FINE-TUNING MBMS TO REDUCE GROUP CALL ESTABLISHMENT TIME



WHITE PAPER

ENENSYS



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This technical white paper aims to demystify the configuration of Multimedia Broadcast Multicast Service (MBMS) transmission. We give special attention to the parameters that can affect multicast group call establishment time for critical communication use cases.

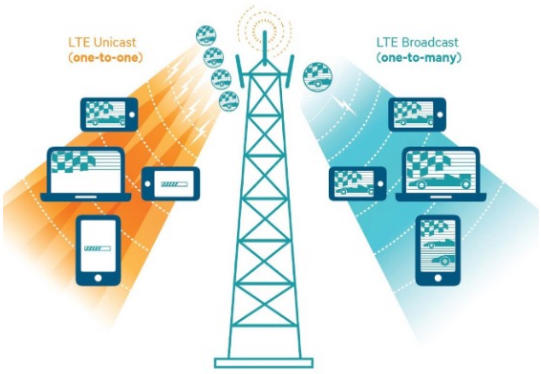
Group communication can take place using unicast or multicast. The same multicast transmission can be received by all the User Equipment (UE) in the group while in unicast we need an individual transmission for each UE. Then, when many mission critical agents belong to the group, we can drastically reduce the required bandwidth using multicast. This is of the utmost importance for governmental agencies that have a restricted bandwidth available for their critical infrastructure.

Even though the advantage of multicast to reduce bandwidth utilization is clear, some actors of the industry and governmental institutions may be reluctant to use multicast technology. One of the reasons is the myth that multicast technology does not comply with mission critical latency requirements, with notably a long time needed for group call establishment time. In this paper we provide insights on how to configure the MBMS transmission to comply with mission critical requirements.

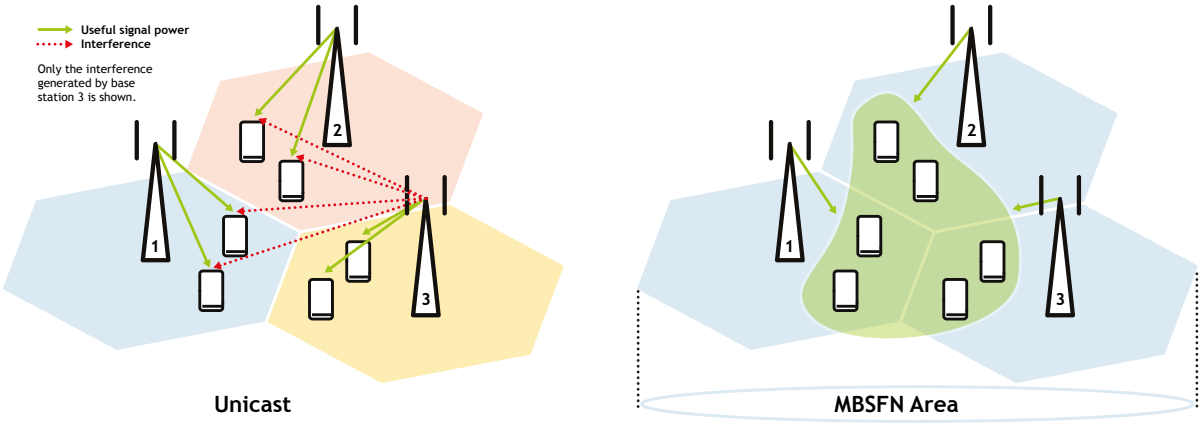
INTRODUCTION TO MBMS

Multicast technology in mobile networks is known as MBMS. While in unicast, each cell transmits in an independent manner, multicast works using the Multicast Broadcast Single Frequency Network (MBSFN) technique.

In MBSFN a group of cells are synchronized and transmit the same waveform at the same time. This group of cells is called MBSFN area. Radio resources used for multicast transmission must be the same in all the cells in the MBSFN area, this is ensured by the Multicell/Multicast Coordination Entity (MCE). The MCE indicates which subframes contain multicast information.



LTE unicast vs LTE MBMS

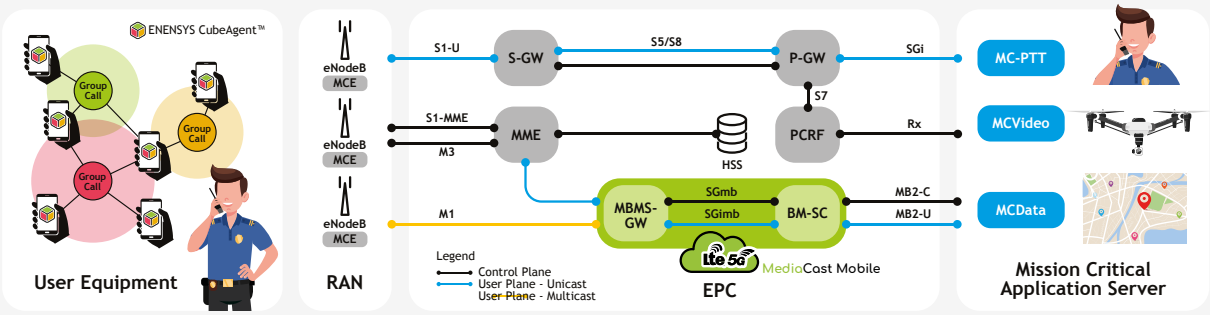


Downlink (DL) unicast and multicast transmissions are time multiplexed by the base station. In mission critical deployments up to 60% of radio resources (6 subframes per radio frame) can be used for MBMS. However, for other services like linear TV, it is possible to allocate 10 subframes per radio frame for MBMS. The base station indicates the UE which subframes carry MBMS data.

In the LTE core network, two logical functions are added to support MBMS: Broadcast Multicast Service Center (BM-SC) and MBMS Gateway (MBMS-GW). The BM-SC manages requests from the mission critical server related to the creation, activation, modification of a tunnel in the LTE network (LTE bearer) for the transmission of MBMS data. BM-SC allocates identifiers for these tunnels called TMGI. Additionally, BM-SC uses the SYNC protocol to ensure that base stations on the MBSFN area start transmitting at the same tame. The MBMS-GW uses IP Multicast to communicate with the base stations in the MBSFN area. It also manages signaling towards the Mobility Management Entity (MME). MME manages MBMS session signaling towards the LTE RAN.

To receive an MBMS transmission, the UE needs an MBMS middleware that acts as intermediary between the LTE modem and the mission critical application for the reception of multicast transmission.

MBMS architecture

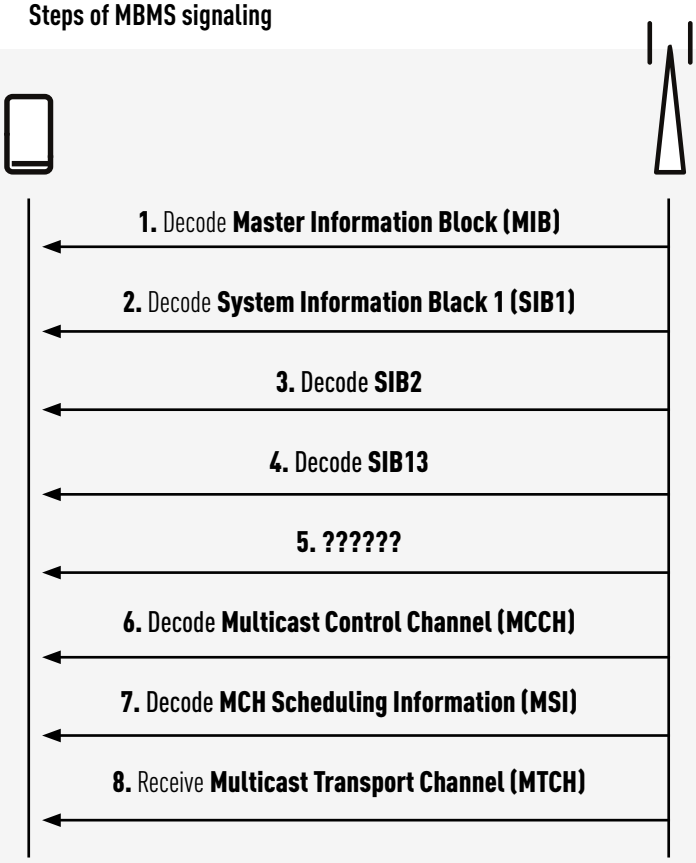




MBMS RADIO SIGNALING

To obtain all the information required to receive the MBMS transmission, the UE must decode several information elements, one after the other. These elements are presented as steps below.

Steps of MBMS signaling



1. The MIB contains the basic information the UE needs to attach to the base station including the DL bandwidth. It is transmitted with a 40 ms periodicity.

2. SIB1 carries the scheduling information of all the other System Information Blocks (SIBs). It is transmitted with a periodicity of 80 ms.

3. The UE obtains the MBSFN subframe configuration from SIB2. It defines the radio frames and specific subframes that are enabled to carry MBSFN data. **SIB2 periodicity** is signaled in SIB1.

Note: When MBSFN information is not transmitted by default in the cell, the System Information (SI), it is the SIBs, are updated with MBSFN information (SIB2, SIB13) when a MBMS transmission will take place. This update is communicated using a paging message. SIB2 signals **Paging message periodicity**. The paging message indicates System Information change notification which is received during a **Broadcast Control Channel (BCCH) modification period**. Updated SI is received in the following BCCH modification period.

4. SIB13 carries the MBSFN area information, in particular the Multicast Control Channel (MCCH) configuration. It includes the **MCCH modification period** and the **MCCH repetition period**. **SIB13 periodicity** is signaled in SIB1.

5. The MCCH carries the MBSFN area configuration. This message includes for each Multicast Channel (MCH) the **MCH Scheduling Period**.

6. For each MCH configured in the MBSFN area, the UE decodes the MCH Scheduling Information (MSI). Each MCH may carry more than one Multicast Transport Channel (MTCH), MTCH carries user data. The MSI contains the scheduling information of all the MTCH.

7. Now the UE has all the information needed to receive the MBMS user data in the MTCHs.

GROUP CALL ESTABLISHMENT TIME

The time required to establish a group call depends on the MBMS configuration. Hereafter we mention the parameters that may influence group call establishment time.

SIB2 periodicity

SIB2 periodicity is configured in the base station.

SIB13 periodicity

SIB13 periodicity is configured in the base station.

Paging message periodicity

Also known as **default paging cycle**, this parameter is relevant if MBMS information is not transmitted by default by the base station. In that case, when a MBMS transmission will take place, system information must be updated to include MBMS signaling on SIB2 and SIB13. In that case, the UE receives the SI change notification in the paging message. The updated SI is received at the beginning of the next BCCH modification period.

BCCH modification period

The MIB and all the SIBs are sent on the BCCH. When SI changes (additional MBMS information on SIB2, transmission of SIB13), the updated SI is received at the begging of the next BCCH modification period following the SI change notification. The BCCH modification is a multiple of the default paging cycle.

BCCH modification period (=)
BCCH modification period coefficient
(x) Default Paging Cycle

The **BCCH modification period coefficient** is configured in the base station.

MCCH modification period

Transmitted in SIB13, this parameter is relevant when MCCH information changes. When MCCH information is modified (new PMCH configured in the MBSFN area, new session in a PMCH, etc.), the base station sends an MCCH information change notification to the UE. The updated MCCH is received at the beginning of the next MCCH modification period following the notification.

MCCH repetition period

Transmitted in SIB13, this parameter indicates the periodicity at which subframes containing MCCH information are transmitted.

MCH Scheduling Period

Indicates the periodicity used for providing MCH Scheduling Information (MSI). It is transmitted in MCCH.

The following table presents the possible values for each of the parameters in 3GPP Release 12 and the new values added in Release 14 and Release 16.

Parameters that may affect group call establishment time

Parameters	Possible Values		
	Release 12	Release 14	Release 16
MIB periodicity [ms]	40		
SIB1 periodicity [ms]	80		
SIB2 periodicity [ms]	80, 160, 320, 640, 1280, 2560, 5120		
SIB13 periodicity [ms]	80, 160, 320, 640, 1280, 2560, 5120		
Paging message periodicity [ms]	320, 640, 1280, 2560		
BCCH modification period coefficient	2, 4, 8, 16	64	
MCCH modification period [ms]	5120, 10240	10, 20, 40, 80, 160, 320, 640, 1280, 2560	
MCCH repetition period [ms]	320, 640, 1280, 2560	10, 20, 40, 80, 160	5120, 10240
MCH Scheduling period [ms]	40, 80, 160, 320, 640, 1280, 2560, 5120, 10240	10, 20	

As you can see there are many possible values for each parameter. The choice of the most adequate value depends on the use case. Mission Critical Communications services are dynamic (voice and video group calls may start at any time under user request) and with exigent latency requirements compared to linear TV services. Therefore, for mission critical services we should not use the same MBMS configuration used for linear TV services.

For Mission Critical Services, MCCH information may change frequently therefore it may be convenient to use short MCCH repetition period and MCCH modification period. Similarly, with the MCH scheduling period. Furthermore, new UEs may arrive to join a call, therefore it may be convenient to use short SIB2 and SIB13 periodicities. This logic is different from the MBMS configuration traditionally used for linear services where these periods are long to avoid transmitting the same signaling information repeatedly wasting resources that may be used to transmit user data.

We can do a quick calculation of the shortest and longest time to receive MBMS data when the MBMS bearers are not pre-established and MBMS system information is not transmitted by default. In that case we need to receive the paging message indicating the change of system information and then all the information elements related to MBMS.

Parameters to consider when starting an MBMS call from scratch

Parameter	Shortest Value	Longest Value
Paging message periodicity	320 ms	2560 ms
BCCH modification period coefficient	2 BCCH modification period = 2 x 320 ms =640 ms	64 BCCH modification period =64 x 2560 ms = 163840 ms
SIB1 periodicity	80 ms	80 ms
SIB2 periodicity	80 ms	5120 ms
SIB13 periodicity	80 ms	5120 ms
MCCH modification period	10 ms	10240 ms
MCH Scheduling period	10 ms	10240 ms
Total Time	**1220 ms**	**197200 ms**

As you can see, the delay induced by these parameters on the MBMS call establishment time can be reduced from 197,2 seconds to 1,22 seconds with the appropriate configuration. Notice that the BCCH modification period accounts for more than 50% of this time. Here we consider the worst-case scenario assuming we have to wait the entire BCCH modification period to receive the updated system information, but it may not be the case. The SI change notification may be received in the middle of the BCCH period thus, reducing the delay to 900 ms.

Now, it is rare to start an MBMS call from scratch. Typically, the base station transmits MBMS related system information (SIB2 and SIB13) by default, even before the beginning of MBMS transmission. Thus, the UE has the information to receive MCCH. Therefore the parameters to consider are the MCCH modification period, to be aware of the allocation of the establishment of new bearers (new TMGIs) and the MCH scheduling period.

Parameters to consider when MBMS related SI is transmitted by default by the BS

Parameter	Shortest Value	Longest Value
MCCH modification period	10 ms	10240 ms
MCH Scheduling period	10 ms	10240 ms
Total Time	**20 ms**	**20480 ms**

The delay induced by the MCCH modification period and MCH Scheduling period on the MBMS call establishment time can be reduced from 20,48 seconds to 20 ms with the appropriate configuration. This delay is far below the group call set-up delay of 300 ms.

Before Release 14, the shortest MCCH modification period was 5120 ms. Therefore, to reduce group call set-up time, the preferred solution was to pre-establish the MBMS bearers. As consequence, bearer pre-establishment is traditionally used in mission critical systems. The mission critical server requests the creation of a certain number of MBMS bearers (allocation of TMGIs) before there is information to transmit. Thus, the UE already has the information provided by MIB, SIB1, SIB2, SIB13 and doesn't need to wait the MCCH modification period, only the MCCH repetition period.

Parameters to consider with pre-established bearers

Parameter	Shortest Value	Longest Value
MCCH repetition period	10 ms	10240 ms
MCH Scheduling period	10 ms	10240 ms
Total Time	**20 ms**	**20480 ms**

The delay induced by the MCCH repetition period and MCH Scheduling period on the MBMS call establishment time can be reduced from 20,48 seconds to 20 ms with the appropriate configuration. This delay is far below the group call set-up delay of 300 ms.

FINAL THOUGHTS

MBMS has historically been regarded as a solution for the transmission of linear services. Since these services work using a rather static configuration, the same MBMS configuration parameters have been used for years and some actors may disregard their importance or how the modification of a certain parameter may affect the system.

In recent years, MBMS has gained momentum as the solution for group communication for Mission Critical Services. These voice, video and data services have exigent requirements in terms of latency. Therefore, the network administrator must review and adapt MBMS configuration to comply with these requirements.

This white paper aims to highlight some of the most important parameters that may affect group call establishment time to help network administrators improve the quality of service of their mission critical infrastructure. As we saw in the examples, an appropriate configuration can drastically reduce MBMS call establishment time.

ACRONYMS

BCCH	Broadcast Control Channel
DL	Downlink
MBMS	Multimedia Broadcast Multicast Service
MBSFN	Multicast Broadcast Single Frequency Network
MCCH	Multicast Control Channel
MCE	Multicell/Multicast Coordination Entity
MCH	Multicast Channel
MIB	Master Information Block
MME	Mobility Management Entity
MSI	MCH Scheduling Information
MTCH	Multicast Transport Channel
SI	System Information
SIB	System Information Block
TMGI	Temporary Mobile Group Identity
UE	User Equipment



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