Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Common PHY issue & Messages for Neighbor Discovery Using CTS**
Date Submitted	**2005-09-06**
Source(s)	Wu Xuyong Huawei Huawei Industrial Base, Bantian, Longgang, Shenzhen 518129 P.R.C Voice: +86-755-28971677 Fax: +86-755-28972045 wuxuyong@huawei.com
Re:	80216h-05_018：Call for Contributions IEEE 802.16's License-Exempt (LE) Task Group. 2005-08-18
Abstract	Provide a PHY independent symbol and a frame structure in using CTS slots
Purpose	Consolidate the neighbor discovery procedure in ad-hoc fashion
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Common PHY issue & Messages for Neighbor Discovery Using CTS

Wu Xuyong
wuxuyong@huawei.com

Overview

In current working document 2.1.1, we now have a possible simple approach to make the initializing BS to get in touch with its neighbors, without any centralized server involved in this phase. That is, initializing BS can use the coexistence time slot to broadcast its IP address to the reachable SS which belong to other serving BS, and let the serving BS to contact the initializing BS using the IP network.

But we haven't deal with the issue that we need a tech independent method for the initializing BS to broadcast its IP address to the SSs. That means, the initializing BS need to make the receiver(SSs), which may using different technology (SCa/OFDM/OFDMA etc.) or even different bandwidth(5MHz, 10MHz,20MHz, etc.), to recognize the information it have transmit in the CTS.

In this paper, we propose a solution using the energy keying signal in air interface, it make the LE BS to be able to broadcast the IP address to the reachable SS in the neighbor network. which are interfered by the BS.

Acronyms

CTS – Coexistence Time Slot

IBS – Initializing Base Station

OBS – Operating Base Station

IPBC – IP address Broadcast

Reference:

[1] *IEEE802.16-2004: IEEE standard for Local and metropolitan area networks Part16: Air Interface for Fixed Broadband Wireless Access Systems 2004-10-01*

[2] *IEEE 802.16-05/017: working document Amendment for Improved Coexistence Mechanisms for License-Exempt Operation 2005-08-15*

[3] *C80216h-05_022r1: Cognitive radio concepts for 802.16h*

Description of the concept

In current working document, we have define the Coexistence Time Slot used by the initializing base station to broadcast the IP network communication address (see 2.1.1):

Coexistence Time Slot

CTS (Coexistence Time Slot): a predefined time slot for the coexistence protocol signaling purpose, especially for the initializing BS to contact its neighbor operating BS through the SS in the common coverage area.

CTS must not be used for other purpose by all the BSs, so that it will be an interference free slot for the neighbor discovery purpose. Initializing BS (IBS) shall use this slot to broadcast its IP identifier, so that the

neighbor operating BS (OBS) could find the new neighbor in IP network after the SS report the message. Then the IBS and OBS begin further negotiation for coexistence protocol.

The broadcasting procedure is unidirectional, only from the IBS to the SSs in IBS's coverage, and the SSs shall report all the useful information to their OBSs they registered to. If the message be forward correctly to the OBSs, the OBSs will then find the IBS in the IP network, and go further signaling using IP network.

Issues to be considered

Issue 1: coexistence with different PHY

According to the scope of the License Exempt task group, we need to face the coexistence between the systems based on IEEE 802.16 standard, that means we need to deal with the communication between the heterogeneous PHY technologies. (SCa/ OFDM/ OFDMA).

Issue 2: coexistence with different bandwidth

Another case we may meet is coexistence between systems which employ different bandwidth. For example, N1&N2 have common bandwidth and interference with each other, N1 use 5MHz Bandwidth and N2 use 10MHz. They need to contact using signal that the receiver can understand.

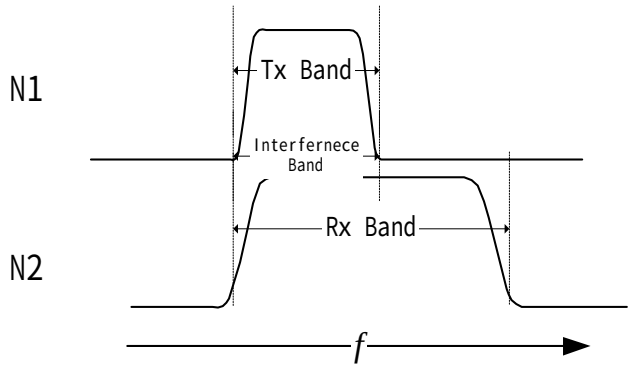


Figure 1. coexistence between systems deploy different bandwidth

So we have a challenge to find some method to carry the information between systems using different PHY and different bandwidth. In [3]*C80216h-05_022r1*, the writer proposed a method using frequency domain energy bin to carry out some information, that make sense in case with systems using frequency division PHY, but may not work for SCa PHY in the neighbor.

Here we propose another candidate that could be used to signal delivery between heterogeneous systems, especially using CTS to broadcast the IP address to the reachable SS in neighbor network.

IBS_IPBC Frame structure

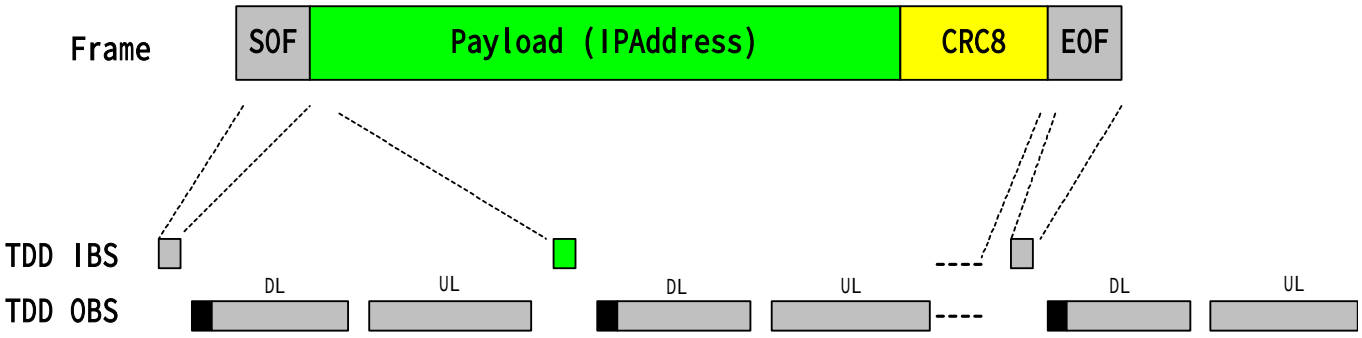
We propose a simplified frame structure, and to make the overhead as low as possible. Since there is no prediction of frame start point, the frame structure need to have a signal to show the start of frame, and the end

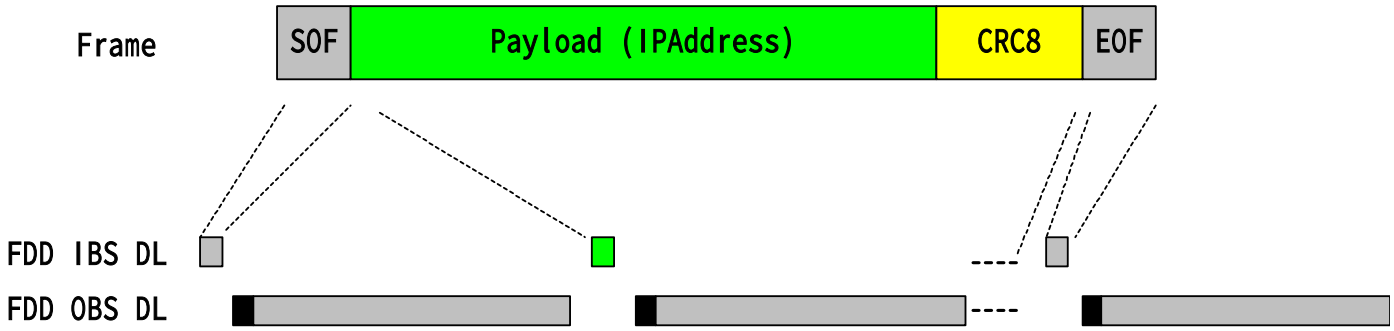
of frame as well. There should be some checking method to make the receiver know whether the frame have been broken. So we propose a simple <SOF>, payload, CRC,<EOF> structure, as shown below:

Syntax	Size	notes
IP address broadcast frame(){		Every CTS is consist of n symbol, (n>=1)
<SOF>Start of frame	1 symbol	
PLD:IP address of initializing base station	32 bits	1 bits = 1 symbol
CRC: Cyclic Redundancy Check	8 bits	Polynomial “X8+X2+X+1”
<EOF>Start of frame	1 symbol	
}		

CTS location

In order not to break the BS downlink PDU, and to prevent overhead of more preamble and gaps, CTS need to locate before the preamble of downlink frame in FDD network or before RTG/TTG in TTD network. To unify the location in TDD and FDD, FDD need to put into the DL structure and better before the preamble to got a easy finding location. Same in TDD, it's better to use the location before RTG. for FDD, insert the CTS at the end of frame will keep the starting point of frame synchronized and make the CTS easy found.



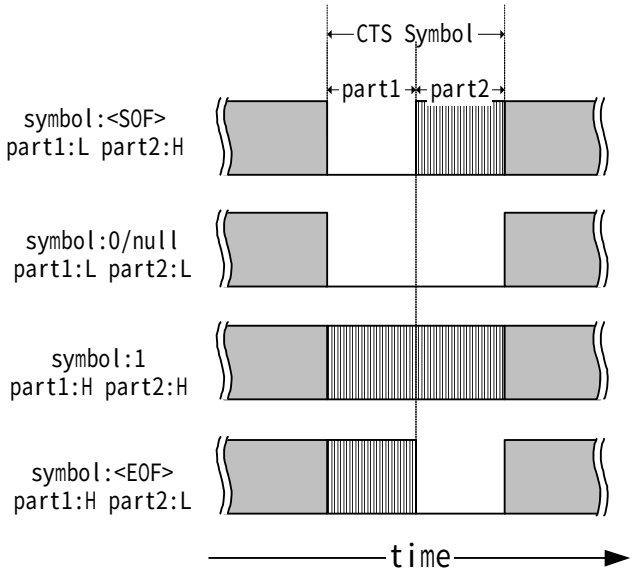


Symbols definition

We define the energy keying symbols as follows. The symbol is divided into to parts with equal length, each part could be transmitted either in high power(H) or low/no power(L). We mapped the four combination into different significations:

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

The symbols are transmitted using the original PHY of the transmitter, and length of the symbol is 1/n of the CTS length. N is a natural number and to be decided and standardized in region/country.

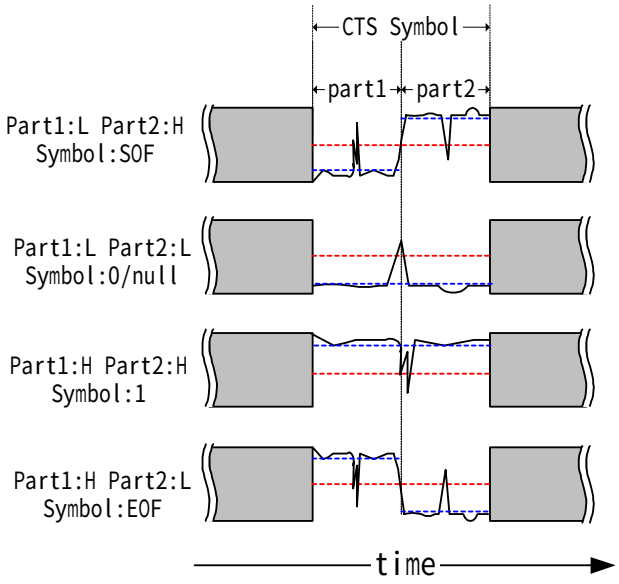


the IBS_IPBC frame receive procedure

The receiver detect the RSSI in whole band during each CTS symbol time make the verdict in each part, by comparing the average RSSI value with the criteria gate value. By combining the result of two parts, the receiver will make the decision of the signification for each CTS symbol. see the figure below.

The receiver SSs will record the average RSSI in null CTS slots, and when they detect a continue symbol that meet the <SOF> aspect, the receiver will memorize the average RSSI values of each of the two parts, and make the mean value as a criteria gate value to do further verdict on the following symbols in this IPBC frame.

By receiving different symbols, the receiver SS will change the internal state machine of the IPBC frame receive procedure. After end of receiving a IPBC frame. The receiving SS will report the result to the serving BS.



Proposed Text changes in working document:

[Insert the following paragraph after the first paragraph of Coexistence Time Slot section in 2.1.1]

Not to break the downlink PDU, and to prevent overhead of more preamble and gaps. CTS slots shall be located before RTG/TTG in TTD frame structure or before the preamble of downlink frame in FDD frame structure .To unify the location in these two kind of duplexing frame , CTS slots in FDD frame shall be put into the downlink structure right before the preamble, and shall be located right before RTG in TDD frame.

[Change the figure8 and figure 9 as indicated]

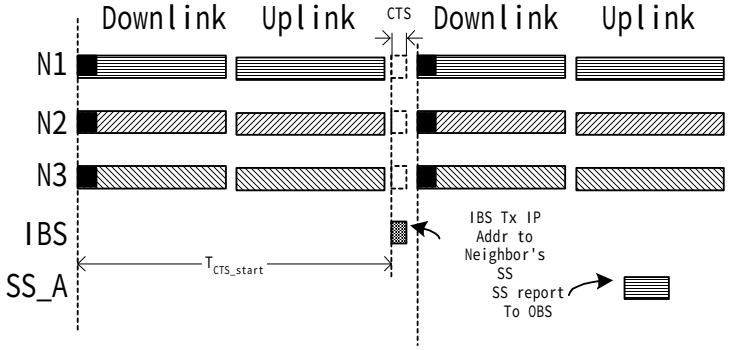


figure8: Timing of Coexistence Time Slot

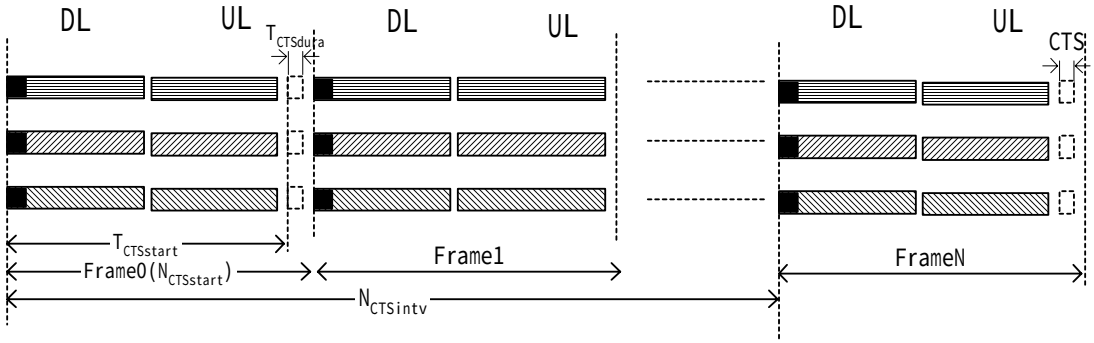


figure9: CTS parameters

[insert the following paragraph into 2.1.8.1 Interferer identification]

In IBS's neighbor discovery phase, the IBS's IP address shall be broadcast using the IPBC frame with pulse energy keying. And this shall be detected by neighbor's SS in the IBS's reachable range and reported to its serving BS.

The IP address is used to identify the neighbor BS by the receiver SS in the IBS's neighbor discovery phase. And also be the identifier of the IBS for the neighbor BS before the neighbor got in touch with the IBS in the IP network.

[insert the following paragraph into the end of 2.1.1 General Principles]

Energy Symbols Used in the CTS

The symbols used in the CTS slots is used to broadcast by the BS and received by the SS in neighbor network. The modulation technology on both side should be one of the3 following: SCa, OFDM or OFDMA, and could be different on two side. The band of the two side shall have overlapped part, and the bandwidth of two side could be different.

The symbol is defined only in the power and time aspect, and could use any one of the modulation technology and any band that have been used in the equipment. The length of the energy symbol shall be 1/N of the CTS length, here N is a natural number and to be consolidated in region/country regulator.

There is 4 kinds of symbols:<SOF>,0/null,1,<EOF>, to be used to form any frame in CTS.

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

－*0/null: Binary code 0 used to compose the data part, same with null symbol.*

－*1: Binary code 1 used to compose the data part.*

－*<EOF>：End Of Frame, indicating the data part ended at the last symbol*

Each symbol is divided into two equal length parts. And for each part, there is 2 kinds of power keying level defined, H (high) and L (low). High power level part need the BS to use the maximum power to transmit and the SS will detect higher RSSI at that part, and the low power level part need BS to be silent and SS will detect lower RSSI at that time.

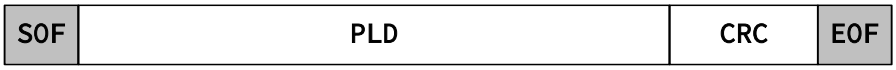
The format of each kind of symbols is shown in the table below:

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

The receiving SS shall follow up the CTS timing and detect each symbol continuously in every symbol space. The SSs shall verdict the symbol by this aspect of RSSI and time. One CTS consists of several symbols with the same length, the number of symbols in each CTS slot is standardized in region/country.

CTS Frame Structure

CTS frame is broadcasted from the base station to neighbor's subscriber station. They are loaded in serialized CTS slots. It consists of power keying energy symbols as basic element and carry the information from BS to the neighbor's SS. The CTS frame has the <SOF> symbols and <EOF> symbols as the boundary, and should be continuously carried in the serialized CTS slots during the whole frame structure. Each CTS frame shall have cyclic redundancy check data to check the validity of the information carried in the frame. The basic structure is shown below:



[Insert the following section in the 6.8.2]

IBS_IPBC

IBS_IPBC message is the message broadcasted by the initializing base station to the SS in the neighbor network. It use the CTS slots and power keying energy symbols to carry the IP address information from the IBS to the SS, and the IP information shall be reported by the SS to the serving neighbor BS. And the serving neighbor BS will find the initializing BS in the IP network, and then start the further coexistence negotiation.

Syntax	*Size*	*notes*
IP address broadcast frame(){		*Every CTS is consist of n symbol, (n>=1)*
<SOF>Start of frame	*1 symbol*	
PLD:IP address of initializing base station	*32 bits*	*1 bits = 1 symbol*
CRC: Cyclic Redundancy Check	*8 bits*	*Polynomial "X8+X2+X+1"*
<EOF>Start of frame	*1 symbol*	
}		