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Title	Changes to Working Draft Document for conformance of Same PHY Profile Processes and the CX_CC concept
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Re:	IEEE 802.16h-06/015r1 – working group review.
Abstract	This document Changes to Working Draft Document for conformance of Same PHY Profile Processes and the CX_CC concept.
Purpose	This document updates the Working Draft Document for conformance of Same PHY Profile Processes and the CX_CC concept.
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Changes to Working Draft Document for conformance of Same PHY Profile Processes and the CX_CC concept

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Introduction

With the development of the Coexistence Control Channel (CX_CC) concept, there are a number of Same PHY profile processes that need to be changed to conform to the new concept. These are not new conceptual additions to the Draft Standard.

Delete the current Section 15.3.2.1 and insert the following new section:

15.3.2.1 Coexistence Messaging Interval (CMI) for use with Same Profile Systems and the CX_CC

The CMI has duration of a frame 1.9 msecs and is a repetitive slot found in the Coexistence Control Channel (CX_CC). A CMI is claimed by a system and consistes of 3 uplink and 3 downlink intervals found within a CX_CC cycle (T_cogn) . Downlinks carry information BSD messages unique to the identity of the base station controlling the network for which the particular CMI is associated. Uplink messages carry SSURF messages unique to the subscriber stations associated with the network and base station associated with the same CMI. During a given CMI all other networks, not associated with the particular CMI, remain silent and receive only.

Every BSD (Section 6.3.2.3.62) sent downlink has a BS_ID associated with it. The BS_ID, when received by a foreign SS as part of the BSD, indicates to the foreign SS the source of interference to it. Additionally the BSD contains an UL-MAP which addresses specific SS associated with the BS_ID to (and the same CMI) to send their SSURF messages (Section 6.3.2.3.63). The SSURF messages when received by a foreign BS, indicates to the foreign BS the source of interference to it. Only one BSD message is inserted randomly into the 1.9 second duration of the downlink CMI whereas multiple SSURFs are inserted inside the uplink CMI.

The rationale for the random placement of the BSD is to handle the event where two or more BSDs occurs in the same CMI. This is possible since there can be adjacent co-channel coexistence communities that interfere. Normally the CMI claiming process and the Clear Channel assessment process that every BS undertakes before entry into the Coexistence Community limits a single system to a single CMI. However, this process cannot be guaranteed because of the nature of sporadic interference and the chance of hidden systems becoming visible. In such situations the detection of interference is imperative. Detection of the multiple BSD messages is facilitated by randomizing their transmissions within the CMI. Randomization limits the chance that BSDs in the same CMI collide. The SS will be able to detect foreign BSDs within durations that they are expecting only their home BSD. Such a detection of interference in the invocation of the Coexistence Protocols, likely between the home and foreign BSD.

The probability of BSD collisions within the same CMI can be calculated, and is a process dependent on the width of the BSD (which is dependent on the datagram content, modulation, and channel bandwidth) and the width of the CMI interval within which the BSD is randomly placed; for Wireless MAN-CX systems the CMI interval is Tcc_s (1.9 msec)

For the worst BSD collision case, there are n base stations in the common coverage area, the successful (non-overlapping) BSD transmission probability is

$$p = 1 - \frac{1}{m} \bullet \frac{1}{m} \bullet C_n^2 = 1 - \frac{1}{m} \bullet \frac{1}{m} \bullet \frac{n!}{(n-2)! \bullet 2!}$$

Where $m = \frac{t}{t_d}$. Assume the CMI downlink duration time length is t which is the uplink portion of a physical frame (physical frame duration is varying from 2, 2.5, 4, 5, 8, 10, 12.5, to 20ms), the BSD downlink PDU time duration is t_d, which is typically < <1 msec

Delete the current Section 15.3.2.2 and insert the following new section:

15.3.2.2 Candidate Channel Determination (Using GPS/UTC Synchronized CMI and Common Profile)

Candidate Channel Determination (CCD) is the process used by WirelessMAN-CX systems (conforming to a synchronized CMI and common profile) where the base station monitors a band to which it has access and selects, within that band, a channel having minimal use and occupancy by neighboring wireless systems. This process is used, for example, by an IBS prior to undertaking entry into a Coexistence Community. Since a base station can only receive uplink traffic, this process relies on the monitoring uplink transmission intervals and the measurement of interference signal power [I] and noise power [N]. Each candidate channel will be ranked in terms of its (I/N) ratio. Those channels with the lowest ratio or ideally a ratio of 1 will be selected for use by the base station and be candidates for entry by an IBS, since such channels will have the lowest amount of discernable activity on them, hence likely have lower interference.

[I] and [N] will be determined using the RSSI measurement capability of the base station receiver as detailed in Section 8.4.11.2. After synchronization to the GPS and initialization of the base station operating parameters, the base station will select a channel and undertake noise floor measurements on CX_CC_No{1-7}, which are unoccupied CX_CC slots (Section 10.5.2.3) used by WirelessMAN-CX networks, but may be used by non-WirelessMAN-CX networks (15.3.1.1.3.1)…or indeed any system synchronized to a GPS.

CX_CC_No{1-7}, in situations when it is unoccupied by any other wireless system, will be de-facto free from all WirelessMAN-CX transmissions and will provide an interval allowing the measurement of the receiver thermal noise floor [N]. The thermal noise floor is the noise power spectral density of the received channel (No) multiplied by the channel bandwidth. Measurements will be undertaken long enough to determine whether [N] has Gaussian characteristics. Measurements not deemed as Gaussian and/or RSSI measurements that are 3 db (TBD) higher than a predetermined [N] value (which can be provided a-priori as a Receiver Noise Figure estimate within RSSI measurement algorithm in the base station receiver) will be an indication that channel may be occupied by non-WirelessMAN-CX users. In this instance the value of the mean RSSI will be taken as the [I] created by the occupying WirelessMAN-CX network and the given channel will be discarded from further consideration as it is considered occupied. Otherwise, the measurement will provide a value for [N].

[I] measurements will be undertaken by calculating the mean signal strength and variance due to uplink SSURF messages summed over intervals CX_CMI_U{1-6}. The number of CMI cycles to be measured will be a variable (TBD) set for the base station by the operator. Measurement of the RSSI will be done in accordance with Section 8.4.11.2, with care being taken to ensure that valid signals are being measured, even at close-to noise floor levels. The mean RSSI and variance calculated for the summed CMI intervals of the channel will be construed as interference values [I] and [Var I] for the channel. In essence, what this measurement represents is the total power that the Base Station measures, on a given channel, due to the total of all Subscriber Stations operating on that channel. {*Because of the granularity of the measurements (each interfering SS will be separately detected) it will be possible for the BS to obtain a more sophisticated understanding of the interference environment above and beyond what is simply given by [I] and [Var I]. The incorporation of such more advanced interference detection approaches will not be presently considered in the context of the current discussion however*}.

The channels are then ranked, with the channel having the lowest I/N and smallest [Var I] measurements likely selected for IBS entry into a Coexistence Community. This process is undertaken for each channel that is specified forms the band of operation for the WirelessMAN-CX system and in essence identifies “white space” spectrum. Additionally, the passive PSD monitoring process described in Section XXX can be considered as a parallel process to the CCD, and can be used as another method of ascertaining spectrum occupancy. Figure h32 shows the CCD process.

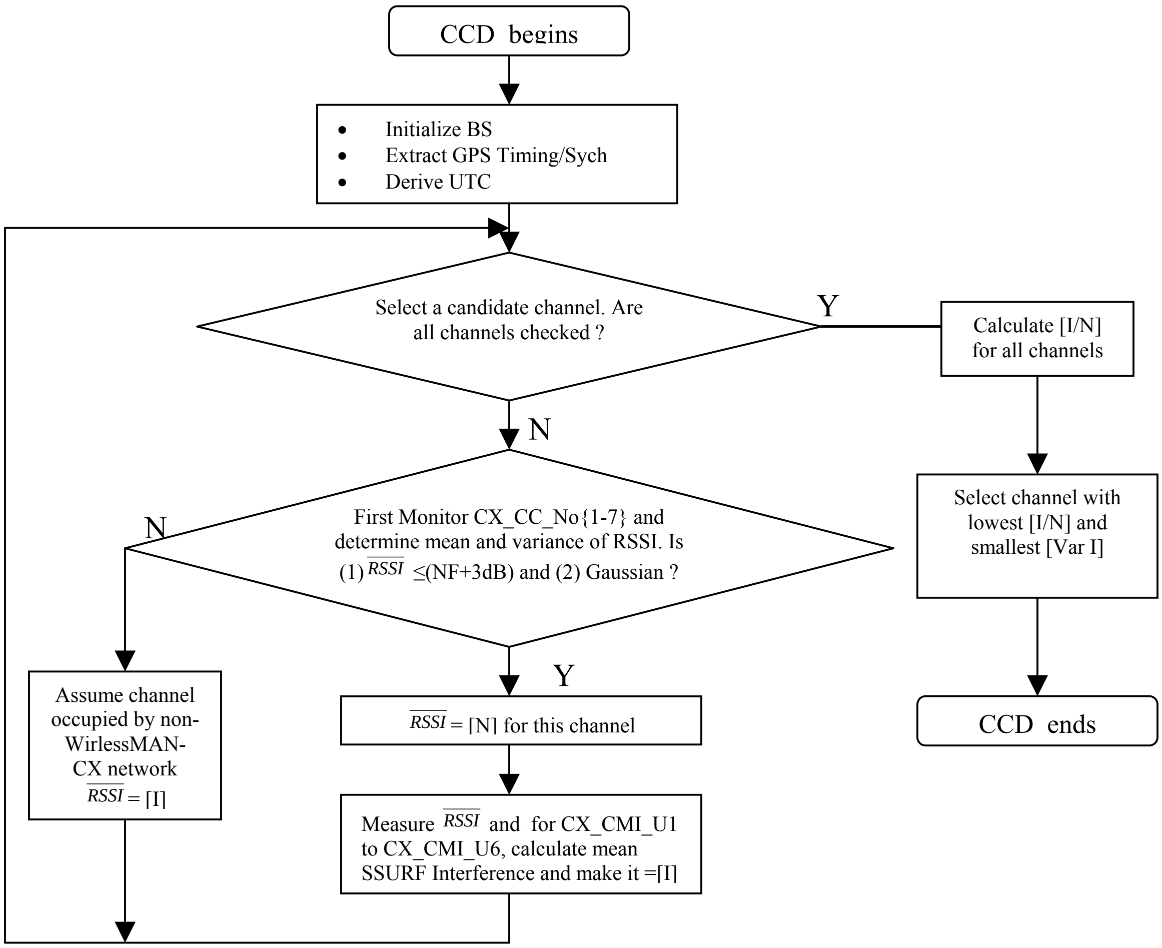

Figure h32 CCD Process

Delete the current Section 15.3.2.3 and insert the following new section:

15.3.2.3 Entry of a new BS into a Interference Neighborhood and the Creation of a Coexistence Community Using CX_CC Synchronized Systems having the Same PHY profile

In applications where the CX_CMI intervals are synchronized to the CX_CC and are used with systems having a common (same) PHY profile, entry of a new Base Station (IBS) will be undertaken in 4 steps, with the IBS:

(a) Monitoring the CX_CMI uplink Intervals,
(b) Selecting an Empty CX_CMI downlink interval,
(c) Claiming an empty CX_CMI downlink interval,
(d) Becoming a member of a Coexistence Community using the claimed CX_CMI.

Prior to entry into a Community of Operating Base Stations (OBS) it is assumed that the IBS will have undertaken the Candidate Channel Determination (Section 15.3.2.2) process and has selected a candidate channel and has no operational SS yet deployed. It is assumed that the IBS is deployed within an Interference Neighborhood, ie: active interference from existing operating systems is present. The IBS entry process is shown in Figure h33. Figure h34 shows aspects of the entry procedure with signaling.

(a) Monitoring the CX_CMI

Having tuned to the candidate channel, the IBS monitors and determines the level of activity on each CX_CMI uplink interval by demodulating the uplink SSURF (Sec 6.3.2.3.63) messages and storing their parameters in its Base Station Information Table(See Table h4). All demodulated SSURF messages will be from SSs that will interfere with the BS on the uplink and eventually coexistence will have to be negotiated with each of the OBS controlling these SSs. Each CMI interval from CX_CMI_U1 to CX_CMI_U3 is monitored (in the future this will include U4-U6). Each interval is monitored over a duration of 10 T_cogn cycles or 2 minutes. If CX_CC_No[1-7] have detectable power on them, the channel will be construed as occupied by a non-Wireless MAN-CX systems (See 15.7). The channel will then be abandoned. In this manner the IBS is able to differentiate interferers as either being capable or not of coexistence. The signaling seen by an IBS is shown in Figure 2.

(b) Selection of an Empty CX_CMI

The monitored CX_CMI uplink intervals in which no (demodulated) SSURF messages are received become candidate CMI intervals. Empty intervals indicate that it is still possible for the IBS to create a new Coexistence Community including the OBS (only a maximum of 3 (future 6) co-channel networks can be accommodated by a single channel. Full loading is indicated by having all 3 (6) CX_CMI intervals occupied).

During each candidate CX_CMI a RSSI (see 8.4.11.2) will be undertaken during the uplink duration. RSSI is undertaken to determine the presence or absence of low level (un-demodulated) uplink SSURF messages. Each candidate interval is monitored in this manner over a duration of 10 T_cogn cycles or 2 minutes. An interval will be considered as useable and chosen if the mean RSSI power measurement in it is no greater than {[N] +3 dB) (TBD); where [N] is the thermal noise floor of the IBS receiver and the noise power is integrated over the full 10 T_cogn cycles.

The absence of uplink SSURFs means that the CX_CMI is free of uplink (and possibly downlink occupancy), hence it can be considered as being ready for claiming.

(c) Claiming Procedure.

The purpose of the claiming process is to make adjacent OBS networks (which are likely members of different Coexistence Communities) aware of the presence of the IBS. Claiming is undertaken by having the IBS broadcast its BSD during an empty CX_CMI downlink. Since the OBS are silent and are monitoring the downlink on each CX_CMI other than their own, the broadcast message will be detectable during what was previously an empty interval (see discussion on undetected broadcasts below).

To begin the claiming procedure the IBS broadcasts at maximum EIRP its BSD (see 6.3.2.3.62) message. This message, when received by foreign SS belonging to adjacent networks that form the Interference Neighborhood, will result in those SS informing their home base stations of the presence of a new base station (the IBS) using the MAC message REP_RSP (see Section 6.3.2.3XX). All OBS having SS that detect the BSD during the claimed CX_CMI downlink interval will then via an IP link respond back to the IBS informing it that it has been detected and is a de facto interferer on the downlink. The IBS will include in its BS Information table the IP addresses of all of the OBS that have in essence redirected their REP_RSP messages to it. The IBS continues its BSD broadcast routine until no new REP_RSP messages are detected (the threshold for this is TBD). With the receipt of the totality of redirected REP_RSP messages the IBS will have then have determined the extent of its Interference Neighborhood which is now determined by the set of foreign SS which have received the IBS's BSD messages transmitted during the claimed CX_CMI. Having this information the IBS will now know with which OBS it must negotiate coexistence, if indeed it is warranted. If it is not warranted (for instance, because the interference created is too difficult to resolve by the Coexistence Protocol), the IBS abandons the CX_CMI and chooses an alternative channel that is identified as part of the CCD process

(d) Capacity Negotiation and membership in the Coexistence Community

The OBS networks which the IBS creates or sustains interference to/from become listed in the BS Information Table (See H4) of the IBS. This table contains the BS_IDs and IP proxy addresses derived either from uplink SSURF messages that the IBS demodulated during its monitoring phase (above (a)) or from the REP_RSP messages that it received via the IP backhaul from the OBS as part of the claiming procedure ((c) above).

Communication and negotiation with each OBS listed in the BS Information Table is undertaken via the {TBD} Coexistence Protocol (CP). Coexistence entails allocation of uplink and downlink transmission intervals in a manner that eliminates co-channel interference amongst users that would otherwise experience it and sustain degraded communications. This is done by parsing uplink and downlink intervals and establishing common, master, and slave subframes (see Sec 15.4.2.1.2). Each OBS that the IBS has listed in its BS Information Table as an interfering network must partake in such resolution of interference by scheduling. By undertaking this process the IBS thus creates a Coexistence Community for itself, and consequently becomes accommodated by the neighbouring networks of its interference neighbourhood.

Undetected BSD Broadcasts/Undetected Uplink SSURF messages.

The BSD and SSURF messages are sent at the lowest, most robust modulation rate specified for IEEE 802.16-2004 transmissions. This rate will be ½ rate BPSK with a nominal sensitivity of 6.4 dB SNR. (see 8.3.11.1). These transmissions may be received at levels below the threshold sensitivity and will be undemodulated, hence unidentifiable (though they may still be detected as interference noise). However, because of the statistical variation in the propagation channel whose variance can exceed 6 dB, there is a finite probability that eventually such signals shall eventually exceed demodulation threshold levels and be detected. The time to achieve this is an important factor in the amount of time the IBS spends undertaking its initial CMI claiming broadcasts. In such instances there is also a high reliance on the CCD (Section 15.3.2.2) and the PSD processes (Section 15.5.2.30) to identify low level interference and channel occupancy.

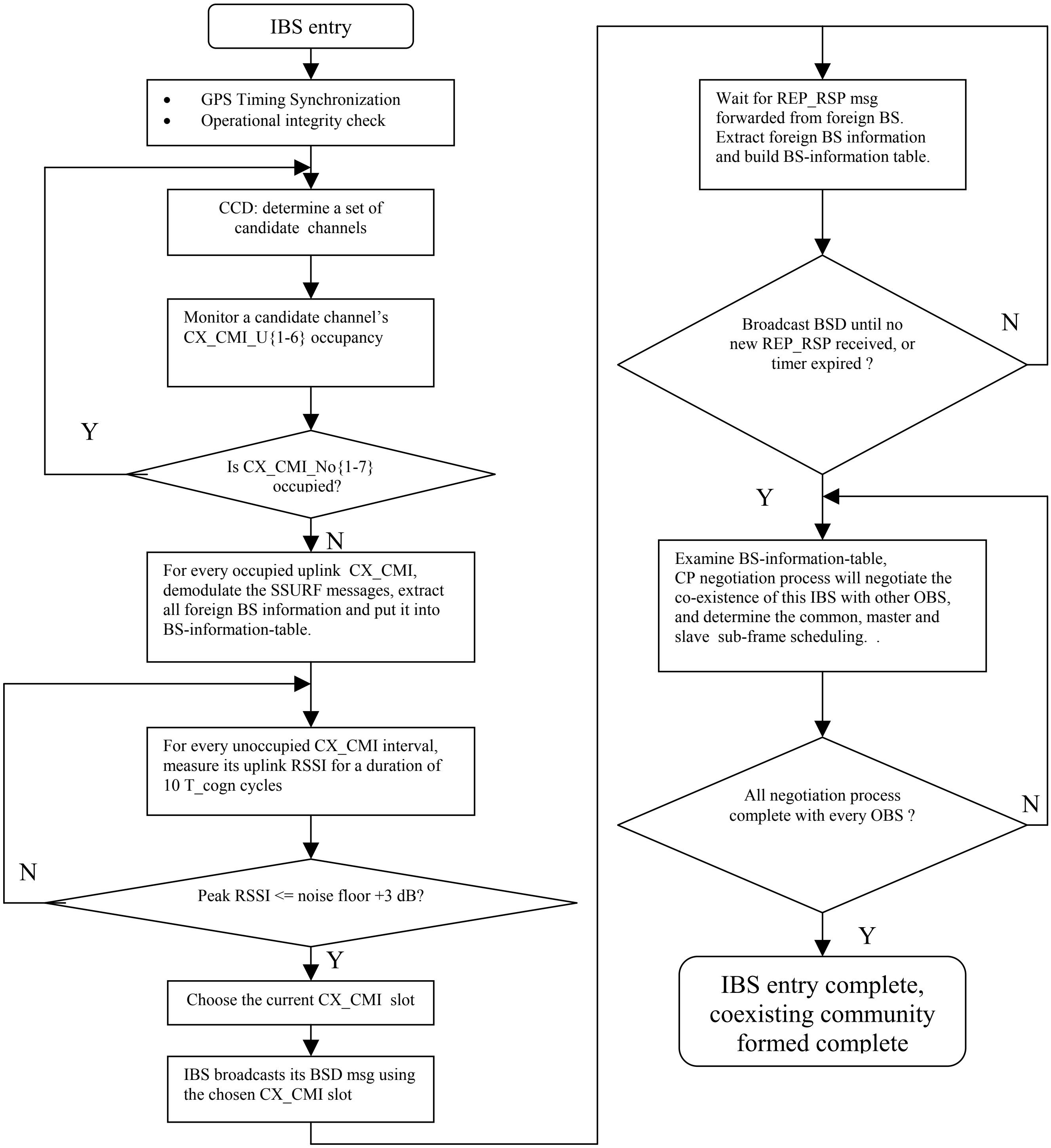

Figure h33. IBS community entry process for Same PHY Systems using CX_CC CMI signaling .