

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:

**Paul Piggin
NextWave Broadband Inc.
12670 High Bluff Drive
San Diego CA 92130 USA**

Voice: **1 858 480 3100**
Fax: **1 858 480 3105**
E-mail: **[ppiggin @ nextwave.com](mailto:ppiggin@nextwave.com)**

Venue:

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

Base Document:

C802.16h-07/038

Purpose:

Notice:

This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release:

The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

IEEE 802.16 Patent Policy:

The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <<http://ieee802.org/16/ipr/patents/policy.html>>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <<mailto:chair@wirelessman.org>> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <<http://ieee802.org/16/ipr/patents/notices>>.

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

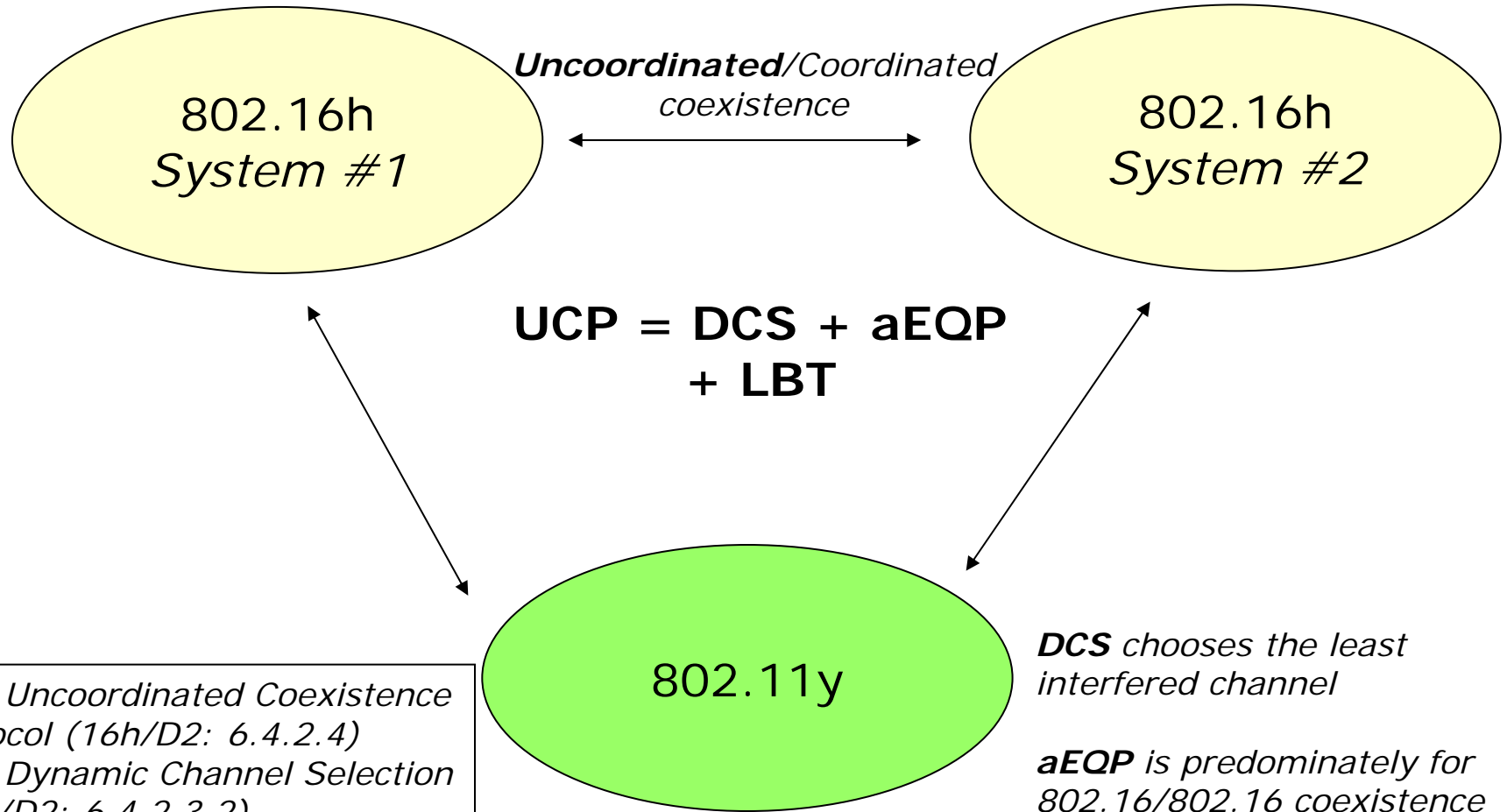
Paul Piggin
NextWave Broadband

Simulation model and starting assumptions

System level simulation based on:

- **Interference assessment (pathloss + link budget evaluation)**
- **Time domain analysis (1 μ s resolution)**
- **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



DCS chooses the least interfered channel

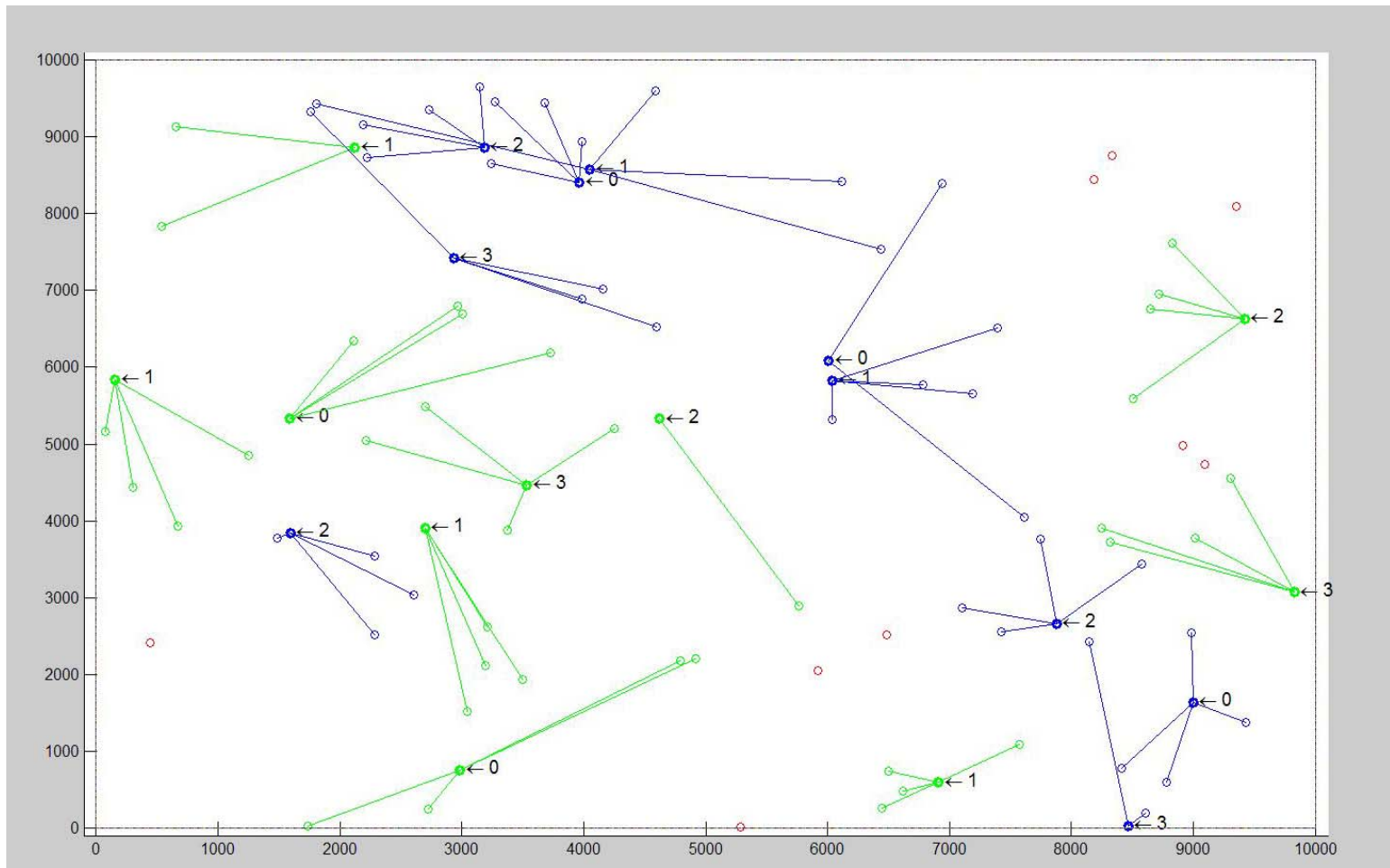
aEQP is predominately for 802.16/802.16 coexistence

LBT is predominately for 802.16/802.11 coexistence

>> Assessed by simulation

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)

Definition of the *Simulation Space*

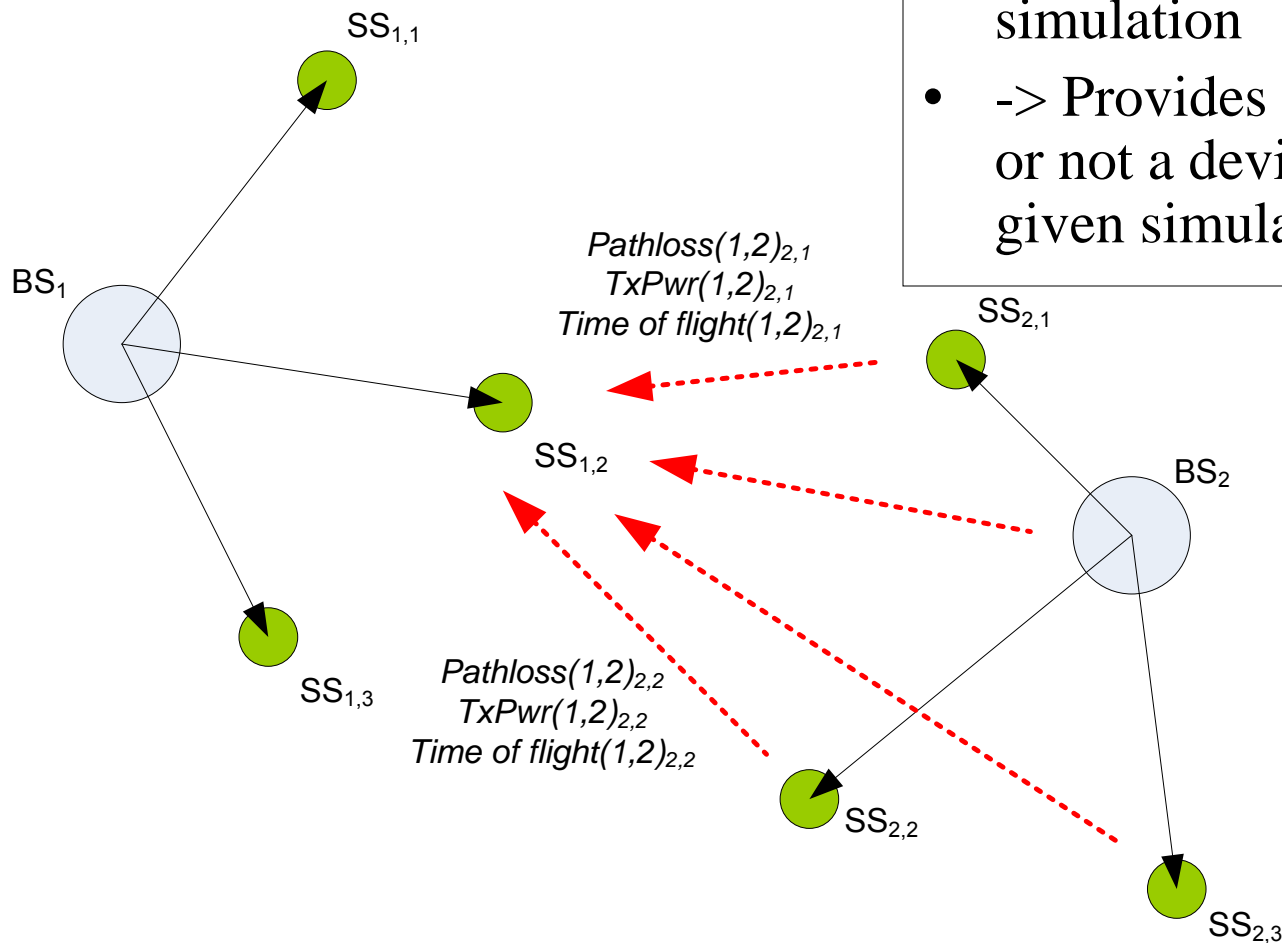


- n 802.11y APs (blue, 10)
- m 802.16 BSs (green, 10)
- Max x SS per AP/BS (4)
- This example uses 4 channels

- 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

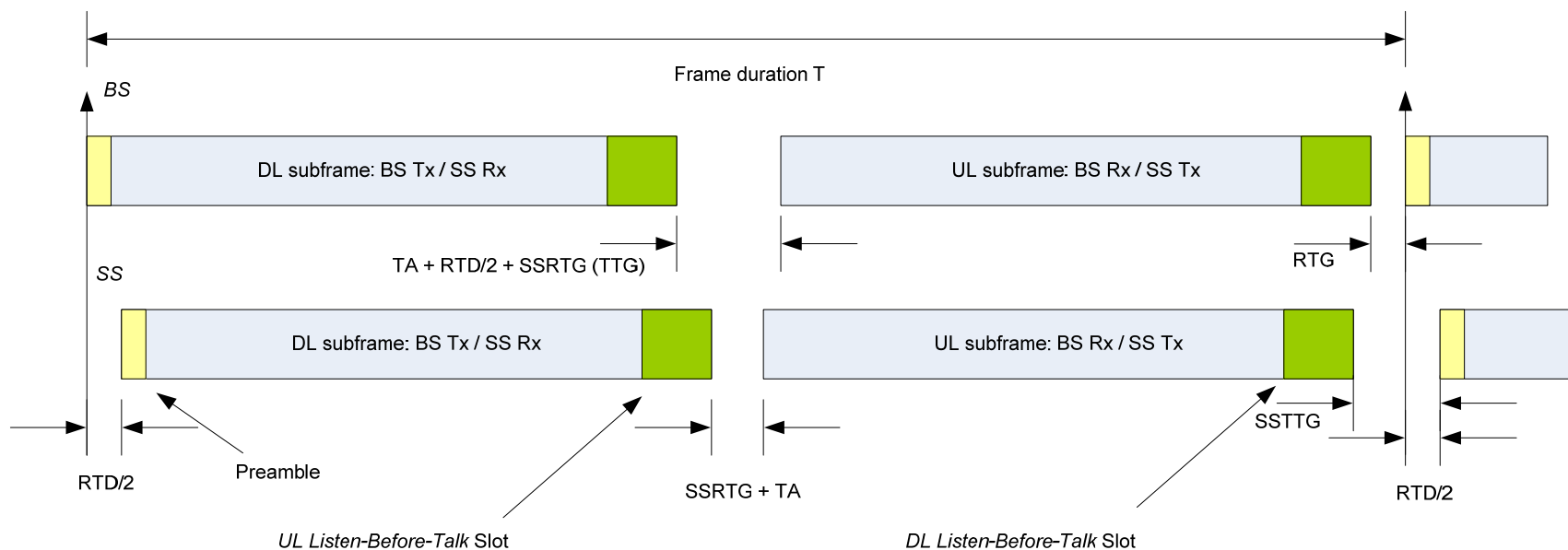
Interference geometry calculation

- 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

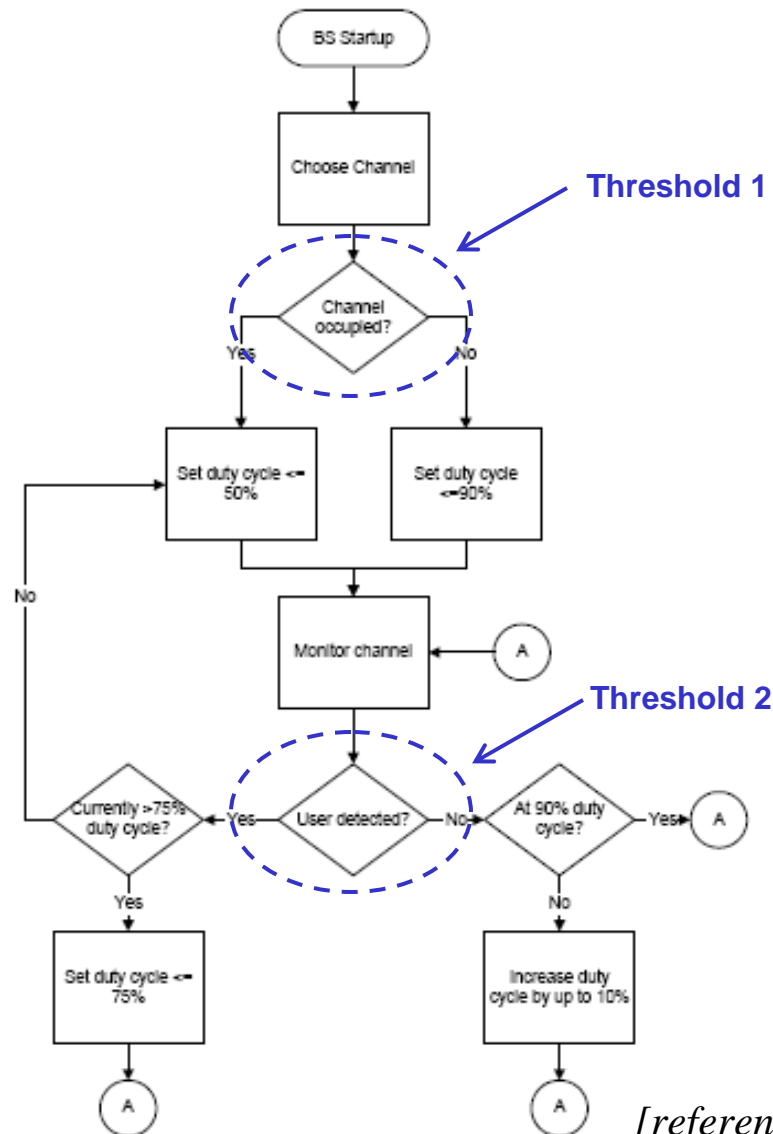


Listen Before Talk (LBT)

- 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



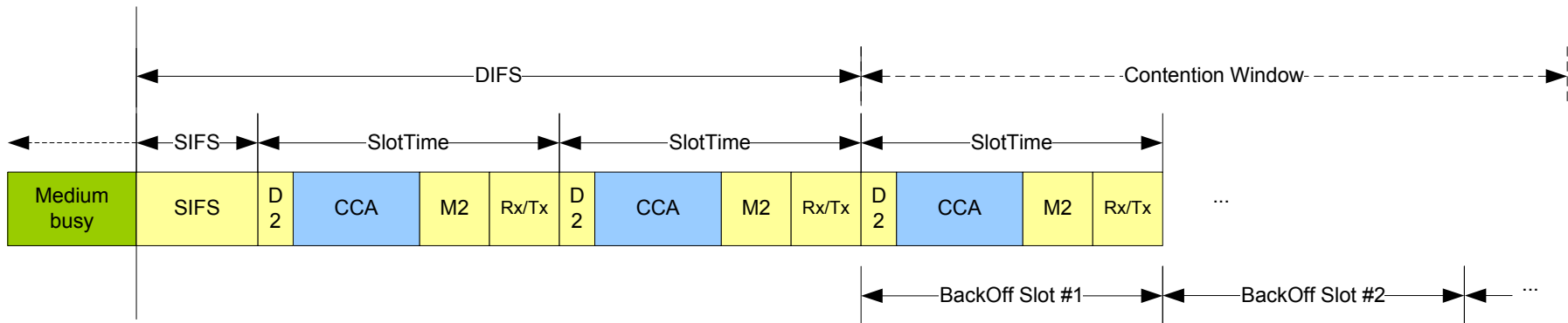
Adaptive Extended Quiet Period (EQP/aEQP)



[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 analysis)



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

DIFS = 34/58/106 uS

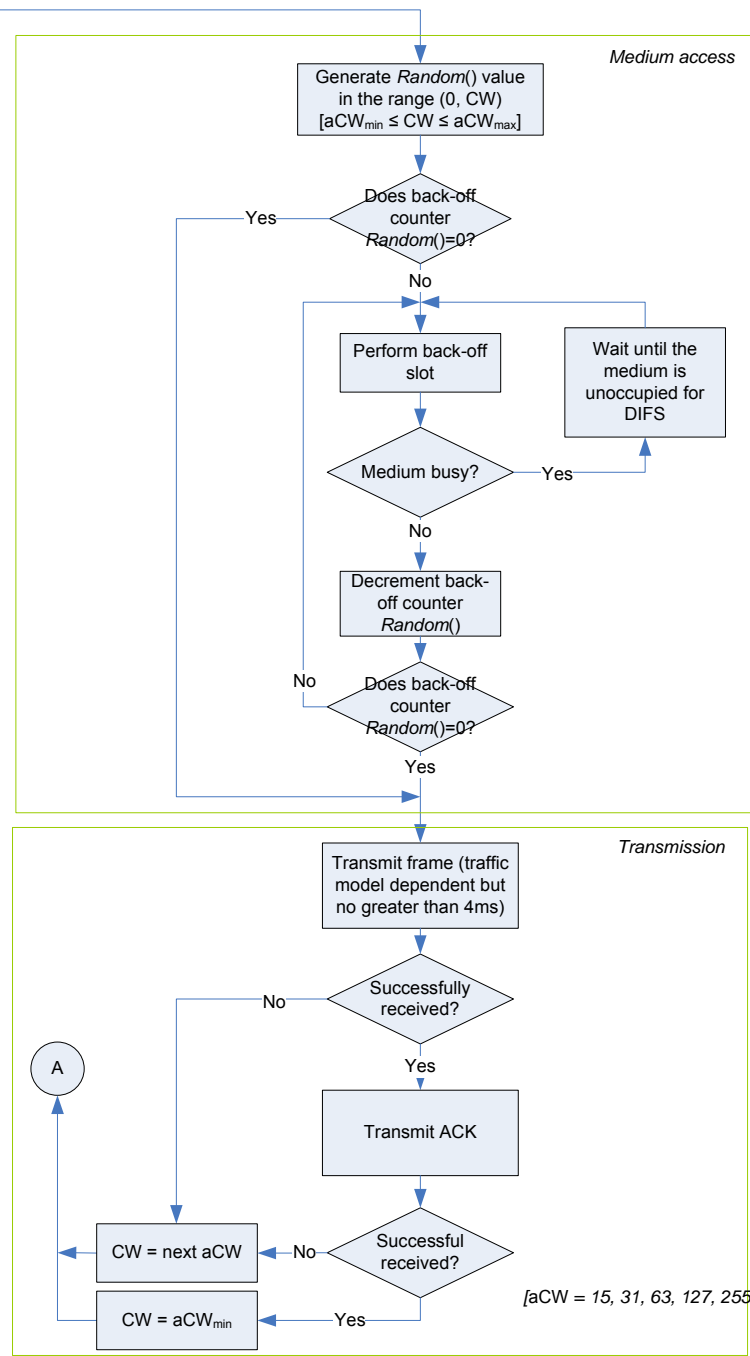
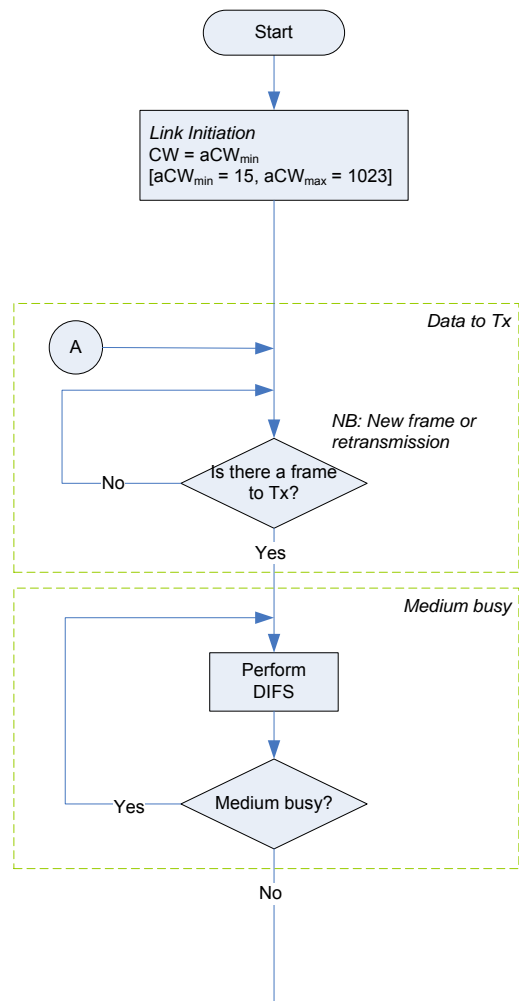
SlotTime = D2 + CCA + M2 + Rx/Tx

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

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



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

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...