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Abstract of document:

This Technical report discusses architectural issues and describes functionalities required for the Multimedia Broadcast/Multicast Service. MBMS requirements are discussed in 3GPP TS 22.146: “Multimedia Broadcast/Multicast Service; Stage 1”.and it is the intention of this document to present one or more alternatives to achieving the required functionality within 3GPP networks.

Changes since last presentation to TSG-SA Meeting #15:

N/A

Outstanding Issues:

The present version of the TR portrays five architectures in various stages of completion. It is the intention to complete these architecture studies and recommend an architecture to support MBMS. When this has been done, the TR can be presented for approval.

Contentious Issues:

None

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Technical Report

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Multimedia Broadcast/Multicast Service; Architecture and Functional Description (Release 6)

Keywords

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
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1 Scope

The present document discusses architectural issues and describes functionalities required for the Multimedia Broadcast/Multicast Service. MBMS requirements are discussed in [2] and it is the intention of this document to present one or more alternatives to achieving the required functionality within 3GPP networks.

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.
- For a specific reference, subsequent revisions do not apply.
- 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: "3G Vocabulary".

[2] 3GPP TS 22.146: “Multimedia Broadcast/Multicast Service; Stage 1”.

[3] IETF RFC 2710 (1999): "Multicast Listener Discovery (MLD) for IPv6"

[4] 3GPP TS 23.107: “QoS Concept and Architecture”3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [1] and the following apply.

MBMS broadcast activation: The process which enables the data reception from a specific broadcast mode MBMS on a UE.

MBMS multicast activation: The process which enables a UE to receive data from a specific MBMS multicast. Thereby the user joins a specific multicast group. The activation may be performed by the user and it may be performed inherently for subscribed multicast services.

MBMS Notification: The mechanism which informs the UEs about a forthcoming (and potentially an ongoing) data transfer from a specific MBMS service

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BM-SC Broadcast Multicast - Service Centre

IGMP Internet Group Management Protocol

MLD Multicast Listener Discovery

MBMS Multimedia Broadcast/Multicast Service

Other abbreviations used in the present document are listed in 3GPP TR 21.905 [1].

4 Introduction

The MBMS [2] is a point-to-multipoint service in which data is transmitted from a single source entity to multiple users. Transmitting the same data to multiple users allows network resources to be shared.

The MBMS offers two modes:

- **Broadcast Mode**
- **Multicast Mode**

5 High Level Functionality

A short overview

5.1 Architecture Principles

In developing and evaluating different architectural options for MBMS, the following principles should be taken as general architectural guidelines that should be followed:

1. MBMS architecture shall enable the efficient usage of radio-network and core-network resources, with the main focus on the radio interface efficiency. Specifically, multiple users should be able to share common resources when receiving identical traffic.
2. The MBMS architecture shall support common features for MBMS multicast and broadcast modes, e.g. both modes shall preferably use the same low-layer bearer for data transport over the radio interface.
3. MBMS architecture shall support external data sources in both modes. MBMS shall support both IP multicast and IP unicast sources.
4. MBMS architecture should re-use, to the extent possible, existing 3GPP network components and protocol elements thus minimizing necessary changes to existing infrastructure and providing a solution based on well-known concepts.
5. MBMS shall be a point-to-multipoint bearer service for IP packets in the PS domain.
6. MBMS shall be interoperable with IETF IP Multicast.
7. MBMS shall support IETF IP Multicast addressing.
8. It shall be possible for UEs to receive MBMS when the terminal is attached.
9. It shall be possible for UEs to receive MBMS data in parallel to other services and signalling (e.g. paging, voice call).
10. MBMS shall support different quality of service levels. The mechanisms for this are for further study, one example is repetitions to all users.
11. MBMS service areas shall be defined per individual service with a per cell granularity.
12. MBMS is not supported in the CS domain.
13. When the UE is already receiving data of an MBMS service, it shall be possible for the UE to be notified about a forthcoming and potentially about an ongoing data transfer from other MBMS services.
14. Charging data shall be provided per subscriber for MBMS multicast mode .

15. The MBMS bearer service concept should contain the decision making process for selection of point-to-point or point-to-multipoint configurations.

16. The architecture should be able to provide home MBMS multicast services to users when roaming outside their home network as subject to interoperator agreements.

17. MBMS should be designed to minimise power consumption within the mobile station.

18. Applications shall be tolerant to packet loss and duplication caused by e.g. UE mobility or transmission loss.

19. "The backwards compatibility of the MBMS service to the R99 IP multicast delivery mechanism shall be considered. Interworking possibilities between MBMS capable network elements and non-MBMS capable network elements (e.g. interworking with R99 IP Multicast service GGSNs) shall be described.

5.2 Architectural Overview

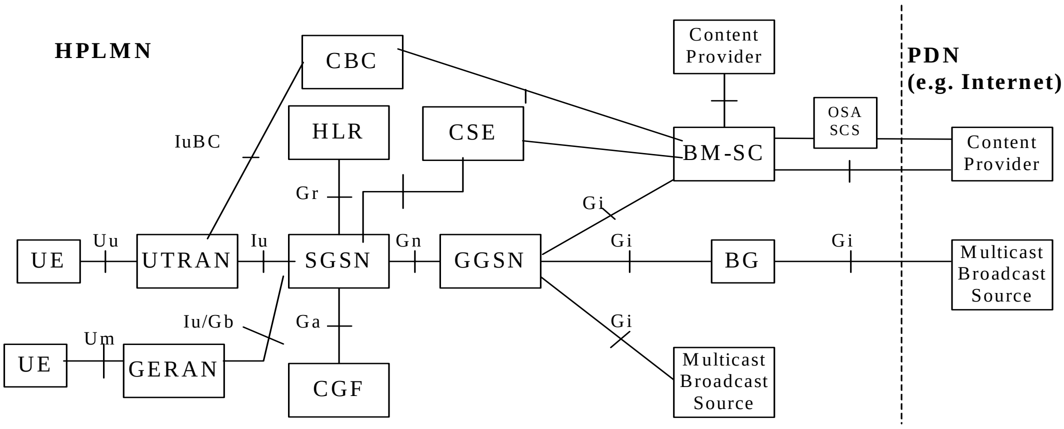

Figure 1. MBMS Architecture

In the MBMS architecture the SGSN performs user individual service control functions and the SGSN concentrates all individual users of the same MBMS service into a single MBMS service. The SGSN maintains a single connection with the source of the MBMS data. The SGSN duplicates the packets received from the GGSN for forwarding to each RNC involved in provision of a specific MBMS service.

The SGSN may use CAMEL to handle pre-paid services, e.g. credit checking for on-line charging.

The GGSN terminates the MBMS GTP tunnels from the SGSN and links these tunnels via IP multicast with the MBMS data source. The GGSN duplicates the packets received from the MBMS data source for forwarding to each SGSN to which a GTP tunnel is established for a specific MBMS service.

The BM-SC is an MBMS data source. MBMS data may be scheduled in the BM-SC, e.g. for transmission to the user every hour. It offers interfaces over that content provider can request data delivery to users. The BM-SC may authorise and charge content provider. The BM-SC might use OSA-SCS to interact with third parties.

The Cell Broadcast Centre (CBC) may be used to announce MBMS services to the users. How this is accomplished is FFS.

The architecture allows for other MBMS broadcast/multicast data sources. Internal data sources may directly provide their data. Data delivery by external sources is controlled by Border Gateways (BG) which may allow for example data from single addresses and ports to pass into the PLMN for delivery by an MBMS service.

The architecture assumes the use of IP multicast at the reference point Gi. The MBMS data source has only one connection to the IP backbone. The reference point from the content provider to the BM-SC is not standardised. It might become to complex or to restrictive for service creation. For example, this may be a reference point between the BM-SC and an authoring system, or the authoring functionality may be distributed between both entities.

The same architecture provides MBMS broadcast services mainly by using the transport functions. The user individual SGSN functions are not required. Instead each individual broadcast service is configured in the SGSN.

Note: For the terminal split case, MBMS shall be able to interoperate with an IP multicast client software on the TE. The mechanism for this interoperability is FFS.

5.3 MBMS Reference Points

Description of MBMS interaction with other entities within the network (e.g. User, VASP, Charging DB, Other?)

5.4 High Level Functions

Multimedia Broadcast/Multicast Service is associated with several logical functions that should be provided by the network.

5.4.1 Authentication and Authorization

5.4.1.1 Content Provider Authentication and Authorization

- MBMS should be able to identify and authenticate the content provider prior to receiving control or data from it.
- A content provider may request to provide a multicast or broadcast service using MBMS possibly stating desired QoS, geographical areas and other service-related parameters. MBMS shall be able to authorize this service provision with the requested parameters prior to service initiation.

5.4.1.2 User Authentication and Authorization

- MBMS shall be able to authenticate and authorize users before joining to multicast groups (i.e. receive MBMS multicast services).

5.4.2 Efficient Routing and Resource Usage

- The MBMS shall be able to efficiently route multicast and broadcast over the radio interface and within the radio network. Efficient routing within the core-network is desired as well.
- In Multicast mode, MBMS should support multicast resource allocation where-by data transmission to a multicast group is carried out in certain cell only if multicast group members are to be found in that cell.
- Hierarchically structured networks can provide coverage for a given location using multiple carrying frequencies or multiple cells of varying sizes. Provisioning and efficient delivery of MBMS services within hierarchical network architectures should be considered.

5.4.3 Mobility Management and Service Continuity

- MBMS shall support service continuity when moving from cell to cell within the multicast/broadcast area.

NOTE: Loss of data may occur during this process.

- MBMS should enable roaming users to receive both home and local multicast services. Roaming users should be able to receive local broadcast services as well.

5.4.4 Service Initiation and Termination

- The UE shall be able to enable and disable broadcast service reception.
- The UE shall be able to join and leave multicast groups. Roaming users should be able to join and leave multicast groups in the home or visited network.

5.4.5 Charging

MBMS shall collect charging information about the delivery 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. This charging information may include duration of service usage, volume of MBMS data, MBMS service area.

MBMS shall collect charging information about the usage of MBMS multicast services by individual users/receivers. This charging information may include duration of service usage, volume of MBMS data, time when joining or leaving a multicast group.

5.4.6 Security

- To prevent unauthorized reception of multicast data, multicast transmission may be secured.
- To prevent injection of malicious content into the network MBMS should be able to authenticate the content provider and verify the integrity of the data received from the content provider.
- See also clause “Authentication and Authorization“

5.4.7 Addressing

5.4.8 Roaming

5.4.9 MBMS Service Provision Phases

5.4.9.1 MBMS broadcast service provision phases

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

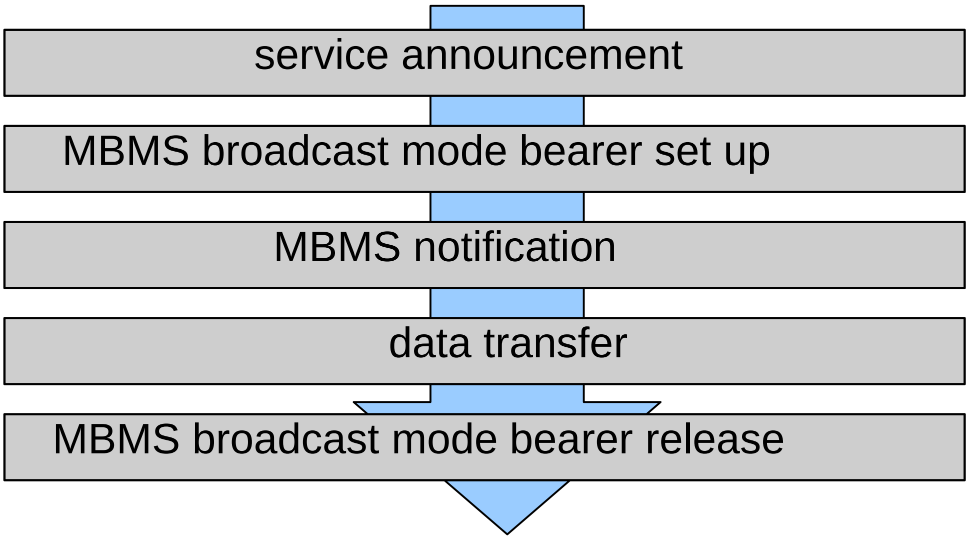

Fig. 2: Phases of MBMS broadcast service provision

Service announcement informs UEs about forthcoming services.

MBMS broadcast mode bearer set up establishes the network resources for MBMS data transfer in the broadcast area.

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

Data transfer is the phase when MBMS data are transferred to the UEs.

MBMS broadcast mode bearer release releases the network resources for MBMS data transfer, e.g. when no more MBMS data have to be transferred.

The sequence of phases may repeat, e.g. depending on the need to transfer data. Also service announcement as well as MBMS notification may run in parallel to other phases to inform UEs which have do not yet receive the related service.

5.4.9.2 MBMS multicast service provision phases

An example for the phases of MBMS multicast service provision is described in the figure below.

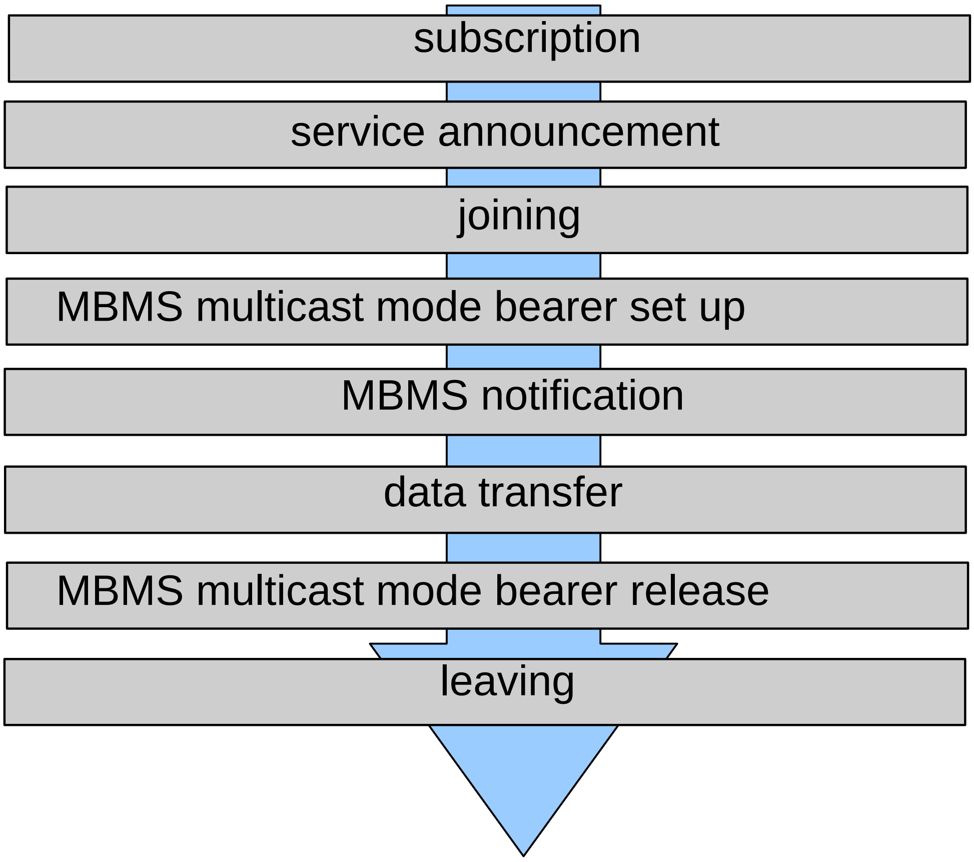

Fig. 3 Phases of MBMS multicast service provision

Subscription establishes the relationship between the user and the service provider, which allows the user to receive the related MBMS multicast service

Service announcement informs UEs about forthcoming services.

Joining (MBMS multicast activation) is the process by which a subscriber joins (becomes a member) a multicast group, i.e. the user indicates to the network that he/she is willing to receive Multicast mode data of a specific service.

MBMS multicast mode bearer set up establishes the network resources for MBMS data transfer in the multicast area.

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

Data transfer is the phase when MBMS data are transferred to the UEs.

MBMS broadcast mode bearer release releases the network resources for MBMS data transfer, e.g. when no more MBMS data have to be transferred.

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

The phases subscription, joining and leaving are performed individually per users. 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.

6 Functions and Entities

More detailed description of functions, discussion of options for functions, description of network entities.

6.1 UTRAN/GERAN Functionality

- The UTRAN shall deliver the MBMS service over at least the broadcast or multicast service area. The served area might be larger than the multicast or broadcast area, e.g. when the multicast or broadcast area does not exactly map onto cell or LA borders of the UTRAN.
- The UTRAN may establish point to multipoint channels at the air interface without any required uplink radio signaling from the UE(s) for broadcast mode

6.1.1 Broadcast Mode

6.1.2 Multicast Mode

The radio access network (UTRAN/GERAN) shall provide the following functionality for efficient support of MBMS

- responsible for establishment of point to multipoint or point to point channels on the air interface to support MBMS.
- capable of routing MBMS traffic over either a point to multipoint channel or over a point to point channel.
- capable of discovering the number of MBMS users within a cell
- makes the decision to select channel type (point to multipoint or point to point) based on the number of users within a cell receiving MBMS service. The threshold value for this is operator defined

6.2 SGSN Functions

A number of functions provided by the SGSN for ptp bearer services may be used to provide MBMS:

- The SGSN authenticates users based on subscription data from HLR
- The SGSN authorises the usage of services/resources based on subscription data from HLR
- The SGSN provides user individual service control (ptp services)
- The SGSN provides user individual mobility management
- The SGSN may limit the service area per individual user
- The SGSN stores contexts per activated service per individual user
- The SGSN generates charging data per service for each user
- The SGSN provides CAMEL functions (e.g. prepaid)
- The SGSN establishes RABs on demand when data has to be transferred to the users

All these functions may be used in an MBMS architecture (potentially with modifications) for user individual control of MBMS multicast services, i.e. to activate, deactivate, authorise, ... the MBMS services for individual users. The mechanisms for provision of RABs on demand when data is to transfer may need extensions to provide shared resources for MBMS.

6.3 GGSN functions

The functions a GGSN could provide for MBMS are:

- Message Screening
- Charging Data Collection

- Mobility management
- Tunnelling of data
- Service (QoS) negotiation
- Policing

Message screening is not needed if the MBMS sources are internal in the PLMN or it is provided by the BM-SC or the BG which are gateways to external MBMS data sources.

Charging data may be collected for the MBMS data sources. But, the potential existing sources like ESS or MMS provide charging information and very likely also the BM-SC. User individual charging information is collected by the SGSN. It is not favourable to keep user individual contexts per multicast service in the SGSN and in the GGSN in parallel under the assumption that such user individual contexts are stored as long as the user is attached.

The mobility management of the GGSN can not support MBMS as the GTP tunnels would be fixed. These tunnels are used by multiple UEs in parallel an can not move with UEs.

The tunnelling seems the most important GGSN function for MBMS. It allows the provision of HPLMN MBMS multicast services to users roaming in a VPLMN. The tunnelling separates the traffic of the different MBMS services from each other and allows therefore the use of the same addresses in HPLMN and VPLMN. A co-ordination of addresses between different PLMNs is not needed.

A GGSN could simplify O&M when used to provide the parameters for the individual MBMS services at the service negotiation when the GTP tunnels are established. This approach has limitation when different configurations are required for the same service (potentially one SGSN has to provide different MBMS data for the same service in different areas, e.g. regional news). Then it has to be configured differently on the SGSN. Also the broadcast service needs to be configured on the SGSN, as there is no signalling with UEs which could trigger a tunnel establishment between SGSN and GGSN.

The GGSN could police the traffic of the individual MBMS services. But, most MBMS data sources are allocated within the PLMN and therefore under control of the operator. In addition, the QoS profile is very likely configured on the SGSN. And, the RAB will limit the possible throughput to the maximum bitrate and inherently police the traffic.

Most of the GGSN functions described above do not add any functionality useful for MBMS. Only for provision of HPLMN MBMS services to roaming users a GGSN is added to the architecture. The same approach is used for provision of MBMS services within one PLMN to avoid two different architectures.

6.4 UE functions

- After activation of a MBMS service, the UE shall be able to receive MBMS data without explicit user request.
- UEs, which store MBMS data, may have functionality for Digital Rights Management..
- The UE shall be able to receive indications for other services e.g. paging in CS. However, this may create losses for which the MBMS applications shall cope with.
- The UE shall allow reception of MBMS service announcements while receiving MBMS data.
- The UE shall provide the functions to activate/deactivate MBMS data reception.
- The UE should support security functions for the provision of MBMS service.

6.4.1 UE Functional Split Considerations

With the aim of enabling UE borne applications to use MBMS in receiving broadcast or multicast transmissions, the UE shall offer the following functions to applications:

- TE request to perform MBMS broadcast activation for a given broadcast service and to receive service related data.

- TE request to perform MBMS multicast activation (join) for a given multicast service and to receive service related data.
- TE request to perform MBMS broadcast deactivation for an activated broadcast service and to cease service-related data reception.
- TE request to perform MBMS multicast deactivation for an activated multicast service and to cease service related data reception.

Note: For broadcast activation and deactivation, it is assumed that no signalling between UE and network is necessary.

6.5 Other MBMS functions

Besides the user individual service control functions comparable to the functions already provided by an SGSN or GGSN there are some additional functions required for MBMS, mainly the specific data transport. It is assumed, that the SGSN performs the user individual service control, generates the charging data per user and establishes the RABs when MBMS data is to transfer. The SGSN concentrates all user individual services into one MBMS service for each specific MBMS service. This includes the establishment of a number of RABs to transfer MBMS data to the radio network entities of the related service area and it includes a single connection between the SGSN and the GGSN for each individual MBMS service. The SGSN duplicates the data received from the GGSN for each RAB established for the service. Similarly, the GGSN duplicates data received from the MBMS source for each GTP tunnel related to the same MBMS service.

6.6 MBMS Context

The entities of the PLMN that provide MBMS services maintain one or more MBMS contexts for each active MBMS service. An MBMS context contains information and parameters necessary for each MBMS service. An MBMS context contains among others the PDP address, which is the IP address of the MBMS service (IP Multicast address), and the APN used to access the MBMS service. The combination of the PDP address and the APN uniquely identify the MBMS service. Other content of the MBMS context is FFS. It is FFS whether PLMN entities maintain service specific MBMS contexts per UE, per network entity, or both.

6.7 BM-SC functions

BM-SC should provide the following functions for MBMS:

- Authorization and authentication of content providers.
- Verify integrity of data received from content provider.
- Determine quality-of-service for MBMS transmissions (within operator configured QoS bounds).
- MBMS data repetition.and error resilient schemes to cope with possible transmission loss.
- Content provider charging.

Further the BM-SC

- shall support functions to allow a content provider to select from operator defined broadcast or multicast areas for a MBMS service.
- shall be able to support several MBMS services taking into account their respective delivery constraints.
- shall provide functions to produce service announcements for the UE. The service announcement may include information about the required UE capabilities.
- shall provide functions to schedule MBMS data .
- shall be able to support one or more service providers

6.8 CBC functions

The Cell Broadcast Centre (CBC) may be used to announce MBMS services to the users. The functions a CBC couldprovide for MBMS service announcement are FFS.

6.9 MBMS Data Transfer in the Core Network

Multicast data must be available at the RNCs to be sent over the radio. The options for the data path are to send multicast data from a multicast "source" (could be a multicast server or multicast capable node) to:

1. all RNCs
2. only to selected RNCs which have multicast users,
3. to the all SGSNs to be further distributed by the SGSN to the RNCs, or
4. to selected SGSNs which have multicast users to be further distributed by the SGSN to the RNCs, or
5. to selected GGSN which support multicast service (possibly identified using APNs) and to be further distributed from the GGSN towards the RNCs.

The first option is wasteful of network resources and also makes it difficult to send data to VPLMNs for roaming users. The second option, an optimisation of the first one, is to send data only to RNCs with multicast users within the PLMN under control of the activation centre but this cannot support roaming users either. Handling user mobility is also an issue here if for example the UE is in PMM idle.

Sending data to the GGSN in the last option is a good choice to support roaming users. The data is then multicast to the SGSNs with registered multicast users. Sending data through the SGSN – either directly (the third option) or via the GGSN (the last option) – has advantages since the SGSN is aware of the user location information even in PMM idle state but the use of Iu-flex introduces complexities. Each SGSN node may use the routing area update procedure to help determine whether a multicast group user exists within its service area.

A combination of the above listed options can also be used – with direct transfer to RNC for the home users and via the GGSN to the roaming user.

The protocol to use to send data to the RNC or SGSN (if they are the recipient NE as per options discussed above) could be GTP or using IP multicast. Using IP multicast would be more efficient over the transport network if it supports multicast routers

Where the option to optimise and send data only to selected NEs is chosen, a signalling mechanism must be used to identify the appropriate nodes to set up the data path. If the data path is through the SGSN and GGSN, signalling similar to the existing GTP-C can be used to set up the tunnels. If IP multicast is used, the NEs wanting to receive multicast data, such as RNC or GGSN that have multicast users, could indicate its inclusion using IGMP/MLD.

The selection of an option is FFS.

6.9.1 Use of IP Unicast on Iu and Gn

The figure below shows the use of IP-unicast to optimise the user-plane on the Gn interface. It is possible to use a single user-plane connection to each SGSN, but this approach has a number of disadvantages:

- The GGSN and SGSN require new functions to manage the MBMS distribution tree, and to fork MBMS data to multiple destinations.
- The architecture has poor scaling because:
    - packets are forked near the top of the tree
    - forking takes place at a single point for all receivers - creating a single point of high-load.

A similar discussion applies to the Iu interface.

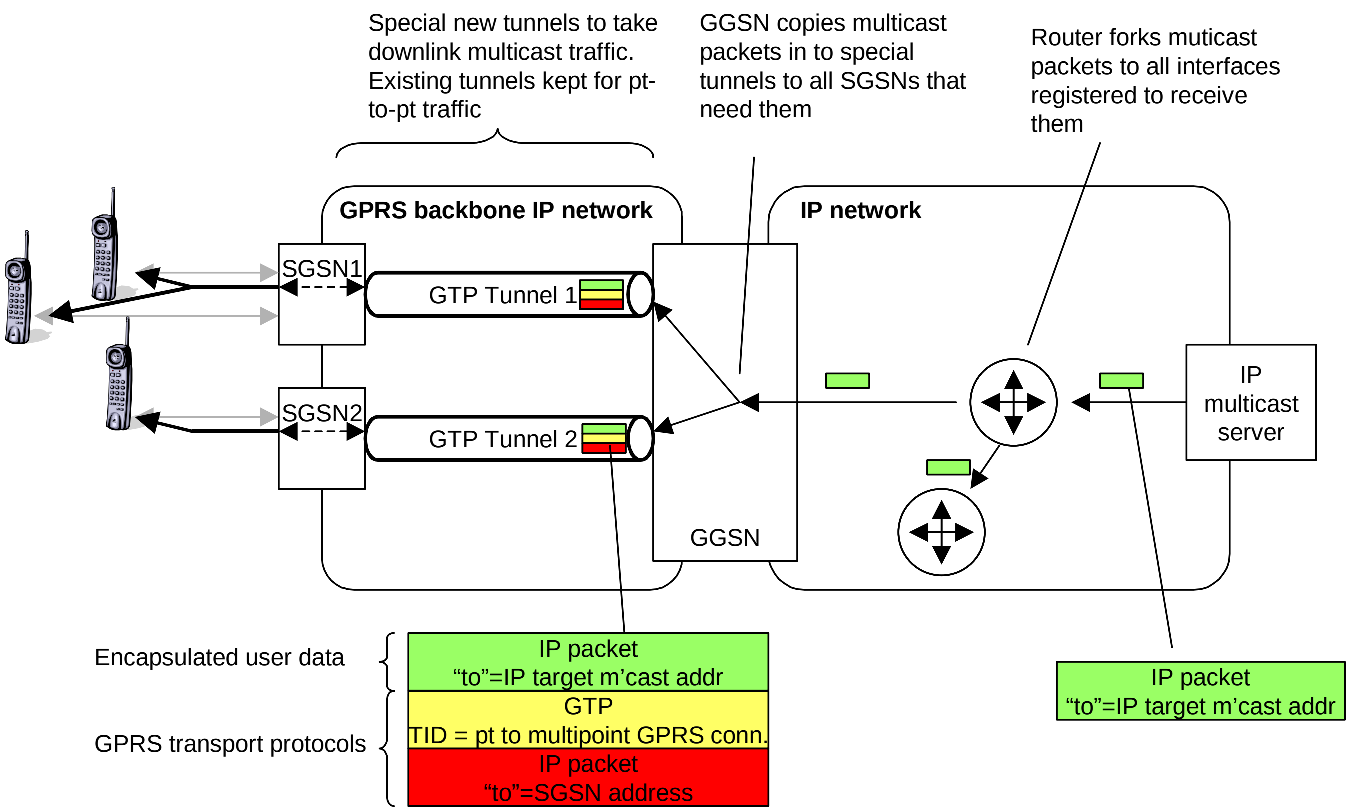

Figure 4: Optimised User Plane connections using IP unicast on the Gn interface

6.9.1.1 Use of IP Multicast on Iu and Gn

An alternative optimisation is to use special IP multicast groups within the GPRS backbone to transport data on the Gn interface. Instead of unicasting data to each individual SGSN, the GGSN only needs to forward packets once addressed to a specific multicast group. All SGSNs that need to receive this data can then register to receive the multicast group. Forking will be done by IP routers (assuming that multicast is supported).

The advantages of this approach are:

Scaling - this solution scales well because it exploits the scaling ability of IP multicast

Low impact on GGSN - GGSN doesn't have to copy packets on to multiple tunnels or manage list of SGSN receivers

Efficiency - IP routers will only fork the tunnels close to the end-points. The previous solution forks the tunnels at the GGSN

It shall be noted that:

IGMP needs to be supported in the SGSN,

routers in the UMTS internal IP Network have to support IP Multicast,

coordination of private IP multicast addresses between networks has to be studied for case when the UE is in a VPLMN and activation is done via the HPLMN GGSN.

A similar discussion applies to the Iu interface.

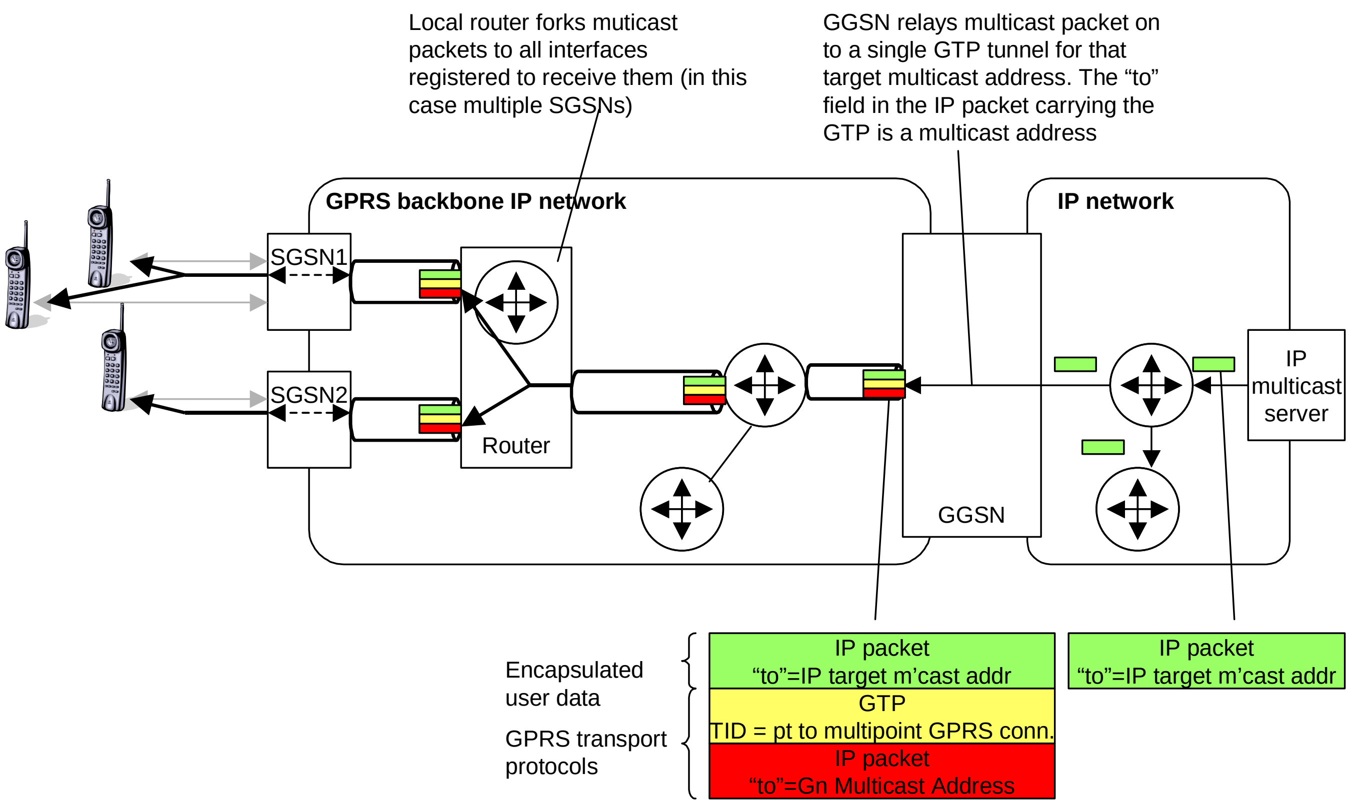

Figure 5: Optimised User Plane connections using IP multicast on the Gn interface

6.9.1.2 Example Activation Procedure on Gn

The following diagram shows an example activation procedure on Gn if IP multicast transport is used. Associated Iu procedures are now shown.

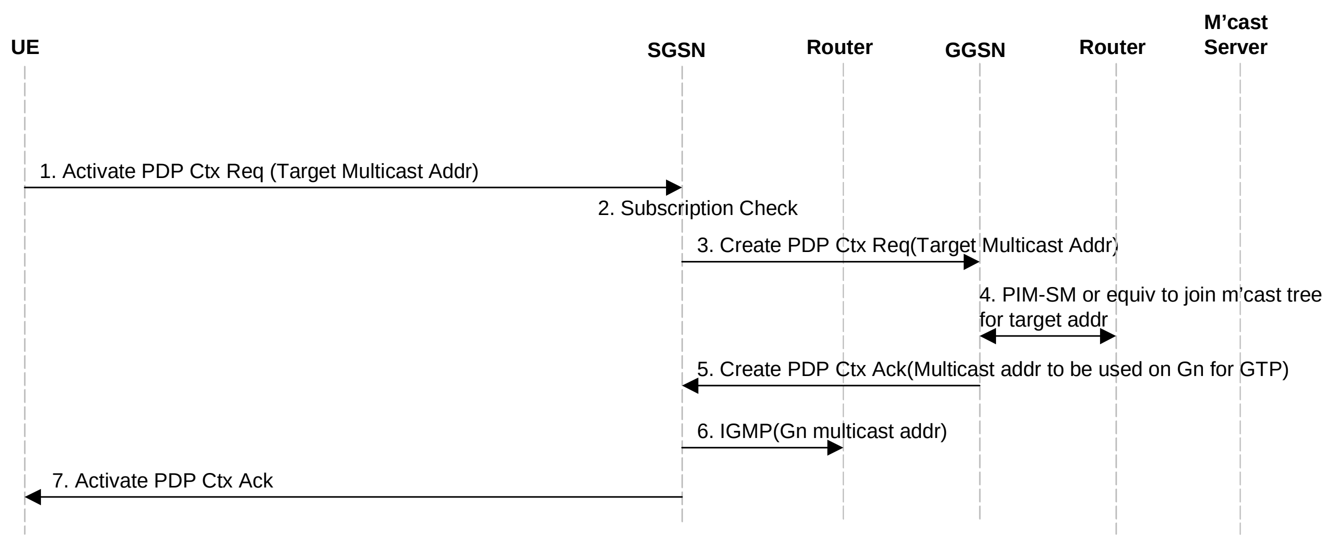

Figure 6 - Example activation procedure

1 A PDP context is established to receive multicast packets sent to the Target IP Multicast Address.

2 The SGSN may perform a subscription check.

3 The SGSN requests the GGSN to receive packets from the target multicast address.

4 If the GGSN is not already registered to receive multicast packets sent to the Target IP Multicast Address it registers with its peer router.

5 The GGSN acknowledges the request. It provides the SGSN with the GTP TID (GPRS Tunneling Protocol Transaction ID) that will be used for the multicast tunnel and also the IP multicast address it will use to send the GTP packets on the Gn interface. The IP multicast address for the GTP tunnel should be chosen from a pool managed by the GGSN.

6 If the SGSN is not already registered to receive multicast packets sent to the Gn IP Multicast Address, it registers with its adjacent router

7 The SGSN passes back to the mobile an acknowledgement

6.10 Intra Domain Connection of RAN Nodes to Multiple CN Nodes (Iu-Flex)

Iu-flex brings some complications to the multicast architecture. Iu-flex allows users on the same RNC to be registered in different SGSNs. Hence following the normal method of user plane using the same SGSN as the user is registered in could result in multiple streams to the RNC.

Whenever a GTP tunnel has to be set up between the RNC and the CN for multicast bearers, (either due to relocation or service initiation), and Iu Flex is configured in the network then the following options are available to reduce the impact on the network resource usage

Options are:

1. Use of a Default SGSN
2. Permitting multiple streams to RNC
3. Bypassing SGSN
4. RNC initiates only required number of RABs

6.10.1 Option 1: Default SGSN

1. As a result of activation or relocation, the RNC has to decide whether a multicast stream has to be established for that user or whether he can be added to an existing stream (this is assuming the network is using a point to multipoint link).
2. In order to ensure only one source of data to the RNC, the RNC has to have a known “default SGSN”, which it uses to establish a pre-configured path for the multicast stream.
3. A control RAB will be established between the RNC and the SGSN the user is registered in.
4. Volume based charging will be restricted.

In this option, SGSN 1 is the “default SGSN”. Only one RAB is established across the Iu interface.

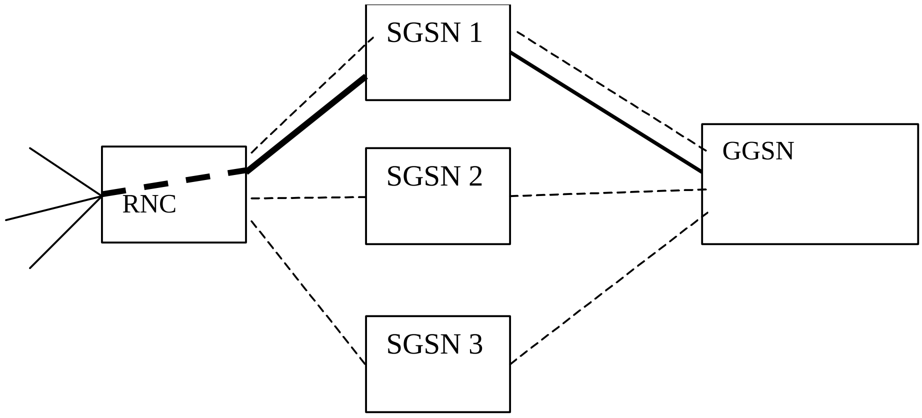

Figure 7.

6.10.2 Option 2 "SGSN Bypass"

This option would require GTP tunnel establishment and release for the user plane between the GGSN and RNC, without the SGSN being involved. Control plane information remains via the SGSN. Removing the SGSN from the data path would remove the inter-operator exposure available between SGSN and GGSN for roaming. Volume based charging would be restricted.

Signalling ______

Data path ______

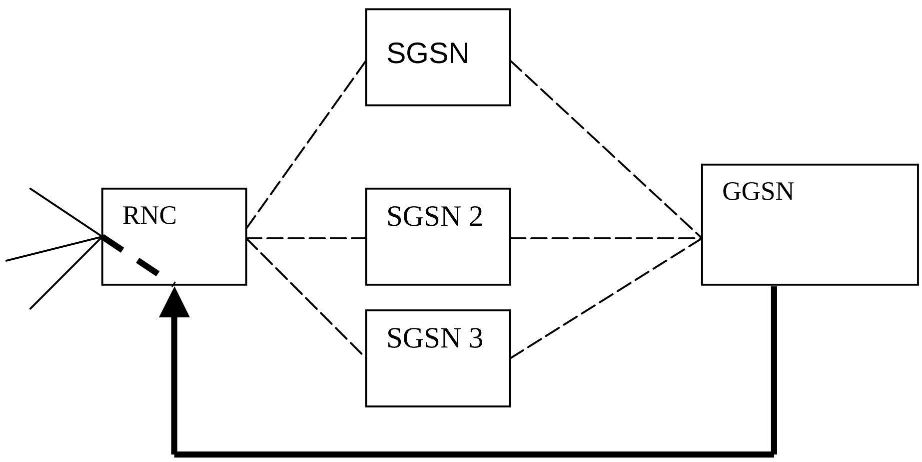

Figure 8.

6.10.3 Option 3 RNC decides on the Multicast Stream

In this option, the RNC is permitted to receive multiple streams. It then decides to take only one of the streams.

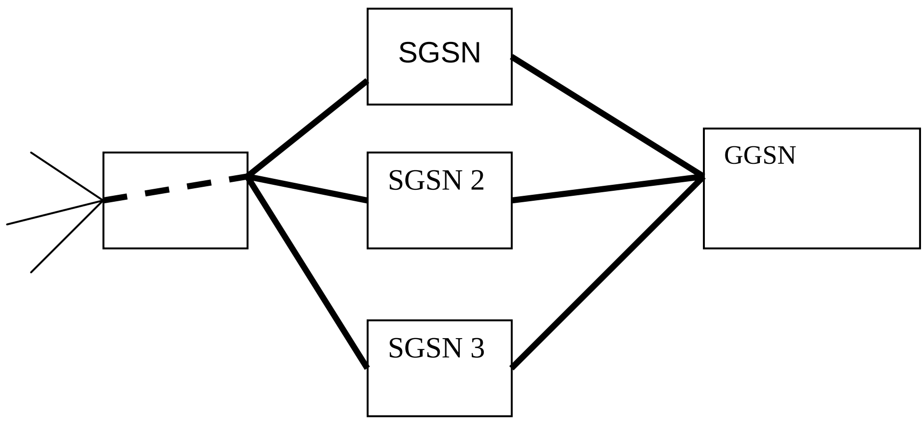

Figure 9.

6.10.4 Option 4 "RNC initiates only required number of RABs"

5. When the data transfer starts for an MBMS multicast the RNC detects that multiple SGSN send notifications to establish the same service. The RNC establishes the multicast RAB with only one SGSN. The other SGSNs establish no RABs for the MBMS multicast. But, the other SGSN receive the MBMS multicast data from the GGSN and generate volume charging information for the attached UEs.

6. If IU-Flex is employed, it is possible for users within a multicast group to be served by the same RNC but different SGSN. In this situation some of the MBMS IE must be the same even though different SGSNs may be involved.

It is FFS how this is done but the following solutions could be considered :

a) These IE can be assigned by the same network element

b) A consistent rule is applied unlike the random generation as used in the TMSI

c) Synchronization between different SGSNs.

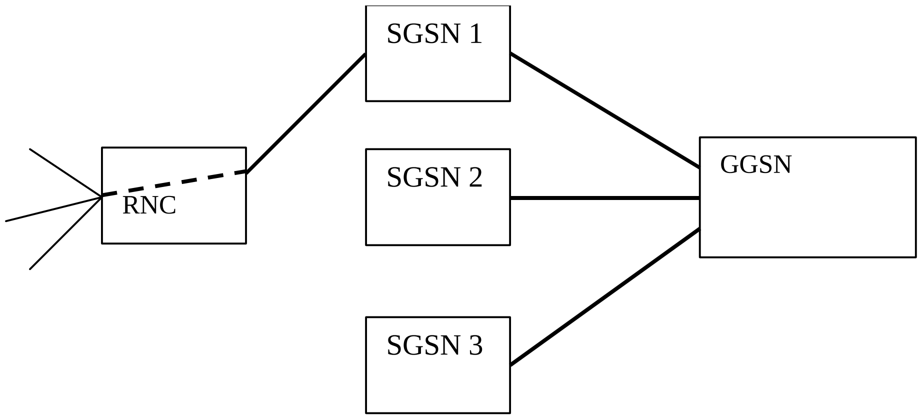

Figure 10.

6.11 Packet Temporary Mobile Group Identity in MBMS

In order to avoid congestion of the paging channels (at least in GSM), one solution is to allocate one common identity to all members of each multicast group, which are served by the same SGSN. This Temporary Mobile Group Identity (TMGI) could be allocated during a Routing Area Update, a GPRS Attach or a P-TMSI Reallocation procedure before the MBMS data transfer (e.g. the first TMGI allocation might occur when the mobile joins the IP multicast group). Separate multicast groups have different TMGIs. TMGIs may also be used to notify users of broadcast transmissions. It is FFS whether the same TMGIs can be used in more than one SGSN.

6.12 Decision process for selection of point-to-point or point-to-multipoint configuration

6.12.1 Multicast Mode

To ensure that radio resources are not wasted, the radio network needs to estimate the number of users in a cell in order to determine whether to establish a point to multipoint channel in that cell or point to point channels to each user.

In the event of the number of users within a cell exceeding an operator defined threshold, the radio network will establish a point to multipoint channel in that cell.

If a point to multipoint channel has been established and the number of users drops below an operator defined value then the radio network may be required to drop back to point to point channels.

Note: The two thresholds may be different.

It is FFS whether this change of channel can occur whilst data is being broadcast/multicast.

6.13 Service Announcement/Discovery

MBMS service announcement/discovery mechanisms should allow users to request or be informed about the range of MBMS services available. This includes operator specific MBMS services as well as services from content providers outside of the PLMN.

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 services may have to account for the users location, (e.g. current cell, in the HPLMN or VPLMN). Users who have not already subscribed to a MBMS service should also be able to discover MBMS services.

The following could be considered useful for MBMS service discovery mechanisms (not exhaustive): -

- SMS -CB
- MBMS Broadcast mode to advertise MBMS Multicast Services
- PUSH mechanism (WAP, SMS-PP)
- Web URL

6.14 Quality-of-Service

It shall be possible for the network to control quality-of-service parameters for multicast and broadcast sessions. All QoS parameters described in [4] shall be supported with the following changes:

- For **traffic class**, only the background and streaming classes shall be supported.

6.14.1 MBMS QoS is a MBMS service attribute

MBMS data will be distributed to multiple users, so that the QoS cannot be associated to one UE in particular.

6.14.2 MBMS QoS over the MBMS distribution tree

MBMS data will be distributed to multiple users through a MBMS distribution tree that can go through many RNCs and many SGSNs. Furthermore some transport resources may be shared between many users accessing the same service in order to save resources.

As a consequence, each branch of a MBMS distribution tree shall be established with the same QoS. The MBMS distribution tree shall have the same QoS for all its branches. It is FFS whether an MBMS service can be provided over multiple distribution trees with differing QoS profiles.

When a branch of the MBMS distribution tree has been created, it is not desirable that the construction of another branch 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) impacts the already established branches. Else, this imply a heavy mechanism to adjust the QoS of all the already established MBMS branches. As a consequence, QoS negotiation shall not be done by the network nodes.One of the consequence is that some branches may not be established if QoS requirement cannot be accepted by the concerned network node.

QoS negotiation should not be allowed by UMTS network elements.

QoS re-negotiation feature in the RNC should not be allowed for MBMS service.

7 Network and Protocol Architecture

Options for different network architectures together with a rough description of necessary functionality, procedures, information flows and alterations required for network elements and protocols.

7.1 Option A)

This architecture option differentiates between the procedure for MBMS multicast service activation and the procedure for MBMS RAB set-up. The MBMS multicast activation procedure adds an individual UE to all contexts, which describe an MBMS multicast service within the network (the UE joins the multicast group). And this procedure establishes shared MBMS data links within the Core Network between GSNs and BM-SC on demand. The MBMS multicast activation procedure is performed for an individual UE. It has no influence whether data transfer to the multicast group is ongoing or not.

MBMS RABs are not established by the MBMS multicast activation procedure. The MBMS RABs are established for the multicast group and not for individual UEs by the MBMS RAB set-up procedure when MBMS multicast data are available for transfer.

This architecture option establishes data transfer resources only for RNCs and SGSNs that have users of the related MBMS multicast service. This corresponds to options 2) and 4) discussed in clause "MBMS Data Transfer in the Core Network".

The approach that solves Iu-Flex issues corresponds to options 2) and 4) discussed in clause "Intra Domain Connection of RAN Nodes to Multiple CN Nodes (Iu-Flex)".

7.1.1 MBMS Multicast Service Activation

The activation procedure registers the user in the network to enable the reception of data from a specific MBMS multicast service. The activation is a signalling procedure between the UE and the network. It establishes the MBMS data transfer path within the network between SGSN(s) and BM-SC. The MBMS multicast service activation does not establish any RABs for the data transfer. The procedure is similar to the PDP context activation.

The activation of an MBMS multicast service without user interaction uses the same procedure. The mechanism which initiates this procedure in this case is FFS (e.g. a request from the network or triggered by data on the SIM after GPRS attach).

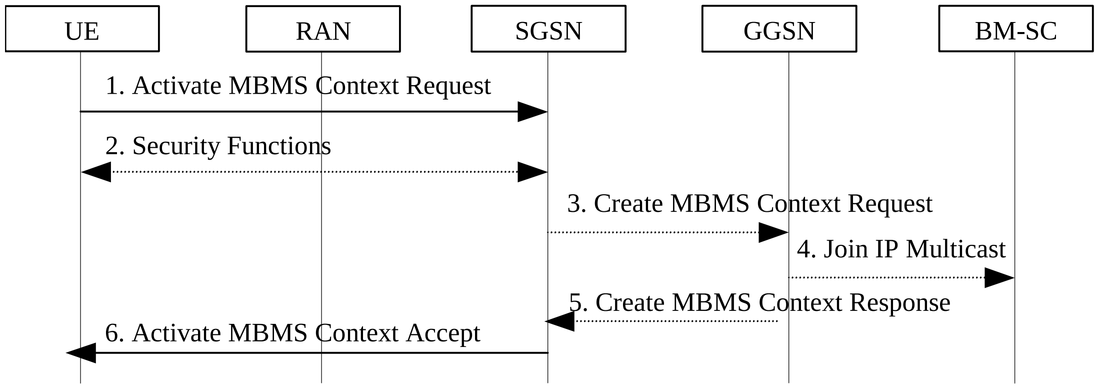

Figure 11. The activation of an MBMS multicast service

1. The UE sends an Activate MBMS Context Request to the SGSN. The IP multicast address identifies the MBMS multicast service, which the UE wants to join. An APN indicates a specific GGSN or BM-SC. The SGSN creates a UE specific MBMS context, which stores the parameters of the activated MBMS multicast service.

2. Security Functions may be performed, e.g. to authenticate the UE.

3. The SGSN checks whether the requested MBMS multicast service identified by the IP multicast address and APN requires a specific subscription or whether a general subscription (e.g. GPRS subscription) allows the activation of the requested service. If it is the first UE activating this specific MBMS multicast service on this SGSN the SGSN requests the creation of an MBMS context on the GGSN and the establishment of a GTP tunnel between the SGSN and the GGSN.

4. If it is the first GTP tunnel for this specific MBMS multicast service on the GGSN the GGSN joins the IP multicast for the requested multicast IP address on the backbone to connect with the MBMS data source (BM-SC).

5. The GGSN confirms the establishment of the MBMS context if performed according to step 4).

6. The SGSN sends an Activate MBMS Context Accept to the UE with the parameter TMGI.

7.1.2 MBMS Broadcast Service activation

The MBMS broadcast service activation is local on the UE and local in the network. The user enables on the UE the reception of data from a specific MBMS broadcast service. This activation does not establish any data transfer resources.

The activation procedure in the network is comparable to the multicast activation. The connections within the network are set-up when the SGSN re-starts or when an MBMS broadcast service is set-up by O&M. The activation procedure establishes the MBMS data transfer path within the network between SGSN(s) and BM-SC. The MBMS broadcast service activation does not establish any RABs for the data transfer.

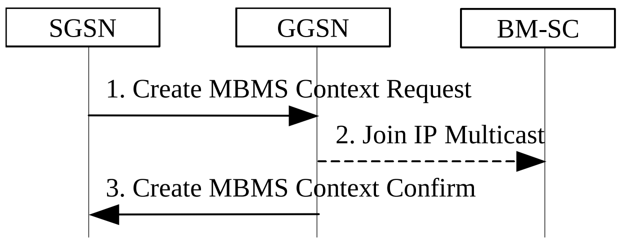

Figure 12. The activation of an MBMS broadcast service

1. At a SGSN re-start or when a new MBMS broadcast service is set-up the SGSN requests the creation of an MBMS context on the GGSN and the establishment of a GTP tunnel between the SGSN and the GGSN.

2. If it is the first GTP tunnel for this specific MBMS multicast service the GGSN joins the IP multicast for the requested multicast IP address on the backbone to connect with the MBMS data source (BM-SC).

3. The GGSN confirms the establishment of the MBMS context.

7.1.3 MBMS RAB set-up

The MBMS RAB set-up procedure establishes the RABs for a specific MBMS service when MBMS data have to be transferred. The procedure is used for MBMS broadcast and MBMS multicast data transfer.

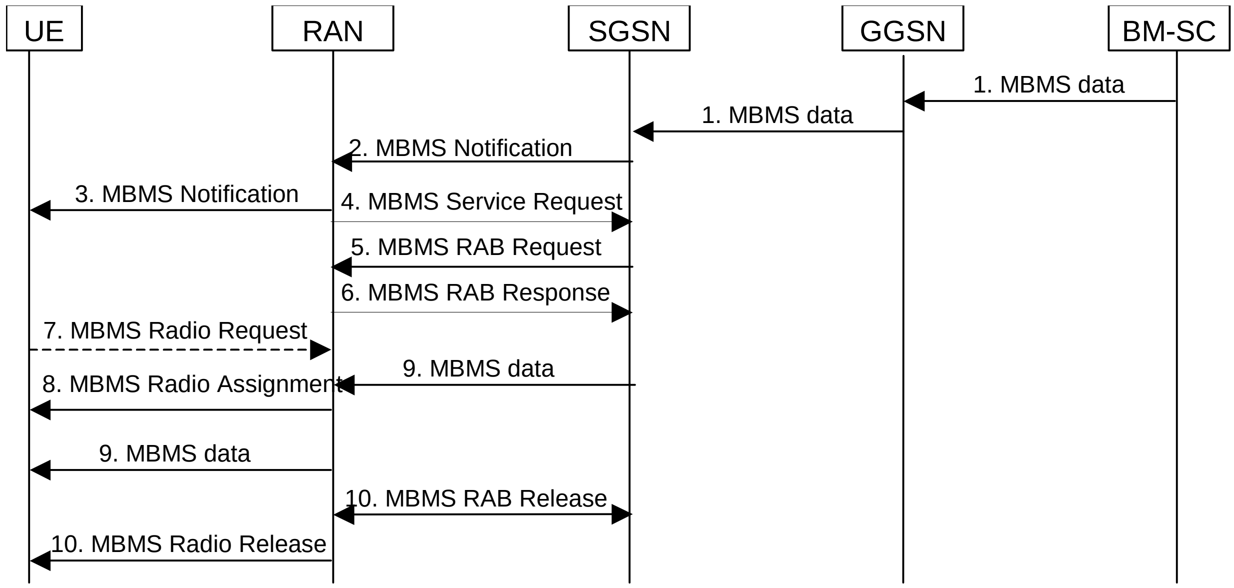

Figure 13. MBMS RAB set-up

1. The BM-SC sends MBMS data that are received by the SGSN.
2. The SGSN sends an MBMS Notification to the RAN indicating the TMGI and the MBMS service area.
3. The RAN sends an MBMS Notification to the UEs within the MBMS service area.
4. The RAN sends one or multiple MBMS Service Request messages to the SGSN. The RAN may need one or multiple MBMS Iu bearers to cover the MBMS service area.
5. The SGSN sends per received MBMS Service Request an MBMS RAB Request message to the RAN. The message indicates the QoS parameters required for the RAB.
6. The RAN sends per MBMS RAB Request an MBMS RAB Response to the SGSN that establishes the MBMS Iu bearers between the RAN and the SGSN.
7. The UEs which have activated this MBMS service and which receive the MBMS Notification send an MBMS Radio Request message to the network. A back-off mechanism to prevent too many request messages is FFS.
8. The RAN establishes MBMS radio bearers and sends MBMS Radio Assignment messages in the cells where MBMS Radio Request messages were received.
9. When the MBMS Iu bearer between the RAN and the SGSN is established the SGSN starts to duplicate and to send received MBMS data on all established MBMS RABs. The RAN duplicates and sends these data on the MBMS radio bearer(s).
10. When the SGSN receives no more MBMS data it may release the MBMS RAB. This causes the RAN to release the MBMS radio bearers.

7.1.4 Service Continuity and Mobility

7.1.4.1 MBMS SGSN change procedure

This procedure is performed when a UE in GMM IDLE changes the SGSN, i.e. there are no RABs and no signalling connections with the SGSN. The RABs for MBMS services are not exclusive for individual UEs. A signalling connection for an UE with MBMS services only is not intended as this is against the multicast concept. UEs which have only active MBMS services are therefore in GMM IDLE. These UEs perform the Routeing Area update with MBMS extensions as described below. The procedure is performed regardless whether MBMS data transfer is ongoing or not. The handling of potential ptp PDP contexts is not affected. The described procedure shows not all details of the Routeing Area update procedure. The MBMS specific additions to the Routeing Area update procedure are in bold.

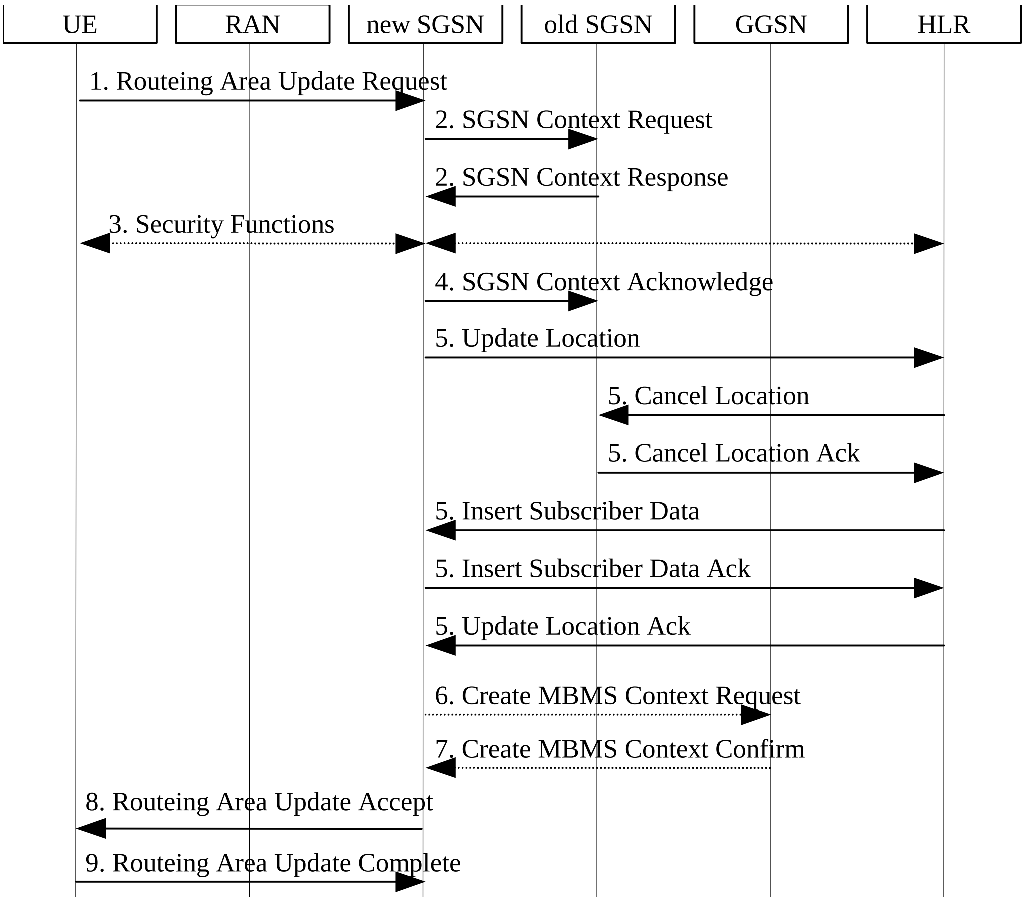

Figure 14. Mobility between SGSNs

1. The UE moves from the service area of the old SGSN to the service area of the new SGSN. The UE sends a Routeing Area Update Request to the new SGSN. The RAN shall add an identity of the area where the message was received before passing the message to the SGSN.

2. The new SGSN sends SGSN Context Request to the old SGSN to get the MM, the PDP and **the MBMS contexts** for the UE. The old SGSN sends all UE contexts with the SGSN Context Response to the new SGSN.

3. Security functions may be executed, e.g. authenticating the UE.

4. The new SGSN sends an SGSN Context Acknowledge message to the old SGSN to indicate that is has taken over the control for that UE.

5. All procedures to provide the subscription and security data in the new SGSN and to register the new SGSN at the HLR are performed.

6. The new SGSN validates the UE's presence. If due to roaming restrictions the UE is not allowed to be attached in the SGSN, or if subscription checking fails, the new SGSN rejects the routeing area update with an appropriate cause. If all checks are successful, the new SGSN constructs MM, PDP **and MBMS** contexts for the UE. **The new SGSN checks each individual MBMS service indicated by the MBMS contexts of the UE. If it is the first UE with this specific MBMS multicast service on this SGSN the SGSN requests the creation of an MBMS context on the GGSN and the establishment of a GTP tunnel between the SGSN and the GGSN.**

7. **The GGSN confirms the establishment of the MBMS context if performed according to step 6.**

8. The new SGSN responds to the UE with Routeing Area Update Accept. **One or more TMGI may be allocated to the UE for MBMS.**

9. The UE acknowledges the new parameters by returning a Routeing Area Update Complete.

7.1.4.2 MBMS relocation and handover

This procedure is performed when a UE in GMM CONNECTED changes the SGSN, i.e. there is a signalling connections with the SGSN. The RABs of ptp services are transferred by relocation/handover. MBMS RABs are not exclusive for individual UEs. Active MBMS services of the UE are transferred to the new SGSN by the context transfer which is embedded in the relocation/handover procedures. The procedure is performed regardless whether MBMS data transfer is ongoing or not. The described procedure shows not all details of the relocation procedure. Only the relocation procedure is described. The handover procedure has similar extensions for MBMS. The MBMS specific additions to the relocation procedure are in bold.

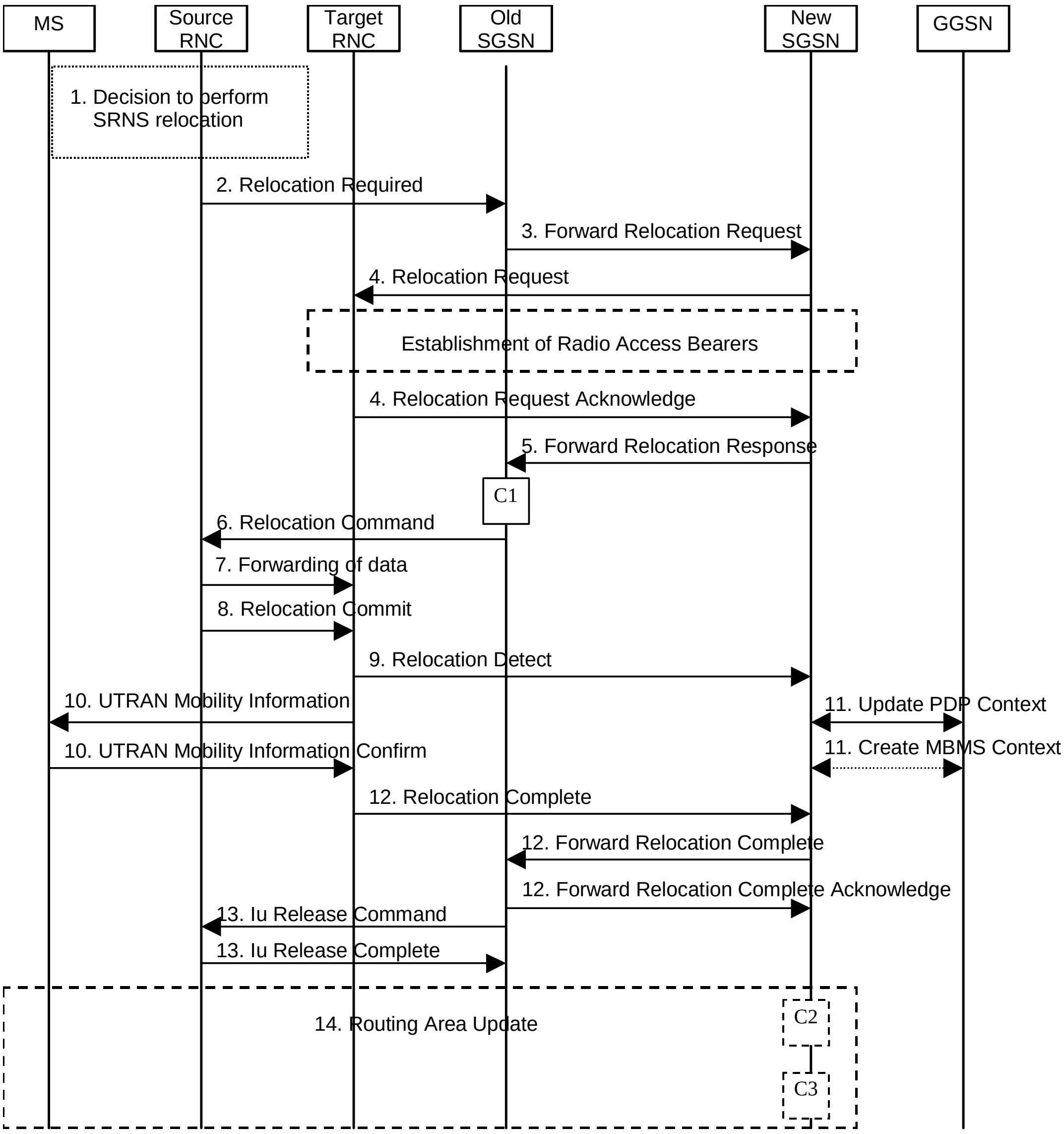

Figure 15.: SRNS Relocation Procedure

1) The source SRNC decides to perform/initiate SRNS relocation.

2) The source SRNC sends a Relocation Required message (Relocation Type, Cause, Source ID, Target ID, Source RNC to target RNC transparent container) to the old SGSN. The source SRNC shall set the Relocation Type to "UE not involved". The Source SRNC to Target RNC Transparent Container includes the necessary information

for Relocation co-ordination, security functionality and RRC protocol context information (including MS Capabilities).

3) The old SGSN determines from the Target ID if the SRNS Relocation is an intra-SGSN SRNS relocation or an inter-SGSN SRNS relocation. In case of inter-SGSN SRNS relocation, the old SGSN initiates the relocation resource allocation procedure by sending a Forward Relocation Request message (IMSI, Tunnel Endpoint Identifier Signalling, MM Context, PDP Context, **MBMS context,** Target Identification, UTRAN transparent container, RANAP Cause) to the new SGSN. The Forward Relocation Request message is applicable only in the case of inter-SGSN SRNS relocation.

4) The new SGSN sends a Relocation Request message (Permanent NAS UE Identity, Cause, CN Domain Indicator, Source-RNC to target RNC transparent container, RABs to be setup) to the target RNC. Only the Iu Bearers of the RABs are setup between the target RNC and the new-SGSN as the existing Radio Bearers will be reallocated between the MS and the target RNC when the target RNC takes the role of the serving RNC.

5) When resources for the transmission of user data between the target RNC and the new SGSN have been allocated and the new SGSN is ready for relocation of SRNS, the Forward Relocation Response message (Cause, RANAP Cause, and RAB Setup Information) is sent from the new SGSN to old SGSN. This message indicates that the target RNC is ready to receive from source SRNC the forwarded downlink PDUs, i.e. the relocation resource allocation procedure is terminated successfully. The Forward Relocation Response message is applicable only in case of inter-SGSN SRNS relocation.

6) The old SGSN continues the relocation of SRNS by sending a Relocation Command message (RABs to be released, and RABs subject to data forwarding) to the source SRNC. The old SGSN decides the RABs to be subject for data forwarding based on QoS, and those RABs shall be contained in RABs subject to data forwarding.

7) The source SRNC may, according to the QoS profile, begin the forwarding of data for the RABs to be subject for data forwarding.

8) Before sending the Relocation Commit the uplink and downlink data transfer in the source, SRNC shall be suspended for RABs, which require delivery order. The source RNC shall start the data-forwarding timer. When the source SRNC is ready, the source SRNC shall trigger the execution of relocation of SRNS by sending a Relocation Commit message (SRNS Contexts) to the target RNC over the Iur interface.

9) The target RNC shall send a Relocation Detect message to the new SGSN when the relocation execution trigger is received. For SRNS relocation type "UE not involved", the relocation execution trigger is the reception of the Relocation Commit message from the Iur interface. When the Relocation Detect message is sent, the target RNC shall start SRNC operation.

10) The target SRNC sends a UTRAN Mobility Information message. This message contains UE information elements and CN information elements. The UE information elements include among others new SRNC identity and S-RNTI. The CN information elements contain among others Location Area Identification and Routeing Area Identification. The procedure shall be co-ordinated in all Iu signalling connections existing for the MS.

11) Upon receipt of the Relocation Detect message, the CN may switch the user plane from source RNC to target SRNC. If the SRNS Relocation is an inter SGSN SRNS relocation, the new SGSN sends Update PDP Context Request messages to the GGSNs concerned. The GGSNs update their PDP context fields and return an Update PDP Context Response. **If the SRNS Relocation is an inter SGSN SRNS relocation, the new SGSN checks each individual MBMS service indicated by the MBMS contexts of the UE. If it is the first UE with this specific MBMS multicast service on this SGSN the SGSN requests the creation of an MBMS context on the GGSN and the establishment of a GTP tunnel between the SGSN and the GGSN.**

12) When the target SRNC receives the UTRAN Mobility Information Confirm message, i.e. the new SRNC—ID + S-RNTI are successfully exchanged with the MS by the radio protocols, the target SRNC shall initiate the Relocation Complete procedure by sending the Relocation Complete message to the new SGSN. The purpose of the Relocation Complete procedure is to indicate by the target SRNC the completion of the relocation of the SRNS to the CN.

13) Upon receiving the Relocation Complete message or if it is an inter-SGSN SRNS relocation; the Forward Relocation Complete message, the old SGSN sends an Iu Release Command message to the source RNC. When the RNC data-forwarding timer has expired the source RNC responds with an Iu Release Complete.

14) After the MS has finished the RNTI reallocation procedure and if the new Routeing Area Identification is different from the old one, the MS initiates the Routeing Area Update procedure. See subclause "Location Management Procedures (Iu mode only)". Note that it is only a subset of the RA update procedure that is performed, since the MS is in PMM-CONNECTED mode. **New TMGI(s) may be allocated to the UE for MBMS services.**

7.1.5 Service Deletion

7.1.6 Interfaces to External Media Sources

7.1.7 Roaming

7.1.8 Security

7.1.9 Charging

7.2 Option B)

7.2.1 MBMS Multicast Service Activation

7.2.2 MBMS Broadcast Service activation

7.2.2.1Network initiated MBMS broadcast activation

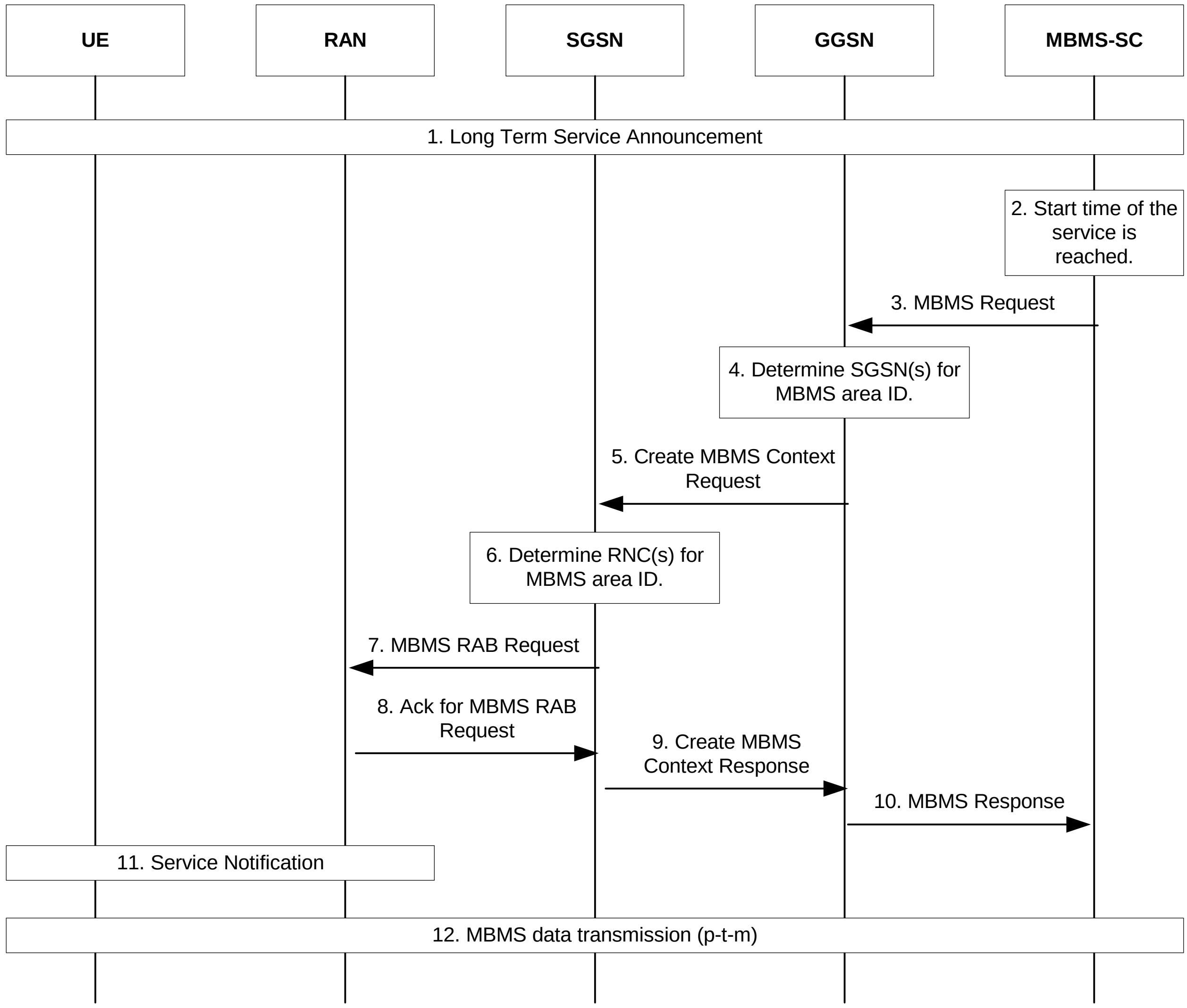

Figure 16. Network initiated activation.

1. Long Term Service Announcement procedure allows UE's to be informed of forthcoming services available.
2. MBMS service has scheduled a broadcast data transmission to start. MBMS-SC is awaken for the transmission. No MBMS bearer exists for the session.
3. MBMS-SC sends an activation message MBMS Request(MBMS ID (session identifier), broadcast area ID, QoS attributes) to the GGSN to ask a MBMS bearer activation for the service session.
4. GGSN finds out to which SGSNs to send the MBMS bearer activation request. How GGSN discover the SGSNs is FFS.
5. GGSN sends Create MBMS Context Request(MBMS ID, broadcast area ID, QoS attributes, GGSN address, TEID) to the SGSN(s) which belong to the broadcast area.

6. SGSN finds out to which RNCs to send MBMS RAB Request. How SGSN finds out the RNCs is FFS.

7. SGSN(s) initiates RAB establishment by sending MBMS RAB Request(MBMS ID, broadcast area ID, QoS attributes, SGSN address, TEID) to all of the RNCs which belong to the broadcast area.

8. If all required configurations and the resource reservations are successful in RAB setup, the RNC sends a positive acknowledgement to the SGSN. However if e.g. no resources are available for the MBMS services, the RNC sends the negative acknowledgement to the SGSN.

   Negotiated QoS attributes may be included in the acknowledgement message if those were downgraded by RNC.

9. SGSN derives the QoS attributes towards GGSN. If MBMS RAB is established towards many RNCs, these RNCs may be able to provide different level of QoS to the MBMS RABs. In this case, SGSN may select either the highest QoS attributes or the lowest QoS attributes. If the lowest QoS attributes are selected, SGSN could modify other MBMS RABs accordingly. SGSN sends Create MBMS Context Response (SGSN address, TEID) to GGSN. Negotiated QoS attributes may be included if those were downgraded by RNC.

10. GGSN sends MBMS Response to MBMS-SC. Negotiated QoS attributes may be included if those were downgraded by RNC.

11. RAN node provides Service Notification which informs the UE about forthcoming (and possible other ongoing) data transfer. Service Notification can be send any time after succesfull RAB set up in step 8.

12. After the successful MBMS bearer activation the MBMS-SC starts transmitting the service data.

It should be noted that in the above scenario, the requested QoS attributes may be downgraded in RNC. This may happen also in other nodes along the signalling path. If QoS downgrading happens, a node indicates the downgraded QoS attributes and possibly the requested QoS attributes- to the next node.

Note: The topic of QoS is FFS.

7.2.3 MBMS RAB set-up

7.2.4 Service Continuity and Mobility

7.2.5 Service Deletion

7.2.6 Interfaces to External Media Sources

7.2.7 Roaming

7.2.8 Security

7.2.9 Charging

7.3 Option C)

7.3.1 MBMS Multicast Service Activation

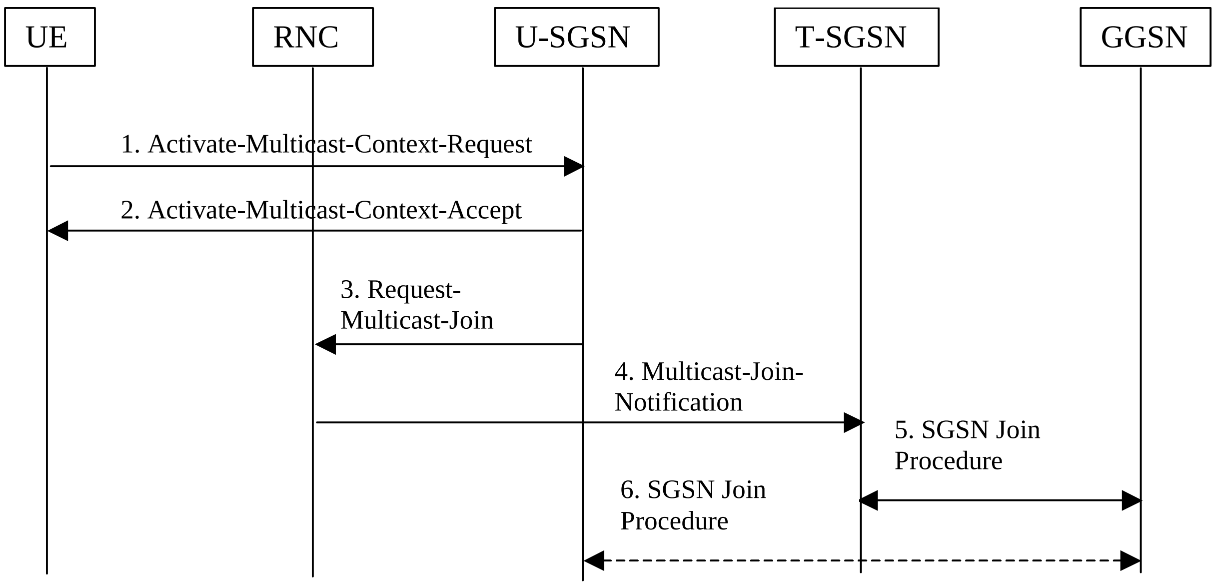

Figure 17.

1. UE Requests to join a specific multicast group and receive the associated service by sending an **Activate-Multicast-Context-Request** containing a multicast address and APN identifying the group. The message is sent to the SGSN currently serving the user (U-SGSN).

2. The U-SGSN checks for user authorization for joining the specific multicast group. If the user is authorized to join the requested multicast group, the SGSN returns an **Activate-Multicast-Context-Accept**. Alternatively, if the user is not authorized to join the service the U-SGSN returns an **Activate-Multicast-Context-Reject**.

3. If the user is the first user to join the specific multicast group in the domain of the U-SGSN and Iu-flex is being used then the U-SGSN sends a **Request-Multicast-Join** to the RNC that is currently serving the user. The **Request-Multicast-Join** identifies the multicast group being joined by including the multicast address and APN received in (1), If Iu-flex is not being used, the U-SGSN assumes the role of the T-SGSN and carries out the procedure described in (5).

4. If the RNC receives the first **Request-Multicast-Join** from the U-SGSN and the RNC is not joined to the specific group then the RNC sends a **Multicast-Join-Notification** to the SGSN designated to provide traffic for the specific multicast group (T-SGSN). The means by which an RNC chooses an SGSN, through which

multicast traffic for a specific service should be routed, are implementation specific and are not subject to further standardization. The **Multicast-Join-Notification** identifies the group being joined by including the multicast address and APN received in (3).

If the T-SGSN has previously joined the multicast group and while receiving the **Multicast-Join-Notification** the T-SGSN is in the process of relaying multicast traffic to other RNCs for the requested service then the T-SGSN sets up the necessary RAB(s) to the sending RNC as described in section 8.1.4.

5. If the T-SGSN has not done so previously, the T-SGSN notifies the GGSN identified by the APN and associated with the specific multicast service of its wish to receive transmissions associated with the service. Since GTP-C uses unreliable transport, it is expected that the join procedure will consist of a request-response message exchange.

   If the GGSN receives a T-SGSN request to join a given multicast service and a transmission for this service is ongoing, the GGSN should follow procedures described in 8.1.4 to set-up bearers and begin transmission.

6. If the U-SGSN chooses to generate volume-based charging information the U-SGSN might itself, follow procedures described in 5 and as a result would be offered to receive all service related traffic.

Multicast Service Deactivation

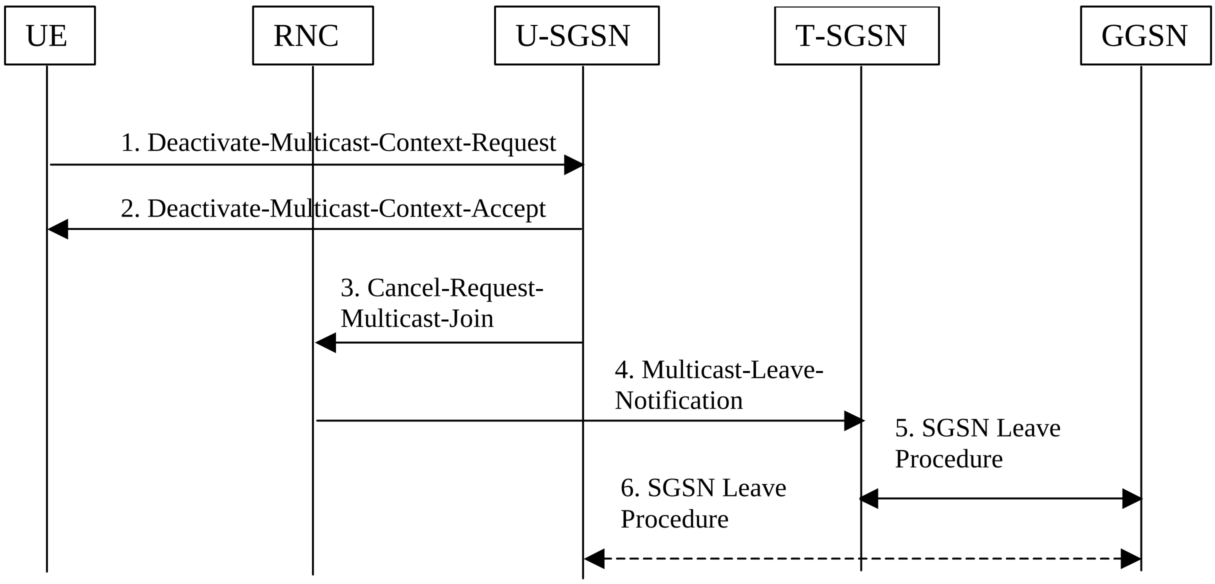

Figure 18.

1. UE Requests to leave a specific multicast group and cease reception of the associated service by sending a **Deactivate-Multicast-Context-Request** containing a multicast address and APN identifying the group. The message is sent to the SGSN currently serving the user (U-SGSN).

2. The U-SGSN checks if the user has previously joined the identified multicast group and returns an **Activate-Multicast-Context-Accept** if this is the case.

3. If the user is the last user to leave the specific multicast group in the domain of the U-SGSN and Iu-flex is being used then the U-SGSN sends a **Cancel-Request-Multicast-Join** to the RNC that is currently serving the user. The **Cancel -Request-Multicast-Join** identifies the multicast group being left by including the multicast address and APN received in (1), If Iu-flex is not being used, the U-SGSN assumes the role of the T-SGSN and carries out the procedure described in (5).

4. If the RNC receives a **Cancel-Request-Multicast-Join** from the U-SGSN and at the time of reception no other SGSNs have asked the RNC to join the specified multicast group then the RNC sends a **Multicast-Leave-Notification** to the SGSN to which it previously sent the **Multicast-Join-Notification** (T-SGSN). The **Multicast-Leave-Notification** identifies the group being joined by including the multicast address and APN received in (3).

If upon reception of a **Multicast-Leave-Notification**, the T-SGSN happens to be in the process of relaying multicast transmissions as part of the specified service, the T-SGSN should terminate all service specific RABs to the sending RNC.

5. If at the time of reception of a **Multicast-Leave-Notification** the T-SGSN determines that no other RNCs have joined the specific multicast group, the T-SGSN notifies the GGSN identified by the APN and associated with the specific multicast service of its wish to cease reception of transmissions associated with the service. Since GTP-C uses unreliable transport, it is expected that the leave procedure will consist of a request-response message exchange.

   If the GGSN has any ongoing transmissions to the specific T-SGSN, it should terminate these transmissions and free the associated resources.

6. If the U-SGSN has previously chosen to generate volume-based charging information the U-SGSN shall itself, follow procedures described in 5 and as a result would itself stop reception of all service related traffic.

7.3.2 MBMS Broadcast Service activation

7.3.3 MBMS RAB set-up

Initiating an MBMS Transmission

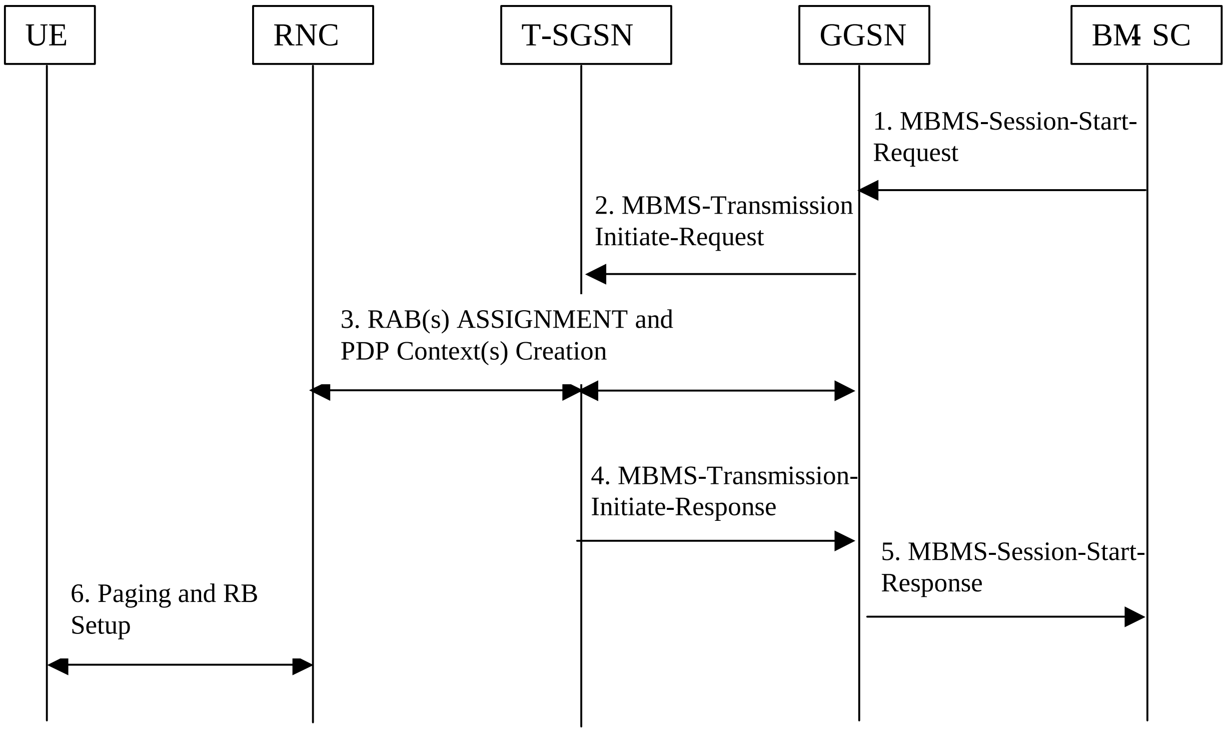

Figure 19. **Initiating an MBMS Transmission**

1. Upon content provider request, due to operator configuration or as part of a repetition scheme a BM-SC may wish to initiate a transmission over an MBMS bearer. In order to signal its wish to transmit and to request suitable quality-of-service for the coming transmission, the BM-SC sends an **MBMS-Session-Start-Request** to the GGSN assigned to the specific service.

2. The GGSN sends an **MBMS- Transmission-Initiate-Request** to all T-SGSNs which have requested to receive traffic associated with the service (as described in 8.1.2). The **MBMS-Transmission-Initiate-Request** includes service parameters received from the BM-SC in (1).

3. Each T-SGSN requests the set-up of a suitable RAB(s) and GTP tunnels based on quality-of-service parameters as received in **MBMS-Transmission-Initiate-Request** from GGSN. The GTP tunnels are set-up towards the GGSN from which the **MBMS-Transmission-Initiate-Request** was received. The T-SGSN requests RAB set-ups to RNCs that have previously sent an RNC-Join-notification as described in 8.1.1.

4. Once RAB and GTP tunnel set-up is complete, the T-SGSN returns an MBMS-Initiate-Transmission-Response specifying whether the procedure was successfully completed and possibly detailing those areas where RAB setup has failed.

5. GGSN responds with **MBMS-Session-Start-Response**. The response indicates whether the bearers for transmission are available and if actual transmissions can start.

6. Actual paging of UEs and RB set-up procedures may be carried out, as RABs are set-up or at first packet arrival. This is currently left FFS.

Terminating an MBMS Transmission

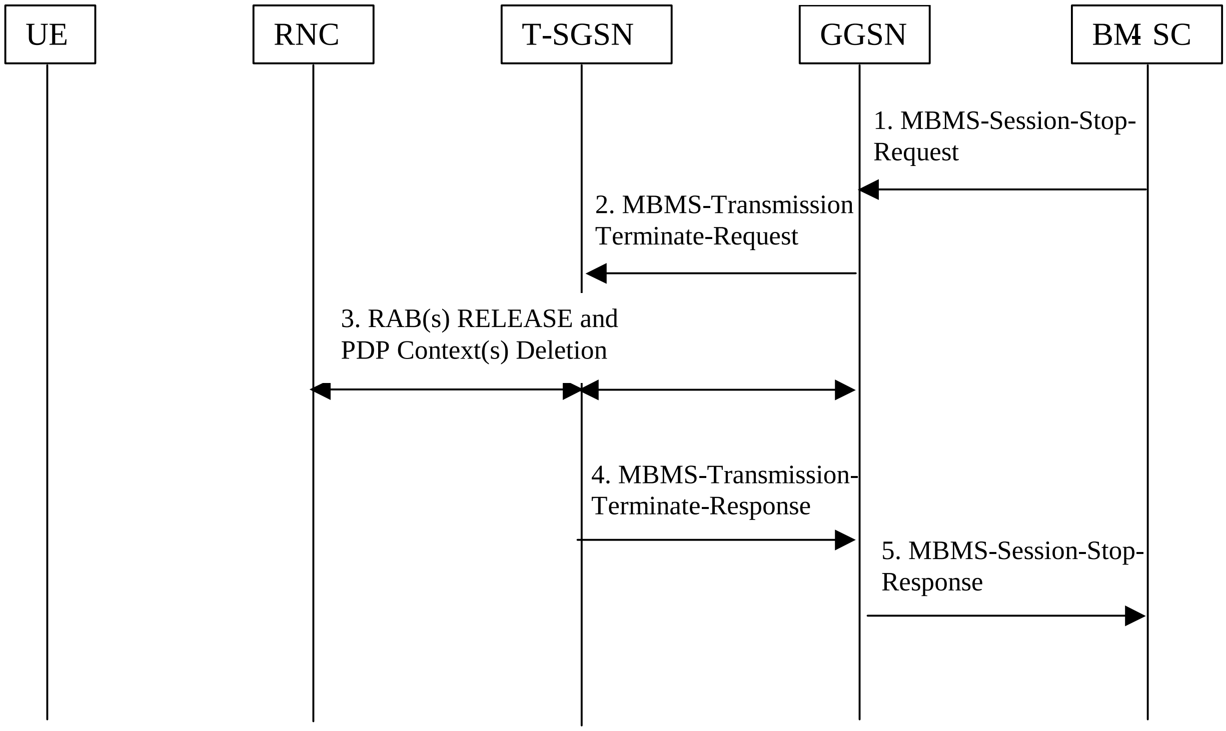

Figure 20. **Terminating an MBMS Transmission**

1. Upon content provider request, due to operator configuration or as part of a repetition scheme a BM-SC may wish to terminate a transmission over an MBMS bearer. In order to signal its wish terminate the transmission, the BM-SC sends an **MBMS-Session-Stop-Request** to the GGSN assigned to the specific service.

2. The GGSN sends an **MBMS- Transmission-Terminate-Request** to all T-SGSNs which are currently receiving traffic associated with the service (as described in 8.1.2).

3. Following **MBMS-Transmission-Terminate-Request**, each T-SGSN terminates the RAB(s) and GTP tunnels previously set-up for carrying out the transmission.

4. When all tunnels and RABs have been terminated, T-SGSN responds to the GGSN with an **MBMS-Transmission-Terminate-Response**.

5. GGSN responds with **MBMS-Session-Start-Response**.

7.3.4 Service Continuity and Mobility

7.3.5 Service Deletion

7.3.6 Interfaces to External Media Sources

7.3.7 Roaming

7.3.8 Security

7.3.9 Charging

7.4 Option D)

In order to allow the RNC to manage the UTRAN UE mobility for MBMS service as well as for non-MBMS services, a MBMS specific context shall exist in the RNC for each UE activating a MBMS service and the Iu Control Plane should not be shared between UEs: one RAB establishment procedure shall be done for each UE activating a multicast MBMS service. A dedicated Iu Control plane shall exist for each UE activating a MBMS multicast service. In order to save resources over Iu, an Iu user plane between a RNC and a SGSN can be shared between UEs for the transport of data for the UEs that have activated the same MBMS multicast service.

On the Gn interface, a separate control plane shall be used for each UE with an active MBMS connection. A shared user-plane may be applied to all UEs in the same SGSN

7.4.1 MBMS Multicast Service Activation

The activation procedure registers the user in the network to enable the reception of data from a specific MBMS multicast service. The activation is a signalling procedure between the UE and the network. The procedure is similar to the PDP context activation with the addition that user planes can be optimised to share resources between UEs that activate the same MBMS multicast service.

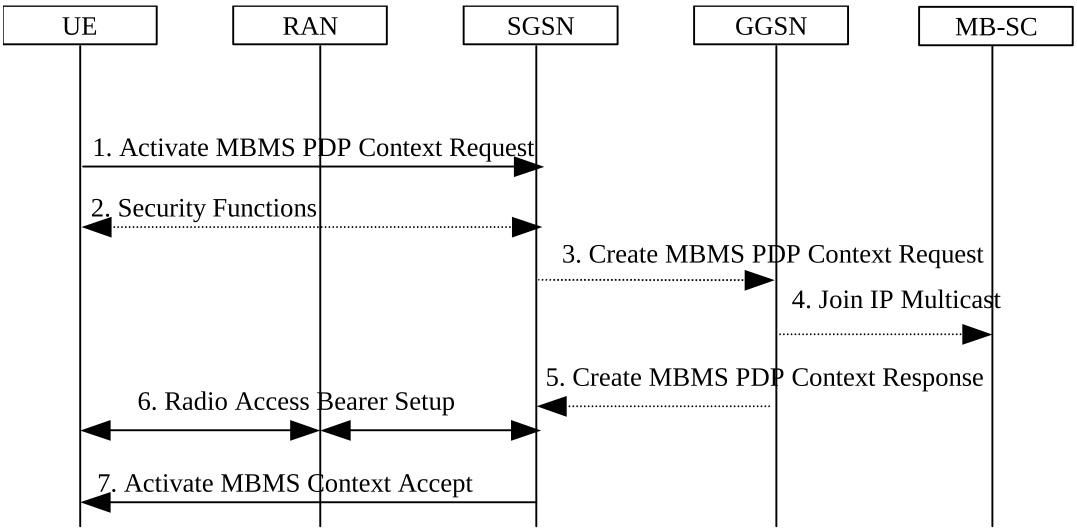

Figure 21. The activation of an MBMS multicast service

The activation of an MBMS multicast service

1 The UE sends an Activate MBMS PDP Context Request to the SGSN. The SGSN creates a UE specific MBMS context which stores the parameters of the activated MBMS multicast service.

2 Security Functions may be performed.

3 The SGSN sends a Create MBMS PDP Context Request message to the affected GGSN. If it is not the first UE activating this specific MBMS multicast service between this SGSN and the GGSN, the GTP user plane can be optimised and shared between all the UEs requesting the same MBMS multicast service.

4 If it is the first GTP tunnel for this specific MBMS multicast service on the GGSN the GGSN joins the IP multicast for the requested multicast IP address on the backbone to connect with the MBMS data source (BM-SC).

5 The GGSN confirms the establishment of the MBMS context if performed according to step 3).

6 The SGSN sends a RAB assignment request to the RAN in order to establish the Iu Control Plane and a UE specific MBMS context in the RAN. An optimisation of Iu user plane can be done to share Iu user plane for many UEs activating the same MBMS multicast service between a SGSN and a RNC.

7 The SGSN sends an Activate MBMS Context Accept to the UE.

7.4.2 MBMS Broadcast Service Activation

7.4.3 MBMS RAB set up

7.4.4 Service Deletion

7.4.5 Service Continuity and Mobility

7.4.6 Interfaces to External Media Sources

7.4.7 Roaming

7.4.8 Security

7.4.9 Charging

7.5 Option E)

7.5.1MBMS Multicast Service Activation

7.5.2 MBMS Broadcast Service Activation

7.5.3 MBMS RAB set up

7.5.4 Service Deletion

7.5.4.1 Network Initiated Termination Mechanism for MBMS

7.5.4.1.1 Broadcast mode

After multimedia service has been delivered, the network should initiate "delete MBMS PDP context" under broadcast mode. This is to enable all network and UE resources to be released, e.g. Multicast address, APN, TMGI, NSAPI/TI, etc. In order to avoid signalling congestion, the signalling flows between UE and network are staggered in time. Typically they would be sent in parallel with the next (periodic) routing area update.

7.5.4.1.2 Multicast mode

There are two cases for MBMS termination under multicast mode: i.e. UE Initiated and Network Initiated. For UE Initiated, the UE can send a deactivate MBMS PDP context message to leave the multicast service. For Network Initiated, care is needed to avoid signalling channel congestion. In order to avoid this, the signalling flows between UE and network are staggered in time. Typically they would be sent in parallel with the next (periodic) routing area update

7.5.4.1.3 Signalling flow for Network Initiated MBMS PDP context release

The MBMS PDP Context Deactivation Initiated by GGSN procedure is illustrated in Fig.1

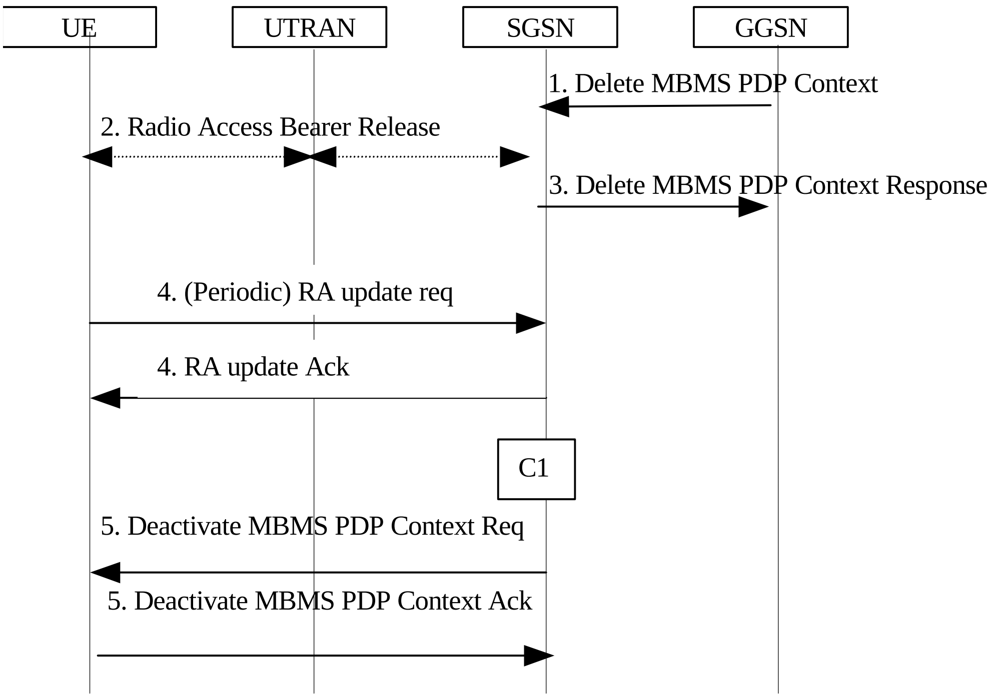

Figure 22. GGSN initiated MBMS PDP context deactivation procedure

1) The GGSN sends a Delete MBMS PDP Context Request (IP multicast address, APN, TEID, NSAPI) message to the SGSN.

2) In Iu mode, radio access bearer release is done by the RAB Assignment procedure.

3) The SGSN returns a Delete MBMS PDP Context Response (IP multicast address, APN, TEID) message to the GGSN. [The GGSN releases the IP multicast address and makes it available for next multicast service.] The SGSN maintains a list of mobiles that it needs to inform that the MBMS PDP Context has been deactivated.

4) A UE performs a (periodic) RA update. The SGSN checks whether the UE has any MBMS PDP contexts that need to be deactivated.

5) The SGSN sends a Deactivate MBMS PDP Context Request (IP multicast address, APN, TI) message to the UE. The UE acknowledges the Context release.

The CAMEL procedure call shall be performed, see referenced procedure in 3GPP TS 23.078: C1) CAMEL_GPRS_PDP_Context_Disconnection.

Note: the case of Network Initiated release after inter-SGSN RA update is FFS (however it is not believed to be difficult to solve).

7.5.5 Service Continuity and Mobility

7.5.6 Interfaces to External Media Sources

7.5.7 Roaming

7.5.8 Security

7.5.9 Charging

8 CHARGING

MBMS architecture should provide flexible charging mechanisms for broadcast and multicast modes. This includes support for on-line and off-line charging.

8.1 Charging for Broadcast mode

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

In addition to this information listed in the stage 1, data will be needed on the number of cells in the broadcast area.

Examples of the type of the charging information that may be collected at the BM-SC include:

- service time and duration
- volume of data
- MBMS broadcast area
- number of cells in broadcast area

The above list of possible charging mechanisms is neither complete nor exhaustive.

8.2 Charging for Multicast mode

It shall be possible to collect charging information (even when roaming) for the use of the multicast mode. Therefore, the following combinable charging mechanisms should be available for the multicast mode:

8.2.1 Content Provider Charging Mechanism

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

In addition to this information listed in the stage 1, data will be needed on the number of cells in the multicast area.

Further, information may be needed on the proportion of users to whom the content was satisfactorily delivered-FFS.

Examples of the type of the charging information that should be collected at the BM-SC include:

- service time and duration
- volume of data
- geographic area of multicast area
- number of cells in multicast area

proportion of users who satisfactorily received the multicast is FFS

The above list of possible charging mechanisms is neither complete nor exhaustive.

8.2.2 Subscriber Charging

8.2.2.1 On-line charging

The architecture should enable the on-line charging of multicast services. To enable this, CAMEL functionality on the SGSN might need to be extended. In addition the CSE may need to interact with the BM-SC to obtain, e.g., rating information. Other solutions to provide on-line charging are not precluded.

8.2.2.2 Off-line charging

The Multicast service should enable the user to be charged for the services that they receive. This charging might be either on the volume of data received and/or just on the fact that the user activated the multicast PDP context. SGSN charging data is also needed to handle cases where the SGSN is in a different network to the BM-SC. To achieve this, the SGSN should be able to generate charging information that include at least the following information:

- service time and duration
- volume of data

The above list of possible charging mechanisms is neither complete nor exhaustive.

9 Interaction with CS/PS services

10 Information Storage

Annex A

This section contains text for information

A.1 Decision process for selection of point-to-point or point-to-multipoint configuration

For GSM, one way to achieve this would be for the paging messages which carry the TMGI to also specify the value to be included by the mobile into any subsequent (Packet) Channel Request message. After receiving a page with their TMGI, each mobile sends one (Packet) Channel Request message with the value specified in the page message. The BSS then counts the number of (Packet) Channel Request messages containing the specified contents received in each cell. This method seems likely to give an accurate measure of either (a) how many mobiles belonging to that group are in the cell (if there are less than, say, 10 mobiles in the cell), or (b) whether there are more than, say, 10 mobiles belonging to that group in the cell.

For UMTS: the method is FFS

A.2 One Tunnel vs. Multiple Tunnels

When only one GTP tunnel exists between the GGSN and the SGSN, the SGSN must

- Be able to create multiple GTP tunnels between itself and the RNCs serving MBMS receivers.
- Be able to duplicate MBMS data packets to these tunnels (between the SGSN and the RNCs) coming from the GGSN.

The other alternative of having only one GTP tunnel between the GGSN and the SGSN is to have multiple tunnels between these elements, i.e. one GTP tunnel for each RNC serving the MBMS receivers. These approaches are illustrated in Figure 23.

By having multiple tunnels, several benefits can be gained:

- There is no need to make changes to the current packet relaying in the SGSN. The SGSN does not have to duplicate packets from a Gn/Gp GTP tunnel to multiple Iu GTP tunnels.
- QoS handling does not require changes to the SGSN. With this approach RNCs may be able to provide different QoS, even though these RNCs would reside below the same SGSN. In the "one GTP tunnel between the GGSN and the SGSN" approach new logic is required in the SGSN to determine the QoS for the Gn/Gp tunnel.
- RAB release and Iu release do not require changes to the SGSN. Again, in the "one GTP tunnel between the GGSN and the SGSN" approach new logic is required in the SGSN to carry out these procedures.
- According to TS 22.146 (Chapters 5.1.1 and 5.2.1) and TR 23.846 (Chapter 6.1.2), it should be possible to send different data to different service areas for the same service (e.g. regional news). When multiple tunnels are used, different data can be flexibly sent to different RNCs (serving different service areas).

Thus, the approach of having multiple tunnels reuses the existing mechanisms and minimizes the changes to the existing infrastructure (architecture principle 4. in TR 23.846), but the expense is that the same data is delivered between the GGSN and the SGSN multiple times. When compared to the approach of having one tunnel, the situation is the opposite: in the solution utilizing one Gn/Gp tunnel new complicated logic is required, but the data is delivered only once between the GGSN and the SGSN.

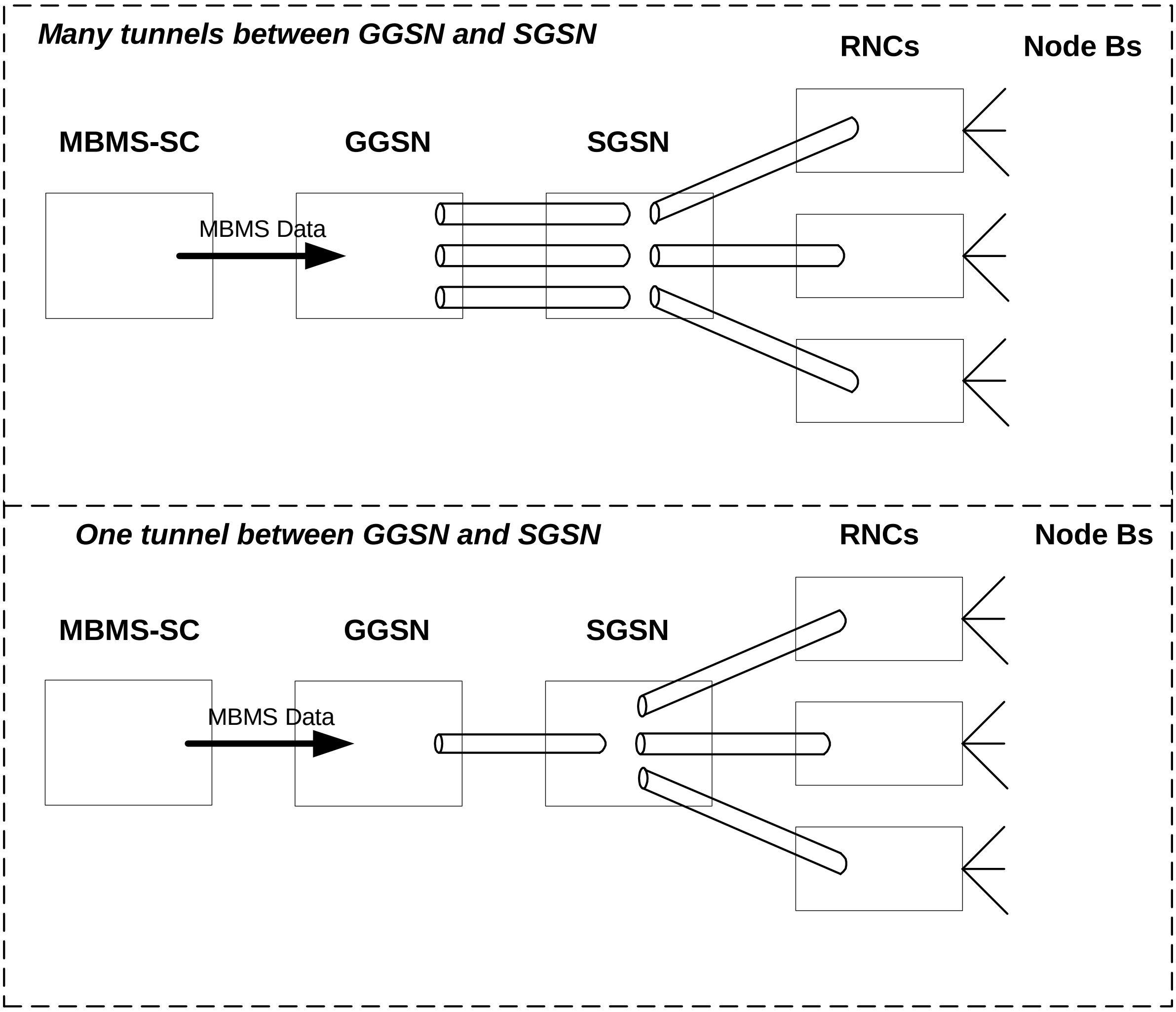

Figure 23. Many tunnels between GGSN and SGSN vs. One tunnel between GGSN and SGSN.

Annex B: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
22/01/02				0.1.0	Output version from TSG SA2#22		
15/03/02				0.2.0	Output version from TSG SA2#23 taking into account S2-020410, S2-020412, S2-020583Rev1, S2-020584, S2-020598Rev1, S2-020769Rev1, S2-020771, S2-020772, S2-020773, S2-020774,S2-020775, S2-020800rev2, S2-020801		
02/04/02				0.3.0	Corrections to V 0.2.0 after email comments on reflector including addition of S2-020525		
25/04/02				0.4.0	Output version from TSG SA2#24 taking into account S2-021262, S2-021245, S2-021259, S2-021263, S2-021138, S2-021257, S2-021163, S2-021218, S2-021261, S2-021029, S2-021137, S2-021404 +General restructuring to allow for architecture options. Common template		
20/05/02				0.5.0	Output version from TSG SA2#24 after email approval taking into account S2-021345rev.1, 1346rev.1, 1349, 1361rev.1, 1362, 1363rev.1, 1364rev.1, 1365, S2-021400rev.1, 1401rev.1, 1402rev.3, 1403rev.1, 1405rev.1, 1406rev.1, 1407rev.2.		
23/05/02				0.5.1	Editorials Corrections V.0.5.0		
09/06/02				1.0.0	v.1.0.0 for presentation to SA#16. Same content as v.0.5.1		