

A WHITE PAPER ON

---

# ENHANCED MULTIMEDIA BROADCAST MULTICAST SERVICE

# CONTENTS

<i>WHY IS EMBMS IMPORTANT TO PUBLIC SAFETY?</i>	<i>4</i>
<i>HISTORY AT A GLANCE</i>	<i>6</i>
<i>EMBMS SYSTEM ARCHITECTURE</i>	<i>8</i>
<i>RADIO PROTOCOL ARCHITECTURE</i>	<i>10</i>
<i>PHYSICAL LAYER ASPECTS</i>	<i>11</i>
<i>PHYSICAL CHANNELS &amp; SIGNALS</i>	<i>12</i>
<i>MECHANISM OF MBSFN</i>	<i>14</i>
<i>HYTERA EMBMS SOLUTION</i>	<i>16</i>
<i>UNICAST V BROADCAST VS MULTICAST</i>	<i>18</i>

**This white paper aims to provide a comprehensive insight of the mechanism of eMBMS and MBSFN, as well as their implementation in Hytera P-LTE system.**

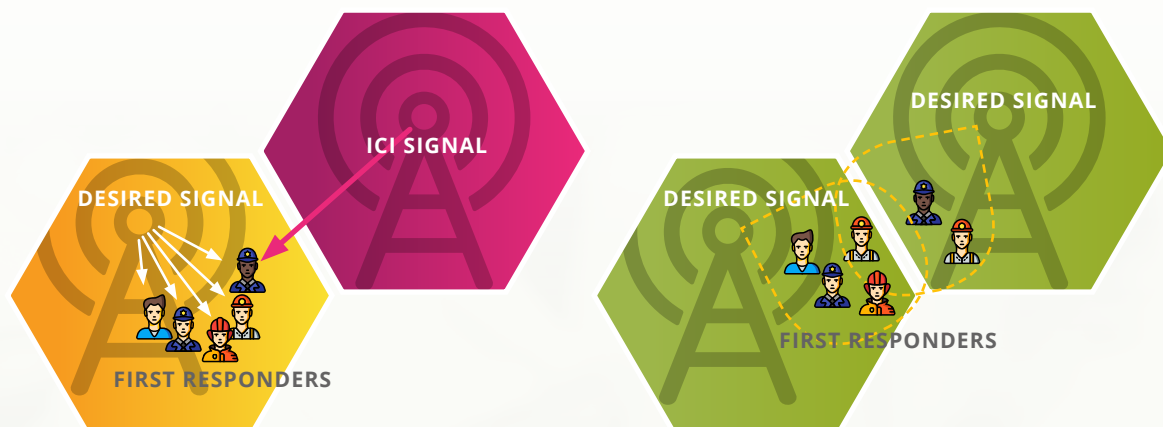
The fast-growing demand for video and multimedia content over mobile networks leads to high requirements in terms of data rate and radio resource management. According to the multicast standard in 3GPP LTE, evolved Multimedia Broadcast/Multicast Service (eMBMS) is one of the most viable solutions to meet such standards. MBMS Single-Frequency Networks (MBSFN) is an operation mode that allows combining of MBMS transmissions from closely time-synchronized cells by using the same radio resource across those cells. In this way the signals can be combined constructively and the spectrum efficiency is improved.

# WHY IS EMBMS IMPORTANT TO PUBLIC SAFETY?

Typical communications in a LMR network are on a broadcast communication channel to allow for one-to-many communications. Users are assigned to a talk group where they can have half-duplex communications. It consumes few resources and allows large-scale group communications to happen with ease. However, in an LTE network the communication is one-to-one, known as unicast. This means that a data session needs to be established for each device that is being communicated to individually.

This dilemma was solved with the introduction of eMBMS. The original intent of eMBMS was to deliver broadcast TV to devices over the network. However, the reservation of spectrum, complexity in the device and network design, and most importantly, changes in viewing habits (the shift from TV to online streaming) have diminished the necessity for eMBMS.

**FIGURE 1. EMBMS USAGE IN GROUP COMMUNICATION FOR PUBLIC SAFETY**



## **UNICAST**

- Network interact with each other
- Low spectrum efficiency
- large quantity of users will cause network congestion
- Inter-cell interference limits data rate

## **MBSFN**

- Network interact with user group
- High spectrum efficiency
- Good Support for large quantity of users
- No Inter-cell interference in SPN, which enables high data rate

## “**EMBMS IS NO DOUBT A NECESSARY FEATURE FOR PUBLIC SAFETY NETWORKS.**”

At present, the availability of eMBMS support are common in user devices while relatively rare in the networks of MNOs around the world. Firstly, this is mainly due to the cost and complexity of deployment and management of the technology, as elements called MBMS-GW and BM-SC have to be deployed in the core network and each eNodeB must have Multi-cast Coordination Entity (MCE) capability added to it, which sometimes requires a hardware upgrade. Secondly, the performance of eMBMS has been limited by the design of the technology until the recent changes brought in Rel-14, which were critical in fostering increased introduction of eMBMS by operators and broadcasters as they will make services more economically and technically attractive to deploy, and will increase accessibility of services to various new types of device.

However, it takes more than technology for the thriving of eMBMS ecosystem, so operators are still working on a potentially successful business model. Until recently, only few networks, for example, Telstra in Australia, has deployed eMBMS in very limited areas. Reliance Jio (India) is using eMBMS to

deliver content to select users through its JioTV app. AT&T (USA) and Globe (Philippines) have previously said that they were deploying the technology. But to our knowledge, there has been no further update. It is highly doubtful that any MNO will deploy eMBMS or wait until 5G to enable multicast services.

Although slow in commercial deployment, the use of eMBMS for public safety is crucial for large-scale events. The number of users that can be supported on MCPTT is directly coupled to the capacity of the site. If a data stream is 1 Mbps for each user, then a unicast system must support 80 Mbps for 80 users. In an eMBMS solution a single 1 Mbps stream would be allocated for all users simultaneously, thus allowing more capacity in the cell for other users. For MCPTT it is likely that a cell can support 300 users simultaneously with no noticeable degradation, given call modelling done by various vendors on VoLTE. In conclusion, it can be foreseen that eMBMS will play a more crucial role with the increasing demand of MCx services like MCPTT, MCCVideo and MCDData.

# HISTORY AT A GLANCE

It has been recognized that the point-to-point delivery of video services is a major consumption on the capacity of mobile networks and that broadcasting would be a much more efficient approach in scenarios where the same content is being sent to multiple users.

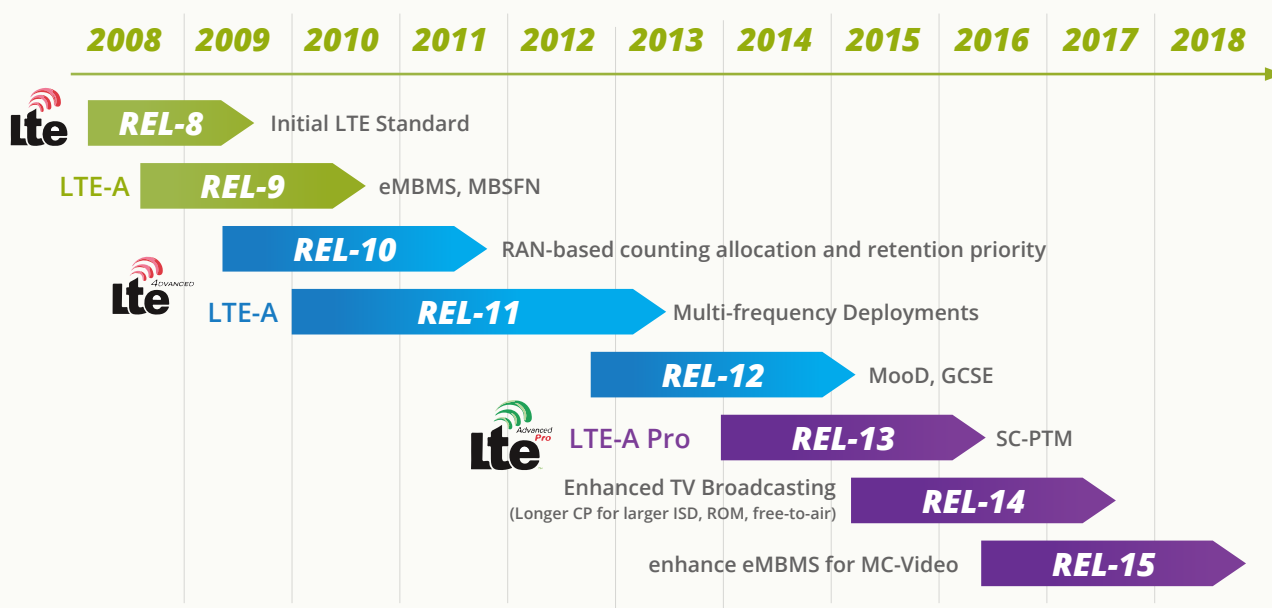
Multimedia Broadcast Multicast Service (MBMS) was first introduced into the 3GPP specifications in Release 6, in the year 2005, with the aim of enabling multicasting or broadcasting of multimedia content over 3G UMTS Radio Access Networks (RAN). However, the limited capacity of UMTS RAN restricted the number and quality of channels it could deliver to a typical configuration of five channels running at 256kbit/s.

In 3GPP Release 9, an enhanced MBMS (eMBMS) was introduced to LTE taking advantage of its radio interface capabilities. The larger throughput and capacity of the LTE interface offer the prospect of more channels at higher quality and the flexible

allocation of resources in LTE avoids the need of permanently dedicated spectrum, which was a weakness of 3G MBMS solutions.

A particularly attractive feature of the LTE radio interface is that it can provide broadcast services across a set of cells as a MBMS Single Frequency Network (MBSFN), whereby a number of synchronized cells delivering a dedicated broadcast channel can operate on the same frequencies. Rather than causing interference to each other, the signals can be combined constructively. The gain becomes especially obvious near cell boundaries, where coverage and interference problems are generally at their worst.

**FIGURE 2. EVOLUTION HISTORY OF EMBMS**





Release 10 introduced a RAN-based counting of User Equipment (UEs) in connected mode interested in an MBMS service. This release also allowed the use of unused MBSFN subframes for unicast reception, and enhanced the admission control for MBMS sessions by the introduction of the allocation and retention priority session parameters.

In 2012 and 2013, 3GPP Release 11 introduced further benefits, including service acquisition and continuity in multi-frequency deployments where the MBMS service is provided via more than one frequency.

Release 12 introduced MBMS operation on Demand (MoD), this feature anticipates the user interest for the specific content, and allows switching back and forth between Unicast and Broadcast modes of Transmission based on the UEs' service consumption reporting. Also some improvements were brought in the physical measurements (e.g., signal power, error rates) the UEs can be ordered to perform for MBSFN network optimization. The eMBMS support for critical communications such as public safety, group communication system enablers (GCSE) for LTE were also introduced in this release.

Release 13 introduced SC-PTM (Single-Cell PTM) to increase the resource allocation flexibility for Point to Multi-point (PTM). SC-PTM allows one cell to broadcast the same content to a group of UEs,

multiplexing broadcast and unicast data on the same physical downlink shared channel (PDSCH) instead of using the physical multicast channel (PMCH), which is a dedicated physical channel for broadcast. SC-PTM reuses eMBMS architecture and core network procedures and partially re-uses eMBMS procedures in RAN.

In Release 14 of 2017, several modifications were made to enhance the 3GPP eMBMS radio interface efficiency and flexibility, such as the support of larger Inter-Site Distance (ISD) at high spectral efficiency, dedicated or mixed eMBMS carrier, new subframe type and shared eMBMS Broadcast. Also some enhancement was done on the system architecture and media formats flexibility for content providers, broadcasters and mobile network operators. Although originally designed to better support wide range TV broadcasting, these modifications can be adopted by mission critical networks to further improve system performance.

Release 15, frozen in June 2018, completed stage 2 of usage of MBMS for mission critical communication services. Work on enhancing eMBMS for MC-Video has also been started. 3GPP has already begun outlining work items to be actioned in Rel-16.

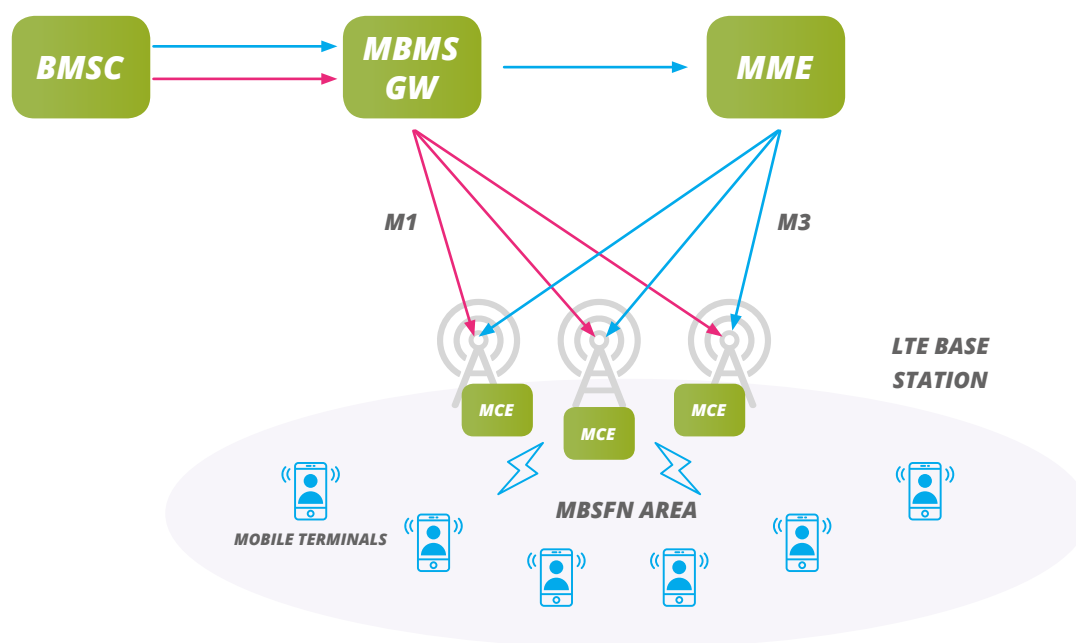
# SYSTEM ARCHITECTURE

In this part, we will briefly introduce the eMBMS architecture and the functions of each network node.

As depicted in Fig. 3, MBSFN requires new network entities to enable MBSFN transmission: BM-SC, MBMS Gateway(GW), and MCE.

BM-SC acts as a proxy content server. It also manages the eMBMS subscriptions, service announcement, sessions control, SYNC protocol, MBMS security, point to point retransmission, and AL-FEC (Application Level Forward Error Correction).

**FIGURE 3. EMBMS SYSTEM ARCHITECTURE TO SUPPORT MBSFN**



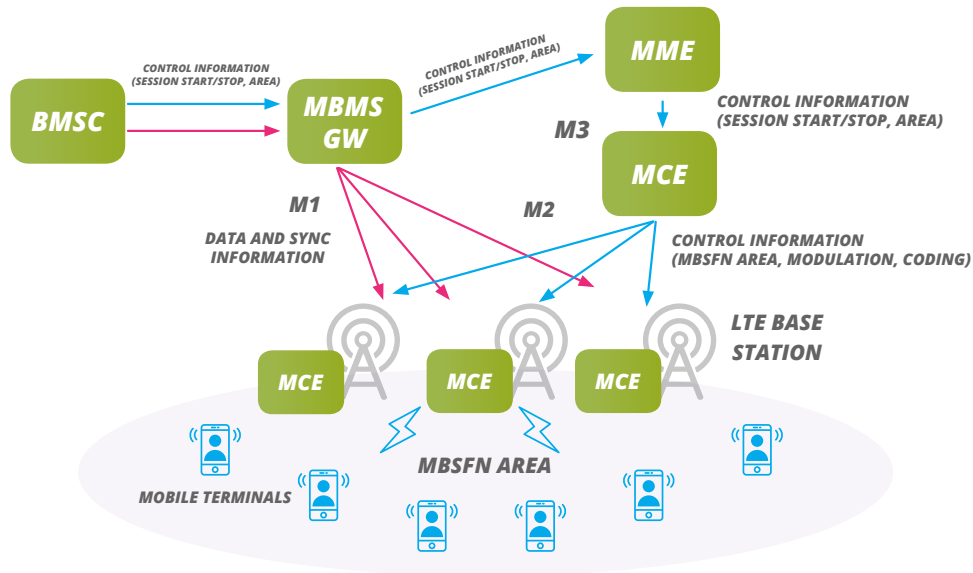
**MBMS GW** is located between BM-SC and all eNBs. Its principal function is to deliver MBMS user data packets to eNBs by means of IP Multicast. When an MBMS session arrives, it allocates IP multicast address to the eNBs that should join to receive MBMS data and maintains the IP Multicast group. Furthermore, MBMS GateWay is responsible for MBMS session announcement and it also performs MBMS session control signaling (Session Start/Stop) toward EUTRAN

**MCE**, acting as a MBMS scheduler, allocates radio resources, performs session admission control, and manages the MBMS services. Therefore, the scheduling of MBSFN transmission is performed through the MCE. When MCE receives a “Session Start” request from MME, it runs Session Admission Control function to determine radio resource availability. Only if there are enough radio resources available will the MCE allocate the required radio frames. In addition to allocate the radio resources, the MCE must decide on the MCS that guarantees the coverage requirements. Finally, the MCE is involved in the MBMS Session Control Signaling.



The 3GPP specifications define two different ways of integrating the MCE in the network: centralized and distributed. The former, as depicted in Fig 4, means that the MCE can be added as a separate network element, which may exist in the form of an extra hardware server and connect multiple eNBs at the same time. While the latter, as in Fig. 3 denotes that locating the MCE directly into the LTE base station, which would be more cost-effective, as it is in most cases only a software upgrade to existing hardware.

**FIGURE 4. ILLUSTRATION OF CENTRALIZED MCE**



To connect these new entities with others components in the network, new interfaces are also defined:

- M1 interface is a user plane interface connecting the MBMS GW and eNBs. IP multicast is used to deliver point-to-multipoint MBMS data packets over the M1 interface. SYNC protocol is used over the M1 interface to keep the content synchronization in MBMS data transmission. There is no control information transmitted over this interface.
- M2 interface is a control plane interface locates between MCE and eNBs. An Application Protocol (M2AP) is defined for this interface to convey at least radio configuration data for the multi-cell transmission mode eNBs and Session Control Signaling. The M2 interface would not exist if the “distributed MCE architecture” is deployed, as in Fig. 3.
- M3 interface connects MME and MCE. M3-Application Part allows for MBMS Session Control Signaling on ERAB level (i.e. it does not convey radio configuration data). This interface supports Session Control Signaling, e.g. for MBMS session initiation and termination (MBMS session start and stop as well as MBMS session update).

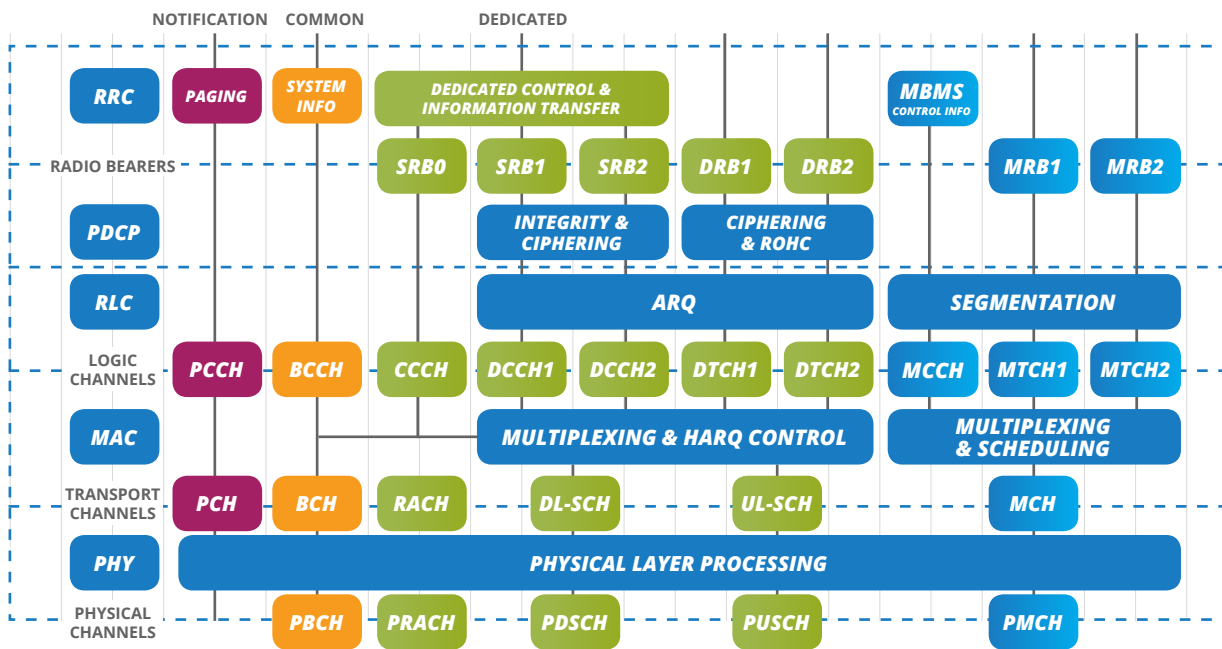
Besides the function of the new entities, eNBs will also need to support some eMBMS related MAC and PHY layer features, including 15 kHz sub-carrier spacing, Extended CP, MBSFN Reference signal, PMCH Physical channel, MCH Transport channel, MTCH/MCCH Logical channels, SIB2 and SIB13 System information, PDCCH with M-RNTI (MBMS Radio Network Temporary Identifier), RLC-UM mode, SYNC protocol, and M2AP (M2 Application Protocol) Interface. Although able to receive MBMS IP multicast packets from multiple MBMS gateways, a single eNB is only served by a single MCE at a time in an eMBMS system.

# RADIO PROTOCOL ARCHITECTURE

In order to support eMBMS, the radio protocols and the structure of channels are extended in Release 9, as depicted in Fig. 5, including:

- a) Two new logical channels; The Multicast Traffic Channel (MTCH) and The Multicast Control Channel (MCCH).
- b) One transport channel, the Multicast transport Channel (MCH).
- c) One physical channel, the Physical Multicast Channel (PMCH).

**FIGURE 5. EMBMS CHANNELS WITHIN LTE RADIO PROTOCOL ARCHITECTURE**



The MTCH is a broadcasting downlink channel for transmitting data traffic from the network to the UEs. It carries data of a certain multimedia content, either a streaming or a file delivery service. The MBMS control information of one or several MTCHs are provided by the MCCH, which also is a broadcasting downlink channel. There is always one MCCH per MBSFN area for all MBMS services provided in that MBSFN area. MCCH holds information of the subframe allocation and the Modulation Coding Schemes (MCSs) used to transmit MBMS services in that MBSFN area. Both logical channels, MCCH and MTCH, are multiplexed to the transport channel MCH. The eNB performs MAC-level multiplexing for different MTCHs to be transmitted on a single MCH. Multiple eMBMS services can therefore be transmitted using a single MCH (because up to 29 MTCHs can be multiplexed on one MCH instance), provided that they use the same MBSFN area. At the Physical Layer up to 15 MCH channels per MBSFN area can be time multiplexed to a PMCH.

# PHYSICAL LAYER ASPECTS

## Physical Resource

In the LTE physical layer, eMBMS service data is carried by PMCH, then multiplexed with physical control channels and physical layer signaling using OFDMA technology to be transmitted over the air. First we will take a look at the physical resource that eMBMS can leverage.

The LTE downlink resources have 3 dimensions, which are time, frequency and space. In time, the transmission in downlink and uplink is organized into radio frames of a duration of 10 ms. Two different radio frame structures are defined by 3GPP, one applicable to FDD and one applicable for TDD. Each 10 ms radio frame is divided into ten subframes with duration of 1 ms, and each subframe consists of two slots of 0.5 ms. Each slot comprises

a number of OFDM symbols which depends on the used Cyclic Prefix (CP) type. Regarding the frequency domain, resources are grouped in the unit of several contiguous sub-carriers, which depends on the OFDM subcarrier spacing, that occupy a total of 180 kHz. Thus, a Resource Block (RB) is composed of one slot of 0.5 ms and 180 kHz, although the smallest unit of resource is the Resource Element (RE), which consists of one subcarrier for a duration of one OFDM symbol. Table 1 shows the possible configurations of both CP and OFDM subcarrier spacing. The spatial dimension is accessed by means of multiple “antenna ports” at the eNB. For each antenna port, a Reference Signal (RS) is provided to enable the UE to estimate the radio channel.

**TABLE 1: CONFIGURATIONS OF CP AND OFDM SUBCARRIER SPACING**

Configuration		Cyclic prefix length $N_{CP, l}$
Normal cyclic prefix	$\Delta f = 15 \text{ kHz}$	160 for $l = 0$ 144 for $l = 1, 2, \dots, 6$
	$\Delta f = 7.5 \text{ kHz}$	1024 for $l = 0, 1, 2$
Extended cyclic prefix	$\Delta f = 15 \text{ kHz}$	512 for $l = 0, 1, \dots, 5$
	$\Delta f = 7.5 \text{ kHz}$	1024 for $l = 0, 1, 2$

For unicast transmissions, the transmission scheme in downlink is based on conventional OFDM with a subcarrier spacing of 15 kHz. For that case, there are two CP lengths: normal CP with duration of 4.6  $\mu\text{s}$  and extended CP with duration of 16.7  $\mu\text{s}$ , corresponding to 7 and 6 OFDM symbols per slot respectively. Theoretically both normal and extended CP can be used for unicast transmissions, normal CP is usually used more. The extended CP is defined mainly for eMBMS transmissions as it allows larger MBSFN area sizes by avoiding ISI. The use of the extended CP allows the construction of SFNs between multiple cells with a maximum of 5 km ISD. In addition, an optional extended CP length of around 33  $\mu\text{s}$  can be used for eMBMS in scenarios with large ISDs (10 km SFN distance), and even longer CP as 200  $\mu\text{s}$  trial are performed in the field. Note that the subcarrier spacing of 7.5 kHz is seldom developed by vendors.

# PHYSICAL CHANNELS & SIGNALS

Within an RB, an RE can be used to map physical channels or physical signals. A physical channel corresponds to a set of REs carrying information which is originated from higher layers whereas a physical signal corresponds to a set of REs carrying a signal originated at the physical layer. On one hand, the different downlink physical channels are the Physical Downlink Shared Channel (PDSCH), which is used basically for user data transport; the Physical Broadcast Channel (PBCH), which provides critical system information; Physical Multicast Channel (PMCH), which carries data for MBMS; the Physical Control Format Indicator Channel (PCFICH), which indicates the number of OFDM symbols used for transmission of control channel information in each subframe; the Physical Downlink Control

Channel (PDCCH), which conveys UE-specific control information; and the Physical Hybrid ARQ Indicator Channel (PHICH), which carries the HARQ ACK/NACK from eNB.

It is worth noting that the PMCH can only be transmitted in certain subframes known as MBSFN subframes, which are indicated in the system information carried on the PDSCH. Maximum valid set of M-subframes in FDD are subframe #1, #2, #3 in the first slot and #6, #7, #8 in the second slot. While in TDD the valid set changes with different UL-DL configuration, as shown in Table 2, the downlink subframes that can be used as M-subframes are highlighted in blue.

**TABLE 2: VALID M-SUBFRAME IN TDD**

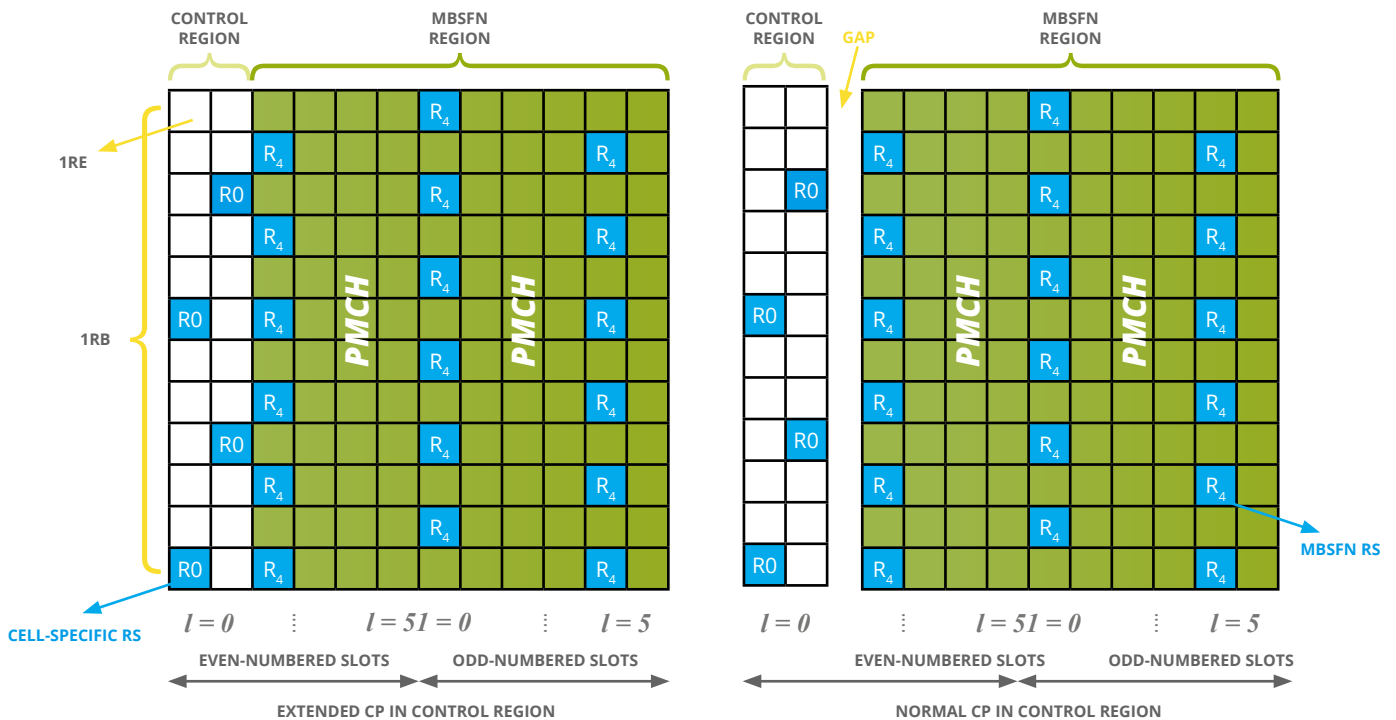
Uplink-downlink configuration	Subframe Number									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

Physical signals in downlink, the synchronization signals stay unchanged, while a new type of Reference Signal (RS) called MBSFN RS is introduced besides the legacy Cell-specific RS for the channel estimation of MBSFN region.

Up to four cell-specific antenna ports, numbered 0 to 3, may be used by an LTE eNB and, for each antenna port, a different RS pattern has been designed. The MBSFN RSs are used only for MBSFN operation within the subframes allocated to eMBMS and they are mapped on the antenna port 4. Two resource assignment diagrams, corresponding scenarios of adopting extended and normal CP are depicted in Figure 6. In the control region, which has 2 OFDM symbols in this case, only patterns of cell-specific

RS port 0 is illustrated for simplicity. MBSFN RS scatters in the MBSFN region, which spans the rest of the RB symbols, and PMCH fill in the REs that are not occupied by MBSFN RS. As shown in Fig. 6, the assigned resource elements for the MBSFN operation are closer in the frequency domain as compared with the cell-specific RS pattern. This is because the use of MBSFN implies longer delay spreads and, consequently, a reduction in the coherence bandwidth.

**FIGURE 6. CELL-RS AND MBSFN RS PATTERN**



# MECHANISM OF **MBSFN** TRANSMISSION

3GPP specifies that MBSFN operations in several cells with synchronized timing within a particular area, defined as MBSFN area in LTE, simultaneously transmit the same eMBMS data on the same frequency resource. Therefore, users observe multiple versions of the same signal with different delays depending on the distance to the eNBs. The UE's receiver is able to combine different path delays from a single signal as long as these delay versions are received within the CP at the beginning of the symbol. In MBSFN operation, given the CP length of  $16.7\mu\text{s}$  ensures the signals arrive within the CP, those signals will be perceived as the same signal from one big cell with multi-path effect. Therefore, the UE would not realize the difference in signals from multiple cells in MBSFN transmission.

In unicast transmission, signals originated from the cell center become attenuated after long

distance transmission when arriving at the cell edge, therefore the signal to interfere and noise ratio(SINR) is relatively low due to signal level and interference from neighboring cells. As a result, the selection of the modulation and coding scheme(MCS) at the cell edge is much limited in the lower portion for the successful demodulation of physical layer channel data. The deployment of MBSFN transforms the interference at the cell edge into delay versions of signal, the constructive combination of eMBMS data brings significant improvement of SINR. Choices of higher MCS order become available and number of bits that can be carried per subcarrier is greatly increased. In conclusion, the MBSFN operation in LTE broadcasting brings higher spectrum efficiency.

*It should be noted that one eNB can belong to more than one MBSFN Area at the same time but can only belong to one MBSFN Synchronization Area on a given frequency layer.*

## **IN GENERAL, THE MBSFN OPERATION ENTAILS THE FOLLOWING BENEFITS:**



### **SIGNAL BOOST**

An increase in the received signal level, especially at the border of cells inside the MBSFN area.



### **REDUCED INTERFERENCE**

A reduction in the interference level, again especially at the cell borders inside the MBSFN area, since the signals received from neighboring cells do not appear as interference but as constructive signals.

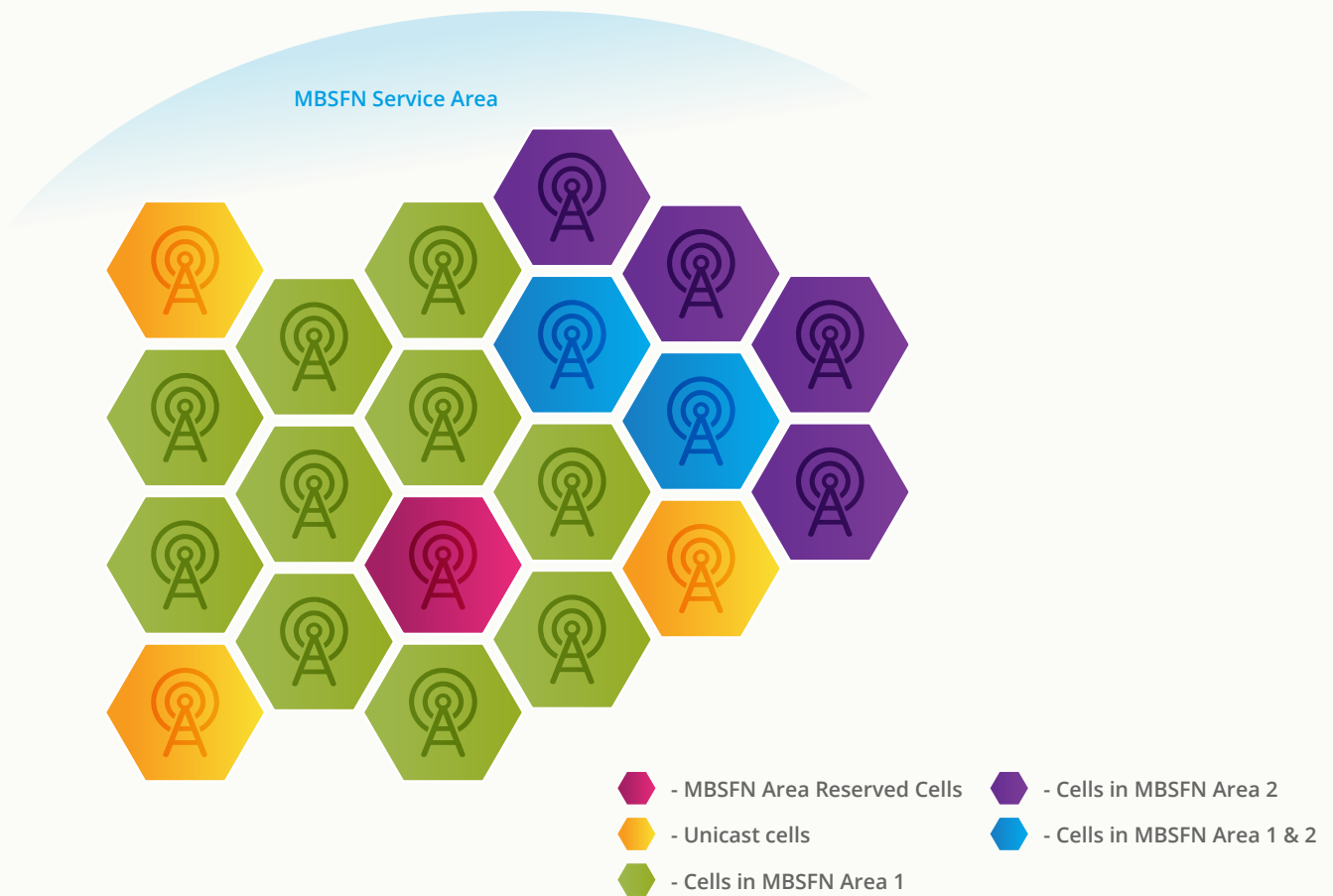


### **MINIMIZE INTERFERENCE**

An additional diversity gain against signal fading, since data are received from different paths.



**FIGURE 7. MBSFN AREA TO PROVIDE EMBMS SERVICE**



**FIGURE 7 SHOWS AN EXAMPLE OF AN MBSFN AREA AS WELL AS SOME OTHER CONCEPTS IN MBSFN TRANSMISSION.**

**MBSFN Area:** An MBSFN Area consists of a group of cells within an MBSFN Synchronization Area of a network, which are coordinated to achieve an MBSFN Transmission. Except for the MBSFN Area Reserved Cells, all cells within an MBSFN Area contribute to the MBSFN Transmission and advertise its availability.

**MBMS Service Area:** The area within which data of a specific MBMS session (or service) are sent. Each individual MBMS session of an MBMS Service may be sent to a different MBMS Service Area.

**MBSFN Synchronization Area:** An area where all eNBs can be synchronized and perform MBSFN transmissions. The MBSFN Synchronization Areas are independent from the definition of MBMS Service Areas.

**MBSFN Area Reserved Cell:** A cell within a MBSFN Area which does not contribute to the MBSFN Transmission.

# **HYTERA EMBMS SOLUTION**

Besides regular eMBMS functionalities, Hytera's P-LTE system supports the following features to better bear MC services.

## **Dynamic MBSFN area configuration**

MCE will create MBSFN areas dynamically according to the demand of MC server, therefore ensure the coverage area for MC services.

## **Dynamic MBSFN subframe allocation**

MCE will configure the proportion of M-subframe in one radio frame according to the requirement of real-time session, for example, Time of MBMS Data transfer, QCI, PDB, BLER and ARP). The dynamic allocation can avoid waste of radio resource compare to fixed M-subframe allocation.

## **New QCI for MC services**

Dedicated QCI for MC services are supported in both unicast and multicast to guarantee QoS and service continuity of MCPTT during uni/multicast switch and dynamic MBSFN area/subframe configuration.

## **Network TTI level SYNC solution**

P-LTE eMBMS synchronization implementations use both satellite-based GPS and synchronized back-haul protocols IEEE 1588, with a TTI level precision over the entire MBSFN area. The forward compatible design with Rel-14 can reduce the time delay of data buffering to better protect the integrity of transmitted data, which leads to a better user experience.

## **Centralized and distributed MCE**

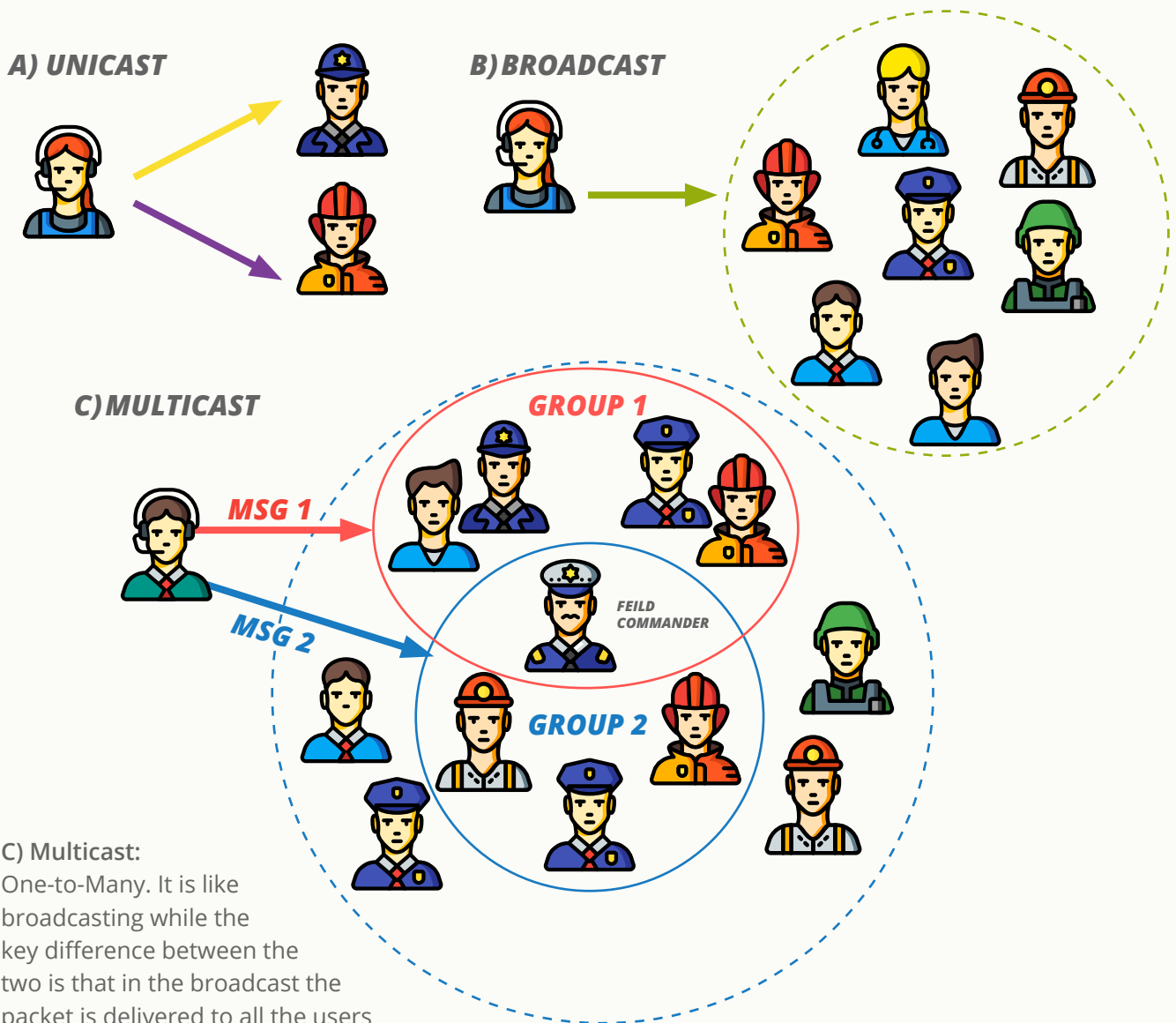
Hytera P-LTE system is designed capable of supporting either centralized (as an EPC element or in an independent hardware) or distributed MCE deployment according to various deployment requirement of mission critical networks.



# UNICAST VS BROADCAST VS MULTICAST

**A) Unicast:** One-to-One. Network will assign one data channel for each user. Services will be provided on users' demand.

**B) Broadcast:** One-to-All. There's no dedicated channel for each user. Network will transmit data on point to multi-point bases and all the users in the region will receive the same content on the same radio resource.



**C) Multicast:** One-to-Many. It is like broadcasting while the key difference between the two is that in the broadcast the packet is delivered to all the users connected to the network, whereas in multicast packet is delivered to intended recipients only. Take mission critical group communication for instance, the packet is delivered to the authorized subscribers only.

## **RELATIONSHIP BETWEEN EMBMS AND MCX**

eMBMS is the pipe to bear MCx services, and MCx services are applications that running on it, the characteristics of the pipe will affect the quality of service of the MCx in the following aspects:

### **Service Continuity**

For MCx services, the degree of reliability of the service must be maintained. The service continuity of eMBMS is limited in MBSFN to the MBSFN service area, which means there will be discontinuity when user moves from one MA to another.

### **Latency**

The control plane requires about 5s to setup an MBSFN radio bearer, due to the long Multicast Control Channel (MCCH) modification period. Before Rel-14 modification periods were 5.12 s or 10.24 s. In Rel-14 the protocols included fast reconfigurations, and it still require modification period of 10 ms.

MBSFN area configuration and available MBMS services have to be sent on MCCH periodically, thus an MCCH repetition period is necessary, which can range from 320 ms to 2.56 s. With the fast reconfiguration in Rel-14, the repetition period is at least 10 ms.

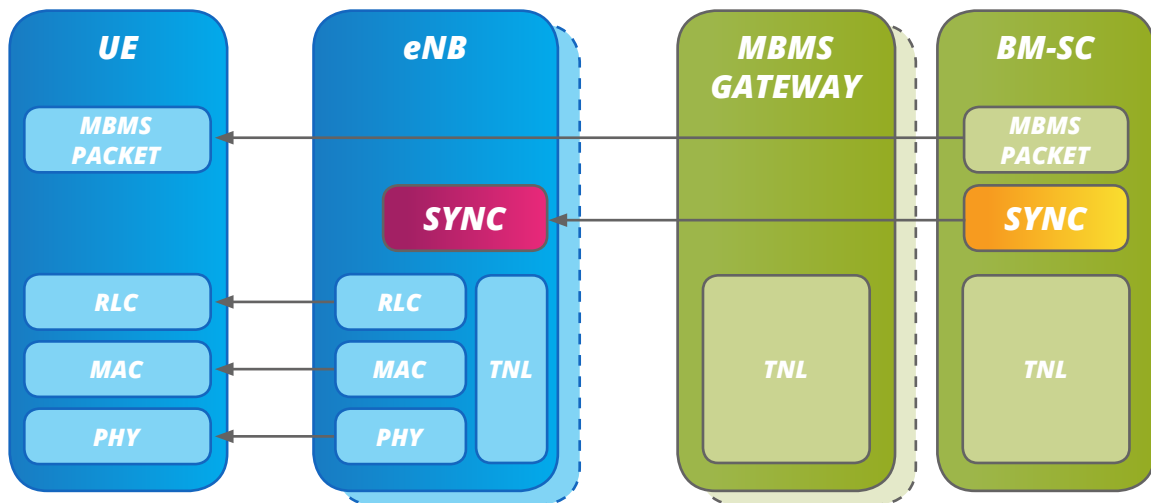
For MBSFN, the user plane requires a minimum delay of 40 ms (long multicast transport channel scheduling period) for mixed unicast/broadcast transmission.

### **Link Level Performance**

The highest modulation and coding scheme is limited by the user in the MBSFN area with the worst link budget, which will further affect the overall throughput. Therefore, it is important to make network coverage plan with careful field trial or system simulation.

## EMBMS SYNCHRONIZATION PROTOCOL

All eNBs within a MBSFN area need to be synchronized with a  $\mu\text{s}$  tolerance and the radio frames need to be aligned. The SYNC protocol defined in 3GPP TS 25.446 specification ensures the ordered delivery of the MBMS content from BMSC to eNB. If there is a delay in transmission of MBMS service PDUs from any eNBs in a MBSFN Area, it will act as an interference. SYNC protocol defines a train of SYNC sequences in a SYNC period. Each SYNC packet contains a time stamp that indicates the start time of the SYNC sequence. The BM-SC labels all packets of a synchronization sequence with an identical time stamp telling the eNB when to start the transmission of the first packet of that synchronization sequence. The time stamp has to cover transfer delays between the BM-SC and all eNBs in the MBSFN area to ensure that all of them have received and buffered the packets of an MSP before any of the eNBs is allowed to transmit the first packet.



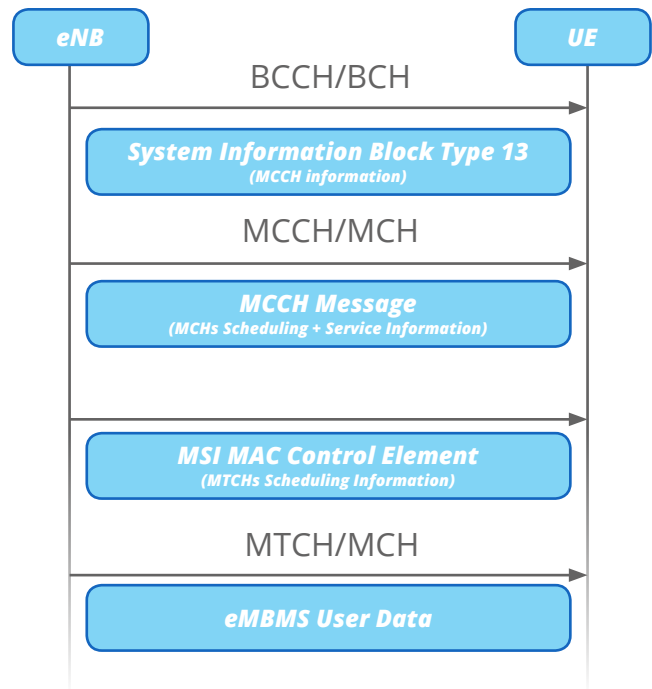


## EMBMS SCHEDULING

Within an MBSFN subframe, the MCH uses all the resources in the frequency domain, so MCH-related scheduling only relates to the subframe allocation in the time domain. Some of the eMBMS scheduling information is provided by System Information Blocks (SIBs) transmitted through BCCH. There are two SIBs related to eMBMS, which are SIB2 and SIB13. The former only informs the user about which subframes are reserved for MBSFN in downlink. However, this information is not enough to receive an MBMS service. As a result, SIB13 is introduced to inform the subscribers about the different MBSFN areas configured in a cell. It indicates the subframes that carry the MCCH of each area and the modulation and coding scheme used for its transmission.

The information provided by SIB13 allows the user to read the MCCH of each area. An MCCH contains the message known as MBSFNAreaConFIguration, which indicates the subframes where the different MTCHs configured in the associated MBSFN area are transmitted. This message carries several information elements such as the Common Subframe Allocation (CSA) pattern, the CSA period and the PMCH-InfoList.

The first two elements are used to indicate which subframes are reserved for all the MCHs of an MBSFN area, whereas the latter indicates how the subframes are shared among those MCHs. More precisely, PMCH-InfoList indicates the last subframe allocated to each MCH through MCH Subframe Allocation (MSA) end.



In addition, PMCH-InfoList reports the MCS of each MCH. Each MCH can multiplex several MBMS services. In order to identify the specific MBMS service, the PMCH-InfoList defines all the MBMS ongoing sessions (identified by MTCH). The scheduling of the subframes used for a particular MTCH is performed once per MCH Scheduling Period (MSP). In particular, this scheduling information is included in the first subframe of that period, where a MAC control element named MCH Scheduling Information (MSI) specifies how the different sessions are multiplexed during the MSP. For that, it indicates the subframe where each MTCH ends in this MSP. MSP was set to 80ms in protocol Rel-10, while later reduced to 40ms in Rel-12 and 10ms in Rel-14 as an eMBMS enhancement.

# ABBREVIATIONS, ACRONYMS, AND TERMS

3GPP	3rd Generation Partnership Project	MCS	Modulation and Coding Scheme
BMSC	Broadcast Multicast Service Center	MCx	3GPP Defined Mission Critical Services Including MC-PTT, MC-Video and MC-Data
BLER	Block Error Rate	MME	Mobility Management Entity
CP	Cyclic Prefix	Mood	MBMS Operation On-Demand
eMBMS	evolved MBMS	OFDM	Orthogonal Frequency Division Multiplexing
eNB	evolved NodeB	PTT	Push-To-Talk
EPC	Enhanced Packet Core	RAN	Radio Access Network
FDD	Frequency Division Duplexing	SFN	Single Frequency Network
IP	Internet Protocol	SIB	System Information Block
ISD	Inter Site Distance	SINR	Signal-To-Interference-Plus-Noise Ratio
ISI	Inter-Symbol Interference	TDD	Time Division Duplexing
LTE	Long Term Evolution	TNL	Transport Network Layer
MBMS	Multimedia Broadcast Multicast Service	UE	User Equipment
MBMS -GW	MBMS Gateway		
MBSFN	Multicast Broadcast Single Frequency Network		
MCCH	Multicast Control Channel		
MCE	Multi-Cell/Multicast Coordination Entity		



Hytera Communications (Australia) Pty Ltd  
 53 Brandl St, Eight Mile Plains QLD 4113 Australia  
 Telephone: 1300 498 372  
 Email: sales\_au@hytera.com

Keep up to date with Hytera on social media.



Hytera retains right to change the product design and specification. Should any printing mistake occur, Hytera doesn't bear relevant responsibility. Little difference between real product and product indicated by printing materials will occur by printing reason.

**HYT** Hytera are registered trademarks of Hytera Communications Co.,Ltd.  
 © 2019 Hytera Communications Co.,Ltd. All Rights Reserved.