Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Backward Compatibility of CSI Mechanism
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Re:	80216h-06_028：Title: TGh Report closing plenary- Meeting 46 (2006-11-17)
Abstract	Discuss the backward compatible CSI mechanism.
Purpose	To consolidate the 16h draft.
Notice	
Release	
Patent Policy and Procedures	

Backward Compatibility of CSI Mechanism

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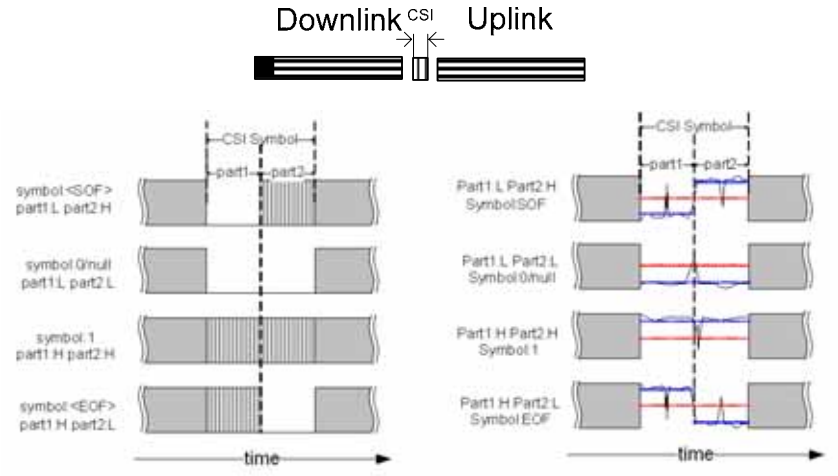
Huawei

Overview

There are several issues unsolved in the current signaling mechanism using the CSI and energy pulse mechanism, summarized below:



(HH1)

1) The transmitter of downlink is ceasing the transmition between the end of downlink data burst and the beginning of the CSI, these small gaps (CTG) together with the energy pulse during CSI is to switch the transmitter on to off and then on and then off in a short period, it is risking the spectrum mask distortion;
2) The GAP between DL data burst and CSI pulse is enlarging the overhead;
3) Energy pulse within CSI is in fact a short burst, but what we should transmit during this burst is a mist.

To make the signaling mechanism more practical, we must make it compatible with the primary standard, easier to be implemented, and to mitigate the spectrum mask distortion.

Reference**:**

[1] *IEEE 802.16h-06/082: Using energy pulses for interference identification between 802.16 systems.| (2006-08-08)*

[2] *IEEE P802.16h/D1: Working Document for P802.16h (2006-08-01)*

[3] *80216h-06_059：IEEE 802.16 Working Group Working Group Letter Ballot #24 (2006-10-11)*

[4] *IEEE C802.16-05/012: IEEE 802.16-2004 and IEEE 802.16e RF Characteristics (2005-04-29)*

[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)*

[7] *ITU-R REC F.758 CONSIDERATIONS IN THE DEVELOPMENT OF CRITERIA FOR SHARING BETWEEN THE TERRESTRIAL FIXED SERVICE AND OTHER SERVICES (1992-1997-2000)*

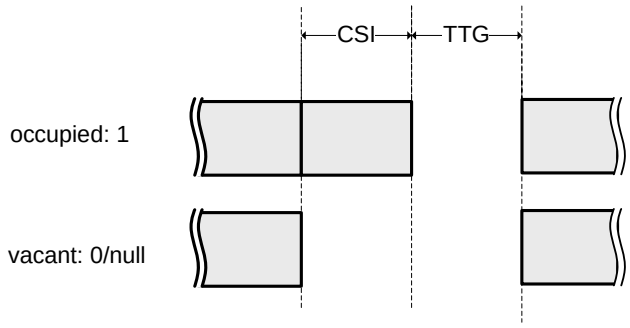
[8] *Calculating the Sensitivity of an ASK Receiver (2003-11-05)*

[9] *IEEE C802.16h-06/054 Discussion on implementing the energy pulse (2006-07-10)*

[10] *IEEE C802.16h-06/112r3* MAC Messages supporting the CSI *(2006-11-16)*

[11] *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit ITU-T Recommendation X.25*

Principle for the enhancement



(HH2)

The principle of the enhancement is just to eliminate the gap between CSI and the data burst, so that it will mitigate the drawbacks of the original issue raised from energy pulse. As we see above, now the transmission signaling is not present by “on-off” keying aspect, although in fact it is. We still reserve a predefined time interval to carry the signaling bit, the key of the modification is to make the allocated BS to continue use these symbols as part of the DL data burst (indicating 1) or to cease transmission during the CSI duration.

Since there are no additional gaps or short burst during this case, only looks like shorter or longer TTG aspect. The short one is the original TTG with the occupied CSI, and the longer one is TTG with a vacant CSI. And as we know the TTG gap is between burst from different transmitters so it will not risk any spectrum distortion comparing to the normal frame structure.

Unfortunately, this enhancement is only applicable to OCSI, for the ICSI, since the signaling is from a transmitter different with the operating one; it will naturally form a short burst, similar with a SS uplink short burst with the length of several symbols. If we can not accept the BS to transmit like an OFDM SS, we can combine the passive scan and OCSI to make the whole approaches work (see e.g. figure HH6). But I’ve still not found the real fault of the CSI burst regarding the spectrum mask. The only contribution shows its spectrum mask distortion is C80216h-06_069, which is based on the assumption of 10us burst duration which is not the truth. So for ICSI, it may still need to use stand alone short burst for the IBS to occupy the interval.

We suggest to have less variety of the CSI symbol, so that it can shorten the length of every information bit carried by the CSI, we need some mature mechanism to use to identified the boundary of the CSI frame, such as simplified x.25 structure:

([11] 2.2Framing aspects

2.2.1 Flag sequence

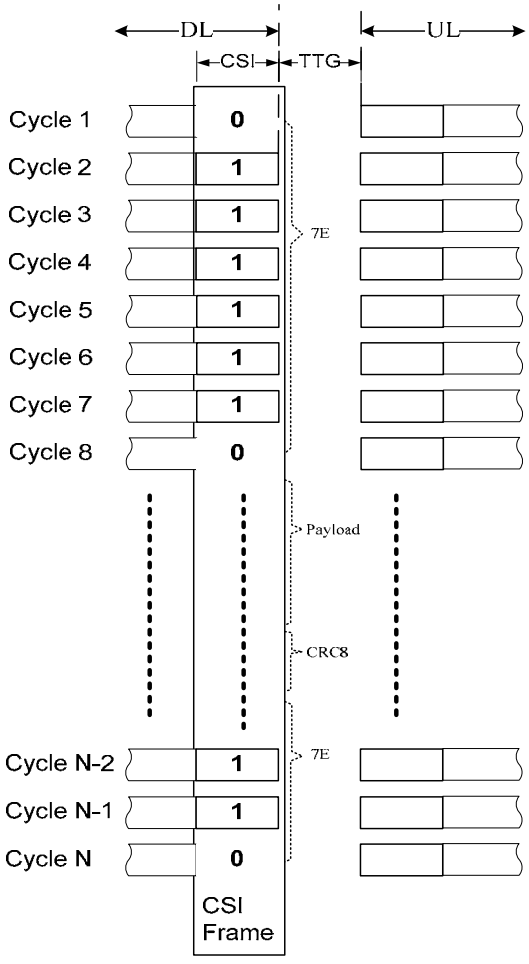
All frames shall start and end with the flag sequence consisting of one 0 bit followed by six contiguous 1 bits and one 0 bit. The DTE and DCE shall only send complete eight-bit flag sequences when sending multiple flag sequences (see 2.2.4). A single flag may be used as both the closing flag for one frame and the opening flag for the next frame.

2.2.2 Transparency

2.2.2.1 Synchronous transmission

The DCE or DTE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS fields and shall insert a 0 bit after all sequences of 5 contiguous 1 bits (including the last 5 bits of the FCS) to ensure that a flag sequence is not simulated. The DCE or DTE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows 5 contiguous 1 bits.)

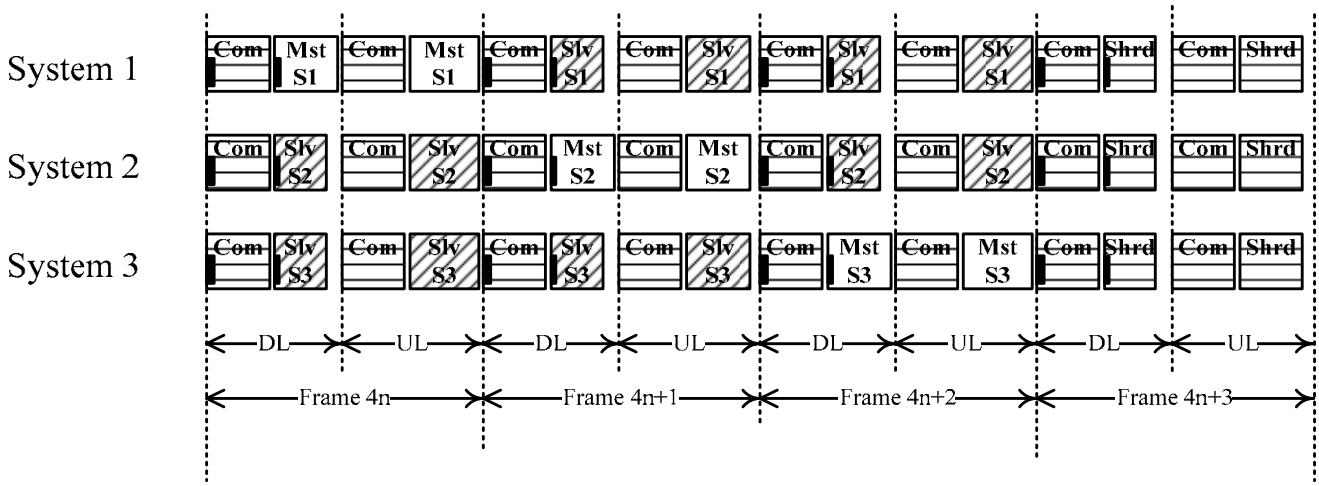
)



(HH3)

Or we can simply use the frame number to be the nature boundary of the CSI frame, e.g. frame number whose bits10 to bit2 is zero is the starting bit of the CSI frame (see the example below with 2 figures, if we

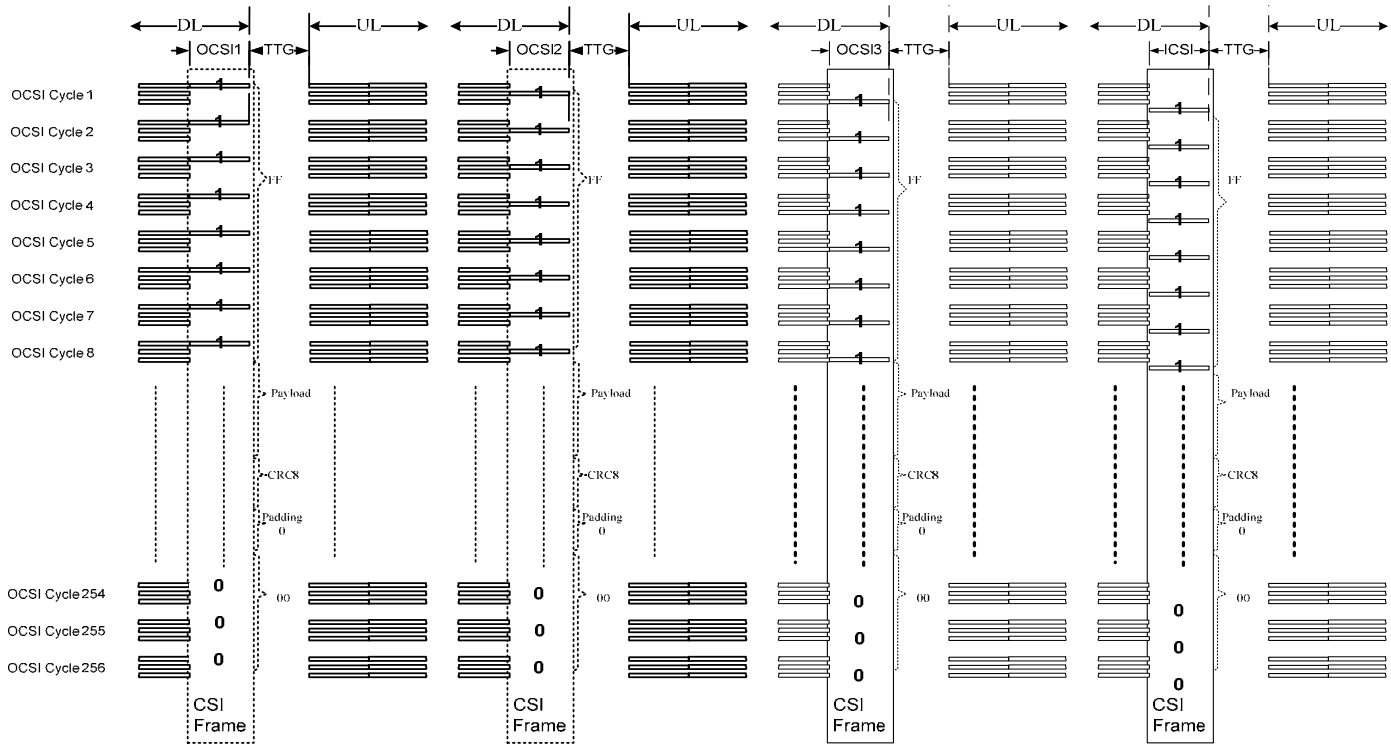
use this scheme, we use frame 0/1024/2048… to be the starting bits of OCSI1 frames, and frame 1/1025/2049… to be the starting bits of OCSI2 frames, and so on.).



(HH4)

(See above figure.) Here is an example of the frame structure which based on some type 2 assumption, we can easily make use of the final part of the master to implement the CSI as well. The gray block is just showing that this duration is allocated to that system, and whether to occupy it or leave it vacant is counting on the bit it carried.

For the threshold measurement purpose, we can make the first 8 bits of the CSI frame fixed to be 1 and the last 8 bits of CSI frame to be 0. So that it will make use of the RSSI result of these interval and also may use it for some kind of synchronization. As shown below:

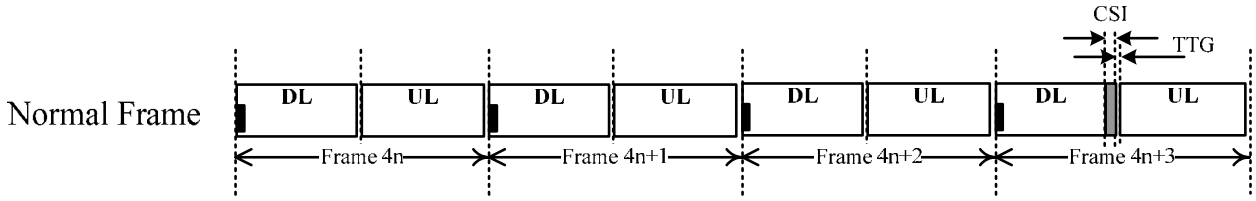


(HH5)

FYI, if we take each CSI for 1 symbol duration, about 100us out of each 10ms frame, it will occupy 1% capacity in the structure, if we take about 200us out of each 10ms frame, it will make 2% overhead which I do not think it will be a disaster either.

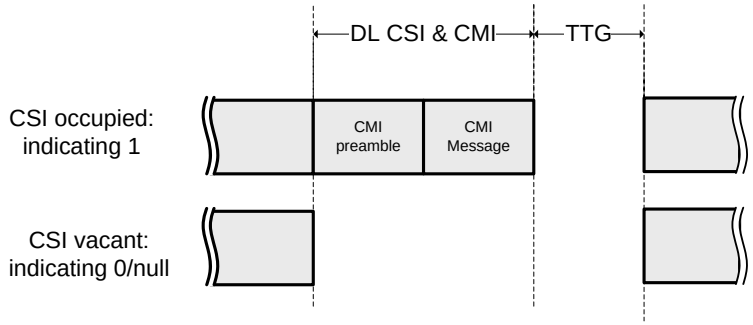
If so, we will have each CSI frame to be transmitted within 1024 CSI cycles (256 OCSI cycles), while each CSI cycle is equal to 1 frame duration. If the frame duration is 1ms, we will have a CSI frame broadcasted in about each 10 seconds. I believe such performance of this slow signaling mechanism can satisfy most of the case.

Notice here, this CSI scheme not only fit for the frame structure with the type 2 subframe, but also fit for normal frame structure to carry the CSI signaling.



(HH6)

FYI, If we want to make use of these CSI to transmit message using fast modulated manner. We can easily have some approach like the following figure.



(HH7)

Conclusion

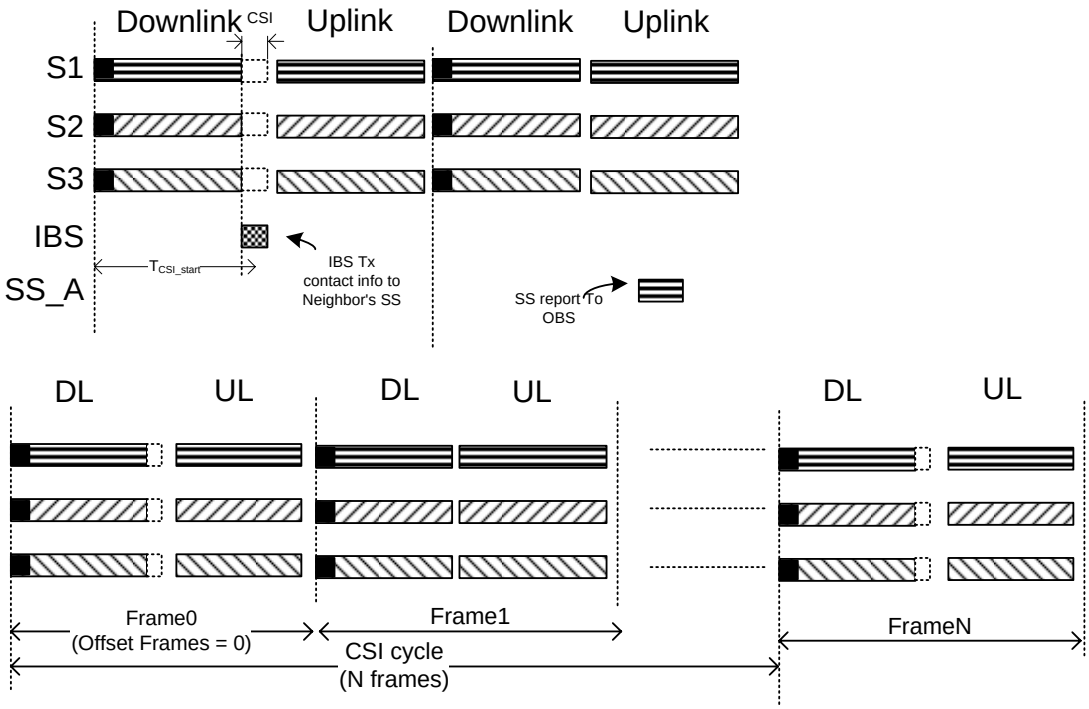
The principle above will solve the 3 issues addressed at the beginning of this contribution.

1) *Short gaps between the transmissions of the same transmitter no longer exist.*
2) *Overhead have been lowered down.*
3) *Transmitter can use the CSI duration to transmit the normal data burst, de facto CSI duration is just part of the data burst or vacant symbols at the end of data burst.*

4) Proposed Changes:

(1) Delete all definition and description of the TCG and CTG in 16h-D1 document

(2) Proposed changes on figure-h14 and h15



(3) Change 15.3.1.1.2 as indicate:

15.3.1.1.2 CSI Frame Structure

The CSI frame is broadcast from the base station to the coexistence neighbor's subscriber station, within a series of CSI slots fragmentally. The CSI frame consists of ~~power keying energy symbols~~ bit carried in each CSI slot as the basic element and carries the information from BS to the coexistence neighbor's SS. The CSI frame ~~has the <SOF> symbols~~ shall start at the 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 frames have fixed 256 bits length, the bits left after the payload and CRC shall always be padded by zero. The CSI frame shall always start with 8 bits one (<SOF>), and end with 8 bits zero (<EOF>).~~and <EOF> symbols as the boundary of slots when there are more than 4 symbols in each CSI slot. Two consecutive <SOF> and <EOF> indicate the signaling frame boundaries.~~ Each CSI frame shall have 8 bits cyclic redundancy check (CRC) (Polynomial "X^8+X^2+X+1") appended to check the validity of the information carried within the CSI frame. In case the last slot of the signaling frame has not been fully used up with the CRC and <EOF>, a pad filled with "~~one~~zero" ~~symbols~~bits will be added between the CRC and the ~~double <EOF>~~ end of frame. CSI frame should be continuously carried in the serialized CSI slots during the whole CSI frame structure. The basic structure is shown below:

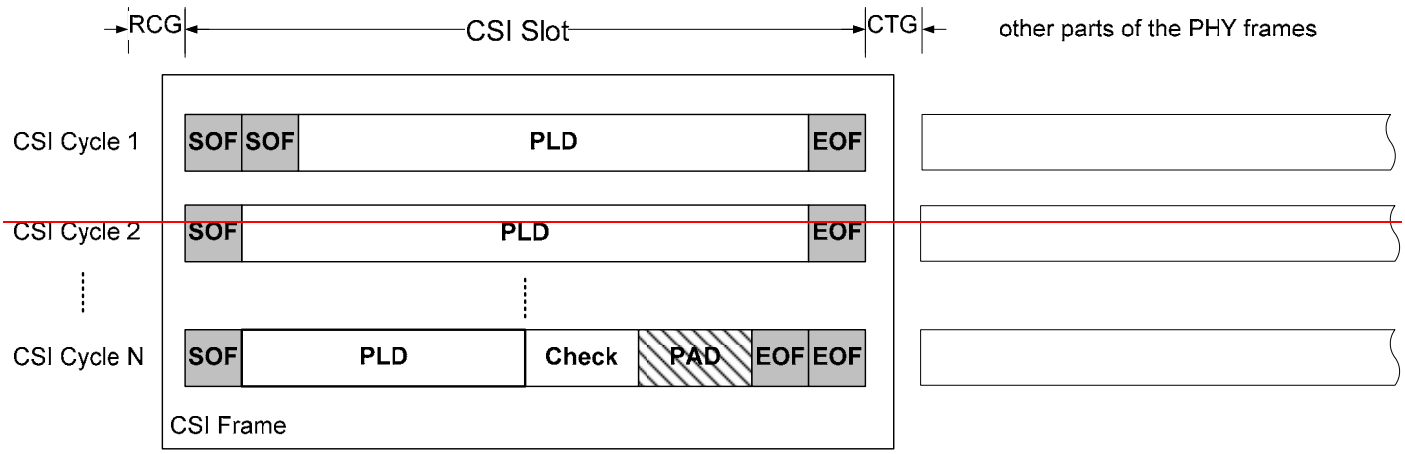
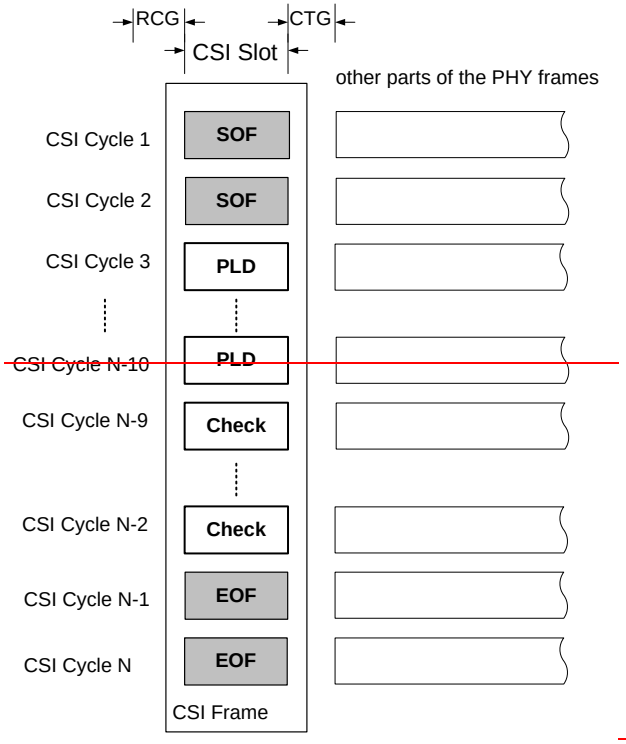


Figure h29_CSI frame construction with no less than 4 symbols in one slot



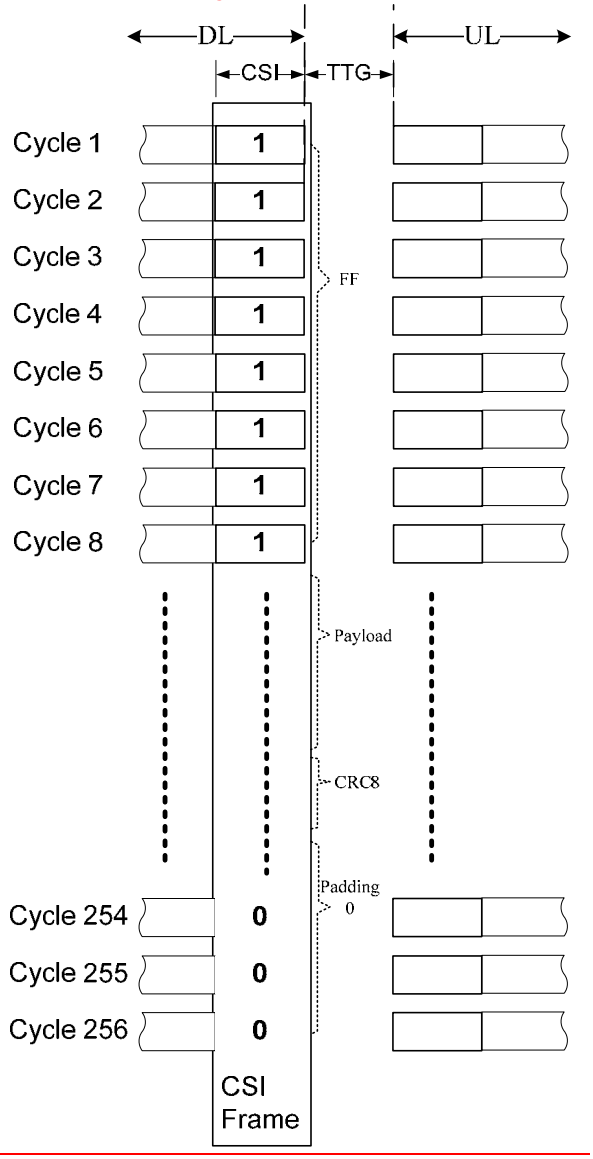
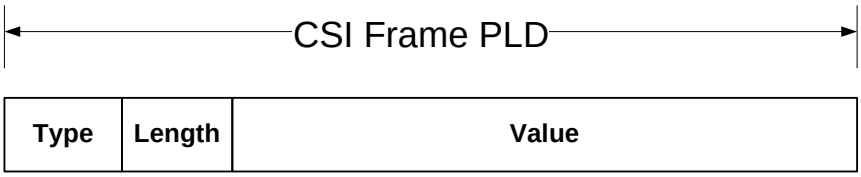


Figure ~~h30~~h29 CSI frame construction for one system ~~with 1 symbol in 1 slot~~

~~The subscriber station of coexistence neighbor cannot get correct timing offset because there is no ranging process between the SS and IBS, so RCG (Receive CSI gap) and CTG (CSI Transmission gap) should be included in the CSI slot for reliable sampling in the SS.~~

The PLD (payload) part of the CSI frame should be structures as a TLV, as described in *Figure h* . 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.)



CSI frame PLD

The SS should keep monitoring the RSSI to detect <SOF> in the CSI interval. <SOF> flag can be detected according to the power value against time, When the power in ~~first half~~ all the first 8 CSI slots ~~of the symbol~~ window is significantly lower than all the second ~~part~~ 8 CSI slot, ~~one~~ the <SOF> 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 symbols. If a couple of following frames act the same and the CRC check passed in the payload area ~~symbol shows lower power in the first part than the threshold and in the second part a higher power than the threshold~~, it will consider as a successful in detection of ~~another~~ <SOF>. A CSI frame considered to start here. ~~When two consecutive <EOF> are detected at the end using a similar method as the <SOF> detection, and~~ When all the ~~symbols~~ bits in the frame are received and verified correctly by the CRC, the whole signaling frame is received correctly and the information inside will be extracted and reported. [notes: the receiving part is unnecessary in this draft.]

Symbols between the ~~two consecutive~~ <SOF> and the ~~two consecutive <EOF>~~ padding zeros are reassembled into CSI frame while the pad is dropped, when the check is passed. If the check fails, the signaling frame will be reported with an error indication and no value will be reported for the payload. The whole CSI ~~symbol~~ bits sequence ~~will~~ shall be ignored if no ~~consecutive two <SOF>~~correct frame structure~~-~~ was ~~were~~ detected.

~~When there are more than 4 symbols in each CSI slots, there will be a <SOF> and an <EOF> at the beginning and the end of the slots respectively. All the <SOF> and <EOF> will be dropped when reassembling the payload of the CSI frame.~~

(4) Change 15.3.1.1.3 as indicate:

15.3.1.1.3 Energy keying in time domain

The ~~symbols~~ information carried in the CSI slots ~~are~~ 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 ~~could~~should be one of the following: SCa, OFDM or OFDMA, and ~~could~~ may be different between the interference source system and interference victim system. ~~The operation bandwidth of the source and victim systems shall have overlapping part, but the bandwidth could be different.~~

The ~~symbol~~ information unit in the CSI slot is bit, ~~defined only by its power profile in time~~ carried by the timing of transmission in CSI~~, and could use any one of the modulation technology and any band that are available in the equipment~~. The duration of the ~~energy symbol shall be 1/N of the~~ CSI length is counted by symbols.~~, where N is a natural number specified by the region/country regulator.~~ 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 10.5.4) 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 frame (see 15.3.1.1.2).

~~There are four kinds of symbols: <SOF>,0/null,1,<EOF>, to be used to form any frame in CSI and to carry the information.~~

~~<SOF>: Start Of Frame, indicating the data portion will start at the following symbol.~~

~~0/null: Binary code 0 used to compose the data portion, same as a null symbol.~~

~~1: Binary code 1 used to compose the data portion.~~

~~<EOF> End Of Frame, indicating the data portion ended at the last symbol~~

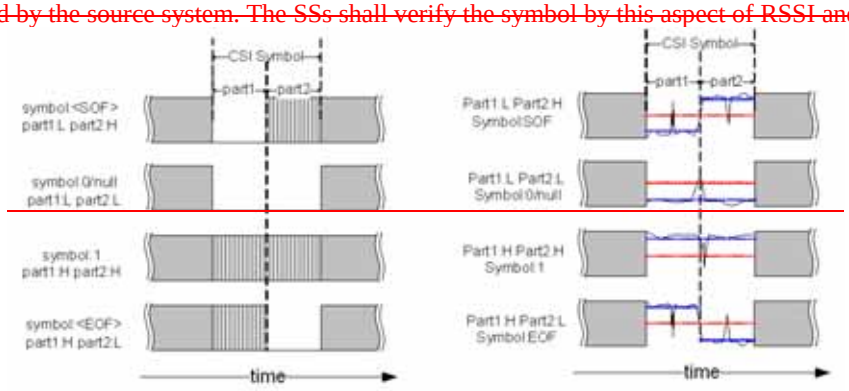
~~Each symbol is divided into two equal length parts. For each part, there are two kinds of power keying level defined, H (high) and L (low). The BS uses the maximum capable and allowed operating EIRP to transmit in the H (high) portion so that the SS can detect higher RSSI, and the BS is silent in the Low (L) portion and the SS can detect lower RSSI at that time.~~

~~The format of each of the four kinds of symbols is shown in the table below:~~

~~Table h5 CSI symbol Format~~

~~format~~		**~~signification~~**
~~Part1~~	**~~Part2~~**	
~~L~~	~~H~~	~~<SOF>~~
~~H~~	~~L~~	~~<EOF>~~
~~L~~	~~L~~	~~0~~
~~H~~	~~H~~	~~1~~

~~The receiving SS shall follow up the CSI timing and decode each symbol continuously in every symbol space, so that it can acquire the information transmitted by the source system. The SSs shall verify the symbol by this aspect of RSSI and time.~~



For the transmission side (BS), to use CSI duration as part of the data burst and continues to transmit indicates bit one, while to stop transmission at the beginning of CSI duration indicates bit zero. (See figure hxx. 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.

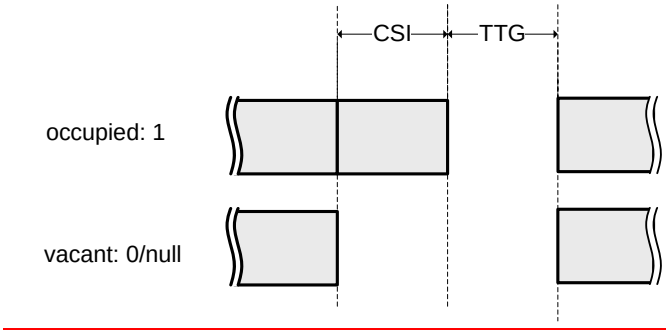
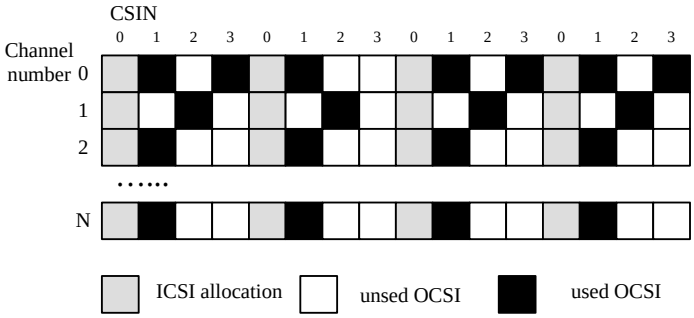
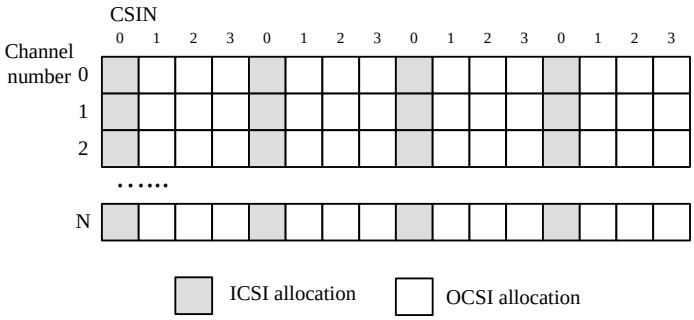


Figure h32- Timing of CSI bit unit ~~symbol transmission and receiving~~

(5) Change figure h27 and figure h28 as indicate.





(6) Check all the related description for (1)-(5).