# MBS Harmonization - Harmonization Ad-Hoc Consensus DRAFT

## Purpose
Review and Adopt the suggested changes into P802.16e/D4

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MBS Harmonization

1. Introduction

1.1 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.

Current specification for mechanics of multimedia broadcast content for the intended services is generally adequate except for a couple of problems. These problems pertain to network deployments of BS performing synchronized transmissions of jointly scheduled multimedia traffic to achieve macrodiversity of signal reception at MSS—a likely common implementation model for the described services. Such networks require all BS in the same multimedia broadcast content transmission zone (MBS Zone) to transmit the synchronized data PDUs regardless of whether the specific BS currently has MSS subscribing to the service. The BS must make the transmissions to achieve macrodiversity gains for MSS serviced by other BS. Also, the BS may never have serviced any MSS in Normal Operation such that the required broadcast or multicast Service Flow would ever have been created through appropriate MSS DSA-REQ. Thus BS supporting the feature must be able to perform network stimulated Service Flow creation onto CIDs not necessarily associated with any MSS in service at the respective BS. Finally, while it is certainly possible to support these services on common CIDs as in other multicast services provided that these CIDs are common to all BS in the same MBS Zone and provided that the CIDs are appropriately mapped to the SFIDs, optionally placing them on a specific allocated CID range eases implementation and enables MSS in Idle Mode, provided they have requisite security active, to receive the broadcast/multicast transmissions. Support of MSS in Idle Mode access to these services is highly desirable as it matches broadcast/multicast multimedia content that do not require UL activity with Idle Mode MSS that similarly do not require UL activity—freeing-up significant air interface resources in the process. Having these services occur on an allocated CID range enables MSS in Idle Mode to detect the presence of such traffic in the DL-MAP during its normal scanning events without having to re-enter the network. There are already adequate mechanisms through Idle Mode management to notify MSS in Idle Mode of multimedia broadcast or multicast traffic that may interest it is pending.

1.2 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 broadcast 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.

1.3 Multicast and Broadcast service operation

- **MBS Information Acquisition**

  1. If MSS is in Idle Mode and determines to seek MBS content or MSS powers up; MSS re-enters the network into Normal Operation.
  2. MSS sends a [HTTP] Request for MBS list to one or more MBS Content Server(s).
  3. MBS Content Server(s) sends an [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 Idle Mode or stays in Normal Operation.
(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. (Note: this is only one example of operation, the initiation of the DSA-REQ can be done from the BS side as well).

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

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

MSS decrypts the encrypted MAC PDUs for corresponding MBS content.

2. Issues and Remedies

1) Same Connection information for MBS over multiple BSs

Originally, Samsung proposes the virtual connection concept to support the MBS in Idle Mode. To receive MBS traffic, a MSS must be able to store the connection information as well as SFID after entering the Idle Mode. If a MSS establishes a virtual connection, the MSS should store the connection information, the security association, SFID, and etc. until the security information becomes invalid. So, the MSS can receive MBS traffic without reestablishing a connection although the MSS is in Idle Mode.

Some companies give their opinion on this issue as follows:
- [Alvarion]: Alvarion agrees to introduce Multicast CID and proposes the Multicast CID shall corresponds to a MBS SFID. Alvarion thinks that the provisioned SFID can be maintained over multiple BSs regardless of the MSS’s mode (e.g., awake, sleep and idle). That is, “For mobile networks Service Flows are globally provisioned as services to be supplied to MSSs. Service Flows may be multicast or broadcast. Parameters of Service Flows are known to all BSs but the way they become known is out of the scope of the standard.” The mapping rule between Multicast CID and MBS SFID is that the Multicast CID can be derived from MBS SFID. That is, “For multicast SFs, SFIDs must be taken from range 0xFF00-0xFFFD [or 0x0000FF00-0x0000FFFD]. Multicast CID value is equal to SFID value. For example SF with SFID = 0x0000FF01 must be instantiated as connection with CID = 0xFF01. After that CID appears in DL-MAP IE to mark destination of certain bursts.”
- [Runcom]: Runcom agrees with the requirement such that “MBS connection information being maintained with the same value over multiple BSs”. However, they think that this issue is out of scope of 802.16e. They don’t think we need any provision for CIDs beyond the one that currently exists in the MAC, as the MAC supports broadcast and multicast service as it currently stands. The only provision required is to ensure that the same CID is used for the same content across multiple BS.

2) MBS Zone concept

Originally, Samsung proposes the MBS Zone Concept in the C80216e-04_201r1. MBS related parameters (e.g. security key, multicast CID, or etc.) may be different in some region. And the MBS content may be broadcast only in a restricted region. Therefore, when a MSS monitoring a MBS content moves and performs a handoff, the MSS should determine whether the stored MBS information is valid, and whether the MSS can continuously monitor the MBS content.

If the MSS knows the MBS content is not monitored in a cell owing to the using the different parameters or not transmitting the MBS content, the MSS should access to a new BS to update its parameters for the MBS content, especially if the MSS is in Idle state. If MBS Zone concept is introduced, a MSS can immediately know the validness of its stored MBS parameters by checking MBS_zone identifier. MBS Zone is associated with a MBS service (or multicast CID). Also a same MBS zone identifier can be assigned for multiple MBS services. Furthermore, within the MBS Zone the MSS can have the Macro Diversity Effects.

Some companies give their opinion on this issue as follows:
- [Runcom]: Runcom thinks the MBS Zone should be reserved for true broadcast service, while for regional broadcast service there is a possibility to handle this without the MBS (i.e. the physical macro-diversity) zone.

3) MBS_MAP Information Element

Originally, Samsung proposes the MBS MAP IE in the C80216e-04_201r1. 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.

The reason of using special IE is to indicate scheduling information of a burst which is transmitted by the BS within serveral frames. The IEs currently defined in the specification only indicates a burst which is sent only in the current frame. A MSS may receive a broadcast burst with IEs currently defined in the specification. However, the MSS should decode every MAP message in every frame not to miss any broadcast burst. Hence no power saving is possible. But, the MBS_MAP IE can provide that a MSS does know exactly how many frames after a burst of broadcast service will arrive. Hence, an Idle mode MSS can sleep between the frames for broadcast services without receiving MAP messages. Consequently, the main reason of the secial MBS IE is to enable power saving for idle mode MSS.

Some companies give their opinion on this issue as follows:
- [Alvarion]: Alvarion has a doubt whether or not this MBS_MAP IE is needed.
- [Runcom]: Runcom seems to agree to the general concept of MBS_MAP IE. They are not against a DL-MAP IE, but if the MBS is indeed defined as an independent entity, it can have its own DL MAP, which would share the advantages of macro-diversity, and will not have to be repeated in each cell. It would also make it much simpler for MSS in SLEEP or IDLE mode to track the MBS.

(4) Group Paging/Awakening Mechanism

Originally, Alvarion raises this issue.
If the BS may awake all MSS to receive the specific MBS content, the BS need a group paging or group traffic indication mechanism for awakening all MSS at the same time to receive the same MBS content.

Some companies give their opinion on this issue as follows:

- [Runcom]: Runcom doesn't think a waking mechanism is required. At most, we need is a definition of the cycle of each broadcast connection, which could be given several frames in advance.
- [Samsung]: The scenario that Alvarion is having is somewhat different from Samsung’s original scenario, Samsung thinks that the BS does not need to know in what mode the MSS currently is when the BS is transmitting the MBS content. The group paging/waking mechanism is not required at this time.

(5) Pre-Advertisement of MBS

Originally, LGE raises this issue.
MSS involved in an MBS service may consider Neighbor BS’s MBS Zone ID before it decides Target BS and sends a MOB-MSSHO-REQ message. Neighbor BS that does not support MBS or has a different MBS Zone ID may be excluded from being selected as Target BS. After determining Target BS, MSS may perform the general procedures for handover. Additionally, the REG-REQ/RSP procedure can negotiate whether or not the BS/MSS can support the MBS.

Some companies give their opinion on this issue as follows:

- [Samsung]: Since Macro-Diversity is supported, the MSS has already received the same MBS content transmitted by neighboring BSs. Accordingly, MSS does not need to know whether or not the target BS can support the MBS Zone and its MBS contents.

(6) Network Reference Model for MBS

Originally, Runcom proposes the MBS operation reference model in Contribution C80216e-04_275.doc with the following reasons.

- 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

Runcom’s proposal for text changes are summarized as follows:

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.

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

3. Proposed Text Changes to 802.16e/D4

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 (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.

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
6.3.14 Seamless Multicast and broadcast service across multiple BS(MBS)

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.

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, MSS 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 MSS 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. MSS 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.

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.x.x.x PKMv2 MBS Security Support.

6.3.14.1 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 BS 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 MSS 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.

6.3.14.2 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.

6.3.14.3 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. 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.
Repetition Coding Indication

No. Subchannels

Boosting

OFDMA Symbol offset

Subchannel offset

Buttering

DIUC

Management Message Type = ?

MBS-MAP_Message_Format() {
MBS-MAP

The 6.3.2.3.57 MBS MAP

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

[Add the text at the end of section 6.3.2.3.1 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.

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

<table>
<thead>
<tr>
<th>Syntax</th>
<th>Size</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBS-MAP_Message_Format()</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management Message Type = ?</td>
<td>8 bits</td>
<td></td>
</tr>
<tr>
<td>Frame number</td>
<td>24 bits</td>
<td>The frame number is identical to the frame number in the DL-MAP</td>
</tr>
<tr>
<td>for (i = 0; i &lt; n; i++)</td>
<td>12 bits</td>
<td>12 LSB of CID for multicast</td>
</tr>
<tr>
<td>MBS Zone identifier</td>
<td>4 bits</td>
<td></td>
</tr>
<tr>
<td>OFDMA Symbol offset</td>
<td>8 bits</td>
<td>OFDMA symbol offset with respect to start of the MBS zone</td>
</tr>
<tr>
<td>Subchannel offset</td>
<td>6 bits</td>
<td></td>
</tr>
<tr>
<td>Boosting</td>
<td>3 bits</td>
<td>000: normal (not boosted); 001: +6dB; 010: -6dB; 011: +9dB; 100: +3dB; 101: -3dB; 110: -9dB; 1111 -12dB;</td>
</tr>
<tr>
<td>No. OFDMA Symbols</td>
<td>7 bits</td>
<td></td>
</tr>
<tr>
<td>No. Subchannels</td>
<td>6 bits</td>
<td></td>
</tr>
<tr>
<td>Repetition Coding Indication</td>
<td>2 bits</td>
<td>0b00 - No repetition coding 0b01 - Repetition coding of 2 used 0b10 - Repetition coding of 4 used 0b11 - Repetition coding of 6 used</td>
</tr>
<tr>
<td>Next MBS frame offset</td>
<td>8 bits</td>
<td>The Next MBS frame offset value is lower 8 bits of the frame number in which the BS shall transmit the next MBS frame.</td>
</tr>
</tbody>
</table>

The BS may notify the number of the frame, which will contain the data for a multicast and broadcast service flow. If MSS knows the frame number that the BS transmits the information in, 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.

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 loses synchronization with the MBS zone, and has to re-acquire via the MBS MAP_IE.

6.3.14.4 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 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)

[..]
Next MBS OFDMA Symbol offset 8 bits The offset of the OFDMA symbol in which the next MBS zone starts, measured in OFDMA symbols from the beginning of the downlink frame in which the MBS-MAP is transmitted.

if !(byte boundary) {
    Padding Nibble 4 bits Padding to reach byte boundary.
}

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.

Table 256—Multicast and Broadcast Service MAP IE

<table>
<thead>
<tr>
<th>Syntax</th>
<th>Size</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBS_MAP_IE()</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended DIUC</td>
<td>4 bits</td>
<td>MBS_MAP = 0x05</td>
</tr>
<tr>
<td>Length</td>
<td>4 bits</td>
<td>Length = 0x03</td>
</tr>
<tr>
<td>Multicast CID</td>
<td>162 bits</td>
<td>12 LSB of CID for multicast</td>
</tr>
<tr>
<td>MBS zone identifier</td>
<td>7 bits</td>
<td>MBS Zone identifier corresponds to the identifier provided by the BS at connection initiation</td>
</tr>
<tr>
<td>OFDMA Symbol offset</td>
<td>8 bits</td>
<td>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.</td>
</tr>
</tbody>
</table>
|   Macro diversity enhanced  | 1 bits| 0 = Non Macro-Diversity enhanced zone
|                               |       | 1 = Macro-Diversity enhanced zone                                      |
Permutation

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0b00</td>
<td>PUSC permutation</td>
</tr>
<tr>
<td>0b01</td>
<td>FUSC permutation</td>
</tr>
<tr>
<td>0b10</td>
<td>Optional FUSC permutation</td>
</tr>
<tr>
<td>0b11</td>
<td>Adjacent subcarrier permutation</td>
</tr>
</tbody>
</table>

IDcell

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 bits</td>
<td></td>
</tr>
</tbody>
</table>

else {

Reserved

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 bits</td>
<td></td>
</tr>
</tbody>
</table>

}