

ETSI TS 123 246 V16.1.0 (2020-11)



**Universal Mobile Telecommunications System (UMTS);
LTE;
Multimedia Broadcast/Multicast Service (MBMS);
Architecture and functional description
(3GPP TS 23.246 version 16.1.0 Release 16)**



Reference

RTS/TSGS-0223246vg10

Keywords

LTE,UMTS

ETSI

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1 Scope

The present document describes the stage 2 description (architectural solution and functionalities) for the MBMS Bearer Service, which includes, together with MBMS User Services defined in TS 26.346 [7], all the elements necessary to realise the stage 1 requirements in TS 22.146 [2] and TS 22.246 [6]. This document encompasses both GPRS and EPS.

The present document also includes considerations on the manner in which User Services should make use of the MBMS Bearer Service described herein. It should be noted that the specification of MBMS User Services in TS 26.346 [7] takes precedence over User Service aspects described in this document.

The present document includes information applicable to network operators, service providers and manufacturers.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
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- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 22.146: "Multimedia Broadcast/Multicast Service; Stage 1".
- [3] 3GPP TS 23.107: "Quality of Service (QoS) concept and architecture".
- [4] 3GPP TS 29.061: "Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN)".
- [5] 3GPP TS 33.246: "Security of Multimedia Broadcast/Multicast Service".
- [6] 3GPP TS 22.246: "Multimedia Broadcast/Multicast Service (MBMS) user services".
- [7] 3GPP TS 26.346: "MBMS: Protocols and Codecs".
- [8] void.
- [9] void.
- [10] 3GPP TS 25.346: "Introduction of the Multimedia Broadcast Multicast Service (MBMS) in the Radio Access Network".
- [11] 3GPP TS 43.246: "Technical Specification Group GSM/EDGE Radio Access Network; Multimedia Broadcast Multicast Service (MBMS) in the GERAN".
- [12] 3GPP TS 23.125: "Overall high level functionality and architecture impacts of flow based charging; Stage 2".
- [13] 3GPP TS 23.003: "Numbering, addressing and identification".
- [14] 3GPP TS 32.422: "Subscriber and equipment trace; Trace control and Configuration Management (CM)".
- [15] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".
- [16] 3GPP TS 23.401: "GPRS enhancements for E-UTRAN Access".

- [17] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN)".
- [18] 3GPP TS 25.446: "MBMS synchronisation protocol (SYNC)".
- [19] IETF RFC 3376: "Internet Group Management Protocol, Version 3".
- [20] IETF RFC 3810: "Multicast Listener Discovery Version 2 (MLDv2) for IPv6".
- [21] IETF RFC 4607: "Source-Specific Multicast for IP".
- [22] IETF RFC 4604: "Using Internet Group Management Protocol Version 3 (IGMPv3) and Multicast Listener Discovery Protocol Version 2 (MLDv2) for Source specific Multicast".
- [23] 3GPP TS 23.203: "Policy and charging control architecture".
- [24] 3GPP TS 23.468: "Group Communication System Enablers for LTE (GCSE_LTE)".
- [25] 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures".
- [26] 3GPP TS 23.007: "Restoration procedures".
- [27] 3GPP TS 29.468: "Group Communication System Enablers for LTE (GCSE_LTE); MB2 reference point; Stage 3".
- [28] 3GPP TS 36.444: "M3 Application Protocol (M3AP)".
- [29] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".
- [30] 3GPP TS 22.101: "Service aspects; Service principles".
- [31] 3GPP TS 26.348: "Northbound Application Programming Interface (API) for Multimedia Broadcast/Multicast Service (MBMS) at the xMB reference point".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions defined in TR 21.905 [1] and TS 22.146 [2] and the following apply:

MBMS Service Announcement: Mechanism to allow users to be informed about the MBMS user services available.

MBMS Bearer Service: the service provided by the PS Domain to MBMS User Services to deliver IP multicast datagrams to multiple receivers using minimum network and radio resources.

MBMS User Service: the MBMS service provided to the end user by means of the MBMS Bearer Service and possibly other capabilities.

MBMS Service Area: The area within which data of a specific MBMS session are sent. Each individual MBMS session of an MBMS Bearer Service may be sent to a different MBMS Service Area. This MBMS Service Area is the same or a subset of the Multicast or Broadcast Service Area as defined in TS 22.146 [2]. An MBMS Service Area smaller than the Multicast or Broadcast Service Area is typically used for localized services.

MBMS over a Single Frequency Network: See TS 25.346 [10].

Receive Only Mode: A UE configuration option that allows a UE to receive only eMBMS broadcast service without the need to access and register with the PLMN offering the eMBMS service. A UE configured to operate in Receive Only Mode receives MBMS service only on a standardised TMGI value range. The UE uses the acquired system information to receive MBMS broadcast. Use of Receive Only Mode does not require USIM for the UE.

Shared MBMS Network: A network shared by multiple PLMNs that provides MBMS services. The Shared MBMS network consists of the following shared network elements: BM-SC(s) and MBMS-GW(s). The shared MBMS network may also include eNB(s), MCE(s), and shared MME(s) for MBMS operation.

3.2 Abbreviations

For the purposes of the present document, the abbreviations in TR 21.905 [1] and TS 22.146 [2] apply.

EPS	Evolved Packet System
C-TEID	Common TEID
MBSFN	MBMS over a Single Frequency Network
MCE	Multi-cell/Multicast Coordination Entity
SSM	Source Specific Multicast
TMGI	Temporary Mobile Group Identity
TPF	Traffic Plane Function
SMN	Shared MBMS Network

4 MBMS Architecture

4.1 Overview

MBMS is a point-to-multipoint service in which data is transmitted from a single source entity to multiple recipients. Transmitting the same data to multiple recipients allows network resources to be shared.

The MBMS bearer service offers two modes:

- Broadcast Mode;
- Multicast Mode.

Broadcast Mode is supported for EPS and GPRS, and Multicast Mode is supported for GPRS. MBMS for EPS supports E-UTRAN and UTRAN. MBMS for GPRS supports UTRAN and GERAN.

MBMS architecture enables the efficient usage of radio-network and core-network resources, with an emphasis on radio interface efficiency.

MBMS is realised by the addition of a number of new capabilities to existing functional entities of the 3GPP architecture and by addition of a number of new functional entities.

The existing PS Domain functional entities (GGSN, SGSN, MME, E-UTRAN, UTRAN, GERAN and UE) are enhanced to provide the MBMS Bearer Service. In the EPS a functional entity MBMS GW exists at the edge between the CN and the BM-SC. In the bearer plane, this service provides delivery of IP Multicast datagrams from the Gi and SGi-mb reference points to UEs with a specified Quality of Service. In the control plane, this service provides mechanisms for:

- managing the MBMS bearer service activation status of UEs (in the case of multicast mode);
- outsourcing authorisation decisions to the MBMS User Service (i.e. to the BM-SC) (in the case of multicast mode);
- providing control of session initiation/modification/termination by the MBMS User Service and managing bearer resources for the distribution of MBMS data (in the case of multicast and broadcast modes).

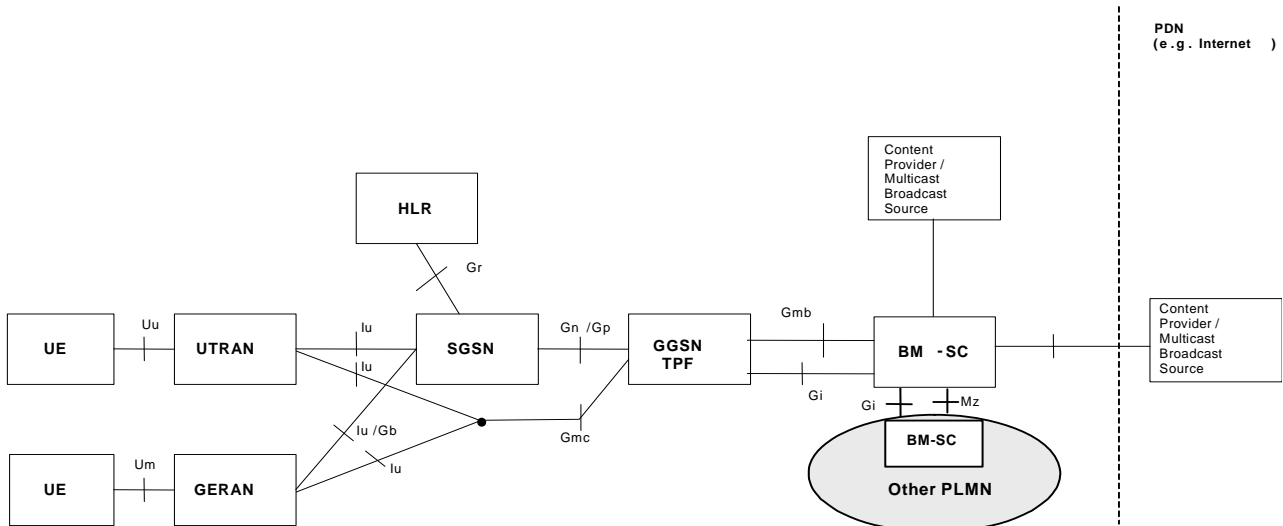
A particular instance of the MBMS Bearer Service is identified by an IP Multicast Address and an APN Network Identifier. A TMGI also can be used to identify one MBMS Bearer Service inside one PLMN.

For GPRS the boundary of the MBMS Bearer Service is the Gmb and Gi reference points as shown in Figure 1 below. The former provides access to the control plane functions and the latter the bearer plane. For EPS the boundary is the SGmb and the SGi-mb as shown in figure 1b below.

A functional entity, the Broadcast Multicast Service Centre (BM-SC) provides a set of functions for MBMS User Services. BM-SC functions for different MBMS User Services may be supported from the same or different physical network elements.

4.2 Reference Architecture Model

4.2.1 GPRS



- Note 1: Network entities and reference points solely used by the MBMS user service (e.g. for service announcement as described in clause 4.4.1.2) are not shown in this figure.
- Note 2: Gp applies only when SGSN and GGSN are in different PLMNs.
- Note 3: the Iu/Gn reference point above is a direct tunnel according to clause 5.6.2.2, figure 6b in TS 23.060 [15] with IP multicast based addressing according to RFC 4607 [21].

Figure 1a: Reference architecture for GPRS to support the MBMS bearer service with GERAN and UTRAN

4.2.2 EPS

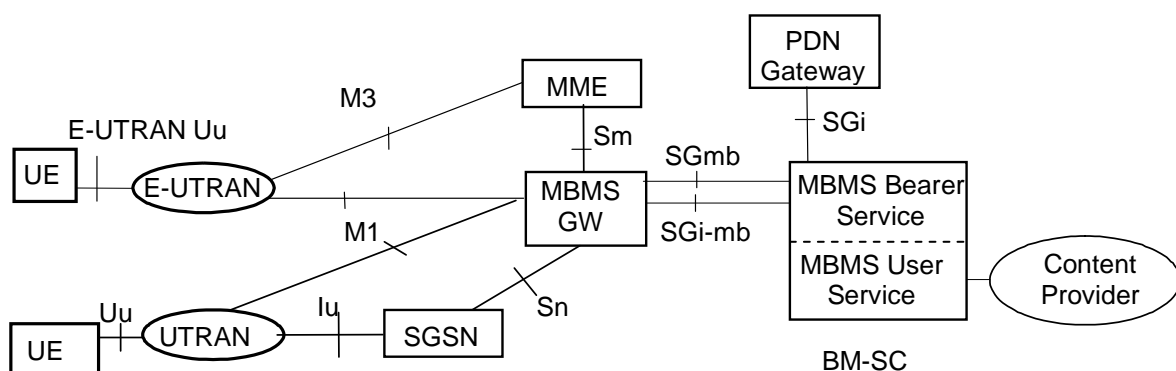


Figure 1b: Reference architecture for Evolved Packet System with E-UTRAN and UTRAN (MBMS Broadcast Mode only)

- NOTE 1: In addition to MBMS Bearers (over SGmb/SGi-mb), the BM-SC may use EPS Bearers (over SGi) to realize an MBMS User Service as specified in TS 26.346 [7].
- NOTE 2: The MCE (see TS 36.300 [17]) is not shown in the figure.
- NOTE 3: MBMS service over Gn-SGSN is supported when the MBMS-GW is co-located with the PDN GW and this PDN GW has the necessary GGSN functions to control the MBMS Bearer Service over Gn.

4.3 MBMS Specific Reference points

4.3.1 Gmb

Signalling between GGSN and BM-SC is exchanged at Gmb reference point. This represents the network side boundary of the MBMS Bearer Service from a control plane perspective. This includes user specific Gmb signalling and MBMS bearer service specific signalling.

MBMS bearer service specific Gmb signalling:

- The GGSN establishes the MBMS bearer context and registers at BM-SC.
- The GGSN or the BM-SC releases the MBMS bearer context and de-registers the GGSN from the BM-SC.
- The BM-SC indicates session start, update and stop to the GGSN including session attributes like QoS and MBMS service area.

User specific Gmb signalling:

- The BM-SC authorises the user specific MBMS multicast service activation (join) at the GGSN.
- The GGSN reports to the BM-SC the successful user specific MBMS multicast activation (join) to allow the BM-SC to synchronise the BM-SC MBMS UE context with the MBMS UE contexts in the SGSN and GGSN.
- The GGSN reports to the BM-SC when a user specific MBMS multicast service is released or deactivated (e.g. at implicit detach). The GGSN makes this report in order to synchronise the BM-SC MBMS UE context with the MBMS UE contexts in the SGSN and GGSN.

The BM-SC initiates the deactivation of a user specific MBMS bearer service when the MBMS user service is terminated.

BM-SC functions for different MBMS bearer services may be provided by different physical network elements. Further, MBMS bearer service specific and user specific signalling for the same MBMS bearer service may also be provided by different physical network elements. To allow this distribution of BM-SC functions, the Gmb protocol must support the use of proxies to correctly route the different signalling interactions in a manner which is transparent to the GGSN.

4.3.1a SGmb

The SGmb reference point has similar functions with the Gmb interface in control plane except for the Multicast Mode related functions. Specifically,

MBMS bearer service specific SGmb signalling:

- The BM-SC indicates session start, update and stop to the MBMS-GW including session attributes like QoS and MBMS service area, and some of attributes may be different from them in Gmb.

4.3.2 Mz

Mz is the roaming variant of the Gmb reference point with the same functionality as described under Gmb, i.e. with MBMS bearer and User specific signalling.

MBMS bearer and User specific Mz signalling is used between a BM-SC in the visited PLMN and a BM-SC in the home PLMN when MBMS services from the home PLMN are offered by the visited PLMN.

User specific signalling is used between a BM-SC in the visited PLMN and a BM-SC in the home PLMN when the visited PLMN offers MBMS user services to roaming users. This user specific Mz signalling provides home PLMN authorisation for MBMS user services that are provided by the visited PLMN. This mechanism supports only MBMS user service classes that are offered by the visited and by the home PLMN.

Mz may use proxying capabilities as described for Gmb, e.g. to proxy signalling between BM-SCs. An APN may be included in the signalling between BM-SCs, which is used to select an appropriate GGSN to access the MBMS service aiming for an optimized routing, resource saving, or operator policy.

NOTE: For EPS, the Mz reference point is not supported in this release.

4.3.3 Reference Points for Evolved Packet System

NOTE: The below listed reference points are applicable for the E-UTRAN and UTRAN MBMS Broadcast Mode (with or without counting) only.

M1: It is the reference point between MBMS GW and E-UTRAN/UTRAN for MBMS data delivery. IP Multicast is used on this interface to forward data.

M3: It is the reference point for the control plane between MME and E-UTRAN.

Sm: It is the reference point for the control plane between MME and MBMS GW.

Sn: It is the reference point between MBMS GW and SGSN (S4 based) for the control plane and for MBMS data delivery. Point-to-point mode is used on this interface to forward data..

SGi-mb: It is the reference point between BM-SC and MBMS GW function for MBMS data delivery.

SGmb: It is the reference point for the control plane between BM-SC and MBMS GW.

Protocol assumption:

- The Sm reference point is based on GTPv2-C.
- The Sn reference point is based on GTPv2-C and GTPv1-U.
- The M1 reference point is based on GTPv1-U.

4.4 MBMS Service Provision

4.4.1 MULTICAST MODE

Reception of an MBMS MULTICAST service is enabled by certain procedures that are illustrated in the Figure below.

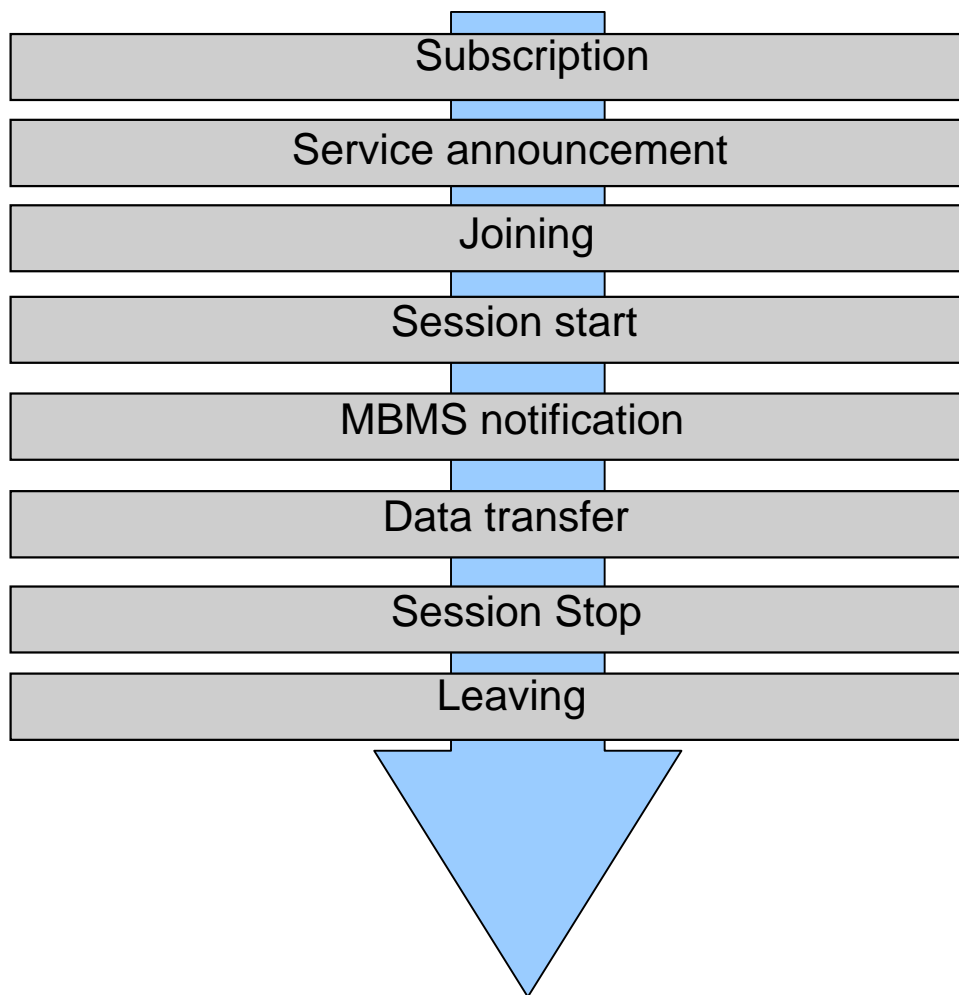


Figure 2: Phases of MBMS Multicast service provision

The phases subscription, joining and leaving are performed individually per user. The other phases are performed for a service, i.e. for all users interested in the related service. The sequence of phases may repeat, e.g. depending on the need to transfer data. Also subscription, joining, leaving, service announcement as well as MBMS notification may run in parallel to other phases.

This is illustrated with the following example of timeline:

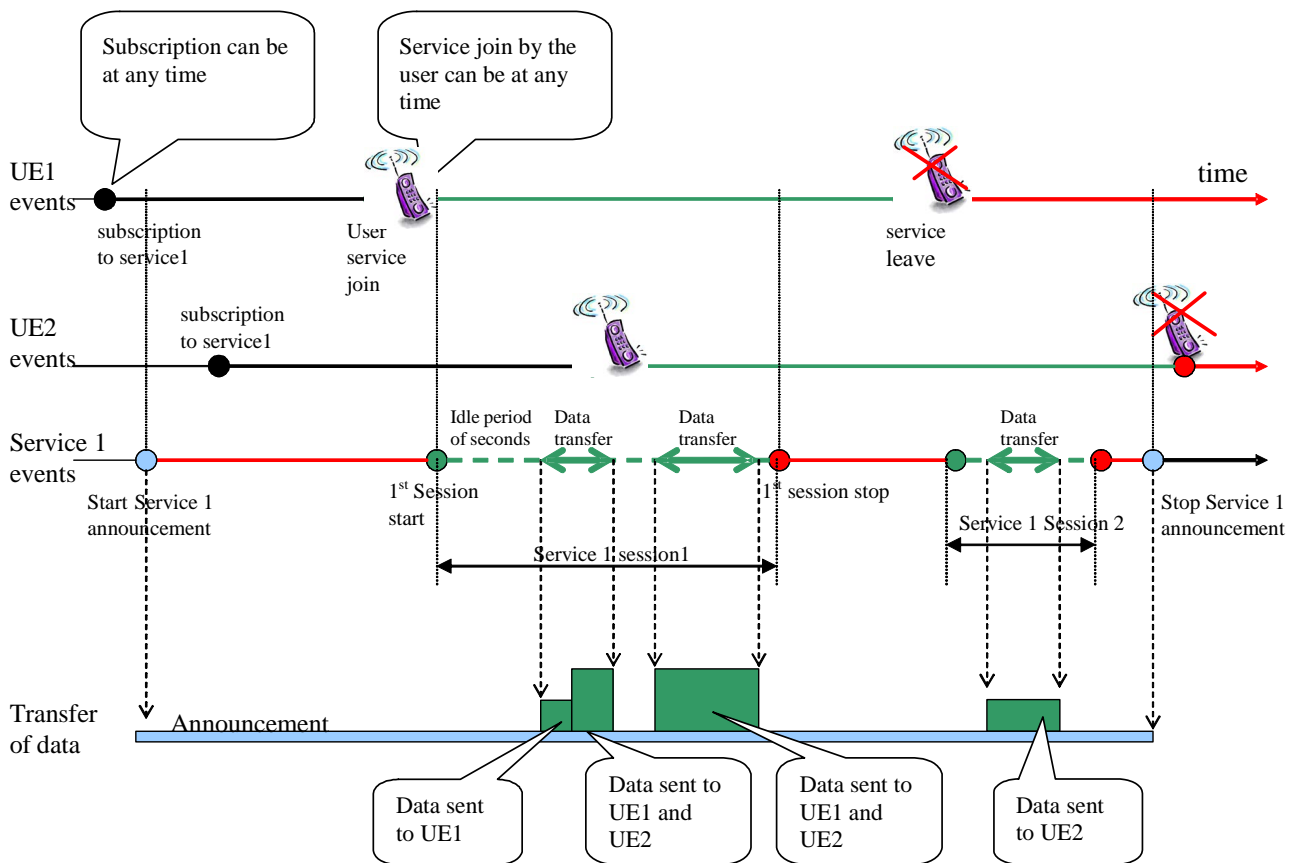


Figure 3: Timeline example

4.4.1.1 Subscription

Establishes the relationship between the user and the service provider, which allows the user to receive the related MBMS multicast service.

Service Subscription is the agreement of a user to receive service(s) offered by the operator. Subscription information is recorded in the BM-SC. Subscription information and other BM-SC functionality may be on separate entities, which is enabled by proxy capability of the Gmb interface.

NOTE: procedures for the subscription phase are out of scope of this specification.

4.4.1.2 Service announcement

MBMS user service announcement/discovery mechanisms shall allow users to request or be informed about the range of MBMS user services available. This includes operator specific MBMS user services as well as services from content providers outside of the PLMN. Service announcement is used to distribute to users information about the service, parameters required for service activation (e.g. IP multicast address(es)) and possibly other service related parameters (e.g. service start time).

Operators/service providers may consider several service discovery mechanisms. This could include standard mechanisms such as SMS, or depending on the capability of the terminal, applications that encourage user interrogation. The method chosen to inform users about MBMS user services may have to account for the user's location, (e.g. current cell, in the HPLMN or VPLMN). Users who have not already subscribed to a MBMS user service should also be able to discover MBMS user services.

The following could be considered useful for MBMS user service announcement mechanisms (not exhaustive):

- SMS Cell Broadcast to advertise MBMS Multicast and Broadcast user services;
- MBMS Broadcast mode to advertise MBMS Multicast and Broadcast user Services;

- MBMS Multicast mode to advertise MBMS Multicast user Services;
- PUSH mechanism (WAP, SMS-PP, MMS);
- URL (HTTP, FTP).

The details of the MBMS service announcement mechanisms are out of scope of this specification, but MBMS shall allow the utilisation of solutions using IETF protocols.

Service announcement is further defined within MBMS User Service specifications TS 26.346 [7].

4.4.1.3 Joining

Joining (i.e. MBMS multicast activation by the user) is the process by which a subscriber joins (becomes a member of) a multicast group, i.e. the user indicates to the network that he/she wants to receive Multicast mode data of a specific MBMS bearer service. An MBMS user service may also be carried by more than one MBMS bearer service. In that case the MBMS user service part in the UE initiates the relevant MBMS bearer services to receive the service (see clause 8.2).

4.4.1.4 Session Start

Session Start is the point at which the BM-SC is ready to send data. This can be identified with the start of a "Multicast session" as defined in TS 22.146 [2]. Session Start occurs independently of activation of the service by the user – i.e. a given user may activate the service before or after Session Start. Session Start is the trigger for bearer resource establishment for MBMS data transfer. If an MBMS user service is carried by more than one MBMS bearer service, a Session Start message is sent for each MBMS bearer service. In that case the UE may need to initiate the reception of multiple relevant MBMS bearer services to receive the MBMS user service.

4.4.1.5 MBMS notification

Informs the UEs about forthcoming (and potentially about ongoing) MBMS multicast data transfer.

4.4.1.6 Data transfer

It is the phase when MBMS data are transferred to the UEs.

4.4.1.7 Session Stop

It is the point at which the BM-SC determines that there will be no more data to send for some period of time – this period being long enough to justify removal of bearer resources associated with the session. At Session Stop, the bearer resources are released.

4.4.1.8 Leaving

Leaving (i.e. MBMS multicast deactivation by the user) is the process by which a subscriber leaves (stops being a member of) a multicast group, i.e. the user no longer wants to receive Multicast mode data of a specific MBMS bearer service.

4.4.2 Multicast Mode timeline

4.4.2.1 Period between Service Announcement and Session Start

The service announcement may contain a schedule of Session Start times and may be sent some time before the service is due to start. So, this time period could be hours, days or even weeks.

4.4.2.2 Period between Service Announcement and Service Subscription

Service Subscription can be done anytime before or after Service announcement.

4.4.2.3 Period between Service Announcement and Joining

The Joining time is chosen by the user and/or UE possibly in response to a Service Announcement. Users will typically join at the time of their choosing so that the period between announcement and joining may be very long or very short. In order to avoid overload situations being caused by many users attempting to join in a short period of time, the UE shall be able to use parameters sent by the BM-SC in the service announcement to randomise the joining time.

4.4.2.4 Period between Joining and Session Start

Some MBMS bearer services may be 'always on'. In this case, Joining can take place immediately after Service Announcement and possibly many hours before, or after, Session Start.

In other cases, if a Session Start time is known, Joining may take place immediately before Session Start or after Session Start. For these services, the announcement may contain some indication of a time period which users and UEs should use to choose a time to Join the MBMS bearer service.

4.4.2.5 Period between Session Start and First Data Arrival

Session Start indicates that the transmission is about to start. The time delay between a Session Start indication and actual data should be long enough for the network actions required at Session Start to take place e.g. provision of service information to the UTRAN, establishment of the bearer plane.

Session Start may be triggered by an explicit notification from the BM-SC. In the case of bearer plane resources which are set-up after the start of session data transmission, the network is not required to buffer the session data and loss of data can be assumed.

4.4.2.6 Period between Session Start and Session Stop

When the BM-SC knows that there is no more data to be sent for a "long idle period", it should indicate Session Stop to the network, causing the release of bearer resources. However, if this idle period with no data is short, this may not be appropriate as it brings more signalling and processing.

The duration of this "long idle period" is implementation dependent. The order of magnitude should be defined to take into account network constraints (including UTRAN, GERAN, and CN).

If the BM-SC wants to use session repetition identification on the MBMS bearer service level, the BM-SC must stop the MBMS session before starting the next MBMS user service session for that TMGI.

4.4.2.7 Session Update

Session Update is used to update specific parameters of an ongoing MBMS Multicast session. The SGSN can use the procedure to update the list of RAs where MBMS multicast users are located for an ongoing MBMS Multicast service session.

4.4.3 BROADCAST MODE

An example for the phases of MBMS broadcast service provision is described in the figure below:

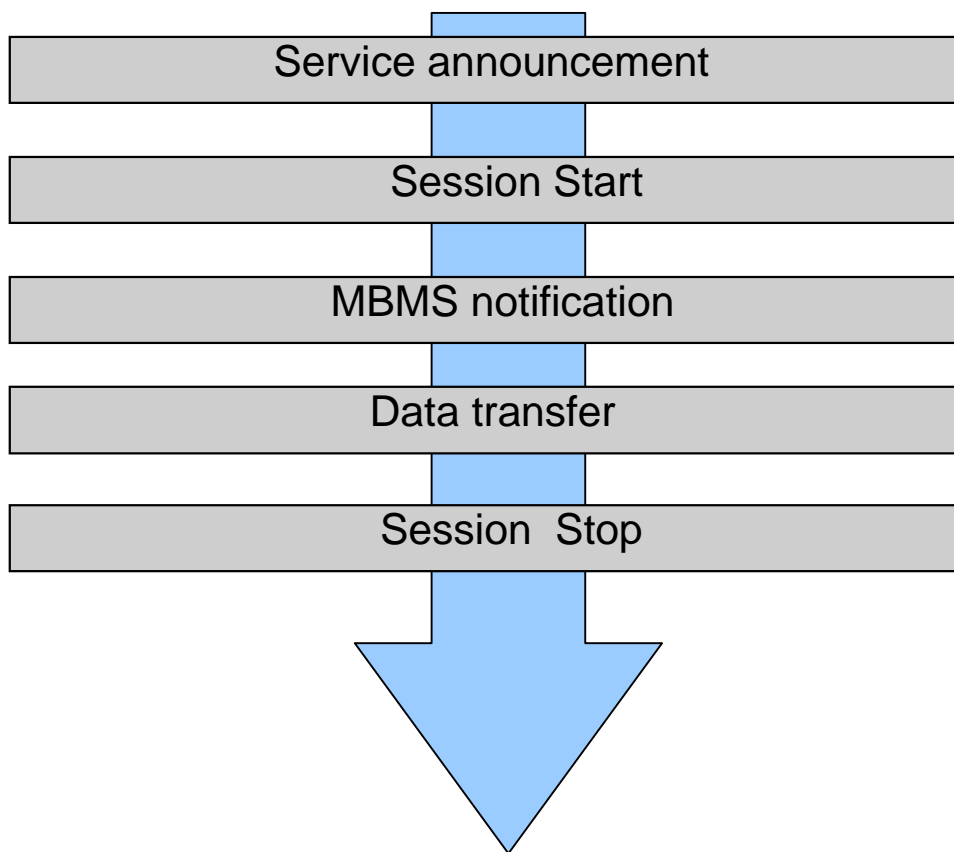


Figure 4: Phases of MBMS broadcast service provision

The sequence of phases may repeat, e.g. depending on the need to transfer data. It is also possible that the service announcement and MBMS notification phase may run in parallel with other phases, in order to inform UEs which have not yet received the related service.

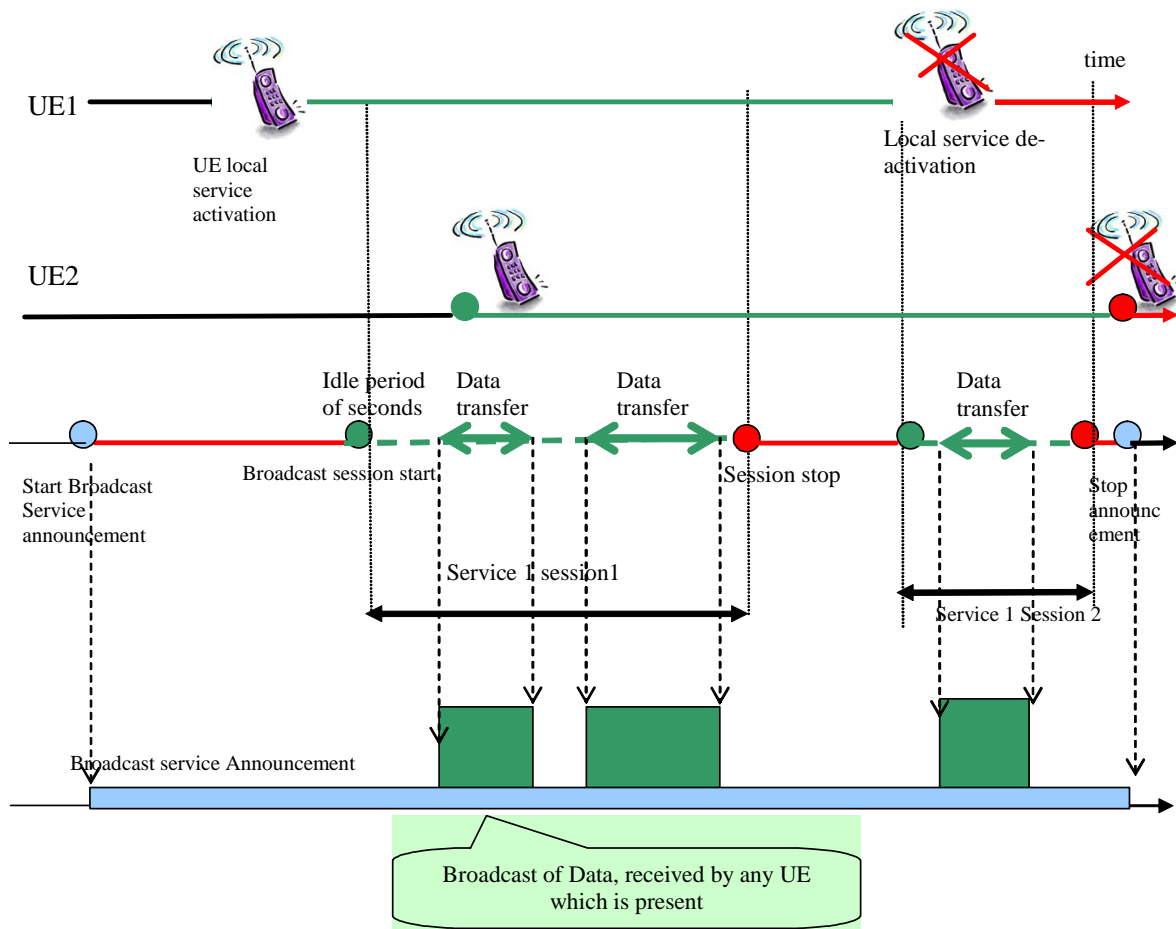


Figure 5: Broadcast service timeline

4.4.3.1 Service announcement

Informs UEs about forthcoming MBMS user services. Also see clause 4.4.1.2 on Multicast mode.

4.4.3.1a UE local service activation

The MBMS user service part in the UE initiates reception of the MBMS bearer service to receive an MBMS user service. In case one MBMS user service is carried by more than one MBMS bearer service, the UE may need to initiate the reception of multiple relevant MBMS bearer services to receive the MBMS user service (see clause 8.12).

4.4.3.2 Session Start

Session Start is the point at which the BM-SC is ready to send data. This can be identified with the start of a "Broadcast session" as defined in TS 22.146 [2]. Session Start is the trigger for bearer resource establishment for MBMS data transfer. If an MBMS user service is carried by more than one MBMS bearer service, a Session Start message is sent for each MBMS bearer service. In that case the UE may need to initiate the reception of multiple relevant MBMS bearer services to receive the MBMS user service.

4.4.3.3 MBMS notification

Informs the UEs about forthcoming (and potentially about ongoing) MBMS broadcast data transfer.

4.4.3.4 Data transfer

It is the phase when MBMS data are transferred to the UEs.

4.4.3.5 Session Stop

It is the point at which the MBMS user service determines that there will be no more data to send for some period of time – this period being long enough to justify removal of bearer resources associated with the service. At Session Stop, the bearer resources are released.

4.4.3.6 Session Update

Session Update is used to update specific parameters of an ongoing MBMS Broadcast session. Parameters which can be updated are MBMS Service Area, and/or the List of SGSNs/MMEs (only from BM-SC to GGSN or MBMS GW). A Session Update received in one node, results in a Session Update being sent to downstream nodes, to inform of the changed MBMS Service Area. When a Session Update is received in the GGSN or MBMS GW including the List of SGSN/MME parameter, it results in a Session Start being sent to new downstream nodes, and in a Session Stop being sent to downstream nodes that have been removed from the list.

In order to support the update of the priority of a broadcast data flow of a group communication service as specified in TS 23.468 [24], the QoS(ARP parameter only) of an MBMS Broadcast service session may be modified by the Session Update procedure.

NOTE: The update of the QoS(ARP) only applies to the E-UTRAN.

4.4.4 Broadcast Mode timeline

4.4.4.1 Period between Service Announcement and Session Start

Same as for Multicast mode.

4.4.4.2 Period between Session Start and First Data Arrival

Same as for Multicast mode.

4.4.4.3 Period between Session Start and Session Stop

Same as for Multicast mode.

5 Functional Entities To Support MBMS

5.0 General

To provide MBMS bearer services existing functional entities, GGSN, MME, SGSN, eNodeB/RNC/BSC, perform several MBMS related functions and procedures, some of which are specific to MBMS. An MBMS specific functional entity – Broadcast Multicast Service Centre (BM-SC) supports various MBMS user service specific services such as provisioning and delivery. In the EPS a functional entity MBMS GW exists at the edge between the CN and the BM-SC.

5.1 Broadcast-Multicast Service Centre (BM-SC)

5.1.0 General

The BM-SC provides functions for MBMS user service provisioning and delivery. It may serve as an entry point for content provider MBMS transmissions, used to authorise and initiate MBMS Bearer Services within the PLMN and can be used to schedule and deliver MBMS transmissions.

The BM-SC is a functional entity, which must exist for each MBMS User Service.

The BM-SC consists of the following sub-functions:

- Membership function;
- Session and Transmission function;
- Proxy and Transport function;
- Service Announcement function;
- Security function.
- Content synchronization for MBMS in UTRAN.
- Content synchronization for MBMS in E-UTRAN for broadcast mode.
- Header compression for MBSFN MBMS data in UTRAN.
- Header compression for Mission Critical services using MBMS in E-UTRAN (see TS 23.468 [24]).

NOTE: Header compression of MBMS data is not supported in E-UTRAN only for Mission Critical services in this Release.

- For MBMS bearer service for NB or M UE categories, provide mapping from UE Capability for MBMS as defined in TS 23.682 [29] to QCI as defined in clause 6.3.2.

This clause describes BM-SC functions, which are defined for the standardised MBMS User Services.

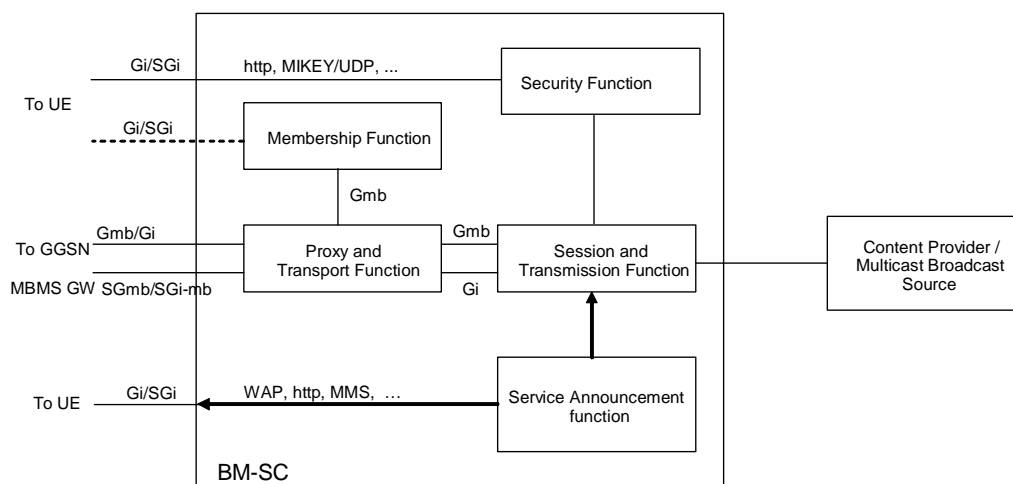


Figure 5a: BM-SC functional structure

5.1.1 Membership Function

The BM-SC Membership function provides authorization for UEs requesting to activate an MBMS service.

The Membership function may have subscription data of MBMS service users.

The Membership Function may generate charging records for MBMS service users.

The Membership Function is an MBMS bearer service level function, but it may also provide user service level functions e.g. membership management etc. In this case it does also have a Gi/SGi interface.

5.1.2 Session and Transmission Function

The BM-SC Session and Transmission Function shall be able to schedule MBMS session transmissions.

The BM-SC Session and Transmission Function should be able to schedule MBMS session retransmissions, and label each MBMS session with an MBMS Session Identifier to allow the UE to distinguish the MBMS session retransmissions. The BM-SC Session and Transmission Function allocates TMGIs.

Each transmission and subsequent retransmission(s) of a specific MBMS session are identifiable by a common MBMS Session Identifier (2-3 Octets) passed at the application layer in the content, and also passed in a shortened form (i.e. the least significant octet) in the MBMS Session Start Request message to the eNodeBs/RNCs/BSCs. The full MBMS Session Identifier should be used by the UE to identify an MBMS session when completing point-to-point repair, while the shortened MBMS Session Identifier is included by the RANs in the notification messages for MBMS

The BM-SC Session and Transmission Function shall be able to provide the MBMS GW or GGSN with transport associated parameters such as quality-of-service and MBMS service area.

The BM-SC Session and Transmission Function shall be able to initiate and terminate MBMS bearer resources prior to and following transmission of MBMS data.

The BM-SC Session and Transmission Function should be able to send MBMS data. It could also apply favourable error resilient schemes e.g. specialized MBMS codecs or Forward Error Correction schemes.

When IP multicast is used for distribution of payload from GGSN to RNC or from MBMS GW to eNodeB and RNC, the BM-SC Session and Transmission Function shall include synchronization information for the MBMS payload. If the header compression is used over the radio, the compression is done in the BM-SC. The details of synchronization and header compression for the MBMS payload are specified in TS 25.346 [10] and TS 25.446 [18].

The BM-SC Session and Transmission Function should be able to authenticate and authorize external sources and accept content from them.

The Session and Transmission Function is user service level function and it triggers bearer level functions when MBMS sessions are scheduled.

5.1.3 Proxy and Transport Function

The BM-SC Proxy and Transport Function is a Proxy Agent for signalling over SGmb and Gmb reference points between MBMS GWs/GGSNs and other BM-SC sub-functions, e.g. the BM-SC Membership Function and the BM-SC Session and Transmission Function. Further, the BM-SC Proxy and Transport Function shall also be able to handle when BM-SC functions for different MBMS services are provided by multiple physical network elements. Routing of the different signalling interactions shall be transparent to the MBMS GW and the GGSN.

The BM-SC Proxy and Transport function shall be able to generate charging records for content provider charging of transmitted data. Content provider name is provided to BM-SC Proxy and Transport function over SGmb/Gmb at session start.

The BM-SC Proxy and Transport function may act as an intermediate device for the MBMS data sent from the BM-SC Session and Transmission function to the MBMS GW or GGSN.

The Proxy and Transport Function may be divided further into a Proxy function managing the control plane (SGmb/Gmb) and a Transport function managing the multicast payload.

The Proxy and Transport Function is an MBMS bearer service function.

5.1.4 Service Announcement Function

The BM-SC Service Announcement function shall be able to provide service announcements for multicast and broadcast MBMS user services.

The BM-SC Service Announcement function shall be able to provide the UE with media descriptions specifying the media to be delivered as part of an MBMS user service (e.g. type of video and audio encodings).

The BM-SC Service Announcement function shall be able to provide the UE with MBMS session descriptions specifying the MBMS sessions to be delivered as part of an MBMS user service (e.g. multicast service identification, addressing, time of transmission, etc.).

The BM-SC Service Announcement function shall be able to deliver media and session descriptions by means of service announcements using IETF specified protocols over MBMS multicast and broadcast bearer services.

The Service Announcement Function is a user service level function.

The following mechanisms should be supported for service announcement. Service announcements may be triggered by the BM-SC but are not necessarily sent by the BM-SC:

- MBMS bearer capabilities to advertise MBMS user Services;
- PUSH mechanism (WAP push);
- URL (WAP, HTTP);
- SMS (point-to-point);
- SMS-CB cell broadcast.

Other mechanisms could be considered in future releases.

5.1.4a MBMS Security Function

MBMS user services may use the Security functions for integrity and/or confidentiality protection of MBMS data. The MBMS Security function is used for distributing MBMS keys (Key Distribution Function) to authorized UEs. Detailed description of the security functions is provided in (TS 33.246 [5]).

5.1.5 MBMS Content Transfer for the same MBMS User Service for GPRS and EPS

5.1.5.1 General

For GPRS, although these procedures mention GERAN and UTRAN extensively, only the BM-SC (which renders the content differently) and the SGSN have to implement functionality to deliver this. The GGSN, RNC and BSC shall all be transparent to this functionality.

For EPS, although these procedures mention UTRAN and E-UTRAN extensively, only the BM-SC and the MBMS-GW have to implement functionality to deliver this. The MME, S4-SGSN, RNC and eNodeB remain transparent to this functionality.

5.1.5.2 Separate MBMS Bearer Services for the same MBMS User Service

The same MBMS user service may transfer its data on separate MBMS bearer services for different access technologies, typically with different QoS, e.g. for GPRS using separate MBMS bearer services for GERAN and UTRAN or for EPS using separate MBMS bearer services for UTRAN and E-UTRAN. For this purpose two IP multicast addresses (multicast mode only) and/or two TMGIs should be allocated for the same MBMS user service. One IP multicast address (multicast mode only) and/or one TMGI is for, e.g. GERAN, and another IP multicast address (multicast mode) and/or another TMGI is for, e.g. UTRAN. The detailed impacts on the network nodes are listed below:

- a) The service announcement instructs the UE to join two multicast MBMS bearer services (e.g. for GPRS one is for GERAN and the other is for UTRAN), i.e. for multicast mode, two IP multicast addresses that are allocated in the BM-SC are sent to UE within one service announcement message.

NOTE 1: One MBMS User Service may use several MBMS Bearer Services.

- b) A UE that might move between areas covered by different access technologies activates both MBMS bearer services.
- c) The UE monitors the paging/notification channels for both TMGIs and receives MBMS data when transferred by the MBMS bearer services.
- d) When the BM-SC needs to deliver the content, the BM-SC produces two sets of MBMS data from the same content and sends independent Session Start messages for both of the MBMS bearer services. The "different" content streams for the same MBMS user service are sent on the separate MBMS bearer services. For GPRS, a 2G/3G indicator in the Session Start message (which the GGSN passes transparently to the SGSN) indicates whether the content should be delivered in GERAN-only or UTRAN-only (or both) coverage areas.

- e) For GPRS, the SGSN uses the 2G/3G indicator to decide whether a MBMS Session Start Request message should be sent to the BSCs and/or the RNCs.

NOTE 2: See clause 7.3 for potential issues.

5.1.5.3 Same MBMS Bearer Service for the same MBMS User Service

The same MBMS user service may also transfer its data on the same MBMS bearer service for multiple access technologies, i.e. for GPRS using a same MBMS bearer service for GERAN and UTRAN or for EPS using a same MBMS bearer service for UTRAN and E-UTRAN. For this purpose one IP multicast address (multicast mode only) and/or one TMGI should be allocated for the same MBMS user service. In such application, the "different" content for the same MBMS user service are sent in separate MBMS Sessions sequentially. For GPRS, the 2G/3G indicator in the Session Start message indicates whether the MBMS session should be delivered in GERAN-only or UTRAN-only (or both) coverage areas and the SGSN uses the 2G/3G indicator to decide whether a MBMS Session Start Request message should be sent to the BSCs and/or the RNCs.

NOTE: The same MBMS bearer service for both UTRAN and E-UTRAN may be used if the BM-SC does not execute header compression for the MBMS service.

5.1.6 Location Dependent Content Transfer for the same MBMS User Service (Broadcast Mode only)

Some MBMS user services may broadcast different content in different areas of the network. In such case the UE is not aware of the relation between location and content, i.e. the UE just activates the reception of the service and receives the content that is relevant for its location.

The BM-SC controls which content is broadcasted in which area by establishing a separate MBMS bearer service for each content data flow. All MBMS bearer services of the same MBMS user service share the same TMGI but bear different Flow Identifiers. The BM-SC allocates the Flow Identifier during the MBMS Session Start procedure and initiates a separate session for each content data flow. For IP Multicast support in EPS, the MBMS GW allocates an IP Multicast Address based on the TMGI and Flow Identifier (broadcast mode only). Since in any specific location only one version of the content shall be available at any point in time, the MBMS Service Areas of each session of a same user service shall not overlap; this shall be ensured by proper configuration of the service in the BM-SC. The RNC and the eNodeB ultimately enforces this constraint by rejecting any session start request with the same TMGI as an already active session if there is any overlap in the respective service areas. As indicated above, the UE is unaware of the Flow Identifier and of the existence of multiple sessions for the same MBMS user service.

5.1.7 MBMS User Service Consumption Reporting (Broadcast mode only)

MBMS User Service Consumption Reporting functionality better enables the MBMS service operator to decide in a dynamic manner, based on real time demand of an MBMS User Service, to either:

- establish service delivery over an MBMS bearer;
- tear down service delivery over an already established MBMS bearer to only leave service delivery over unicast.

By permitting these decisions to be made dynamically, this functionality enables the MBMS service operator to better utilize overall network resources in supporting unicast and/or MBMS services delivery. The MBMS service consumption reporting procedure is optional and initiated by the MBMS receiver (UE) to the BM-SC, in accordance with parameters in the Associated Delivery Procedure description as defined in TS 26.346 [7].

The BM-SC can specify the nominal periodicity by which the UE, when it is continuously consuming the service of concern, performs consumption reporting. The BM-SC can specify whether the UE includes its current location (serving cell-ID or MBMS SAI) when it performs consumption reporting. The location type is selected based on the Associated Delivery Procedure Description settings, or the Mood Management Object (MO) on the UE, or via UE pre-configuration rules. Typically, the BM-SC is pre-configured, via OAM procedures, with a threshold per location (number of UEs reporting consumption) to be used in making the decision to switch delivery method.

The service offloaded to the MBMS bearer could be either one delivered by unicast not involving MBMS User Services, or an MBMS User Service delivered on a unicast bearer. Furthermore, the BM-SC can determine, based on Consumption Reporting from UEs consuming that MBMS User Service over an MBMS bearer, the interest for that MBMS User Service has decreased sufficiently to terminate the MBMS bearer. In such event, UEs may continue to

receive the service but over unicast instead, either not involving the MBMS User Service, or as an MBMS User Service over unicast. Continued consumption monitoring by the BM-SC, and consumption reporting by UEs, may be employed to facilitate further switching, over time, between bearer modes.

Along with MBMS Consumption Reporting, the use of MBMS operation on Demand (clause 7.4) permits certain content that is initially delivered over the unicast network to be turned into an MBMS User Service, in order to efficiently use network resources when the traffic exceeds a certain threshold.

5.2 User Equipment

The UE shall support functions for the activation/deactivation of the MBMS bearer service.

Once a particular MBMS bearer service is activated, no further explicit user request is required to receive MBMS data although the user may be notified that data transfer is about to start.

The UE shall support security functions as appropriate for MBMS.

The UE should, depending on terminal capabilities, be able to receive MBMS user service announcements, paging information (non MBMS specific) and support simultaneous services (for example the user can originate or receive a call or send and receive messages whilst receiving MBMS video content). Reception of this paging or announcements may however, create losses in the MBMS data reception. The MBMS user service should be able to cope with such losses.

A UE in Multicast Mode shall be able to synchronise with the SGSN, which of its MBMS UE contexts are still active.

Depending upon terminal capability, UEs may be able to store MBMS data. This may involve DRM but this is out of scope of this specification.

The MBMS Session Identifier contained in the notification to the UE shall enable the UE to decide whether it needs to ignore the forthcoming transmission of MBMS session (e.g. because the UE has already received this MBMS session).

5.3 UTRAN/GERAN

UTRAN/GERAN are responsible for efficiently delivering MBMS data to the designated MBMS service area.

Efficient delivery of MBMS data in multicast mode may require mechanisms in the UTRAN/GERAN, e.g. the number of users within a cell prior to and during MBMS transmission could be used to choose an appropriate radio bearer.

MBMS transmissions may be initiated and terminated intermittently. The UTRAN/GERAN shall support the initiation and termination of MBMS transmissions by the core-network. Further, the UTRAN/GERAN shall be able to receive MBMS data from the core-network over Iu bearers shared by many UEs.

.UTRAN (and GERAN in Iu mode) may also support reception of MBMS data from the core-network over IP multicast. When UTRAN (or GERAN Iu mode) supports IP multicast reception, the UTRAN (GERAN Iu mode) should support TEID coordination, i.e. avoid using the same value ranges for its own unicast TEIDs as are used by the GGSN and MBMS GW for the Common TEID-Us (C-TEIDs). If clashes anyhow occur, the RNC (Iu mode BSC) shall reject IP multicast reception and fallback to normal shared Iu bearers for reception of MBMS data.

The UTRAN/GERAN shall support both intra-RNC/BSC and inter-RNC/BSC mobility of MBMS receivers. Mobility is expected to cause limited data loss. Therefore, MBMS user services should be able to cope with potential data loss caused by UE mobility.

The UTRAN/GERAN shall be able to transmit MBMS user service announcements, paging information (non MBMS specific) and support other services in parallel with MBMS (for example depending on terminal capabilities the user could originate or receive a call or send and receive messages whilst receiving MBMS video content).

5.4 SGSN

The SGSN's role within the MBMS architecture is to perform MBMS bearer service control functions for each individual UE and to provide MBMS transmissions to UTRAN/GERAN. When IP multicast is used for MBMS

transmissions the SGSN is bypassed in the 3G case (and GERAN Iu mode case), i.e. MBMS data sent directly from GGSN to RNC (or Iu mode BSC) or from MBMS GW to RNC in EPS.

The SGSN shall provide support for intra-SGSN and inter-SGSN mobility procedures. Specifically this requires the SGSN to store a user-specific MBMS UE context for each activated multicast MBMS bearer service and to pass these contexts to the new SGSN during inter-SGSN mobility procedures.

The SGSN shall be able to indicate its MBMS support to the UE as well as it shall be able to synchronise with the UE, which of the UE's MBMS UE contexts are still active.

The SGSN shall be able to generate charging data per multicast MBMS bearer service for each user. The SGSN does not perform on-line charging for either the MBMS bearer service or the MBMS user service (this is handled in the BM-SC).

The SGSN shall be able to establish Iu and Gn bearers shared by many users upon receiving a session start from the GGSN. Likewise, the SGSN shall be able to tear down these bearers upon instruction from the GGSN.

When MBMS in EPS for UTRAN access is supported, the SGSN shall support the necessary control plane functions provided via Sn interface to/from MBMS GW.

5.5 GGSN

The GGSN role within the MBMS architecture is to serve as an entry point for IP multicast traffic as MBMS data. Upon notification from the BM-SC the GGSN shall be able to request the establishment of a bearer plane for a broadcast or multicast MBMS transmission. Further, upon BM-SC notification the GGSN shall be able to tear down the established bearer plane. Bearer plane establishment for multicast services is carried out towards those SGSNs and /or RNCs that have requested to receive transmissions for the specific multicast MBMS bearer service. For an optimized bearer plane, IP multicast transport may be used within the core network. The bearer plane is then established between the GGSN and the RNCs.

When IP multicast is used for distribution payload from GGSN to RNC, and one or more RNC rejects IP multicast distribution, the GGSN should in parallel with the IP multicast distribution provide legacy MBMS payload distribution (i.e. using point-to-point GTP-tunnels) via the SGSNs to these RNCs. In that case, the GGSN shall remove the synchronisation protocol elements included by the BM-SC (i.e. synchronization information and the compressed header) before forwarding the payload on the legacy path (see TS 25.446 [18]).

The GGSN shall be able to receive MBMS specific IP multicast traffic and to route this data to the proper IP multicast distribution address and/or GTP tunnels set-up as part of the MBMS bearer service.

The GGSN may also provide features that support the MBMS bearer service that are not exclusive to MBMS. Examples are:

- Message Screening (not needed if the MBMS sources are internal in the PLMN);
- Charging Data Collection;
- Flow Based Charging (see clause 10).

5.6 MBMS Data Sources and Content Provider

For group communications related services, the standard interface to and from BM-SC is MB2 (TS 23.468 [24], TS 29.468 [27]). For services other than Group Communications, the standard reference point between the content provider and the BM-SC is defined in TS 26.348 [31].

5.7 Other Functional Element

5.7.1 Void

5.7.2 CBC

The Cell Broadcast Centre (CBC) may be used to announce MBMS user services to the users.

5.7.3 Void

5.8 Void

5.9 Functional Elements for the Evolved Packet System

5.9.1 MBMS GW

One or more MBMS GW function entities may be used in a PLMN.

Note that MBMS GW may be stand alone or co-located with other network elements such as BM-SC or combined S-GW/PDN GW.

MBMS GW functions include:

- It provides an interface for entities using MBMS bearers through the SGi-mb (user plane) reference point;
- It provides an interface for entities using MBMS bearers through the SGmb (control plane) reference point;
- IP multicast distribution of MBMS user plane data to E-UTRAN (M1 reference point). If the MBMS-GW has allocated both an IPv4 and an IPv6 IP Multicast address, IP multicast distribution of MBMS user plane data is performed towards both IP Multicast addresses, using the same C-TEID;
- IP multicast distribution of MBMS user plane data to RNCs (M1 reference point);

NOTE 1: In case of mobility in or out from an MBMS service area, the service continuity is handled by the Service Layer (in UE and network).

- In the case of UTRAN access, it allocates either an IPv4 or an IPv6 IP Multicast address. An RNC should join to IP Multicast distribution to receive the MBMS data. The IP Multicast address together with the IP address of the multicast source (SSM) and a C-TEID is provided to the RNC via SGSN;
- In the case of E-UTRAN access, and if the MBMS-GW supports both IPv4 and IPv6, it may allocate both an IPv4 and an IPv6 IP Multicast address (e.g. in deployments with a mix of IPv4 and IPv6 eNodeBs and/or backhauls). Otherwise it allocates either an IPv4 or an IPv6 IP Multicast address. An eNodeB should join to IP Multicast distribution using one IP Multicast address (either IPv4 or IPv6) to receive the MBMS data. When a single IP Multicast address is allocated by the MBMS-GW, this IP Multicast address together with the IP address of the multicast source (SSM) and a C-TEID is provided to the eNodeB via MME. When two IP Multicast addresses are allocated by the MBMS-GW:
 - each of them is associated with an IP address of the multicast source (SSM);
 - the same C-TEID is associated to both IP Multicast addresses;
 - both IP Multicast addresses together with the corresponding IP addresses of the multicast source (SSM) and the C-TEID is provided to the E-UTRAN via MME;

NOTE 2: The C-TEID is allocated based on MBMS bearer service uniquely identified by the TMGI and Flow Identifier (Broadcast mode only).

The IP Multicast Address or, optionally in case of E-UTRAN access and if the MBMS-GW supports both IPv4 and IPv6, both an IPv4 and an IPv6 IP Multicast address are either uniquely allocated for the MBMS bearer service (identified by the TMGI and Flow Identifier), or it may be reused from another active MBMS bearer service with an identical service area and of the same QoS.

NOTE 3: Care should be taken to avoid clashes among C-TEIDs generated in MBMS-GWs. and UTRAN/E-UTRAN.

- An MBMS GW may support fall back to point to point mode where applicable for UTRAN access;
- An MBMS GW can communicate with multiple control plane entities (i.e. MME, SGSN and BM-SCs).

5.9.2 MBMS Control plane function

The MBMS control plane function is supported by MME for E-UTRAN access and by SGSN for UTRAN access. For SGSN functions, see clause 5.4.

One or more MBMS control plane functional entities are used in a PLMN.

MME supports the following functions in order to enable MBMS support for E-UTRAN:

- Session control of MBMS bearers to the E-UTRAN access (including reliable delivery of Session Start/Session Stop to E-UTRAN);
- Transmit Session control messages towards multiple E-UTRAN nodes;
- When connected to multiple MCEs (see TS 36.300 [17]), the MME should filter the distribution of Session Control message to the MCEs based on the MBMS service area;
- Provision of the list of MBMS Service Areas served by the MCE to the MME using M3AP Setup signalling;
- Transmit Session Control messages towards the necessary E-UTRAN nodes to ensure the distribution of content from ongoing MBMS sessions:
 - if an MCE sets up (or restarts) an M3AP connection with the MME, by applying the MCE Failure procedure specified in TS 23.007 [26]; or
 - if the MCE modifies the list of MBMS Service Areas it serves, by triggering the MCE Configuration Update procedure.
- It provides an Sm interface to the MBMS GW function: it receives MBMS service control messages and the IP Multicast address or, optionally, (e.g. in deployments with a mix of IPv4 and IPv6 eNodeBs and/or backhauls) and if the MBMS-GW supports both IPv4 and IPv6, both an IPv4 and an IPv6 IP Multicast address for MBMS data reception from MBMS GW function over the Sm interface.

NOTE: When a UE leaves or enters MBMS bearer coverage, the service continuity is handled by the Service Layer (in UE and network).

5.9.3 E-UTRAN

E-UTRAN is responsible for efficiently delivering MBMS data to the designated MBMS service area.

The E-UTRAN for MBMS in EPS shall have capability of receiving IP multicast distribution.

In order to provide the appropriate MBMS bearer service for NB or M UE categories, E-UTRAN/MCE may map received QCI into appropriate radio configurations for the appropriate UE categories, when such mapping is configured as described in clause 6.3.2.

6 MBMS Attributes and Parameters

6.1 MBMS UE Context

The MBMS UE Context is used in Multicast Mode and contains UE-specific information related to a particular MBMS bearer service that the UE has joined. An MBMS UE Context is created in the UE, SGSN, GGSN and BM-SC Membership function when the UE joins an MBMS bearer service. In the SGSN, an MBMS UE Context is also created as a result of an inter-SGSN routing area update after the transfer of the MBMS UE Context from the old SGSN.

In Iu mode, all MBMS UE Contexts of a UE are provided via MBMS UE Linking mechanism to the BSC/SRNC at least when the first PS RAB is established for the UE, or when the UE performs MBMS Multicast Service Activation. MBMS UE Contexts are provided to the Iu mode BSC/SRNC regardless whether MBMS Sessions are ongoing or not (i.e. before, between and after Sessions). In addition, all MBMS UE Contexts of a UE are provided via MBMS UE Linking mechanism when a UE, which has an MBMS UE Context active, moves to PMM-Connected state via the MBMS Service Request procedure for the purpose of MBMS.

In the UE and SGSN, the MBMS UE Context is stored as part of the MM Context for the UE. The MBMS UE Context is stored in the GGSN. There is one MBMS UE Context per MBMS bearer service that the UE has joined.

In the Iu mode BSC/RNC, the MBMS UE Contexts are stored as part of the UE Context of the BSC/RNC.

The content of the MBMS UE Context is described in Table 1.

Table 1: MBMS UE Context

Parameter	Description	UE	SGSN	GGSN	RNC	BSC	BM-SC
IP multicast address	IP multicast address identifying an MBMS bearer that the UE has joined.	X	X	X	X	Iu - X Gb - none	X
APN	Access Point Name on which this IP multicast address is defined.	X	X	X	X	Iu - X Gb - none	X
GGSN Address in Use	The IP address of the GGSN currently used		X				
SGSN address	The IP address of SGSN			X			
TMGI	Temporary Mobile Group Identity allocated to the MBMS bearer.	X	X		X	Iu - X Gb - none	
RAI	The Routing Area Identity		(5)				
Linked NSAPI	NSAPI of the PDP context used by the UE to carry IGMP/MLD signalling.	X	X				
IMSI	IMSI identifying the user.	(1)	(1)	X	(2)	Iu - (2) Gb - (3)	X
TI	Transaction Identifier	X	X				
TEID for Control Plane	The Tunnel Endpoint Identifier for the control plane between SGSN and GGSN.		X	X			
MBMS_NSAPI	Network layer Service Access Point Identifier which identifies an MBMS UE Context.	X	X	X	X		
Additional MBMS Trace Info	Identifies additional information required to perform trace.		(4)	(4)			(4)
Trace Reference	Identifies a record or a collection of records for a particular trace.		(4)	(4)	(4)	(4)	
Trace Type	Indicates the type of trace.		(4)	(4)	(4)	(4)	
Trigger Id	Identifies the entity that initiated the trace.		(4)	(4)	(4)	(4)	
OMC Identity	Identifies the OMC that shall receive the trace record(s).		(4)	(4)	(4)	(4)	
(1)	In the UE and SGSN, the IMSI is available within the MM Context which contains the MBMS UE Context.						
(2)	The IMSI is available within the UE Context which contains the MBMS UE Context.						
(3)	IMSI availability does not depend on MBMS.						
(4)	Trace parameters are only stored if trace is activated.						
(5)	RAI is available within the MM Context of the UE.						

6.2 MBMS Bearer Context

The MBMS Bearer Context, which is referred to as MBMS Service Context in RAN, contains all information describing a particular MBMS bearer service and is created in each node involved in the delivery of the MBMS data.

In MBMS multicast mode a MBMS Bearer Context is created in the SGSN and GGSN when the first MBMS UE Context is created in the node or when a downstream node requests it. The MBMS Bearer Context is statically configured in the BM-SC Proxy and Transport Function; how this is done is out of the scope of this specification. The MBMS Bearer Context is created in the Iu mode BSC and in SRNC when a first MBMS UE Context is created in BSC/SRNC. MBMS Session Start procedure may create MBMS Bearer Context in a BSC/RNC which has no MBMS Bearer Context yet.

In MBMS broadcast mode, an MBMS Bearer Context is created in the MME/SGSN, MBMS GW/GGSN and RAN as a result of the MBMS Session Start procedure.

An MBMS Bearer Context, once created, can be in one of two states reflecting the bearer plane resource status of the corresponding MBMS bearer service.

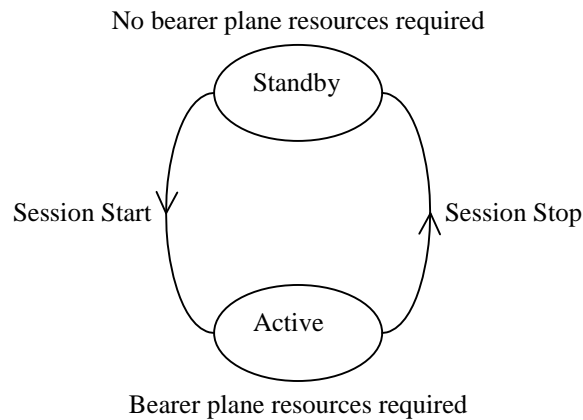


Figure 6: MBMS Bearer Context State Model

'Active' reflects the state of an MBMS Bearer Context in which bearer plane resources are required in the network for the transfer of MBMS data. This state is maintained as long as there is a corresponding MBMS session ongoing.

'Standby' reflects the state of an MBMS Bearer Context in which no bearer plane resources are required in the network for the transfer of MBMS data. This state is maintained as long as there is no corresponding MBMS session ongoing.

In MBMS broadcast mode, the MBMS Bearer Context is always implicitly in state 'active' (since it is created as a result of an MBMS Session Start procedure) and does not use the MBMS Bearer Context State Model in Figure 6.

The content of the MBMS Bearer Context is described in Table 2.

Table 2: MBMS Bearer Context for GPRS

Parameter	Description	RAN	SGSN	GGSN	BM-SC
Multicast/broadcast mode	MBMS bearer service in broadcast or multicast mode	X	X	X	X
IP multicast address (multicast mode only)	IP multicast address identifying the MBMS bearer described by this MBMS Bearer Context.	X	X	X	X
APN (multicast mode only)	Access Point Name on which this IP multicast address is defined.	X	X	X	X
TMGI	Temporary Mobile Group Identity allocated to the MBMS bearer service.	X	X	X	X
Flow Identifier (broadcast mode only)	Location dependent subflow of the MBMS bearer service. When present, the Flow Identifier together with the TMGI uniquely identify the MBMS Bearer Context.		X (note 1)	X (note 1)	X (note 1)
GGSN TEID-C	Tunnel Endpoint Identifier of GGSN for control plane.		X		
GGSN IP Address for Control Plane in use	The IP address of the GGSN used for the control plane.		X (note 4)		
State	State of bearer plane resources ('standby' or 'active')	X	X	X	X
Required MBMS Bearer Capabilities (multicast mode only)	Minimum bearer capabilities the UE needs to support		X	X	X
QoS	Quality of Service required for the MBMS bearer service.	X	X	X	X
MBMS Service Area	Area over which the MBMS bearer service has to be distributed.	X	X	X	X
List of downstream nodes	List of downstream nodes that have requested the MBMS bearer service and to which notifications and MBMS data have to be forwarded.		X (note 5)	X (notes 3, 4,6)	X
Number of UEs (multicast mode only)	Number of UEs hosted by the node that have joined the multicast MBMS bearer service.		X	X	
List of PMM-CONNECTED UEs	List of PMM-CONNECTED UEs which have activated an MBMS service.	X ²⁾			
List of RAs (multicast mode only)	List of RAs, each of which contains at least one UE that has joined the MBMS bearer service.	X ¹⁾	X ¹⁾		
IP multicast and Source address for distribution	IP addresses identifying the SSM channel used for user plane distribution on the backbone network	X	X	X	
MBMS HC indicator	Flag set by BM-SC if it is using compressed header for the payload.		X	X	X
<p>NOTE 1: It is an optional parameter.</p> <p>NOTE 2: It is available only for UTRAN, not for GERAN.</p> <p>NOTE 3: For GGSN, the list at least includes the couples of the SGSN IP addresses and TEIDs for control plane, and the couples for user plane.</p> <p>NOTE 4: GSN that supports both IPv4 and IPv6 address types, stores only the IP address in use.</p> <p>NOTE 5: For SGSN, the list includes the registered DRNC.</p> <p>NOTE 6: The GGSN shall include SGSN Address for user data and TEID-U for downstream SGSNs that do not accept the IP multicast backbone distribution.</p>					

Table 3: MBMS Bearer Context for EPS (E-UTRAN/UTRAN) broadcast mode only

Parameter	Description	RAN	MME/ SGSN	MBMS- GW	BM-SC
MBMS GW TEID-C	Tunnel Endpoint Identifier of MBMS GW for control plane.		X		
TMGI	Temporary Mobile Group Identity allocated to the MBMS bearer service.	X	X	X	X
Flow Identifier	Location dependent subflow of the MBMS bearer service. When present, the Flow Identifier together with the TMGI uniquely identify the MBMS Bearer Context.		X (note 1)	X (note 1)	X (note 1)
MBMS GW IP Address for Control Plane in use	The IP address(es) of the MBMS GW used for the control plane.		X (note 2)		
MBMS GW IP Address for User Plane in use	The IP address of the MBMS GW used for the user plane.		X (note 2)		
C-TEID	Common Tunnel Endpoint Identifier of MBMS GW for user plane	X		X	
QoS parameters	Quality of Service required for the MBMS bearer service.	X	X	X	X
MBMS Service Area	Area over which the MBMS bearer service has to be distributed.	X	X	X	X
List of downstream nodes	List of downstream nodes that have requested the MBMS bearer service and to which notifications have to be forwarded.		X (note 3)	X (note 4)	X
IP multicast address(es) and IP Source address(es) for distribution	IP addresses identifying the SSM channel used for user plane distribution on the backbone network. The IP multicast address and paired IP address of the multicast source shall be of the same IP type.	X	X (note 6)	X (note 6)	
MBMS HC indicator	Flag set by BM-SC if it is using compressed header for the payload.		X (note 5)		X (note 5)
SGSN IP Address and TEID for User Plane over Sn-U	The IP address and TEID of SGSN used for the user plane over Sn-U when some RNCs have not accepted IP multicast distribution.			X	
List of cell ID(s)	Cell(s) for which the MBMS bearer service may be distributed.	X (note 7)	X (note 7)	X (note 7)	X (note 7)
<p>NOTE 1: It is an optional parameter.</p> <p>NOTE 2: An MBMS GW that supports both IPv4 and IPv6 address types, stores both IP addresses.</p> <p>NOTE 3: For SGSN, the list includes the registered DRNC.</p> <p>NOTE 4: For MBMS GW, the list includes the couples of the SGSNs and MMEs IP addresses and TEIDs for control plane.</p> <p>NOTE 5: Header Compression is only supported for UTRAN and for Mission Critical services over E-UTRAN for this Release.</p> <p>NOTE 6: An MBMS-GW or an MME that supports IPv4 and IPv6 M1 multicast address types stores both IPv4 and IPv6 pairs of source and multicast addresses. The alternative IP multicast address and paired IP address of the multicast source are of the same IP type.</p> <p>NOTE 7: It is applicable for LTE only.</p>					

6.3 Quality-of-Service

6.3.1 Quality-of-Service for GPRS

It shall be possible for the network to control quality-of-service parameters for sessions of multicast and broadcast MBMS bearer services. All QoS attributes related to the UMTS bearer service described in TS 23.107 [3] are applicable to MBMS bearer services. Compared to point-to-point bearer services the following limitations exist:

- For **traffic class**, only the background and streaming classes shall be supported.
- For **SDU error ratio**, only higher values are supported, i.e. the values describing higher numbers of lost or corrupted SDUs (actual values are for the background and streaming classes are 10^{-2} and 10^{-1}).
- For **maximum bit-rate**, see the values described in TS 22.246 [6].

- For **Guaranteed bit rate** of the Streaming Traffic Class: depending on radio resource usage by other services, some cells of the MBMS Service Area may not have sufficient resources available for a MBMS Session. The RAN may decide not to establish RB in cells where requested resources are not available. The RAN does not reject a MBMS Session Start Request message even if one or more cells do not have enough resources to establish radio bearers.

MBMS bearer services of background class are best suited for the transport of MBMS user services such as messaging or downloading. Buffering, shaping schemes and packet dropping may be applied to the traffic flow to adapt to the available resources and changing network conditions. The total transfer time is not critical for background class bearer services since the content must normally have been received in totality and stored in the UE before the user can access it.

MBMS bearer services of streaming class are best suited for the transport of MBMS user services such as streaming. As for point-to-point bearer services, the network should minimise the packet transfer delay of streaming class bearer services as far as possible. Packet dropping should be the preferred traffic conditioning action applied to the traffic flow to adapt to the available resources.

The principle difference between background and streaming classes for MBMS is the support of a guaranteed bit-rate in the streaming case. No indication is provided to the UE in cases where the RAN cannot provide the requested QoS. As a result, some UEs may not receive the MBMS session or parts of it. For background class, the RAN may continue to distribute data in congestion conditions but at potentially high packet loss rates, therefore the MBMS user service will have to provide sufficient redundancy within the data to be able to cope with the high packet loss.

MBMS user services that would normally use MBMS bearer services of background class may however decide to use a streaming class MBMS bearer service if the MBMS user service cannot cope with high packet loss.

The Allocation and Retention Priority of the MBMS bearer service allows for prioritisation between MBMS bearer services.

As the MBMS bearer service transfers data to many UEs in parallel and because of the lack of feedback channel on radio level low SDU error ratios are difficult to achieve. When the resulting packet error ratio is not suitable for the MBMS user service or when prevention of data loss is required, an MBMS user service may perform retransmission of MBMS data over a point-to-point PDP context.

6.3.2 Quality-of-Service for EPS

It shall be possible for the network to control quality-of-service parameters for sessions of broadcast MBMS bearer services. All EPS QoS attributes related to the EPS bearer service are applicable to MBMS bearer services.

For EPS, only GBR MBMS service is defined and the MBMS bearer service QoS includes the parameters QCI, ARP, GBR and MBR (TS 23.401 [16]).

For E-UTRAN MBMS bearer service for NB or M UE categories, operator defined QCIs may be configured in the BMSC and in the EUTRAN.

The BMSC may take into account the UE Capability for MBMS received via Activate MBMS Bearer Request in addition to the QoS requirements of the service and map that to a QCI value that is sent using MBMS Session Start Procedure towards EUTRAN (see TS 23.682 [29]).

BMSC may be configured to take into account the UE Category for MBMS to derive operator defined QCIs.

An example mapping is shown below for a service with otherwise the same QoS requirements:

Table 6.3.2-1: QCI association with UE Categories

UE Categories supported	Operator defined QCI (not standardised)
IoT UE type M2	a
Both UE Category M1 and M2 UEs	b
IoT UE type NB2	c
Both UE Category NB1 and NB2	d

The BMSC may receive coverage level information for MBMS in addition to the UE Category for MBMS. When coverage information is received, and the BMSC is configured to take into account the coverage level, then BMSC

generates the appropriate QCI based on the UE Category for MBMS and coverage level information for the MBMS service as defined in TS 23.682 [29].

An example mapping is shown below for a service with otherwise the same QoS requirements including coverage level:

Table 6.3.2-2: QCI association with UE Categories and coverage level

UE Categories supported	Operator defined QCI (not standardised)
IoT UE type M2, Coverage level: Medium	a
IoT UE type M2, Coverage level: Normal	b
IoT UE type M2 Coverage level: High	c
Both UE Category M1 and M2 UEs	d
IoT UE type NB2	e
Both UE Category NB1 and NB2	f

NOTE 1: The QCI to and from UE Capability for MBMS needs to be the same in E-UTRAN and BMSC.

Each GBR MBMS bearer service is associated with the following MBMS bearer level QoS parameters:

- QoS Class Identifier (QCI);
- Allocation and Retention Priority (ARP);
- Maximum Bit Rate (MBR);
- Guaranteed Bit Rate (GBR).

Unlike point-to-point EPS bearers, the MBR of a particular GBR bearer service shall be set equal to the GBR.

NOTE 2: UE-AMBR and APN-AMBR do not apply to MBMS bearer services.

Compared to point-to-point bearer services the following limitations exist:

- For Guaranteed bit rate: depending on radio resource usage by other services, some cells of the MBMS Service Area may not have sufficient resources available for a MBMS Session. The RAN may decide not to establish RB in cells where requested resources are not available. The RAN does not reject a MBMS Session Start Request message even if one or more cells do not have enough resources to establish radio bearers.
- MBMS bearer admission control within E-UTRAN is constrained by the E-UTRAN resources that are configured for MBMS.

In the case of E-UTRAN, established MBMS bearers may not always use all the resources configured for MBMS. When the resources configured for MBMS are not fully utilised, the E-UTRAN may schedule delivery of traffic from point-to-point bearers using some of the un-utilised MBMS resources (refer to TS 36.213 [25]).

GBR MBMS bearer services are best suited for the transport of MBMS user services where a constant bit rate is needed. As for point-to-point bearer services, the network should comply with the transfer delay for GBR QCI's (TS 23.203 [23]). Packet dropping should be the preferred traffic conditioning action applied to the traffic flow to adapt to the available resources. The BM-SC ensures that the bit rate is not larger than the MBR. There is no radio aware flow shaping in the BM-SC.

The Allocation and Retention Priority of the MBMS bearer service allows for prioritisation between MBMS bearer services at MBMS bearer service establishment.

When the MBMS bearer service experience a packet error ratio which is not suitable for the MBMS user service or when prevention of data loss is required, an MBMS user service may perform retransmission of MBMS data over a point-to-point PDP context or PDN connection.

6.3.3 MBMS QoS distribution tree

MBMS data will be distributed to multiple users through a MBMS distribution tree that can go through many BSCs/RNCs, many SGSNs and one or more GGSNs. Furthermore some bearer resources may be shared between many users accessing the same MBMS bearer service in order to save resources. As a result, each branch of a MBMS distribution tree shall be established with the same QoS.

MBMS distribution tree shall have the same QoS for all its branches.

When a branch of the MBMS distribution tree has been created, it is not possible for another branch (e.g. due to arrival of a new UE or change of location of a UE with removal of a branch and addition of a new one) to impact the QoS of already established branches.

There is no QoS (re-)negotiation between network elements (e.g. between RNC and SGSN). This implies that some branches may not be established if QoS requirement cannot be accepted by the concerned network node.

6.4 Temporary Mobile Group Identity

Temporary Mobile Group Identity (TMGI) is used for MBMS notification purpose. The BM-SC allocates a globally unique TMGI per MBMS bearer service. The structure of the TMGI is defined in TS 23.003 [13].

For Multicast MBMS bearer services the TMGI is transmitted to UE via the MBMS Multicast Service Activation procedure. For Broadcast Service the TMGI can be obtained via service announcement see "Service Announcement".

The TMGI is a radio resource efficient MBMS bearer service identification, which is equivalent to the MBMS bearer service identification consisting of IP multicast address and APN.

6.5 IP Multicast distribution

6.5.1 General

For GPRS in GGSN or for EPS in MBMS GW it shall by configuration be possible to enable distribution of MBMS payload by using IP Multicast in the backbone network. IP Multicast distribution is done from GGSN to RNC downstream nodes or from MBMS GW to eNodeB or RNC downstream nodes. The Source Specific Multicast (SSM) service model shall be used by nodes and routers as specified in RFC 4607 [21] and RFC 4604 [22].

6.5.2 IP Multicast distribution for GERAN Iu-mode and UTRAN for GPRS

Fallback to legacy point-to-point distribution is done for RNC nodes which do not support IP Multicast distribution.

NOTE: Support of fallback assumes the corresponding SGSNs have user plane functionality.

The GGSN chooses an IP Multicast address for distribution and a Source address as well as a common TEID-U (C-TEID). The proposed IP Multicast and Source address for distribution and the C-TEID is indicated by the GGSN to the downstream SGSNs at Session Start. The SGSN forwards the request to the downstream RNC (and BSC in Iu mode) at Session Start. The RNC may accept or reject the proposed IP Multicast distribution in the MBMS Session Start Response to the SGSN. If accepted the RNC shall report the channel (IP Multicast and Source address) to the backbone in order to join the bearer service multicast distribution. At Session Stop the RNC shall correspondingly report to the backbone in order to leave the bearer service multicast distribution.

If one or more downstream RNC nodes do not accept IP Multicast distribution, the SGSN will establish a normal MBMS point-to-point GTP-U tunnel to related RNCs and a point-to-point GTP-U tunnel to the GGSN. The SGSN does not respond to the GGSN until it has received responses from all RNCs. The SGSN shall indicate to the GGSN if IP Multicast distribution is accepted (by one or more RNCs) and it shall also indicate if normal MBMS point-to-point distribution is required (by one or more RNCs). The SGSN will also establish a normal MBMS point-to-point GTP-U tunnel to GGSN if there are BSCs in Gb mode in the MBMS distribution tree.

The RNC node shall indicate to SGSN if IP Multicast distribution is accepted in the Session Start Response. If this indication is missing, the SGSN node shall treat the RNC node as not accepting IP Multicast distribution and use unicast distribution.

IP Multicast distribution is only used within a PLMN. In the roaming case the GGSN establishes normal MBMS point-to-point GTP-U tunnels to SGSNs/RAN nodes in other networks.

GGSN shall assign IP Multicast addresses used for MBMS distribution according to RFC 4607 [21]. When several GGSN are used for MBMS payload distribution, the used IP Multicast addresses and common TEIDs shall be coordinated by configuration. Clashes between common TEIDs allocated by GGSN and TEIDs allocated by RNC should be avoided by coordinated TEID ranges.

The GTP-U Error Indication mechanism shall be disabled for MBMS bearers using IP Multicast distribution. The receiving node controls itself what is received using the IGMPv3/MLDv2 protocol, RFC 4604 [22].

The MBMS payload with the synchronization information received from the BM-SC included, shall be distributed by the GGSN with IP Multicast to the RNC. The synchronization information is used in the radio interface for the user data transmission synchronization across the RNCs as described in TS 25.346 [10]. It is up to RAN configurations whether the inter-RNC MBMS combining/MBSFN operation mode is used during the MBMS payload delivery.

6.5.3 IP Multicast distribution for E-UTRAN and UTRAN for EPS

The MBMS GW chooses an IP Multicast address for distribution or, optionally, in the case of E-UTRAN access (e.g. in deployments with a mix of IPv4 and IPv6 eNodeBs and/or backhauls) and if the MBMS-GW supports both IPv4 and IPv6, both an IPv4 and an IPv6 IP Multicast address for distribution. The IP Multicast Addresses may be unique for the MBMS bearer service, or it may be reused from another active MBMS bearer service with an identical service area and of the same QoS. The proposed IP Multicast and Source addresses for distribution is indicated by the MBMS GW to the downstream MMEs and/or SGSNs at Session Start. The MME/SGSN forwards the request to the downstream eNodeB/RNC at Session Start.

In the UTRAN case, the RNC may accept or reject the proposed IP Multicast distribution in the MBMS Session Start Response to the SGSN. The RNC node shall indicate to SGSN if IP Multicast distribution is accepted in the Session Start Response. If accepted the RNC shall report the channel (IP Multicast and Source address) to the backbone in order to join the bearer service multicast distribution. For an IP Multicast address that is shared by several MBMS bearer services, RNC only reports to the backbone once. At Session Stop the RNC shall correspondingly report to the backbone in order to leave the bearer service multicast distribution. For a MBMS bearer service that shares the IP Multicast address with one or more other MBMS bearer service(s), the RNC does only report to the backbone at session stop of the last remaining bearer service that has used a shared IP Multicast address. If one or more downstream RNC nodes do not accept IP Multicast distribution, the SGSN will establish a normal MBMS point-to-point GTP-U tunnel to related RNCs and a point-to-point GTP-U tunnel to the MBMS GW. The SGSN does not respond to the MBMS GW until it has received responses from all RNCs or until a configurable time has elapsed (e.g. with a recommended default of 5 seconds). The SGSN shall indicate to the MBMS GW if IP Multicast distribution is accepted (by one or more RNCs) and it shall also indicate if normal MBMS point-to-point distribution is required (by one or more RNCs). The RNC node shall indicate to SGSN if IP Multicast distribution is accepted in the Session Start Response. If this indication is missing, the SGSN node shall treat the RNC node as not accepting IP Multicast distribution and use unicast distribution.

IP Multicast distribution is only used within a PLMN.

MBMS GW shall assign IP Multicast addresses used for MBMS distribution according to RFC 4607 [21]. When several MBMS GWs are used for MBMS payload distribution, the used IP Multicast addresses shall be coordinated by configuration. Clashes between common TEIDs allocated by MBMS GW and TEIDs allocated by eNodeB/RNC should be avoided by coordinated TEID ranges.

The receiving node controls itself what is received using the IGMPv3/MLDv2 protocol RFC 4604 [22].

The MBMS payload with the synchronization information received from the BM-SC shall be distributed by the MBMS GW with IP Multicast to the eNodeB/RNC. The synchronization information is used in the radio interface for the user data transmission synchronization across the eNodeBs and RNCs as described in TS 25.346 [10]. It is up to RAN configurations whether the inter-RNC MBMS combining/MBSFN operation mode is used during the MBMS payload delivery.

Mobility between cells may cause limited MBMS data loss towards the UE. Therefore, MBMS user services should be able to cope with potential data loss caused by UE mobility.

7 Architectural Aspects of MBMS User Services

MBMS bearers may be used in numerous ways to provide different types of applications. MBMS user services employ MBMS bearers and possibly point-to-point bearers in order to provide application data in an efficient manner. This clause is used to discuss different aspects of MBMS user services that directly relate to the usage of MBMS and point-to-point bearers. This clause is not intended to deal with the architecture and interfaces of MBMS user services.

7.1 Alternative User Service Support

For many MBMS services, it will be necessary to provide alternative means for the UE to access the service without using MBMS bearer capabilities. This is required, for example, after completion of the MBMS session for a file download to permit errors in the file to be corrected; to permit the network to charge for a successful download; to pass a decrypt key to the UE; etc. It may also be useful in cases where all or part of an MBMS transmission has been missed due to the UE being out of coverage, switched off, etc.

Care is needed to ensure that such alternative access mechanisms do not create traffic that overloads the network (radio, RNC, BSC, SGSN, GGSN and BM-SC). In the case that such alternative access requires direct interaction between the UE and a network server, one way for this load to be distributed is for the BM-SC to distribute to each UE, at activation time, one or more server addresses (from a group of addresses), along with parameter(s) that are used to generate a random time dispersion of the requests.

7.2 Avoid overload in SGSN, GGSN and BM-SC caused by Joining

For Joining that is triggered by a service announcement (e.g. CBS or MBMS), then the service announcement needs to be able to contain parameters to help avoid overload in the SGSN, GGSN and BM-SC. The UE uses the defined parameters in the service announcement to randomly select the time at which to join the service. Hence the BM-SC needs to be able to generate the parameters and needs to be able to get them sent to the UE in the service announcement.

7.3 Access aspects of MBMS user services

In networks with multiple accesses, e.g. GERAN and UTRAN for GPRS, users may in some situations experience problems in receiving MBMS services. These situations include:

- an operator that has chosen to provide a service on one access only (e.g. only on GERAN), and where a UE is camping on the wrong access (i.e. on UTRAN in the previous example) when an MBMS session is started. This UE may miss the MBMS content, as the MBMS architecture doesn't provide any mechanism for paging coordination, etc.
- an operator that has chosen to provide a service with different QoS levels e.g. on GERAN and UTRAN (see clause 5.1.5.2). A UE that is changing access type during an ongoing MBMS session may not be able sort the situation out and receive the MBMS content correctly.

7.4 MBMS operation on Demand

"MBMS operation on Demand" (MooD) allows certain content that is initially delivered over the unicast network to be turned into an MBMS User Service, in order to efficiently use network resources when the traffic exceeds a certain threshold. Two types of MBMS operation on Demand are described in TS 26.346 [7]: UE-Elected and Network-Elected offloading. In both types, there could be a network proxy/server to detect whether unicast traffic volume for the same service or content exceeds a certain threshold, and to indicate such occurrence to the BM-SC to enable MBMS offloading. The MooD feature is optional.

UEs that support MooD functionality support handling of the MooD redirection message. To assist the MooD decision, the network proxy/server may obtain UE location by many possible means as per the operator's policy, including use of the current location field in the MooD Header.

MooD is supported for E-UTRAN and UTRAN accesses.

7.5 Enhanced TV services support over E-UTRAN

Enhanced TV services over E-UTRAN enables operators and service providers to deliver TV services from broadcasters as well as 3rd party service providers. The separation of access to MBMS transport services from MBMS user services allow separate content delivery and transport services from the operators. This is achieved by:

- A broadcast component where mechanisms to enable decoupling of content, MBMS service and MBMS transport, allowing the system to offer: MBMS transport only, a shared MBMS network between operators, broadcast only TV service to devices with no operator subscription.
- A unicast component via PDN connectivity is achieved through operator's EPC network, in which operator subscription for TV service may be achieved via dedicated APN.
- Enable mechanisms for broadcast/unicast fall-back support, consumption-based switching between unicast/broadcast are supported.
- Support standardised interface between BM-SC and the content provider, as defined in TS 26.348 [31], in order to facilitate both transport and user services delivery for TV services via MBMS (for broadcast) and EPC (for unicast).

There are 2 MBMS Service Types considered for TV service:

- MBMS transport only mode:
 - The 3GPP network provides only transport of data/TV content in a transparent manner.
 - The 3rd party content provider's signalling and data transferred via MBMS bearer(s) are transparent to BM-SC and the MBMS bearer service.
 - All other service aspects, e.g. decision of whether to send data over broadcast or unicast, is not within 3GPP network, and assumed to be performed by application server.
- MBMS full service mode:
 - 3GPP MBMS system provides full service layer capability.
 - BM-SC is aware of the content stream and is capable of transforming the content stream into 3GPP compliant stream.
 - BM-SC can perform decision on whether to switch an MBMS user service between broadcast or unicast service.

8 MBMS Procedures

8.1 MBMS Notification

8.1.1 lu mode notification (UTRAN and GERAN) for GPRS

When an MBMS Session starts, UEs interested in the MBMS bearer service (PMM-CONNECTED UEs and PMM-IDLE UEs) shall be notified.

MBMS Session attributes such as Session Identifier and MBMS Service Area(s) are made available in all interested RNCs during the Session Start procedure.

For radio efficiency reasons, the UTRAN may select on a per cell basis whether to establish point-to-point or point-to-multipoint links for the distribution of MBMS data to the UEs.

In order to perform this selection, the UTRAN requests a proportion of UEs to move to PMM-CONNECTED mode by means of MBMS notification sent in the MBMS service Area.

The exact number of UEs moved to PMM-CONNECTED mode is a decision of the RAN node. It is not necessary for all UEs to move to PMM-CONNECTED mode in order for the RAN to decide to use point-to-multipoint, other UEs may remain in PMM-IDLE state. This is a UTRAN choice (based on Radio Resource Management criteria).

Following the decision to set up point-to-point or point-to-multipoint links, the number of UEs that need to be maintained in PMM-CONNECTED mode or moved to PMM-IDLE mode for MBMS data reception is also a decision of the RAN node.

8.1.2 A/Gb mode notification (GERAN)

When an MBMS Session starts, UEs interested in the MBMS bearer service and that are in READY or STANDBY states shall be notified. The MBMS notification triggers detection or counting of UEs per cell for selection of the most appropriate MBMS radio bearer.

MBMS Session attributes such as Session Identifier, MBMS Service Area, QoS are made available in all interested BSCs that are connected to a registered SGSN by the Session Start procedure.

8.2 MBMS Multicast Service Activation

The MBMS multicast service activation procedure registers the user in the network to enable the reception of data from a specific multicast MBMS bearer service. The activation is a signalling procedure between the UE and the network. The procedure establishes MBMS UE contexts in UE, SGSN and GGSN and Iu mode BSC/RNC for each activated multicast MBMS bearer service comparable to regular PDP contexts.

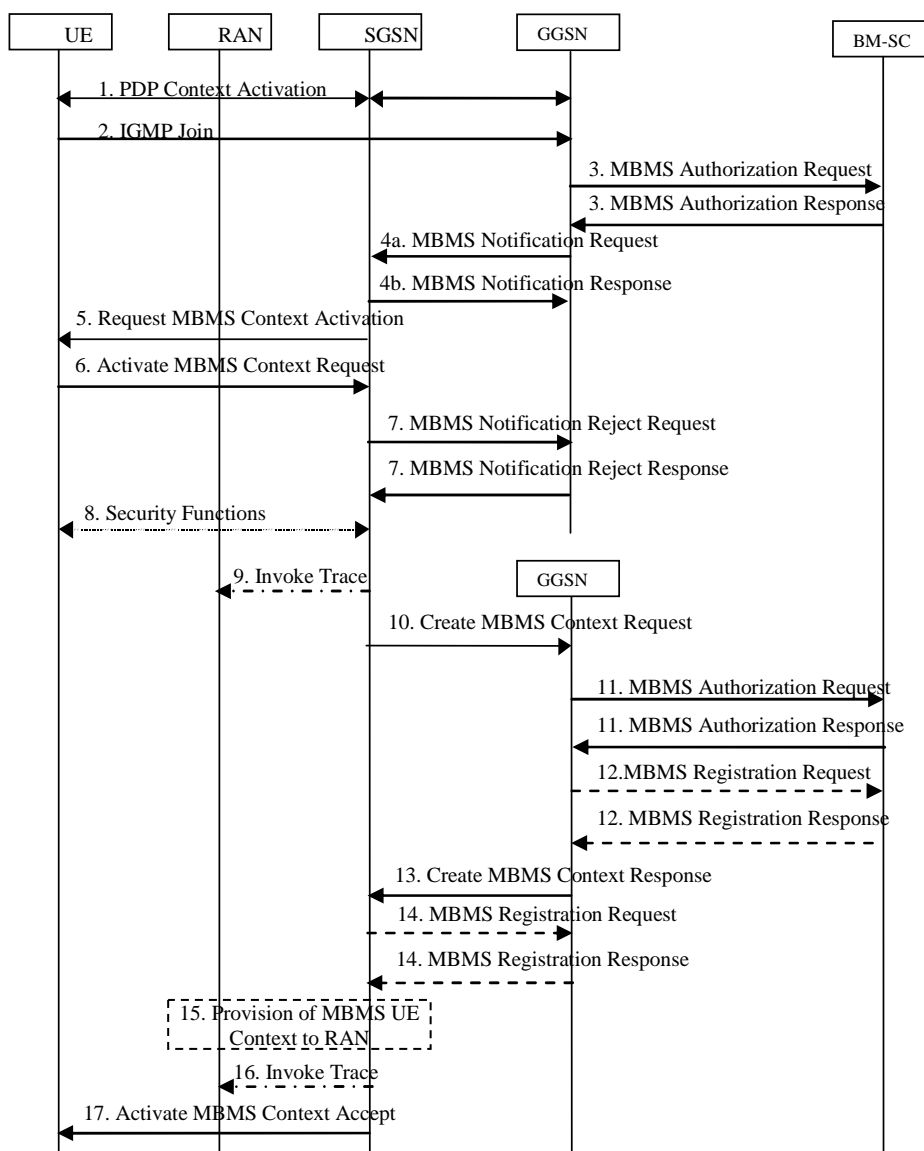


Figure 7: The activation of an MBMS multicast service

1. The UE activates a general purpose PDP context if one is not already established.

2. The UE sends an IGMP (IPv4) or MLD (IPv6) Join message over the default PDP context to signal its interest in receiving a particular multicast MBMS bearer service identified by an IP multicast address.
3. The GGSN sends an MBMS Authorization Request seeking authorization for the activating UE to receive data. The MBMS Authorization Request may include trace information (Additional MBMS Trace Info), if activated. The authorization decision, which may be based on subscription data in the BM-SC, Membership function is provided in the MBMS Authorization Response together with the APN to be used for creation of the MBMS UE context. If the MBMS Authorization Response indicates that the UE is not authorized to receive the MBMS data the process terminates with no additional message exchange.
- 4a. The GGSN sends an MBMS Notification Request (IP multicast address, APN, Linked NSAPI) to the SGSN. Linked NSAPI is set equal to the NSAPI of the PDP context over which the Join request was received. The IP multicast address is the one requested by the UE in the Join request. The APN may be different from the APN to which the default PDP context has been activated. In any case, the APN may resolve to a GGSN that is different from the GGSN receiving the IGMP/MLD Join request.
- 4b. The SGSN sends a MBMS Notification Response (Cause) to the GGSN that sent the MBMS Notification Request, where Cause shall indicate whether or not the MBMS context activation will proceed. Upon reception of the response message with Cause indicating unsuccessful operation the GGSN should not send any further MBMS Notification Request messages. The procedure is then terminated.
5. The SGSN sends a Request MBMS Context Activation (IP multicast address, APN, Linked NSAPI, TI) to the UE to request it to activate an MBMS UE Context. Linked NSAPI allows the UE to associate the MBMS UE Context with the PDP context over which it sent the IGMP/MLD Join message in step 2. TI was chosen by the SGSN and contains a value not used by any other activated PDP context and MBMS UE context for this UE.
6. The UE creates an MBMS UE context and sends an Activate MBMS Context Request (IP multicast address, APN, MBMS_NSAPI, MBMS bearer capabilities) to the SGSN. The IP multicast address identifies the MBMS multicast service, which the UE wants to join/activate. An APN may indicate a specific GGSN. The MBMS bearer capabilities indicate the maximum QoS the UE can handle. The MBMS_NSAPI was chosen by the UE and contains a value not used by any other activated PDP context and MBMS UE context for this UE. If the SGSN has the MBMS Bearer Context information for this MBMS bearer service, the SGSN should verify the UE's MBMS bearer capabilities. If the SGSN determines that the UE's MBMS bearer capabilities are less than the Required MBMS Bearer Capabilities, it shall reject the request for activation of an MBMS context with an appropriate cause.
7. If the MBMS UE Context was not established, the SGSN sends a MBMS Notification Reject Request (Cause) to the GGSN that sent the MBMS Notification Request, where Cause shall indicate the reason why the MBMS UE Context could not be established. The GGSN then sends a MBMS Notification Reject Response back to the SGSN. This should prevent further sending of MBMS Notification Request messages. The procedure is then terminated.
8. Security Functions may be performed, e.g. to authenticate the UE.
9. In A/Gb mode and if BSS trace is activated, the SGSN shall send an Invoke Trace (Trace Reference, Trace Type, Trigger Id, and OMC Identity) message to the BSS. Trace Reference, and Trace Type are copied from the trace information received from the HLR or OMC.
10. The SGSN creates an MBMS UE context and sends a Create MBMS Context Requests (IP multicast address, APN, MBMS_NSAPI, IMSI, MSISDN, RAI, IMEI-SV, RAT Type, MS Time Zone, CGI/SAI, Trace Reference, Trace Type, Trigger Id, OMC Identity, Additional MBMS Trace Info) to the GGSN. The SGSN shall include Trace Reference, Trace Type, Trigger Id, and OMC Identity if GGSN trace is activated. The SGSN shall include Additional MBMS Trace Info if BM-SC trace is activated. The SGSN shall copy Trace Reference, Trace Type, and OMC Identity from the trace information received from the HLR or OMC. The inclusion of CGI/SAI shall be according rules detailed in clause 15.1.1a in TS 23.060 [15].
11. The GGSN sends an MBMS Authorization Request (IMSI, MSISDN, RAI, IMEI-SV, RAT Type, MS Time Zone, CGI/SAI, Additional MBMS Trace Info) seeking authorization for the activating UE. The GGSN shall include Additional MBMS Trace Info if BM-SC trace is activated. The CGI/SAI is included, if available. The authorization decision is provided in the MBMS Authorization Response. The BM-SC creates an MBMS UE Context.
12. If the GGSN does not have the MBMS Bearer Context information for this MBMS bearer service, the GGSN sends a MBMS Registration Request to the BM-SC. See clause "MBMS Registration Procedure".

If no TMGI has been allocated for this MBMS bearer service, the BM-SC will allocate a new TMGI. This TMGI will be passed to GGSN and SGSN via the MBMS Registration Response message and further to UE via Activate MBMS Context Accept message.

The BM-SC responds with a MBMS Registration Response containing the MBMS Bearer Context information for this MBMS bearer service and adds the identifier of the GGSN to the "list of downstream nodes" parameter in its MBMS Bearer Context. See clause "MBMS Registration Procedure".

13. The GGSN creates an MBMS UE context and sends a Create MBMS Context Response to the SGSN.

14. If the SGSN does not have the MBMS Bearer Context information for this MBMS bearer service, the SGSN sends a MBMS Registration Request to the GGSN. See clause "MBMS Registration Procedure".

The GGSN responds with a MBMS Registration Response containing the MBMS Bearer Context information for this MBMS bearer service and adds the identifier of the SGSN to the "list of downstream nodes" parameter in its MBMS Bearer Context. See clause "MBMS Registration Procedure".

15. The SGSN provides Iu mode RAN with the MBMS UE Context(s) if at least one PS RAB is established for the UE.

16. In Iu mode and if trace is activated, the SGSN shall send an Invoke Trace (Trace Reference, Trace Type, Trigger Id, and OMC Identity) message to the RAN. Trace Reference, and Trace Type are copied from the trace information received from the HLR or OMC.

NOTE: Step 16 is applied when the trace activation is triggered by means of signalling. Another alternative is the triggering of trace activation by the OMC. The details of both Trace Activation procedures are described in TS 32.422 [14].

17. The SGSN sends an Activate MBMS Context Accept (TMGI) to the UE. If it was not possible to verify the UE's MBMS bearer capabilities in Step 6, the UE's MBMS bearer capabilities shall be verified now by the SGSN. If the SGSN determines that the UE's MBMS bearer capabilities are lower than the Required MBMS Bearer Capabilities the SGSN rejects the request for activation of an MBMS context indicating an appropriate cause and starts the deactivation of the already established MBMS UE contexts.

8.2.1 Void

8.3 MBMS Session Start Procedure

8.3.0 General

The BM-SC initiates the MBMS Session Start procedure when it is ready to send data. This is a request to activate all necessary bearer resources in the network for the transfer of MBMS data and to notify interested UEs of the imminent start of the transmission.

Through this procedure, MBMS session attributes such as QoS, MBMS service Area, estimated session duration, are provided to the registered GGSN(s) and SGSN(s), to all BSCs/RNCs that are connected to a listed SGSN and to the registered MBMS GW(s) and MME(s). In addition the procedure allocates the bearer plane to all registered GGSNs, all registered SGSNs and all registered MBMS GWs, to BSCs/RNCs and E-UTRAN that respond to the session start request message. If IP multicast distribution of MBMS user plane data to E-UTRAN/UTRAN is supported, the MBMS-GW allocates an IP Multicast address together with the corresponding IP address of the multicast source (i.e. MBMS GW) and the C-TEID are provided to the eNodeB via MME and to the RNC via SGSN in this procedure. Optionally, in the case of E-UTRAN access (e.g. in deployments with a mix of IPv4 and IPv6 eNodeBs and/or backhubs) and if the MBMS-GW supports both IPv4 and IPv6, both an IPv4 and an IPv6 IP Multicast address together with the corresponding alternative IP addresses of the multicast source are also allocated by the MBMS-GW and provided to the E-UTRAN via the MME. An IP multicast address and the paired IP address of the multicast source shall be of the same IP type.

After sending the Session Start Request message the BM-SC waits for a configurable delay (time to MBMS data transfer) before sending MBMS data. This delay should be long enough to avoid buffering of MBMS data in entities other than the BM-SC, i.e. the delay should allow the network to perform all procedures required to enable MBMS data

transfer before the BM-SC sends MBMS data. For example notification of UEs and radio bearer establishment should be performed before MBMS data arrive in the RAN. The delay may be in the region of multiple seconds or tens of seconds. It may be useful for the BM-SC to be able to configure different delays for MBMS bearer services on 2G, 3G and E-UTRAN, respectively.

For the distributed MCE architectures, i.e. when the MCE is part of the eNB as described in clause 15.1.1 in TS 36.300 [17], an absolute time stamp for when data can be expected, "MBMS data transfer start", should be used at MBSFN operation mode to ensure synchronized session control and to facilitate a graceful reallocation of resources for the MBSFN when needed. When the parameter "MBMS data transfer start" is present, a receiving supporting node shall ignore the parameter "time to MBMS data transfer". For session stop signalling, the parameter "MBMS data transfer stop" is if present used to schedule the release of the radio resources in order to ensure a synchronized session control.

8.3.1 MBMS Session Start Procedure for GERAN and UTRAN for GPRS

For multicast MBMS bearer services the registration of SGSNs and GGSNs is initiated by MBMS multicast Service Activation procedures, Inter SGSN Routeing Area Update procedures, Inter SGSN Serving RNS Relocation procedure and performed by MBMS Registration procedures. The GGSN keeps track of the registered SGSNs in the list of downstream nodes.

For broadcast MBMS bearer services the list of downstream nodes of BM-SC and GGSN are achieved in the following ways:

- The list of downstream nodes for GGSN will be sent from the BM-SC to the GGSN in the Session Start Request.

Normally, the GGSN contained in the "list of downstream nodes" for BM-SC is the default GGSN (or two for resilience).

The overall Session Start procedure is presented in the following figure:

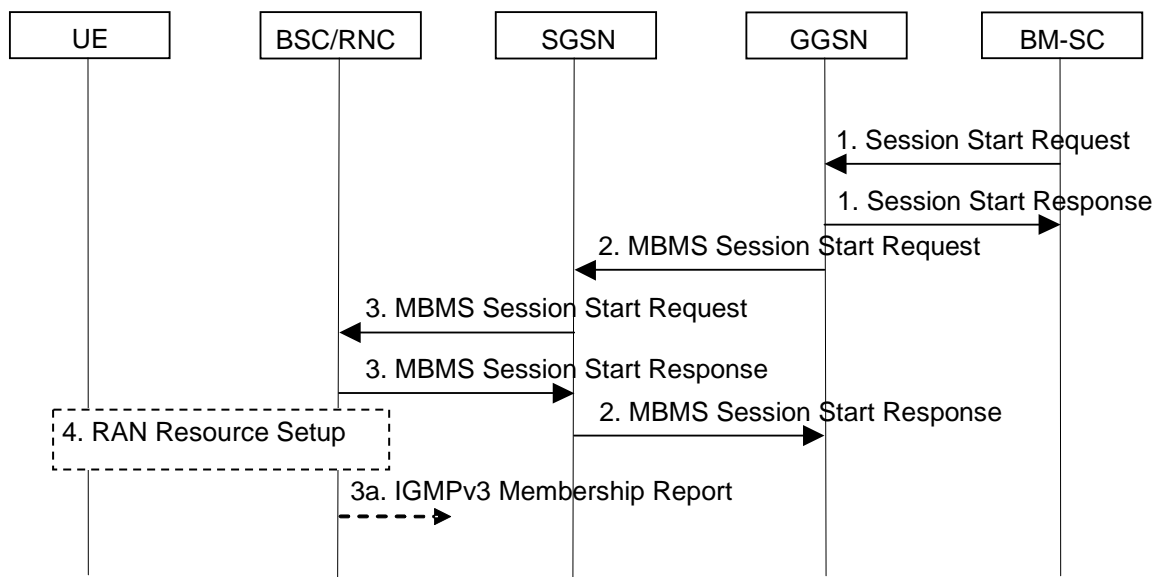


Figure 8a: Session Start procedure for GERAN and UTRAN for GPRS

1. The BM-SC Session and Transmission function sends a Session Start Request message to indicate the impending start of the transmission and to provide the session attributes (TMGI, Flow Identifier (Broadcast only), QoS, MBMS service Area, Session identifier, estimated session duration, broadcast/multicast, list of downstream nodes for GGSN (Broadcast only), time to MBMS data transfer, MBMS HC indicator (if header compression is used for MBMS payload), ...) and the 2G/3G indicator. The message is sent to the BM-SC Proxy and Transport function, which then forwards it to the GGSNs listed in the "list of downstream nodes" parameter of the corresponding MBMS Bearer Context. The BM-SC Proxy and Transport function sets the state attribute of its MBMS Bearer Context to 'Active'. For a broadcast MBMS bearer service the GGSN creates an MBMS bearer context. In broadcast mode, the BM-SC may start multiple sessions for the same MBMS bearer service (identified by the TMGI) but with different content. If so, a Flow Identifier is included in the Session Start Request to identify the different sub-sessions and the associated MBMS Service Areas shall not overlap. The GGSN stores the session attributes and the list of downstream nodes in the MBMS Bearer Context, sets the state

attribute of its MBMS Bearer Context to 'Active' and sends a Session Start Response message to the BM-SC Proxy and Transport function which forwards it to the BM-SC Session and Transmission function. The BM-SC Proxy and Transport function copies Session Start Requests to the BM-SC Membership function for charging purposes.

2. The GGSN sends an MBMS Session Start Request message containing the session attributes (TMGI, Flow Identifier (Broadcast only), QoS, MBMS service Area, Session identifier, estimated session duration, broadcast/multicast, time to MBMS data transfer, IP Multicast and Source addresses for backbone distribution, common TEID-U, MBMS HC indicator, ...) and the 2G/3G indicator to the SGSNs listed in the "list of downstream nodes" parameter of the corresponding MBMS Bearer Context. For a broadcast MBMS bearer service the SGSN creates an MBMS bearer context. The SGSN stores the session attributes and the 2G/3G indicator in the MBMS Bearer Context, sets the state attribute of its MBMS Bearer Context to 'Active'. If one or more of the downstream nodes accepts the Session Start and the proposed IP Multicast and Source address for backbone distribution and the proposed C-TEID, the SGSN includes an indication that IP Multicast distribution is accepted in the MBMS Session Start Response message to GGSN. If one or more of the downstream nodes does not accept the proposed IP Multicast and Source address for backbone distribution or the proposed C-TEID or if there are downstream BSCs in Gb mode connected to the SGSN, the SGSN falls back to normal point-to-point MBMS bearer establishment for these nodes and responds with an MBMS Session Start Response message providing the TEID for bearer plane that the GGSN shall use for forwarding the MBMS data. Otherwise if all nodes accept multicast, the SGSN returns the C-TEID and the IP Multicast distribution address in the Session Start Response message. The GGSN shall initiate IP Multicast distribution if at least one of the SGSNs indicates it has accepted IP Multicast distribution. For MBMS bearer service a SGSN receiving multiple MBMS Session Start Request messages establishes only one bearer plane with one GGSN.
3. The SGSN sends an MBMS Session Start Request message including the session attributes (TMGI, QoS, MBMS service Area, Session identifier, estimated session duration, broadcast/multicast, time to MBMS data transfer, list of RAs, MBMS HC indicator, ...) to each BSC and/or each RNC that is connected to this SGSN. When the message is sent to an RNC/BSC in Iu mode, the IP Multicast and Source address for backbone distribution and C-TEID shall also be included if received from the GGSN. The 2G/3G indicator shall be used by the SGSN to determine whether the MBMS Session Start Request message is sent only to BSCs, or only to RNCs, or to both RNCs and BSCs. For a broadcast MBMS bearer service the BSC/RNC creates an MBMS Service Context. The BSC in Iu mode/RNC stores the session attributes in the MBMS Service Context, sets the state attribute of its MBMS Service Context to 'Active'. If the RNC accepts the Session start and the proposed IP Multicast and Source address for backbone distribution and the proposed C-TEID the RNC sends an MBMS Session Start Response message to SGSN including an indication that IP Multicast distribution is accepted. If an RNC does not accept the proposed IP Multicast and Source address for backbone distribution (or the proposed C-TEID), the RNC falls back to normal point-to-point MBMS bearer establishment. A BSC in Gb mode which does not serve the MBMS Service Area need not store the session attributes. A BSC/RNC receiving multiple MBMS Session Start Request messages establishes only one bearer plane with one SGSN.
- 3a If the BSC/RNC accepts IP Multicast distribution the BSC/RNC joins the multicast group in the IP backbone according to RFC 3376 [19], RFC 3810 [20] and RFC 4604 [22].
4. The BSC/RNC establishes the necessary radio resources for the transfer of MBMS data to the interested UEs. RAN resource set up can be scheduled according to the time to MBMS data transfer parameter.

NOTE: The upstream node normally provides the MBMS Session Start Request message once per MBMS session to a downstream node. Due to "Intra Domain Connection of RAN Nodes to Multiple Core Network Nodes" however, a BSC/RNC may receive the MBMS Session Start Request message from several SGSNs.

8.3.2 MBMS Session Start Procedure for E-UTRAN and UTRAN for EPS

The list of downstream nodes of BM-SC and the list of MBMS control plane nodes (MMEs and SGSNs) of MBMS GW are achieved in the following ways:

- The list of MBMS control plane nodes for MBMS GW will be sent from the BM-SC to the MBMS GW in the Session Start Request.

Normally, the MBMS GW contained in the "list of downstream nodes" for BM-SC is the default MBMS GW (or two for resilience).

The overall Session Start procedure is presented in the following figures:

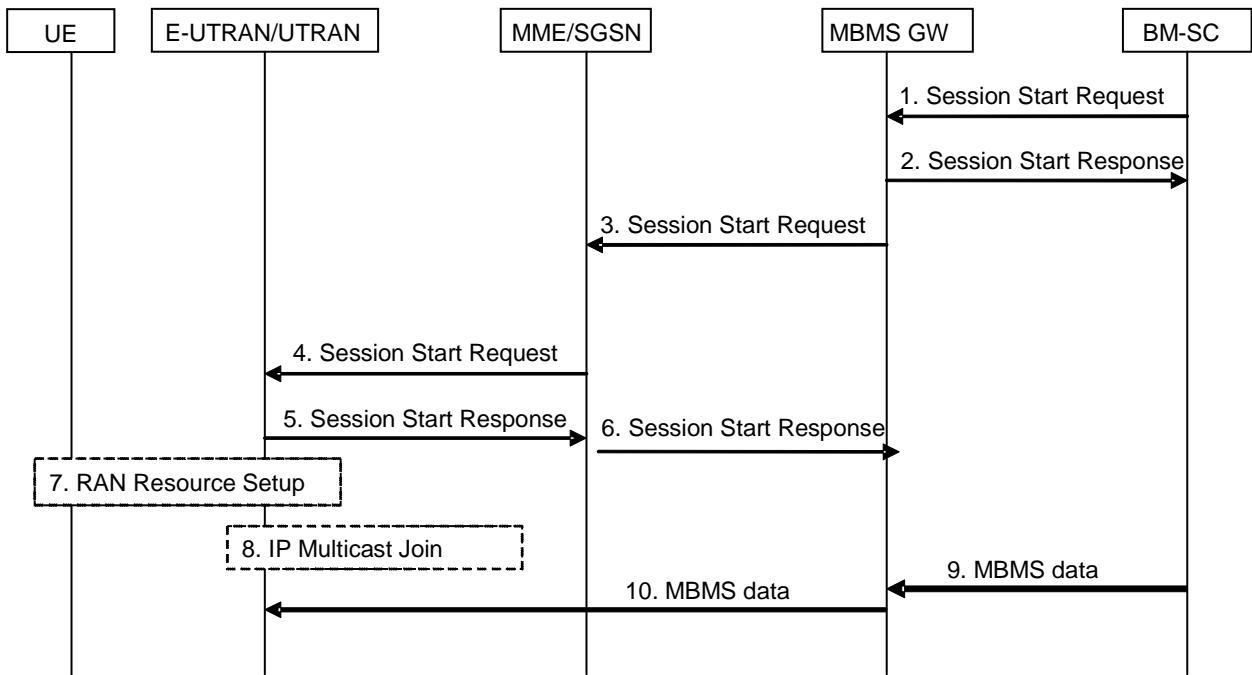


Figure 8b.1: Session Start procedure for E-UTRAN and UTRAN for EPS

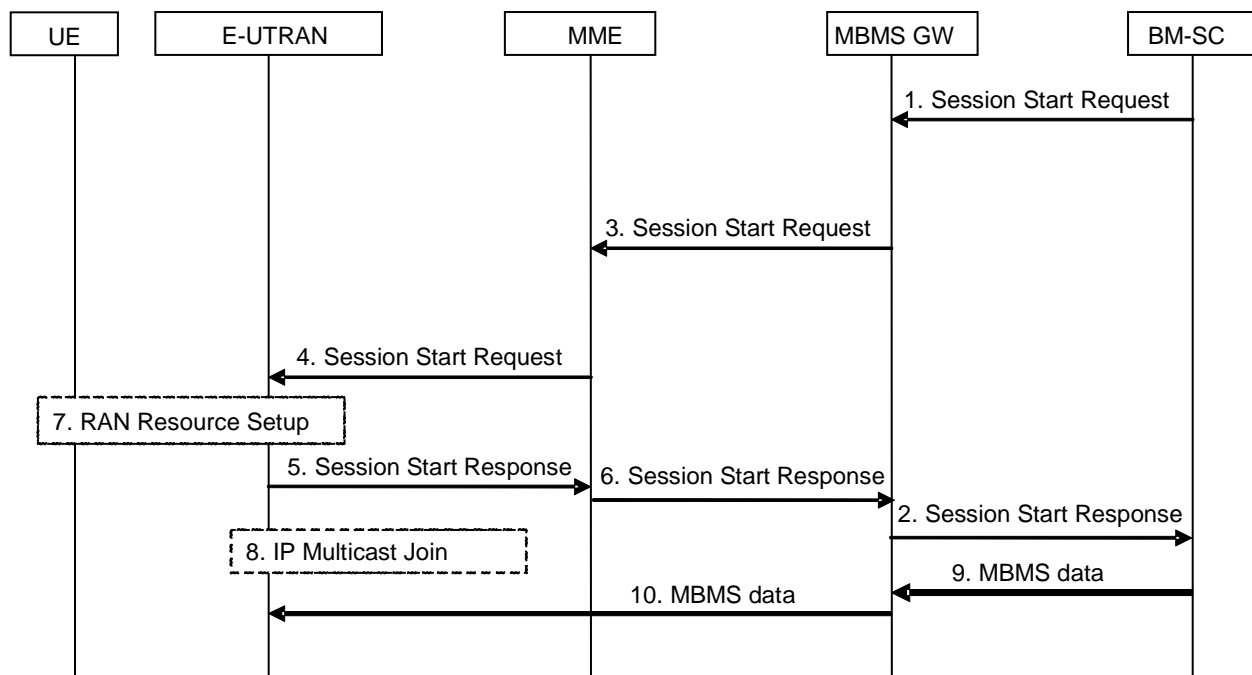


Figure 8b.2: Session Start procedure for E-UTRAN for EPS with delayed response

1. BM-SC sends a Session Start Request message to MBMS GW to indicate the impending start of the transmission and to provide the session attributes (TMGI, Flow Identifier, QoS, MBMS service Area, list of cell IDs if available, Session identifier, estimated session duration, list of MBMS control plane nodes (MMEs, SGSNs) for MBMS GW, time to MBMS data transfer, MBMS data transfer start, access indicator, ...). The message is sent to the MBMS GWs listed in the "downstream nodes" parameter of the corresponding MBMS Bearer Context in the BM-SC. The BM-SC may start multiple sessions for the same MBMS bearer service (identified by the TMGI) but with different content. If so, a Flow Identifier is included in the Session Start Request to identify the different sub-sessions and the associated MBMS Service Areas shall not overlap. The Access indicator indicates in which radio access types the MBMS service should be broadcasted, i.e. UTRAN, or E-UTRAN, or both. The Access indicator may be included in charging information generated by the MBSM GW.

If MBMS-GW is configured to delay response to BMSC when access type is E-UTRAN, then MBMS-GW delays response to BMSC (i.e. step 2) until after step 6 is executed as shown in figure 8b.2. This configuration should be only performed when E-UTRAN executes step 7 below before responding to the MBMS Session Start message as specified in TS 36.300 [17].

NOTE: It is up to the operator to ensure that E-UTRAN, MBMS-GW and BMSC are configured only when E-UTRAN supports delaying the response from eNB.

2. The MBMS GW responds with a Session Start Response message with information for BM-SC to send MBMS data to the MBMS GW, if figure 8b.1 is executed. The MBMS-GW responds only after first MME response in step 6 is received, if it is configured to do so as shown in figure 8b.2.
3. The MBMS GW creates an MBMS bearer context. The MBMS GW stores the session attributes and the list of MBMS control plane nodes in the MBMS bearer context and allocates a transport network IP multicast address or, optionally, for E-UTRAN access (e.g. in deployments with a mix of IPv4 and IPv6 eNodeBs and/or backhauls) and if the MBMS-GW supports both IPv4 and IPv6, both an IPv4 and an IPv6 IP Multicast address, according to clause 6.5.3 and a C-TEID for this session. The MBMS GW sends a Session Start Request message including the session attributes (TMGI, Flow Identifier, QoS, MBMS service Area, list of cell IDs if available, Session identifier, estimated session duration, transport network IP Multicast Address(es), IP address(es) of the multicast source, C-TEID, ...) to MMEs and/or SGSNs listed in the "list of MBMS control plane nodes" parameter after filtering the list using the Access indicator, thus ignoring entries not consistent with the Access indicator.
4. The MME or SGSN creates an MBMS bearer context. The MME/SGSN stores the session attributes and sends a Session Start Request message including the session attributes (TMGI, QoS, MBMS service area, list of cell IDs if available, Session identifier, estimated session duration, broadcast (for UTRAN only), transport network IP Multicast Address, IP address of the multicast source, C-TEID, ...) to E-UTRAN/UTRAN. Optionally in the case of E-UTRAN access and if the MBMS-GW supports both IPv4 and IPv6, the MME includes both an IPv4 and an IPv6 IP Multicast address together with the corresponding alternative IP address(es) of the multicast source. When connected to multiple MCEs, the MME should filter the distribution of Session Control message to the MCEs based on the MBMS service area.

For UTRAN, if one or more of the downstream nodes accepts the Session Start with the proposed IP Multicast and Source addresses for backbone distribution and the proposed C-TEID, the SGSN includes an indication that IP Multicast distribution is accepted in the MBMS Session Start Response message to MBMS GW. If one or more of the downstream nodes does not accept the proposed IP Multicast and Source addresses for backbone distribution or the proposed C-TEID, the SGSN falls back to normal point-to-point MBMS bearer establishment for these nodes and responds with an MBMS Session Start Response message providing the TEID for bearer plane that the MBMS GW shall use for forwarding the MBMS data. Otherwise if all nodes accept multicast, the SGSN returns the C-TEID and the IP Multicast distribution address in the Session Start Response message.

For E-UTRAN access, eNB may respond to Session Start Request after first successful MBMS resources have been reserved (i.e. step 7) which indicates to the BMSC that there are resources already available for MBMS data delivery, as shown in figure 8b.2.

5. The E-UTRAN/UTRAN creates an MBMS bearer context. The E-UTRAN/UTRAN stores the session attributes, sets the state attribute of its MBMS Bearer Context to 'Active' (in UTRAN only) and responds the MME/SGSN to confirm the reception of the Session Start Request message. When a cell ID list is included in the Session Start Request, E-UTRAN uses it to determine a set of radio resources to be used for the broadcast. Based on the cell ID list, the set of radio resources selected may be reduced from the full set of resources defined by the MBMS service area. The E-UTRAN ensures that all of its corresponding nodes make the same decision on the reduced set.

For UTRAN, if an RNC accepts the Session start and the proposed IP Multicast and Source addresses for backbone distribution and the proposed C-TEID the RNC sends an MBMS Session Start Response message to SGSN including an indication that IP Multicast distribution is accepted. If an RNC does not accept the proposed IP Multicast and Source address for backbone distribution (or the proposed C-TEID), the RNC falls back to normal point-to-point MBMS bearer establishment.

6. The MME/SGSN stores the session attributes and the identifier of the eNBs/RNCs as the "list of downstream nodes" parameter in its MBMS Bearer Context and responds to the MBMS GW. The SGSN should wait for a response from all UTRAN nodes (until an acceptable duration) to be able to report to the MBMS-GW whether all, part or none of the RNCs have accepted IP multicast distribution and to provide an SGSN IP address and TEID for user plane over Sn if some RNCs did not accept IP multicast distribution. The MME may return an

MBMS Session Start Response to the MBMS-GW as soon as the session request is accepted by one E-UTRAN node. The MBMS-GW initiates IP Multicast distribution and/or point-to-point MBMS bearers (for UTRAN only) depending on the responses from the MMEs/SGSNs.

If the MBMS-GW is configured to delay response to the BMSC, MBMS-GW waits until step 6 occurs before responding to the BMSC as shown in figure 8b.2.

7. The E-UTRAN/UTRAN establishes the necessary radio resources for the transfer of MBMS data to the interested UEs. For E-UTRAN the radio resource set up is scheduled using the MBMS data transfer start parameter if it is present, otherwise using the time to MBMS data transfer parameter. The MBMS data transfer start parameter is not used by UTRAN.
8. If the E-UTRAN/UTRAN node accepts IP Multicast distribution, it joins the appropriate transport network IP multicast address (including the IP address of the multicast source) allocated by the MBMS GW, to enable reception of MBMS data. If several MBMS bearer services use the same IP multicast address, the join is only done once.
9. The BM-SC starts sending the MBMS data.
10. MBMS GW function receives MBMS data. MBMS GW sends the MBMS data using IP multicast distribution towards all joined eNodeBs/RNCs.

8.4 MBMS Registration Procedure

The MBMS Registration is the procedure by which a downstream node informs an upstream node that it would like to receive session attributes and data for a particular MBMS bearer service in order to distribute it further downstream. This procedure builds up a distribution tree for the delivery of MBMS session attributes and data from the BM-SC to the UEs interested in the service. This procedure results in the set-up of a corresponding MBMS Bearer Context in the nodes along the distribution tree, but it does not result in the establishment of bearer plane which will be established by the Session Start procedure.

The MBMS Registration procedure is initiated:

- When the first MBMS UE Context for a particular MBMS bearer service is created in the SGSN or GGSN (see clause "MBMS UE Context") and the corresponding MBMS Bearer Context is not already established in the node;
- When an MBMS Registration Request for a particular MBMS bearer service is received from a downstream node but the corresponding MBMS Bearer Context is not established in the node; or
- When a DRNC detects that it hosts UEs interested in the MBMS bearer service.

NOTE: The terms 'downstream' and 'upstream' refer to the topological position of one node with respect to another and relative to the direction of the MBMS data flow, i.e. from BM-SC to UE.

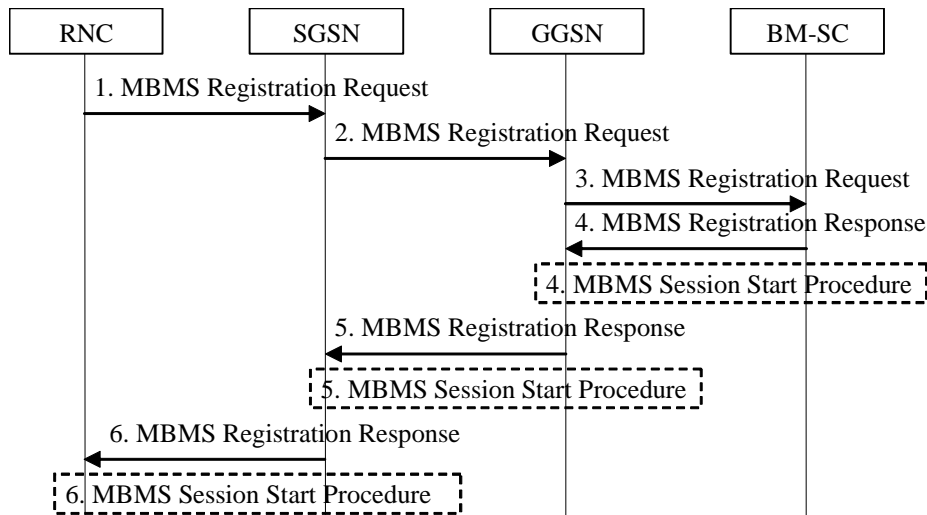


Figure 9: MBMS Registration procedure

1. When the DRNC detects that it hosts UEs interested in the MBMS bearer service, the DRNC sends a MBMS Registration Request message to its parent SGSN if not already done. How the RNC determines its parent SGSN is a matter of implementation.
2. If the SGSN has no MBMS Bearer Context for an MBMS bearer service and the SGSN receives an MBMS Registration Request from an RNC for this MBMS bearer service, or if the first MBMS UE Context is created in the SGSN for an MBMS bearer service for which the SGSN has no corresponding MBMS Bearer Context, the SGSN creates an MBMS Bearer Context (in "Standby" state) and sends an MBMS Registration request (IP multicast address, APN) message to the GGSN. How the SGSN selects a GGSN is a matter of implementation; it may for instance be based on prior signalling related to a particular UE or via APN resolution.
3. If the GGSN has no MBMS Bearer Context for an MBMS bearer service and the GGSN receives an MBMS Registration from an SGSN for this MBMS bearer service, or when the first MBMS UE Context is created in the GGSN for an MBMS bearer service for which the GGSN has no MBMS Bearer Context, the GGSN creates an MBMS Bearer Context (in "Standby" state) and sends a Registration Request (IP multicast address, APN) message to the BM-SC. Proxy and Transport function The exact nature of the signalling between GGSN and BM-SC via Gmb interface is specified in TS 29.061 [4].
4. Upon reception of an MBMS Registration Request from a GGSN, the BM-SC Proxy and Transport function adds the identifier of the GGSN to the "list of downstream nodes" parameter in its MBMS Bearer Context and responds with a MBMS Registration Response (TMGI, Required Bearer Capabilities) message. The exact nature of the signalling between GGSN and BM-SC via Gmb interface is specified in TS 29.061 [4]. If the MBMS Bearer Context is in the 'Active' state, the BM-SC initiates the Session Start procedure with the GGSN, as described in clause "MBMS Session Start Procedure".
5. If the GGSN receives a Registration Request from the SGSN in step 2, the GGSN:
 - adds the identifier of the SGSN to the "list of downstream nodes" parameter in its MBMS Bearer Context,
 - responds with an MBMS Registration Response (TMGI, Required Bearer Capabilities) message, and
 - if the MBMS Bearer Context is in the 'Active' state, initiates the Session Start procedure with the SGSN, as described in clause "MBMS Session Start Procedure".
6. If the SGSN received MBMS Registration Request from the DRNC in step 1, the SGSN:
 - adds the identifier of the RNC to the "list of downstream nodes" parameter in its MBMS Bearer Context,
 - responds with an MBMS Registration Response message, and
 - if the MBMS Bearer Context is in the 'Active' state, initiates the Session Start procedure with the DRNC, as described clause "MBMS Session Start Procedure".

8.5 MBMS Session Stop Procedure

8.5.0 General

The BM-SC Session and Transmission function initiates the MBMS Session Stop procedure when it considers the MBMS session to be terminated. The session is typically terminated when there is no more MBMS data expected to be transmitted for a sufficiently long period of time to justify a release of bearer plane resources in the network. For GERAN and UTRAN for GPRS, the procedure is propagated to all SGSNs and GGSNs that are registered for the corresponding MBMS bearer service and to BSCs/RNCs that have an established Iu bearer plane with an SGSN. For E-UTRAN and UTRAN for EPS, the procedure is propagated to all MBMS GWs, MMEs and SGSNs that are registered for corresponding MBMS bearer service and to E-UTRAN/UTRAN that have accept to receive IP multicast distribution.

8.5.1 MBMS Session Stop Procedure for GERAN and UTRAN for GPRS

The overall MBMS Session Stop procedure is presented in the following figure:

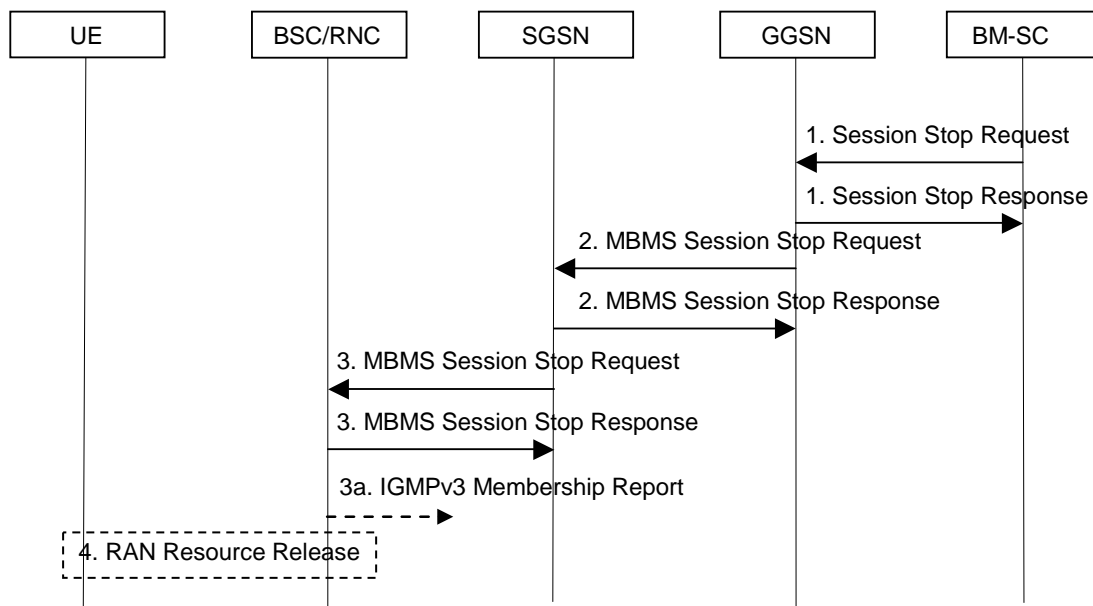


Figure 10: MBMS Session Stop procedure for GERAN and UTRAN for GPRS

1. The BM-SC Session and Transmission function sends a Session Stop Request message to the BM-SC Proxy and Transport function, which forwards it to all GGSNs listed in the "list of downstream nodes" parameter of the affected MBMS Bearer Context to indicate that the MBMS session is terminated and the bearer plane resources can be released. The MBMS Bearer Context is uniquely identified by the TMGI or the combination of TMGI and Flow Identifier. The BM-SC Proxy and Transport function sets the state attribute of its MBMS Bearer Context to 'Standby'. The GGSN sends a Session Stop Response message to the BM-SC Proxy and Transport function, which forwards it to the BM-SC Session and Transmission function. The BM-SC Proxy and Transport function copies Session Stop Requests to the BM-SC Membership function for charging purposes.
2. The GGSN sends an MBMS Session Stop Request message to all SGSNs that have a bearer plane established with the GGSN, releases the corresponding bearer plane resources towards these SGSNs and sets the state attribute of its MBMS Bearer Context to 'Standby'. The GGSN releases the MBMS Bearer Context in case of a broadcast MBMS bearer service.
3. The SGSN releases the TEID and bearer plane resources on which it was receiving MBMS data from the GGSN for the affected MBMS bearer service and sends an MBMS Session Stop Request message to all BSCs/RNCs that have a bearer plane established with the SGSN and sets the state attribute of its MBMS Bearer Context to 'Standby'. The SGSN releases the MBMS Bearer Context in case of a broadcast MBMS bearer service.
- 3a If the RNC/BSC is using IP multicast distribution it shall disable reception from the IP backbone of the particular MBMS bearer service according to RFC 3376 [19], RFC 3810 [20] and RFC 4604 [22].

- The RNC releases the affected radio and Iu resources; the BSC releases the affected radio resources. The BSC/RNC sets the state attribute of its MBMS Bearer Context to 'Standby'. The BSC/RNC releases the MBMS Service Context in case of a broadcast MBMS bearer service. A BSC in Gb mode shall send an acknowledgement to the SGSN even if there is no active MBMS context in the BSC.

8.5.2 MBMS Session Stop Procedure for E-UTRAN and UTRAN for EPS

The overall MBMS Session Stop procedure is presented in the following figure:

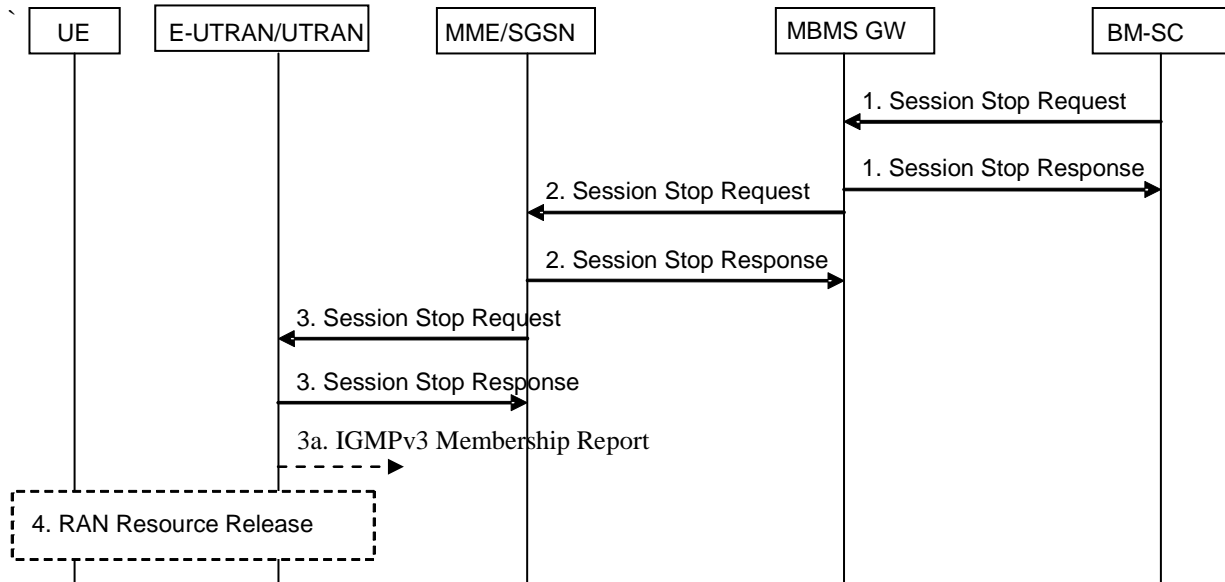


Figure 10b: MBMS Session Stop procedure for E-UTRAN and UTRAN for EPS

- The BM-SC sends a Session Stop Request message (MBMS data transfer stop, ...) to the MBMS GW listed in the "list of down stream nodes" parameter of affected MBMS Bearer Context to indicate the end of session and the bearer plane resources can be released. The MBMS Bearer Context is uniquely identified by the TMGI or the combination of TMGI and Flow Identifier. The BM-SC sets the state attribute of its MBMS Bearer Context to 'Standby'. The MBMS GW responds with Session Stop Response and release its information regarding the session.
- The MBMS GW forwards Session Stop Request message to the MME/SGSN which previously received the Session Start Request message, release the corresponding bearer plane resources to E-UTRAN/UTRAN and sets the state attribute of its MBMS Bearer Context to 'Standby'. The MBMS GW releases the MBMS Bearer Context in case of a broadcast MBMS bearer service.
- MME/SGSN forwards Session Stop Request message to the E-UTRAN/UTRAN which previously received the Session Start Request message and sets the state attribute of its MBMS bearer Context to 'Standby'. Each E-UTRAN/UTRAN responds with Session Stop Response message to the MME/SGSN. The MME/SGSN releases the MBMS Bearer Context in case of a broadcast MBMS bearer service.
- 3a If the E-UTRAN/UTRAN is using IP multicast distribution it shall disable reception from the IP backbone of the particular MBMS bearer service according to RFC 3376 [19], RFC 3810 [20] and RFC 4604 [22]. If several MBMS bearer services shares the same IP multicast address, the reception from the IP backbone shall only be disabled when the last MBMS bearer service that has used a shared IP multicast address is stopped.
- The E-UTRAN/UTRAN releases the affected resources and removes the MBMS Bearer Context (in E-UTRAN) or sets the state attribute of its MBMS Bearer Context to 'Standby' (in UTRAN). For E-UTRAN the release of the radio resources are scheduled using the MBMS data transfer stop parameter if present. It may be provided by the BM-SC in the Session Stop signalling. The MBMS data transfer stop parameter is not used by UTRAN.

8.6 MBMS De-Registration Procedure

8.6.0 Common MBMS De-Registration procedure

The MBMS De-Registration is the procedure by which a downstream node informs an upstream node that it does not need to receive signalling, session attributes and data for a particular MBMS bearer service anymore and therefore would like to be removed from the corresponding distribution tree.

The MBMS De-registration procedure is initiated:

- By the SGSN or GGSN when the last MBMS UE Context for a particular MBMS bearer service is deleted from the node and the "list of downstream nodes" parameter in the corresponding MBMS Bearer Context is empty;
- By the SGSN or GGSN when the last node registered in the "list of downstream nodes" de-registers from an MBMS bearer service for which there is no corresponding MBMS UE Context; or
- By the DRNC that registered at an SGSN when it deletes the associated MBMS Service Context.

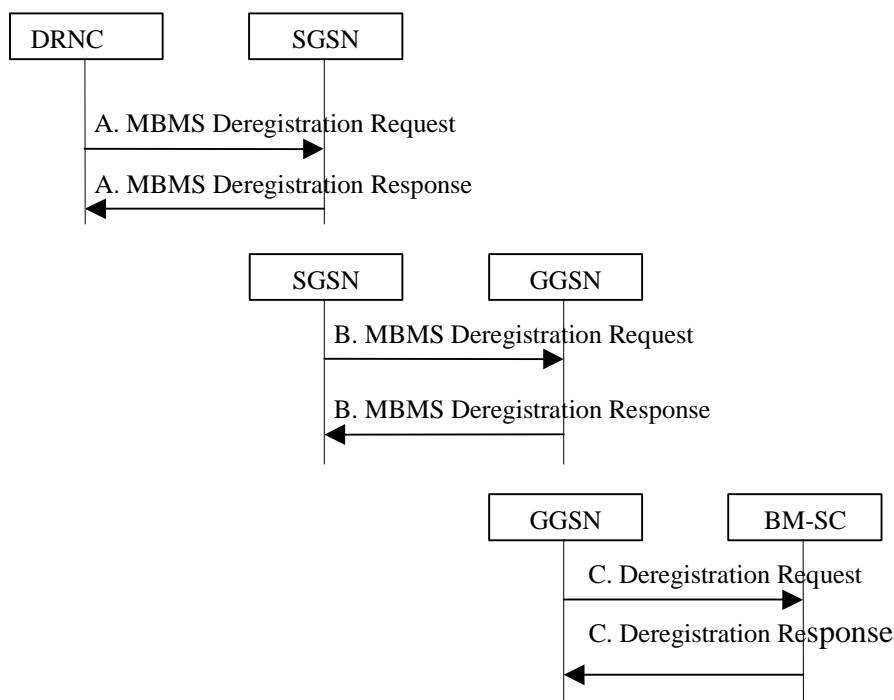


Figure 11: MBMS De-Registration Procedure

- A. When the DRNC that is registered at an SGSN no longer hosts any UE interested in that MBMS bearer service, the DRNC requests the de-registration from the MBMS bearer service to its parent SGSN. As an implementation option, the DRNC may decide not to de-register from the MBMS bearer service immediately when these conditions are met, e.g. in order to avoid unnecessary signalling in the case where the RNC would again need the same MBMS bearer service shortly after.

The SGSN removes the identifier of the RNC from the "list of downstream nodes" parameter of the affected MBMS Bearer Context and confirms the operation by sending an MBMS De-Registration Response message to the RNC. If an Iu bearer plane had been established between the DRNC and the SGSN for this MBMS bearer service, the Iu bearer plane is released. If the RNC is using IP multicast distribution it shall disable reception from the IP backbone of the particular MBMS bearer service according to RFC 3376 [19], RFC 3810 [20] and RFC 4604 [22].

- B. When the "list of downstream nodes" of a particular MBMS Bearer Context in the SGSN becomes empty and the SGSN has no MBMS UE Contexts linked to that MBMS Bearer Context, the SGSN sends an MBMS De-Registration Request (IP multicast address, APN) message to its upstream GGSN associated with the MBMS Bearer Context.

The GGSN removes the identifier of the SGSN from the "list of downstream nodes" parameter of the affected MBMS Bearer Context and confirms the operation by sending an MBMS De-Registration Response message to the SGSN. If a bearer plane had been established between the SGSN and the GGSN for this MBMS bearer service, the bearer plane is released.

- C. When the "list of downstream nodes" of a particular MBMS Bearer Context in the GGSN becomes empty and the GGSN has no MBMS UE Contexts linked to that MBMS Bearer Context, the GGSN sends a De-Registration Request (IP multicast address, APN) message to the BM-SC. Proxy and Transport function If a bearer plane had been established over Gi for this MBMS bearer service, the bearer plane is released.

The BM-SC removes the identifier of the GGSN from the "list of downstream nodes" parameter of the affected MBMS Bearer Context and confirms the operation by sending a De-Registration Response message to the GGSN.

8.6.1 BM-SC initiated MBMS De-Registration Procedure

This MBMS De-Registration Procedure is initiated by BM-SC when the specific MBMS bearer service is terminated. This procedure tears down the distribution tree for the delivery of session attributes and MBMS data. This procedure results in releasing of all MBMS Bearer Contexts and associated MBMS UE Contexts in the nodes along the distribution tree.

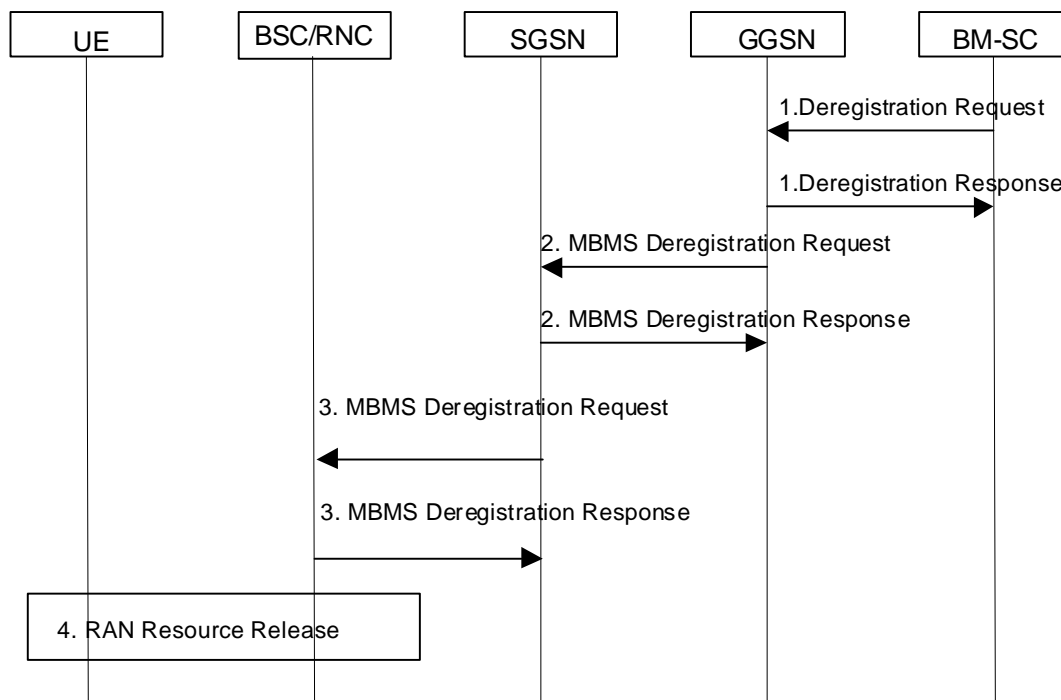


Figure 12: BM-SC initiated MBMS De-Registration Procedure

1. The BM-SC sends a De-Registration Request message to all GGSNs contained in the "list of downstream nodes" parameter of the corresponding MBMS Bearer Context to indicate the session is terminated and any related MBMS bearer resources shall be released.

The GGSN returns a De-Registration Response message to the BM-SC. The BM-SC releases all MBMS UE Contexts and the corresponding MBMS Bearer context.

2. The GGSN sends an MBMS De-Registration Request message to all SGSNs contained in the "list of downstream nodes" parameter. of the corresponding MBMS Bearer Context. The SGSN returns an MBMS De-registration Response message to the GGSN and releases all bearer resources if the state attribute of the MBMS Bearer Context is 'Active'. The GGSN releases all MBMS UE Contexts and the affected MBMS Bearer Context. If a bearer plane had been established over Gi for this MBMS bearer service, the bearer plane is released.

3. The SGSN sends an MBMS De-Registration Request message to all BSCs/RNCs connected with this SGSN. The BSC/RNC returns an MBMS De-Registration Response message to the SGSN, and releases all bearer resources if the state attribute of the MBMS Service Context is 'Active'. If the BSC/RNC is using IP multicast distribution it shall disable reception from the IP backbone of the particular MBMS bearer service according to RFC 3376 [19], RFC 3810 [20] and RFC 4604 [22]. The SGSN releases all MBMS UE Contexts and the affected MBMS Bearer Context. If a bearer plane had been established between the SGSN and the GGSN for this MBMS bearer service, the bearer plane is released.
4. The BSC/RNC releases the affected radio resources, all MBMS UE Contexts and the MBMS Service Context. The detailed procedures are specified in TS 25.346 [10] and TS 43.246 [11]. RAN may notify the UEs that the MBMS Bearer service has being terminated, so that the UE can locally deactivate its MBMS UE context, detailed procedures are specified in TS 25.346 [10] and TS 43.246 [11].

8.7 MBMS Multicast Service Deactivation

The multicast service deactivation is a signalling procedure between the UE and the network. The procedure removes the MBMS UE Context from the UE, RAN, SGSN and GGSN for a particular MBMS multicast service. The multicast service deactivation can be initiated by:

- The UE;
- The GGSN;
- The BM-SC; or
- The SGSN

All these cases are contained in the procedure illustrated in figure 13. The UE initiated Multicast Service Deactivation starts with step 1), the BM-SC initiated Multicast Service Deactivation starts with step 3), the GGSN initiated Multicast Service Deactivation starts with step 4), the SGSN initiated Multicast Service Deactivation starts with step 5) or 9), and the MBMS UE de-linking is performed at step 7).

At GPRS detach, all MBMS UE contexts of the UE are implicitly deactivated in the UE, SGSN and GGSN, i.e. the SGSN performs the deactivation procedure starting with step 7).

If the PDP context linked to the MBMS UE context by the linked NSAPI is deactivated by the UE or SGSN or GGSN, then the SGSN shall perform the MBMS deactivation procedure starting with step 7). The UE will remove all MBMS UE Contexts locally after the Linked PDP Context was deactivated.

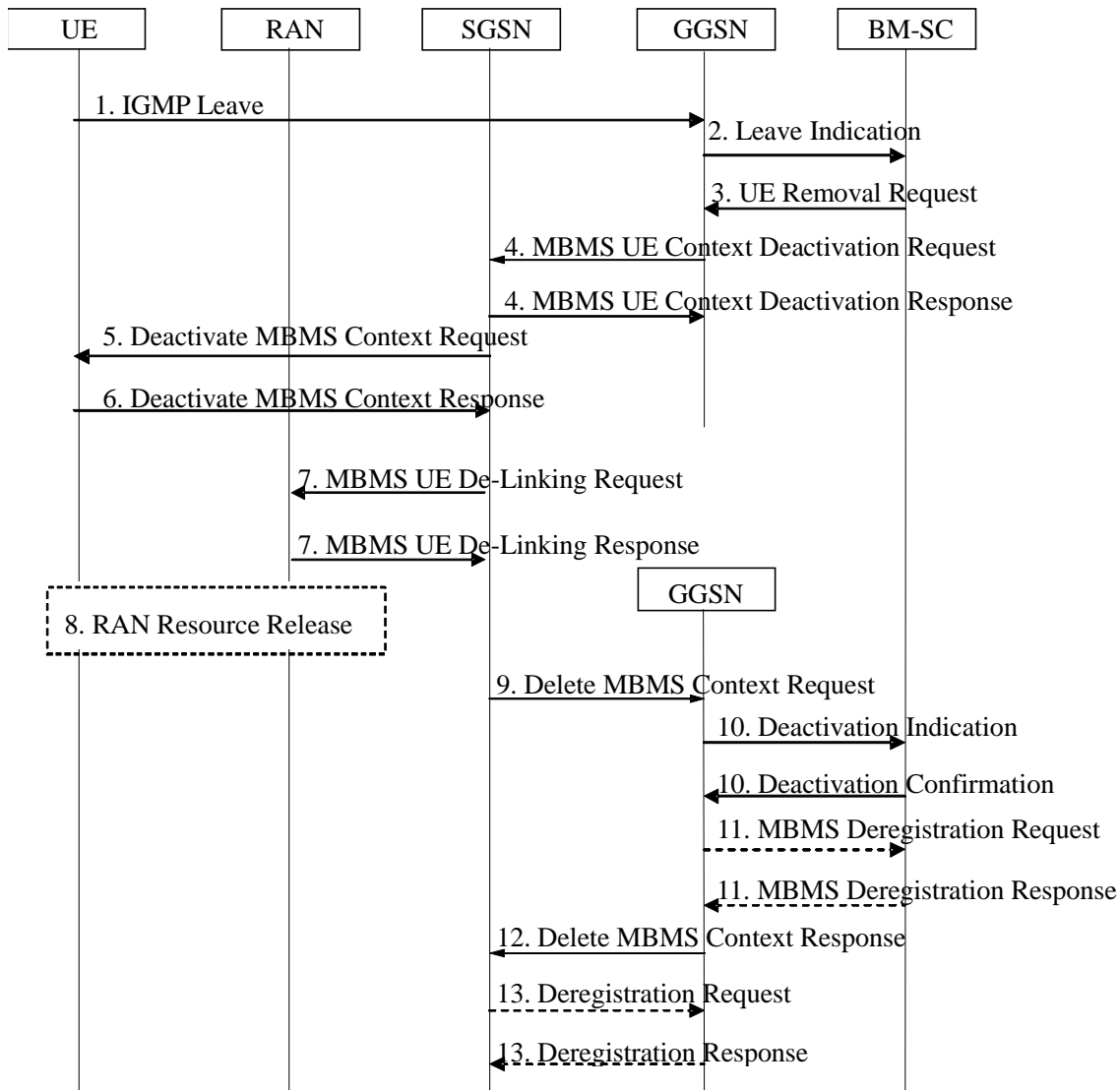


Figure 13: MBMS Multicast Service Deactivation

1. The UE sends an IGMP (IPv4) or MLD (IPv6) Leave message (here, the Leave message means Leave Group message in RFC 2236 for IGMP (IPv4) and Multicast Listener Done in RFC2710 for MLD (IPv6)) over the default PDP context to leave a particular multicast service identified by an IP multicast address.
2. The GGSN sends a Leave Indication (IP multicast address, APN, IMSI) to the BM-SC Proxy and Transport function, which forwards it to the BM-SC Membership function, indicating that the UE is requesting to leave the multicast service identified by the IP multicast address. The exact nature of the signalling between GGSN and BM-SC is specified in TS 29.061 [4].
3. Upon reception of the Leave Indication, the BM-SC Membership function verifies that the IP multicast address corresponds to a valid MBMS bearer service and sends a UE Removal Request (IP multicast address, APN, IMSI) to the GGSN that originated the Leave Indication. The APN shall be the same that was provided during service activation (see "MBMS Multicast Service Activation"). The exact nature of the signalling between GGSN and BM-SC is specified in TS 29.061 [4]. The BM-SC Membership function may also initiate the deactivation of an MBMS UE Context for service-specific reasons (e.g. the service is terminated but the UE has not yet left the multicast group) by directly sending a UE Removal Request message to the GGSN.
4. Upon reception of the UE Removal Request or for other reasons (e.g. Error cases), the GGSN sends an MBMS UE Context Deactivation Request (IP multicast address, APN, IMSI) to the SGSN. The IP multicast address, APN and IMSI together identify the MBMS UE Context to be deleted by the SGSN. The APN is the one received in step 3. The SGSN acknowledges reception of the MBMS UE Context Deactivation Request by sending an MBMS UE Context Deactivation Response to the GGSN.

5. Upon reception of the MBMS UE Context Deactivation Request or for other reasons (e.g. due to a change in the roaming restrictions for the user) the SGSN sends a Deactivate MBMS Context Request (TI) to the UE. The TI identifies the MBMS UE Context to be deleted by the UE.
6. The UE deletes the MBMS UE Context and sends a Deactivate MBMS Context Accept (TI) to the SGSN.
7. If the UE is PMM-CONNECTED and has been already linked towards the RAN, the SGSN sends a MBMS UE De-Linking Request to the RNC (IP multicast address, APN, TMGI). RAN deletes the MBMS UE Context and sends a MBMS UE De-Linking Response (TMGI) to the SGSN.
8. If dedicated radio resources are currently assigned to the UE for the reception of the MBMS data, the RAN releases these radio resources. If shared radio resources are currently assigned for the distribution of the MBMS data, the RAN may decide to move the remaining UEs to dedicated resources. The detailed procedures and conditions are specified in TS 25.346 [10] and TS 43.246 [11].
9. Upon reception of the Deactivate MBMS Context Accept or for other reasons (e.g. due to expiry of the long timer that is started upon a periodic routing area update not being received) the SGSN sends a Delete MBMS Context Request (MBMS_NSAPI) to the GGSN that holds the MBMS UE Context. This GGSN may be different from the GGSN that receives IGMP Leave request in step 1.
10. The GGSN deletes the MBMS UE Context and sends a Deactivation Indication to the BM-SC to confirm the successful deactivation of the MBMS UE Context. The BM-SC, after receiving the Deactivation Indication, deletes the MBMS UE Context and sends a confirmation to the GGSN. The exact nature of the signalling between GGSN and BM-SC is specified in TS 29.061 [4].
11. If the GGSN does not have any more users interested in this MBMS bearer service and the "list of downstream nodes" in the corresponding MBMS Bearer Context is empty, the GGSN sends a MBMS De-Registration Request to the BM-SC Proxy and Transport function. The BM-SC Proxy and Transport function responds with a MBMS De-Registration Response and removes the identifier of the GGSN from the "list of downstream nodes" parameter in its MBMS Bearer Context. See clause "MBMS De-Registration Procedure".
12. The GGSN confirms the deactivation of the MBMS UE Context to the SGSN by sending a Delete MBMS Context Response to the SGSN, which then deletes the MBMS UE Context.
13. If the SGSN does not have any more users interested in this MBMS bearer service and the "list of downstream nodes" in the corresponding MBMS Bearer Context is empty, the SGSN sends an MBMS De-Registration Request to the GGSN. The GGSN responds with an MBMS De-Registration Response and removes the identifier of the SGSN from the "list of downstream nodes" parameter in its MBMS Bearer Context. See clause "MBMS De-Registration Procedure".

8.8 MBMS Session Update procedure

8.8.1 General

The MBMS Session Update procedure may be invoked by BM-SC or by SGSN. The BM-SC uses the procedure to update the service area or the QoS(ARP) for an ongoing MBMS Broadcast service session. The SGSN can also use the procedure to update the list of RAs where MBMS multicast users are located for an ongoing MBMS Multicast service session.

For the distributed MCE architectures, i.e. when the MCE is part of the eNB as described in clause 15.1.1 in TS 36.300 [17], an absolute time stamp for when data can be expected, "MBMS data transfer start", should be used at MBSFN operation mode to ensure synchronized session control and to facilitate a graceful reallocation of resources for the MBSFN when needed. When the parameter "MBMS data transfer start" is present, a receiving supporting node shall ignore the parameter "time to MBMS data transfer". For session stop signalling, the parameter "MBMS data transfer stop" is if present used to schedule the release of the radio resources in order to ensure a synchronized session control. The MME also sends an MBMS Session Start Request message to any added MCEs, and an MBMS Session Stop Request message to any removed MCEs. The MME shall set "MBMS Data Transfer Start" to "Time of MBMS Data Transfer" or "Time of MBMS Data Stop" respectively as specified in TS 36.444 [28].

8.8.2 SGSN initiated Session Update for GERAN and UTRAN for MBMS Multicast service

If the SGSN has provided a list of RAs in the MBMS Session Start Request message (even if the list was empty) and RAs are added or removed from the list, the SGSN shall use the MBMS Session Update procedure to inform the RNCs that the list has changed. The SGSN sends the Session Update message only to the RNCs that are affected by the list change. The procedure is used only during the MBMS Multicast service session and when SGSN has already sent a MBMS Session Start Request message to the RNC.

If the SGSN has provided a list of RAs in the MBMS Session Start Request message (even if the list was empty) the SGSN shall send the Session Update to a RNC when:

- the first UE which have activated the service enters in a RA that is not in the list;
- the last UE which have activated the service leaves from a RA that was in the list.

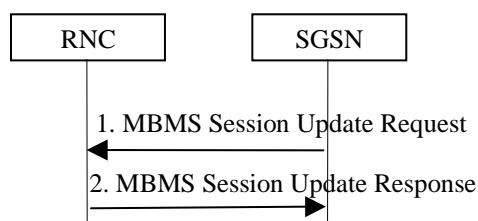


Figure 13a. Session Update procedure

- 1) The SGSN sends MBMS Session Update Request message to a RNC.
- 2) The RNC acknowledges the MBMS Session Update Request with the MBMS Session Update Response message.

8.8.3 BM-SC initiated Session Update for GERAN and UTRAN for MBMS Broadcast service

The BM-SC initiates the MBMS Session Update procedure when the service area for an ongoing MBMS Broadcast service session shall be modified.

The attributes that can be modified by the Session Update Request are the MBMS Service Area, and the list of downstream nodes for GGSN (Broadcast only). A node receiving the Session Update Request determines how the attributes have changed by comparing the attributes in the message with corresponding attributes in its stored MBMS Bearer Context.

A Session Update received in one node, results in a Session Update being sent to downstream nodes, to inform of the changed MBMS Service Area. If a Session Update with the List of SGSN parameter included is received in the GGSN, it does also result in a Session Start being sent to new downstream nodes, and in a Session Stop being sent to downstream nodes that have been removed from the list.

The overall Session Update procedure is presented in figure 13b.

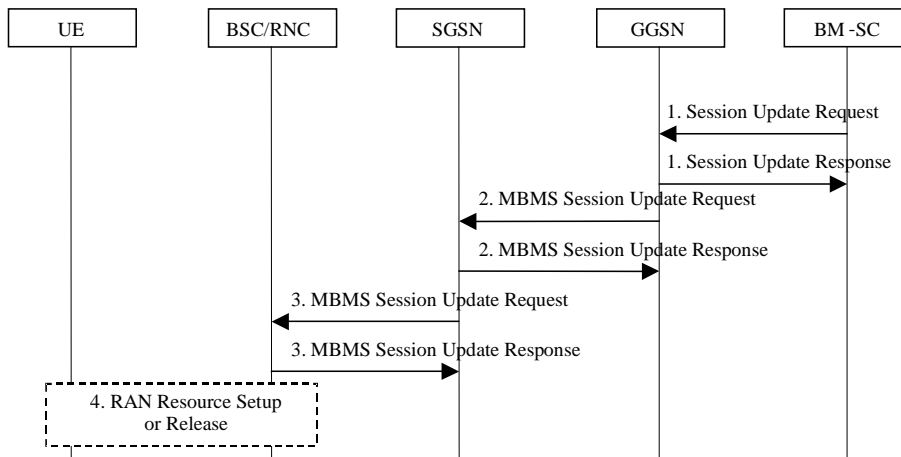


Figure 13b: Session Update procedure for GERAN and UTRAN

1. The BM-SC Session and Transmission function sends a Session Update Request (TMGI, Flow Identifier (Broadcast only), QoS, MBMS Service Area, Session identifier, estimated session duration, broadcast/multicast, list of downstream nodes for GGSN, time to MBMS data transfer) to the BM-SC Proxy and Transport function, which then forwards it to the GGSNs listed in the "list of downstream nodes" parameter of the corresponding MBMS Bearer Context. The TMGI and Session identifier identifies the ongoing session. The QoS, broadcast/multicast attributes and the 2G/3G indicator shall be identical as in the preceding Session Start message. The MBMS Service Area and the List of downstream nodes for GGSN define the new service area. The time to MBMS data transfer shall be set to 0 and the estimated session duration shall be set to a value corresponding to the remaining part of the session.

The GGSN stores the new session attributes and the list of downstream nodes in the MBMS Bearer Context and sends a Session Update Response message to the BM-SC Proxy and Transport function which forwards it to the BM-SC Session and Transmission function. The BM-SC Proxy and Transport function copies the Session Update Request to the BM-SC Membership function for charging purposes.

2. The GGSN compares the new list of downstream nodes with the list of downstream nodes it has stored in the MBMS Bearer Context. It sends an MBMS Session Start Request message to any added SGSN, an MBMS Session Stop Request to any removed SGSN, and an MBMS Session Update Request to the remaining SGSNs in the new list.
3. The SGSN receiving an MBMS Session Update Request message, sends an MBMS Session Update Request message including the session attributes (TMGI, QoS, MBMS service Area, Session identifier, estimated session duration, broadcast/multicast, time to MBMS data transfer, list of RAs, etc.) to each BSC and/or each RNC that is connected to this SGSN.
4. The BSCs/RNCs establish or release the necessary radio resources for the transfer of MBMS data to the interested UEs.

8.8.4 BM-SC initiated Session Update for EPS with E-UTRAN and UTRAN

The BM-SC initiates the MBMS Session Update procedure when the service attributes (e.g. Service Area, list of cell IDs or ARP) for an ongoing MBMS Broadcast service session shall be modified, e.g. the Session Update procedure for EPS is initiated by BM-SC to notify eNBs to join or leave the service area. Update of the QoS(ARP) is triggered when the priority of a broadcast data flow of a group communication service is changed as specified in TS 23.468 [24].

The attributes that can be modified by the Session Update Request are the MBMS service area, list of cell IDs, Access indicator, MBMS data transfer start, QoS(ARP) and the List of MBMS control plane nodes. A node receiving the Session Update Request determines how the attributes have changed by comparing the attributes in the message with corresponding attributes in its stored MBMS Bearer Context.

A Session Update received in one node, results in a Session Update being sent to downstream nodes, to inform of the changed MBMS service attributes. If a Session Update with the List of MME and SGSN parameter included is received

in the MBMS GW, it does also result in a Session Start being sent to new downstream nodes, and in a Session Stop being sent to downstream nodes that have been removed from the list.

NOTE: For a MBMS session the change of service area does not result in a change of MBMS-GW.

The overall Session Update procedure is presented in figure 13c-1 and 13c-2.

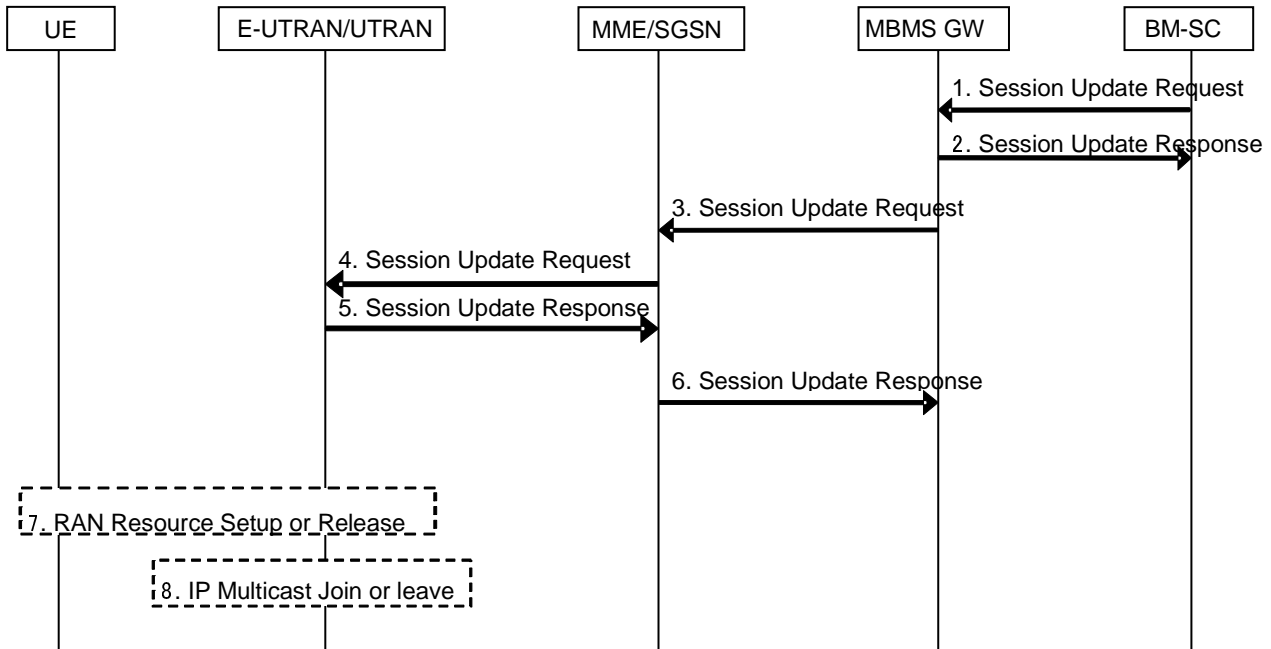


Figure 13c-1: Session Update procedure for EPS with E-UTRAN and UTRAN

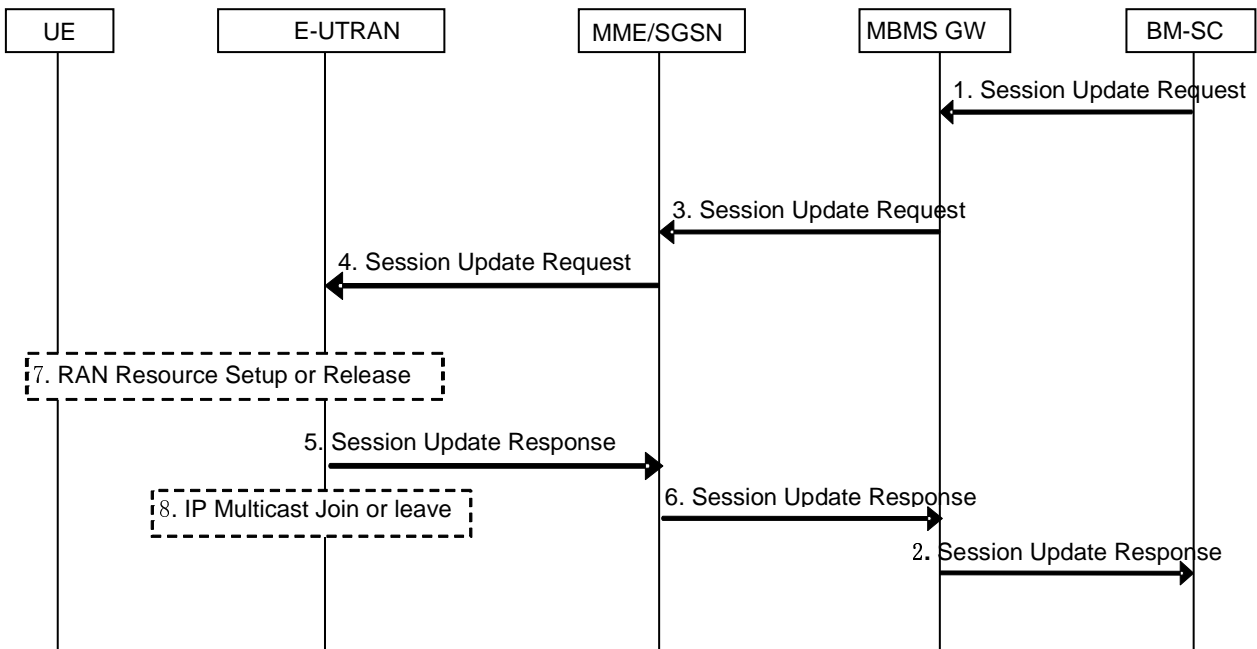


Figure 13c-2: Session Update procedure for EPS with E-UTRAN with delayed response

1. The BM-SC sends a Session Update Request (TMGI, Flow Identifier, QoS, MBMS Service Area, list of cell IDs if available, Session identifier, estimated session duration, the list of MBMS control plane nodes(MMEs, SGSNs) for MBMS GW, time to MBMS data transfer, MBMS data transfer start, Access Indicator, ...) to MBMS GW. The TMGI and Session identifier identifies the ongoing session. Apart from the ARP parameter, all other parameters in the QoS profile shall be identical as in the preceding Session Start message. The ARP parameter may be different if it is to be updated. The MBMS Service Area and the list of MBMS control plane nodes (MMEs, SGSNs) for MBMS GW define the new service area. The estimated session duration shall be set

to a value corresponding to the remaining part of the session. If radio access of MBMS service is updated the Access indicator shall be included to indicate in which radio access types the MBMS service should be broadcasted, i.e. UTRAN, or E-UTRAN, or both. The ARP parameter may be updated only if the Access Indicator indicates E-UTRAN. The Access indicator may be included in charging information generated by the MBMS-GW.

If MBMS-GW is configured to delay response to BMSC when access type is E-UTRAN, then MBMS-GW delays response to BMSC (i.e. Step 2) until after step 6 is executed as shown in figure 13c-2. This configuration should be only performed when E-UTRAN executes step 7 below before responding to the MBMS Session Update message as specified in TS 36.300 [17].

NOTE: It is up to the operator to ensure that E-UTRAN, MBMS-GW and BMSC are configured only when E-UTRAN supports delaying the response from eNB.

2. The MBMS GW stores the new session attributes in the MBMS Bearer Context and sends a Session Update Response message to the BM-SC, if figure 13c-1 is executed. The MBMS-GW responds only after first MME response in step 6 is received, if it is configured to do so as shown in figure 13c-2.
3. The MBMS GW filters the new list of MBMS control plane nodes using the Access indicator to ignore entries not consistent with the Access indicator, and compares remaining entries in the new list of MBMS control plane nodes with the list of MBMS control plane nodes it has stored in the MBMS Bearer Context. It sends an MBMS Session Start Request message to any added MME/SGSN, an MBMS Session Stop Request to any removed MME/SGSN, and an MBMS Session Update Request (TMGI, Flow Identifier, QoS, MBMS Service Area, list of cell IDs if available, Session identifier, estimated session duration, ...) to the remaining MME/SGSNs in the new list. The handlings of the MBMS Session Start/Stop Request message are described in clauses 8.3.2 and 8.5.2.
4. The MME/SGSN receiving an MBMS Session Update Request message, sends an MBMS Session Update Request message including the session attributes (TMGI, QoS, MBMS service Area, list of cell IDs if available, Session identifier, estimated session duration, broadcast (for UTRAN only), transport network IP Multicast Address, IP address of the multicast source, C-TEID, etc.) to each eNodeB/MCE/RNC that is connected to the MME/SGSN.

For E-UTRAN, when connected to multiple MCEs, the MME should filter the distribution of MBMS Session Update Request messages to the MCEs based on the MBMS service area.

For UTRAN, if one or more of the downstream nodes newly added to the MBMS Service Area accepts the Session Update and the proposed IP Multicast and Source address for backbone distribution and the proposed C-TEID, the SGSN includes an indication that IP Multicast distribution is accepted in the MBMS Session Update Response message to MBMS GW. If one or more of the downstream nodes newly added to the MBMS Service Area does not accept the proposed IP Multicast and Source address for backbone distribution or the proposed C-TEID, the SGSN falls back to normal point-to-point MBMS bearer establishment for these nodes and responds with an MBMS Session Update Response message providing the TEID for bearer plane that the MBMS GW shall use for forwarding the MBMS data. Otherwise if all nodes accept multicast, the SGSN returns the C-TEID and the IP Multicast distribution address in the Session Update Response message.

E-UTRAN may respond to Session Update Request after first successful MBMS resources have been set up or released (i.e. Step 7) which indicates to the BMSC that there are resources already available for MBMS data delivery, as shown in figure 13c-2.

5. If the E-UTRAN/UTRAN has no MBMS bearer context with the TMGI indicated in the MBMS Session Update Request message, the E-UTRAN/UTRAN creates an MBMS bearer context and sets its state attribute to 'Active' (in UTRAN only). Otherwise the E-UTRAN/UTRAN compare the new service area with the one it has stored in the MBMS Bearer Context and make the corresponding update. Then the E-UTRAN/UTRAN responds the MME/SGSN to confirm the reception of the Session Update Request message. When a cell ID list is included in the Session Start Request, E-UTRAN uses it to determine a set of radio resources to be used for the broadcast. Based on the cell ID list, the set of radio resources selected may be reduced from the full set of resources defined by the MBMS service area. The E-UTRAN ensures that all of its corresponding nodes make the same decision on the reduced set.

For UTRAN, if an RNC newly added to the MBMS Service Area accepts the Session Update and the proposed IP Multicast and Source address for backbone distribution and the proposed C-TEID the RNC sends an MBMS Session Update Response message to SGSN including an indication that IP Multicast distribution is accepted. If an RNC newly added to the MBMS Service Area does not accept the proposed IP Multicast and Source address

for backbone distribution (or the proposed C-TEID), the RNC falls back to normal point-to-point MBMS bearer establishment.

6. The MME/SGSN updates the session attributes in its MBMS Bearer Context and responds to the MBMS GW. The SGSN should wait for a response from all UTRAN nodes (until an acceptable duration) if the Service Area has been changed to be able to report to the MBMS-GW whether all, part or none of any newly added RNCs have accepted IP multicast distribution and to provide an SGSN IP address and TEID for user plane over Sn if some RNCs did not accept IP multicast distribution. The MME may return a response to the MBMS-GW as soon as the session update request is accepted by one E-UTRAN node.

If the MBMS-GW is configured to delay response to the BMSC, MBMS-GW waits until step 6 occurs before responding to the BMSC as shown in figure 13c-2.

7. The E-UTRAN/UTRAN establishes/releases the radio resources for the transfer of MBMS data to the interested UEs. If the ARP parameter is updated the MCE shall ensure that any necessary changes to radio resources are synchronized across all eNBs in the corresponding MBSFN area. For E-UTRAN the radio resource set up is scheduled using the MBMS data transfer start parameter if it is present, otherwise using the time to MBMS data transfer parameter if it is present. The MBMS data transfer start parameter is not used by UTRAN.
8. The eNodeBs/RNCs send IP multicast Join or Leave message to the received user plane IP multicast address allocated by the MBMS GW. If multiple MBMS bearers services shares the same IP multicast address, this shall be considered before a Join or Leave message is sent.

8.9 MBMS UE Context Synchronisation Procedure

The Routing Area Update procedure transfers the MBMS UE Context status between UE and SGSN. This MBMS UE Context status identifies MBMS UE contexts, which are lost or deactivated only on one side. All MBMS UE Contexts, which are active on one side only shall be deactivated locally. If the UE wishes to re-activate the related MBMS bearer service, it shall join the MBMS bearer service again. See clause 8.2 "MBMS Multicast Service Activation".

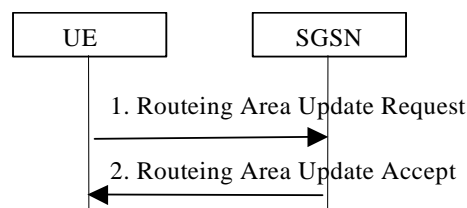


Figure 13d. MBMS UE Context Synchronisation procedure

- 1) The UE sends Routing Area Update Request to the SGSN. It includes the MBMS UE Context status, which indicates the UE's active MBMS UE Contexts.
- 2) The SGSN sends Routing Area Update Accept to the UE. It includes the MBMS UE Context status, which indicates the UE's MBMS UE Contexts that are stored in the SGSN.

8.9a MBMS feature support indication

An SGSN that supports MBMS shall indicate MBMS feature support to the UE during Routing Area Update procedure in the Routing Area Update Accept message and during GPRS attach procedure in the Attach Accept message. The UE then knows it can use already activated MBMS bearers, or activate new MBMS bearers according to clause 8.2 "MBMS Multicast Service Activation".

An SGSN that does not support MBMS will not indicate MBMS feature support to the UE. This indicates to the UE that MBMS bearers are no longer supported, which may allow the UE to use point-to-point bearers for MBMS data transfer. In this case, the UE shall deactivate all active MBMS UE Contexts locally.

8.10 Inter SGSN Routing Area Update

This procedure describes the handling of MBMS bearer services when an MBMS UE performs a Routing Area Update and the serving SGSN changes. It is based on the Inter SGSN Routing Area Update procedure specified in TS 23.060 [15]. The procedure is performed regardless whether MBMS sessions are ongoing or not. The handling of any PDP contexts established by the UE is not changed compared to the procedure without MBMS. The procedure described below does not show all details of the Routing Area update procedure. Only for the MBMS specific additions the steps are described.

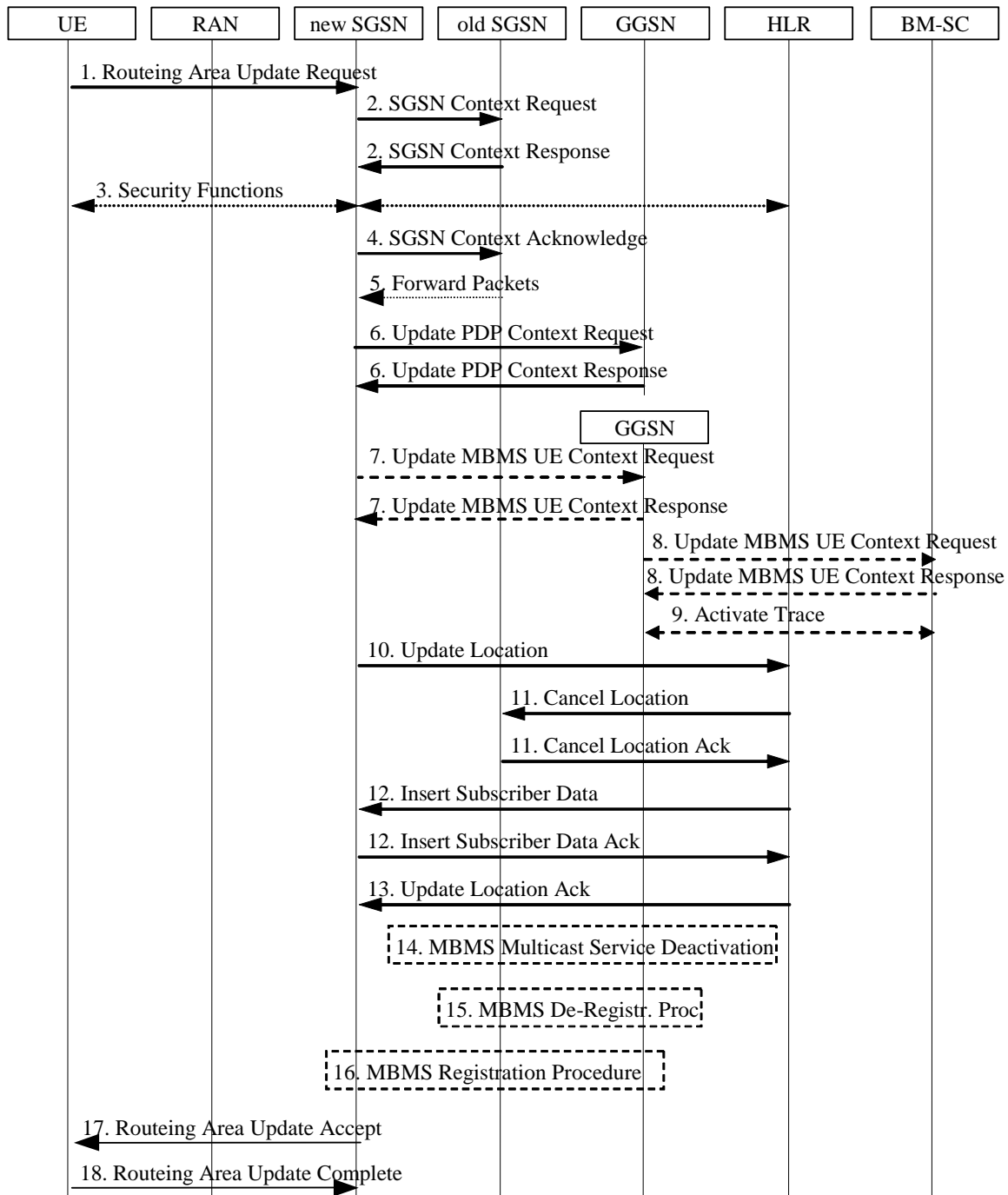


Figure 14: Inter SGSN Routing Area Update

- 2) An SGSN supporting MBMS indicates its MBMS support in the SGSN Context Request message. If the SGSN indicates that it supports MBMS, the old SGSN includes the transfer of the MBMS UE Context(s) in the SGSN Context Response message.

- 7) For the MBMS UE context(s) received in step 2) the new SGSN sends Update MBMS UE Context Request (Serving network identity, MS Time Zone, CGI/SAI, RAT Type, Additional MBMS Trace Info) to the GGSNs concerned. The GGSNs update their MBMS UE Context fields and return Update MBMS UE Context Response.
- 8) The GGSN sends Update MBMS UE Context Request (RAI) to the BM-SC. The inclusion of CGI/SAI shall be according rules detailed in clause 15.1.1a in TS 23.060 [15]. The BM-SC updates its MBMS UE Context fields and return Update MBMS UE Context Response.
- 9) If the GGSN receives new or updated Additional MBMS Trace Info from the new SGSN, the GGSN sends an Activate Trace (Additional MBMS Trace Info) message to the BM-SC.
- 14) In case the new SGSN indicated no MBMS support in step 2) the old SGSN deactivates all MBMS UE context(s) of the UE in SGSN, GGSN and BM-SC by initiating deactivation procedure(s) as described in clause "8.7 MBMS Multicast Service Deactivation".
- 15) If the old SGSN does not have any more MBMS UE Contexts for the MBMS bearer service(s) and the "list of downstream nodes" in the corresponding MBMS Bearer Context is empty, the SGSN initiates the MBMS De-Registration Procedure. See clause "8.6 MBMS De-Registration Procedure".
- 16) In case the new SGSN indicated MBMS support in step 2), the new SGSN verifies for each MBMS UE Context received whether it has a corresponding MBMS Bearer Context. For each MBMS Bearer Context that the SGSN does not already have, the SGSN creates an MBMS Bearer Context (in "Standby" state) and initiates the MBMS Registration Procedure towards the GGSN. See clause "8.4 MBMS Registration Procedure".
- 17) An SGSN without MBMS support does not indicate MBMS feature support in the Routing Area Update Accept message. On the other hand if the SGSN supports MBMS, the Routing Area Update Accept indicates to the UE that the network supports MBMS.

8.10a Inter-system Intra-SGSN change

For an MBMS UE transitioning between UTRAN and A/Gb mode GERAN, the procedures are the same as the Iu mode to A/Gb mode Intra SGSN Change and A/Gb mode to Iu mode Intra SGSN Change procedures specified in TS 23.060 [15].

Furthermore, the same considerations on Radio Access Technology changes apply as specified in the impacts of applying flow based charging specified in TS 23.060 [15], i.e. the SGSN shall send an Update MBMS UE Context Request to the GGSN. Subsequently the GGSN shall send an Update MBMS UE Context Request to the BM-SC as described in the Inter SGSN Routing Area Update procedure in clause 8.10.

8.11 Inter SGSN Serving RNS Relocation Procedure

This procedure is performed when the SGSN changes due to SRNS relocation. It bases on the SRNS Relocation procedure specified in TS 23.060 [15]. The procedure is performed regardless whether MBMS sessions are ongoing or not. The handling of any PDP contexts established by the UE is not changed compared to the procedure without MBMS. The procedure described below does not show all details of the SRNS relocation procedure. Only for the MBMS specific additions the steps are described.

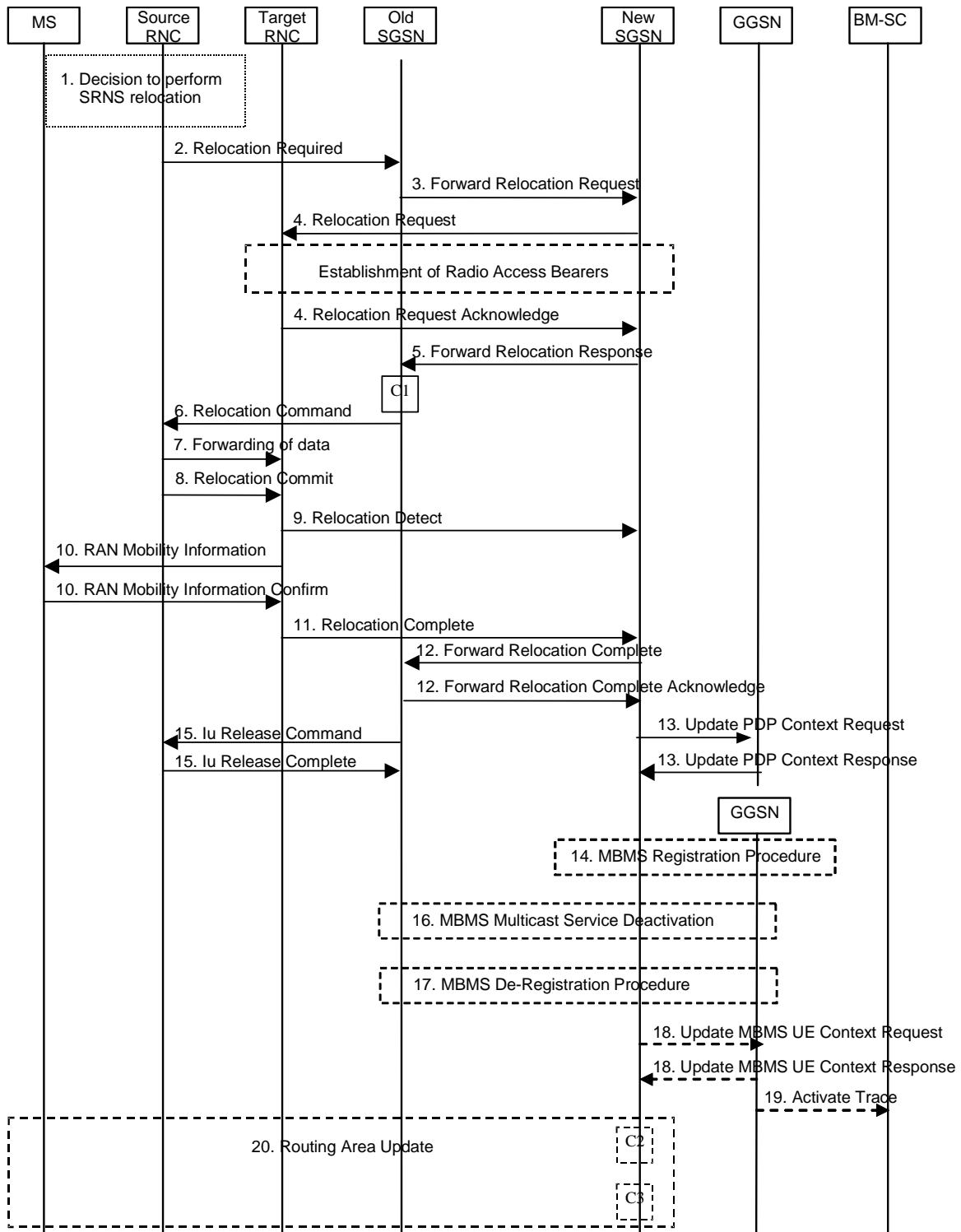


Figure 15: SRNS Relocation Procedure

- 3) The old SGSN transfers the MBMS UE Context(s). in the Forward Relocation Request message to the new SGSN
- 5) An MBMS supporting SGSN indicates its MBMS support in the Forward Relocation Response message.
- 14) In case the new SGSN supports MBMS it verifies for each MBMS UE Context received whether it has a corresponding MBMS Bearer Context. For each MBMS Bearer Context not yet existing in the SGSN the SGSN creates an MBMS Bearer Context (in "Standby" state) and initiates the MBMS Registration Procedure. See clause "MBMS Registration Procedure".

- 16) In case the new SGSN indicated no MBMS support in step 3) the old SGSN deactivates all MBMS UE contexts of the UE in SGSN, GGSN and BMSC by initiating deactivation procedure(s) as described in clause "8.7 MBMS Multicast Service Deactivation".
- 17) If the old SGSN does not have any more MBMS UE Contexts for this MBMS bearer service and the "list of downstream nodes" in the corresponding MBMS Bearer Context is empty, the SGSN initiates the MBMS De-Registration Procedure. See clause "MBMS De-Registration Procedure".
- 18) If the new SGSN supports the MBMS and for the MBMS UE context(s) received in step 5) the new SGSN sends Update MBMS UE Context Request (Serving network identity, MS Time Zone, CGI/SAI, RAT Type, Additional MBMS Trace Info) to the GGSNs concerned. The GGSNs update their MBMS UE Context fields and return Update MBMS UE Context Response. The GGSN sends updated Serving network identity to the BM-SC. The inclusion of CGI/SAI shall be according to rules detailed in clause 15.1.1a in TS 23.060 [15].
- 19) If the GGSN receives new or updated Additional MBMS Trace Info from the new SGSN, the GGSN sends an Activate Trace (Additional MBMS Trace Info) message to the BM-SC.
- 20) An SGSN without MBMS support does not indicate MBMS feature support in the Routing Area Update Accept message. On the other hand if the SGSN supports MBMS, the Routing Area Update Accept indicates to the UE that the network supports MBMS.

8.12 MBMS Broadcast Service Activation

MBMS Broadcast service activation is the procedure by which a UE locally activates a broadcast MBMS bearer service:

- The MBMS broadcast service activation procedure does not register the user in the network. There is no MBMS bearer service specific signalling exchanged between the UE and the Network.
- The broadcast service activation procedure does not establish MBMS UE contexts in UE, SGSN and GGSN.

8.13 MBMS Broadcast service de-activation

The MBMS Broadcast service de-activation by the UE is local to the UE, i.e. without interaction with the Network.

8.14 Void

8.15 MBMS UE Linking/De-linking mechanism

MBMS UE Linking is the process by which UE MBMS context(s) is (are) provided to an Iu-mode RAN.

MBMS UE linking procedure is performed when the UE is PMM-CONNECTED at least in the following cases.

- When a UE which has a MBMS UE context is moved to the PMM CONNECTED state and a PS RAB is established. This may happen at any point in time e.g. before, during and between Sessions.
- When a UE joins the MBMS bearer service and is in the PMM CONNECTED state due to an existing PS RAB. This may happen at any point in time e.g. before, during and between Sessions.
- When a UE is moved to the PMM CONNECTED state via the MBMS Service Request procedure. This may happen at any point in time during a MBMS session.

The UE linking is performed to link a specific UE to an MBMS service. It provides the SRNC/Iu-mode BSC with a list of MBMS service identifiers (including TMGI) for MBMS bearer services activated by the UE. If no MBMS service context exists for this particular MBMS bearer service then the SRNC/Iu-mode BSC creates an MBMS service context after this procedure.

NOTE: the MBMS Bearer Context is referred to as the MBMS Service Context in 3GPP RAN specifications

MBMS UE De-Linking denotes the process where a MBMS UE context is removed from the RAN.

MBMS UE De-Linking procedure is performed if the UE is PMM-CONNECTED and has been already linked towards the RAN at least when it initiates MBMS Multicast Service Deactivation procedure. This may happen at any point in time during the whole MBMS service availability i.e. before, during and between MBMS sessions.

The UE De-Linking is performed to unlink a specific UE from a MBMS service. The entry for this UE is removed from the concerned MBMS service context(s) in the SRNC.

8.16 MBMS Service Request Procedure

For MBMS, when UTRAN wants to count the number of users that are interested in a specific MBMS service which are present in a cell, it will request a percentage of the interested UEs to transit to PMM-CONNECTED state. The MBMS Service Request procedure is used by a UE in the PMM-IDLE state to move to the PMM-CONNECTED state. The MBMS Service Request procedure is also used by a UE in PMM IDLE or PMM-CONNECTED state to request to be maintained in PMM-CONNECTED state for the purpose of receiving data over an MBMS point-to-point radio bearer.

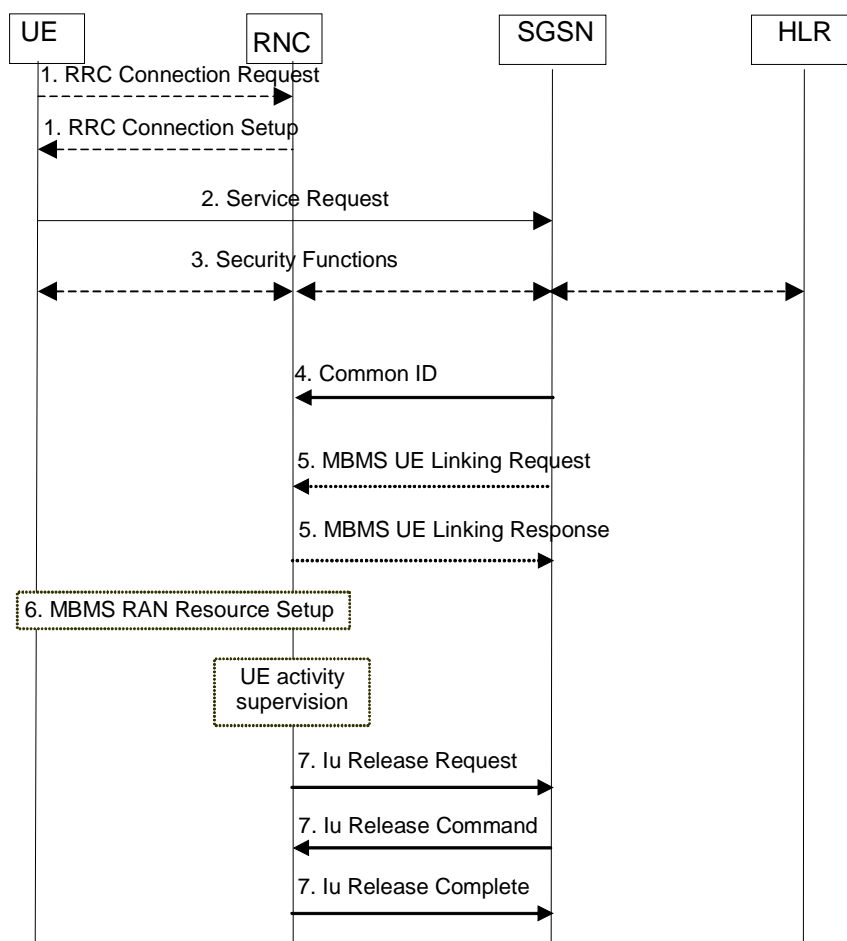


Figure 17: MBMS Service Request procedure

- 1) An RRC connection is established if it doesn't already exist.
- 2) The UE sends a Service Request message to the SGSN if MBMS PTP reception shall be used or if otherwise required to do so by the RAN when MBMS reception shall be started. The Service Type shall indicate MBMS multicast service reception or MBMS broadcast service reception. The SGSN shall not release the Iu signalling connection until requested by the RAN.
- 3) The SGSN may perform the security functions.
- 4) The SGSN provides the RAN with the IMSI of the UE.
- 5) The SGSN provides the RAN with the MBMS UE context(s) (IP multicast address/APN, TMGI, MBMS_NSAPI) via MBMS UE Linking procedure, if the SGSN has active MBMS UE context(s) for the UE.

NOTE: Step 6 is independent of steps 4 to 5 and can occur before or simultaneously with any of these steps.

- 6) The RNC establishes the necessary radio resources for the transfer of MBMS data to the interested UEs.
- 7) When PTP transmission of a MBMS multicast or MBMS broadcast service is active for a UE then the RNC shall supervise the Iu signalling connection. When the RAN determines that it does not need to keep the UE in RRC-CONNECTED state anymore, it shall trigger a normal Iu release towards SGSN.

8.17 Notification in case of parallel services

8.17.1 Notification of incoming CS domain call during an ongoing MBMS session

For the RRC connected mobiles in UTRAN, the RNS will have received the IMSI from the core network and hence is able to perform paging coordination. The UEs in RRC idle state in UTRAN need to perform paging coordination while receiving the MBMS session's user data.

In GERAN, this is achieved by the UE monitoring its paging channels while receiving the MBMS session's user data. If the mobile responds to the CS paging in GERAN, then the ongoing MBMS service is likely to be interrupted in the UE.

8.17.2 Notification of additional MBMS session during an ongoing MBMS session

For the RRC connected mobiles in UTRAN, the SGSN has sent the list of MBMS bearer services that the user has activated to the UTRAN. The RNS needs to notify an RRC connected UE.

For the UEs in RRC idle state, the UTRAN performs MBMS notification for the UE.

In GERAN, this is achieved by the UE monitoring its paging channel(s) where notification is sent while receiving the MBMS session's user data.

If the mobile accepts the new MBMS session in GERAN, then the ongoing MBMS service is likely to be interrupted in the UE.

8.17.3 Notification of Mobile Terminating PS data during an ongoing MBMS session

For the RRC connected mobiles in UTRAN, the SGSN request the establishment of a RAB which will be used to deliver the MT user data.

For the UEs in RRC idle state, the UTRAN performs paging notification for the UE.

In GERAN, this is achieved by the UE monitoring its paging channels while receiving the MBMS session's user data.

If the mobile responds to the PS paging in GERAN, then the ongoing MBMS service is likely to be interrupted in the UE.

8.17.4 Notification of MBMS session during an ongoing CS or PS domain "connection"

When the UE establishes the UTRAN RRC connection for a CS service, the UE shall send a flag indicating that it has activated at least one MBMS bearer service. The RNC requests the SGSN to send the list of MBMS bearer services that the user has activated to enable the RNC to notify the UE when MBMS session starts.

When a UE moves to PMM-connected state, the SGSN sends the list of MBMS bearer services that the user has activated to the RNC. The RNC notifies the UE when an MBMS session of the user's activated MBMS bearer services starts.

These procedures are not supported by GERAN in this version of the specification.

9 Security

Security of MBMS is found in TS 33.246 [5].

10 Charging requirement

10.1 General

The MBMS architecture shall support on-line and off-line charging.

It shall be possible to collect charging information for the multicast mode. It shall also be possible to collect charging information for MBMS services in visited networks.

MBMS shall collect charging information about the transmission of MBMS broadcast or multicast data that are provided by content or service providers (e.g. 3rd parties). This shall enable billing of broadcast and multicast content or service providers.

To enable billing of broadcast and multicast content providers, data shall be collected at the BM-SC.

NOTE: SGSN, GGSN and BM-SC generate charging data for the transmitted data, always under the assumption that the UEs are within the MBMS service area. If the MBMS service area is less than the PLMN, then there is the possibility that a UE will have moved outside the MBMS service area. Charging data will still be generated for that UE causing an inaccuracy in the data. This inaccuracy increases as the size of the MBMS service area is decreased.

10.2 Bearer level charging for MBMS

To provide bearer level charging for MBMS, mechanisms and functional elements described in TS 23.125 [12] are used for MBMS Bearer Contexts.

For EPS, MBMS GW shall collect charging information about the transmission of MBMS broadcast for UTRAN and E-UTRAN. MBMS Bearer context in MBMS GW should include charging related information elements.

Flow Based Charging (FBC) may be used to collect charging data records for MBMS Bearer Contexts e.g. for the purpose to charge the service provider, cf. TS 23.125 [12].

NOTE: Since multiple users share an MBMS bearer context FBC cannot be used for creating reports on a per user basis.

10.3 Application level charging for MBMS

For GPRS, in order to meet the MBMS charging requirements in TS 22.146 [2] and TS 22.246 [6], the following elements and functionalities are provided by the GPRS MBMS architecture:

- a) The MSISDN and IMSI are passed to the BM-SC. This provides the operator with the ability to associate GPRS location information (i.e. serving network identity) with a user.
- b) In order to permit differential roaming tariffs, the serving network identity is provided to the BM-SC.
- c) Charging for MBMS services is based on application layer mechanisms, since it is only at the application layer that security is provided which can restrict content to authorised users or confirm delivery of content to users:

The following general requirements apply to charging information generated by the BM-SC:

- Charging information generated for application layer charging events should include the above information provided by the GPRS network to facilitate differential roaming tariffs.

- Charging information should include an indication of the point at which the user had access to the content (e.g. if and when decryption keys for encrypted content are sent to the UE.).

For EPS, in order to meet the MBMS charging requirements in TS 22.146 [2], charging requirements for MBMS in EPS should be supported in broadcast mode and be same as that in broadcast mode for MBMS in GPRS network on application level.

10.4 Generation of charging records in the VPLMN

In this Release, charging for roaming scenario of MBMS in EPS will not be considered.

For GPRS, in order to permit the settlement of inter-operator roaming charges, the SGSN needs to raise CDRs. The information that needs to be included on these CDRs is FFS.

11 Roaming Support for MBMS user services

11.1 Scenarios description

There are three specific scenarios to provide MBMS user services to roaming users.

One uses a GGSN in the HPLMN, the other two are enabled by use of the Mz interface and are further described below:

- A visited PLMN may offer to roaming users MBMS user services from their home PLMN. For this case, the PDP connection, which will be used for the JOIN step, may always be from the UE to the V-GGSN due to operator policy or routing optimization, then the authorization is done in the BM-SC in visited PLMN with the authorization information retrieved from the BM-SC in home PLMN. Then the MBMS user traffic is provided by the BM-SC in home PLMN and proxied. An APN indicating a GGSN will be included in the authorisation information sent from home BM-SC to visited BM-SC. Whether GGSN of home or visited PLMN would be used is based on the operator policy, or agreement between PLMNs, for example, the visited BM-SC may modify the APN from the home BM-SC according to configuration of operator policy.
- Or, a visited PLMN may offer its own MBMS user services to roaming users when visited and home PLMN support the same classes of MBMS user services. For this case, the authorization is done in the BM-SC in visited PLMN with the authorization information retrieved from the BM-SC in home PLMN. Then the MBMS user traffic is provided by the BM-SC in visited PLMN.

Editors' note: It is FFS how to deal with the services in the BM-SC in visited network which are not the same service class as supported by the BM-SC in home network.

The usage of any of the scenarios and the offered MBMS user services are subject to the roaming agreement between visited and home PLMN operators.

11.2 Scenario signalling flow

11.2.1 APN selection

When a UE is authorized through the BM-SC in the visited PLMN (by proxying the authorization signalling), an APN may be selected and decided by the BM-SC in the home PLMN or the BM-SC in the visit PLMN depending on the operator policy or agreement between PLMNs. See step 4 of the figure 18.

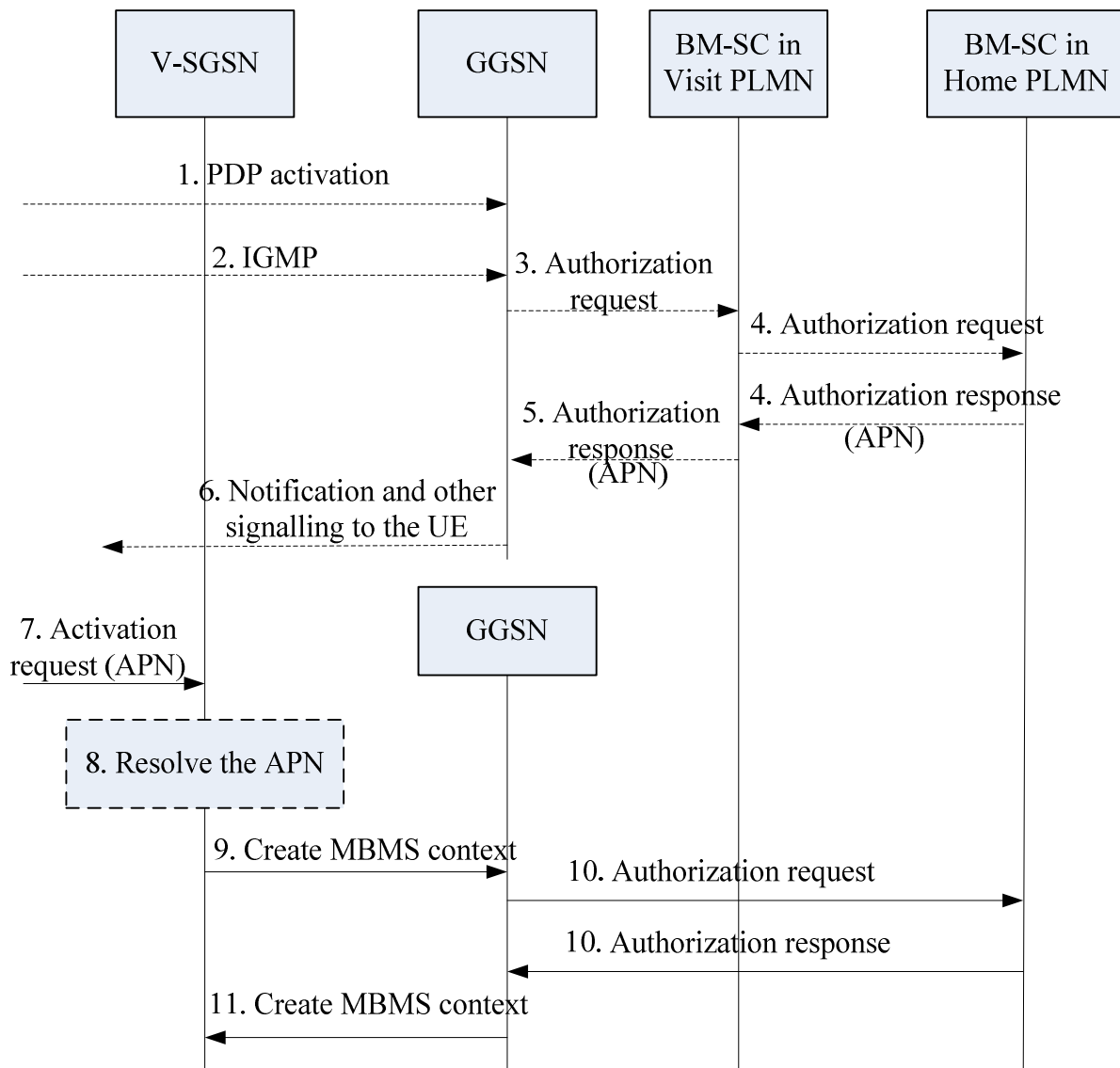


Figure 18: MBMS route optimization for HPLMN provided MBMS services

Figure 18 is an extension of MBMS multicast service activation procedure described in clause 8.2, the only revise is that an authorization step (step 4) is added according to clause 11.1.

- The BM-SC in visited PLMN finds the BM-SC in home PLMN which will serve the UE based on the multicast IP address, and identity of the user, and sends the authorization request to it. The BM-SC in home PLMN can respond with an APN, which indicates a GGSN in home PLMN which will serve the UE for the specific MBMS service. The BM-SC in the visit network may modify the APN based on the operator policy or agreement between PLMNs.

Annex A (Informative): Void

Annex B (Informative): Void

Annex C (normative): TV services delivery using unicast mode & switching between broadcast & unicast modes for E-UTRAN

To enable TV services delivery using unicast mode of transport, the applicable functions need to be enabled in the operator's network:

UE:

Able to support TV services as required including:

- For Unicast support, there needs to be additional PDN connection via dedicated APN for TV services delivery.

NOTE: It can require explicit connection towards TV Content Provider for Unicast reachability information (e.g. IP addresses, ports, etc.). UE should be configured with appropriate APN to facilitate easy access to TV services via unicast.

- Ability to support Consumption Reporting and Mood feature for enabling switching between broadcast and unicast operation on demand, if required.

Content Provider/Packet Streaming Server needs to provide the required functions for MBMS Broadcast services as defined in this specification. The operator needs to enable access to the transport and MBMS user services towards TV content providers, if required, as described in clause 7.5.

MME: If APN is configured in the HSS for enabling unicast delivery for TV services for the user, then MME checks when UE provides an APN and verifies that the user has subscription for that APN against the HSS provided APN, using existing procedures.

HSS: Shall be configured well known dedicated APN in the user's subscription for Unicast TV services support when dedicated PDN connectivity for TV services is required.

The main deployment options for TV services are, but not limited to :

Deployment Option 1:

Joint broadcast + unicast TV service through BM-SC and PDN GW via SGI.

Scenario A:

The Content Provider has a Service Level Agreement with an operator. The dedicated TV service includes a TV Service subscription associated with the operator subscription, which allows tuning to TV unicast and MBMS broadcast for transport.

In case popularity based switching according to MBMS operations on Demand (Mood, TS 26.346 [7]) is supported, then:

- The operator monitors the TV service consumption per channel in areas and decide to use unicast or MBMS broadcast usage.

According to the agreement between the Content Provider and the operator, the operator may provide usage information to the Content Provider.

Scenario B :

This Scenario enables the realization for multi-purpose devices, where the managing operator provides all functionality.

In case popularity based switching according to MBMS operations on Demand (MOOD, TS 26.346 [7]) is supported, then:

- The operator monitors the TV service consumption per channel in areas and decide to use unicast or MBMS broadcast transport.

According to the agreement between the Content Provider & the operator, the operator may provide usage information to the Content Provider.

Deployment option 2:

Separate direct broadcast service through BM-SC and direct unicast service via SGi through PDN GW.

For Unicast TV transport, the Content Provider uses regular unicast data connectivity. For MBMS broadcast, the Content Provider provides the content of the TV channel via user plane.

In case popularity based switching according to MBMS operations on Demand (MooD, TS 26.346 [7]) is supported, then:

- The Content Provider monitors the popularity of the TV service over Unicast, for each operator individually.
- When unicast TV service usage of a channel is high in a certain area, the Content Provider interacts with operator in order to activate MBMS Broadcast in the identified area.

In order to monitor popularity in the MBMS Broadcast Areas, the operator can expose popularity information (derived from HTTP Consumption Reporting, TS 26.346 [7]) to the Content Provider via dedicated provisioning interface (see TS 26.348 [31]).

Annex D (normative): Shared MBMS Network over E-UTRAN

D.1 General

A Shared MBMS network (SMN) consists of network elements shared by multiple PLMNs to offer MBMS service over E-UTRAN. The shared network elements are at least a shared BM-SC and shared MBMS-GW. Shared MBMS Network has MBMS synchronization area (MBSFN area) defined within each PLMN.

The SMN has the following properties:

- The BM-SC and MBMS-GW are shared among participating PLMNs.
- The SMN provides the entry point of the data stream.
- The BM-SC can provide full service layer functionality or act only in transparent mode for the case of MBMS as transport only.
- An MBMS service area may span across RAN nodes from different participating PLMNs.
- RAN nodes (eNBs/MCEs) dedicated to MBMS bearer service may be deployed, in which case these nodes are part of the SMN. This deployment requires a shared MME function.

D.2 Architecture

D.2.1 Architecture for per PLMN MBSFN synchronization area

Figure D.2.1-1 shows an example network architecture for Shared MBMS Network with MBMS synchronization area defined within each PLMN. The example shows two PLMNs (PLMN 1 and PLMN2) providing shared MBMS service. In the example, F3 is shared spectrum used by all involved PLMN for MBMS service.

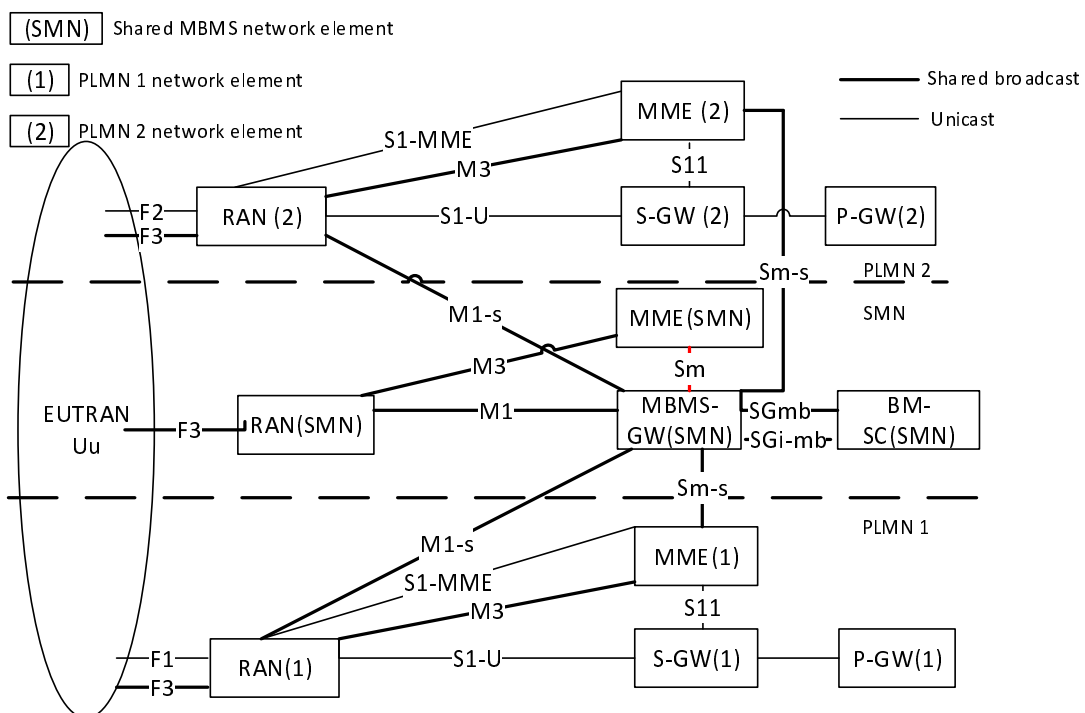


Figure D.2.1-1: Shared MBMS Network architecture with per-PLMN MBMS synchronization area

The SMN contains the following network elements:

- Shared BM-SC (denoted BM-SC(SMN) in Figure D.2.1-1):
 - Provides all the functionality defined in clause 5.1 for EPC.
- Shared MBMS-GW (denoted MBMS-GW(SMN) in Figure D.2.1-1)
 - Provides all the functionality defined in clause 5.9.1.
 - In addition:
 - It connects to MMEs from one or multiple PLMNs via the inter-PLMN Sm-s reference point for control plane signalling.
 - It connects to E-UTRAN nodes from one or multiple PLMNs via the inter-PLMN M1-s reference point for IP multicast distribution.

The SMN may also contain shared E-UTRAN functionality for the purpose of MBMS service only. In that case the SMN also contains the following network entities:

- Shared E-UTRAN - eNB, MCE (denoted RAN(SMN) in Figure D.2.1-1)
 - Provides functionality as defined in clause 5.9.1.
- Shared MME MBMS function (denoted MME(SMN)):
 - The shared MME MBMS control function provides the functionality defined in clause 5.9.2.

NOTE: The shared MME MBMS control function provides only a subset of the functionality of a regular MME as defined in TS 23.401 [16], dedicated only to providing control plane functionality related to MBMS service.

D.2.2 Reference Points

The following reference points are defined for Shared MBMS Network:

- All internal reference points within the SMN leverage existing reference points M1, M2, M3, Sm, SGmb, SGI-mb.
- All internal reference points within each PLMN existing reference points M2, M3
- M1-s:
 - Inter-PLMN reference point between the Shared MBMS-GW and the E-UTRAN node from a participating PLMN.
 - Provides equivalent functionality to M1.
- Sm-s:
 - Inter-PLMN reference point between the Shared MBMS-GW and MME from a participating PLMN.
 - Provides equivalent functionality to Sm.

D.2.3 UE Aspects

Different scenarios can be supported from the perspective of the UE. The following is a non-exhaustive list of possible scenarios:

- UE Scenario 1: The UE receives both unicast and broadcast service from same PLMN. The UE follows the same functionality as defined in clause 5.2.

UE Scenario 2: The UE receives broadcast MBMS service without PLMN subscription over E-UTRAN without the need to access and register with the PLMN offering the MBMS service. The UE acts in Receive Only mode as defined in Annex E.

UE Scenario 3: The UE receives unicast service from one serving PLMN's (e.g. the PLMN for which it has unicast subscription), and receive MBMS service through a different PLMN. The UE acts in Receive Only mode with independent unicast as defined in Annex E.

D.2.4 TMGI for shared MBMS networks

As described in TS 23.003 [13], the TMGI is composed by an MBMS Service ID and a PLMN ID (MCC/MNC).

The construction of the PLMN ID field in the TMGI is deployment dependent. The following are example deployment options:

- Example Deployment Option 1: Shared PLMN ID
 - A Shared PLMN ID is used for the shared MBMS service. The shared PLMN ID is broadcasted in the cells broadcasting the shared MBMS service content.
- Example Deployment Option 2: Internal PLMN ID in the Shared MBMS network
 - The Shared MBMS network (i.e. BMSC) uses the "Internal" PLMN ID to generate the TMGI. MBMS-GW uses the PLMN ID from the incoming SGmb interface towards the rest of the network entities in the MBMS path. eNB announces a MBMS session TMGI whose PLMN ID is not in the SIB1 PLMN ID list. The "Internal" PLMN ID is not used for any other PLMN services.

Annex E (normative): UE behaviour in Receive Only Mode

A UE configured as Receive Only Mode can receive only MBMS broadcast service over E-UTRAN without the need to access and register with the PLMN offering the MBMS service. A UE configured to operate in Receive Only Mode shall camp on a network cell in an eMBMS Broadcast carrier, shall attempt to receive MBMS service based only on a standardized TMGI value range for Receive Only Mode. The UE shall not attempt to receive MBMS service for TMGIs outside the standardized TMGI range. The UE shall refrain from any Mobility Management or other signalling with the network offering MBMS. The UE uses the acquired system information to receive MBMS broadcast. Use of Receive Only Mode does not require USIM for the UE.

A UE may be configured as Receive Only Mode with independent unicast using EPS bearer contexts. This configuration option allows a UE to operate as Receive Only Mode (as defined above) for MBMS broadcast service, and independently follows regular NAS/RRC procedures for unicast service with a PLMN. This mode of operation requires USIM and PLMN subscription to receive unicast service. No additional subscription or credentials are required to receive MBMS broadcast service.

Any device that is equipped with MBMS broadcast receiver and is configured to operate in Receive Only Mode is able to receive the broadcast content, with the following characteristics:

- No PLMN credentials/subscription are required, as long as use of EPS unicast bearers is not required by the device.
- Without PLMN credentials/subscription, the UE can only access broadcast services without subscription. The content can be Free To Air (FTA) content as defined in TS 22.101 [30] in which case it can be viewed without content subscription.
- There is no need for the UE to support uplink.

NOTE: It is possible though that there is content protection handled at application layer. In that case security is provided at application layer, and keys, etc. are provisioned out of band. This provisioning is out of scope of 3GPP.

The UE is preconfigured with all the necessary information for the UE to acquire the system information and receive MBMS service. This information includes:

- PLMN ID(s) that provide the MBMS service.
- TMGI(s):
 - In the case of the network providing MBMS service in MBMS transport only mode, the TMGI(s) for each MBMS service need to be configured in the UE.
 - The UE may be configured to receive TMGI(s) via Service Announcement (see clauses 4.4.3.1, 5.1.4 and 6.4).
- RAN specific information,
- USD(s).

Figure E-1 shows the components of a UE in Receive Only Mode and in Receive Only Mode with independent unicast.

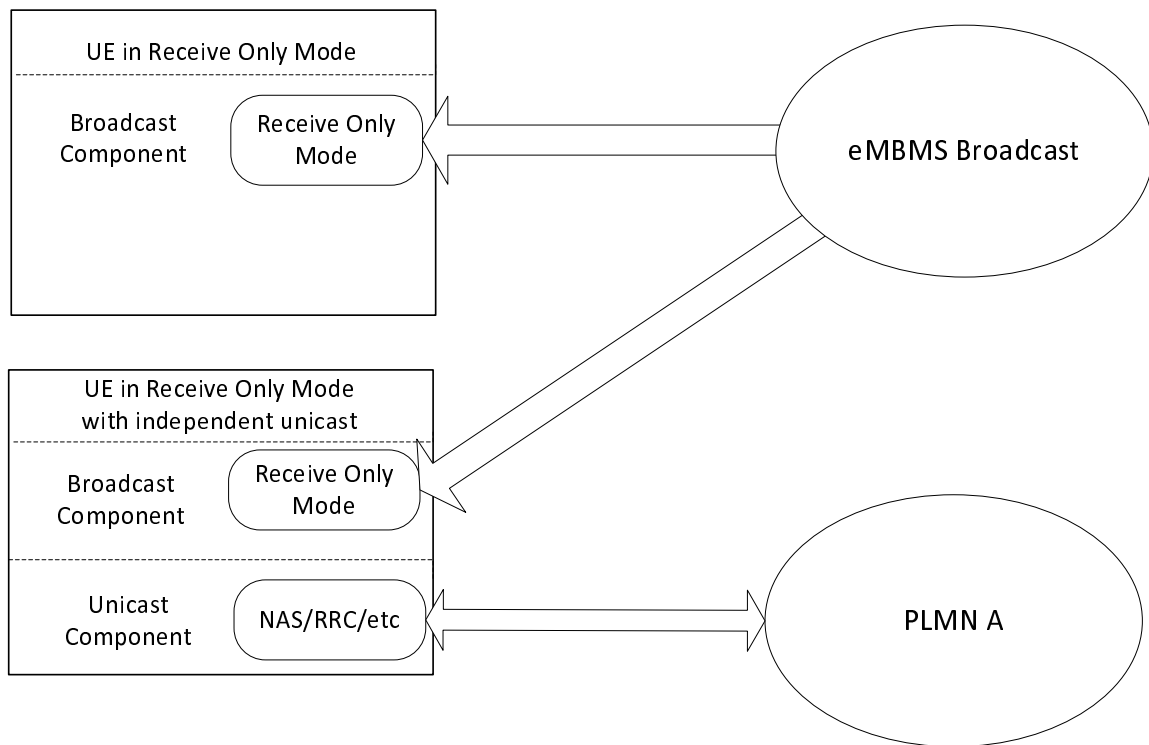


Figure E-1: UE components in Receive Only Mode and Receive Only Mode with independent unicast

The unicast component is active only in Receive Only Mode with independent unicast. The unicast component follows regular NAS/RRC procedures for E-UTRAN/EPC in order to receive unicast service.

For the broadcast component, the UE is configured with MBMS radio resources for TV service with no PLMN subscription. The broadcast component of the UE shall camp on a network cell in an eMBMS Broadcast carrier and shall attempt to receive MBMS service based only on a standardised TMGI value range. The UE shall not attempt to receive MBMS service for TMGIs outside the standardized TMGI range. The broadcast component shall refrain from any Mobility Management or other signalling with the network offering MBMS. The broadcast component uses the acquired system information to receive MBMS broadcast.

Annex C (Informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2011-12	SA#54	SP-110748	0269	4	C	MBMS data transfer time	11.0.0
2012-03	SA#55	SP-120088	0273	-	F	Correction to Absolute Start Time for MBMS Data Delivery	11.1.0
2013-12	SA#62	SP-130534	0276	3	C	M1 Group reuse	12.0.0
2014-03	SA#63	SP-140102	0277	1	B	MBMS bearer priority update	12.1.0
2014-06	SA#64	SP-140377	0279	2	F	Resource allocation for the MBMS bearer	12.2.0
2014-06	SA#64	SP-140260	0281	1	F	Lift restriction GBR=MBR for MBMS when GCSE is used	12.2.0
2014-09	SA#65	SP-140425	0384	1	F	Clarify the MBMS session update procedure	12.3.0
2014-12	SA#66	SP-140678	0387	4	F	Long Group Calls and New Cells	12.4.0
2015-03	SA#67	SP-150015	0390	-	A	Correction to BM-SC initiated Session Update procedure	12.5.0
2015-03	SA#67	SP-150027	0391	2	B	eMBMS alternative IP multicast distribution address	13.0.0
2015-03	SA#67	SP-150239	0392	1	F	MBMS Session Start procedure correction and editorial corrections	13.1.0
2015-09	SA#69	SP-150239	0394	2	A	Support for UE Consumption Reporting towards BM-SC	13.2.0
2015-09	SA#69	SP-150506	0396	2	B	MBMS bearer establishment and update with cell ID list	13.2.0
2015-12	SA#70	SP-150616	0397	2	F	Cell ID in MBMS bearer context table for EPS	13.3.0
2015-12	SA#70	SP-150614	0398	2	F	Differentiate MBMS User and Bearer Services	13.3.0
2016-09	SA#73	SP-160656	0402	1	B	Enhanced TV services using Broadcast and Unicast mode of operation	14.0.0
2016-09	SA#73	SP-160656	0404	2	B	Introducing Shared eMBMS Network and Receive Only Mode for TV services	14.0.0
2016-12	SA#74	SP-160820	0405	1	F	Corrections of MBMS Shared Network	14.1.0
2016-12	SA#74	SP-160820	0406	1	F	3GPP network and Content provider reference point	14.1.0
2016-12	SA#74	SP-160820	0407	1	F	Shared MBMS Network scope clarification	14.1.0
2016-12	SA#74	SP-160820	0408	2	F	Use of TMGI & PLMN ID for Shared MBMS Network	14.1.0
2016-12	SA#74	SP-160825	0412	1	F	MBMS Update with session time	14.1.0
2017-09	SA#77	SP-170723	0414	4	C	UE Capabilities for MBMS	14.2.0
2017-12	SA#78	SP-170928	0415	1	C	MBMS session setup/event notification procedure alignment with RAN WG3	15.0.0
2017-12	SA#78	SP-170928	0416	2	F	MB2 improvements for GCS AS to be able to request application of FEC and/or RoHC to a MBMS bearer	15.0.0
2019-03	SA#83	SP-190175	0417	1	F	Change xMB reference	16.0.0
2019-09	SA#85	SP-190602	0419	2	A	Fix missed update to Session Update procedure - add delayed response	16.1.0

History

Document history		
V16.1.0	November 2020	Publication