



**IEEE Standard for
Local and metropolitan area networks**

Part 16: Air Interface for Broadband Wireless Access Systems

Amendment 2: Improved Coexistence Mechanisms for License-Exempt Operation

**IEEE Computer Society
and the
IEEE Microwave Theory and Techniques Society**

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997, USA

30 July 2010

IEEE Std 802.16h™-2010
(Amendment to
IEEE Std 802.16™-2009)

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Approved 17 June 2010
IEEE-SA Standards Board

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

Keywords: broadband wireless access, BWA, coexistence, Coexistence Control Channel, coexistence mechanism, Coexistence Protocol, Coexistence Signaling, contention-based protocol, license-exempt, OFDMA, radio, standard, WAS, wireless access systems, WirelessMAN[®], WirelessMAN-CX, WirelessMAN-UCP, wireless metropolitan area network

The Institute of Electrical and Electronics Engineers, Inc.
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PDF: ISBN 978-0-7381-6351-2 STD96081
Print: ISBN 978-0-7381-6352-9 STDPD96082

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This introduction is not part of IEEE Std 802.16h-2010, IEEE Standard for Local and metropolitan area networks—Part 16: Air Interface for Broadband Wireless Access Systems—Amendment 2: Improved Coexistence Mechanisms for License-Exempt Operation.

This amendment updates and expands IEEE Std 802.16, specifying improved mechanisms, as policies and medium access control enhancements, to enable coexistence among license-exempt systems and to facilitate the coexistence of such systems with primary users. As of the publication date, the current applicable version of IEEE Std 802.16 is IEEE Std 802.16-2009, as amended by IEEE Std 802.16j™-2009 and IEEE Std 802.16h-2010.

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IEEE Standard for
Local and metropolitan area networks

Part 16: Air Interface for
Broadband Wireless Access Systems

Amendment 2: Improved Coexistence
Mechanisms for License-Exempt Operation

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NOTE—The editing instructions contained in this amendment define how to merge the material contained herein into the existing base standard and its amendments to form a comprehensive standard.

The editing instructions are shown ***bold italic***. Four editing instructions are used: ***change***, ***delete***, ***insert***, and ***replace***. ***Change*** is used to make small corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by either using ~~striketrough~~ (to remove old material) or underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make large changes in existing text, subclauses, tables, or figures by removing existing material and replacing it with new material. Editorial notes will not be carried over into future editions because the changes will be incorporated into the base standard.

1. Overview

1.3 Frequency bands

Change title of 1.3.3 as follows:

1.3.3 License-exempt bands ~~frequencies below 11 GHz (primarily 5-6 GHz)~~

Delete the last two paragraphs in 1.3.3 as follows:

~~It is recognized that some administrations require notification of terminal location for certain services in some license exempt bands, which is a form of licensing. Conversely, it is possible to have uncoordinated usage within a licensed allocation. In these and other similar cases, the pertinent issues for license exempt usage remain as described in the preceding paragraph.~~

~~In the context of this standard, the use of the term “license exempt frequencies” or “license exempt bands” should be taken to mean the situation where licensing authorities do not coordinate individual assignments of frequency bands to operators, regardless of whether the spectrum in question has a particular regulatory status as license exempt or licensed.~~

1.3.4 Air interface nomenclature and PHY compliance

Change the seventh row of Table 1 in 1.3.4 as indicated:

Designation	Applicability	PHY specification	System features	Duplexing alternative
WirelessHUMAN™	~~Below 11 GHz license-exempt bands~~ <u>License-exempt bands below 11GHz</u>	~~{8.4} and 8.5~~ <u>8.3, 8.4, and 8.5</u>	~~AAS (6.3.7.6)~~ ~~ARQ (6.3.4)~~ ~~STC (8.3.8/8.4.8)~~ <u>12.3, 12.4</u>	TDD

Insert the following rows at the end of Table 1:

Designation	Applicability	PHY specification	System features	Duplexing alternative
WirelessMAN-CX	License-exempt bands below 11GHz	8.3, 8.4	12.8.2	TDD
WirelessMAN-UCP	License-exempt bands below 11GHz	8.4	12.8.1	TDD

Change the last paragraph in 1.3.4 as indicated:

Implementations of this standard for license-exempt frequencies below 11 GHz (such as those listed in B.1) use the designations WirelessHUMAN, WirelessMAN-CX and WirelessMAN-UCP, and shall comply with the WirelessMAN-OFDM PHY as described in 8.3, or the WirelessMAN-OFDMA PHY as described in 8.4. WirelessMAN-UCP provides uncoordinated coexistence mechanisms (6.4) and WirelessMAN-CX provides

coordinated coexistence mechanisms (Clause 15). They shall further comply with the DFS protocols (6.3.156.4.1.2) (where mandated by regulation) and with 8.5.

1.4 Reference models

Insert the following text in 1.4, as part of the sixth paragraph:

The PHY definition includes multiple specifications, each appropriate to a particular frequency range and application. The various PHY specifications supported are discussed in Clause 8. The Management/Control Plane may also include the “CX Management part” of WirelessMAN-CX composed of the “Distributed Coexistence Information Database,” “Distributed Radio Resource Management,” and “Coexistence Protocol (CXP).” All these parts are supported at the MAC level.

Replace Figure 1 with the following:

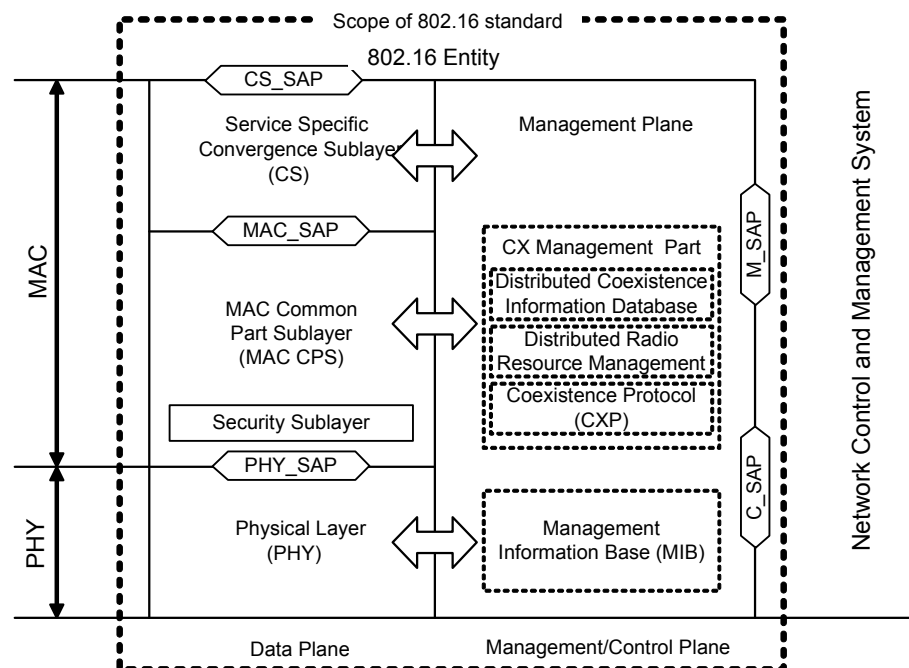


Figure 1—IEEE 802.16 protocol layering, showing SAPs

2. Normative references

Insert the following reference in alphabetical order:

ITU Radio Regulations, Volume 1, Article 5, 2008.

3. Definitions

Insert the following new terms after 3.129:

3.130 acceptable interference: An interference caused by an interference signal that does not degrade the current selection of modulation and coding at a receiver.

3.131 acceptable interference threshold: A value (in dBm) of a signal level, below which an interference signal causes acceptable interference.

3.132 alternative channel (ALTCH): A physical (frequency) channel determined by the base station as being a suitable alternative physical channel for use if its current physical channel becomes unavailable.

3.133 alternative subframe (ALTSF): A subframe that can be used by the base station of a system because it is unoccupied.

3.134 bursty system: A bursty system in this standard refers to non-SSU (see non-specific spectrum users) units only and transmits data in short uneven intervals. Wireless LANs are an example of bursty systems.

3.135 candidate channel: A frequency channel within the frequency band that may be used by a system.

3.136 coexistence: A state of acceptable co-channel and/or adjacent channel operation of two or more radio systems (possibly using different wireless access technologies) within the same geographical area.

3.137 coexistence community: A coexistence community is composed of those systems that have resolved their interference and coexist within it.

3.138 Coexistence Control Channel (CXCC): A logical channel composed of a periodic sequence of time slots, which may be used for sensing, synchronization, cumulated interference measurement and broadcast of the coordinated coexistence related information. CXCC is used for WirelessMAN-CX, and may be used for WirelessMAN-UCP.

3.139 Coexistence frame (CX-Frame): A pre-defined sequence of IEEE 802.16 DL and UL subframes that, in conjunction with associated operational rules, is used for facilitating coexistence between systems.

3.140 coexistence messaging mechanism: The messaging mechanism defined in WirelessMAN-CX to exchange information specifically between wireless systems with the same PHY profiles.

3.141 Coexistence Messaging Interval (CMI): A unique repetitive sequence of intervals defined in CXCC and claimed by a system. It is used for broadcasting system's main radio parameters to other systems in its Coexistence Community using always the same predefined PHY parameters.

3.142 Coexistence Protocol (CXP): An inter-system protocol for improving coexistence through the exchange of information, using communication over-the-air or back-haul. Messages for inter-system communication over-the-air and primitives for communication over the backhaul are provided.

3.143 coexistence signaling: The signaling mechanism defined in WirelessMAN-CX to exchange information between wireless systems with or without the same PHY profiles.

3.144 Coexistence Signaling Interval (CSI): A predefined time slot not associated with the CXCC, used for coexistence signaling purposes between systems that may have different PHYs. This technique uses power keyed energy symbols and RSSI detection, by a BS to contact its coexistence neighbor BS through one or more coexistence neighbor SSs in the common coverage area.

3.145 Coexistence Signaling Interval Number (CSIN): The allocation of CSI according to the time order within CX-Frame. The range of CSIN is from 0 to 3 while 0-3 is referring to OCSI1/OCSI2/OCSI3/ICSI respectively.

3.146 cognitive radio (CR): A system that is aware of its operational environment and internal state, and has the capability to make decisions about its radio operating behavior. An active cognitive radio can share information regarding its spectral/temporal/spatial characteristics with other similar systems and/or dynamically and autonomously adjust its radio operating parameters depending on the results of its actions and environmental usage patterns. This definition reflects the CR functionality in this standard.

3.147 Common subframe: That part at the beginning of the MAC Frame within the CX-Frame where all the systems of a coexistence neighborhood may operate in parallel. The operation of non-Master systems during these subframes may require limitations on the transmit power.

3.148 community: A community is composed of those systems that coordinate to resolve their interference.

3.149 Coordinated Coexistence Mechanism: A coexistence mechanism relying on rules of behavior based on a common Coexistence Frame (CX-Frame) and a Coexistence Control Channel (CXCC).

3.150 Credit Token-Based Coexistence Protocol (CT-CXP): Over-the-air or backhaul-based mechanisms enabling dynamic subframe sharing between systems.

3.151 destination base station (BS): The BS that responds to an inter-system communication request

3.152 destructive interference: Interference that disables a particular PHY receiver from receiving using any combination of its modulation and coding methods.

3.153 detection threshold: A value (in dBm) of a signal level, used for the purpose of initiating an action.

3.154 Dynamic Channel Selection (DCS): The ability of a system to switch to a different physical (frequency) operating channel based on channel measurements avoiding interference in license-exempt bands of operation. DCS is distinct from DFS (Dynamic Frequency Selection) because DCS is not used for interference avoidance to regulatory protected devices, such as radar systems, but to other non-SSUs in the band.

3.155 harmful interference: An interference caused by an interference signal that seriously degrades, obstructs, or repeatedly interrupts the radio communication.

3.156 Interference Evaluation Burst (IEB): The Interference Evaluation Burst consists of a short regular data transmission during an interference-free slot. This transmission is scheduled using CXP messages. The time position of this interval is associated with an IEB identifier.

3.157 interference neighborhood: A system will perceive as an interference neighbor any other systems that create/receive interference to/from it.

3.158 Initialization Coexistence Signaling Interval (ICSI): The periodically appointed CSI specially used by an Initializing Base Station (IBS) to contact its neighbor OBS. When the IBS gets the OCSI allocation and starts the operating stage, it will cease from using the ICSI.

3.159 licensing regime: Specific service rules defined by a regulatory body for a given band and possibly region of operation.

3.160 Master subframe: The part of the MAC frame that is used by a specific system (Master system) of a coexistence community to operate with reduced interference from its neighboring systems.

3.161 Master system: A specific system that operates during the Master subframe. Systems of a coexistence community equally share the role of Master system on a rotating basis.

3.162 Operation Coexistence Signaling Interval (OCSI): All the CSIs other than ICSI, periodically reallocated to OBSs.

3.163 Primary service: This term is defined in the ITU Radio Regulations.

NOTE—See 5.23 to 5.31.

3.164 Primary (Spectrum) users: Users of radio services that have a regulatory PRIMARY status in a band. In a given frequency allocation there may be SSU, non-SSU, or both SSU and non-SSU, assigned as primary users.

3.165 random temporary key (RTK): The temporary key sent over-the-air, to be cross-checked with the key contained in the request primitive (15.6.5.2) received by the BS that originally sent it over-the-air. RTK is used to obstruct the coexistence requests from unauthenticated terminals.

3.166 regulatory threshold: A value (in dBm) of a signal level, as defined by the regulatory rules, above which the receiver has to initiate an action.

3.167 Shared subframe: The MAC Frame where all the systems of a coexistence community may operate in parallel. The operation during this frame may require limitations on the transmit power.

3.168 Slave subframe: That part of the MAC frame coinciding with the Master subframe in which all systems (other than the Master) of the coexistence community have restricted operation.

3.169 Slave system: A specific system that operates during the Slave subframe. This system shall not create interference to the Master systems that operate during its Master subframe.

3.170 source base station (BS): The BS that initiates an inter-system communication procedure.

3.171 specific spectrum user (SSU): A service specifically identified in regulation as requiring protection from harmful interference. These systems are given a priority from a regulatory point of view within a given frequency band.

3.172 system: A base station (BS) and its subscriber stations (SSs).

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

3.174 WirelessMAN-CX: The designation used to describe the realization that adds coordinated coexistence mechanisms to systems operating below 11 GHz in license-exempt bands.

3.175 WirelessMAN-UCP: The designation used to describe the realization that adds uncoordinated coexistence mechanisms to systems operating below 11 GHz in license-exempt bands.

4. Abbreviations and acronyms

Insert the following abbreviations in alphabetical order:

ACLR	Adjacent Channel Leakage Ratio
ACS	Adaptive Channel Selection

ADPD	Advertisement Discovery Policy Descriptor
ALTCH	alternative channel
BSD	base station descriptor
BSIS	Base Station Identification Server
CCA	Clear Channel Assessment
CCD	Candidate Channel Determination
CCMFA	Candidate Channel and Master Frame Assessment
ChCtrFr	channel center frequency
CMI	Coexistence Messaging Interval
CoNBR	coexistence neighbor
CR	cognitive radio
CSI	Coexistence Signaling Interval
CSIN	Coexistence Signaling Interval Number
CTG	CSI Transmission GAP
CT-CX	credit token-based coexistence
CW	contention window
CX	Coexistence
CXCBI	Coordinated Contention-Based Interval
CXCC	Coexistence Control Channel
CXCW	coexistence contention window
CXP	Coexistence Protocol
CXSBI	Coordinated Scheduled-Based Interval
CX-CBP	Coordinated Contention-Based Protocol
CX_CMI_D	Coexistence Message Interval Downlink
CX_CMI_U	Coexistence Message Interval Uplink
DCS	Dynamic Channel Selection
EOF	End of Frame (of the CSI message)
EQP	extended quiet period
FCC	Federal Communications Commission
IBS	initializing base station
ICSI	Initialization Coexistence Signaling Interval
IEB	Interference Evaluation Burst
IEBBSn	Nth Interference Evaluation Burst of a BS
IEBSSn	Nth Interference Evaluation Burst over all the SS associated with a BS
INR	interference-to-noise ratio
LBT	listen-before-talk
LBT-TXOP	Transmission Opportunity depending on LBT result
LE	license-exempt
NTI	Network Time Intervals
NTI_S	Network Time Interval Slots
NTP	Network Time Protocol
NURBC	Neighborhood Update Request BroadCast
OBS	operating base station
OCSI	Operation Coexistence Signaling Interval
PLD	PayLoaD (of the CSI message)
QP	quiet period
RAIS	Radio Application Identification Server
RLAN	Radio Local Area Network
RRU	renting resource unit
RCG	Receive CSI GAP
RTK	random temporary key
SAP	Service Access Point
SOF	Start of Frame (of the CSI message)
SSU	specific spectrum user

SSURF	Subscriber Station Uplink Radio Frequency
TPC	Transmit Power Control
UCP	Uncoordinated Coexistence Protocol
UTC	coordinated universal time
WirelessMAN-CX	Wireless Metropolitan Access Network Coexistence
WirelessMAN-UCP	Wireless Metropolitan Access Network Uncoordinated Coexistence Protocol

6. MAC common part sublayer

6.3 Data/Control plane

6.3.2 MAC PDU formats

6.3.2.3 MAC management messages

Insert the following rows at the end of Table 38:

Table 38—MAC management messages

Type	Message name	Message description	Connection
98	CX-CCID-IND	Co-Channel Interference Detection Indication	Basic
99	CX-CCID-RES	Co-Channel Interference Detection Resolution	Basic
100	CX-FWD-REQ	Coexistence Forward Request message	Broadcast/Basic/ Multicast
101	CX-FWD-RSP	Coexistence Forward Response message	Broadcast/Basic/ Multicast
102	CX-FWD-ACK	Coexistence Forward Acknowledge message	Broadcast/Basic/ Multicast
103	CX-ACCESS-NBS-REQ	Access neighbor BS request message	Basic
104	CX-ACCESS-NBS-RSP	Access neighbor BS response message	Basic
105	CX-FWD-END-REQ	Forward end request message	Basic
106	CX-CSI-MNTR-CFG	CSI monitoring request message	Broadcast
107	CX-CSI-MNTR-REP	CSI monitoring response message	Basic
108	CX-DL-MAP	Coexistence Downlink Map message	Broadcast
109	CX-UL-MAP	Coexistence Uplink Map message	Broadcast
110–255		Reserved	

6.3.2.3.23 SBC-REQ (SS and RS basic capability request) message

Insert the following text at the end of 6.3.2.3.23:

The following TLV shall only be included by WirelessMAN-CX capable devices:

WirelessMAN-CX feature support (see 11.8.22.1)

The following TLV shall only be included by WirelessMAN-UCP capable devices:

WirelessMAN-UCP feature support (see 11.8.22.2)

6.3.2.3.24 SBC-RSP (SS and RS basic capability response) message

Insert the following text at the end of 6.3.2.3.24:

The following TLV shall only be included by WirelessMAN-CX capable devices:

WirelessMAN-CX feature support (see 11.8.22.1)

The following TLV shall only be included by WirelessMAN-UCP capable devices:

WirelessMAN-UCP feature support (see 11.8.22.2)

6.3.2.3.33 Channel Measurement REP-REQ/RSP (report request/response)

Change the text in 6.3.2.3.33 as indicated:

If the BS, operating in bands below 11 GHz, requires RSSI and CINR channel measurement reports, or requires coexistence neighbor report, it shall send the Channel Measurement REP-REQ message. The Channel Measurement REP-REQ message shall additionally be used to request the results of the measurements the BS has previously scheduled. Table 103 shows the Channel Measurement REP-REQ message.

The REP-REQ message shall contain the following TLV encoded parameters:

Report Request

The Channel Measurement REP-RSP message shall be used by the SS to respond to the channel measurements listed in the received Channel Measurement REP-REQ messages. Where regulation mandates detection of specific signals by the SS, the SS shall also send a Channel Measurement REP-RSP message in an unsolicited fashion upon detecting such signals on the channel in which it is operating if mandated by regulatory requirements. The SS may also send a Channel Measurement REP-RSP message containing channel measurement reports, in an unsolicited fashion, or when other interference is detected above a threshold value. When specific signal detection by an SS is not mandated by regulation, the SS may indicate “Unmeasured. Channel Not Measured” (see 11.12) in the Channel Measurement REP-RSP message when responding to the Channel Measurement REP-REQ message from the BS. For systems compliant with WirelessMAN-CX, if an SS detects the CXCC transmissions from a coexistence neighbor, it shall use REP-RSP to report the information to its serving BS in an unsolicited manner. Table 104 shows the Channel Measurement REP-RSP message.

The following threshold levels shall be used by systems compliant with Wireless-MAN CX for the report:

- For specific signals mandated by regulation: the regulatory threshold (15.1)
- For non-SSUs: destructive interference threshold (15.1), of the reporting SS

Change the text in 6.3.2.3.33 as indicated:

The Channel Measurement REP-RSP message shall contain the following TLV encoded parameters:

Report

Compound TLV that shall contain the measurement Report in accordance with the Report Request (see 11.11).

Upon sending a Channel Measurement REP-RSP message, an SS shall reset all its measurement counters for each channel on which it reported.

The following TLV should be included:

Network address for inter-system communication (see 11.1)

Systems compliant with 12.8 shall support the following TLVs: Frame-specific CINR Report, Frame-specific RSSI Report.

Insert new subclauses after 6.3.2.3.85 as follows:**6.3.2.3.86 CX-CCID-IND message**

The CX-CCID-IND message is sent by SS to the serving BS for requesting the BS to undertake a coexistence action. The SS initiates the request after the detection of unresolved co-channel interference. This message is sent by the foreign SS and contains co-channel interference information detected at the subscriber station. The source of co-channel interference can be foreign sources such as radars or non-WirelessMAN-CX compliant devices, as well as other WirelessMAN-CX base stations that may or may not be members of the coexistence community.

This MAC management message is sent by a SS to its home base station when unresolved co-channel interference is detected at the SS. Unresolved co-channel interference typically is interference new to the SS and is not recorded in the SS Interference Table as having been resolved using the Coexistence Protocol. Resolved interference implies that messages destined to the SS will not be corrupted by interference created by a foreign WirelessMAN-CX base station. The generation of this message is controlled by setting an inhibition period and interference detection threshold using the CX-CCID-RES message. CX-CCID-IND will be sent only after a specific number of CXCC cycles providing interference exceeds the threshold and is detected at least once. The intensity of the interference is reported using the INT_BSD_Frq field.

The message is also sent when non-WirelessMAN-CX systems are detected, such as RLAN signals or radars that have higher regulatory priority to the bandwidth. Information about the specific interferer can be sent, assuming that this information can be specifically determined by the foreign SS. Such information can include the classification of a radar or bursty non-WirelessMAN-CX system. Thresholds for sending CX-CCID-IND messages in response to non-WirelessMAN-CX interference can be set in the complementary CX-CCID-RES message.

The CX-CCID-IND MAC management message shall contain the following minimum information to help determine the source and victim of co-channel interference:

BSID

The foreign BS identity taken from the BSD message.

Network_Address_IE

The network address associated with a foreign base station, derived from the BSD

BS_RF_Sector_ID

The RF antenna sector ID is used to identify the RF antenna at the interfering base station where multiple RF antennas may be used; this information is derived from the BSD. It contains information about the following:

- ID of RF transmitting antenna at the subscriber station
- Antenna gain (dBi)
- Azimuth direction of transmission relative to the true North
- Antenna aperture at 3 dB attenuation
- Antenna polarization (Vertical, Horizontal, Cross, Circular)

BS_EIRP

The EIRP of the interfering base station, taken from the BSD.

CX_CMI_D(n)

The Coexistence Messaging Downlink Interval (where $n = 1-4$) during which the interference was received. If this variable contains zero, detection of interference was done during the silent period of subchannel 1 of CXCC, and not during CMI.

INT_BSD_Frq

This parameter is used to quantify the number of interference instances either from other same-PHY WirelessMAN-CX sources or from non-WirelessMAN-CX sources. Quantification is done by counting interference events during specific CXCC repetition periods (see 15.3.1.1) Same PHY WirelessMAN-CX sources are identified during CMI in Subchannel 2; non-WirelessMAN-CX sources are identified during silent periods created in Subchannel 1 (see 15.3.1.2.2 and 15.3.1.2.1). The parameter sent applies only to: a) this specific BSD and BSID, as forwarded by this CX-CCID-IND message (in the case of same-PHY WirelessMAN-CX) or, b) to the specific non-WirelessMAN-CX source identified in the DFS_LE_PWR_FRQ parameter. The threshold for the detection of an interference event is set by the CX-CCID-RES message.

Device type

0—reserved; 1—Radar; 2—Analog TV; 3—Digital TV; 4—Wireless Microphone; 5—Cable modem; 6—ADSL Modem; 7—Satellite—8–31 reserved.

DFS_LE_PWR_FRQ

This parameter is used to identify the types of interfering non-WirelessMAN-CX devices and provide information that may be specific to those particular devices. It is possible to identify up to 32 classes of devices. Radar information such as PPS and Pulse duration shall be given in the Device Detection Specific field. The CCID is the identification number of this specific CX-CCID-IND message and is used to tag this specific interference event. The number shall be a rolling number from 1 to 65536.

RSSI report

The mean and standard deviation of the interfering signal reported by this message, measured only for interfering signals that are valid interference detection events and exceed the RSSI threshold in the CX-CCID-RES message. See 8.3.9 and 8.4.11 for details.

HGHT

The height of the BS above sea level in meters.

The following TLV shall be included:

Network address for inter-system communication (see 11.1)

GPS_Loc (see 11.30, Table 617a)

Table 166a—CX-CCID-IND message format

Syntax	Size (bit)	Notes
CX-CCID-IND_Message_Format() {		
Management Message Type =98	8	
DFS_LE_PWR_FRQ	32	Bit 0: 0 for WirelessMAN-CX interference, also set Bits 1-15 to zero; 1 for non-WirelessMAN-CX interference, set Bits 1–15: As below. Bits 1–5: Device Type (0: reserved, 1: radar, 2: Analog TV, 3: Digital TV, 4: Wireless microphone, 5: Cable modem, 6: ADSL modem, 7: Satellite, 8–31: reserved). Bits 6–15: <i>Reserved</i> : Device detection specific Bits 16–31: CCID
INT_BSD_Frq	16	Bits 0–7: The number of interference detection events Bits 8–15: CXCC repetition cycles.
BSID	48	Foreign base station ID; Set to 0 for Non-WirelessMAN-CX Interference
BS_RF_Sector_ID	40	Bits 0–3: ID Bits 4–7: Gain (dBi), 2 dB resolution Bits 8–15: Azimuth, 2 degree resolution Bits 16–23: 3 dB aperture, 2 degrees resolution Bits 24–25: Polarization, with: 00-vertical, 01-horizontal, 10-cross, 11-circular Bit 26: Beam-forming, 1=yes Bits 27–30: Number of antenna elements Bits 31–34: Number of possible beams Bit 35: Interference cancellation capability Bit 36: MIMO capability (which can imply interference cancellation to the same PHY cases) Bits 37–39: <i>Reserved</i> <i>Set all to 0 for Non-WirelessMAN-CX Interference</i>
BS EIRP	8	Nominal EIRP of interfering BS; Set to 0 for Non-WirelessMAN-CX Interference

Table 166a—CX-CCID-IND message format (continued)

Syntax	Size (bit)	Notes
CX_CMI_D(n)	8	Coexistence Messaging Interval ID in which WirelessMAN-CX interference detected. Set to 0 if interference event detected during silent period of subchannel 1. Set to 1–3 if detected during CX_CMI_D(1–3); Set to 4 if detected during CX_CMI_D(4).
HGHT	16	The height of the interfering BS above sea level in meters
RSSI report	16	Bit 0–7: RSSI Mean value in dBm Bit 8–15: RSSI standard deviation in dB
TLV Encoded Attributes	<i>variable</i>	TLV specify
}		

6.3.2.3.87 CX-CCID-RES message

This message is sent from the BS to the SS initiating the CX-CCID-IND message. It is used to indicate whether the interference events identified in the CX-CCID-IND (specifically identified by the CCID) have been resolved. For DFS and non-WirelessMAN-CX interference events, in addition to this message there likely will be other actions issued by the network management systems, which can entail moving to other channels. For WirelessMAN-CX systems the actions could include reducing EIRP at the interfering BS or assigning the foreign SS to a different subframe, etc. This message is also sent to adjust the RSSI threshold of interference detection at the SS, the number of CXCC repetition periods over which an interference measurement takes place, and to inhibit the sending of CX-CCID-IND messages due to specifically identified interferers.

CX-CCID-RES shall contain the following parameters:

BSID

The identity of the foreign BS noted in the CX-CCID-IND. This can be null if the message was originally due to DFS or non-WirelessMAN-CX sources.

RSP_FIELD

The response field indicates the following:

- 1) The specific CX-CCID-IND for which the response is this CX-CCID-RES message, as indicated by the CCID (bits 0–15). If this value is 0, this message resets RSSI threshold parameters, and repetition cycles and inhibition periods.
- 2) Status of the interference resolution (bits 16–17), which if equal to
 0 = DL interference source identified in the CX-CCID-IND has been resolved/tolerated/pending and SS shall cease sending a CX-CCID-IND until the given inhibition period (applicable to the specific source) expires.
 1 = Stop sending all CX-CCID-IND until given inhibition period expires.
 2 = Start sending CX-CCID-IND, reset inhibition period.
 3 = Vacant.
- 3) RSSI threshold (bits 18–25). Interference measured higher than this mean RSSI level in the operational bandwidth of the receiver shall be construed as a valid interference detection event and shall trigger a RSSI measurement for the calculation of a mean level and

standard deviation for the interfering signal. Levels are set between -40 and -103 dBm in increments of 0.25 dB. See 8.3.9 and 8.4.1.1 for details.

- 4) The number of CXCC repetition cycles (bits 26–33) for the SS measurement of interference before a CX-CCID-IND message is to be sent, given that the RSSI threshold is exceeded at least once.
- 5) The length of the inhibition period (in CXCC cycles) during which the SS suppresses CX-CCID-IND messages due to either a specifically identified interference source or to all interference in general.

Table 166b—CX-CCID-RES message format

Syntax	Size (bit)	Notes
CX-CCID-RES_Message_Format() {		
Management Message Type = 99	8	
BSID	48	Interfering BS station ID for which this response is sent to SS; set to zero if non-WirelessMAN-CX.
RSP_Field	32	Bits 0–15: CCID of BS_CCIC_RSP to which this message is reacting to. If 0, this message is for reset of threshold parameters. Bits 16–17: Resolution Status 0—Interference resolved/tolerated/pending 1—Stop sending all CX-CCID-IND for given inhibition period. 2—Start sending CX-CCID-IND messages, reset inhibition period. Bits 18–25: Threshold RSSI Setting. Bits 26–33: CXCC repetition cycles. Bits 34–48: Inhibition Period in unit of CXCC cycles.
}		

6.3.2.3.88 Coexistence Forward Request message (CX-FWD-REQ)

This message transmits inter-system coexistence information from a source BS to a destination BS. For the downlink, based on the number of forwarding SSs, the CX-FWD-REQ message may be transmitted using a broadcast CID, multicast CID, or basic CID allocated by the source BS. For the uplink, the CX-FWD-REQ message shall be transmitted using the forwarding SS's basic CID allocated by the destination BS.

The CX-FWD-REQ management message shall include the following parameters:

Action Code

The Action Code is one byte in length, and identifies the action type for an inter-system coexistence message. When a message is received with an invalid Action Code, it shall be silently discarded. The action code values are defined in Table 657 of 15.5.3.

Message number

Random number for CX-FWD-REQ, matching number for CX-FWD-RSP and CX-FWD-ACK.

TLV Encoded Attributes

The message attributes carry the specific authentication, coexistence resolution, and coexistence negotiation data exchanged between peers. Each coexistence message Action Code has its own set of required and optional attributes. Unless explicitly stated, there are no requirements on the ordering of attributes within a CX-FWD-REQ message. The end of the list of attributes is indicated by the LEN field in the MAC PDU header. The TLV encoded attributes values are defined in Table 617a of 11.30.

Table 166c—CX-FWD-REQ message format

Syntax	Size (bit)	Notes
CX-FWD-REQ_Message_Format () {		
Management Message Type = 100	8	
Action Code	8	
BSID	48	If the CX-FWD-REQ message is sent from the source BS to the forwarding SS, the BSID shall be the “BSID of destination BS.” If the CX-FWD-REQ message is sent from the forwarding SS to the destination BS, the BSID shall be the “BSID of source BS.”
Message number	16	Random number for CX-FWD-REQ, matching number for CX-FWD-RSP and CX-FWD-ACK.
TLV Encoded Attributes	<i>variable</i>	TLV specify.
}		

6.3.2.3.89 Coexistence Forward Response message (CX-FWD-RSP)

This message is sent by the destination BS of the CX-FWD-REQ message to the source BS. For the downlink, based on the number of forwarding SSs, the CX-FWD-RSP message may be transmitted using a broadcast CID, multicast CID or basic CID allocated by the destination BS. For the uplink, the CX-FWD-RSP message shall be transmitted using the forwarding SS’s basic CID allocated by the source BS.

The CX-RSP MAC management message shall include the following parameters:

Action Code

The Action Code is one byte in length and identifies the action type for an inter-system coexistence message. When a message is received with an invalid action code, it shall be silently discarded. The action code values are defined in Table 657 of 15.5.3.

BSID

If the CX-FWD-RSP message is sent from the destination BS to the forwarding SS, the BSID shall be the “BSID of source BS.” If the CX-FWD-REQ message is sent from the forwarding SS to the source BS, the BSID shall be the “BSID of destination BS.”

Message number

Number matching the message number used for the CX-FWD-REQ.

TLV Encoded Attributes

The message attributes carry the specific authentication, coexistence resolution, and coexistence negotiation data exchanged between peers. Each coexistence message Action Code has its own set of required and optional attributes. Unless explicitly stated, there are no

requirements on the ordering of attributes within a CX-FWD-RSP message. The end of the list of attributes is indicated by the LEN field in the MAC PDU header. The TLV encoded attributes values are defined in Table 617a of 11.30.

Table 166d—CX-FWD-RSP message format

Syntax	Size (bit)	Notes
CX-FWD-RSP_Message_Format() {		
Management Message Type = 101	8	
Action Code	8	
BSID	48	If the CX-FWD-RSP message is sent from the destination BS to the forwarding SS, the BSID shall be the “BSID of source BS.” If the CX-FWD-REQ message is sent from the forwarding SS to the source BS, the BSID shall be the “BSID of destination BS.”
Message number	16	Number matching the Message number used in CX-FWD-REQ.
TLV Encoded Attributes	<i>variable</i>	TLV specify.
}		

6.3.2.3.90 Coexistence Forward Acknowledge Message (CX-FWD-ACK)

This message is sent by the destination BS of CX-FWD-RSP to the source BS.

This message shall be transmitted after receiving one of the CX-FWD-RSP messages with the Action Code as described at 15.5.3.4, 15.5.3.6, 15.5.3.9, 15.5.3.17, 15.5.3.19, 15.5.3.21, 15.5.3.23, 15.5.3.25, 15.5.3.27, 15.5.3.29, and 15.5.3.31.

The message shall include the following parameters:

BSID

If the CX-FWD-ACK message is sent from the source BS to the forwarding SS, the BSID shall be the “BSID of destination BS.” If the CX-FWD-REQ message is sent from the forwarding SS to the destination BS, the BSID shall be the “BSID of source BS.”

Message number

Number matching the message number used for CX-FWD-RSP.

Table 166e—CX-FWD-ACK message format

Syntax	Size (bit)	Notes
CX-FWD-ACK_Message_Format() {		
Management Message Type = 102	8	
BSID	48	
Message number	16	
}		

6.3.2.3.91 Access Neighbor BS Request message (CX-ACCESS-NBS-REQ)

This message is sent by the BS to its serving SS to request this SS to access the neighbor BS during neighbor BS's Master subframe as a forwarding SS. After receiving this message, the SS shall attempt to access the neighbor BS as a forwarding SS during the neighbor BS's Master subframe. The index of the Master subframe is provided by the neighbor BS in the UCD message (6.3.2.3.3), DCD message (6.3.2.3.1) or in the CXP message M-CX-REQ (Action_Type = Add neighbor).

The ACCESS-NBR-REQ message shall include the following parameters:

BSID of neighbor BS

The BSID of the neighbor BS for which the serving BS requests access through the forwarding SS.

Table 166f—CX-ACCESS-NBS-REQ message format

Syntax	Size (bit)	Notes
ACCESS-NBR-REQ_message_Format() {		
Management Message Type = 103	8	
Neighbor BSID	48	The BSID of the neighbor BS for which the serving BS requests access through the forwarding SS.
}		

6.3.2.3.92 Access Neighbor BS Response message (CX-ACCESS-NBS-RSP)

After receiving the ACCESS-NBR-REQ message from its serving BS, the SS shall attempt to access a neighbor BS as a forwarding SS during the neighbor BS's Master subframe. The SS uses CX-ACCESS-NBS-RSP to report to its serving BS whether or not it can successfully access the requested neighbor BS.

The ACCESS-NBR-RSP message shall include the following parameters:

BSID of neighbor BS

The BSID of neighbor BS that the SS shall access.

Result of access procedure:

The SS shall indicate whether or not it has successfully accessed the requested neighbor BS.

Table 166g—CX-ACCESS-NBR-RSP message format

Syntax	Size (bit)	Notes
ACCESS-NBR-RSP_message_Format() {		
Management Message Type =104	8	
BSID of neighbor BS	48	The BSID of Neighbor BS to which the SS shall access.
Result of access procedure	8	0: SS has successfully accessed the requested neighbor BS >0: SS has failed to access the requested neighbor BS 1: SS can't get PHY synchronization with neighbor BS 2: SS can't get MAC synchronization with neighbor BS 3: Ranging procedure failed 4: other reason
Padding Nibble	6	Padding to reach byte boundary.
}		

6.3.2.3.93 Forward End Request message (CX-FWD-END-REQ)

This message is encapsulated as a CX-FWD-END-REQ MAC message.

This message terminates inter-system communication procedures through a forwarding SS. This message is transmitted from a source BS to a forwarding SS, and/or from a forwarding SS to a destination BS.

Attributes are shown in Table 166h.

Table 166h—CX-FWD-END-REQ message format

Syntax	Size (bit)	Notes
FWD_END_REQ_message_Format() {		
Management Message Type =105	8	
BSID of Destination	48	The BSID of the BS that responds to the inter-system communication request.
BSID of source BS	48	The BSID of BS that initiates the inter-system communication procedure.
}		

6.3.2.3.94 CSI Monitoring Configure message (CX-CSI-MNTR-CFG)

This message is broadcast from an operating BS to a SS within the system. The WirelessMAN-CX BS uses this message to configure the SS during CSI monitoring and to switch between OCSI collision detection

mode and collision backoff mode according to the status of its system. (See 15.3.4.4.) The DCD messages notify the SS of the timing for CSI monitoring.

Table 166i—CX-CSI-MNTR-CFG format

Syntax	Size (bit)	Notes
CX-CSI-MNTR-CFG message format () {		
Management Message Type = 106	8	
CX-CSI-MNTR-CFG TLVs	<i>variable</i>	(See 11.28)
}		

6.3.2.3.95 CSI monitoring report message (CX-CSI-MNTR-REP)

This message is the report message from the SS to the BS for Initialization Coexistence Signaling Interval (ICSI) monitoring and OCSI collision detection.

For ICSI:

The SS reports the information it received from ICSI signaling that exceeds the *acceptable interference threshold* (see 15.3.4.2).

For OCSI:

In collision detection mode, the SS uses this message to report a suspicious collision detected during OCSI monitoring. Suspicious collision here means that during the OCSI interval in the CSI signaling sequence for which interference is not supposed to be detected, the SS has detected interference beyond the *acceptable interference threshold*.

In collision backoff mode, the SS uses this message to report interference beyond the light interference threshold and the information from a neighboring system (see 15.3.4.4).

The following TLV shall be included:

Network address for inter-system communication (see 11.1)

CX-CSI-MNTR-REP TLVs (see 11.29)

Table 166j—CX-CSI-MNTR-REP format

Syntax	Size (bit)	Notes
CX-CSI-MNTR-REP message format () {		
Management Message Type = 107	8	
TLV Encoded Information	<i>variable</i>	TLV specify
}		

6.3.2.3.96 Coexistence Downlink Map message (CX-DL-MAP)

The CX-DL-MAP message defines the access to the DL information during the CX-Frame, including CX-CBI, and schedules the CXCC subchannels and separated Interference Evaluation Bursts transmissions. This message should be transmitted during the Master DL subframe and has an extended relevance. The burst in which this message is transmitted shall be indicated with broadcast CID in the DL MAP. Note that

this message does not exclude the usage of the DL-MAP message, for those subframes in which the DL-MAP message is applicable.

A BS shall generate CX-DL-MAP messages in the format shown in Table 166k, including the following parameters:

PHY Synchronization Field

The PHY synchronization field is dependent on the PHY specification used. The encoding of this field is given in each PHY specification separately.

DCD Count

Matches the value of the configuration change count of the DCD, which describes the DL burst profiles that apply to this map.

Base Station ID

The Base Station ID is a 48-bit long field identifying the BS. The Base Station ID shall be programmable. The 24 MSBs shall be used as the operator ID. This is a network management hook that can be sent with the DCD message for handling edge-of-sector and edge-of-cell situations.

Number of Subframes

The number of DL subframes for which the DL activity is scheduled by this message. The scheduled subframes may be not adjacent.

Relative Frame Number

The frame number relative to the frame in which the message is transmitted; Relative Frame Number = 0 indicate the same frame.

Persistent allocation flag

This DL subframe contains persistent allocations.

Interference Evaluation Burst flag

This DL subframe contains Interference Evaluation Burst transmissions.

N

Number of DL-MAP information elements

DL preamble transmission

This field indicates if the transmission during CX-CBI will start with a preamble.

DL-MAP_IE()

The encoding of DL-MAP_IE() is PHY-specification dependent and may be absent. Refer to the appropriate PHY specification.

The DL-MAP IEs in the CX-DL-MAP shall be ordered in the increasing order of the transmission start time of the relevant PHY burst. The transmission start time is conveyed by the contents of the DL_MAP IE in a manner that is PHY dependent.

Table 166k—CX-DL-MAP message format

Syntax	Size (bit)	Notes
CX-DL-MAP_Message_Format() {	—	—
Management Message Type = 108	8	—
PHY Synchronization Field	<i>variable</i>	See appropriate PHY specification; may include MAC Frame Number.
DCD Count	8	—
Base Station ID	48	—
Begin PHY-specific section {	—	See applicable PHY subclause.
if (WirelessMAN-OFDMA) {	—	—
No. OFDMA symbols	8	Number of OFDMA symbols in the DL subframe including all AAS/permutation zone and including the preamble.
}	—	—
Nsubframes	4	Number of DL subframes addressed by this message.
for ($i=1$; $i \leq N$; $i++$) {	—	For each DL subframe.
Relative Frame Number	4	Frame number relative to the frame in which the message is transmitted; Relative Frame Number = 0 means same frame.
N	6	Number of DL MAP information elements.
Persistent allocation flag	1	$b_0=1$ this DL subframe contains persistent allocations.
Interference Evaluation Burst flag	1	$b_0=1$ this DL subframe is used for Interference Evaluation Burst transmission.
for ($j=1$; $j \leq N$; $j++$) {	—	CXCBI transmission.
if ($\text{mod}(\text{CX_MAC_NO}/4) > 1$) {	—	—
DL preamble transmission	4	$b_0=1$ the first DL transmission during CXCBI uses a preamble.
}	—	—
DL-MAP length	8	b_0 – b_7 DL-Map_Length (PHY specific); for OFDMA see 8.4.4.4 DL Frame prefix.
DL-MAP_IE()	<i>variable</i>	See corresponding PHY specification.
}	—	For each DL-MAP element 1 to n .
}	—	For each Frame.
}	—	End PHY specific section.
if !(byte boundary) {	—	—
Padding Nibble	4	Padding to reach byte boundary.
}	—	—
}	—	—

The logical order in which MPDUs are mapped to the PHY bursts in the DL is defined as the order of DL-MAP IEs in the DL-MAP message.

6.3.2.3.97 CX-UL-MAP (CX-UL-MAP) message

The CX-UL-MAP message defines the scheduling of the UL transmission information during the CX-Frame, including CXCBI, and schedules the CXCC subchannels and separated Interference Evaluation

Bursts transmissions. The burst in which this message is transmitted shall be indicated with broadcast CID in the DL MAP. This message should be transmitted during the Master DL subframe and has an extended relevance. Note that this message does not exclude the usage of the UL-MAP Message, for those subframes in which the UL-MAP message is applicable.

The CX-UL-MAP message format shall be as shown in Table 166l.

Table 166l—CX-UL-MAP message format

Syntax	Size (bit)	Notes
CX-UL-MAP_Message_Format() {	—	—
Management Message Type = 109	8	—
UCD Count	8	—
Reserved	8	Shall be set to zero.
Begin PHY-specific section {	—	See applicable PHY subclause.
if (WirelessMAN-OFDMA) {	—	—
No. OFDMA symbols	8	Number of OFDMA symbols in the UL sub-frame.
}	—	—
Nsubframes	4	Number of UL subframes addressed by this message.
for ($i=1$; $i \leq Nsubframes$; $i++$) {		For each UL subframe.
Relative Frame Number	3	Frame number relative to the frame in which the message is transmitted; Relative Frame Number = 0 means same frame.
Interference Evaluation Burst flag	1	$b0=1$ this DL subframe is used for Interference Evaluation Burst transmission.
if (Activity type within UL subframe : $b6=1$) {	—	—
Number of Subscriber Station Uplink Radio Frequency (SSURF) transmission opportunities	8	Number of SSURF transmission opportunities used in this CX_CMI_U.
for ($j = 1$; $j \leq N$; $j++$) {	—	—
CID	16	Basic CID of SS that transmits the SSURF message in the SSURF transmission opportunity.
SSURF transmission opportunity	4	Index of SSURF transmission opportunity.
}	—	—
Allocation Start Time	32	—
N	7	Number of UL MAP information elements.

Table 166I—CX-UL-MAP message format (continued)

Syntax	Size (bit)	Notes
Persistent allocation flag	1	b0=1 this message contains persistent allocations.
for ($j = 1; i \leq N; j++$) {	—	
UL-MAP_IE()	<i>variable</i>	—
}	—	For each UL-MAP element 1 to n .
}	—	For each UL subframe.
}	—	See corresponding PHY specification.
if !(byte boundary) {	—	—
Padding Nibble	4	—
}	—	Padding to reach byte boundary.
}	—	—

The BS shall generate the CX-UL-MAP with the following parameters:

UCD Count

Matches the value of the Configuration Change Count of the UCD, which describes the UL burst profiles that apply to this map.

Number of Subframes

The number of UL subframes for which the UL activity is scheduled by this message. The scheduled subframes may be not adjacent.

Relative Frame Number

The frame number relative to the frame in which the message is transmitted; Relative Frame Number = 0 indicate the same frame.

Interference Evaluation Burst flag

This UL subframe contains Interference Evaluation Burst transmissions.

Number of SSURF transmission opportunities

Number of SSURF transmission opportunities used in this CX_CMI_U.

SSURF transmission opportunity

The index of SSURF transmission opportunity, as defined in 15.3.3.5.

N

Number of UL-MAP information elements.

Allocation Start Time

Effective start time of the UL allocation defined by the UL-MAP (units are PHY-specific, (see 10.3). The Allocation Start Time may indicate allocations in subsequent MAC frames.

UL-Map IEs

The content of an UL-MAP IE is PHY-specification dependent.

Persistent allocation flag

This message contains persistent allocations.

The IEs for this message define UL bandwidth allocations. Each UL-MAP message (except when the PHY is an OFDMA PHY) shall contain at least one information element (IE) that marks the end of the last allocated burst. Ordering of IEs carried by the UL-MAP is PHY-specific.

The CID represents the assignment of the IE to either an unicast, multicast, or broadcast address. When specifically addressed to allocate a bandwidth grant, the CID shall be the Basic CID of the SS. A UIUC shall be used to define the type of UL access and the UL burst profile associated with that access. An Uplink_Burst_Profile shall be included in the UCD for each UIUC to be used in the UL-MAP.

The logical order in which MPDUs are mapped to the PHY bursts in the UL is defined as the order of UL-MAP IEs in the UL-MAP message.

6.3.7 MAC support of PHY

6.3.7.5 Map relevance and synchronization

6.3.7.5.3 WirelessMAN-OFDMA PHY

Change the text in 6.3.7.5.3 as indicated:

Allocation Start Time shall be subject to the following limitations (excepting WirelessMAN-CX and WirelessMAN-UCP):

- Minimum value: Allocation Start Time $\geq T_f$
- Maximum value: Allocation Start Time $< 2 \times T_f$

For WirelessMAN-CX and WirelessMAN-UCP, the allocation Start Time should be subject to the following limitations:

- Minimum value: Allocation Start Time $\geq \text{round trip delay} + T_{proc}$
- Maximum value: Allocation End time $< 8 \times T_f$

For WirelessMAN-CX and WirelessMAN-UCP, the MAP relevance supported by a SS is indicated in SBC-REQ/RSP messages.

Delete 6.3.15 from IEEE Std 802.16-2009.

~~6.3.15 Procedures for shared frequency band usage~~

Insert a new 6.4. after 6.3 as follows:

6.4 Procedures for uncoordinated coexistence

This subclause describes enhancements in support of operation in license-exempt bands. First, general concepts are described, after which details of support for uncoordinated coexistence mechanisms are presented. The mechanisms detailed are as follows:

- Coexistence with *specific spectrum users* (SSUs) (6.4.1.2) often termed Dynamic Frequency Selection (DFS) ITU-R Recommendation F.1499 [B35], ETSI EN 301 893 [B49].
- Coexistence with *non-specific spectrum users (non-SSUs)* (6.4.1.3). Dynamic Channel Selection (DCS) (6.4.1.3.2) is a realization.
- Uncoordinated Coexistence Protocol (UCP) (6.4.1.3).

Mechanisms are related to bands containing SSUs and those containing non-SSUs. It shall be left to regulation to mandate such mechanisms for a particular band.

6.4.1 Uncoordinated coexistence mechanisms

6.4.1.1 Overview

This subclause details a number of uncoordinated coexistence mechanisms. Whether these features are mandatory or optional is governed by adherence to profiles described in 12.8.1.

The mechanism overviewed in 6.4.1.2 is intended to protect *specific spectrum users* (SSUs) where regulation mandates. Subclause 6.4.1.3 provides a general uncoordinated coexistence mechanism suitable, for example, in bands where no mandatory coexistence behavior is required.

In bands containing both SSUs and non-SSUs, it can be expected that a combination of schemes presented in 6.4.1 will be required to provide mandatory protection for the SSUs and as well as a means of coexistence with non-SSUs.

Subclause 6.4.1.3 provides a UCP to provide a further mechanism to allow operation in license-exempt bands for non-SSUs.

Upon system startup, the BS shall choose a suitable channel in which to operate. Channel selection shall depend upon the requirements for operation in a given band. If the band contains SSUs, the BS shall use a protocol termed in this subclause “DFS” to attempt to find a channel free of SSUs; this protocol is described in 6.4.1.2. If the band contains only non-SSUs (IEEE 802.16 or non-IEEE 802.16), the BS uses the DCS protocol to find the best channel for operation; this protocol is described in 6.4.1.3. In certain regulatory regimes where SSUs are not present, it may be sufficient for the choice of channel to be able to be performed manually with coordination between operators as needed. If the band contains both SSUs and non-SSUs (IEEE 802.16 or non-IEEE 802.16) then both DFS and DCS protocols are used together. The DFS protocol is used to avoid interference to SSUs by vacating the channels on which SSUs are detected, and additionally DCS is used to select the best channel of the set of channels in the band that are cleared for operation by DFS.

The BS shall continue to perform DFS and DCS operation, as required, selecting the most appropriate channels based on the prevailing conditions and reacting to reported measurements from the SSs. For the case where SSUs are detected on a channel then the DFS protocol shall attempt to select an alternative channel. For the non-SSU (IEEE 802.16 or non-IEEE 802.16) detection of the BS shall use the DCS protocol in order to select an alternative channel, previously checked to be clear of SSUs. For improved coexistence with other uncoordinated IEEE 802.16 systems, the BS shall claim a Master frame (15.4.1.2)

sequence as described in 6.4.1.3.3 and shall use the described mechanism to share the channel with up to two other IEEE 802.16 systems on a minimally interfering basis.

This clause describes the use of a UCP. The UCP is designed to use passive cognitive radio techniques to allow co-channel coexistence between multiple IEEE 802.16 systems.

6.4.1.2 Uncoordinated coexistence with specific spectrum users (SSUs)

6.4.1.2.1 Overview

Procedures are defined in this subclause that may be used when the IEEE 802.16 system is sharing a frequency band with another system or service to reduce interference to and from other systems, to facilitate coexistence of systems, or to address other reasons. These procedures generally involve mechanisms to facilitate the detection of other users and to avoid and prevent harmful interference into other users. Within these procedures for certain sharing scenarios, regulatory requirements specify that DFS (as defined by ITU Recommendation M.1652 [B36]) shall be used to facilitate sharing with SSUs identified by regulation. A specific spectrum user is a user from a service specifically identified by regulation as requiring protection from harmful interference. When DFS is mandated by regulatory requirements, it shall be implemented according to this specification.

Further, the use of a channel selection algorithm may be required, which results in uniform channel spreading across a minimum number of channels. This specification is intended to be compliant with regulatory requirements such as ERC/DEC/(99)23 [B10]. The timing and threshold parameters used for DFS are specified by each regulatory administration.

The procedures specified in this subclause provide for the following:

- Testing channels for other users including SSUs (6.4.1.2.2)
- Discontinuing operations after detecting other users including SSUs (6.4.1.2.3)
- Detecting other users including SSUs (6.4.1.2.4)
- Scheduling for channel testing (6.4.1.2.5)
- Requesting and reporting of measurements (6.4.1.2.6)
- Selecting and advertising a new channel (6.4.1.2.7)

6.4.1.2.2 Testing channels for other users (including specific spectrum users)

A BS or SS implementing these procedures shall not use a channel that it knows contains other users or has not been tested recently for the presence of other users. A BS shall test for the presence of other users based on timing parameters and values that may be set locally or, in the case of DFS and the detection of specific spectrum users, may be defined in regulation. Timing parameters include the following:

- **Startup Test Period** before operating in a new channel if the channel has not been tested for other users for at least **Startup Test Period** during the last **Startup Test Valid**.
- **Startup Test Period** before operating in a new channel if a channel was previously determined to contain other users during the last **Startup Test Valid**.
- **Operating Test Period** (where the period is only accumulated during testing) of each **Operating Test Cycle** while operating in a channel. Testing may occur in quiet periods or during normal operation.

An SS may start operating in a new channel without following the above start-up testing procedures if

- The SS moves to the channel as a result of the receipt of a Channel Switch Announcement from the BS.
- The SS is initializing with a BS that is not currently advertising, using the Channel Switch Announcement, that it is about to move to a new channel.

A BS may start operating in a new channel without following the above start-up testing procedures if it has learned from another device by means outside the scope of this standard that it is usable.

6.4.1.2.3 Discontinuing operations after detecting specific spectrum users

If a BS or an SS is operating in a channel and detects SSUs, it shall discontinue any transmission of the following:

- MAC PDUs carrying data within **Max Data Operations Period**.
- MAC PDUs carrying MAC management messages within **Management Operations Period**.

The values of the above parameters may be set locally or, in the case of DFS, may be defined in regulation.

The detection of a *specific spectrum user* shall mean the channel is unusable for a **Channel Exclusion Period**. The channel is marked as an Excluded Channel for a period defined by regulation.

6.4.1.2.4 Detecting specific spectrum users

Each BS and SS shall use a method to detect SSUs operating in a channel that satisfies the regulatory requirements, where applicable. The particular method used to perform detection is outside the scope of this standard.

6.4.1.2.5 Scheduling for channel testing

A BS may measure one or more channels itself and may request any SS to measure one or more channels on its behalf, either in a quiet period or during normal operation.

To request the SSs to measure one channel, the BS shall include in the DL-MAP a Channel Measurement IE as specified in 8.3.6.2.3. The BS that requests the SSs to perform a measurement shall not transmit MAC PDUs to any SS during the measurement interval. If the channel measured is the operational channel, the BS shall not schedule any UL transmissions from SSs to take place during the measurement period.

Upon receiving a DL-MAP with the Channel Measurement IE, an SS shall start to measure the indicated channel no later than **Max. Channel Switch Time** after the start of the measurement period. An SS may stop the measurement no sooner than **Max. Channel Switch Time** before the expected start of the next frame or the next scheduled UL transmission (of any SS). If the channel to be measured is the operating channel, Max. Channel Switch Time shall be equal to the value of the receive/transmit transition gap (RTG), as specified in Table 575, or, in the case of DFS Max. Channel Switch Time, may be defined in regulation.

6.4.1.2.6 Requesting and reporting of measurements

The SS shall, for each measured channel, keep track of the following information:

- Frame Number of the frame during which the first measurement was made
- Accumulated time measured
- Existence of a specific spectrum user on the channel
- Whether a IEEE 802.16 system using the same PHY system was detected on the measured channel
- Whether unknown transmissions [such as radio local area network (RLAN) transmissions] were detected on the channel

The BS may request a measurement report by sending a REP-REQ message. This is typically done after the aggregated measurement time for one or more channels exceeds the regulatory required measurement time. Upon receiving a REP-REQ the SS shall reply with a REP-RSP message and reset its measurement counters for each channel on which it reported.

If the SS detects a SSU on the channel where it is operating during a measurement interval or during normal operation, it shall immediately cease to send any user data if so mandated by regulatory requirements and send at the earliest possible opportunity an unsolicited REP-RSP. The BS shall provide transmission opportunities for sending an unsolicited REP-RSP frequently enough to meet regulatory requirements, where applicable. The SS may also send, in an unsolicited fashion, a REP-RSP when other user interference is detected above a threshold value.

6.4.1.2.7 Selecting and advertising a new channel

A BS may decide to stop operating in a channel at any time. The algorithm used to decide to stop operating in a channel is outside the scope of this standard, but shall satisfy any regulatory requirements.

A BS may use a variety of information, including information learned during SS initialization and information gathered from measurements undertaken by the BS and the SSs, to assist in the selection of the new channel. The algorithm to choose a new channel is not standardized but, in the case of DFS, shall satisfy any regulatory requirements, including uniform spreading rules and channel testing rules. If a BS would like to move to a new channel, a channel supported by all SSs in the sector should be selected.

A BS shall inform its associated SSs of the new channel using the Channel Nr in the DCD message. The new channel shall be used starting from the frame with the number given by the Channel Switch Frame Number in the DCD message. The BS shall not schedule any transmissions during the last Max. Channel Switch Time before the channel change is to take place.

The Uplink Burst Profiles used on the old channel defined shall be considered valid also for the new channel, i.e., the BS need not define new Uplink Burst Profiles when changing channels. When operating in license-exempt bands, the BS shall not send the Frequency (Type = 3) parameter as a part of UCD message.

6.4.1.3 Uncoordinated coexistence with non-specific spectrum users (non-SSUs)

6.4.1.3.1 Overview

This subclause considers uncoordinated coexistence mechanisms for use in bands where non-SSUs are present. The important distinction for coexistence with non-SSUs, when compared with SSUs (6.4.1.2), is that there are less stringent, if any, regulatory demands placed on the coexistence solution. Aspects where