

Simulating coexistence between 802.11y and 802.16h systems in the 3.65GHz band – Scenarios and assumptions

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Simulating coexistence between 802.11y and
802.16h systems in the 3.65GHz band – *scenarios
and assumptions*

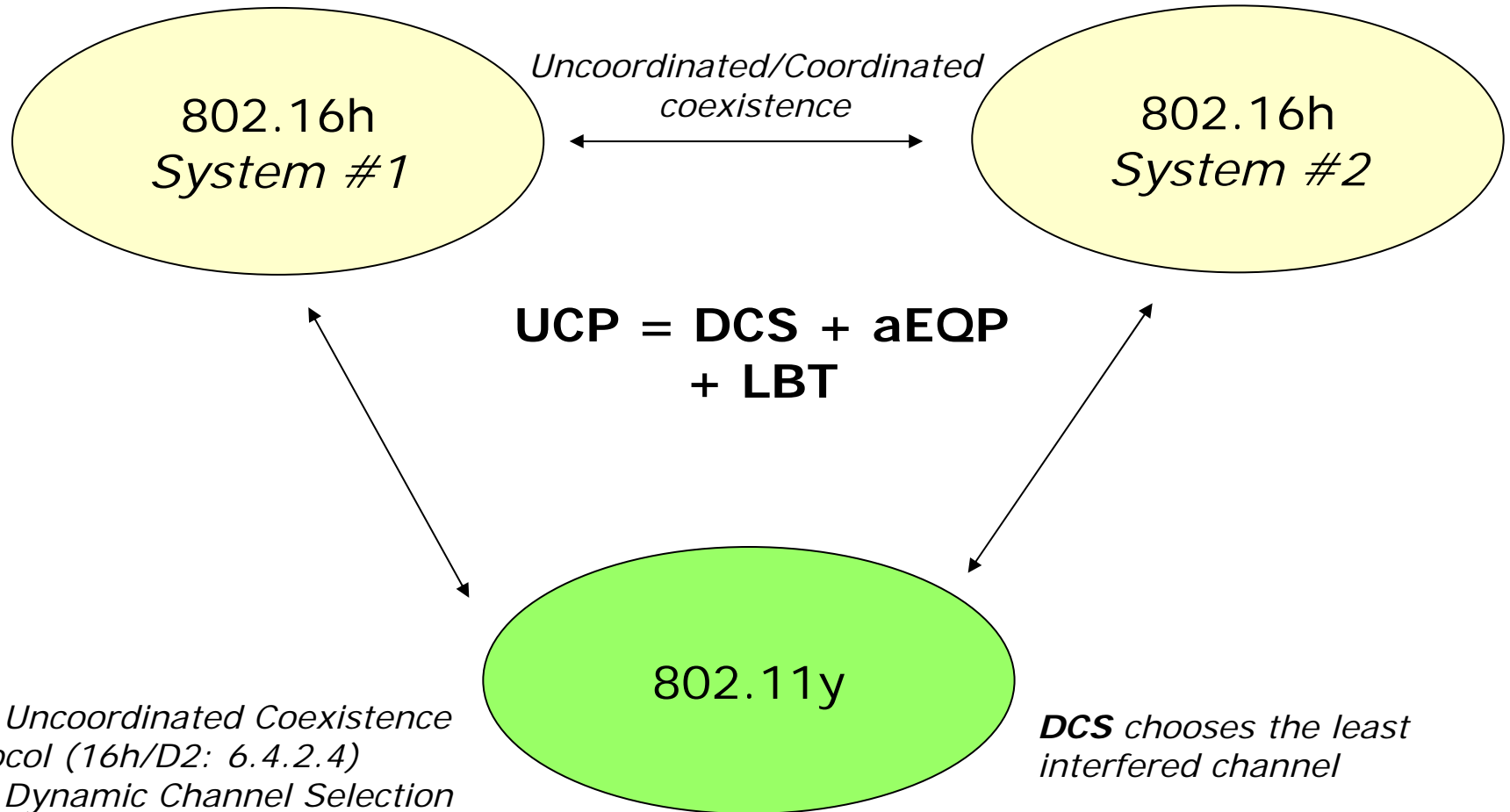
Paul Piggin
NextWave Broadband

Simulation model and starting assumptions

System level simulation based on:

- **Interference assessment (pathloss + link budget evaluation)**
- **Time domain analysis (1 μ s resolution)**
- 802.16h assumptions are based on *WiMAX Forum Mobile System Profile (Release 1.0 – Revision 1.2.2)* parameters with features to meet CBP (Contention Based Protocol) as specified in 16h/D2
- 802.11y model is based on 802.11a 5GHz OFDM with modifications defined by 802.11 TGy:
 - Maximum packet duration of 4ms
 - CCA-ED thresholds (details on a later slide)
 - Specific Contention Window values (15 -> 1023)
 - *Other parameters within the scope of this simulation effort?*

Simulating the coexistence environment



UCP Uncoordinated Coexistence Protocol (16h/D2: 6.4.2.4)

DCS Dynamic Channel Selection (16h/D2: 6.4.2.3.2)

aEQP Adaptive Extended Quiet Period (16h/D2: 6.4.3.3)

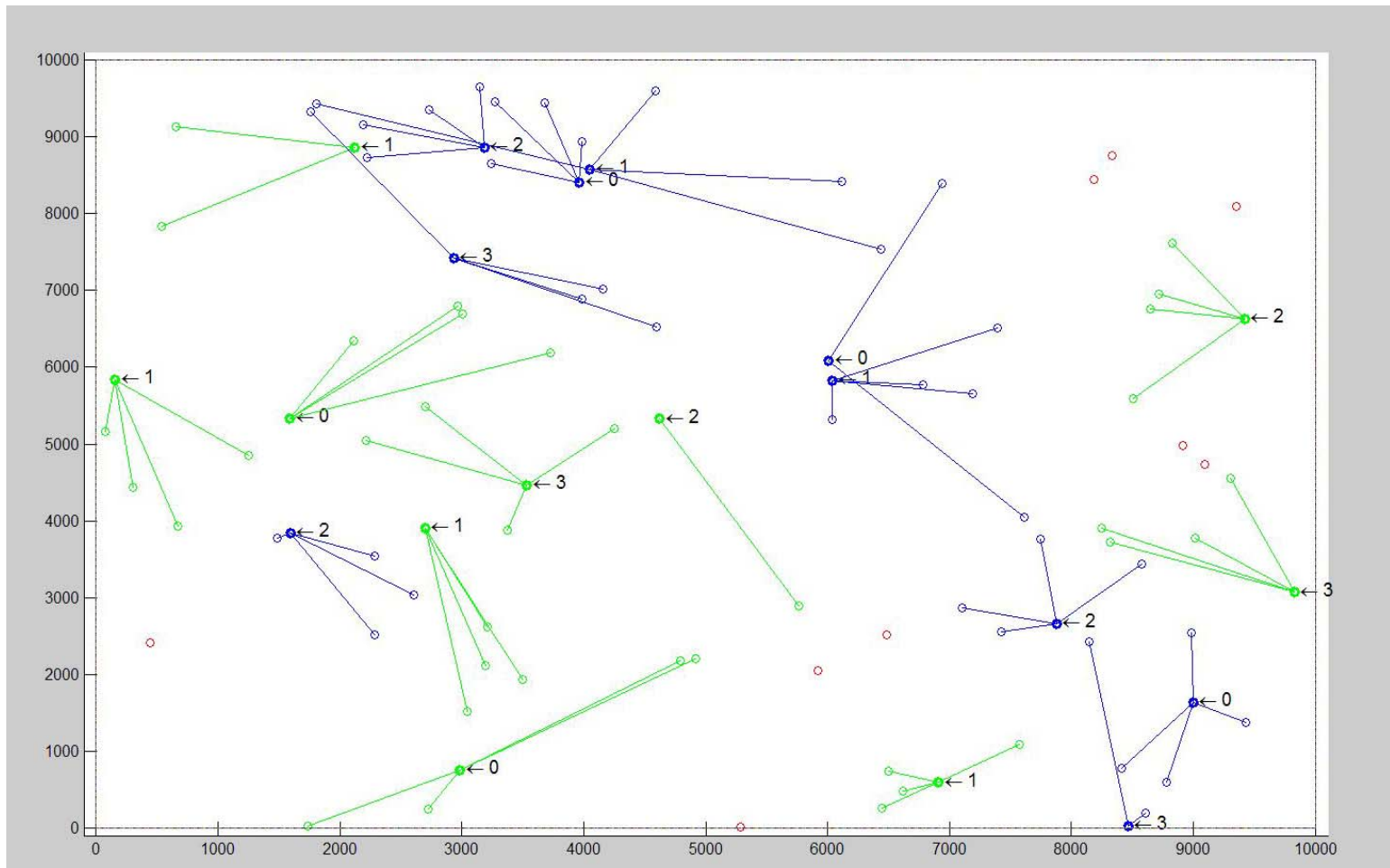
LBT Listen Before Talk (16h/D2: 6.4.3.4)

DCS chooses the least interfered channel

aEQP is predominately for 802.16/802.16 coexistence

LBT is predominately for 802.16/802.11 coexistence

Definition of the *Simulation Space*

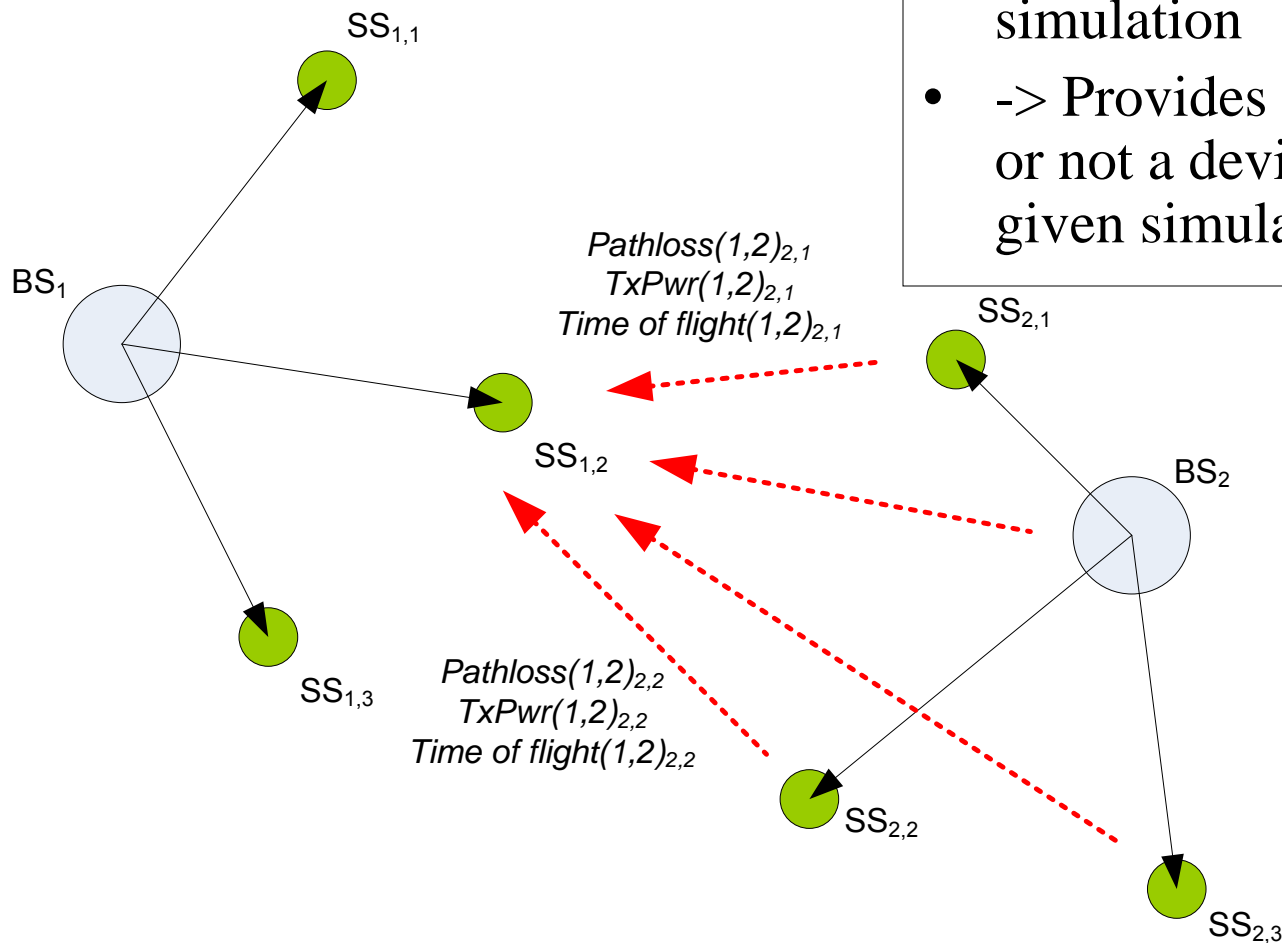


- n 802.11y APs (blue, 10)
- m 802.16 BSs (green, 10)
- Max x SS per AP/BS (4)
- This example uses 4 channels

- SS are associated to AP/BS on minimum pathloss
- Not all SS are associated in a given simulation run
- This example defines a 10kmx10km simulation area

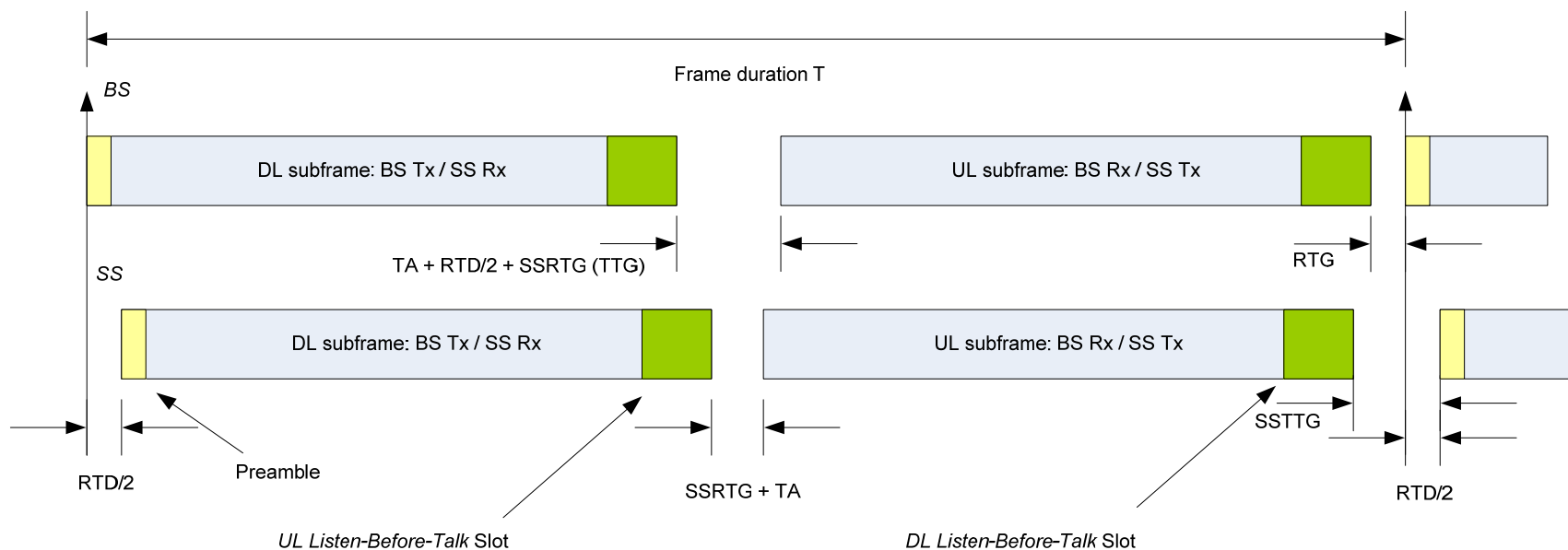
Interference geometry calculation

- Evaluation of link budget to calculate interference
- Compensation for *time of flight* given the $1\mu\text{s}$ resolution of the simulation
- -> Provides a decision on whether or not a device is transmitting at a given simulation interval

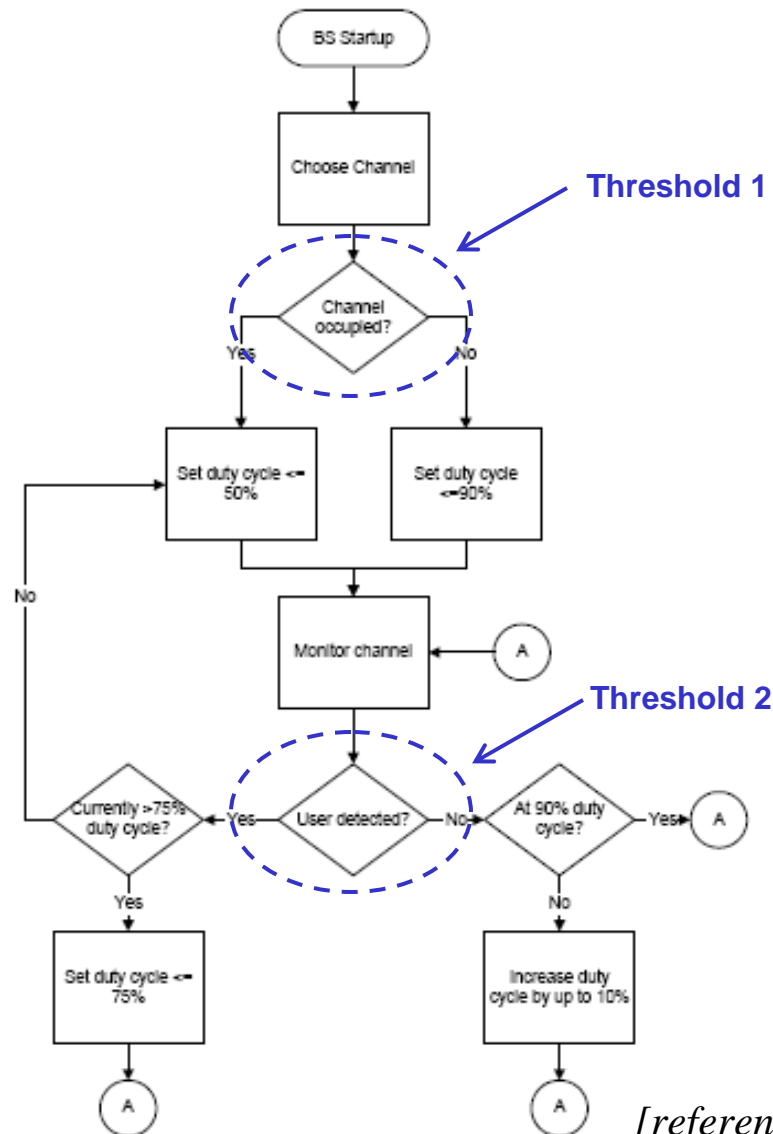


Listen Before Talk (LBT)

- As implemented in 802.16h/D2 sub clause 6.4.3.4
- Configuration:
 - DL LBT
 - UL LBT
 - DL&UL LBT
- Measurements are made in a dedicated OFDM slot ($102\mu\text{s}$) just prior to respective DL and UL subframe
- Controlled at BS with the associated SS acting independently



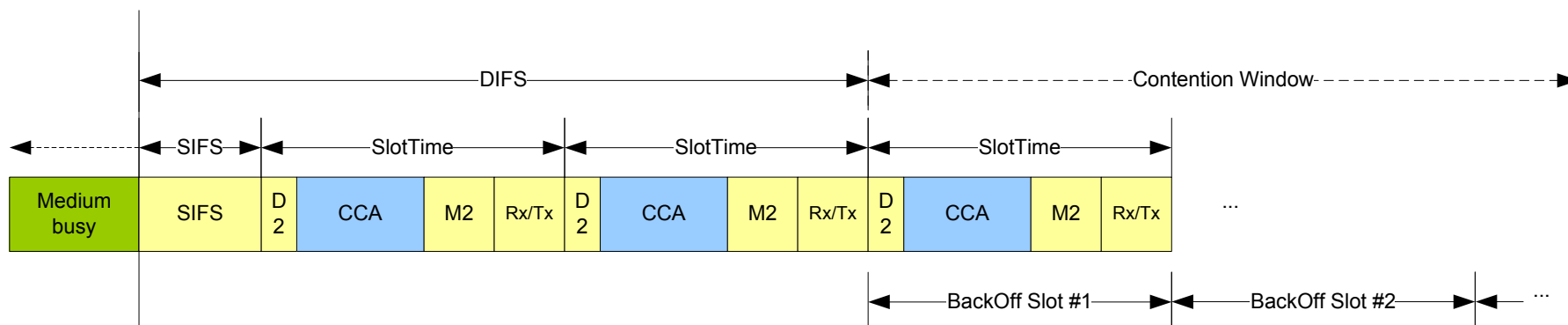
Adaptive Extended Quiet Period (EQP/aEQP)



[reference 802.16h/D2]

- As implemented in 802.16h/D2
 - Sub clause 6.4.3.2 and 6.4.3.3
- Controlled at the BS
- Driven by interference calculations in the entire EQP UL sub-frame
- Measured at 50 μ s intervals
- Measurements provide a mechanism to allocate quiet frames based on prevailing conditions and therefore provide other systems an opportunity to transmit

802.11y model representation (time domain)



SIFS = 16/32/64 uS
 SlotTime = 9/13/21 uS
 DIFS = SIFS + 2 x SlotTime

DIFS = 34/58/106 uS

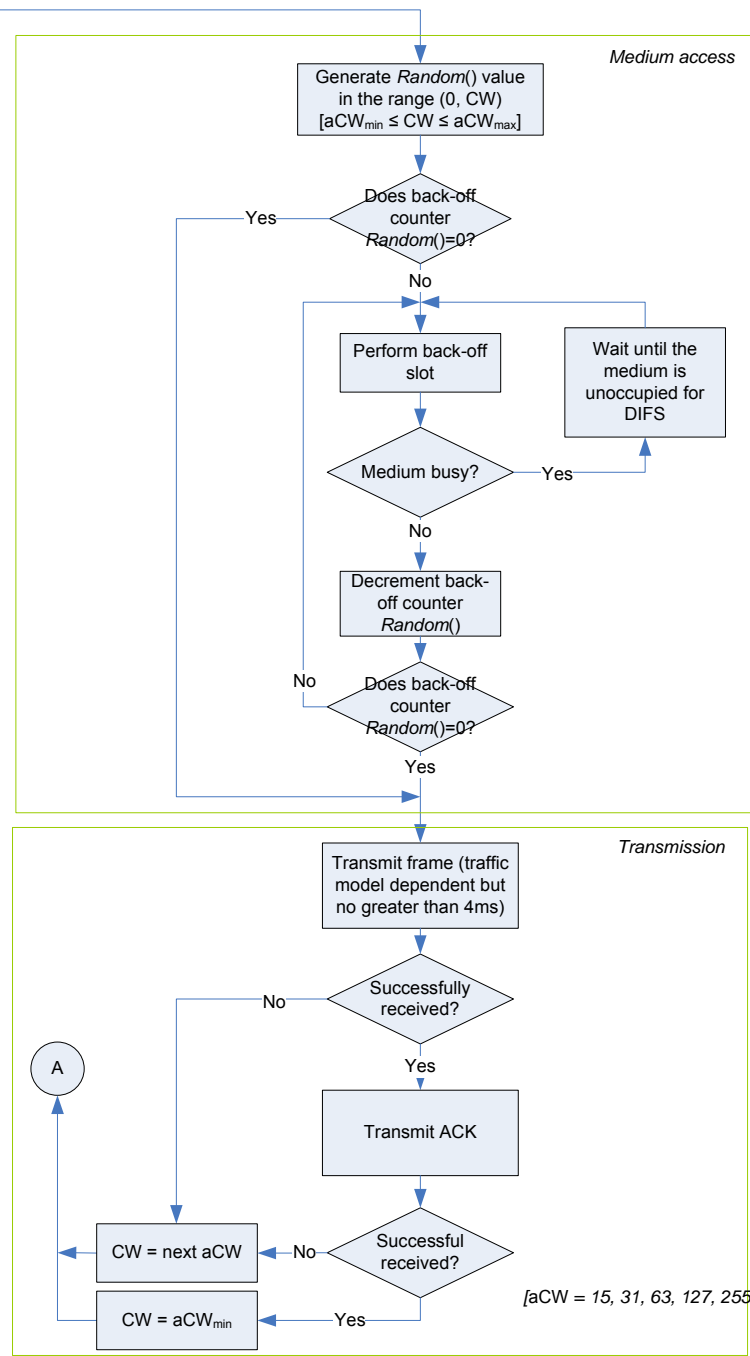
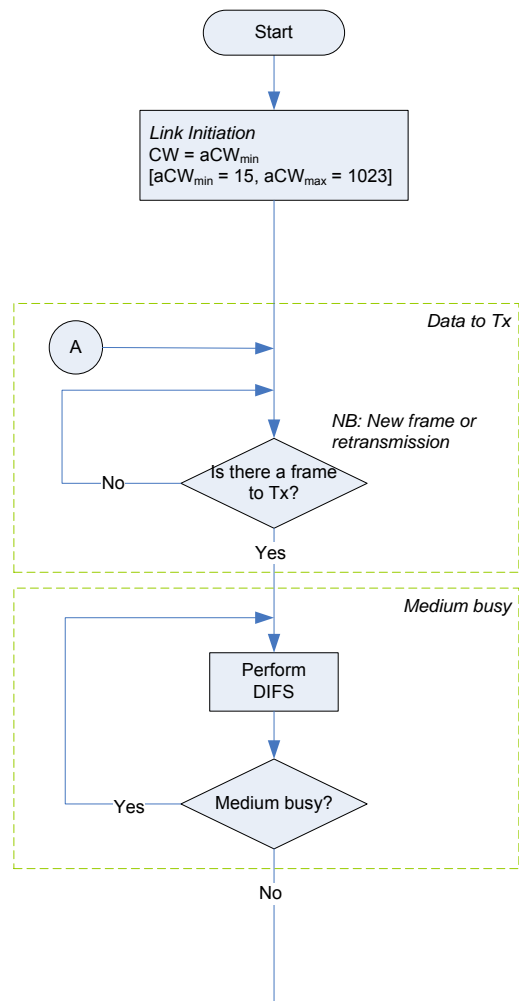
SlotTime = D2 + CCA + M2 + Rx/Tx

D2 (aRxRFDelay + aRxPLCPDelay) = 1/1/1 uS
 CCA (Clear Channel Assessment) = 4/8/16 uS
 M2 (aMACProcessingDelay) = 2/2/2 uS
 Rx/Tx (aRXTXTurnaroundTime) = 2/2/2 uS

Legend: 20MHz/10MHz/5MHz Channel Bandwidth
 Reference: *Table 147 OFDM PHY characteristics*

First transmit opportunity – based on remaining back-off

- 802.11y proposes the following thresholds:
 - CCA-CS: -82/-85/-88dBm
 - CCA-ED: -62/-65/-68dBm
- *Specifically for the 3.65GHz band only.*
 - **CCA-CS: -82/-85/-88dBm**
 - **CCA-ED: -72/-75/-78dBm**
- What is the motivation for choosing -72/-75/-78dBm?
- It's not clear what analysis has gone into the revised numbers for 3.65GHz
- Driven by a need to minimize the probability of false detection



[aCW = 15, 31, 63, 127, 255, 511, 1023]

802.11y model for
medium access control

Conclusions and continuing work

- *Any comments on 802.11 simulation model?*
- *Any comments on simulation scenarios and the stated assumptions?*
- Simulation results are seeking to consider:
 - 802.11y impact on 802.16h (*e.g. given the CBP interpretations*)
 - 802.16h impact on 802.11y (*e.g. TTG/RTG values*)
 - 802.11y impact on 802.11y (*e.g. CCA-ED thresholds*)
 - 802.16h impact on 802.16h (*e.g. 16h features*)
 - Relative performance based on system loading
 - Performance of LBT and aEQP features
 - The validity of the current proposed CCA-ED thresholds
 - Optimization of 802.16h and 802.11y parameters for operation in 3.65GHz band