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Title	**Changes to the Sections 15.3.2, 15.3.2.1, 15.3.2.2, & 15.3.2.3 re:Coexistence Messaging Mechanism**
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Source(s)	John Sydor Communications Research Centre 3701 Carling Avenue Ottawa, Ontario Voice: 613-998-2388 Fax: [Fax Number] john.sydor@crc.ca
Re:	Changes to Draft Standard
Abstract	Editorial changes to provide clarity and change terms common to draft standard
Purpose	Add consistency and clarity to draft document.
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Changes to the Sections 15.3.2; 15.3.2.1,15.2.3.2 & 15.3.2.3 re: Coexistence Messaging Mechanism

John Sydor
Communications Research Centre

Introduction

The current draft document [1] has an outdated description of the coexistence messaging mechanism, the candidate channel determination process, and the community entry by an IBS.

The following editorial changes are made to correct the inconsistencies and provide more detail on the function of the coexistence messaging mechanism, especially with its use of the CMI..

Specific Editorial Changes

Blue Underlined text represents specific editorial additions
~~Red strikethrough text~~ is to be deleted.
Black text is already in the draft.
Bold Italic text is editorial instructions to the editor.

Make the following changes to Section 15.3.2 by adding the following editorial changes to the text currently found on page73 and between lines 1 and 3 of [1].

15.3.2 Coexistence messaging mechanism

Interference resolution amongst systems having the same profile is undertaken by the transmission, reception, and detection of messages sent during coexistence messaging intervals (CMI). Every radio emitter in a WirelessMAN-CX system has scheduled intervals on the CXCC to transmit identity data unique to itself during the CMI claimed by the system. All other WirelessMAN-CX systems, by detecting these messages, can determine the origin of the interference and can quantify the severity of its effects. Such messaging implements interference sensing and identification required for Cognitive Radio applications. WirelessMAN-CX systems can use sensed information to alter their temporal or spatial emission characteristics in support of coexistence with other similar systems or avoid or accommodate interference caused by other non-WirelessMAN-CX systems.

Make the following changes to Section 15.3.2.1 by adding the following editorial changes to the text currently found on page73 and between lines 4 and 65 of [1].

15.3.2.1 Coexistence Messaging Interval (CMI) for ~~use~~ Interference resolution with same Profile Systems ~~and~~ using the ~~CX_CC~~ CXCC

The CMI has duration ~~of a frame~~ 1.9 ms and is a repetitive slot found in specific subframes of the Coexistence Control Channel(~~CX_CC~~ CXCC). A CMI is claimed by a system and consists of ~~3~~ 2 uplink and ~~3~~ 2 downlink ~~intervals~~ slots found over the duration of a ~~within a CX_CC~~ CXCC cycle (~~T_cogn~~ Tcxcc). Downlinks carry ~~information~~ BSD messages unique to the identity of the base station controlling the ~~network~~ system ~~for~~ to which ~~the~~ a particular CMI is associated. Uplink messages carry SSURF messages unique to the subscriber stations associated with the ~~network and~~ same base station and associated with the same CMI. During a given CMI all other networks, not associated with ~~the~~ that particular CMI, remain silent and receive only.

Every BSD (Section *6.3.2.3.62andTBD*) sent downlink has a BSID associated with it. The BSID, 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 BSID to ~~(and the same CMI) to~~ send their SSURF messages (Section *6.3.2.3.63andTBD*) on the complementary uplink CMI. The SSURF messages when received by a foreign BS, indicate~~s~~ to the foreign BS the sources 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 (Section 15.1.4.1.2).

The rationale for the random placement of the BSD is to handle the event where two or more BSDs ~~occur~~ appear in the same CMI. This ~~is possible since~~ can occur when ~~there~~ ~~can be~~ adjacent interfering co-channel coexistence communities ~~that interfere~~ contain systems claiming the same CMI.

Normally the CMI claiming process and the ~~Clear~~ Candidate Channel Determination ~~assessment~~ process (15.3.2.2) that every BS undertakes before entry into the Coexistence Community limits a single system to a ~~single~~ unique CMI. However, ~~this process~~ the uniqueness of the CMI cannot be guaranteed because of ~~the nature of~~ sporadic interference and ~~the chance of~~ situations where hidden systems becoming visible to each other. ~~In such situations the detection of interference imperative~~. The detection of the multiple BSD messages from overlapping systems is ~~facilitated~~ achieved by randomizing their transmissions within the CMI. Randomization limits the chance that BSDs ~~in~~ within the same CMI collide. ~~The~~ This allows SS ~~will be able~~ to detect foreign BSDs within durations that they are normally expecting only their home BSD. Such detection will force both interfering systems to invoke coexistence protocol measures which either result in changes to the CMI occupancy or to having one system move to an alternate channel. ~~Such a detection of interference in the invocation of the Coexistence Protocols is likely between the home and foreign BSD.~~

The probability of BSD collisions within the same CMI can be calculated~~,~~ and it 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~~ For WirelessMAN-CX systems the CMI ~~interval~~ is Tcc_s (1.9 ms)

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 $m=t/t_d$. 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 ms.

Make the following changes to Section 15.3.2.2 by adding the following editorial changes to the text currently found between line 1 and line 65 on page 74 of [1].

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 forming ~~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 thermal 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 a universal timing standard ~~the GPS~~ and initialization of the base station's operating parameters, the base station will select a channel and undertake noise floor measurements during the (No+Io) intervals ~~on~~ ~~CX_CC_No{1-7},~~ which are unoccupied ~~CX_CC~~ CXCC slots (section *10.5.3*) used by WirelessMAN-CX. ~~networks., but may be used by non-WirelessMAN-CX~~

networks (*15.9.1.1*) or indeed any system synchronized to a GPS.

CX_CC_No {1-7}, The (No +Io) slots, in situations when it is unoccupied by any other wireless system, will be de facto free of 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. Measurement 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) result in a combined thermal [N] and interference noise [I] floor higher than 1dB above [N] alone ((N+I)>1 dB) 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 interfering RSSI will be taken as the [N+I] created by the occupying non-WirelessMAN-CX network user and the given channel will be discarded from further consideration as it is considered occupied.(the discarded channel's noise plus interference floor will be stored in the BS interference table). Otherwise, the measurement will provide a value for [N].

The determination of [N] may be difficult if the channels have high occupancy even though specific measurement intervals (No+Io) are provided on the CXCC. The manufacturer of the WirelessMAN-CX receiver may be required to resort to special measurement techniques or determine a-priori the noise figure of the receiver. The Gaussian characteristic test is recommended as a proof of thermal noise unaltered by man-made interference and requires multiple sampling of the channel to be statistically valid.

[I] measurements on channels occupied by WirelessMAN-CX systems will be undertaken by calculating the mean signal strength and variance due to uplink SSURF messages summed over the uplink CMI intervals CX_CMI_Un {n=1-3(6)}. The number of CMI Tcxcc cycles to be measured over which the measurements are to be conducted 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 SSURF occurrences over the repeated 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 interference 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 *15.5.2.29and15.5.2.30*can be considered as a parallel process to the CCD, and can be used as another method of ascertaining\spectrum occupancy. *Figureh 35*shows the CCD process.

Delete the following figure h35 found between lines 1 and 36 of page 75 of [1]

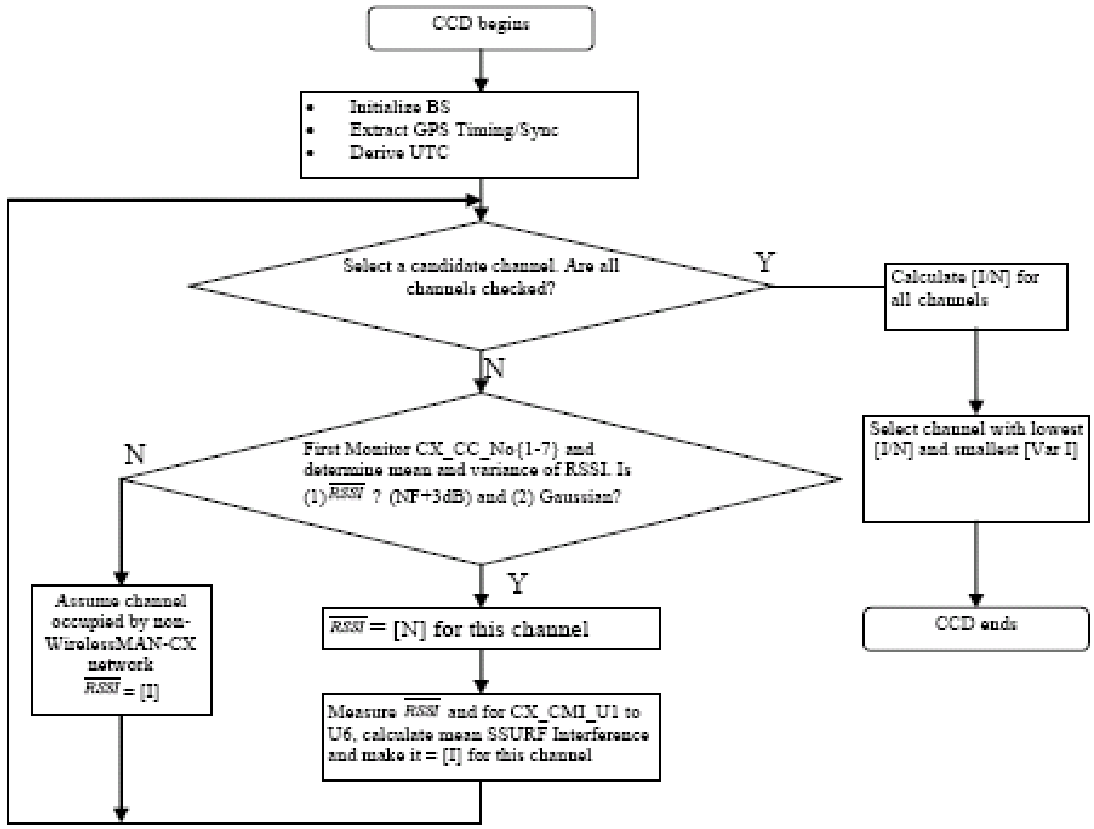


Figure h35—CCD Process

Replace the figure h35 deleted above with the following figure. The markings in Blue represent the changes between the above figure and the new figure below.

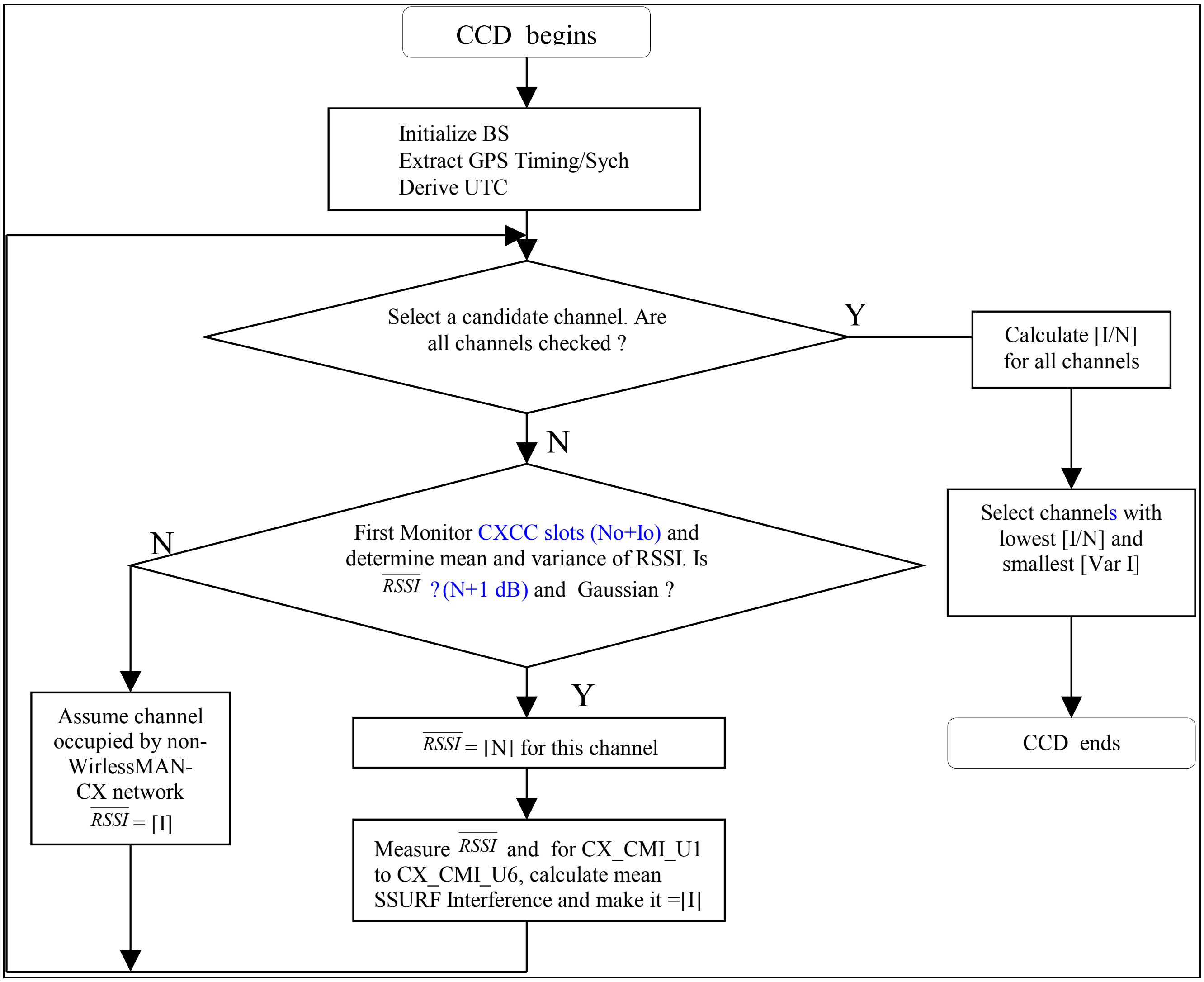


Figure h35 ~~CCD~~ Candidate Channel Determination Process

Make the following changes to Section 15.3.2.3 by adding the following editorial changes to the text currently found between line 39 on page 75 and line 30 on page 77 of [1].

15.3.2.3 Community entry for systems using a common profile

In applications where the CX_CMI intervals CMI are synchronized to the CX_CC CXCC 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_Un uplink Intervals,
(b) Selecting an Empty CX_CMI_Dn downlink interval,
(c) Claiming an empty CX_CMI_Dn 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. The IBS must be synchronized to the universal timing standard and can determine the position of the CXCC intervals. It is assumed that the IBS is deployed within an Interference Neighborhood, e.g.: active interference from existing operating systems is present. The IBS entry process is shown in Figureh 36. Figureh 37 shows aspects of the entry procedure with signaling.

(a) Monitoring the CX_CMI_Un Uplink Intervals

Having tuned to the candidate channel, the IBS monitors and determines the level of activity on each uplink interval CX_CMI_Un uplink interval by demodulating the uplink SSURF (see 6.3.2.3.6.2 and TBD) messages and storing their parameters in its Base Station Information Table (see Tableh 6). 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 the duration of 10 T_cogn Tcxcc cycles or 100 seconds 2 minutes. Additionally, during this time the CXCC slots (No+Io) will be monitored as well and if there is If CX_CC_No[1-7] have detectable power on them (ie, when ((N+I)/N)>1 dB), the channel will be construed as occupied by a non-Wireless MAN-CX systems (See 15.9.1). The channel will then be abandoned, and a new candidate channel will be tested. In this manner the IBS is able to differentiate interferers as either being capable or not of coexistence. The signaling flowchart for this operation seen by an IBS is shown in Figureh 367.

(b) Selection of an Empty CX_CMI_Dn Downlink Interval

The monitored CX_CMI_Un uplink intervals in which no (demodulated) SSURF messages are received become indicate candidate CMI intervals. Empty intervals indicate that it is still may be possible for the IBS to create a new form a Coexistence Community including the OBS (only a maximum of 3 (future 6) co-channel networks can be accommodated by a single channel to form a full Coexistence Community. Full loading is indicated by having all 3 (future 6) CX_CMI_D/U intervals occupied). During each Each candidate CX_CM_Un will have 1 a RSSI measurement undertaken on it (see 8.4.11.2) will be undertaken during the uplink duration. This is done specifically to detect the presence of SSURF messages that may be below the level needed for demodulation. Such SSURFs, if they exist, indicate that the chosen interval has interference and that Coexistence Community sub-frames are likely being used. 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 the duration of 10 T_cogn Tcxcc cycles or 100 seconds 2 minutes. An interval will be considered as usable and chosen if the mean RSSI power measurement results in a ((N+I)/N)<1 dB. 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_Un is free of uplink occupancy and likely the complementary CX_CMI_Dn is the same (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_Dn . Since the OBS are silent and are monitoring the downlink on each CX_CMI_Dn 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 operational EIRP its BSD (see 6.3.2.3.62 and TBD) 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 BS_CCID_RSP (see

6.3.2.3.68). All OBS having SS that detect the BSD during the claimed CX_CMI_Dn 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 BS_CCID_RSP messages to it. The IBS continues its BSD broadcast routine until no new BS_CCID_RSP messages are detected (the threshold for this is TBD). With the receipt of the totality of redirected BS_CCID_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_Dn. 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_Dn and chooses an alternative channel that is identified as part of the CCD process (15.3.2.2).

(d) Capacity Negotiation and membership in the Coexistence Community

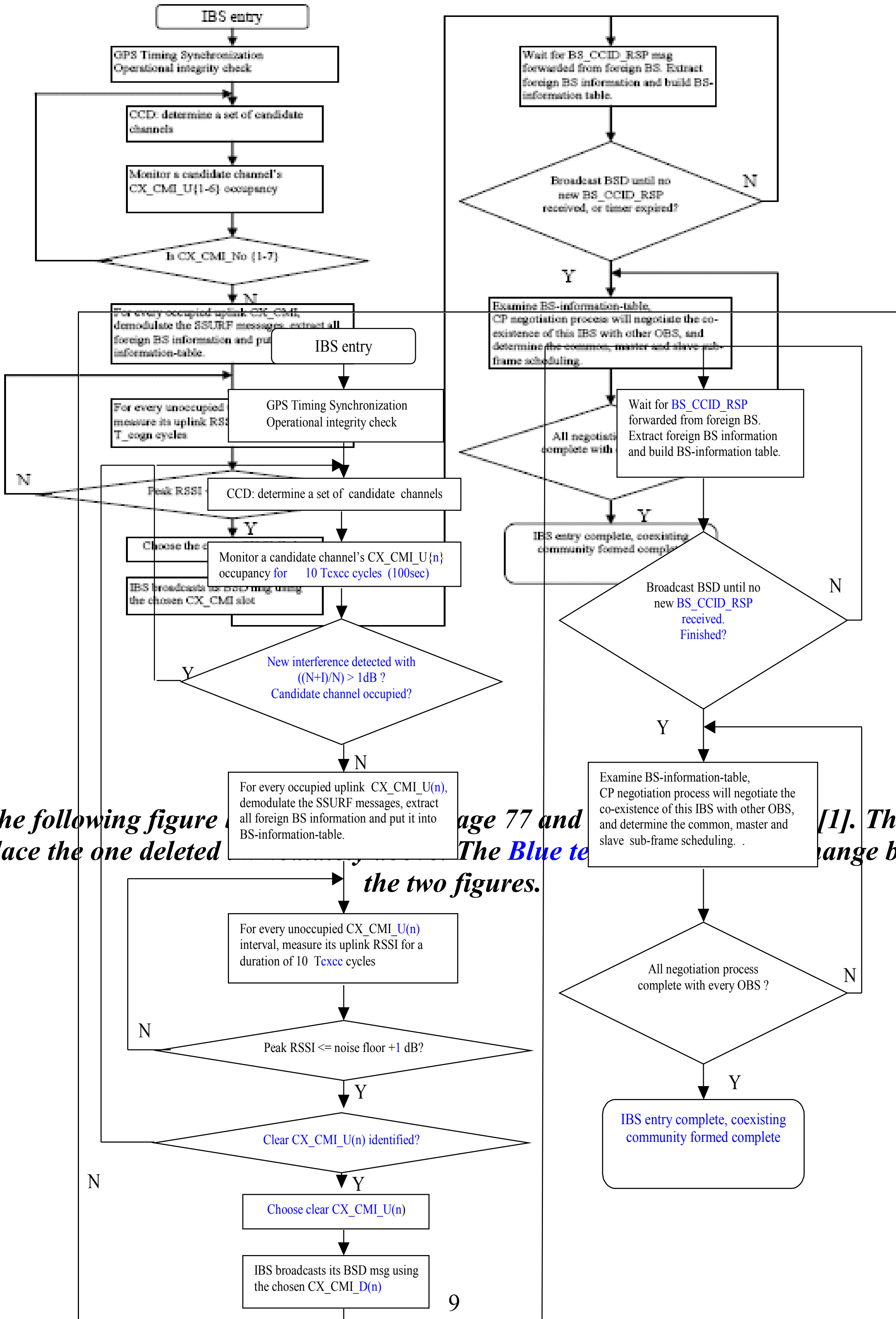
The OBS networks which the IBS creates or sustains interference to/from become listed in the BS Information Table (See *Table h 6*) of the IBS. This table contains the BSIDs and IP proxy addresses derived either from uplink SSURF messages that the IBS demodulated during its monitoring phase (above (a)) 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 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 neighboring networks of its interference neighborhood.

Undetected BSD Broadcasts/Undetected Uplink SSURF messages & Sporadic Interference

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 1/2 rate ~~BPSK~~ QPSK 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 not be demodulated, hence they will be unidentifiable (~~though they may still be~~ but detected as interference noise). Such interference can be termed sporadic. 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 may be greater than the ~~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~~ it is recommended that ~~on~~ the CCD (*see 15.3.2.2*) and the PSD processes (*Section 15.5.2.30*) be used to identify low level interference and channel occupancy.

Delete the following figure h36 currently found between line 30 of page 77 and line 2 of page 78 of [1].



Insert the following figure i… age 77 and … [1]. This figure to replace the one deleted … The Blue te… ange between the two figures.

Figure h36 CMI Identification and Claiming and IBS Community Entry Process Using CMI Signaling on the CXCC

References

[1] IEEE P802.16h/D1: Air interface for Fixed Broadband Wireless Access Systems Improved Coexistence Mechanisms for License-Exempt Operation, Draft Standard