Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Timing for sending messages using the frequency – domain energy pulses**
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Re:	IEEE 802.16h-06/011 – Working Group Review
Abstract	Proposes a more logical structure which will allow better understanding of the existing mechanisms
Purpose	
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Introduction

In the Working Document are two mechanisms using well known, absolute time moments:

1. Candidate channel selection, which can identify the co-channel and adjacent channel interference, as perceived in the listener channel.
2. Signaling to ad-hoc systems, which has the scope the separation of the remaining interference in the time-domain.

In [1] there is no correlation between the timing of the two mechanisms, such that from time to time they may overlap. The scope of this contribution is to propose a non-overlapping timing for the two mechanisms.

Overview of the existing timing

The timing for the Candidate Channel Selection is shown below:

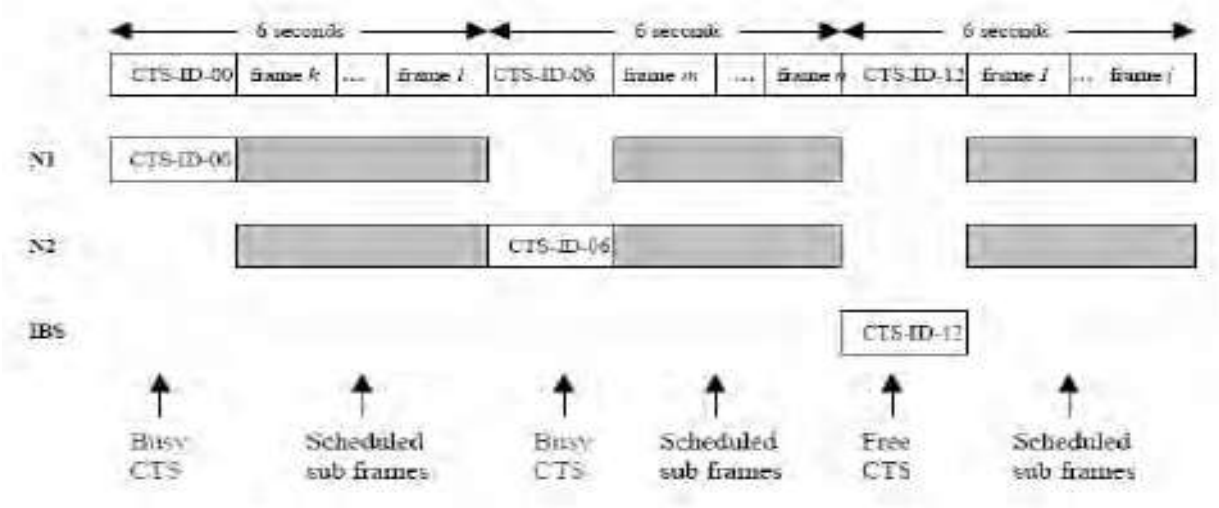

Figure h17—CMI Timing (CTS should be changed to CMI)

According to the standard, the duration of a MAC frame is max. 20ms.

The examples provided in [1] show the possibility of starting a CTS slot at the absolute times 00:00, with increments of 6sec.

The timing for the signaling to ad-hoc systems is shown below:

10.5.1 Radio signaling

The absolute time runs on a periodic base of 1800 sec. (30 minutes). For cases when one or more seconds are added/subtracted at the mid-night, the absolute time is supposed to follow those changes. All the values below are repeating based on the relation:

Time = (Absolute time) mod 1800.

The time is expressed as sec: ms, according to the decimal format xxxx:yyy.

Table 345a—parameter of absolute time reference

Absolute time reference	Chapter	Reference	Value
AT1	Radio signaling (15.5.1.2)	Start of the first MAC Frame (no. N) including cognitive radio signaling	0010:000
AT2	Radio signaling (15.5.1.2)	Start of the 2nd MAC Frame including cognitive radio signaling	0010:020
AT3	Radio signaling (15.5.1.2)	Start of the 3rd MAC Frame including cognitive radio signaling	0010:040
AT4	Radio signaling (15.5.1.2)	Start of the 4th MAC Frame including cognitive radio signaling	0010:060

Table 345b—parameter of radio signaling timer

Timer	Chapter	Reference	Value
T_cogn	Radio signaling (15.5.1.2)	Repetition period of the cognitive signaling	20s
Tcr_reg	Radio signaling (15.5.1.2)	Duration of the registration interval for ad-hoc transmitters	2s
Tcr_rep	Radio signaling (15.5.1.2)	Time interval between the start of consecutive time-slots for registration	100ms
Tcr_reg_ack	Radio signaling (15.5.1.2)	Time interval which starts immediately after a time-slot for registration and last as specified	20ms
Tad_reg	Radio signaling (15.5.1.2)	Maximum time-interval in which an ad-hoc unit has to repeat the registration	1800s
T_iptx	Radio signaling (15.5.1.2)	Time interval between the start of consecutive CSI slots for the transmission of the IP address using frequency-keyed energy pulses	20ms

The overall timing is shown below:

Start of CMI slots, in seconds:

00:000, 6:000, 12:000,18:000, 24:000, 30:000, 36:000, 42:000, 48:000, 54:000.

Start of radio signaling:

10:000, 30:000, 50:000

As can be seen, at 30sec the slots overlap.

On the other hand, the radio signaling procedures use 5 intervals, and every interval needs a 20ms slot. Will be better to spread these slots, to reduce the latency in data transmission.

Proposal

It is proposed to change the period of radio signaling, to 12sec and the start of the radio signaling, to start at 3:000, 15:000, 27:000, 39:00 and 51:00sec.

Due to the fact that the OFDM signal duration, for a 5MHz channel, is well know, there is no need to indicate the reserved periods for registration. Instead, the registration interval can be slotted, such to allow for propagation delays. This will make the process shorter.
The ad-hoc devices requesting registration will chose randomly one slot inside the requested sub-frame, for sending their registration request.
The registration NACK will be sent in the registration response interval, using the same slot as the device requesting registration, if a NACK will be sent.

The used intervals shall be spread as follows: AT2=AT1+1sec, AT3=AT1+2sec, AT4 (registration replay) =AT1+4sec, AT5=AT1+10sec (IP address transmission).

Text for the Working Document

Implement the following changes:

15.5.1.2 Registration

The 802.16h pro-active cognitive radio approach defines signals and procedures for the reservation of the activity intervals and registration of ad-hoc systems. The operational procedures are described below:
802.16h Community registered systems, using a Coexistence Protocol, will reserve the MAC frame Tx/Rx intervals by using, during the MAC Frame N, starting at the absolute time AT1, cognitive signals to indicate the MAC Tx_start, MAC Tx_end, MAC Rx_start, MAC Rx_end. These signals are transmitted by Base Stations and Repeaters. These procedures will repeat after T_cogn seconds; the values of these parameters are specified in chap. 10.5. No regular data transmission should take place 20 ms from the start of AT1 (the maximum 802.16 MAC frame duration).
During the MAC frame starting at the absolute time AT2, cognitive signals will indicate the beginning and the end of Master sub-frames, by transmitting signals indicating by their transmission start the Tx_start, Tx_end, Rx_start, Rx_end for the specific sub-frame; these signals are transmitted by Base Stations, Repeaters and those SSs which experiences interference, at intervals equal with N_{cog} MAC Frames; no regular data transmission should take place 20 ms from the start of AT2 (the maximum 802.16 MAC frame duration).
~~During the MAC frame starting at the absolute time AT2, will be indicated the position of the time-slots, in each Master sub-frame, to be used during the MAC Frame starting at the absolute time AT3for registration using cognitive signaling. The start of the "Rx_slot" signal will indicate the start of the time-slot.~~
The MAC frame starting at the absolute time ~~AT4~~ AT3 is the beginning of a registration interval using the cognitive signaling; the registration interval has the duration of Tcr_reg seconds; The ad-hoc transmitters shall use during the MAC frame starting at the absolute time ~~AT4~~AT3, the marked master sub-frames~~slot~~ for sending their radio signature. The radio signature will be used for the evaluation of the potential interference during the Master slot, to systems which use the sub-frame as

Master systems. ~~The next transmission opportunities for sending the radio signatures use time-slots having the duration as indicated previously and repeating every Tcr_rep sec during the Tcr_reg interval.~~

- The radio signature will consist of a preamble and a MAC header, sent on the working channel and using the same power and sub-carrier allocation, as used in the regular data transmission mode;
- The sub-frame starting at Tx_start is slotted, each slot having the duration of 100µs. The tramsmission of a radio signature will start at a slot boundary, as perceived by ad-hoc systems. No ranging assumptions were taken in the assessment of the slot duration.
- An ad-hoc radio unit (BS, Repeater or SS) will send this signal using a random access mode for Tcr_reg seconds, using the sub-frame intended for their regular transmission (BSs and SSs use different sub-frames for transmission).
- The ad-hoc transmitters will have to use the registration procedures every Tad_reg seconds.
- No regular data transmission should take place 20 ms from the start of AT3 (the maximum 802.16 MAC frame duration).

Registration replay

- The radio units using the Master sub-frame will send a NACK signal, during the MAC Frame starting at the absolute time AT4, and using the same sub-frame as used by the un-acceptable transmitter, ~~to be sent in a random mode during the next Tcr_reg_ack seconds,~~ if they appreciate that the ad-hoc transmitter will cause interference. Typically, to a registration signal sent during a DL sub-frame, the NAK will be sent by one or more SSs, while to a registration signal sent during UL sub-frame, the NACK signal will be sent by a Base Station. ~~The radio units using the Master sub-frame will send their response in random mode.~~
- The NACK signal indicates that the requesting ad-hoc device cannot use the specific sub-frame, while using the requesting radio signature
- Same device may try again, if using a different radio signature (for example, lower power).
- Lack of response~~, for Tcr_reg_ack seconds,~~ indicates that the registration is accepted for transmission during the specific sub-frame.
- no regular data transmission should take place 20 ms from the start of AT4 (the maximum 802.16 MAC frame duration).

Change section 10.5.1

Absolute time reference	Chapter	Reference	Value
AT1	Cognitive radio signaling (insert reference)	Start of the first MAC Frame (no. N) including cognitive radio signaling	~~0010:000~~ 0003:000, 15:000, 27:000, 39:000, 51:000
AT2	Cognitive radio signaling (insert reference)	Start of the 2nd MAC Frame including cognitive radio signaling	~~0010:020~~ AT1+0001:000
AT3	Cognitive radio signaling (insert reference)	Start of the 3d MAC Frame including cognitive radio signaling	~~0010:040~~ AT1+0002:000
AT4	Cognitive radio signaling (insert reference)	Start of the 4th MAC Frame including cognitive radio signaling	~~0010:060~~ AT1+0004

In table 345b, delete the lines dedicated for Tcr_reg, Tcr_rep, Tcr_reg_ack and modify the value of T_cogn to 12s.

Signaling from/to non-802.16 systems

1. Candidate Channel Selection, presented as useful for the detection of the co-channel interference, can be used in a much larger scale for interference determination. A slot is reserved for NON-802.16 systems, which may, in the future, to signal their presence in a controlled mode to 802.16 systems.

2. Signaling to ad-hoc systems, by using a simple, well-known PHY transmission, with increased power on the used sub-carriers, this mode has a better level of penetration. These transmissions may be detected in the future by non-802.16 systems, and used by them for choosing an optimal operation channel.

For NON-802.16 systems, these mechanisms are complementary: the first will allow to NON-802.16 systems to signal their presence to 802.16 systems, while the second will permit to NON-802.16 systems to:

- Detect the potential interference to be caused by 802.16 systems in both frequency and time domain
- Select the operating channels and time intervals, such that will avoid to interfere with 802.16 systems.

Will be useful the insertion of a new Chapter in the Working Document, highlighting the use of these two mechanisms for better co-existence with NON-802.16 systems.

Text for the Working Document

Add new paragraph 15.5.1.6 (if contribution C802.16h-06/28 will be accepted, should be a new chapter 15.10)

Coexistence with NON-802.16 systems

In continuation we provide a review of the main mechanisms that can be used for providing better spectrum sharing with NON-802.16 systems, other than those considered as “preferred spectrum users”.

The Candidate Channel Selection, presented as useful for the detection of the co-channel interference, can be used in a much larger scale for interference determination. A slot is reserved for NON-802.16 systems, which may, in the future, to signal their presence in a controlled mode to 802.16 systems.

The Signaling to Ad-hoc Systems, by using a simple, well-known PHY transmission, with increased power on the used sub-carriers, provide a better level of penetration. These transmissions may be

detected in the future by NON-802.16 systems, and used by them for choosing an optimal operation channel and to further isolate the interference in time domain.

For non-802.16 systems, these mechanisms are complementary: the first will allow to non-802.16 systems to signal their presence to 802.16 systems, while the second will permit to non-802.16 systems to:

- Detect the potential interference to be caused by 802.16 systems in both frequency and time domain
- Select the operating channels and time intervals, such that will avoid to interfere with 802.16 systems.

References

[1] IEEE 802.16h-06/010: IEEE P802.16h Working Document