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Re:	This is harmonized contribution of C802.16e-04/442r2, C802.16e-04/449, C802.16e-04/450 and C802.16e-04/461. Response to Sponsor Ballot about TGe Rev1 is revision of C802.16e-04/444 to fit template.
Abstract	For clarification of current description and messages about MBS
Purpose	Discuss and Adopt this proposal
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MBS Clarification

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Proposed Solution

1. For Clarificatioin, we reorganize section and define Single-MB-MBS and Multi-BS-MBS
2. For MBS supporting Macro diversity, i.e. Multi-BS-MBS, we shall synchronize also MBS_MAP message in MBS region with other BS at same MBS zone. Therefore, we propose using MBS_MAP message only for Multi-BS-MBS ~~supporting macro diversity. Therefore, for MBS supporting Macro diversity, we need only one MBS_MAP_IE pointing MBS region.~~

~~1.For MBS not supporting macro diversity, imbedded bandwidth allocation in DL_MAP for MBS suffice since MSS should synchronize with BS.~~

3. Since MBS service only for H-ARQ enabled MSS, it is named as “MBS with time diversity”, is available, we also applied macro diversity to MBS with time diversity only for H-ARQ enabled MSS. And it is separately applied to each MBS service for general MSS and H-ARQ enabled MSS.
4. MBS for general MSS covers all MSS including H-ARQ enabled MSS but doesn’t use H-ARQ and MBS with time diversity for H-ARQ enabled MSS is informed with H-ARQ MAP message only applied to H-ARQ enabled MSS.
5. To indicate MBS with time diversity only to H-ARQ enabled MSS, we use H-ARQ Compact MBS_MAP_IE in H-ARQ MAP message.
6. In MBS-MAP message, it is used to indicate data allocation of Multi-BS-MBS data ~~using macro diversity~~, we use different IE for allocation of MBS data for general MBS and MBS with time diversity.
7. Currently, MBS zone is used as several meaning. It is fixed here as following :

   MBS portion : it indicates a portion in frame for an allocation for Multi-BS-MBS data.

   MBS zone : it indicates a set of BS through which a CID and SA for a multicast and broadcast service flow is valid for Multi-BS-MBS.

Proposed Text Change

[Remedy 1 : Modify 6.3.13~~.1.3~~ as following:]

6.3.13 ~~Establishment of multicast connections~~Multicast and Broadcast Services(MBS)

Two types of multicast and broadcast services (MBS) may be supported: single-BS-MBS and multi-BS-MBS. The single-BS-MBS is defined as multicast and ~~multimedia~~ broadcast services within one BS, while the multi-BS-MBS is defined as multicast and ~~multimedia~~ broadcast services synchronized across multiple BS.
Both single-BS-MBS and multi-BS-MBS are optional.
ARQ is not applicable to either single-BS-MBS or multi-BS-MBS.

6.3.13.1 Single-BS-MBS

The BS may establish a downlink multicast service for MBS by creating a connection with each SS to be associated with the service. Any available traffic CID value may be used for the service (i.e. there are no dedicated CIDs for multicast transport connections). ~~For networks of BS employing synchronized transmissions of common multicast data, some traffic CID values may be assigned for the service (.i.e. there may be some 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. ~~To ensure proper multicast~~

~~operation on networks of BS employing synchronized transmissions of common multicast data, the CID used for the service may be the same for all BS and 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.
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. For single-BS-MBS data, DL_MAP_IE or MBS_MAP_IE may be used. The difference of usage of DL_MAP_IE and MBS_MAP_IE for single-BS-MBS data is whether MBS zone identifier is assigned. If there is an logical controller(it may be named as MBS server) to handle MBS service regardless of single-BS-MBS or multi-BS-MBS, by the decision of the controller, BS may assign MBS zone identifier.

6.3.13.2 Multi-BS-MBS

~~**6.3.13.1 Seamless Multicast and broadcast service across multiple BS(MBS)**~~
~~Multicast and broadcast service~~Multi-BS-MBS is defined as a kind of service that all MSSs successfully registered to the specific Multi-BS-MBS connection, simultaneously each MSS need to register to MBS service at the network level, ~~specific multicast and broadcast content on the network level~~ can receive on the cell the encrypted MAC PDUs of the multicast and broadcast content that multiple BSs transmit anywhere under the given time period. It requires the multiple BS participating in same Multi-BS-MBS service ~~-~~to be synchronized in the transmissions of common multicast/broadcast data. To ensure proper multicast operation on networks of BS employing synchronized transmissions of common multicast data, the CID used for a multi-BS-MBS connection shall be the same for all BS and SSs on the same channel that participate in the connection.
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 Single-BS-MBS~~normal multicast and broadcast~~ connections, Multi-BS-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 Multi-BS-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.
Multi-BS-MBS connections are established like Single-BS-MBS~~normal multicast~~ connections (i.e. when the MSS is registered to a specific BS), but unlike Single-BS-MBS~~normal multicast~~ connection, they may be maintained by the MSS during IDLE and Sleep mode, or when transitioning to another BS.
Multicast and broadcast service may provide access control against theft of service by enforcing data encryption based on AES-CTR defined in NIST Special Publication 800-38A, FIPS 197. Detail of MBS Security is defined in section 7.8.1~~x.x.x~~ PKMv2 MBS Security Support.

6.3.13.~~1~~.2.1 Establishment and Maintenance of multicast and broadcast services

Since the MSS in the Idle Mode can receive the multicast and broadcast service on the cell, the connection establishment of multicast and broadcast service between the BS and the MSS should be maintained regardless of the MSS's current mode. That is the connection for the MBS that is not dedicated to the specific MSS and is maintained even though the MSS is either in awake/Sleep Mode or in the Idle Mode. If the MSS receiving MBS enters into the Idle Mode, the MSS continuously maintains the information of MBS connection such as the session context and the security context for the specific MBS and receives the current MBS without any interruption.
Multicast and Broadcast services are associated with Multicast and Broadcast Service Flows. Multicast and Broadcast Service Flows are not dedicated to the specific MSS and are maintained even though the MSS is either in awake/sleep mode or in the idle mode. When an MSS is registered at a BS for receiving Multicast and

Broadcast service, Multicast and Broadcast Service Flows shall be instantiated as multicast connections.
Data of Multicast and Broadcast Service Flows may be transmitted from BS and received at MSS also regardless of what mode the MSS is currently in. The BS may establish a downlink multicast and broadcast service by creating a Multicast and Broadcast Service Flows when the service commences.
Mapping of Multicast and Broadcast Service Flow IDs to CIDs may be known to all BSs belong to the same Multicast and Broadcast Service Zone.
When the MSS is being registered at BS for receiving Multicast and Broadcast services, it may initiate DSA procedure with respect to Multicast and Broadcast connections to inform the BS that the MSS is a consumer of certain Multicast / Broadcast services. Such knowledge may be used to initiate bi-directional upper layers communication between the MSS and the network for the purpose of configuration of Multicast / Broadcast service. After the successful configuration, the MSS may reuse the same configuration when it moves to another BS without re-configuration.
~~ARQ is not applicable to multicast and broadcast connection associated with Multicast and Broadcast Service Flows..~~
Multicast and Broadcast Service Flows are encrypted at either application layer or MAC layer. Upper layer encryption may be employed to prevent non-authorized access to multicast and broadcast content.

6.3.13.2~~1~~.2 Performance enhancement with macro diversity
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. In order to indicate the allocation of Multi-BS-MBS data of a MBS_ZONE, some OFDM symbols of a frame are used and it is said “MBS portion”.
Multi-BS-MBS data, assigned on some OFDM symbols indicated by MBS_ZONE, should start from the first subchannel of the OFDM symbol.

6.3.13.2~~1~~.3 Power saving operation
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 ~~(see 8.4.5.3.9)~~. 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. Furthermore, this IE is used not only to direct MSS to the MBS portion for Multi-BS-MBS data but also may be used to allocate Single-BS-MBS data together. If MBS_MAP_IE in the DL-MAP indicates the MBS portion, the MBS portion uses two dimensional allocation using OFDMA symbol and subchannel. And if H-ARQ Compact MBS_MAP_IE in H-ARQ MAP message indicates the MBS portion, the MBS portion uses one dimensional allocation. 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.

6.3.13.2~~1~~.4 **Multicast and broadcast zone (MBS_Zone)**
A multicast and broadcast service flow may be transmitted in only a certain region. Also, a different CID or a different SA(Security Association) may be used in a different region for the same multicast and broadcast service flow. A multicast and broadcast zone identifier (MBS_ZONE) is used to indicate a region through which a CID and SA for a broadcast and multicast service flow are valid. If a MSS moves into BSs in the same MBS zone, the MSS does not have to re-establish a connection or a virtual connection to monitor the multicast and broadcast service flow. However, if a MSS moves into a different MBS zone, the MSS may need to re-establish a connection or a virtual connection for the multicast and broadcast service flow. MBS zone may be associated with a CID for a multicast and broadcast service. Therefore, one BS may have multiple MBS zone

identifiers. ~~(see 8.4.5.3.10)~~

[Remedy 2 : Modify Table 283b as following at page 167 line 4, section 8.4.5.3.11]

Table 283b—Multicast and Broadcast Service MAP IE

Syntax	Size	Notes
MBS_MAP_IE{		
Extended DIUC	4 bits	MBS_MAP = 0x05
Length	4 bits	
Multicast CID	12 bits	12 LSB of CID for multicast
MBS Zone identifier	7 bits	MBS Zone identifier corresponds to the identifier provided by the BS at connection initiation
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 = Adjacent subcarrier permutation
Idcell	6 bits	
OFDMA Symbol Offset	8 bits	OFDMA symbol offset with respect to start of the MBS portion
Boosting	3 bits	It is used to indicate whether boosting is used or not for MBS_MAP message. 000: normal(not boosted); 001:+6dB; 010: -6dB; 011: +9dB; 100:+3dB; 101 : -3dB; 110 : -9dB; 111: -12dB;
DIUC	4 bits	DIUC for MBS_MAP message in MBS portion
NO. Subchannels	6 bits	It is to indicate the size of MBS_MAP message in MBS portion
NO. OFDMA symbols	2 bits	It is to indicate the size of MBS_MAP message in MBS portion
} else{		
DIUC	4 bits	
OFDMA Symbol Offset	8 bits	The offset of the OFDMA symbol in which the burst starts, measured in OFDMA symbols from beginning of the downlink frame in which the DL-MAP is transmitted.
Subchannel offset	6 bits	The lowest index OFDMA subchannel used for carrying the burst, starting from subchannel 0.
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
Next MBS frame offset	8 bits	The Next MBS frame offset value is lower 8 bits of the frame number in which the BS shall transmit the next MBS frame.
Next MBS OFDMA Symbol offset	8 bits	The offset of the OFDMA symbol in which the next MBS portion starts, measured in OFDMA symbols from the beginning of the downlink frame in which the MBS-MAP is transmitted.
}		
if !(byte boundary){		
Padding Nibble	variable	Padding to reach byte boundary
}		
}-		

~~Syntax~~	~~Size~~	~~Notes~~
~~MBS_MAP_IE{~~		
~~Extended DIUC~~	~~4 bits~~	
~~Length~~	~~4 bits~~	
~~Multicast CID~~	~~12 bits~~	~~12 LSB of CID for multicast~~
~~MBS Zone Identifier~~	~~7 bits~~	
~~OFDMA Symbol Offset~~	~~8 bits~~	
~~Macro diversity enhanced~~	~~1 bits~~	
~~If(macro diversity enhanced = 1){~~		
~~Permutation~~	~~2 bits~~	
~~Idcell~~	~~6 bits~~	
~~}~~		
~~Else{~~		
~~Reserved~~	~~8 bits~~	

~~}~~		
~~}~~		

[Remedy 3 : Replace H-ARQ Compact MBS_MAP_IE at page 55 as following and move it from 6.3.2.3.43.8 to 6.3.2.3.43.6.9 at the end of section 6.3.2.3.43.6.8, page 44]

~~6.3.2.3.43.8~~6.3.2.3.43.6.9 **H-ARQ Compact MBS MAP IE**

Table 14c—H-ARQ Compact MBS-MAP IE format for extension

Syntax	Size	Notes
Compact MBS_MAP_IE{		
DL_MAP Type = ??		
Multicast CID	12 bits	12 LSB of CID for multicast
MBS Zone Identifier	7 bits	
Macro diversity enhanced	1 bits	
If(macro diversity enhanced = 1){		
Permutation	2 bits	
Idcell	6 bits	
OFDMA Symbol Offset	8 bits	OFDMA symbol offset with respect to start of the MBS portion
N_EP code	4 bits	The combination of NEP code and NSCH code indicates the number of allocated subchannels and scheme of coding and modulation for the MBS_MAP message in MBS portion
N_SCH code	4 bits	
} else {		
N_EP code	4 bits	The combination of NEP code and NSCH code indicates the number of allocated subchannels and scheme of coding and modulation for the DL burst
N_SCH code	4 bits	
AI_SN	1 bits	
SPID	2 bits	
ACID	4 bits	
Next MBS frame offset	8 bits	The Next MBS frame offset value is lower 8 bits of the frame number in which the BS shall transmit the next MBS frame.
Next MBS OFDMA Symbol offset	8 bits	The offset of the OFDMA symbol in which the next MBS portion starts, measured in OFDMA symbols from the beginning of the downlink frame

		in which the MBS-MAP is transmitted.
}		
if !(byte boundary){		
Padding Nibble	Variable	Padding to reach byte boundary
}		
}		

AI_SN
Defines ARQ Identifier Sequence Number. This is toggled between '0' and '1' on successfully transmitting each encoder packet with the same ARQ channel.
SPID
Defines SubPacket ID, which is used to identify the four subpackets generated from an encoder packet.
ACID
Defines ARQ Channel ID for TimeDiversity MBS packet. Each TimeDiversity MBS connection can have multiple ARQ channels, each of which may have an encoder packet transaction pending.

The MBS burst indicated by the H-ARQ Comapct MBS_MAP_IE is encoded at the same way of HARQ. But it does not need the acknowledgement from MSS.

[Remedy 4 : Replace MBS_MAP message at page89, section6.3.2.3.56 as following:]

6.3.2.3.56 MBS MAP

The BS may send an MBS-MAP message on an MBS portion~~zone~~ to describe the MBS connections serviced by the MBS portion~~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 107—MBS-MAP

Syntax	Size	Notes
MBS-MAP Message Format(){		
Management Message Type = ?	4 bits	
Frame number	4 bits	The frame number is identical to the frame number in the DL-MAP
MBS_DIUC_Change_Count	8 bits	
#MBS_DATA_IE	4 bits	Number of included MBS_DATA_IE
For (i = 0; i<n; i++){	12 bits	N = #MBS_DATA_IE
MBS_DATA_IE	Variable	
}	8 bits	
#MBS_DATA_Time_Diversity_IE	4 bits	Number of included MBS_DATA_Time_Diversity_IE
For(i = 0; i<m; i++){		M = #MBS_DATA_Time diversity_IE
MBS_DATA_Time_Diversity_IE	Variable	
}		
TLV encoding element		
If(!byte boundary){		
Padding_Nibble		
}	8 bits	
}-		

MBS_DIUC_Change_Count

It is used to notify the Burst Profile used for Multi-BS-MBS data has been changed. If MBS_DIUC_Change_Count change, MSS should wait until receiving DCD message unless Downlink Burst Profile TLV is included in MBS_MAP message.

The following TLV may be included in MBS_MAP message.

Downlink Burst Profile

Downlink Burst Profile is used for the definition of MBS DIUC

Table 107a MBS_MAP_Type

MBS_MAP_Type	Description
0	MBS_DATA_IE
1	MBS_DATA_Time_Diversity_IE
2~255	Reserved

Table 107b MBS_DATA_IE

Syntax	Size	Notes
MBS_DATA_IE{		
MBS_MAP Type = 0	4 bits	
Multicast CID	12 bits	12 LSB of CID for multicast
MBS_DIUC	4 bits	
OFDMA Symbol Offset	8 bits	OFDMA symbol offset with respect to start of the MBS portion
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
Next MBS frame offset	8 bits	The Next MBS frame offset value is lower 8bits of the frame number in which the BS shall transmit the next MBS frame.
Next MBS OFDMA Symbol offset	8 bits	The offset of the OFDMA symbol in which the next MBS portion starts, measured in OFDMA symbols from the beginning of the downlink frame in which the MBS-MAP is transmitted.
}-		

Table 107c MBS_DATA_Time_Diversity_IE

Syntax	Size	Notes
MBS_DATA_Time_Diversity_IE{		
MBS_MAP Type = 1	4 bits	

Multicast CID	12 bits	12 LSB of CID for multicast
N_EP code	4 bits	
N_SCH code	4 bits	
AI_SN	1 bits	
SPID	2 bits	
ACID	4 bits	
Next MBS frame offset	8 bits	
Next MBS OFDMA Symbol offset	8 bits	
}		

NEP code, NSCH code
The combination of NEP code and NSCH code indicates the number of allocated subchannels and scheme of coding and modulation for the DL burst
AI_SN
Defines ARQ Identifier Sequence Number. This is toggled between '0' and '1' on successfully transmitting each encoder packet with the same ARQ channel.
SPID
Defines SubPacket ID, which is used to identify the four subpackets generated from an encoder packet.
ACID
Defines ARQ Channel ID for TimeDiversity MBS packet. Each TimeDiversity MBS connection can have multiple ARQ channels, each of which may have an encoder packet transaction pending.

MBS_DATA_Time_Diversity_IE presents when MBS only for H-ARQ enabled MSS is provided.
The MBS burst indicated by the MBS_DATA_Time_Diversity_IE is encoded at the same way of HARQ.
But it does not need the acknowledgement from MSS.

[Remedy 5 : Modify Table 381 at section 11.13 Service Flow management encoding and add section 11.13.20 as following:]

Table 381-- Service Flow Encodings

Type	***Parameter***
…	***…***
3	***Service Class Name***
4	***~~reserved~~MBS service***
5	***QoS Parameter Set Type***
…	***…***

11.13.20 MBS service

This TLV indicates whether or not the MBS service is being requested for the connection that is being setup. A value of 0 indicates Single-BS-MBS is requested and a value of 1 indicates Multi-BS-MBS is requested. If MSS or BS want to initiate MBS service, DSA-REQ with MBS service shall be used. The DSA-RSP message shall contain the acceptance or rejection of request and if there is no available MBS, MBS service value may be

set to 0. ARQ shall not be enabled for this connectio.

Type	Length	Value	Scope
[145/146].4	1	0 : No available MBS 1 : Single-BS-MBS 2 : Multi-BS-MBS	DSx-REQ DSx-RSP DSx-ACK