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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 contains suggested amendments to the working draft and base standard to facilitate a framework from which MAC enhancements for license-exempt and uncoordinated system operation can be developed.
Purpose	
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Technical and editorial amendment of 802.16-2004 facilitating license-exempt and uncoordinated band operation

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Overview

This document describes technical and editorial amendments of the 802.16h working document [1] facilitating modification of 802.16-2004 standard [2] and providing license-exempt and uncoordinated band operation.

General concepts

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

- Specific editorial suggestions to the base standard [2] facilitating a framework for MAC schemes supporting LE and uncoordinated operation.

- Provide clarification in the introductory section of the amendment to 'set the scene' for this work of the amendment. This is added in a new section 1.5. Also a new entry is added in table 1.

- Developing the idea of a new section 6.4 entitled '*MAC enhancement for coexistence*'.

- Adding a new section 6.4.1 to provide MAC specific functions and 6.4.2 to provide MAC support for the PHY. Initially focusing on the OFDMA PHY.

- The protocols discussed in this contribution are assumed to operate in license-exempt and uncoordinated bands that are profiled with a shared channel raster. This reduces the degrees of freedom in the implementation and enables the current PHYs defined in the base standard to be used in such bands.

Figure 1 gives a representation of how a 16h implementation may be realized. This particular example draws on the 16e amendment and therefore the WirelessMAN-OFDMA PHY. The reasoning lies in the fact that 16e has added many features that could be of significant benefit to WirelessMAN-CX operation. This assertion does not preclude the use of any other PHY in the base standard.
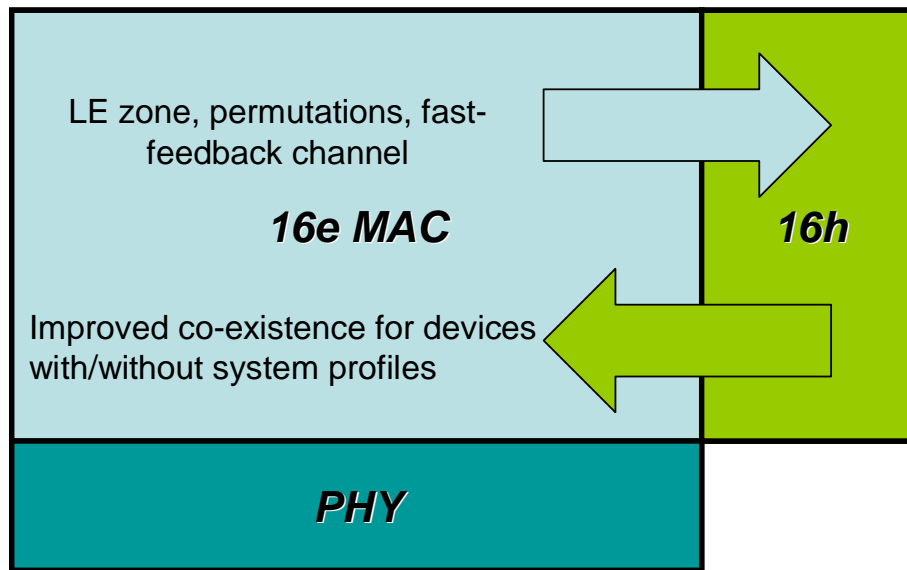
Figure 1 Representation of 16h amendment interfaces with the baseline standard.

Concepts presented in this contribution

Concepts to be introduced and editorial changes suggested include:

- Change all reference from 'WirelessHUMAN' to 'WirelessMAN-CX'.

- Co-existence (CX) zone for both the downlink and uplink.

- The use of fast feedback channels for improved measurement and reporting.

The following sections consider some of these concepts in greater detail.

Co-existence zone (CXZ) for downlink and uplink

The CXZ is proposed to provide the following features:

- A suitable partition to add co-existence MAC enhancements. This has the advantage of simplifying the implementation and amending the base standard.

- Further addition of co-existence support structures at the MAC layer can be implemented with reduced impact on the base standard.

- The CXZ, in this contribution at least, does not support any of the advanced features e.g. AAS and STC concepts. This is for later contributions once the basic ideas have been introduced into the amendment.

To realize the CXZ the following modifications to the base standard are proposed:

- Modify '*Extended DIUC Code Assignment for DIUC=15*' table 275a, section 8.4.5.3.2.1 for the downlink. This assigns a code for the case DIUC=15 and provides a code specification for the extended DIUC.

- Modify '*Extended UIUC Code Assignment for UIUC=15*' table 289a, section 8.4.5.4.4.1 for the uplink. This assigns a code for the case UIUC=15 and provides a code specification for the extended UIUC.

    o The DL and UL CXZ is terminated by another CXZ IE or the end of the frame.

    o Multiple CXZ zones can exist within the same frame.

- Add the CXZ to the generic diagram figure 219 (Section 8.4.4.2) describing the zones supported by the standard.

Specific details of these modifications are added in the section called '*Specific Editorial Changes*'.

Specific editorial changes

This section provides a list of changes to the draft document.

Blue text represents specific editorial additions.

~~Red strikethrough~~ text is to be deleted.

Black text is text already in the draft.

Bold italic text is editorial instructions to the editor.

Introductory section

Delete sections 1.1, and 1.2 in the draft document and replace with a new section 1.5. This will remove erroneous reference to '16h' and 'amendment'.

~~1 Overview~~

~~1.1 IEEE 802.16h scope~~

~~This amendment specifies improved mechanisms, as policies and medium access control enhancements, to enable coexistence among license-exempt systems based on IEEE Standard 802.16 and to facilitate the coexistence of such systems with primary users.~~

~~1.2 IEEE 802.16h applicability~~

~~This amendment is applicable for un-coordinated frequency operation in all bands in which 802.16-2004 is applicable, including bands allowing shared services.~~

1.5 Co-existence for license-exempt and uncoordinated systems

Section 1.3.3 acknowledges that the equipment conformant to this standard may be used in license-exempt and uncoordinated bands. The WirelessHUMAN PHY (section 8.5) addresses the additional needs of systems operating in license-exempt bands; and section 6.3.15 provides suggested procedures and MAC support for addressing the needs of 'specific spectrum users'; users who are deemed to be protected from interference by regulation. Further enhancements to facilitate co-existence for license-exempt and uncoordinated systems in utilizing improved co-existence mechanisms is embodied in policies, MAC enhancements, and recommended practice introduced in this section. This operation is designated WirelessMAN-CX. This designation, being PHY independent, provides specific features in additional to those supported for WirelessHUMAN and builds on new features and evolves those originally designed for licensed band operation.

License-exempt or uncoordinated bands may adopt RF profiling in terms of selecting a known set of RF parameters, such as a band plan. If such a convention is adopted the design, management and inter-working of uncoordinated systems is eased significantly. If no baseline assumptions about other systems sharing the band can be made then complexity is added to both system design and algorithms implemented. In adding license-exempt or uncoordinated operation to the WirelessMAN standard it is assumed that an amendment can draw heavily from the material embodied in the original air interface standard and provide a solution to a problem that is not significantly more complex than the base standard. To this end therefore assumptions about RF parameters, for example channel raster and channel bandwidths, are appropriate to the solution based on WirelessMAN. WirelessMAN-CX therefore provides enhancements to the MAC protocol to facilitate communication between infrastructure and subscriber devices for interference measurement, reporting and management; together with negotiation for spectrum sharing.

Add the following row to table 1.

Designation	Applicability	PHY	Additional MAC requirements	Options	Duplexing alternative
WirelessMAN-CX	Below 11 GHz license-exempt and/or uncoordinated bands	[8.2, 8.3, or 8.4] and/or 8.5	MAC enhancements for coexistence (6.4)	Those applicable to PHY implemented. Section 15.	TDD

Add the following to section 3 'Definitions'.

3.75 WirelessMAN-CX: The designation used to describe the realization that adds co-existence procedures and recommended practice to systems implemented below 11GHz in license-exempt or uncoordinated bands. This designation is PHY independent and adds additional MAC functionality.

Add the following to section 4 'Abbreviations and Acronyms'.

WirelessMAN-CX   Wireless Metropolitan Access Network Co-eXistence

CX   Co-eXistence

Modifications to 6.4 – MAC, and PHY support

Make the following changes to section 6.4.

Add the following paragraph below the heading for section 6.4.

This section describes MAC enhancements for WirelessMAN-CX in support of license-exempt and uncoordinated bands. Firstly concepts are described which are general to the MAC, after which PHY specific interactions are considered. PHY specific discussion is required since WirelessMAN-CX operation is dependant on the features supported for a given PHY.

6.4.1 ~~Extension to [WirelessHUMAN] operation~~ General concepts

This section describes ~~extensions to [WirelessHUMAN]~~ WirelessMAN-CX 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~~ specific to the MAC and support of the PHY from the MAC.

6.4.1.1 Capability Negotiation

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

- A device with ~~[WirelessHUMAN]~~ WirelessMAN-CX functionality will need to *interact* with infrastructure that knows nothing of ~~[WirelessHUMAN]~~ WirelessMAN-CX.

- A non-~~[WirelessHUMAN]~~ WirelessMAN-CX device will need to *interact* with ~~[WirelessHUMAN]~~ WirelessMAN-CX compliant infrastructure.

- A non-~~[WirelessHUMAN]~~ WirelessMAN-CX device shall have the ability to be barred from working in a ~~[WirelessHUMAN]~~ WirelessMAN-CX network – this is deployment specific.

- A ~~[WirelessHUMAN]~~ WirelessMAN-CX device shall work in a non- ~~[WirelessHUMAN]~~ WirelessMAN-CX network as 'normal' non-~~[WirelessHUMAN]~~ WirelessMAN-CX device.

6.4.1.2 Extended channel numbering structure

License-exempt or uncoordinated bands may require or provide scope for the use of a defined channel raster or channel bandwidth. This section provides a means to achieve this, and therefore offer simplification to issues of interference managements. Extended channel numbering provides an enhancement to channelization and definition of *channel number* for WirelessHUMAN operation 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*) – 21 byte specific channel number reference in MHz.

- Base Channel Reference (*BaseChRef*) – 1 byte base reference to frequency range or deployment band in MHz. This reference maps to an absolute frequency value.

- Channel spacing (*ChSp*) - 12 byte channel spacing value (10kHz increments)

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

Channel Centre Frequency [MHz] = *BaseFrequency*(*BaseChRef*)[MHz] + (*ExChNr* [MHz]. * *ChSp* [0.01MHz10kHz])   [xxx]

This is shown in a graphical representation in figures [xyz].
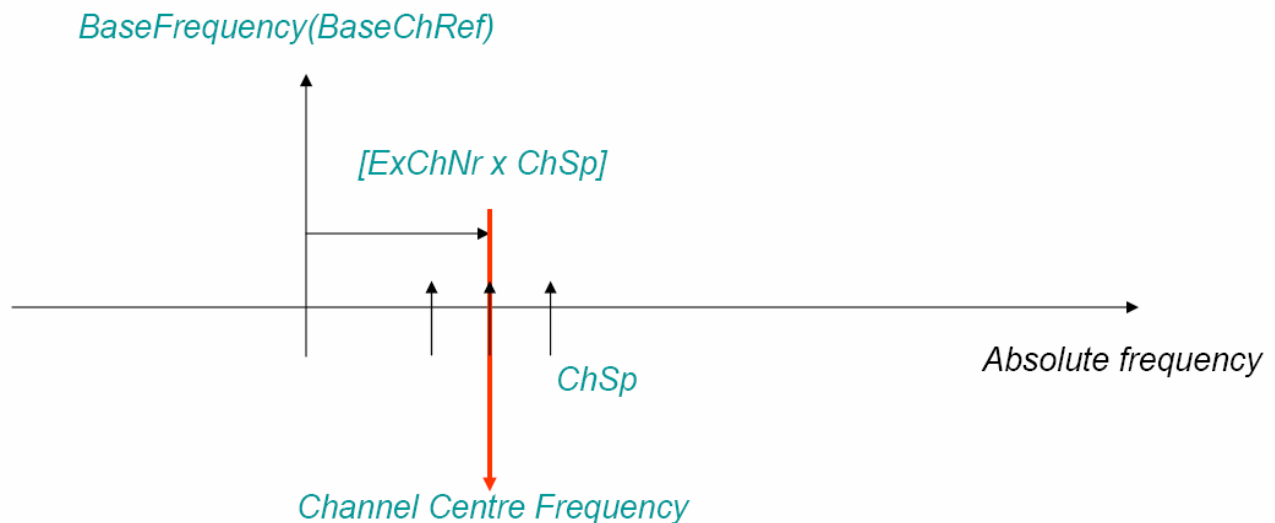

Figure xyz Representation of 'Channel Centre Frequency' calculation.

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

6.4.1.3 Measurement and Reporting

License-exempt or uncoordinated bands are likely to present an operating environment that has a significantly higher and more dynamic interference profile than licensed bands. Measurement and reporting of the prevailing environment is therefore an important consideration for system operation and stability. Measurement and Reporting enhancements provide the ability to:

- Enhance details on environmental knowledge for license-exempt and uncoordinated band operation.
- Provide timely reports for fast link adaptation in an attempt to maintain BER performance.
- Provide bandwidth efficient reports maintain spectral efficiency but also to ensure interference reports are not out-of-date.
- Provide accurate measurements to retain WirelessMAN-CX integrity.

Add the following section 6.4.2.

6.4.2 WirelessMAN-CX support for OFDMA PHY

This section provides a description of WirelessMAN-CX support for the WirelessMAN-OFDMA PHY.

6.4.2.1 Co-existence zone (CXZ) for downlink and uplink

The addition of a CXZ provides the means to include all co-existence enhancements in a defined region within the WirelessMAN-OFDMA PHY. It is expected that all co-existence operation will occur within this zone.

6.4.2.2 Measurement and Reporting

In order to meet strict requirement on measurement and reporting in license-exempt and uncoordinated bands enhanced reporting for WirelessMAN-CX is supported through the REP-REQ/REP-RSP MAC messages (see sections 11.11 and 11.12 respectively). Also the use of the WirelessMAN-OFDMA fast feedback channel is used to enhance reporting capabilities. Section 6.3.18.2 discusses periodic CINR report with fast-feedback (CQICH) channel. It is recommended that interference measurements are undertaken on the effective (feedback type=0b01) or physical (feedback type=0b00) CINR measurement for a CXZ permutation zone (Zone permutation=0b110 and report type=1) from pilot subcarriers (measurement type=0). Section 8.4.5.4.12 gives specific details of the CQICH allocation IE.

In support of the material added in section 6.4.2 make the following changes to the OFDMA PHY specification in figure 219 in section 8.4.4.2.

The OFDMA frame may include multiple zones (such as PUSC, FUSC, PUSC with all subchannels, optional FUSC, and AMC, CXZ, TUSC1, and TUSC2), the transition between zones is indicated in the DL-Map by the

STC_DL_Zone IE (see 8.4.5.3.4), CXZ_DL_IE (see 8.4.5.3.11), or AAS_DL_IE (see 8.4.5.3.3). No DL-MAP or UL-MAP allocations can span over multiple zones. Figure 219 depicts the OFDMA frame with multiple zones.
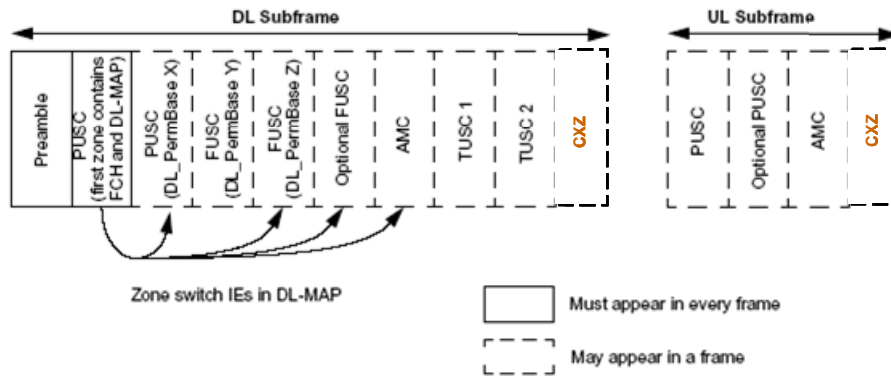

Figure 219—Illustration of OFDMA frame with multiple zones

In support of material added in section 6.4.2 make the following changes to the OFDMA PHY specification in section 8.4.

Add the following row to table 275a, section 8.4.5.3.2.1.

Extended DIUC (hexadecimal)	Usage
09	CXZ_DL_IE
~~09~~ 0A	*reserved*

Insert a new section after 8.4.5.3.11

8.4.5.3.12 Co-existence zone (CXZ) downlink IE format

Within a frame, the switch to co-existence operation is marked by using the extended DIUC = 15 with the CXZ_DL_IE(). The CXZ_DL_IE defines a DL CX zone that spans continuous OFDMA symbols until terminated by another CXZ_DL_IE or the end of the DL frame. Multiple CXZ zones can exist within the same frame. When used, the CID in the DL_MAP_IE() shall be set to the broadcast CID.

Table 285a—CXZ downlink IE

Syntax	Size	Notes
CXZ_DL_IE() {		
Extended DIUC	4 bits	CXZ = 0x09
Length	4 bits	Length = 0x01
OFDMA symbol offset	8 bits	Denotes the start of the zone (counting from the frame preamble and starting from 0).
}		

Add the following row to table 289a, section 8.4.5.4.4.1.

Extended UIUC (hexadecimal)	Usage
0B	CXZ_UL_IE
0B0C … 0F	*reserved*

Modify table 300 in section 8.4.5.4.12 'CQICH Allocation IE format' accordingly

Table 300 – CQICH alloc IE format

Syntax	Size	Notes
Zone permutation	3 bits	The type of zone for which to report 0b000 - PUSC with 'use all SC = 0' 0b001 - PUSC with 'use all SC = 1' 0b010 - FUSC 0b011 - Optional FUSC 0b100 - Safety Channel region 0b101 - AMC zone (only applicable to AAS mode) 0b110 - CXZ 0b110 111 - Reserved

Insert a new section after 8.4.5.4.15

8.4.5.4.16 Co-existence zone (CXZ) uplink IE format

Within a frame, the switch to co-existence operation is marked by using the extended UIUC = 15 with the CXZ_UL_IE(). The CXZ_UL_IE defines a DL CX zone that spans continuous OFDMA symbols until terminated by another CXZ_UL_IE or the end of the DL frame. Multiple CXZ zones can exist within the same frame. When used, the CID in the DL_MAP_IE() shall be set to the broadcast CID.

Table 302aa—CXZ uplink IE

Syntax	Size	Notes
CXZ_UL_IE() {		
Extended DIUC	4 bits	CXZ = 0x09
Length	4 bits	Length = 0x01
CXZ zone length offset	8 bits	The length of the uplink CXZ zone.
}		

Capability negotiation

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

Type	Parameter
45	[WirelessHUMAN] WirelessMAN-CX capability

Make the following changes to section to 11.7.8 SS capability encodings

11.7.8.14 [WirelessHUMAN] WirelessMAN-CX capability

Name	Type (1 byte)	Length (1 byte)	Value	Scope
[WirelessHUMAN] WirelessMAN-CX	45	1	Bit #0: No [WirelessHUMAN] WirelessMAN-CX capability	REG-REQ

capability			Bit #1: ~~[WirelessHUMAN]~~ WirelessMAN-CX capability Bits #2 - #7: *Reserved*	
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	2	Channel Spacing in 10kHz increments.	REG-RSP

Channel numbering structure and reporting

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

Name	Type	Length	Value
ExChNr	1.10	2	Physical extended channel number (~~[WirelessHUMAN]~~ WirelessMAN-CX 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*

Make the following changes to the table 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]~~ WirelessMAN-CX 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

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*.