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Title	**MBS (Multicast and Broadcast Service) enhanced for macro-diversity reception**
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Re:	Recirc #14c for review of IEEE P802.16e/D4-2004
Abstract	Addition of a multimedia broadcast service enhanced for reception on OFDMA PHY regions which support macro-diversity reception
Purpose	Adoption and inclusion in 802.16e specification
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MBS (Multicast and Broadcast Service) with Macrodiversity

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1 Background

The Multicast and Broadcast Service is a mechanism for distribution of data content across multiple base-stations from a centralized media server in a manner, which takes advantage of OFDMA PHY to support macro-diversity.

The current 802.16e specification supports multicast and broadcast connections, but some changes are required in order to guarantee the following key issues,

- BS must perform synchronized transmissions of the multimedia traffic to achieve the macro-diversity effect at the MSS
  - This requires all BS in the same multimedia broadcast (MBS) to transmit a synchronized PDU stream. Some means for synchronizing SDU distribution, conversion to PDUs, and any process that changes the PDU transmission over the air must be the same for all the BS in the same MBS zone
  - The 802.16e reference model and standard must be accordingly updated to support a centralized data transmitter that performs data scheduling for simultaneous, identical, transmissions over multiple Base Stations
- A BS does not know which MSS are currently listening to the MBS zone it transmits
  - Service-flow for the transmission might not have been created in the normal manner at the BS
  - CID for the service and associated service flows for MBS should be known to all BS (or even well-known)
- MBS should be available to MSS in idle-mode and sleep-mode in a manner consistent with the power saving objective of these modes
  - An efficient security mechanism for multicast/broadcast traffic is required
  - An efficient method of tracking MBS content is required

2 Summary of Solution

2.1 Reference Model

We add an *MBS Distribution Server* entity to the reference model. An MBS Distribution Server is a generic entity responsible for scheduling of data across multiple Base Stations and distributing the MBS stream. An MBS SAP resides above the security sublayer – as classification and scheduling services are not performed for the MBS-controlled flows.

2.2 MBS Service Operation

Each BS participating in the MBS zone "outsources" the scheduling and PDU building functions for the MBS zone data interval to the MBS distribution server. The MBS Server supplies the transmittable data and timing information to each BS to transmit directly over the PHY.

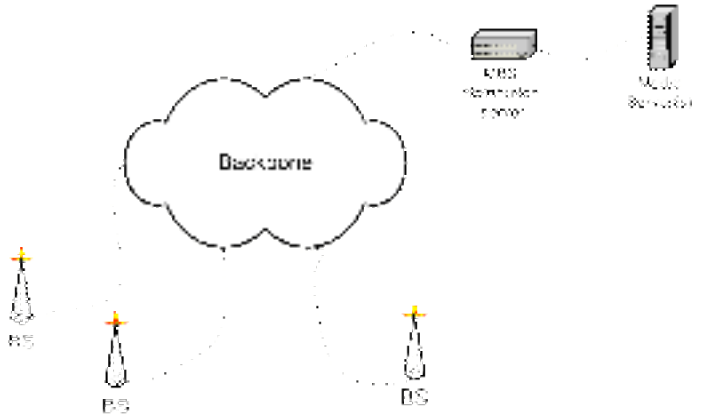

Figure 1: Example of MBS service scenario

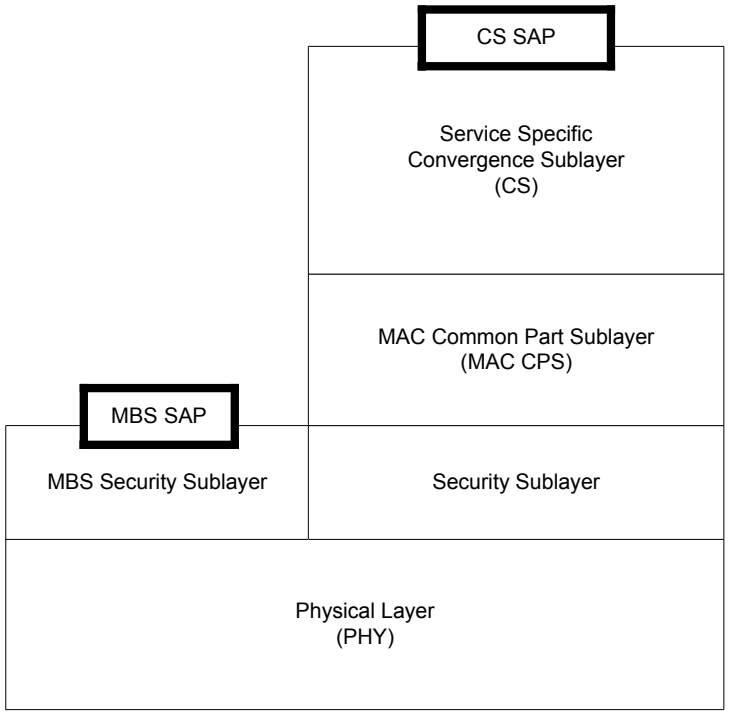

Figure 2: MBS operation reference model

2.3 MBS Service Setup

The manner in which MSS acquire information about the MBS distribution server and any media servers it may service and their associated service flows is outside the scope of 802.16e specification. The manner in which MBS connections are created is the following:

1. When registered with any BS participating in the MBS zone, and after acquiring the information about MBS associated service flows, the MSS sends DSA-REQ message with the specific MBS service flow(s) required the BS.
2. The BS and MSS complete the DSA-RSP/DSA-ACK handshake (including authentication) in the same way it is done for any other, non-MBS connection. Since the MSS is registered with the BS, all security issues, CID provision, etc., are handled in a manner similar to any other, non-MBS connection. The difference (which is transparent to the MSS) is that these connection parameters are not unique, but are used by any other BS participating in the MBS zone.
3. The MSS is provided with an identifier for the MBS zone (as part of the connection parameters in DSA-RSP)

2.4 Service maintenance

Service maintenance consists mostly of ensuring continued security for the MBS connections. This is done by the MBRA (Multicast & Broadcast Rekeying Algorithm) currently defined in the specification.

2.5 PHY Support

In the physical layer there are several key issues essential to efficient MBS operation that takes full advantage of the macro-diversity effect and enables seamless operation in sleep and idle modes.

2.5.1 MBS MAP_IE

The MBS MAP IE is placed in the DL-MAP and points to the location of the MBS zone in the DL sub-frame. The IE also provides information about MBS zone identifier. The purpose of this IE is to do the initial direction of the MSS to the MBS zone, and to redirect MSS that lost synchronization with MBS zone back to the MBS zone.

2.5.2 MBS_MAP

MBS_MAP is a message transmitted inside the MBS zone, and thus enjoys the macro-diversity benefit. The MBS_MAP functions somewhat like the DL-MAP in the sense that it provides the location of specific PDUs in the physical OFDMA symbols and sub-channels allocated to the MBS zone. In addition to this functionality, the MBS_MAP provides per each connection a the location of the next frame where it will be found.

2.5.3 Behavior in Idle and sleep modes

MSS in idle or sleep mode are only required to wake up at frames indicated as carrying the MBS connection they are interested in. Any MBS zone will point to the next MBS zone, so the MSS does not need to decode the DL-MAP message unless it losses synchronization with the MBS zone, and has to re-acquire via the MBS MAP_IE.

3 Specific text changes

On page 52, line 52 add the following:

6.3.2.3.57 MBS MAP

The BS may send an MBS-MAP message on an MBS zone to describe the MBS connections serviced by the MBS zone. When a MBS-MAP is sent, the connections need be described in the DL-MAP, but a MBS-MAP_IE() shall be substituted instead.

Table xxx—MBS- MAP

Syntax	Size	Notes

MBS-MAP_Message_Format() {		
Management Message Type = ?	8 bits	
for (*i* = 0; *i* < *n*; *i*++) {		
DIUC	4 bits	
OFDMA Symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	000: normal (not boosted); 001: +6dB; 010: -6dB; 011: +9dB; 100: +3dB; 101: -3dB; 110: -9dB; 111: -12dB;
No. OFDMA Symbols	7 bits	
No. Subchannels	6 bits	
Repetition Coding Indication	2 bits	0b00 - No repetition coding 0b01 - Repetition coding of 2 used 0b10 - Repetition coding of 4 used 0b11 - Repetition coding of 6 used
}		
if !(byte boundary) {		
Padding Nibble	4 bits	Padding to reach byte boundary.
}		
}		

On page 56, line 53 add the following:

[Modify section 6.3.13 as follows:]

6.3.13 Establishment of multicast connections

The BS may establish a downlink multicast service by creating a connection with each SS to be associated with the service. Any available traffic CID value may be used for the service, yet a range of well-known CIDs is reserved for use in multicast services that are synchronized across multiple BS ~~(i.e. there are no dedicated CIDs for multicast transport connections)~~. To ensure proper multicast operation, the CID used for the service is the same for all SSs on the same channel that participate in the connection. The SSs need not be aware that the connection is a multicast connection. The data transmitted on the connection with the given CID shall be received and processed by the MAC of each involved SS. Thus each multicast SDU is transmitted only once per BS channel. Since a multicast connection is associated with a service flow, it is associated with the QoS and traffic parameters for that service flow. ARQ is not applicable to multicast connections.

If a downlink multicast connection is to be encrypted, each SS participating in the connection shall have an additional security association (SA), allowing that connection to be encrypted using keys that are independent of those used for other encrypted transmissions between the SSs and the BS.

6.3.13.1 Multicast and broadcast service synchronized across multiple BS (MBS)

6.3.13.1.1 MBS connection establishment and maintenance

Multicast service synchronized across multiple BS enables an MSS to receive the multicast or broadcast transmission from multiple BS, and thereby improve the reliability of reception. In contrast to normal multicast and broadcast connections, MBS does not require that the MSS be registered to the BS from which it receives the transmission, or to any other BS. To provide seamless multicast and broadcast service over multiple BS, a MBS connection shall use the same CID, and transport the same data in a synchronized manner across the group of BS. A multicast and broadcast zone identifier (MBS_ZONE) is used to indicate the group of BS through which a CID and SA for a broadcast and multicast service flow are valid.

MBS connections are established like normal multicast connections (i.e. when the MSS is registered to a specific BS), but unlike normal multicast connection, they may be maintained by the MSS during IDLE and Sleep mode, or when transitioning to another

BS. The MSS at may terminate MBS connections anytime, without need to notify the BS. MBS connections may be protected against theft of service by enforcing high-speed data encryption based on AES-CCM defined in NIST Special Publication 800-38A, FIPS 197. When encryption is used, a MBS connection shall use the same security association across the group of BS. Details of MBS Security is defined in section 7.x.x.x PKMv2 MBS Security Support.

6.3.13.1.2 Macro-diversity support for MBS

To increase the receiving performance, MBS transmission in a group of BS may be synchronized. In such case, each BS shall transmit the same PDUs, using the same transmission mechanism (symbol, subchannel, modulation, and etc.) at the same time. The way that multiple BSs accomplish the synchronized transmission (which implies performing functions like classification, fragmentation, scheduling at a centralized point called the MBS Server) is outside the scope of the standard.

6.3.13.1.3 MBS power efficient reception

Power efficient reception of MBS connections is particularly important to MSS in Sleep and IDLE mode. To facilitate that, an MBS MAP IE may be placed in the DL-MAP to points to the location of a dedicated MBS zone in the DL sub-frame. The purpose of this IE is to do the initial direction of the MSS to the MBS zone, and to redirect MSS that lost synchronization with MBS zone back to the MBS zone. Inside the MBS zone a MBS_MAP message is transmitted and functions like a DL-MAP in the sense that it provides the physical attributes for the connection allocated to the MBS zone. In addition to this functionality, the MBS_MAP provides per each connection the location of the next frame where data will be sent on it.

MSS in idle or sleep mode may only wake up at frames indicated as carrying the MBS connection(s) they are interested in. Since connections on the MBS zone point to future relevant MBS zones, there is no need for an MSS in IDLE or Sleep mode to decode the DL-MAP message unless it losses synchronization with the MBS zone, and has to re-acquire via the MBS MAP_IE.

On page 25, line 65 add the following:

[Add the text at the end of section 6.3.2.3.11 as follows:]

Whether successful or unsuccessful, the message shall include the following:

HMAC Tuple (see 11.1.2)
The HMAC Tuple attribute contains a keyed message digest (to authenticate the sender). The HMAC Tuple attribute shall be the final attribute in the DSx message's attribute list.

When the connection requested in the DSA-REQ is a MBS connection, the BS may include in the DSA-RSP the following parameter:

MBS Zone identifier
The MBS Zone identifier is used by the MSS to identify the DL-MAP element which points to the MBS zone where the connection will be mapped

On page 131, line 62 add the following:

[Add the text below:]

8.4.5.3.19 Multicast and Broadcast Service MAP IE (MBS_MAP_IE)

In the DL-MAP, a BS may transmit DIUC=15 with the MBS_MAP_IE() to indicate when the next data for a multicast and broadcast service flow will be transmitted. The offset value is associated with a MBS zone identifier, and indicates the presence and location of an MBS zone on the current frame.

Table 256—Multicast and Broadcast Service MAP IE

Syntax	Size	Notes
MBS_MAP_IE {		

Extended DIUC	4 bits	MBS_MAP = 0x0d
Length	4 bits	Length = 0x02
MBS zone identifier	7 bits	MBS Zone identifier corresponds to the identifier provided by the BS at connection initiation
OFDMA Symbol offset	8 bits	The offset of the OFDMA symbol in which the MBS zone starts, measured in OFDMA symbols from the beginning of the downlink frame in which the DL-MAP is transmitted.
Macro diversity enhanced	1 bits	0 = Non Macro-Diversity enhanced zone 1 = Macro-Diversity enhanced zone
If (Macro diversity enhanced == 1){		
Permutation	2 bits	0b00 = PUSC permutation 0b01 = FUSC permutation 0b10 = Optional FUSC permutation 0b11 = Adjcent subcarrier permutation
IDcell	6 bits	
}		
else {		
Reserved	8 bits	
}		
}		

On page 175, line 57 add the following:

[Insert a row in Table 343 in section 10.4]

Table 343—CIDs

CID	Value	Description
Transport CIDs and secondary Mgt CIDs	*2m*+1—~~0xFEFE~~ 0xFE9F	For the secondary management connection, the same value is assigned to both the DL and UL connection.
MBS connection CIDs	0xFEA0 —0xFEFE	For the downlink synchronized multicast service. The same CID value is uniquely used in within a single MBS zone
AAS initial ranging CID	0xFEFF	A BS supporting AAS shall use this CID when allocating a Initial Ranging period for AAS devices

On page 202, line 15 add the following:

11.13.27 MBS zone identifier assignment

The DSA-RSP message may contain the value of this parameter to specify a MBS Zone identifier. This parameter indicates a MBS zone in which the connection for the associated service flow is valid and unique.

Type	Length	Value	Scope
[145/146].29	8	MBS zone identifier	DSA-RSP