An overview of 802.16h ‘uncoordinated’ coexistence approach in 3.65-3.7GHz

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An overview of 802.16h ‘uncoordinated’ coexistence approach in 3.65-3.7GHz

Paul Piggin
NextWave Broadband
• To facilitate an overview and discussion of issues related to protocols, methodologies, and parameter selection for 11y and 16h operation/co-existence in 3.65-3.7GHz band

• Overview of the relationship between coordinated and uncoordinated modes of operation within P802.16h/D1

• Specific details of uncoordinated procedures to address coexistence in 3.65-3.7GHz:
  – specifically FCC’s definition of CBP

• Clarification of parameters for 11y and 16h coexistence
Overview of Coordinated and Uncoordinated co-existence in 802.16h

Definitions from (P802.16h/D1):

Coordinated Coexistence Mechanism: A coexistence mechanism relying on the exchange of protocol based messages among radios.

Uncoordinated Coexistence Mechanism: A mechanism by which a radio system attempts to achieve coexistence without exchanging messages with other spectrum users.

Coexistence: A state of acceptable operation of two or more radio systems (possibly using different wireless access technologies).

Section 1.3.3 + Annex B Detailing band specific operation

Enhancements for uncoordinated coexistence

Sub clause 15

Mechanism for coordinated coexistence

Possible route for sharing mechanisms

Coexistence Messaging

Coexistence Signalling

IP proxy

Coexistence with Specific Spectrum Users

Coexistence in non-exclusively assigned/licensed bands with Secondary Users

WirelessMAN-CX

WirelessHUMAN Extension

IP network message

Sub clause 6.4

Sub clauses of 15

Sub clause 6.4.2.2 [Formerly 6.3.15]

Sub clauses 6.4.2.3, 6.4.2.4

General concepts
CBP – Contention Based Protocol

• FCC definition of CBP:
  – “A protocol that allows multiple users to share the same spectrum by defining the events that must occur when **two or more transmitters attempt to simultaneously access the channel** and establishing the rules by which a transmitter **provides reasonable opportunities for other transmitters to operate**. Such a protocol may consist of procedures for initiating new transmissions, procedures for determining the state of the channel (available or unavailable), and procedures for managing retransmissions in the event of a busy channel.”

• Industry Canada
  – Reuse the FCC definition and add clarification:
  – “Examples of protocols used in existing radio systems that the Department **would consider** as meeting the requirements of a contention-based system include the Carrier-Sense Multiple-Access with Collision Detection (CSMA/CD) protocol used in Wi-Fi gear or any other form of **Dynamic Frequency Selection (DFS) or listen-before-talk** approach.”
  – Note that they think Wi-Fi has CSMA/CD when it has CSMA/CA.

Salient aspects highlighted:
• “**Two or more transmitters attempt to simultaneously access the channel**” -> **Listen Before Talk (LBT) protocol**
• “**Provides reasonable opportunities for other transmitters to operate**” -> **Extended Quiet Period (EQP) protocol related to the 802.16 frame structure**
The *uncoordinated* coexistence situation in 3.65-3.7GHz

From the perspective of 802.16h, consideration needs to be taken of:

- CBP requirements
- Coexistence with other 802.16h devices
- Coexistence with 802.11y devices

**Diagram:**
- 802.16
- 802.11
- **Uncoordinated coexistence**
  - DFS/DCS + EQP + LBT
UCP – Uncoordinated Coexistence Protocol
P802.16h/D1

• UCP is the realisation of CBP as defined by 802.16h
• UCP is designed to meet CBP but is not limited to operation in 3.65-3.7GHz band
• UCP draws upon the following tools:
  – DFS/DCS
  – LBT
  – EQP (aEQP)

Table B1—Summary of non-exclusively assigned and non-exclusively licensed bands of operation

<table>
<thead>
<tr>
<th>Band</th>
<th>Regulatory operational requirement, including reference to relevant sub clause</th>
<th>Additional features, including reference to relevant sub clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>902 - 928 MHz [US band]</td>
<td></td>
<td>Coexistence with Secondary Users (6.4.2.3) Coordinated operation (15)</td>
</tr>
<tr>
<td>2400 - 2483.5 MHz [US band]</td>
<td></td>
<td>Coexistence with Secondary Users (6.4.2.3) Coordinated operation (15)</td>
</tr>
<tr>
<td>3650 - 3700 GHz [US band]</td>
<td>UCP (6.4.2.4)</td>
<td>Coexistence with Secondary Users (6.4.2.3) Coordinated operation (15)</td>
</tr>
<tr>
<td>5150 - 5850 MHz [Parts of U-NII bands in the US]</td>
<td>DFS (6.4.2.2) [5470 - 5725 MHz only]</td>
<td>Coexistence with Secondary Users (6.4.2.3) Coordinated operation (15)</td>
</tr>
<tr>
<td>5725 - 5850 MHz [UK band]</td>
<td>DFS (6.4.2.2)</td>
<td>Coexistence with Secondary Users (6.4.2.3) Coordinated operation (15)</td>
</tr>
</tbody>
</table>

DCS – Dynamic Channel Selection
DFS – Dynamic Frequency Selection
LBT – Listen Before Talk
aEQP – Adaptive Extended Quiet Period
DCS (Dynamic Channel Selection) & DFS (Dynamic Frequency Selection)

- **Attempt to select a clear/least interfered channel**
  - 802.16h uses DCS as a means of channel selection and avoidance of non-regulatory protected devices
  - DFS is a similar mechanism for regulatory protected devices, e.g. radar
  - In the context of UCP both DCS and DFS perform interference avoidance by means of a frequency/physical channel change
  - This is an ongoing process based on prevailing conditions

Figure h3—Link level representation of DCS operation

[P802.16h/D1 sub clause 6.4.2.3.2]
LBT (Listen Before Talk)

- CBP states: "Two or more transmitters attempt to simultaneously access the channel"
- BS allocates time between UL and DL subframe for measurement opportunities and reacts accordingly

Figure h7—Listen-Before Talk
[P802.16h/D1 sub clause 6.4.3.3 and 6.4.3.4]
EQP (Extended Quiet Period) & aEQP (Adaptive EQP)

- CBP states: “Provides reasonable opportunities for other transmitters to operate”
- DFS/DCS undertaken first.
- EQP: suspends transmission on integer number of frames to provide these opportunities
- aEQP: A measurement based enhancement to EQP to optimise the duty cycle of the EQP based on prevailing channel occupancy estimates

\[P802.16h/D1\ sub\ clause\ 6.4.3.5\]
Clarification of parameters for 11y and 16h coexistence

Clarification on which 11y features are mandatory and which are optional

- EQP assumes a minimum period of 4ms (bandwidth independent) based on 11y parameters – assumed to be normative for 11y?
- Threshold recommendation: 0dB 11y system, 0dB for other systems
- Use of the full 50MHz band in 3.65-3.7GHz with 5, 10, 20MHz channelisation

- How long does 11y monitor until the channel is assumed to be clear?
- How long does 11y monitor until the channel is assumed to be busy?

- WiMAX Forum TWG specifies (for 5 and 10MHz bandwidths) the following parameters for certification:
  - TTG = 105us \textit{(related to the number of symbols per frame and cell size requirements)}
  - RTG = 60us
  - SSTTG = 50us
  - SSRTG = 50us