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Title	**An Evolved Frame Structure for IEEE 802.16m**
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Re:	IEEE 802.16m-07/040 - Call for Contributions on Project 802.16m System Description Document
Abstract	The IEEE standard 802.16m is intended to be an evolution of IEEE WirelessMAN-OFDMA targeting requirements for lower latency and backward compatibility as per [1]. Within this framework, we propose an Evolved Frame Structure for 802.16m.
Purpose	To create a Physical Layer Chapter with a Frame Structure section in the System Description Document (SDD). To include the proposed evolved frame structure in frame structure section of the physical layer chapter of SDD.
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Evolved Frame Structure for IEEE 802.16m

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1. Introduction

This contribution discusses the basic frame structure aspect of the IEEE WirelessMAN-OFDMA and proposes a new frame structure for the IEEE 802.16m physical layer. The IEEE 802.16m standard is intended to be an evolution of IEEE WirelessMAN-OFDMA with the requirements on lower latency and backward compatibility. The new proposal for an evolved frame structure for IEEE 802.16m reduces the round-trip latency and CQI latency additionally it satisfies the backward compatibility requirement as specified in [1].
We propose that a section on a frame structure be added into the system description document. We additionally propose to include the new evolved frame structure and the subsequent text, in the frame structure section of the System Description document.

2. WirelessMAN-OFDMA Frame Structure

The frame structure used in IEEE WirelessMAN-OFDMA is shown in Figure 1.

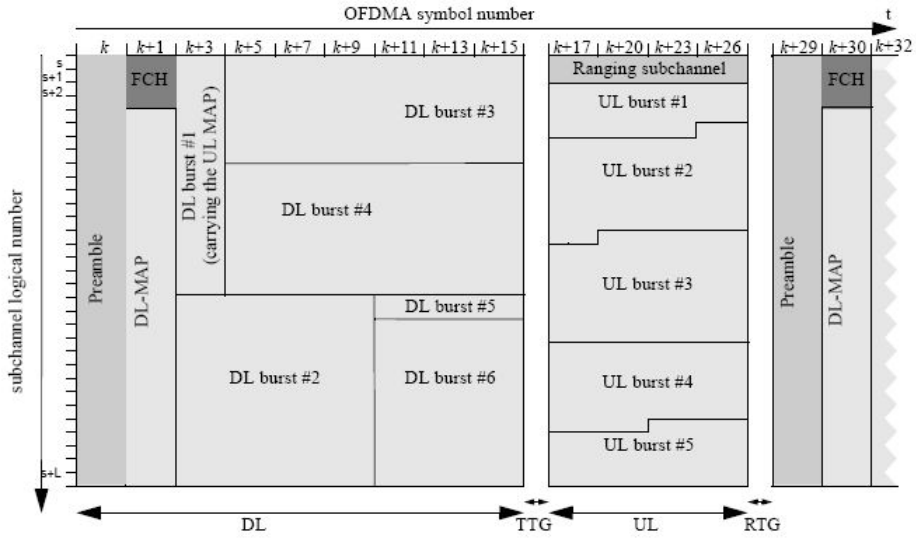

Figure 1: Frame structure used in IEEE WirelessMAN-OFDMA. The frame length is 5ms.

The IEEE802.16m systems requirement document [1] requires higher performance for higher mobility classes. WirelessMAN-OFDMA [2] uses a 5ms frame length, thus limiting the CQI reporting to 5ms and hence degrading the mobility performance.

In WirelessMAN-OFDMA, the BS can send a data block in Frame 1, and the MS can send a NACK in Frame 2, allowing for processing delay at the MS. With processing and scheduling delay at the BS, a retransmission can be sent in Frame 4.

IEEE 802.16m [1] requires that data latency for DL between MS and BS, be <10ms. In the case of retransmission this requirement implies that the retransmission has to be sent in the very next frame after a transmission. This is only possible if the NACK is sent by the MS in the same 5ms frame, and the BS reacts immediately to the NACK to send the retransmission. This introduces significant processing burden on the BS and the MS.

3. Proposed Evolved Frame Structure

The proposal for an evolved frame structure for IEEE 802.16m reduces the latency requirements and satisfies the backward compatibility requirement as specified in [1]. The evolved frame structure is shown in figure 2.

The 5ms frame is divided into two 2.5 ms sub-frames for the purposes of illustration. Each sub-frame has a downlink portion and an uplink portion. Sub-frame1 constitutes of DL Burst 1 and UL Burst 1 and sub-frame 2 consists of DL Burst 2 and UL Burst 2. These four consecutive bursts: DL Burst 1, UL Burst 1, DL Burst 2, and UL Burst 2 are separated by TTG1, RTG1, TTG2 and RTG2 gaps as shown in figure 2.
In figure 2, the preamble is not present in the DL part of sub-frame 2 additionally the ranging sub-channel is not present in the uplink part of sub-frame 1. These functionalities are present in DL Burst 1 and UL Burst 2, however they need not be repeated in DL Burst 2 and UL Burst 1, but can be optionally included. The offset of UL Burst 1 from the beginning of sub-frame 1 may be different from the offset of UL Burst 2 from the beginning of sub-frame 2.

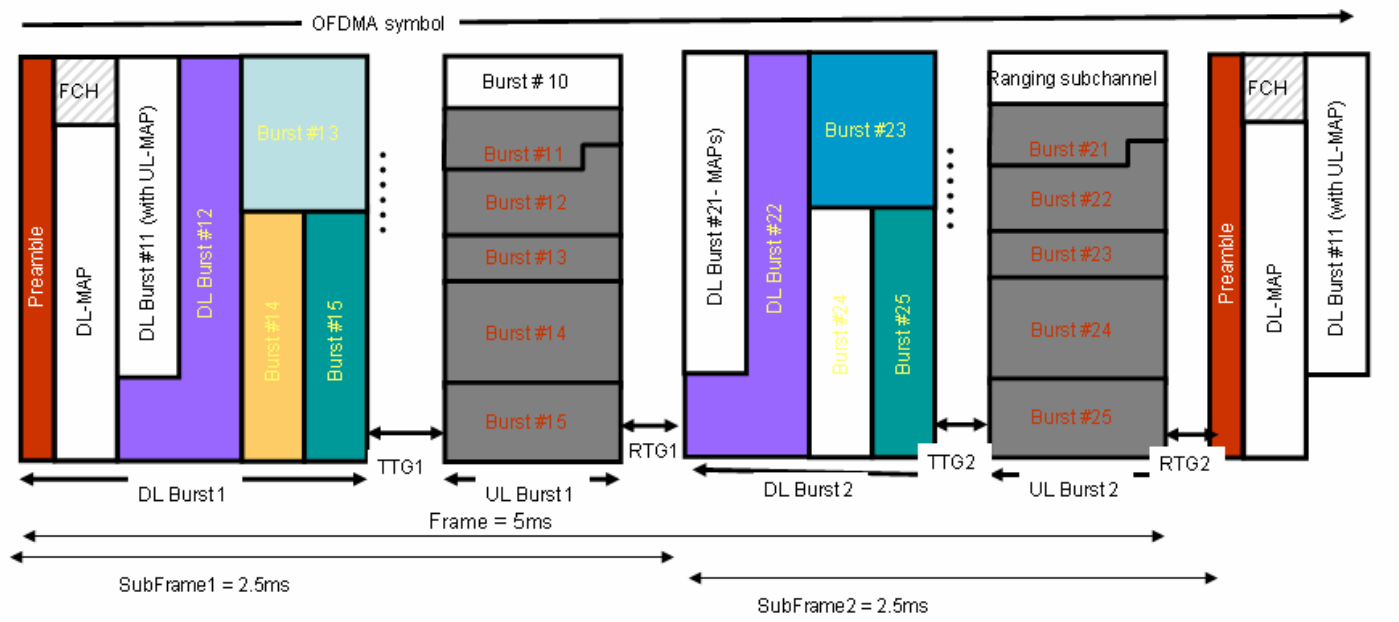

Figure 2: Proposed Frame Structure Showing the Two Sub-frames for IEEE 802.16m

New users can be allocated either to DL/UL Burst 1 and or DL/UL Burst 2. The relevant signaling of information elements is achieved using DCD, UCD and UL/DL MAP messages. New IE's are needed so that the new mobile stations can fully exploit the new frame structure and the features available with it.

The modified new DL/UL MAP message is sent in DL-Burst 1 for allocating the resources to new users in UL/DL Burst 1, UL/DL Burst 2. Additionally such a message may be sent in the DL-Burst 2 for allocating the resources to new users in UL/DL Burst 2.

The UL-MAP sent in subframe1 could use the existing "Allocation Start time" IE to signal the start of UL Burst 2. Similarly an additional new IE is required to signal the start of UL Burst 1 for new users.

The gaps namely TTG1, RTG1 and TTG2, RTG2 are signaled respectively in the new and existing IE's of the existing DCD message.

3.1 Latency Requirement

IEEE 802.16m [1] requires that data latency for DL and UL between MS and BS be <10ms. With the evolved frame structure, new mobile stations can receive the DL transmission in DL Burst 1, send an ACK/NACK in UL Burst 2, and receive a retransmission in DL Burst 2 of the next frame. Thus, the new frame structure allows for lower round trip latency due to ACK/NACK response in the same frame.

The IEEE802.16m [1] requires higher performance for higher mobility classes. With the proposed evolved frame structure, a new mobile station has the possibility to report CQI in every sub-frame i.e. every 2.5ms. Thus the new frame structure allows for higher mobility performance of a high speed mobile station as required by [1].

3.2 Backward compatibility Requirement

Figure 3, shows how the proposed new evolved frame structure appears to legacy mobile stations.

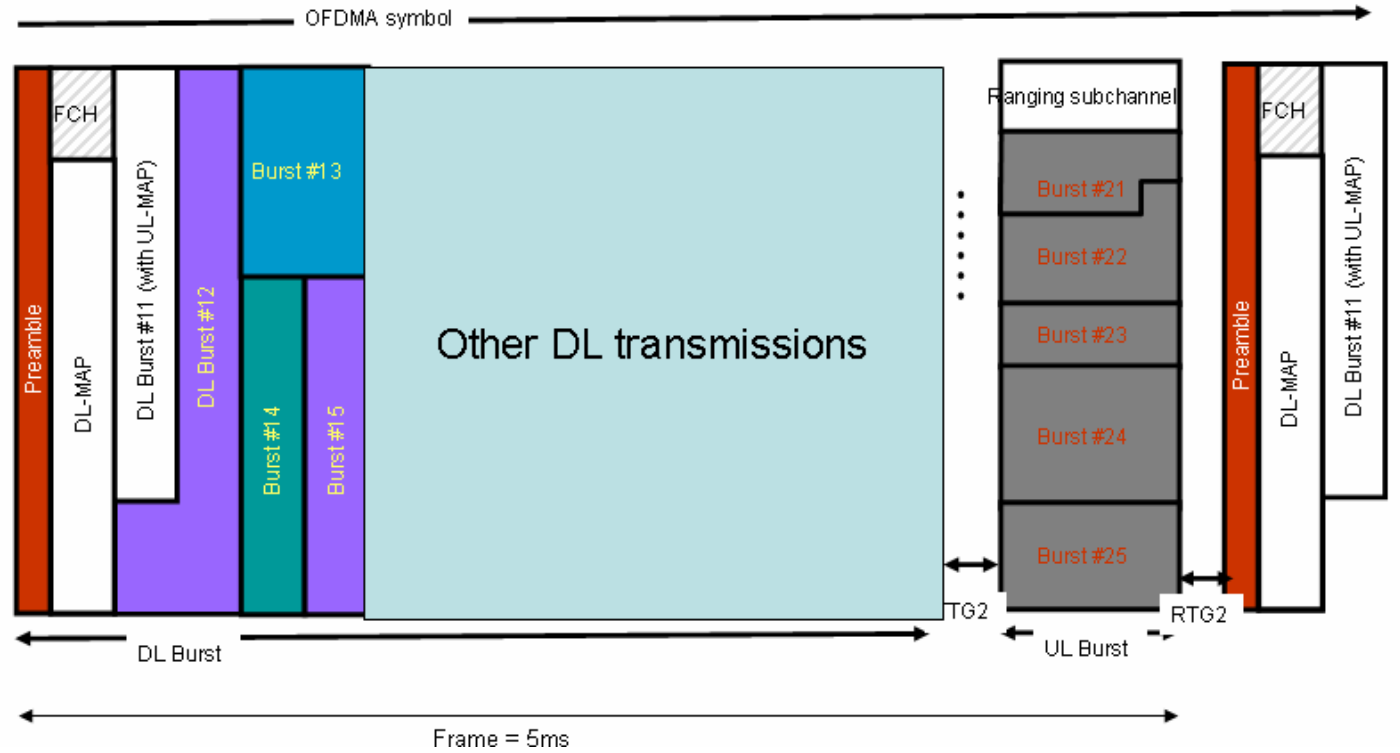

Figure 3 Proposed frame as seen by a Legacy MS

Backward compatibility requirement [1] is met as follows:

1. The relevant signaling is proposed to be carried out in the relevant UL/DL MAP and UCD/DCD messages such that the modification is totally transparent to legacy MS.

2. The part of the frame, shown in figure 2, between DL Burst 1 and UL Burst 2 will not be assigned to any legacy mobile stations and will appear as other downlink transmissions. Typically, this may be seen as DL transmission using a zone that is not supported by the MS. The DL-MAP message is sent in DL Burst 1 and is used to allocate DL resources to legacy mobile station in DL Burst 1.

3. IEEE WirelessMAN-OFDMA defines the start of the UL part of the frame using the "Allocation Start Time" IE in the UL-MAP message. This existing IE "Allocation Start Time" is used to signal the beginning of UL Burst 2 to the legacy mobile stations. The mobile station will be able to act on the IE, treating UL Burst 2 as the UL part of the 5ms frame.

4. The TTG and RTG in IEEE WirelessMAN-OFDMA are signaled in the DCD message. The same TTG, RTG values can be used as TTG2 and RTG2 values for the legacy mobiles. The operation is transparent to the legacy mobile.

3.3 RTG TTG Gaps

The IEEE 802.16m new proposed frame structure includes the following TTG/RTG gaps: TTG1, TTG2, RTG1 and RTG2.
The RTG and TTG gap values in the current WiMax Mobile System profile [2] are significantly higher values than required by most deployment environment. Thus the total gap duration in the proposed IEEE 802.16m frame structure could easily fit within the overall WirelessMAN-OFDMA budget for gap duration.

3.4 Proposal

We propose that a Physical Layer Chapter with a Frame Structure section be created in the System Description Document (SDD) be created.

Additionally we propose that the frame structure section of the physical layer of SDD includes the evolved frame structure and the subsequent text in chapter 3, 3.1 and 3.2 of this paper.

References

[1] IEEE 802.16m System Requirements IEEE 802.16m-07/002r4

[2] WiMax Mobile System profile, Release 1.0

[3] IEEE Std WirelessMAN-OFDMA-2005 and IEEE Std 802.16-2004/Cor1-2005 (Amendment and Corrigendum to IEEE Std 802.16-2004), "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 License Bands," Feb 28, 2006