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Re:	IEEE 802.16m Call for contributions (IEEE 802.16m-08/033); PHY & MAC aspects of enhanced MBS		
Abstract	MBS as defined in 802.16Rev2 has several deficiencies. P802.16m provides an opportunity to improve on these deficiencies. This contribution lists areas of improvement and proposed solutions		
Purpose	Discuss and adopt		
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# Multicast/Broadcast Services in 16m

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## 1 Introduction

We believe that 802.16 is a technology suitable for Multicast/Broadcast Services (MBS), but that the solution that is currently specified in 802.16Rev2 can and must be improved. P802.16m provides an opportunity for enhancing the service. In this contribution we are identifying areas of improvement together with possible remedies.

## 2 Use cases

### 2.1 Unlimited Access

This use case is characterized by the user not having to register every time it is receiving MBS service. Charging for this service is simple; there is no charge per minute or number of bytes received and rendered to the user. The content may be encrypted and the user may have to pay to obtain the decryption keys. Typical content includes TV or radio programs such as news, sports, entertainment, and public information.

### 2.2 Other uses cases

*[TBD. Other participants are invited to extend this section.]*

## 3 Problems with MBS in 802.16e

*[Below is a non-comprehensive list of problems. It is yet to be completed with problems identified by other participants, e.g., the length of the CP, MIMO, lack of feedback ...]*

### 3.1 MAP Inefficiency

Current 802.16e requires that every MBS region in a frame be described by a MBS MAP message. While this provides great flexibility it provides unnecessary overhead. It is often possible to predict for a short time interval (in the order of one second) the necessary allocations that are needed for MBS. By allowing one MBS-MAP message pertain to multiple MBS regions, and thus be sent less frequently, overhead may be reduced. MAP efficiency can be improved by allocating MBS contents to dedicated (reserved) sub-channels or carriers.

### 3.2 Service Interruptions

In 802.16e, MBS-MAP messages are transmitted in an MBS region of the frame, and thus benefit from macro

diversity. Each MBS-MAP message points to the next MBS-MAP message. If one MBS-MAP message is lost, the MS must resort to messages that are broadcast from a single BS (such as DCD and DL-MAP), i.e., messages that do not benefit from macro-diversity, to recover the service.

### **3.3 Poorly Encoded Data**

MBS is very sensitive to errors. Video is known to be sensitive to errors. Using the typical 802.16e encoding schemes the IP packet rate is  $10^{-2}$ , which is insufficient. In order to provide adequate QoS, IP packet error rates of  $10^{-5}$  or less are desirable.

### **3.4 MS Power Inefficiency**

Currently in 802.16e, the MS must demodulate and decode an entire MBS region, which possibly carries data from multiple streams, and search for the PDUs that carry the stream that the application requires, before it can retrieve the data.

### **3.5 High Data Overhead**

In 802.16e, data from multiple data MBS connections are sent as separate MAC PDUs encapsulated in an MBS DATA IE. Each PDU has a 6-byte Generalized MAC Header and a 4-byte CRC. The MBS DATA IE overhead is 8-9 bytes plus 1.5 bytes per MBS connection. Finally there is padding to fill the data burst. We believe that this overhead can be reduced significantly.

### **3.6 Unnecessary UL signaling**

In 802.16e, the MS must register for MBS. This currently requires DSx message transactions. These transactions serve two purposes: 1) they allow the MS to retrieve information about the assignment of the MBS service flows of interest to multicast connections at the current BSs, and 2) they allow the network to account for MSs that are presently receiving MBS content.

Depending on the use case (see section 2), the need for uplink signaling may vary, which should be reflected in a flexible service initiation process. For instance, for the use case described in Section 2.1, there may be no need for the MS to signal to the network every time it is receiving MBS content. The 802.16e standard does not support such flexibility.

## **4 E-MBS Wish List**

### **4.1 MBS Scheduling Interval (MSI) and Low Duty Cycle (LDC) MBS-MAP**

Most MBS applications are tolerant of fixed delay. In addition, in certain use cases, MBS services do not require adaptive MCS. These characteristics allow for planning the resource utilization ahead of time. We can take advantage of this by introducing the concept of an MSI during which the MBS resource needs are stable and predictable. The MSI may be described by a single LDC MBS MAP message. Since the frequency of the LDC MBS-MAP is reduced relatively to the 802.16e MBS-MAP message, the probability of service

interruption is reduced.

## **4.2 Better Forward Error Correction**

Better FEC can be achieved by a scheme that obtains significantly higher time diversity than what can be achieved in the PHY layer alone.

## **4.3 Minimizing Reception and Decoding Time**

Energy may be reduced by scheduling that maximizes the proportion of time that the MS can turn off its receiver. It may also be reduced by scheduling that reduces the need to decode unwanted information.

## **4.4 Flexible Service Initiation**

*[TBD Other participants are invited to extend this section.]*

## **4.5 Efficient Application Layer PDU to PHY PDU Mapping**

By describing in the LDC MBS MAP message how data corresponding to the desired service is mapped to PHY PDUs, much of the MAC PDU overhead may be removed.

## **4.6 Dedicated Sub-channel/Carrier Support for MBS**

Dedicated resources such as carriers, sub-channels may be used for MBS content delivery. A specific content may be mapped to a dedicated carrier or dedicated sub-channels. Using dedicated resource allocation allows the MS to access the content easily and reduces control signaling overhead. Carriers or sub-channels shall be allocated dynamically to accommodate the amount of traffic and indicated to MS with minimum signaling overhead and delay.

## **4.7 Summary**

<b>Problem</b>	<b>Requirement</b>
MAP Inefficiency	MSI and LDC MBS-MAP
Service Interruptions	MSI and LDC MBS-MAP
Poorly Encoded Data	Better Forward Error Correction
MS Power Inefficiency	Minimizing Reception and Decoding Time
Unnecessary UL signaling	Flexible Service Initiation
Data overhead	Efficient Application Layer PDU to PHY PDU Mapping

## Proposed Text for the System Description Document (SDD)

### 9 Convergence Sub-Layer

#### 9.x E-MBS CS Layer Support

##### 9.x.1 Header Compression

Header compression, e.g., ROHC, is performed on the IP packets at the Convergence sub-layer.

##### 9.x.2 Forward Error Correction

The Convergence Sub-Layer provides forward error correction (FEC), which complements the FEC provider by the PHY layer. The FEC provided by the convergence sub-layer takes advantage of extended time diversity and deeper interleaving in order to achieve adequate IP packet error rates.

### 10 Medium Access Control Sub-Layer

#### 10.x E-MBS MAC Support

*<Note: The MAC Layer may be physically split with certain functions deployed at the ASN-GW. There is no need to modify the scope of the MAC for MBS. >*

##### 10.x.1 Scheduling Support

For each MBS Zone there is an MBS Scheduling Interval (MSI), which refers to a number of successive frames for which the access network may schedule traffic for the streams associated with the MBZ Zone prior to the start of the interval. The length of this interval depends on the particular use case of MBS. An MBS MAP message addresses the mapping of MBS data associated with an MBS Zone for an entire MSI.

The MBS MAP message is structured such that it may be used to efficiently define multiple transmission instances for a given stream within an MSI.

##### 10.x.2 Mapping of E-MBS Data onto the DL Sub-Frame

E-MBS traffic may be transmitted without adaptive modulation and encoding. For a given stream, modulation and encoding schemes are assumed not to change during an MSI. This reduces the need for MAC PDU overhead for the purpose of MAC PDU delineation within the MBS frames. The delineation is derived from the MBS MAP message.

##### 10.x.3 E-MBS Mobility Management

### 11 Physical Layer

#### 11.x E-MBS PHY Support

*<Enter here particular PHY considerations applicable modulation and coding schemes, MIMO, location of*

*MBS regions in the frame, feedback mechanisms, etc.>*

#### **11.6.2.4 Multicast Service Control Channels**

11.6.2.4.1 Multicast service control information/content

11.6.2.4.2 Multiplexing scheme of data and multicast service control and (e.g. TDM, FDM, Hybrid TDM/FDM)

11.6.2.4.3 Location of control blocks within a frame/Subframe

11.6.2.4.4 Transmission format (e.g. modulation, coding, multiple antenna schemes)

11.6.2.4.5 Resource allocation (physical to logical mapping, pilots, block size)

#### **11.x.1.6 E-MBS feedback**

The performance of MBS can be further enhanced by link adaptation using E-MBS feedback information. The feedback information of 1 bit NACK signal is sent back from the MSs that are not satisfied with the QoS. E-MBS feedback channel is based on contention using orthogonal codes.

## **12 Security**

### **12.x E-MBS Security**

## **15 Support for Enhanced Multicast Broadcast Service**

### **15.1 General Concepts**

#### **15.1.1 E-MBS Transmission Mode**

15.1.1.1 Single-BS transmission

15.1.1.2 Multi-BS transmission (MBSFN)

An MBS Zone is a set of BSs transmitting synchronously the same set of MBS streams in a connected geographic area. A BS may belong to multiple MBS Zones. An MBZ zone is associated with a set of MBS streams. An MBS region is a contiguous set of symbols in a frame that contains data associated with one MBS Zone.

#### **15.1.2 E-MBS Transmission Carrier/Sub-channels**

##### **15.1.2.1 E-MBS dedicated carrier/sub-channels**

Dedicated resources such as carriers, sub-channels may be used for MBS content delivery. A specific content may be mapped to a dedicated carrier or dedicated sub-channels. Using dedicated resource allocation allows the MS to access the content easily and reduces control signaling overhead. Carriers or sub-channels shall be allocated dynamically to accommodate the amount of traffic and indicated to MS with minimum signaling overhead and delay.

##### **15.1.2.2 E-MBS/Unicast mixed carrier**

### 15.1.3 E-MBS Service Initiation and Acquisition

Service Initiation refers to the process of obtaining information related to when and where MBS content is broadcast. This information includes the Electronic Service Guide for the geographic area where the user is interested in receiving MBS service. It may also include MBS Zone IDs and Stream IDs corresponding to the streams that the user is interested in.

The user may access this information in different ways, e.g., while attached to the network via another access technology, and it is not in the scope of 802.16 to specify how a user obtains this information.

Service Acquisition refers to the continuous process of obtaining additional information that the MS needs in order to receive MBS content. This information is more closely tied to the encoding and transmission of the MBS streams and includes information about how streams are mapped to the frames that the BSs are transmitting. In particular, it includes the location of the MBS regions in the frames and the mapping and encoding of the data belonging to each stream within these regions. Unlike Service Initiation, Service Acquisition falls under the scope of 802.16.

Dedicated carriers or sub-channels may be allocated for MBS contents and this information is delivered to the MS during Service Initiation and Acquisition.

*<TBD: Backward compatibility with 802.16e is assumed achieved by using different zones mapped to disjoint regions in the frames.>*

*[Other key concepts to be added by other participants]*