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

IEEE 802.16 Presentation Submission Template (Rev. 8.3)

Document Number:

S802.16h-07/038r1

Date Submitted:

2007-03-29

Source:

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Venue:

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

Base Document:

C802.16h-07/038

Purpose:

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

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Simulation model and starting assumptions

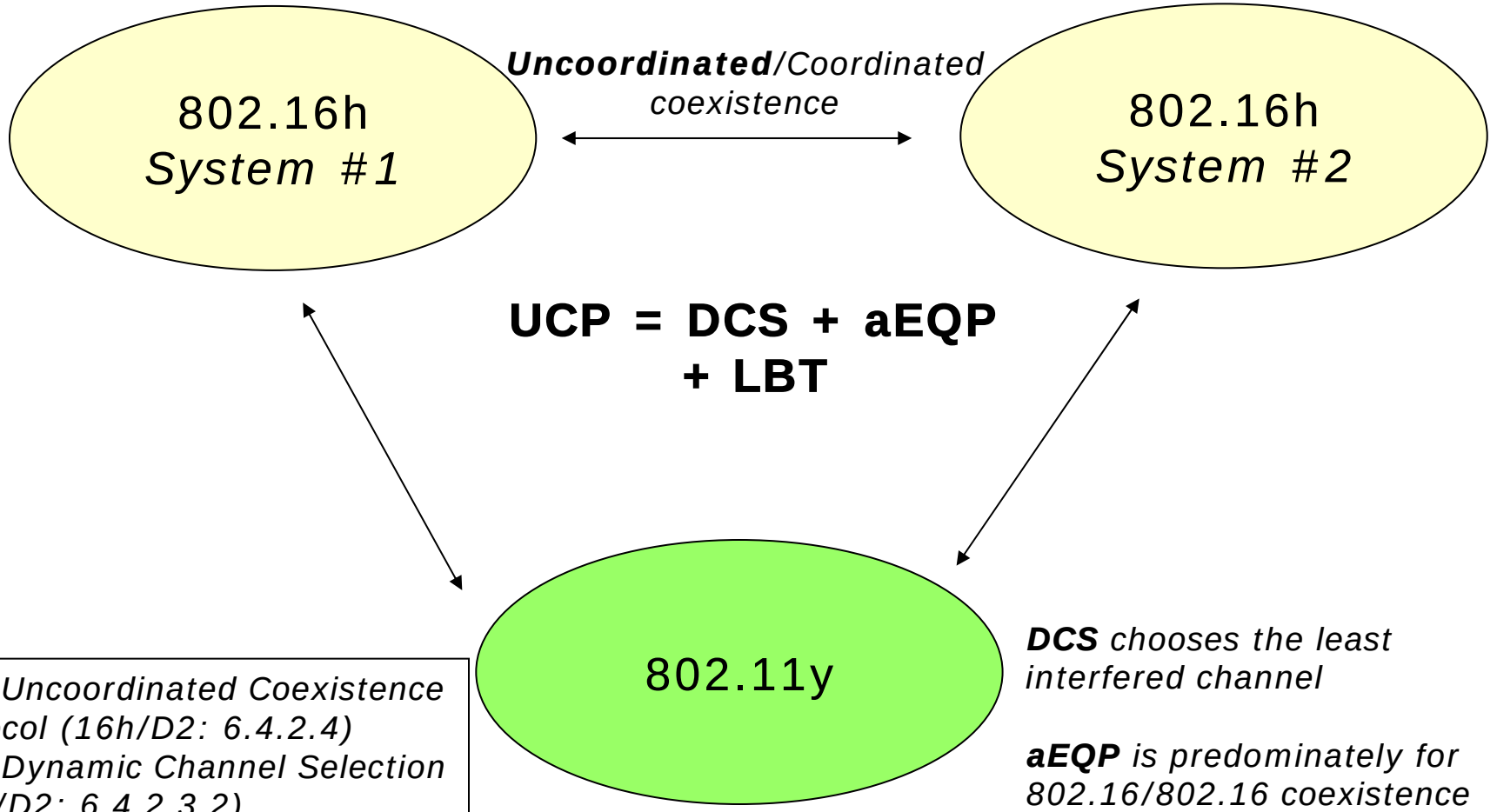
System level simulation based on:

- **Interference assessment (pathloss + link budget evaluation)**
- **Time domain analysis (1 µs resolution)**
- **Explicit simulation of 802.16 and 802.11 (details on a later slide)**

- 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 frame duration of 4ms
  - CCA-ED thresholds (details on a later side)
  - Contention Window values (15 -> 1023)

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)*

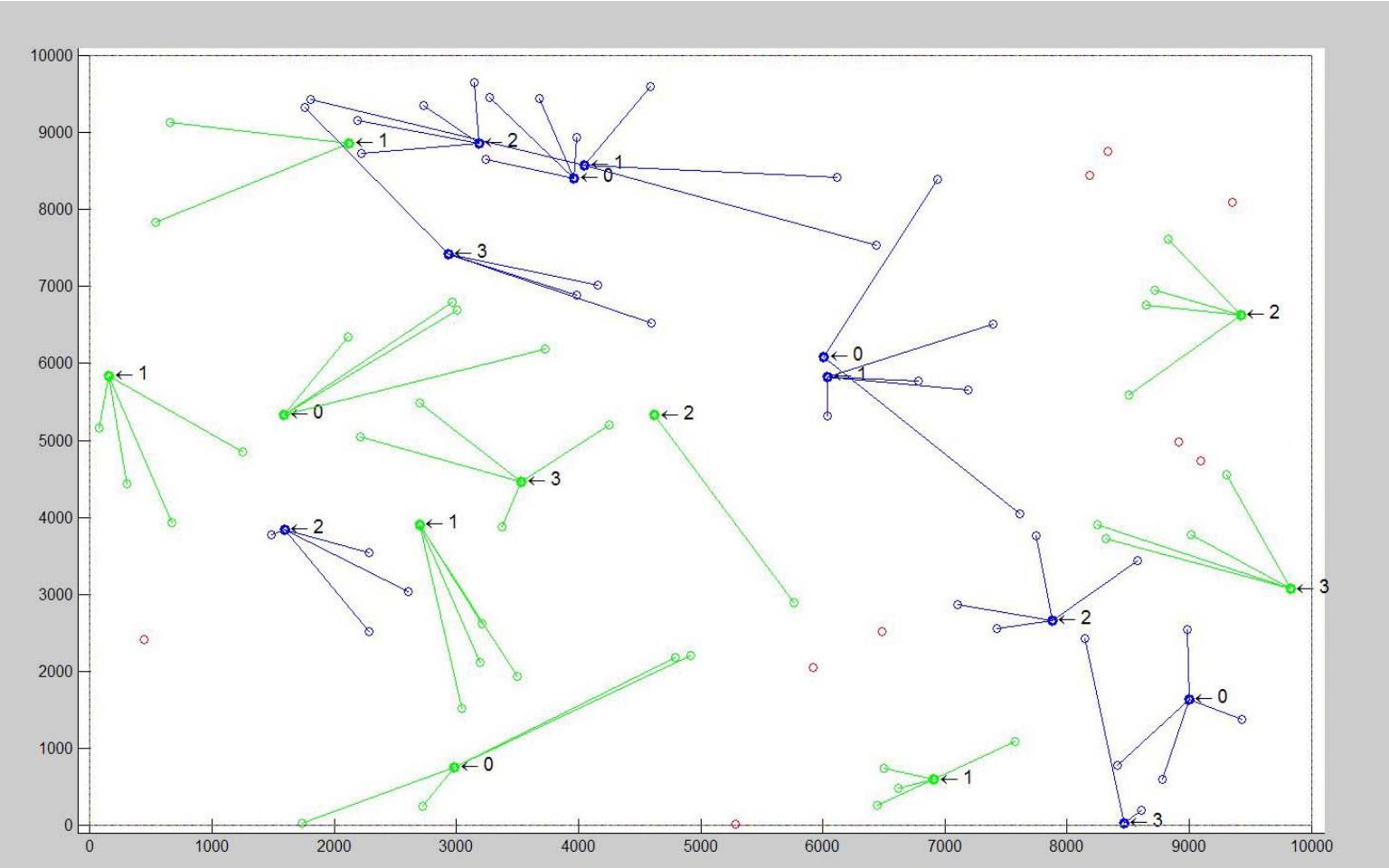
DCS *chooses the least interfered channel*

aEQP *is predominately for 802.16/802.16 coexistence*

LBT *is predominately for 802.16/802.11 coexistence*

>> Assessed by simulation

Definition of the *Simulation Space*

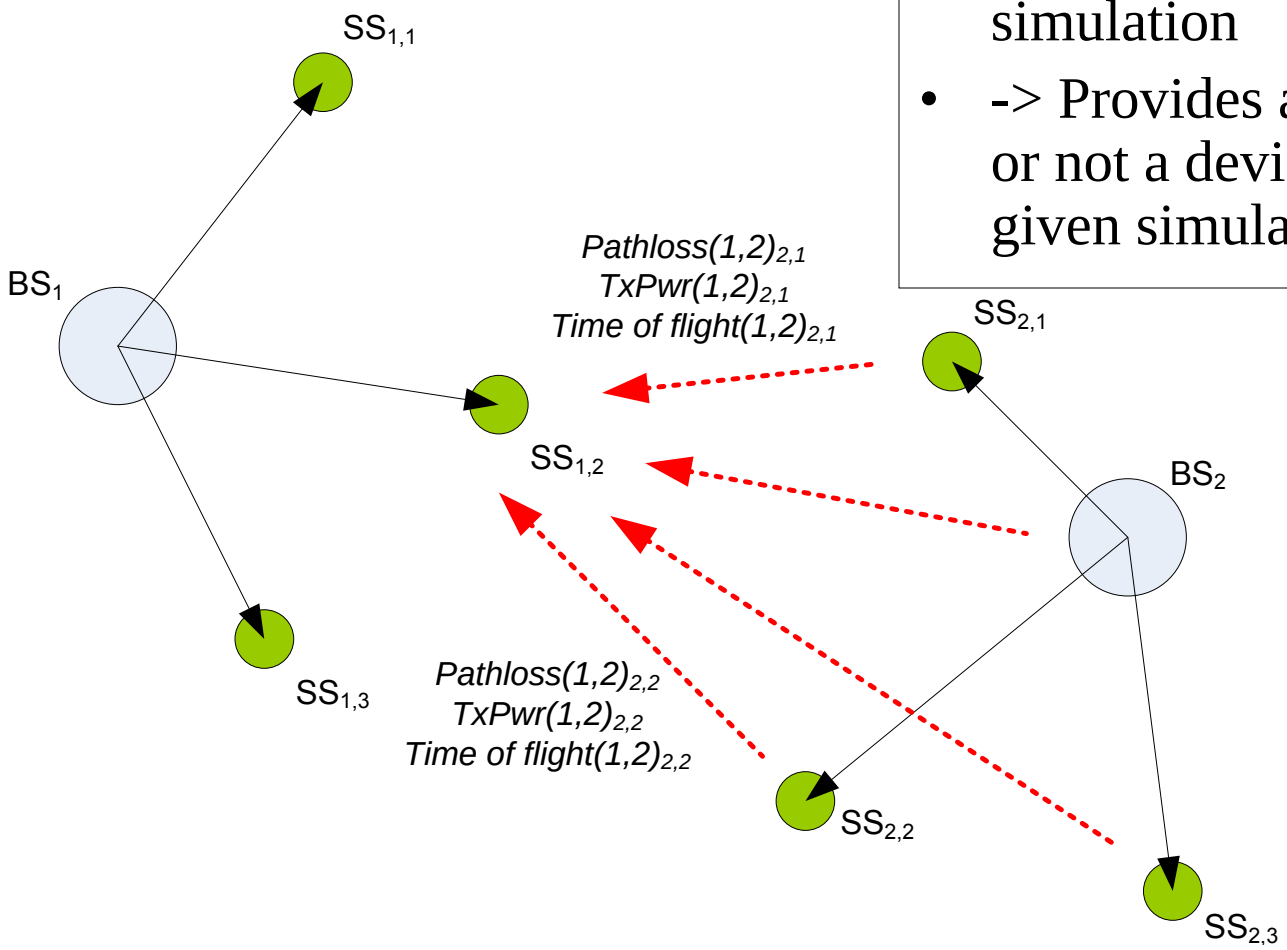


- *n* 802.11y APs (blue, 10)
- *m* 802.16 BSs (green, 10)
- Max *x* SS per AP/BS (4)
- This example uses 4 channels

- 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

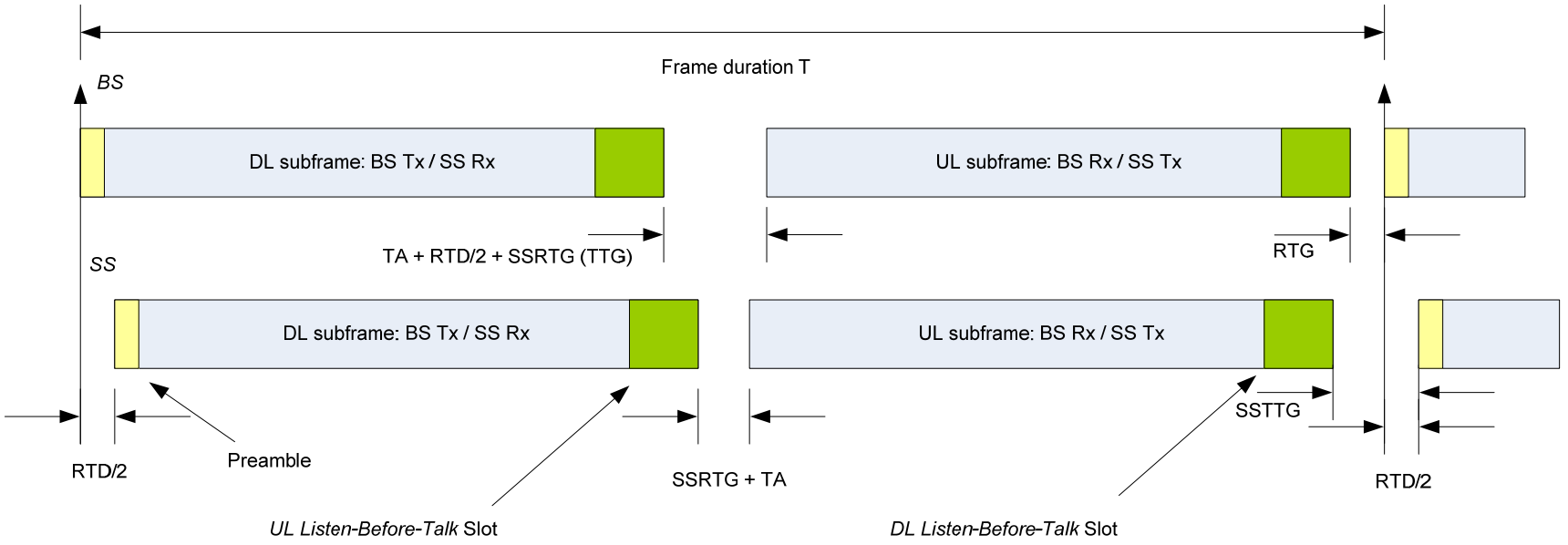
Interference geometry calculation

- Evaluation of link budget to calculate interference
- Compensation for *time of flight* given the 1µs resolution of the simulation
- -> Provides a decision on whether or not a device is transmitting at a given simulation interval

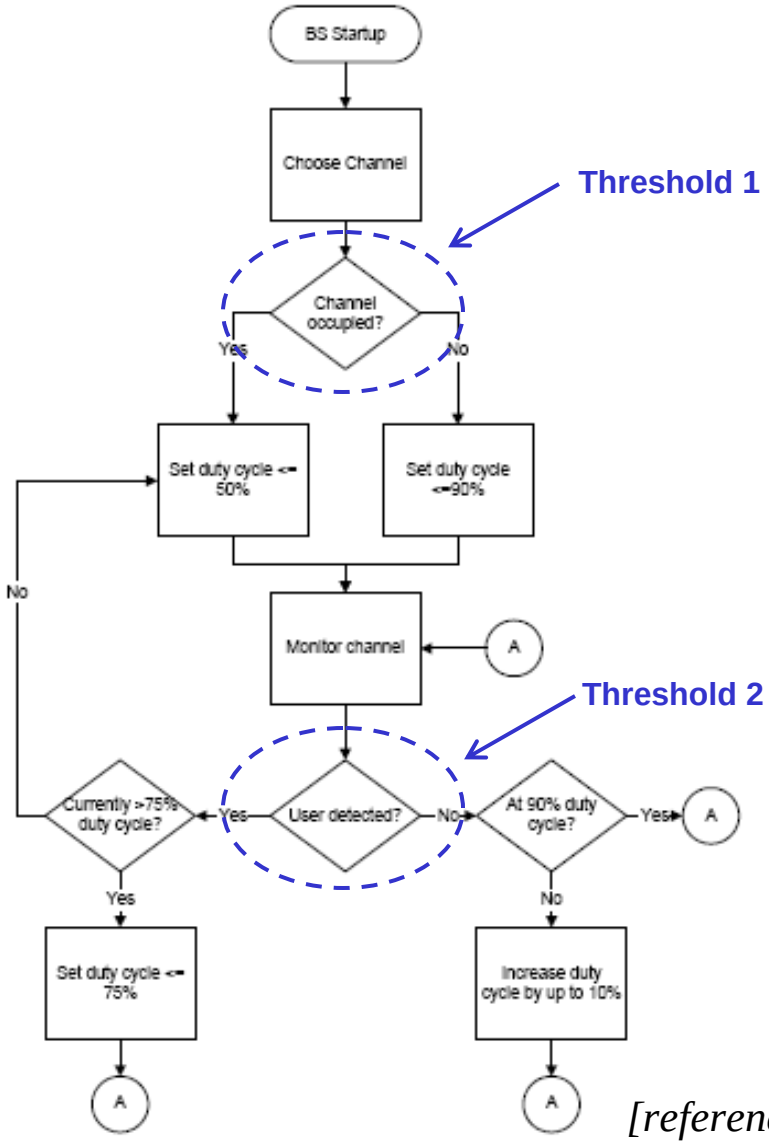


Listen Before Talk (LBT)

- 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 (102µs) just prior to respective DL and UL subframe
- Controlled at BS with the associated SS acting independently



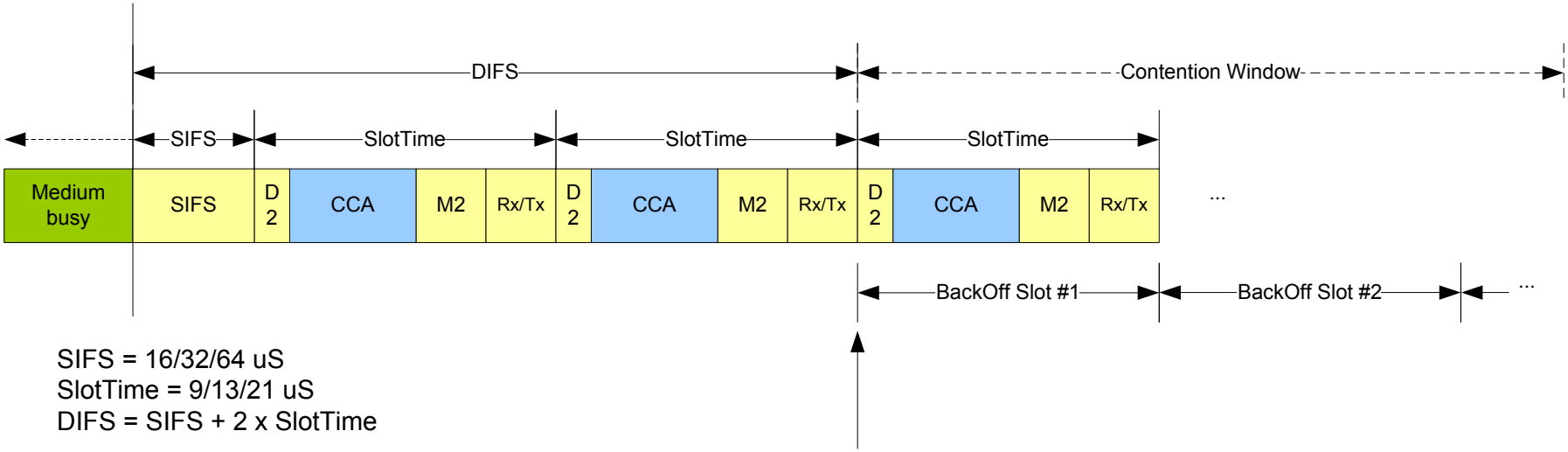
Adaptive Extended Quiet Period (EQP/aEQP)



- 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 50µs intervals
- Measurements provide a mechanism to allocate quiet frames based on prevailing conditions and therefore provide other systems an opportunity to transmit

[reference 802.16h/D2]

802.11y model representation (time domain analysis)



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

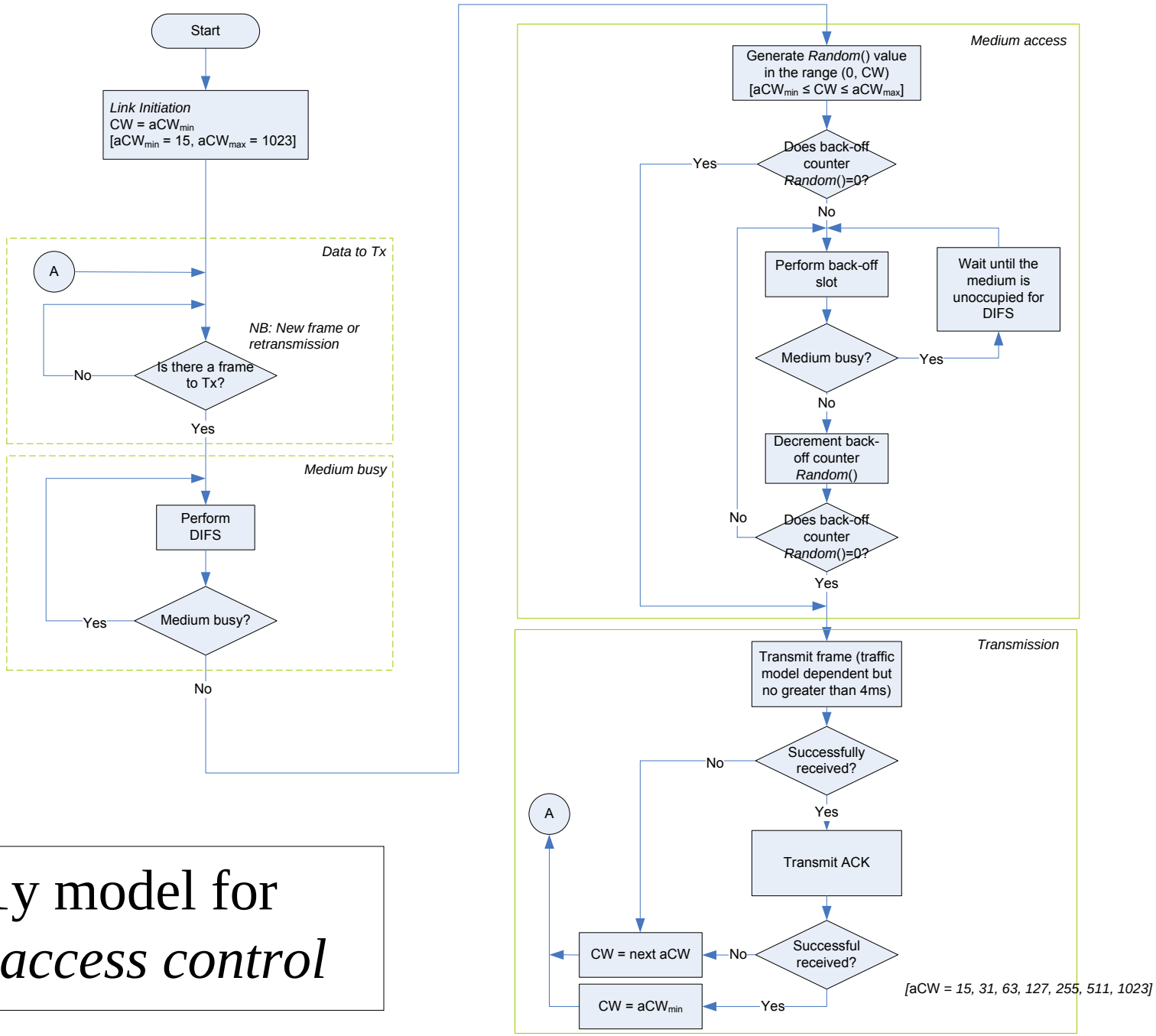
DIFS = 34/58/106 uS

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*

- 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?
- *Driven by a need to minimize the probability of false detection, and half way between the two ranges*



802.11y model for *medium access control*

Simulation calibration

- *Propagation model*
  - d_1=1m, d_1=500m, d_2=1000m, d_3=4000m
  - n_1=2, n_2=2.5, n_3=3.5, n_4=4
- *802.11y traffic model*
  - Independent links supported (a max of 4 STAs per AP)
  - Transmitted in a TDM manner on the air interface
  - Delay calculations based on the time to access the air interface – no traffic queue delay included
  - Fixed duration frames, transmitted with a random inter-arrival time
- *802.16h traffic model*
  - Based on the OFDMA air interface BS can transmit to a number of SS, and a number of SS can transmit to the BS, at the same time
  - Similar traffic model definition as for 802.11y but handled differently
- *802.11y equipment parameters (link budget parameters)*
  - Max frame duration, CCA-ED, Contention Window -> defined in 11y/D1.1
  - Number of MCS? Rx sensitivity values? General link budget parameters?
- *802.16h equipment parameters (link budget parameters)*
  - Based on *WiMAX Forum Mobile System Profile (Release 1.0 – Revision 1.2.2)*

Simulation results

- *What are the simulation scenarios*:
  - 802.11y performance alone in the band (baseline)
  - 802.16 (without any coexistence) performance alone in the band (baseline)
  - 1) 802.16h (w/UCP) performance in the band – 16h-16h coexistence as defined by UCP
  - 2) 802.11y performance with 802.16h systems present in the channel
  - 3) 802.16h performance with 802.11y systems present in the channel
  - 4) Assessment of the coexistence possible between the two systems

- *Simulations aim to address*:
  - Any issues with assumed 802.16h TTG/RTG values
  - Any issues with 802.11y CCA-ED thresholds
  - Relative performance of systems based on system loading
  - Performance of LBT and aEQP features
  - Optimization of 802.16h and 802.11y parameters for operation in the band…