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Re:	Call for Contributions, IEEE 802.16h Task Group on License-Exempt Coexistence, IEEE 802.16h-05/023
Abstract	This document puts forward some editorial suggestion to be applied to the 16h Working Document that will provide a basis for the addition of License-Exempt operation within the base standard (802.16-2004).
Purpose	
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Editorial suggestions for the 16h Working Document facilitating License-Exempt amendment to 802.16-2004

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Overview

This document describes some editorial changes that can be applied to the 16h Working Document [1]. These changes facilitate the provision of amendments to the IEEE 802.16-2004 base standard [2] in support of License-Exempt (LE) operation. The latest version of the 802.16h working document [1] has been formatted to appear as an amendment to the base 802.16-2004 standard, with significant contribution material placed in a new section 15 which addresses '*Mechanisms for improved coexistence*'. There is less information concerning editorial instruction for amendment of sections contained in the base standard document. This contribution is seeking to address this matter. Above all this document is a primer to instill the need to consider how any LE scheme can fit within the base standard. Changes made in the 802.16-2004 corrigendum [4] left the way open to providing interference avoidance schemes other than those related to DFS (Dynamic Frequency Selection), and this is the focus of this contribution.

General concepts

In general the tenets by which this contribution is defined are:

- Specific editorial suggestions to the base standard [2] facilitating a framework for MAC schemes supporting LE operation.
- Changes centred on the use of the WirelessHUMAN (High-speed Unlicensed Metropolitan Area Network) PHY (section 8.5 in [2]).
- Comments centred on 802.16-2004 OFDMA PHY, i.e. less focus on the OFDM PHY. The reason for this approach is because OFDMA provides a route for supporting more advanced LE operation with features added as part of the 802.16e project.
- Considering issues of backwards compatibility for 802.16 and 802.16h systems.
- No consideration of PHY changes as this is outside the scope of the PAR.

Figure 1 presents a summary of LE operation as defined currently in the base standard. The figure uses the terms DFS (Dynamic Frequency Selection) and ACS (Automatic Channel Selection). Both techniques, however defined from an implementation perspective, are broadly defined for use in LE spectrum; the distinction being that DFS is used with the protection of 'specific spectrum users' in mind, and defined in a regulatory sense, while ACS is used for avoidance of user interference with systems of the same and different technology. This document seeks to provide more detail concerning the right-hand branch of Figure 1 – developing ideas for co-existence at the MAC and PHY level. DFS is not considered. A generic example of how DFS and ACS can work within the base standard is given in Figure 2.

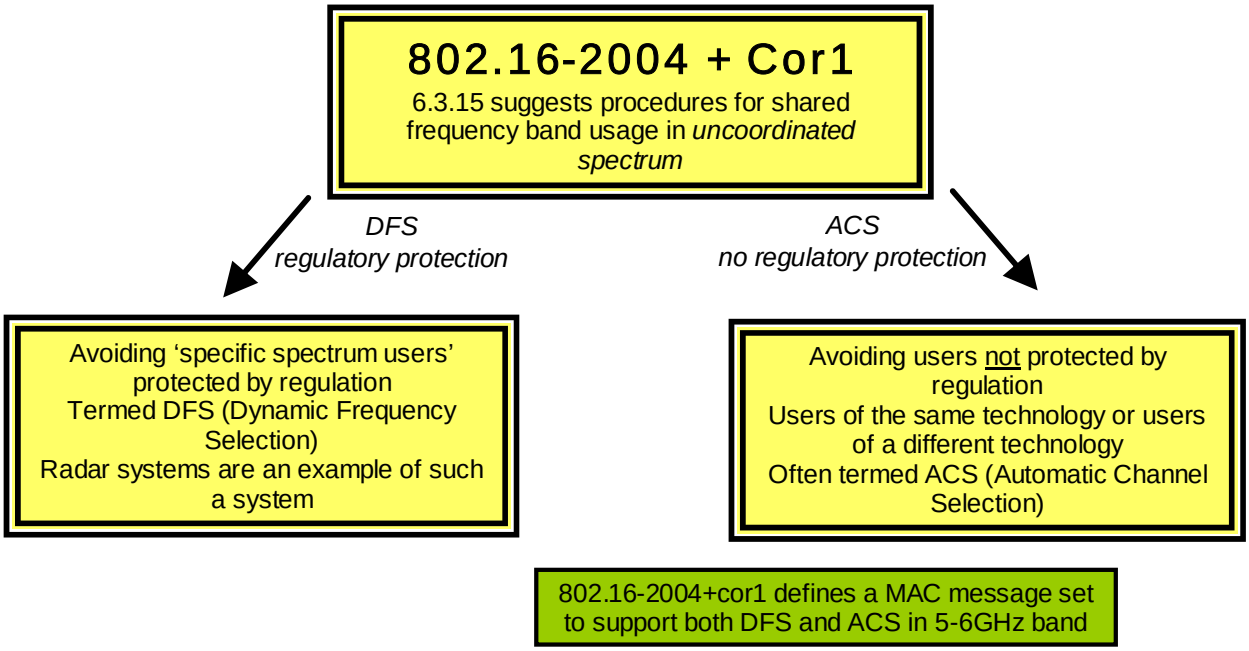

Figure 1 Representation of DFS and ACS in 802.16

The distinction between DFS and ACS in the example given in Figure 2 is seen in the way action is taken following the detection of interference. DFS would require that the frequency band is vacated, while ACS perhaps can be thought of as having less stringent requirements whereby, for example, the judicial choice of a different timeslot on the same frequency can be used in an attempt to avoid interference.

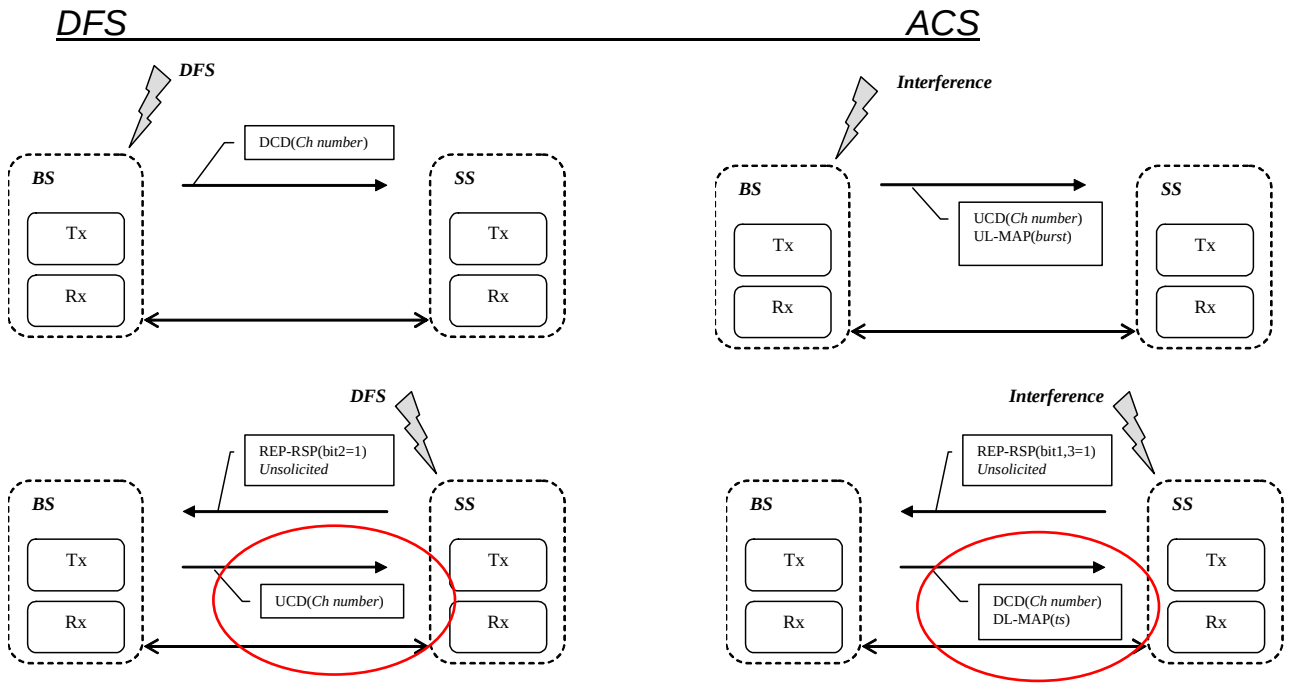

Figure 2 Example of the use of DFS and ACS in 802.16

What enhancements can be achieved beyond ACS?

Beyond that which is already contained in the base standard (and depicted in Figure 2) what LE enhancements can be provided to improve coexistence? Here are some ideas:

- Guideline schemes for coordinated and un-coordinated co-existence – coordinated and un-coordinated could be realised by a device's ability to communicate with another.
- Performance requirements for interference avoidance, i.e. the speed at which an interference situation (which is service limiting) can be rectified and the network stabilised.
- MAC enhancements that will improve detection, avoidance and minimise service outage rates.
- In summary a 16h-enhanced MAC based on the 802.16 PHY likely to be using the 16e amendment.

Some notes on the management of backwards compatibility for 16h devices

The issue of backwards compatibility is one that needs considering. A policy is required on how 16h and non-16h devices are to inter-work. This is a device question and goes beyond any deployment situation as the deployment scenario imposed by a given regulatory region is not known ahead of time. Here are some examples:

- A device with 16h functionality will need to *interact* with infrastructure that knows nothing of 16h.
- A non-16h device will need to *interact* with 16h compliant infrastructure.
- A non-16h device shall have the ability to be barred from working in a 16h network – deployment specific.
- A 16h device shall work in a non-16h network as 'normal' non-16h device.

These scenarios in themselves provide a set of conditions that can be dealt with by considering how the 16h working document is developed with respect to the base standard.

Overview of editorial suggestions

This section addresses specific areas of the base 802.16-2004 standard which needs addressing for the 16h amendment to provide a basis on which to build LE schemes discussed above. *This list is by no means intended to be exhaustive, is open to further comment, and is likely to result in further contributions in the future.*

The WirelessHUMAN route

At present the base standard uses the idea of wirelessHUMAN to implementation operation in an LE manner (section 8.5 in [2]). The sections of the standard where this is apparent are:

- Section 8.5 ('WirelessHUMAN specific components'),
    - Channelization

  - Transmit spectral mask
- Section 1.3.3 (‘License-exempt frequencies below 11 GHz (primarily 5–6 GHz)’),
  - Scope description and overview
- Table 1 (‘Air interface nomenclature’),
  - Limited to TDD
  - Applicable to WirelessMAN-SCa, WirelessMAN-OFDM, and WirelessMAN-OFDMA PHYs
  - Options supported
- Section 6.3.15 (‘Procedures for shared frequency band usage’)
  - Introduces ‘specific spectrum users’ and DFS

Capability negotiation and network entry procedures

How can capability negotiations be defined in a backwards compatible sense? An application for this could be the use of device barring which do not support 16h functionality as defined by regulation. This will therefore modify the network entry procedure.

‘Channel number’

At present there is a single byte used to specify the *channel number* for LE operation (see Figure 2). This is used for specification of frequencies between 5-6GHz in section 8.5. This byte is referenced in TLVs and channel measurement IEs. The *channel number* granularity is 5MHz. It is likely that this *channel number* will need extending to cover <11GHz references. The author feels that the most prudent way to proceed is to add a number *channel number* rather than extending the existing one.

Modifications to REP-REQ/REP-RSP MAC messages

It is expected that the expansion of the REP-REQ/REP-RSP MAC messages could be a route to enhanced LE operation. This is used heavily for the WirelessHUMAN implementation.

Any potential modifications to these messages can be managed via TLVs as this is the main structure of the message.

Specific editorial changes

This section provides a list of changes that provide a framework for LE operation. More complex scheme may be added at a later date but these suggested changes provide the basic set of amendments. Blue text represents specific addition editorial additions.

Descriptive text

Add a new section 8.5.3 in support of extended reporting for WirelessHUMAN operation

8.5.3 Extension to WirelessHUMAN operation

This section describes extensions to WirelessHUMAN operation beyond that which is described in the sections above. Extended operation includes capability negotiation, extended channel numbering, and reporting. These aspects are discussed in the sections below.

8.5.3.1 Capability Negotiation

A mechanism is provided on how WirelessHUMAN and non-WirelessHUMAN devices are to inter-work. This is an important mechanism for deployment scenarios where regulatory designation of WirelessHUMAN operation is required. Some examples of how the capability negotiation can be used:

- A device with WirelessHUMAN functionality will need to *interact* with infrastructure that knows nothing of WirelessHUMAN.
- A non-WirelessHUMAN device will need to *interact* with WirelessHUMAN compliant infrastructure.
- A non-WirelessHUMAN device shall have the ability to be barred from working in a WirelessHUMAN network – deployment specific.
- A WirelessHUMAN device shall work in a non- WirelessHUMAN network as 'normal' non-WirelessHUMAN device.

8.5.3.2 Extended channel numbering structure

Extended channel numbering provide an enhancement to channelization and definition of *channel number* in section 8.5.1. This extension provides channelization references beyond the limits of 5-6GHz as defined in that section. The channelization is defined accordingly.

- Extended Channel Number (*ExChNr*) – 2 byte specific channel number reference in MHz.
- Base Channel Reference (*BaseChRef*) – 1 byte base reference to frequency range or deployment band in MHz.
- Channel spacing (*ChSp*) - 1 byte channel spacing value (200kHz increments)

In summary the definition of the *Channel Centre Frequency* is:

Channel Centre Frequency [MHz] = *BaseChRef* [MHz] + (*ExChNr* [MHz]. *ChSp* [200kHz]) [xxx]

ExChNr is used in REP-REQ/REP-RSP messages while *BaseChRef*, and *ChSp* are communicated at a session setup or reconfiguration.

8.5.3.3 Reporting

Reporting enhancements provide the ability to:

- Enhance details on environment knowledge for license-exempt operation.

Capability negotiation

Add the following to table 369a REG-REQ/RSP management message encodings

Type	Parameter
45	WirelessHUMAN capability

Add a new section to 11.7.8 SS capability encodings

11.7.8.14 WirelessHUMAN capability

Name	Type (1 byte)	Length (1 byte)	Value	Scope
WirelessHUMAN capability	45	1	Bit #0: No WirelessHUMAN capability Bit #1: WirelessHUMAN capability Bits #2 - #7: *Reserved*	REG-REQ
Base Channel Reference (*BaseChRef*)	46	1	Base Channel Reference in MHz providing base reference to frequency range or deployment band	REG-RSP
Channel Spacing (*ChSp*)	47	1	Channel Spacing in 200kHz increments.	REG-RSP

Channel numbering structure and reporting

Add the following row to second table in section 11.11 (REP-REQ management message encoding)

Name	Type	Length	Value
ExChNr	1.10	2	Physical extended channel number (WirelessHUMAN only)
Extended report type	1.11	1	Bit #0 = 1: Include extended report type A Bit #1 = 1: Include extended report type B Bits #2 - #7: *Reserved*

Add the following row to the first table in section 11.12 (REP-RSP management message encoding)

Name	Type	Length	Value
Extended report type	3	*variable*	Compound

Add the following new table and text in section 11.12 (REP-RSP management message encoding)

The extended report type consists of the following parameters.

REP-REQ Extended report type	Name	Type	Length	Value
Bit #0 = 1 OR Bit #1 = 1	*ExChNr*	1.1	2	Extended physical channel number to be reported on.
Bit #0 = 1 OR Bit #1 = 1	WirelessHUMAN interference indicator	1.2	1	Bit #0: Low interference indication Bit #1: Medium interference indication Bit #2: High interference indication Bit #3: Primary user detected on the channel Bit #4: Channel not measured.
Bit #1 = 1	Zone specific CINR report	1.3	2	1 byte: mean 1 byte: standard deviation
Bit #1 = 1	Zone specific RSSI report	1.4	2	1 byte: mean 1 byte: standard deviation

Further work

Further work items and areas for further consideration include:

- The addition of a ‘LE zone’ for the OFDMA PHY. This could be one way of grouping together all LE functionality and supporting specific permutations used for LE operation.
- The use of a fast-feedback channel.
- Consideration of certification testing of the 16h amendment.
- Consideration of a set of performance parameters for LE operation. Parameters could include:
    - Expected performance,
    - Air interface overhead incurred by a given LE scheme, including signaling overhead,
    - interference thresholds and reaction times, time for network settling once interference has been detected and acted upon,
    - assessment of maintenance of QoS.

References

[1] IEEE 802.16h-05/022: *Part 16: Air Interface for Fixed Broadband Wireless Access Systems Amendment for Improved Coexistence Mechanisms for License-Exempt Operation*, Working document.

[2] IEEE 802.16-2004: *Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems*, October 2004.

[3] IEEE P802.16e/D12: *Draft IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands*.

[4] IEEE P802.16cor1/D5: *Draft IEEE Standard for Local and metropolitan area networks Corrigendum to IEEE Standard for Local and Metropolitan Area Networks - Part 16: Air Interface for Fixed Broadband Wireless Access Systems*.