Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**updating the text related to CSI under CX-Frame scheme**
Date Submitted	**2007-09-07**
Source(s)	Wu Xuyong Huawei, Huawei Industry Base, Bantian, Longgang, Shenzhen, China 518129 Voice: +86-755-28976776 Fax: wuxuyong@huawei.com，
Re:	IEEE 802.16-07/019：Task Group Review: Working Group Draft P802.16h/D2c (2007-08-13)
Abstract	AI to update the text related to CSI
Purpose	To consolidate the 16h draft.
Notice	
Release	
Patent Policy and Procedures	

Updating the text related to CSI under CX-Frame scheme

Wu Xuyong
Huawei Tech.

Overview

Comment #046 by Kenneth Stanwood in 80216h-07_014r3(15.1.4.1):

Comment:

Both CSI and CMI are now in cycles of frames which are themselves tied to absolute time.

Suggest Remedy:

Reword this paragraph to agree with 15.1.5.3.

Group Resolution: Accept Modified

AI for John and Xuyong to update the related text.

Comment #045 by Mariana Goldhamer in 80216h-07_014r3(15.1.4.1):

Comment:

CSI text shall be up-date to reflect the CXCC structure

Group Resolution: Accept Modified

AI taken by Xuyong to update the related text.

Comment #090 by Kenneth Stanwood in 80216h-07_014r3(15.3.1.1.1):

Comment:

In Figure h34, CSIN 1 and 3 are used, but the text says a BS could choose 1, 2, or 3 which is incorrect.

Suggest Remedy:

Change the example to indicate that the BS with the map in Figure h34 could only choose CSIN 2. In fact, the example would be better if the BS chose one of the more lightly loaded channels like channel 1 or 2.

Group Resolution: Superceded

by resolution of comment 045

Discussion

Reference:

[1] *IEEE 802.16h-07/014r3: Comments on Working Group Draft P802.16h/D2b (final) (2007-07-14)*

[2] *IEEE P802.16h/D2c: 802.16h draft for Task Group Review (2007-07-31)*

[3] *IEEE 802.16-07/019：Task Group Review: Working Group Draft P802.16h/D2c (2007-08-13)*

[4] *IEEE C802.16h-07/075: Action Items from Session #50 (Mariana Goldhamer; 2007-07-19)*

[5] *IEEE 802.16-2004: IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems (2004-10-01)*

[6] *IEEE 802.16e-2005: IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands and Corrigendum 1 (2006-02-28)*

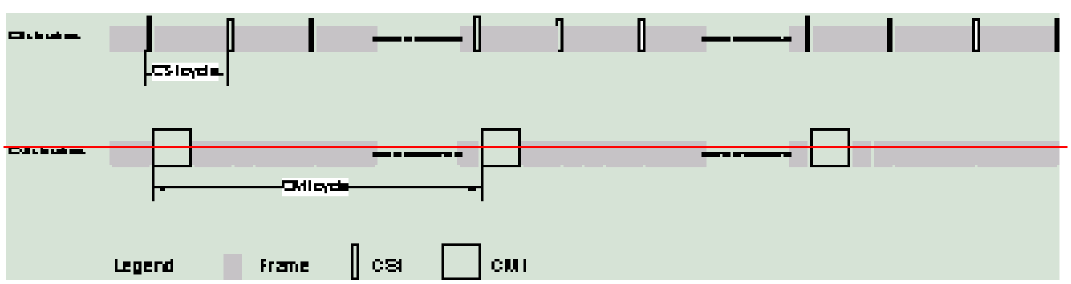
Proposed Changes accordingly:

15.1.4 Frame Structure for WirelessMAN-CX

There are two basic kinds of frame-based ~~object of frame structure~~ enhancements for WirelessMAN-CX ~~compared to other WirelessMAN~~ compared to other WirelessMAN systems. One ~~enhancement~~ (15.1.4.1) implements (see **Frame Structure for interference identification**) is for interference identification between neighbor systems using time intervals within the frames. Another (see ***Error! Reference source not found.***) is for interference prevention and resolution between neighbor systems operating in the same band, which using resource sharing in the time domain~~, by defining multiple subframes in each DL period and UL period of the frame structure~~.

15.1.4.1 Frame Structure for interference identification

~~There are two types of time interval defined in WirelessMAN-CX, called coexistence signaling interval (CSI) (see *15.1.4.1.1*) and coexistence messaging interval (CMI) (see *15.1.4.1.2*). While CSI refers to short time intervals reserved periodically in some frames, CMI refer to longer intervals reserved periodically. CSIs are reserved in cycles counted by frames, while CMIs are allocated according to absolute time in cycles counted by seconds. CMIs are reserved slots within the CXCC. CSI is defined to carry signaling between neighbor systems which may use different PHY or profile, whereas CMI is defined to carry messages between neighbor systems which are using the same profile.~~

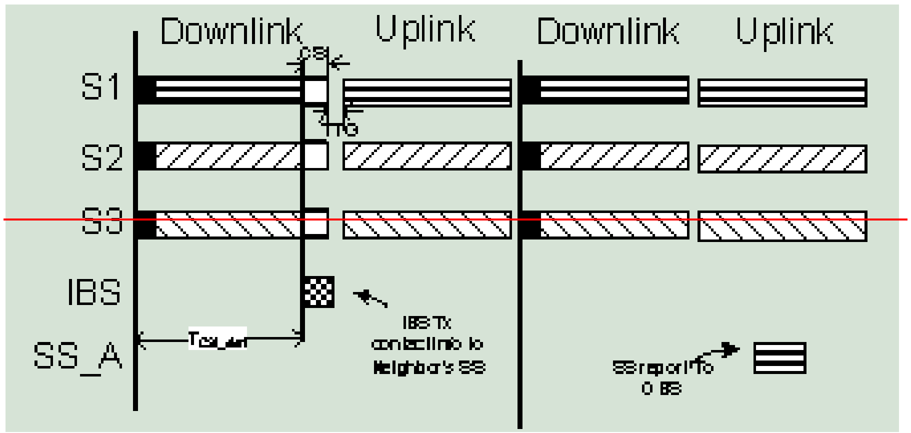


~~**Figure h26—CSI and CMI locations in WirelessMAN-CX**~~

Coexistence Control Channel (CXCC) is a logic channel which has integrated multiple sub-channels for a set of interference identification functionality (see 15.3.1). Within CXCC, there are two kinds of basic timing interval element which form up the CXCC, called Coexistence Signaling Interval (CSI) (see 15.1.4.1.1) and Coexistence Messaging Interval (CMI) (see 15.1.4.1.2).

15.1.4.1.1 Coexistence signaling interval

The CSI (Coexistence Signaling Interval) is a predefined reserved short time slot at the end of DL subframe, in which only the specific BS may allowed transmitting, and other BS need to cease transmitting before the CSI begins. ~~in which t~~The BS ~~may~~ use CSI to identify itself~~contact~~ to its ~~coexistence~~ neighbor ~~BSs~~systems through one or more ~~coexistence neighbor~~ SSs in its neighbor system which have received the signaling higher than the acceptable interference threshold ~~the common coverage area~~ (see ***Error! Reference source not found.***). The timing of each system within the neighborhood shall be synchronized, by using a unique time reference in the same region such as GPS (or equivalent), or by using synchronization mechanism in adhoc manner such as CXCC sub-channel 1 or sub-channel 3. Every CSI ~~has its number~~ shall be assigned to specific BS in a neighborhood~~, called CSIN (Coexistence Signaling Interval Number) (see 15.3.2.1 Figure h 40). The sequence of CSINs is periodic with a period of NCSIintv (see Figure h 28).~~ For the Initializing BS (IBS), the correspondent CSI is called the ICSI (Initialization Coexistence Signaling Interval) which is allocated in the shared frame in CX-Frame. ~~and~~ ICSI is used by the IBS to contact its neighbor Operating BSs (OBSs). By coordination with the other BSs, the IBS will get its OCSI (Operation Coexistence Signaling Interval), which is allocated into one of the three frame master frame allocation in CX-Frame. ~~only for this BS,~~ Once a BS ~~and~~have started the operating stage and claimed its master frame, this BS will occupy the OCSI within this master frame, ~~hence~~ and releas~~eing~~ the ICSI for ~~another~~ IBS (see e.g. in **ICSI/OCSI occupation and timing allocation example**~~**ICSI/OCSI occupation and timing**~~ **allocation** ~~**example**~~).



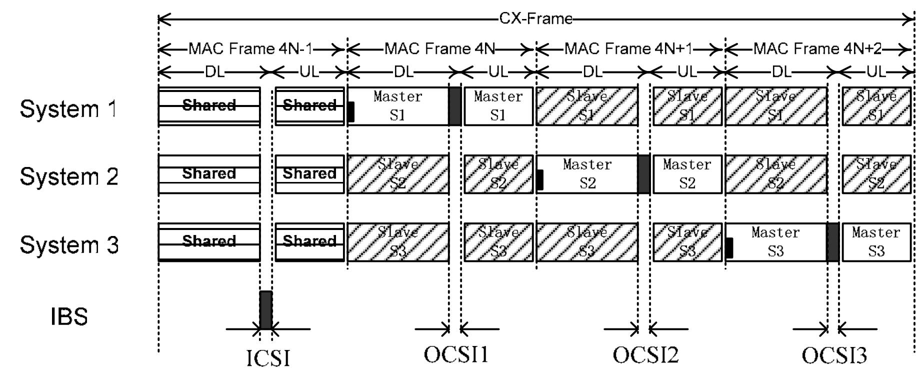
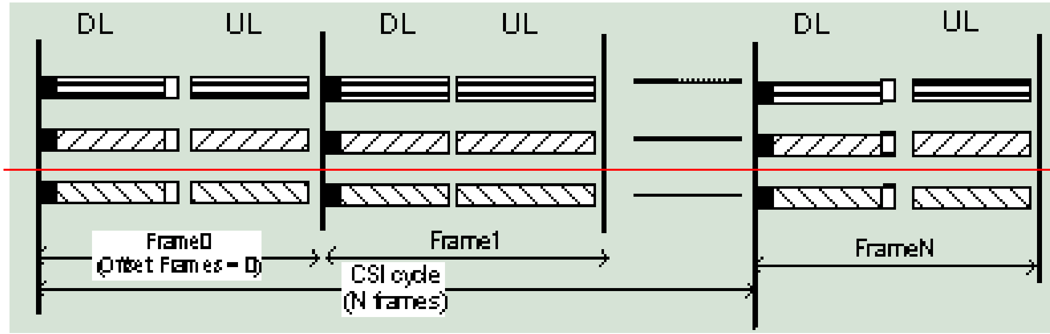


Figure h27—~~Timing of~~ Coexistence Signaling Interval allocation in CX-Frame

~~In order not to change the structure of the downlink PDUs and to avoid the overhead of more preamble and gaps,~~ CSI slots shall be located before the TTG in the TTD frame structure (see e.g. in ***Error! Reference source not found.***). The timing parameter and the allocation of CSI may be broadcasted in DCD (*See 11.4.1*) in the WirelessMAN-CX system by the BS.

~~The CSI/ICSI parameters need to be unified in a particular region, and to be well known by the BSs. So that each BS could know the exact time to transmit the BS_NURBC (15.3.2.5) mesage in its initialization (see Figure h 28). The parameters include:~~

- ~~$T_{CSIstart}$: CSI starting time from the beginning of the frame~~
- ~~$T_{CSIdurat}$: CSI duration time~~
- ~~$N_{CSIstart}$: CSI starting frame number~~
- ~~$N_{CSIintv}$: number of frames in CSI interval~~



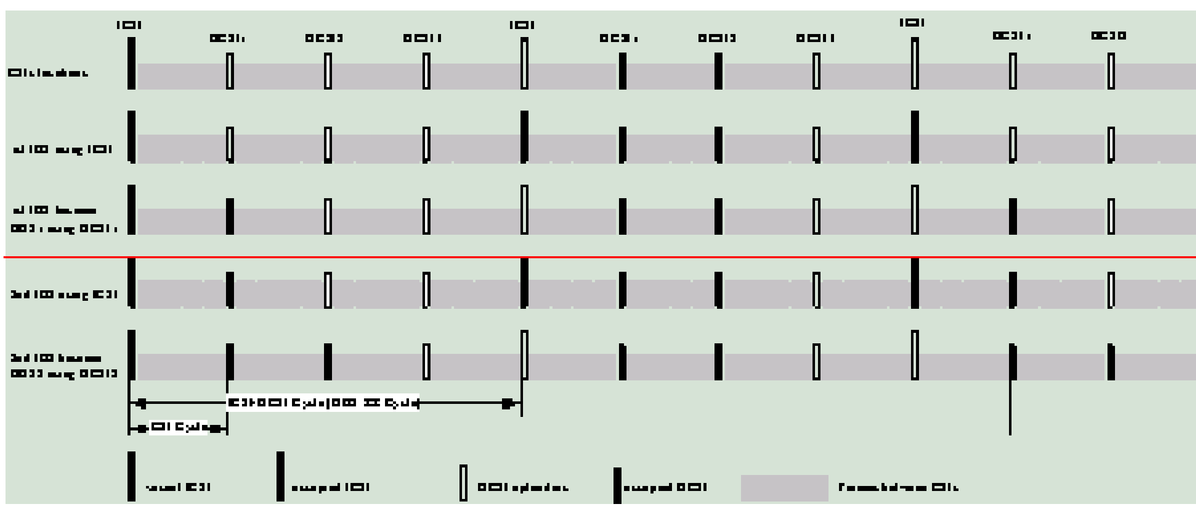
~~**Figure h28—CSI parameters**~~

~~*[Editor's notes: figure above should be update according to CX-Frame structure, lack of proposed figure from C80216h-07_072r1.]*~~

~~And parameters that deal with the CSI cycle (see *15.3.2.1.1*):~~

~~CSI_Cycle: Number of CX-Frames between the bits in CSI sequence of one system.~~

~~Assuming CSI_Cycle = 2, a~~An example of the timing indication is illustrated in **ICSI/OCSI occupation and timing allocation example**~~**ICSI/OCSI occupation and timing allocation example**~~.The first IBS that enters an environment where none of the OCSIs is occupied. It uses the ICSI to broadcast coexistence signaling, then, since it has not detected any other CSI signal, it becomes OBS1 and chooses OCSI1 as the OCSI occupied for its system. Afterwards IBS2 starts up and uses ICSI to broadcast coexistence signaling. It finds its neighbor system, OBS1, occupying OCSI1, chooses OCSI2 as its OCSI and become OBS2 after the initializing phase. (see also **CSI scheduling**). IBS2 can be made aware of the occupation of OCSI1 by OBS1 either by detecting signal~~d~~ from the system OBS1, or by information received via CXP messages as feedback to the IBS2's broadcasting signals by the OBS1's SS's.



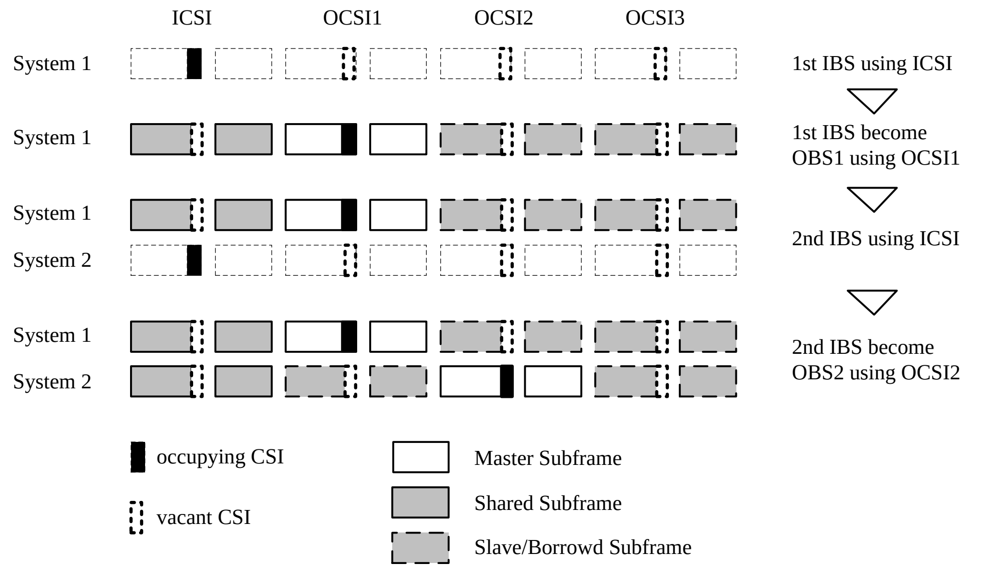


Figure h29—ICSI/OCSI occupation and timing allocation example

~~*[Editor's notes: figure above should be update according to CX-Frame structure, lack of proposed figure from C80216h-07_072r1.]*~~

15.3.2 Coexistence signaling mechanisms

The radio signaling mechanisms are defined in order to provide the basic connectivity information between neighbor systems which may be using different PHY profiles.

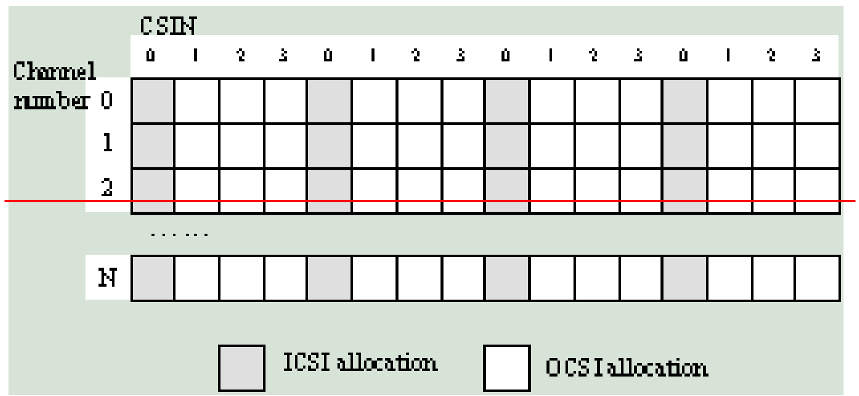
15.3.2.1 Coexistence Signaling Interval

15.3.2.1.1 CSI scheduling

CSI is used by the BSs to broadcast signaling to the neighbor systems (see **Coexistence signaling interval**). ~~These~~ Such signalings~~s~~ are used for interference identification. In order ~~not~~ to prevent collision ~~collide~~ with the other neighboring interferers, the coordinated community should prevent neighboring ~~BSs~~ systems from using the same CSI. There is one ICSI for IBS and three OCSIs for 3 OBSs within a CX-Frame. Thus we can have no more than three systems neighboring with each other according to the capacity limitation of the CX-Frame. In its working channel, each SS in the system can keep monitoring 3 OCSIs, one of them occupied by its serving BS; other two can be respectively occupied by two neighbor system which may cause harmful interference to this SS. In case two systems in the neighborhood is using the same Master Subframe and the signal strength received by one SS in the same OCSI allocation, the system may use the collision detection and resolution procedure described in 15.3.2.4.

~~There is one ICSI for IBS in an CSI cycle, in the example figure below, each CSI cycle has 4 CSIs and CSIN 3 indicate the CSI numbers of the ICSI. The other CSI is left to the OBS as OCSI, as shown in *Figure h 40*. Every OBS needs to obtain an OCSI allocation in one CSI cycle, which is formed by multiple CX-Frames. There are 4 CSIs in each CSI cycle, so that there are 1 ICSI intervals for the IBS and 3 intervals for up to 3 OBSs.~~

~~Notice that the CSI allocation MAP should indicate all the CSI allocation in the uncoordinated channel as unusable. The uncoordinated channel information can be gathered in the DFS procedure or by the failure of coordination procedure in the interfered channel.~~



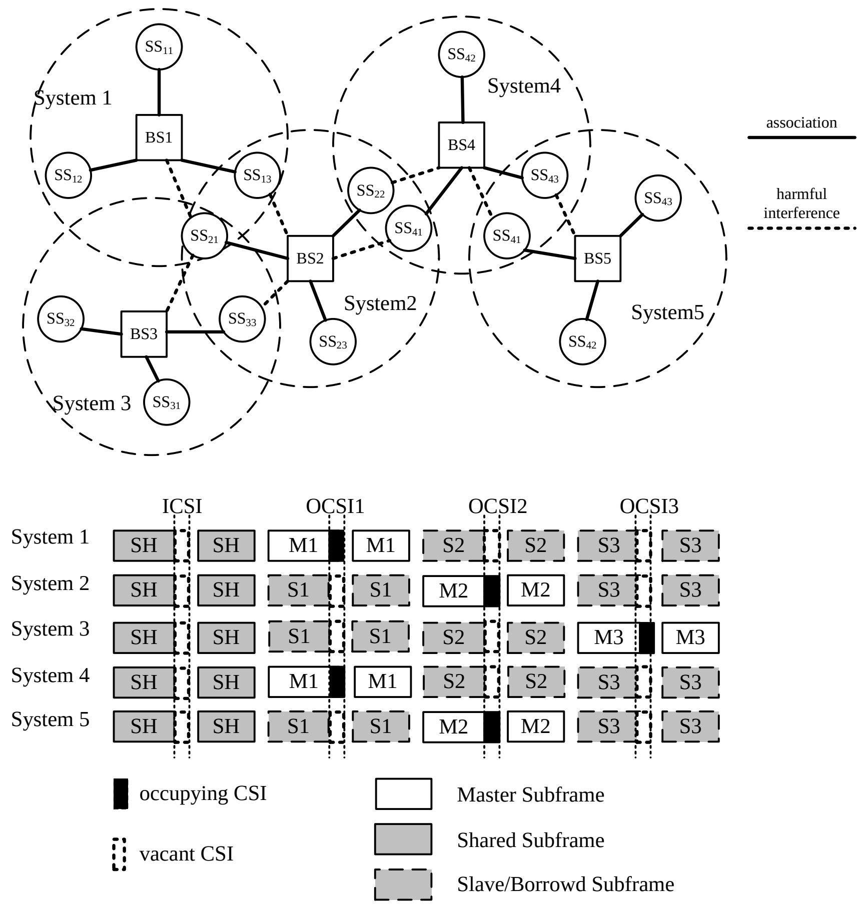
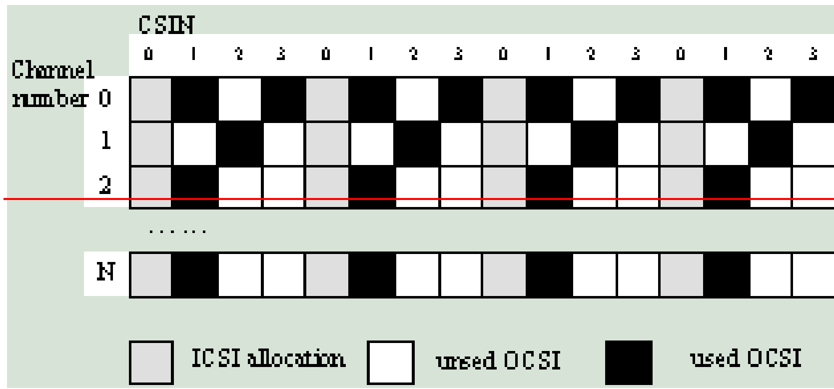


Figure h40—~~format~~ example of ICSI/OCSI allocation ~~MAP~~scheduling

In the initialization phase of a BS, before the BS has an OCSI allocation, the BS should use ICSI to advertise itself at each candidate channel sequentially one by one until it finds a proper channel. The neighbor OBS will then send their current OCSI allocation and current sub-frame allocation to the IBS using CXP message. After the IBS chooses the working channel for its radio link, the IBS shall choose a vacant subframe as its master, ~~CSIN for~~ thus the OCSI within this master subframe in the CX-Frame in this channel is chosen accordingly. ~~and~~ Then it shall inform other neighbors about this ~~choice~~information. Then, this BS will start using this OCSI allocation as its exclusive CSI allocation.

See *figure h40* for an example of the OCSI scheduling in a simple coexisted community. A system may passive and active scan (15.1.3.1) all the potential working channel and record all the neighboring system's OCSI allocation in its coexistence information database (15.5.5.1). For the reason of the CX-Frame structure, an occupied OCSI in the record also indicates that the according master subframe have been claimed by the occupier of the OCSI. By inquiring these records, a system may verify a suitable channel and master subframe and the according radio resource allocation or optimization scheme for operation (15.4), either in its initialization phase or in the operation phase.

The channel which do have harmful interference to the system but can not coordinate with the interference source will be considered as a channel not able to perform collaborative mechanisms.



~~**Figure h41—Example of CSI allocation MAP in one BS's database**~~

~~*Figure h 41* illustrates an example of the CSI allocation MAP of one BS during his initialization phase by collecting the CXP message information from its neighbors. Assume this BS chooses channel 0 as its working channel, it can then choose any one of the CSIN 1/2/3 as its OCSI allocation number. Every BS will have its own CSI allocation map indicating the current situation of CSI occupancy by the neighbors in the working channel and potential neighbors in the potential working channel. The CSI allocation MAP table of potential working channel will be used when the BS moves to another channel, however, the switching BS shall acquire the new CSIN for the new channel. The CSI allocation MAP of the BS should be updated in time when any changes are informed by its neighbors in the working channel and potential neighbors in the potential working channel~~.

~~In the OCSI mapping table, every neighbor in the working channel or potential neighbor in potential channels is mapped to one OCSI allocation, every OCSI allocation will indicate its status as occupied or vacant. By inquiring the mapping table of the OCSI allocations to the BSs, one BS can recognize the source of the interference or signaling in each OCSI allocation.~~

The initializing BS uses the OCSI allocation table to find out its neighbors in the working channel. By the contact information it acquired from the CXP messages, the IBS ~~will then~~ may use CXP messages to negotiate for interference resolution with its neighbors (15.4).

15.3.2.1.2 CSI sequence Structure

The CSI sequence is broadcast from the base station to the coexistence neighbor's subscriber station, within a series of CSI slots fragmentally. The CSI sequence consists of bit carried in each CSI slot as the basic element and carries the information from BS to the coexistence neighbor's SS. The CSI sequence shall start at the first CX-Frame in the CXCC cycle ~~frame numbered with 0-3 respectively~~ in each system~~, counting on the last 10 bits of frame number~~, which was synchronized within the neighborhood, CSI sequences have fixed 256 bits length, the bits left after the payload and CRC shall always be padded by zero. The CSI sequence shall always start with 8 bits one (start-of-sequence), and end with 8 bits zero (end-of-sequence). Each CSI sequence shall have 8 bits cyclic redundancy check (CRC) (Polynomial "X8+X2+X+1") appended to check the validity of the information carried within the

CSI sequence. In case the last slot of the signaling sequence has not been fully used up with the CRC and end-of-sequence, a pad filled with "zero" bits will be added between the CRC and the end-of-sequence. CSI sequence should be continuously carried in the serialized CSI slots during the whole CSI sequence structure. The basic structure is shown below:

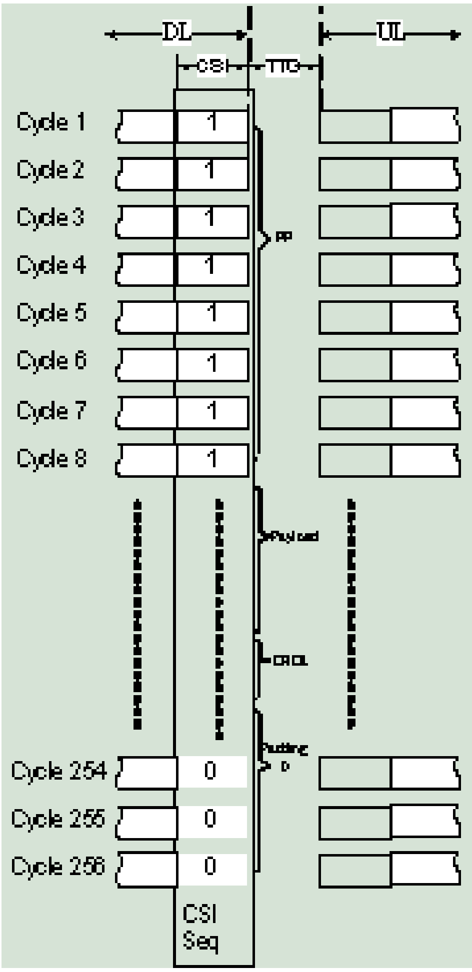


Figure h42—CSI sequence construction for one system

The PLD (payload) part of the CSI sequence should be structures as a TLV, as described in **CSI sequence PLD**. TYPE indicates the type of the payload, LENGTH corresponds to the number of symbols/bits contained in the VALUE portion. (TYPE and LENGTH are 1 octet each.)

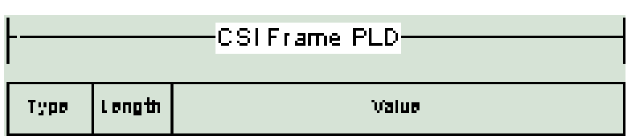


Figure h43—CSI sequence PLD

The SS ~~should keep~~ may monitor~~ing~~ the RSSI to detect start-of-sequence in the CSI interval. start-of-sequence flag can be detected according to the power value against time, When the power in all the first 8-CSI-slots window is significantly lower than all the second 8-CSI-slots, the start-of-sequence is expected to have been received, and the SS will pick a value in the middle of the two ~~value~~ as a threshold for the following CSIs ~~symbols~~. If a couple of following sequences act the same and the CRC check passed in the payload area, it will consider as a successful in detection of start-of-sequence. A CSI sequence considered to start here. When all the bits in the sequence are received and verified correctly by the CRC, the whole signaling sequence is received correctly and the information inside will be extracted and reported. *[notes: detail in the receiving part is unnecessary in this draft.]*

~~Symbols~~ CSIs between the start-of-sequence and the padding zeros are reassembled into CSI sequence TLV ~~while the pad is dropped,~~ when the check is passed. If the check fails, the signaling sequence will be reported with an error indication and no value will be reported for the payload. The whole CSI ~~bits~~ sequence shall be ignored if no correct sequence structure was detected.

15.3.2.1.3 Energy keying in time domain

The information carried in the CSI slots shall be broadcast by the BS and received by the SSs in a coexistence neighbor system. The modulation technology of the interference source and victim system may be different between the interference source system and interference victim system.

The information unit in the CSI slot is bit, carried by the timing of transmission in CSI. The duration of the CSI length is counted by symbols or PSs according to the technology that the system is using. The CSI shall be located right before the TTG Gap, and at the end of the last downlink burst send by BS. The BS shall set the transmission timing parameter (see ***Error! Reference source not found.***) according to the bit value that it is sending. And the SS in victim system is monitoring the signal strength in CSI duration to get each bit value within the CSI sequence (see **CSI sequence Structure**).

For the transmission side (BS), to use CSI duration as part of the data burst and stop transmition at or later than $T_{CSIEREF}$(***Error! Reference source not found.***) indicates bit one, while to stop transmission at or later than $T_{CSIEREF}$(***Error! Reference source not found.***) indicates bit zero. (See **Timing of CSI bit unit**. below) While the receiver side is using the signal strength during the CSI duration to decode the carried bit, in periodical CSI slots allocated for each transmitter, the receiver is de facto demodulate energy keying or so called on/off keying signal. The detail of the receiving algorithm is out of the scope of this standard.

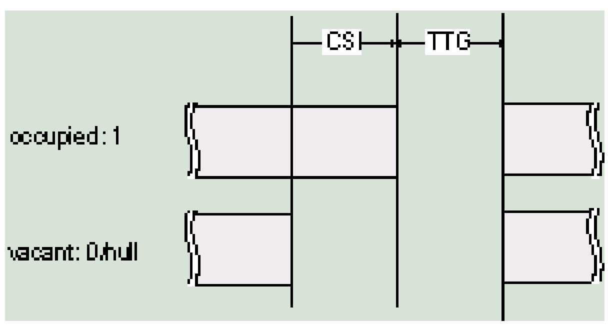


Figure h44—Timing of CSI bit unit