Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Response to IEEE C80216h-07/063**
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Re:	IEEE C802.16h-07/063, itself in response to IEEE 802.16h-07/013 Task Group Review of P802.16h/D2b
Abstract	Response to IEEE C802.16h-07/063
Purpose	Provide clarifying response to the concerns raised by IEEE C802.16h-07/063
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Response to IEEE C80216h-07/063
Ken Stanwood
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Overview

IEEE C802.16h-07/063 [2] provides very good instruction on determining various parameters that can impact the effectiveness of a listen-before-talk (LBT) algorithm. It asks for clarification in [1] of when such a protocol can or should be used. Unfortunately, [2] uses unrealistic parameters in its argument requesting clarification. In fact, the arguments poised in [2] highlight a general rule when developing standards such as 802.16 which are targeted at different bands of operation, some whose rules are yet to be developed by the appropriate regulatory body. That general rule is that the standard provides solutions for known problems and while those solutions may be extensible for use for problems that were not intended (e.g., 802.11b/g used outdoors at 2.4 GHz for municipal Wi-Fi service) it is up to the implementers to determine which features are useable for their particular application. The standard is not responsible for spelling out every possible intended or unintended use of a feature and rating how well that feature performs for the use. The authors of [2] showed that the LBT protocol in 802.16h may not perform well for 50 km cells. In doing so, they determined that it may not be appropriate for solving a problem which it was not intended to solve.

The LBT protocol in [1] was introduced into 802.16h by NextWave [5] as part of a solution specifically designed for the contention based protocol (CBP) required for the US 3.65-3.70 GHz band by the FCC in [3] and later "clarified" by the FCC as the "unrestricted" CBP in [4]. There is no other band in which 802.16 is envisioned to be used that has a similar requirement, although Industry Canada has proposed something similar in [6]. On page 167, line 5 of [1] shows UCP (which includes LBT) to be a likely requirement for meeting regulatory requirements in the 3.65 GHz band in the US. Neither UCP nor LBT are suggested as being necessary for any other band addressed.

Cell Size

The authors of [2] use an example cell size of 50 km.

In [3], the FCC limited the total transmit power at the base station to 25 Watts/25 MHz EIRP, with a PSD limit of 1W/MHz. To illustrate what this means, consider that in the licensed BRS band in the United States a BS typically transmits at 70-100 Watts/MHz EIRP. So the power of a BS in the 3.65 GHz band in the US is 18-20 dB less than a typical licensed WiMAX base station. The power limit, combined with propagation characteristics at 3.65 GHz would limit the cell size considerably compared to the 50 km example. For the sake of this response, let us assume a more realistic cell size of 2.5 km. Using the same equations as in [2], this gives a propagation delay of 8.33 microseconds.

Even using very generous assumptions such as a pathloss exponent of 2.75 and a maximum path loss of 143 dB, our calculations show and effective cell size of 4 km giving 13.5 microsecond propagation delay to a SS on the cell edge of the other BS, and 8 km, giving 26.7 microsecond propagation delay, BS to BS (with associated additional path loss over the second 4 km).

Packet Transmission Time

When considering packet transmission time, one must determine the meaning of the word "packet" in the context of a LBT protocol. It is the PHY perspective we must take, therefore, a "packet" is the total contiguous burst, regardless of its make up of IP packets or fragments thereof. It must be observed that an 802.16 system transmits multiple SDUs or SDU fragments as a single burst, unlike 802.11.

At page 36, line 55 of [1] we see the statement "This allows the DL and UL subframes to be logically viewed as a single 'packet' of constant duration equal to the frame duration." This gives us a logical packet duration of 5 milliseconds = 5000 microseconds. Even if the DL and UL subframes are taken separately, given the 60/40 TDD split mandated by [1] we have "packets" with approximate durations of 3 milliseconds = 3000 microseconds and 2 milliseconds = 2000 microseconds, respectively. Granted, OFDM may not be configurable for quite as long a UL duration per individual UL burst as OFDMA due to less flexible UL subchannelization.

Packet Propagation Delay vs. Packet Transmission Time

So, using the formulas in [2] we want to minimize a/b where a = packet propagation delay and b = packet transmission time we see that with a 2.5 km cell size a/b = 8.33/5000 = 0.001666 for a properly designed system. In fact, just looking at the UL we have 8.33/2000 = 0.004165. This appears to meet the criteria given in [2] that a/b should be much smaller than 1.

In fact if we consider the 50 km case of [2], but apply our knowledge of the characteristics of a logical "packet" we get a/b = 166.6/5000 = 0.03332 viewing the entire frame as a packet or a/b = 166.6/2000 = 0.0833. These ratios also appear to meet the criteria given in [2].

Conclusions

1) It is not the responsibility of the standard to specify all circumstances, both intended and unintended, under which a feature is expected to be useful.
2) The LBT meets the requirements of [2] for the purpose for which it was introduced into 802.16h – operation within the constraints of [3]. The FCC rules do not allow operation such that the 50 km case is necessary.
3) The LBT appears to meet the requirements of [2] even for the hypothetical, unintended 50 km case. We can only hope, therefore, that Industry Canada allows higher transmit powers in rural areas when it finalizes its own rules for the 3.65 GHz band.

Specific editorial changes

This section provides a list of changes to IEEE P802.16h/D2b document [1].

Blue underlined text represents specific editorial additions.

Red strikethrough text is to be deleted.

Black text is text already in the draft.

Bold italic text is editorial instructions to the editor.

No edits necessary.

References

[1] IEEE P802.16h/D2b: *Air Interface for Fixed Broadband Wireless Access Systems Improved Coexistence Mechanisms for License-Exempt Operation*, Working Group Draft.

[2] IEEE C802.16h-07/063: *Comments on Listen-Before-Talk for Wide Area Networks*, Nat Natarajan and David Grandblaise, Motorola, 9 July 2007.

[3] FCC 05-56, *Report and Order and Memorandum Opinion and Order in the matter of Wireless Operations in the 3650-3700 MHz Band*, 16 March 2005.

[4] FCC 07-99, *Memorandum Opinion and Order in the matter of Wireless Operations in the 3650-3700 MHz Band*, 7 June 2007.

[5] IEEE C802.16h-06/074; *Uncoordinated Coexistence Protocol (UCP)*; Paul Piggin, Lei Wang, and Ken Stanwood; NextWave; 17 September 2006.

[6] Industry Canada, DGTP-006-06, *Proposed Spectrum Utilization Policy, Technical Licensing Requirements for Wireless Broadband Services (WBS) in the Band 3650-3700 MHz*, August 2006