Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Further Considerations on IEEE 802.16m Frame Structure**
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Re:	Call for Contributions on Project 802.16m System Description Document (SDD) – pertaining to comment on entire content of IEEE 802.16m-08/003r1.
Abstract	Provide rationale for and description of a absolute-time-interval based frame structure.
Purpose	Discuss and accept the proposed changes to the SDD text on 16m frame structure into the 16m SDD baseline document.
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Further Considerations on IEEE 802.16m Frame Structure

1. Introduction

The current frame structure design that is captured in the 16m SDD Draft IEEE 802.16m-08/003r1 is specifically catered to the 16m OFDMA parameter set that reuses the parameter set defined for the WirelessMAN-OFDMA reference system for operation with 5, 10 and 20 MHz carrier bandwidths and for a Cyclic Prefix length of 1/8. As such it cannot be considered a complete solution since the frame structure parameter values for other carrier bandwidths that are based on other OFDMA parameter sets are yet undefined.

2. Problem Statement

The current frame structure design that is captured in the 16m SDD Draft IEEE 802.16m-08/003r1 is lacking in a couple of areas:

1) It is incomplete since the frame structure parameters are derived only for the case when 16m uses the same OFDMA parameter set that applies for the WirelessMAN-OFDMA reference system operating with 5, 10 or 20 MHz carrier bandwidths

   It can be readily seen that the number of subframes per frame or the number of symbols pre subframe or both need to be different when 16m operation uses one of the other reference system OFDMA parameter sets. Taking the parameter set for 7 MHz bandwidth as an example, we obtain from Table 1 in the current SDD draft text that the number of symbols in a 5-ms frame is 34, which doesn't map well to the 6-symbol regular subframe and 5-symbol irregular subframe types that are available as currently defined.

   Therefore, retaining the different OFDMA parameter sets for the various carrier bandwidths may result in different frame structure and resource structure designs depending both on subcarrier spacing and on Cyclic Prefix length.

2) It does not co-exist well with other competing technologies, most notably LTE.

   LTE has defined a frame structure that is based on a 0.5-ms basic time unit structure called a slot. A fixed time-length approach to defining the basic time unit structure greatly facilitates inter-technology co-existence since it allows synchronization of subframe structure boundaries between systems of different technologies irrespective of their internal structures, such as symbol periods, between these fixed-time-length boundaries. However, since the current frame structure is based on subframes comprising integer numbers of symbols, the lengths of the subframes end up now being dependent on subcarrier spacing (which defines the useful symbol length) and cyclic prefix. Moreover, the regular subframe length of 0.617 ms when a subframe is comprised of 6 symbols, is highly incompatible with the 0.5-ms slot durations in LTE.

Based on the above considerations, a new frame structure element is introduced that defines a time length during which the transmission occur in one direction (i.e. DL or UL). This new frame structure element provides the needed time synchronization base for co-existence with other technologies.

Moreover, the number of frame structure variants can be reduced significantly by adopting a common subcarrier spacing

for all carrier bandiwidths. This topic of common subcarrier spacing is not covered here but in another contribution

3. Frame Structure Based on Time-Based Subframes

The 802.16m frame structure is augmented with a new element which we will call the extended subframe. This extended subframe is comprised of one or more subframes that possess the same directionality. In TDD mode, switching points occur at extended subframe boundaries although not every extended subframe boundary need be a switching point (i.e. two or more extended subframes of the same directionality may occur together). The length of an extended subframe is a fixed absolute time period. The suggested time lengths are 0.5 ms, 1 ms, 1.5 ms, 2 ms, and 2.5 ms for LTE compatibility and 0.675 ms for TD-SCDMA compatibility.

Each extended subframe contains as many whole symbols as can fit and some idle time. The length of the idle time is typically the remaining time left after fitting as many whole symbols into the extended subframe as possible unless the remaining time is too short in which case, a whole symbol's time may be removed from the useful symbols and added to the idle time in the extended subframe. The idle time is used for directionality switching in TDD and H-FDD modes of operation.

4. Proposed Text Change

To modify the proposed SDD text in IEEE 802.16m-08/003r1 as follows:

[Note to editor: Modify Section 11.4.1 from lines 8 to 21 on page 17 as follows:]

The IEEE 802.16m basic frame structure is illustrated in Figure 8. Each 20 ms super-frame is divided into four equally-sized 5 ms radio frames. Furthermore, each radio frame may be comprised of one or more extended sub-frames, where an extended sub-frame contains a sequence of one or more sub-frames possessing the same directionality (i.e. DL or UL). Each extended sub-frame may be of a time length of 0.5 ms, 0.675 ms, 1 ms, 1.5 ms, 2 ms, or 2.5 ms. Typically, the length of extended sub-frames are chosen based on inter-technology co-existence and delay performance considerations. ~~When using the same OFDMA parameters as the reference system with the channel size of 5 MHz, 10 MHz, or 20 MHz, each 5 ms radio frame further consists of eight sub-frames.~~ Each extended sub-frame can be assigned for either downlink or uplink transmission depending on the duplexing scheme. There are two types of sub-frames: 1) the regular sub-frames which consist of six OFDMA symbols and 2) the irregular sub-frames that consist of five or less OFDMA symbols. Each extended sub-frame contains as many regular sub-frames as can be wholly contained and an irregular sub-frame and idle time fill in the remainder of the extended sub-frame.

The basic frame structure is applied to FDD and TDD duplexing schemes, including H-FDD MS operation. The number of switching points in each radio frame in TDD systems is between two to four, where a switching point is defined as a change of directionality, i.e., from DL to UL or from UL to DL.

[Note to editor: Figures 8, 9 and 10 to be updated with extended sub-frame level between frame and sub-frame levels]

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5. Reference

[1] IEEE802.16m-07/002r4, IEEE802.16m system requirements
[2] IEEE Std 802.16e-2005 and IEEE Std 802.16-2004/Cor1-2005 (Amendment and Corrigendum to IEEE Std 802.16-2004)
[3] WiMAX Forum Mobile System Profile Release 1.0 Approved Specification
[4] IEEE 802.16m-08/003r1, 'The Draft IEEE 802.16m System Description Document', 2008-04-30.
[5] IEEE C802.16m-08/236r4, 'Further Considerations on IEEE 802.16m OFDMA numerology', 2005-05-05.