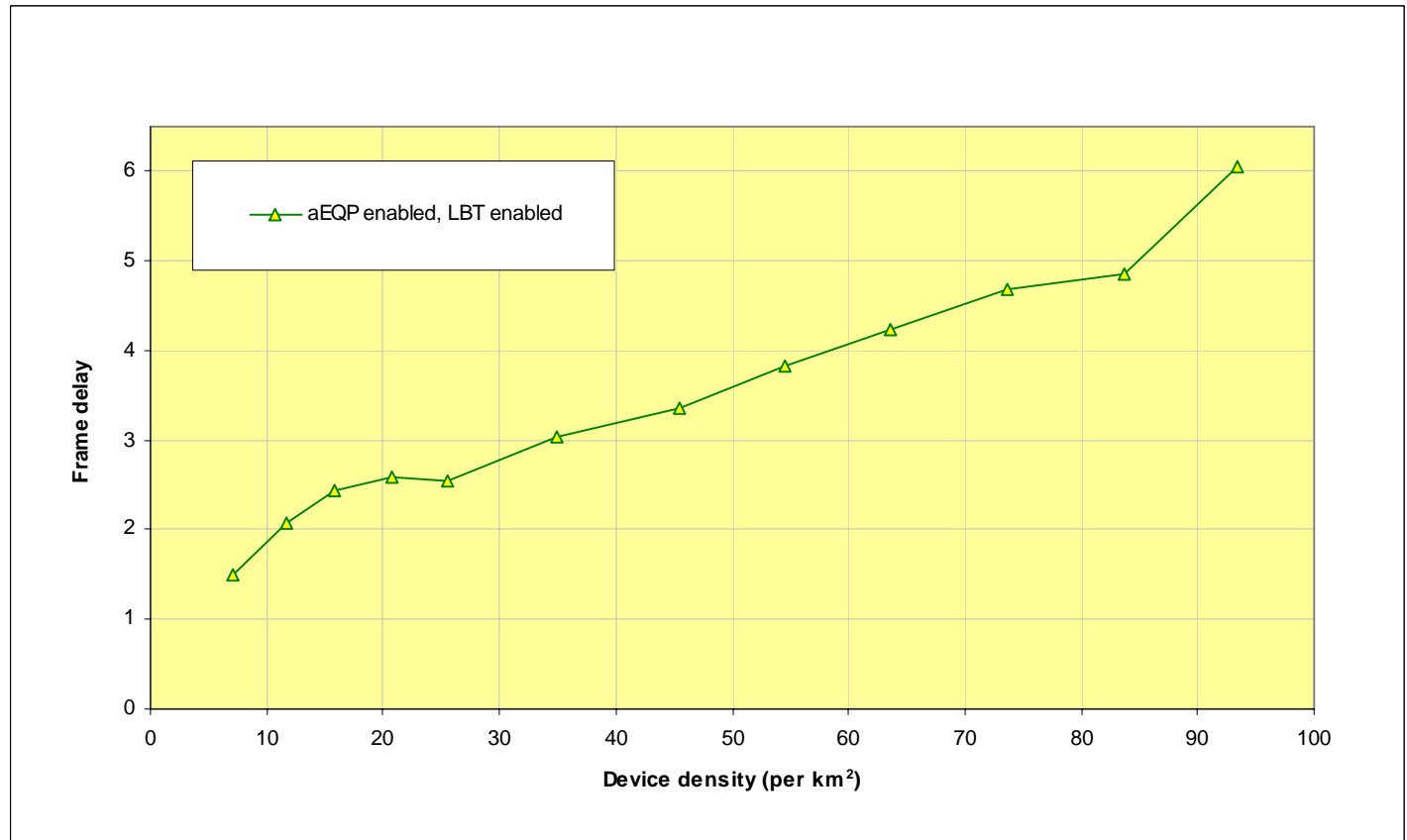- Results for DL
- EQP behaviour
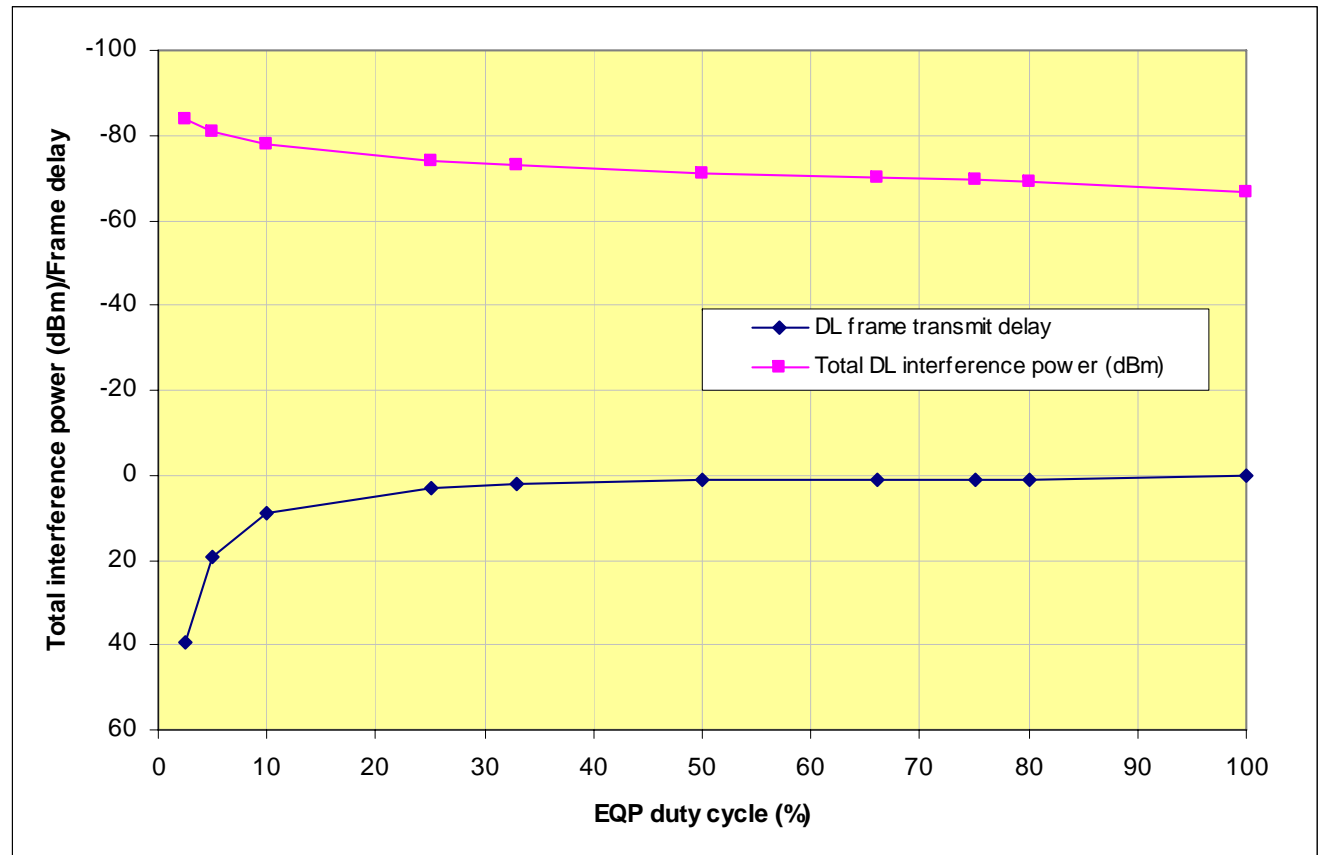
Simulation results II

- 1 channel
- No BS sync.
- DL considered
- aEQP and LBT behaviour

Simulation results III

- 1 channel
- No BS sync.
- DL considered
- aEQP and LBT behaviour

Future work

- Fully integrate the 802.11 model
- Improved interference reporting based on the incorporating of an 802.11 model
- Provide a statistical traffic model
- Provide a more realistic method for interference calculation
- Applicability to other bands containing 802.11 devices in other *legacy bands*