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Re:	IEEE P802.16e/D3-2004
Abstract	Enhanced broadcast/multicast capabilities of 802.16e.
Purpose	Review and Adopt the suggested changes into P802.16e/D3
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Enhanced Broadcast Capabilities

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1. Introduction

(1) Definition for Multicast and broadcast service on the cell

Multicast and broadcast service is defined as all MSS successfully registered to the specific multimedia broadcast content on the network level can receive on the cell the encrypted MAC PDUs of the multimedia broadcast content that multiple BSs transmit on the DL anywhere under the given time period.

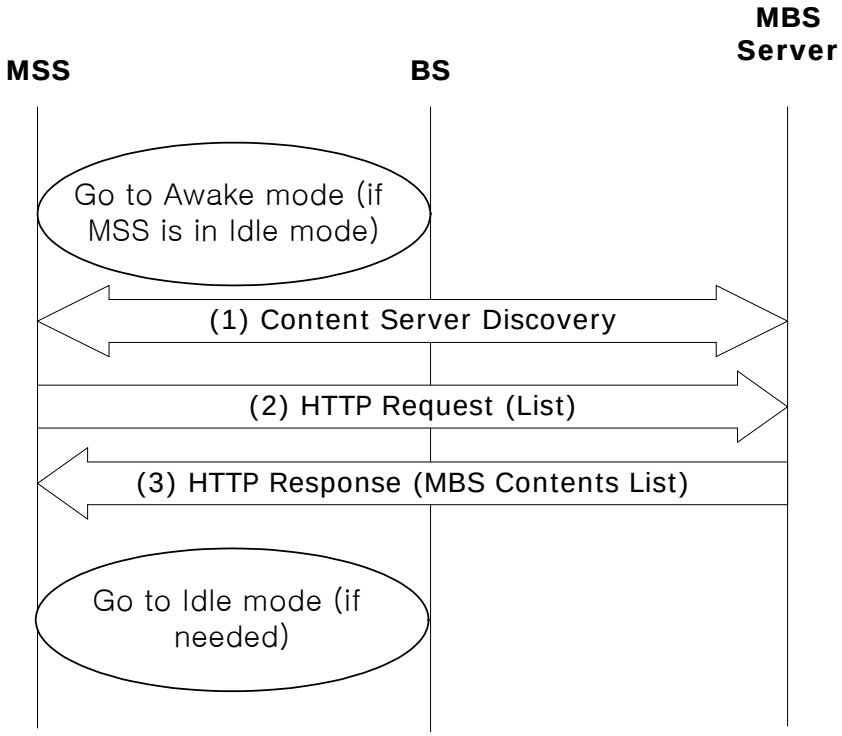
(2) Requirements for the multicast and broadcast service on the cell

There are several basic requirements for MBS(multicast and broadcast service) on the cell. These requirements are listed below:

- **Power saving**: The MSS regardless of its current mode (e.g., awake mode, idle mode) shall save its power consumption during the period that the MSS is receiving MBS. There may be a mechanism for saving MSS's power during the period that the MSS is receiving the multicast and broadcast content from the BS.
- **Mobility**: The MSS shall be provided seamless connection for MBS when the MSS moves across the BSs boundaries.
- **MBS Zone**: MBS content may be transmitted to all or some selected MBS zone of the network. That is, the geographical zones to transmit the MBS content may be configured differently.
- **Security**: MBS contents may be securely delivered to the only authorized users. Encryption keys for MAC PDU of the MBS content may be the same over multiple BSs.

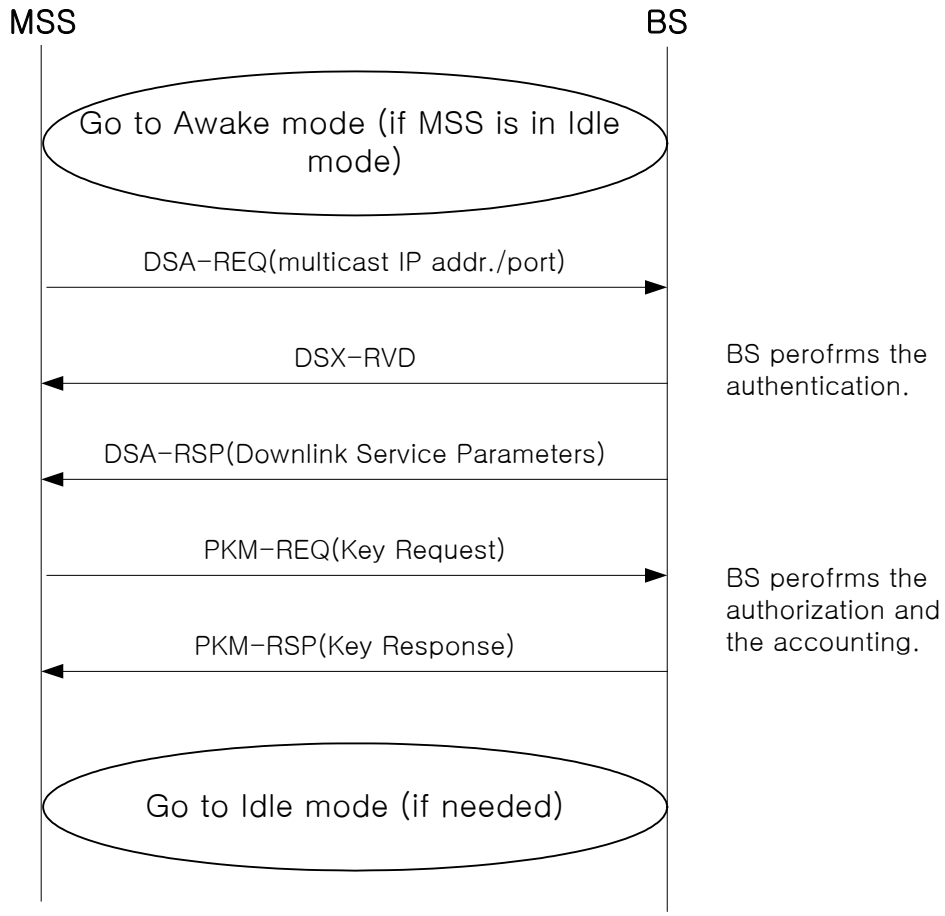
2. Multicast and Broadcast service operation

- **MBS Information Acquisition**
  - (1) If MSS is in idle mode or powers up, MSS transits into the awake-mode.
  - (2) MSS sends a HTTP Request for MBS list to MBS Content Server.
  - (3) MBS Content Server sends a HTTP Response including MBS contents list, which includes some lists of MBS content name, Multicast IP addr./port no. (If MBS packets are delivered in IP packet), etc.
  - (4) MSS either enter into the idle mode or stays in the awake-mode.



- **MBS Authentication and Security Key Acquisition**

(5) After acquiring the MBS Channel information, MSS sends DSA-REQ message with the specific



MBS content's multicast IP address and port number to the BS.

(6) BS sends the DSX-RVD message to acknowledge DSA-REQ message and perform the authentication procedure for authorize the MBS content receipt.

(7) After the successful authentication and authorization, the BS sends DSA-RSP message to the MS with the information of downlink service parameters(e.g, MBS SA-ID, etc)

(8) MSS sends PKM-REQ message to the BS for obtaining the MBS key to decrypt the encrypted MBS MAC PDU transmitted from the BS.

(9) BS sends PKM-RSP message to the MSS with the MBS key.

(10) MSS decrypts the encrypted MAC PDUs for corresponding MBS content.

3. Proposed Text Changes to 802.16e/D3

6.3.13 ~~Establishment of multicast connections~~Multicast service on single cell

The BS may establish a downlink multicastservice 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). 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.

6.3.14 Seamless Multicast and broadcast service over multiple cells

Multicast and broadcast service is defined as a kind of service that all MSSs successfully registered to the 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.

6.3.14.1 Establishment of multicast and broadcast services on the cell

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 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. This characteristic of the MBS connection is slightly different from the current definition of connection.

The BS may establish a downlink multicast and broadcast service by creating a multicast and broadcast virtual connection when the service commences. The virtual connection is a kind of a connection and is associated with the service, but is not associated with a certain MSS. The virtual connection in the BS is maintained until the service is not available furthermore. The virtual connection in the MSS may be created by performing the same procedure of creating a connection. The virtual connection in the MSS may not be deleted even though the MSS goes into Idle mode or the MSS does not monitor a downlink multicast and broadcast service. The virtual connection may be deleted when the service is not available anymore. Any available traffic CID value may be assigned for the virtual connection to be used for the service. To ensure proper multicast and broadcast operation, the CID used for the service is the same for all MSSs on the same channel that have the same virtual connection. The data transmitted with the given CID may be received and processed by the MAC of each involved MSS. And each multicast and broadcast SDU is transmitted only once per BS channel. Since a multicast and broadcast virtual 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 and broadcast virtual connection.

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

6.3.14.2 Validness of a virtual connection and CID assignment over multiple cells

To provide seamless multicast and broadcast service over multiple cells, a virtual connection for a multicast and broadcast service shall be valid through the multiple cells without re-establishment of new virtual connection. Also, CID value associated with the virtual connection shall be the same over the multiple cells.
If symbols for a seamless broadcast and multicast service can be distinguished with symbols for other services, CID value for a seamless multicast and broadcast service in a cell may be the same as a CID value that is used for a unicast service in the cell. The reason is that MSS can determine a CID for multicast and broadcast service and a CID for other services even though the same CID value may be assigned for both services.

6.3.14.3 Transmission of packets for a seamless multicast and broadcast service

BSs can transmit MAC PDUs for a seamless multicast and broadcast service with two approaches. One approach is to transmit a MAC PDU in one frame and another approach is to transmit coded symbols over multiple frames.

6.3.14.3.1 Unitary transmission approach

The unitary transmission approach is that BSs completely transmit a MAC PDU in one frame. BSs transmit a MAC PDU with the same way as BSs transmit a unicast MAC PDU. Therefore, to transmit a MAC PDU for a seamless multicast and broadcast service, BSs may use a DL-MAP_IE that is used for the transmission of a unicast MAC PDU.

6.3.14.3.2 Time-slicing transmission approach

<TBD>

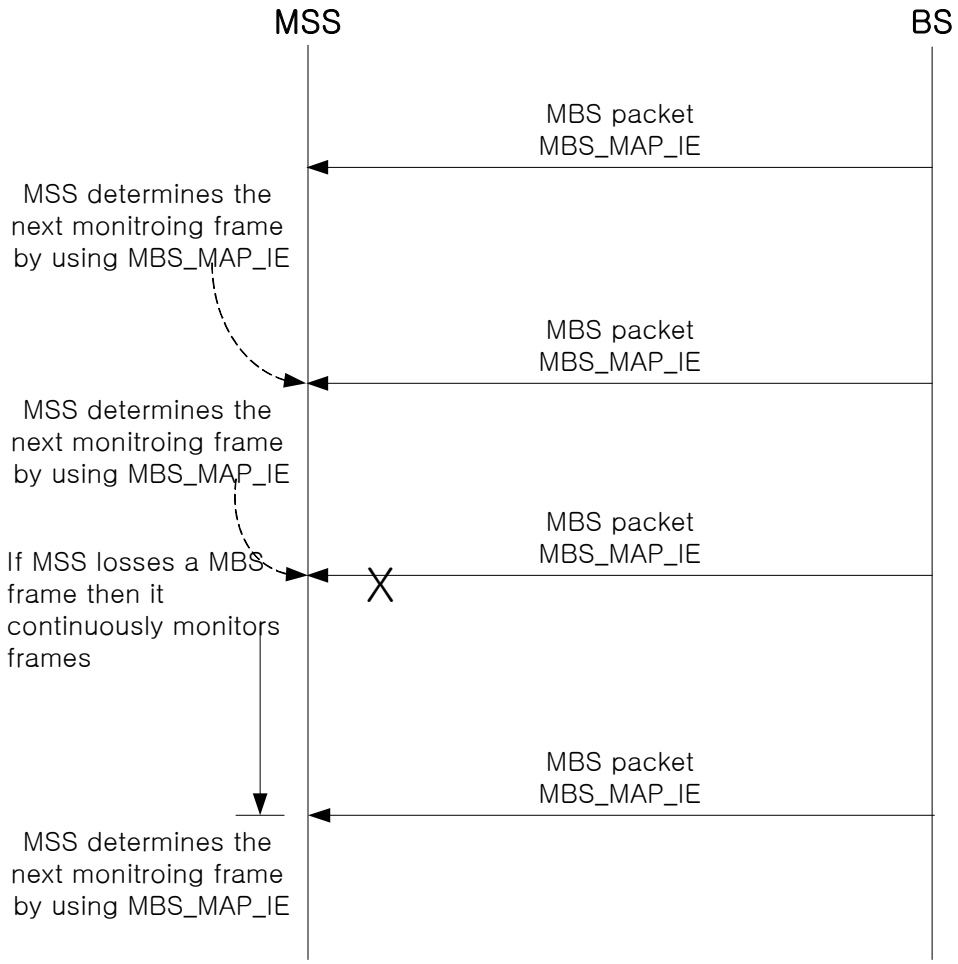
6.3.14.4 Performance enhancement with macro diversity

To increase the receiving performance, the transmission from each BS may be synchronized. That is to say, each BS may use the same CID value, the same security association, the same encrypted PDU, and the same transmission mechanism (symbol, subchannel, modulation, and etc.) for a multicast and broadcast service flow. –The MSS is not necessary to know which BSs are synchronized for the transmission. This makes the BS transmit the same broadcast information to all cells across the network in a synchronized manner such that instead of destructive interference, signals from neighbor cell will add and create a macro-diversity effect.

Such an effect would enable use of much more efficient modulation and coding for the multicast and broadcast content.

6.3.14.5 Power saving operation in MSS's idle mode

To reduce the MSS's power consumption, the BS may notify the number of the frame, which will contain the data for a broadcast and multicast service flow. If MSS knows the frame number that the BS transmits, MSS may not monitor frames except the frame containing the data for the service flow. However, if MSS does not know the frame number, MSS shall continuously monitor frames until it can know the number of the frame containing the data for the service flow. To support this feature, BS may transmit MBS_MAP_IE in DL-MAP message. (see 8.4.5.3.9).



The MSS determines when to awake from the idle mode and to monitor next frame after reading MBS_MAP_IE. After receiving the frame at the time that the next frame scheduled to be transmitted over the air, the MSS repeats to read the MBS_MAP_IE for

next frame to receive. However, if the MSS loses one or a few frames at that time that the next frame is scheduled to be transmitted, then the MSS continuously monitors consecutive frames till MSS reads the MBS_MAP_IE(see figure x.x.x)

6.3.14.6 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 is not necessary 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 zone, the MSS may be necessary 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)

[…]

8.4.5.3.9 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 CID value, and indicates the frame that the next data will be transmitted in by using the CID value. The offset value is an integer value and the next frame is calculated by adding the current frame number and offset value.

Table 256—Multicast and Broadcast Service MAP IE

Syntax	Size	Notes
MBS_MAP_IE {		
Extended DIUC	4 bits	MBS_MAP = 0x05
Length	4 bits	Length = 0x03
CID	16 bits	
Offset	8 bits	
}		

8.4.5.3.10 Multicast and Broadcast Zone IE (MBS_Zone_IE)

In the DL-MAP, a BS may transmit DIUC=15 with the MBS_Zone_IE() to indicate which MBS zone identifier a BS supports. A BS may concurrently support multiple MBS Zones, but only one MBS zone identifier for one broadcast and multicast service shall be used in a BS.

Table 257—Multicast and Broadcast Zone IE

Syntax	Size	Notes
MBS_Zone_IE {		
Extended DIUC	4 bits	MBS_MAP = 0x06
Length	4 bits	Length in bytes of Unspecified data field
MBS Zone Identifier	8 bits	
}		

[…]

11.13.x 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 through which the connection or virtual connection for the associated service flow is valid.

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