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Technical Report

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Contents

Foreword

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1 Scope

The present document captures the results of the study and evaluation of possible solutions for architectural enhancements to support Group Communication System Enablers for LTE (GCSE_LTE). The Stage 1 requirements for GCSE_LTE are defined in 3GPP TS 22.468 [3].

Specifically, GCSE_LTE covers the following aspects:

- Group Communication (GC) among entitled group members via E-UTRAN;
- Group Communication (GC) among entitled group members using E-UTRAN and members of the same group using ProSe communication paths via a ProSe UE-to-Network Relay;
- The relationship between ProSe and GCSE for GCs.

The functional descriptions of "ProSe communication paths via ProSe UE-to-Network Relay" and "ProSe GCs" have been defined in 3GPP TR 23.703 [4].

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: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 41.101: "Technical Specifications and Technical Reports for a GERAN-based 3GPP system".

[3] 3GPP TS 22.468: "Group Communication System Enablers for LTE (GCSE_LTE)".

[4] 3GPP TS 23.703: "Study on architecture enhancements to support Proximity Services (ProSe)".

[5] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[6] Open Mobile Alliance: "OMA PoC System Description" v2.1.

[7] IETF RFC 4582 (November 2006): "The Binary Floor Control Protocol (BFCP)".

[8] 3GPP TS 23.246: "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description".

[9] 3GPP TS 24.147: "Conferencing using the IP Multimedia (IM) Core Network (CN) subsystem; Stage 3".

[10] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[11] 3GPP TS 26.346: "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

GCSE Group: A set of members that are entitled to participate in a GC service.

Multipoint Service: A service, which is offered to the GCSE AS and used to distribute the same Group Communication data to the UEs of a GCSE Group in a resource efficient way.

Multicast Delivery: A delivery mode where the Group Communication data is delivered via shared network resources to multiple group members.

NOTE: RAN might study a "Multicast Delivery" consisting of PtP or PtM radio bearers.

Unicast Delivery: A delivery mode where the Group Communication data is delivered to a particular group member via resources dedicated to a group member.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

BM-SC	Broadcast Multicast - Service Centre
DL	Down Link
EMBMS	Evolved Packet System MBMS
GC	Group Communication
GCSE_LTE	Group Communication Service Enabler over LTE
GCSE AS	Group Communication Service Enabler Application Server
MBMS	Multimedia Broadcast/Multicast Service
MBSFN	MBMS over a Single Frequency Network
MOCN	Multi-Operator Core Network
MuSe	Multipoint Service
MTCH	Multicast Traffic Channel
ProSe	Proximity Services
PCRF	Policy and Charging Rules Function
PtP	Point to Point
PtM	Point to Multipoint
TMGI	Temporary Mobile Group Identity

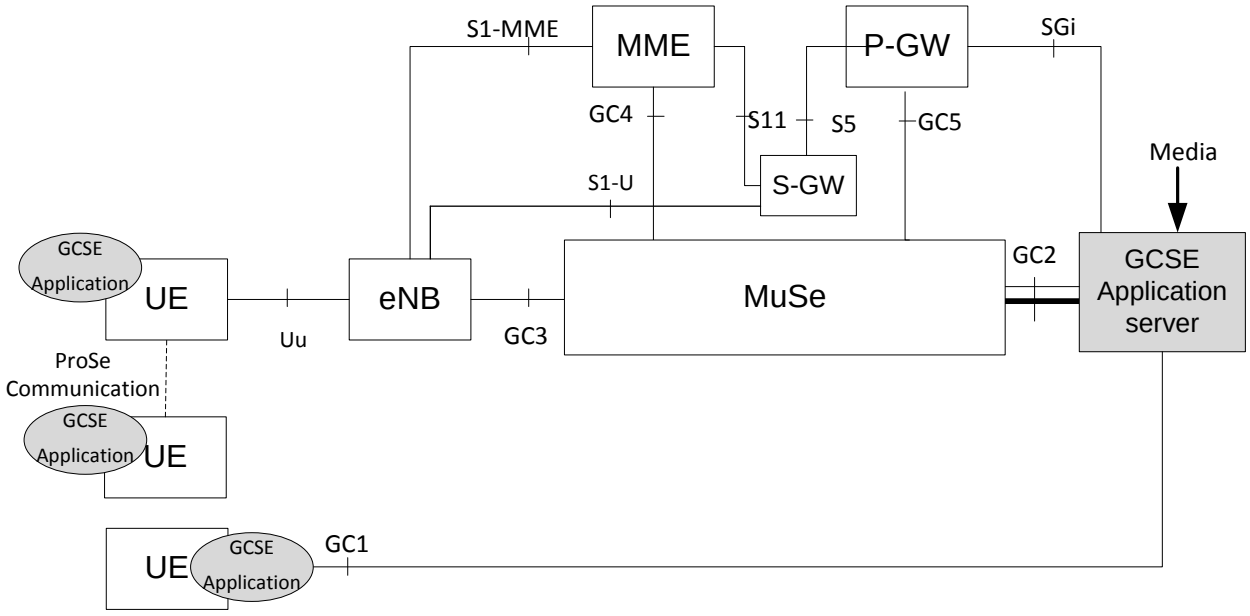
4 Assumptions and architectural requirements

4.1 General

Editor's Note: Placeholder for any general aspect of this study.

4.2 High-level reference diagram

Figure 4.2-1 shows the high level view of the GCSE architecture.



NOTE 1: It is for FFS on whether the unicast service is provided via GC5 or SGi.
NOTE 2: It is FFS on how this architecture will be further decomposed (based on solution proposal).
NOTE 3: Multiple PLMNs (i.e., members for the same group are served by different PLMNs concurrently) and roaming architecture is FFS.

Figure 4.2-1: Overall of high level architecture view for GCSE_LTE

This high-level architecture diagram consists of Application layer and 3GPP EPS layer. The Application layer consists of GCSE AS. The 3GPP EPS layer consists of a MuSe function. The MuSe function interworks with the 3GPP EPS entities (defined by 3GPP TS 23.401 [5]) to provide the Multipoint Service (MuSe) functionality.

4.3 Reference points

GC1: It is the reference point between the GCSE application in the UE and in the application server. It is used to define application level signalling requirement to enable Multipoint functionality for GCSE_LTE, and possibly for session establishment and floor control usages, etc.

GC2: It is the reference point between the GCSE AS and the MuSe function. It is used to define the interaction between GCSE AS and MuSe functionality provided by the 3GPP EPS layer.

GC3: It is the reference point between the E-UTRAN and MuSe function. It is used to define the interaction between E-UTRAN and MuSe function in order to achieve Multipoint functionality provided by the 3GPP EPS layer.

GC4: It is the reference point between the MME and MuSe function It is used to define the interaction between MME and MuSe function in order to achieve Multipoint functionality provided by the 3GPP EPS layer.

GC5: It is the reference point between the P-GW and MuSe function. It is used to provide DL unicast service by MuSe..

Editor's Note: The use of the above new reference points for normative work will need to be justified..

4.4 Assumptions

Editor's Note: This clause will define the underlying assumptions of this study.

4.5 Architectural requirements

Editor's Note: This clause will define the architectural requirements for this study.

The architecture shall allow as an option for the GCSE AS to determine whether to deliver the group call data using Unicast delivery or Multicast delivery or both.

5 Key Issues

Editor's Note: For each key issue identified, the clause will capture the "General description and assumptions" (sub-clause 1). Different architecture solutions to address the key issues will be documented in clause 6.

5.1 Key Issue #1: Decision point for using PtP and/or PtM

5.1.1 General description

Should the decision to use PtP and/or PtM distribution be done at the application layer or within the 3GPP EPS layer? Proposed solutions should explain why the proposed method should be used and how this may be achieved.

5.1.2 Group Privacy considerations for PtP/PtM decision

The use of PtM by a cell is communicated in broadcast information and typically most cells might not use PtM.

Editor's Note: It is FFS whether Groups are treated independently or whether several Groups share a single PtM identifier at the RAN or EPS level.

Hence the activation (or modification) of PtM resources in a cell may serve as a warning to criminals of the nearby presence of public safety personnel.

Some entity in the network needs to take account of the Group's privacy settings before deciding to use PtM, e.g.

- Whether to NEVER establish PtM for that group;
- Whether to perform a "fast" PtM activation over a single DRX period thereby risking some mobiles not discovering the broadcast but minimising the time that PtM can be detected;
- Whether there are no restrictions on PtM for that group.

Privacy considerations such as these should be taken into account when making the decision on 'application layer' vs. '3GPP EPS' control of PtM/PtP bearer usage.

5.2 Key Issue #2: GCSE_LTE interaction with ProSe UE-to-Network Relays

5.2.1 General description

A public safety ProSe-enabled UE not served by E-UTRAN can take part in a GC of one or more GCSE Groups for which it is authorised via a ProSe UE-to-Network Relay.

The details of the Prose UE-to-Network Relay procedures and interaction with the network at the "transport layer" will be studied in Proximity Services Study Report 3GPP TR 23.703 [4].

Aspects specific to the interaction between GCSE_LTE and the ProSe UE-to-Network Relay need to be considered in potential solutions.

5.3 Key Issue #3: Group Communication with geographical scope

5.3.1 General description

Based on the requirements defined in 3GPP TS 22.468 [3] on "Geographical scope of GCSE Groups", the group members may be restricted to receive and/or transmit only within those cells corresponding to the area defined by the geographical scope of the GCSE group. This geographical scope of the GCSE group is typically agreed between customer and GCSE application service provider as part of the subscription for the GCSE Group.

When requested, a notification shall be sent to a requesting entity when the group member ceases to participate in the communications from the GCSE Group, i.e. in case of a group with restricted geographic scope when the group member leaves the Group's Service Area.

NOTE 1: This notification requirement is not just related to geographical scope.

Proposed solutions should explain how GCSE is accomplished for groups with a geographic scope as per 3GPP TS 22.468 [3] and how any required notifications are provided when a group member ceases to participate in the communications from its GCSE group due to leaving the Group's Service Area.

Per instance of group communication the geographic area in which the group communication is delivered can be further restricted within the geographic scope of the GCSE group.

Some scenarios may require overriding the geographic scope of the GCSE group. An operator may want to charge for this.

NOTE 2: The geographic area concept is independent of whether the Group Communication data is delivered over unicast or multicast.

Editor's note: It's FFS where this functionality is most optimally implemented (e.g. in MuSe or at application level).

5.4 Key Issue #4: MuSe with additional media handling

5.4.1 General description

In GCSE, a Group Communication may consist of different media (e.g,. voice+video or voice only, IP packet for data communications, etc). A Transmitter Group Member may choose to send IP packet for data communication or particular media type (e.g. voice) initially and later adds data/media component(s) (e.g. video) to this group session based on the situation and then removes the additional data/media when it is no longer needed.

Receiver group members may choose to receive only the data/media type that are in its interest to receive (e.g. only voice media and not video).

Proposed solutions should explain how the addition and removal of additional data/media component(s) (e.g. video) is performed within the current Group Communication session and how the Receiver group members can decide which type of data/media to receive if only certain media/data is wanted.

5.5 Key Issue #5: Service continuity

5.5.1 General description

It is assumed that continuity of service will be provided when a UE moves between cells in the same PLMN providing a GC via Multipoint Service (MuSe) exists in both cells.

The SA2 study phase needs to consider at least:

- will the 3GPP EPS provide service continuity for a GCSE Group Communication between delivery over a unicast EPS bearer and delivery over a Multipoint Service (MuSe) ?
  - If so, what EPS procedures will be required?
  - If not, what interface support, in order to minimize service disruption, will the EPS provide to 3rd party applications to manage the switch to/from unicast EPS bearers and a Multipoint Service (MuSe) ?
- what EPS procedures will be required to provide service continuity when UE numbers in a cell / MuSe service area rise and fall across the threshold indicating that multicast/broadcast delivery should or should not be provided?
- what are the interfaces between the RAN and EPC? In collaboration with RAN WGs, determine the split of responsibilities between RAN and CN for service continuity.

5.6 Key Issue #6: Roaming support

5.6.1 General description

The SA2 study phase needs to consider at least:

- what EPS procedures will be required so that GCSE_LTE Group Communication support may be provided by the HPLMN when the UE is roaming (attached to a VPLMN)?

5.7 Key Issue #7: Interworking

5.7.1 General description

The SA2 study phase needs to consider at least:

- what EPS procedures, entities and interfaces will be required to provide GCSE-based GC interworking between UEs which are connected to a common RAN but are attached to different PLMNs (support for MOCN with all UEs attached to their HPLMN). More than one PLMN may provide access to a GCSE Application Server. The GCSE Application Server(s) may be within the operator domain or outside the operator domain,
- the architecture, including interfaces and location of any interworking function (i.e. inside or outside the EPS), that would enable interworking between:
  - UEs which are connected to different EPS networks where each network provides GCSE-based GC services,
  - UEs connected to a 3GPP network offering GCSE-based GC and terminals connected to a non-3GPP network which also offers group communication services for Public Safety (e.g. legacy systems such as TETRA and P25).

In each of the above cases it is assumed that suitable interworking agreements are in place between the different operators.

5.8 Key Issue #8: Priority and Pre-emption on Group Communication

5.8.1 General description

One Group Communication may include different transport paths, i.e. unicast/ multicast delivery. For one Group Communication the priority and pre-emption capability for a particular media within a PLMN should be same no matter which transport path is selected.

One Group Communication can include different media, e.g. voice and picture. For one GCSE group different user may have different priority. During the exceptional situation of resource limitations, the system may decide to release resources allocated for Group Communications based on the priority level and pre-emption capability of the different communication groups.

The SA2 study phase needs to consider at least：

- In the 3GPP network, how to assign the priority level and pre-emption capability to the traffic of the Group Communication?

6 Solutions

Editor's Note: This clause is intended to document architecture solutions. Each solution should clearly describe which of the key issues it covers and how.

6.1 Solution 1 - Group Communications using pre-established eMBMS bearers

6.1.1 Functional description

6.1.1.1 Solution description

These are the salient features of the solution:

1. Solution leverages eMBMS on downlink for GCs.

2. The solution uses pre-established eMBMS bearers for fast GC setup.
   It implies the followings:

   - TMGI(s) associated with the group call is pre-assigned by the BM-SC and the MBMS bearers for this group call (one MBMS bearer per QoS class) are pre-established in advance.

   - The network establishes MBMS session in preconfigured MBSFN areas.

NOTE: Different groups can have different preconfigured MBSFN areas.

Editor's Note: The size of MBSFN area is FFS.

Editor's Note: Whether UE's can receive in more than one MBSFN area simulataneosly is FFS by RAN.

   - The network sends the corresponding TMGI(s) and session information over MCCH.

   - If there is no group call data, E-UTRAN does not schedule the corresponding TMGI(s) in MCH Scheduling Information (MSI). In this case, if not all MBMS subframes allocated in MCCH are needed for transmission of existing MBMS services, the left over MBMS subframes can be used for unicast.

Editor's Note: Above needs confirmation from RAN.

   - The UE acquires MCCH configuration information periodically as if it is receiving the MBMS service. The UE also monitors MCH scheduling information (MSI) periodically to detect if the TMGI associated with MTCH has been scheduled.

3. Unicast bearers are used for uplink communication. In certain cases (e.g. eMBMS is not supported) unicast is also used for DL.

4. The solution uses PCRF as interface between GCSE As and BM-SC for exchange of eMBMS related control information.

Editor's Note; The use of PCRF for exchanging eMBMS control information is FFS.

6.1.1.2 Architecture reference model

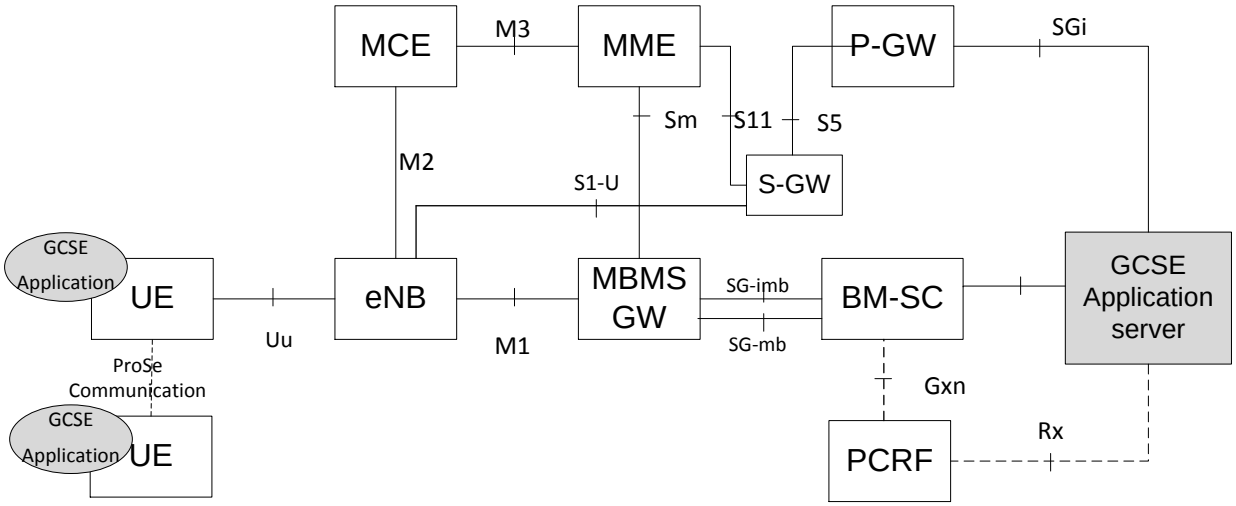
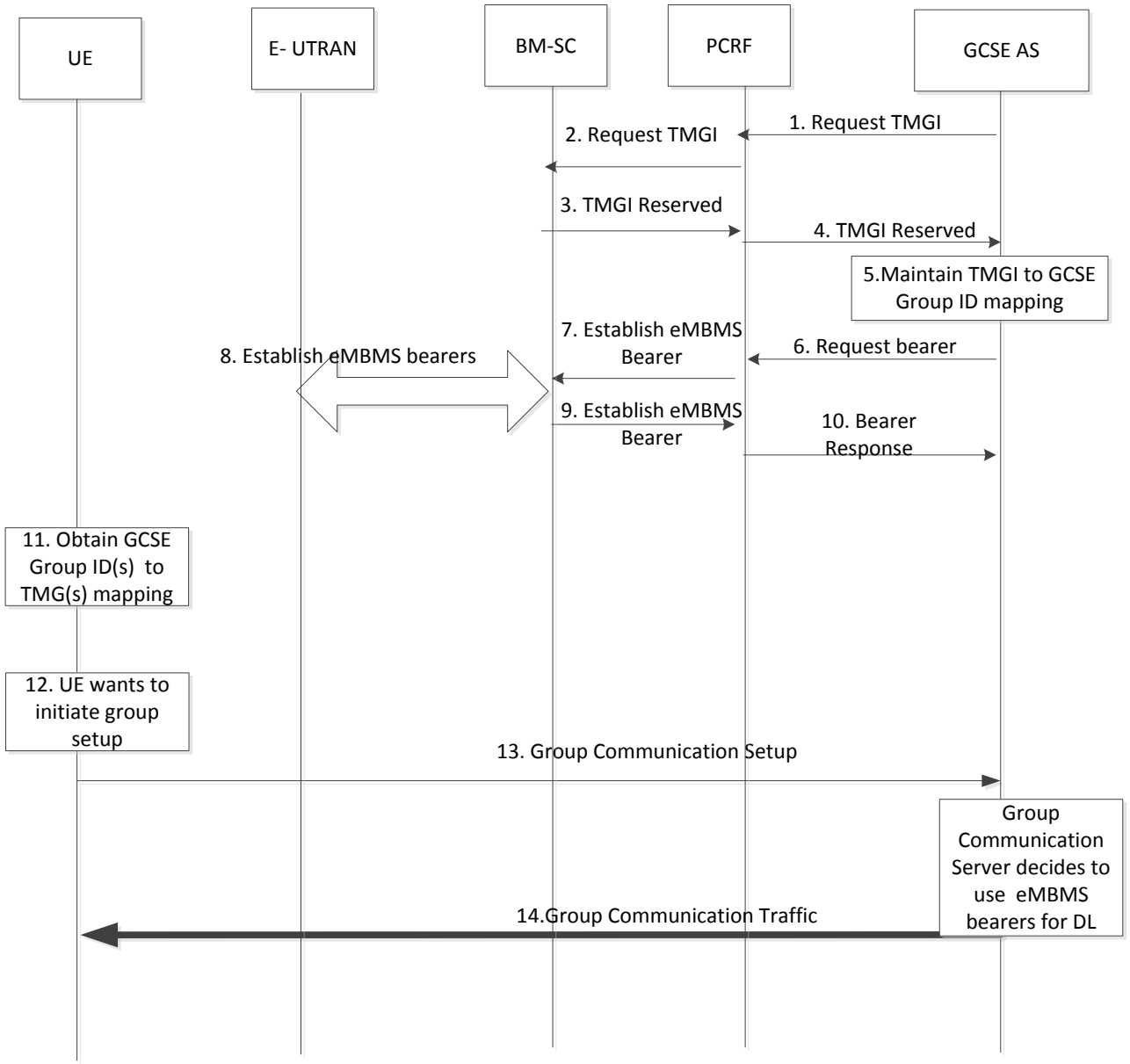


Figure 6.1.1.2-1: Architecture for 3GPP GCSE service

6.1.2 Procedures

6.1.2.1 Group Communication Setup using pre-established eMBMS bearers

The interaction between the UE and GCSE AS is shown as an example.



1-4. GC Server requests the TMGI(s) for the GCSE group(s) from the BM-SC through the PCRF.

5. GC Server maintains a mapping of the TMGI to the GCSE Group ID.

6-10. Pre-established bearers are set up for the group(s). The corresponding MBSFN area is based on the eNBs that were pre-selected for this GCSE GC as provided to the BM-SC. Triggered by step 8, the E-UTRAN sends MBMS related system information and MCCH configuration information over the air. The UE periodically monitors MCH scheduling information (MSI) to detect if the TMGI associated with MTCH has been scheduled.

11. The GCSE Application on UE registers with GCSE Application Server.
The register message may include all the group identifiers the UE is in interested.

12. The TMGI(s) of the GCSE group(s), if available, are returned to the UE.
The UE maintains a mapping of the TMGI to the GCSE group identifier.

13. The UE monitors the network to determine the availability of the eMBMS transmission corresponding to the TMGI(s) of the interested GCSE group(s). The UE initiates a Group Communication set up for a particular GCSE group using Unicast UL bearers. The UE also indicates the availability of the eMBMS transmission corresponding to the TMGI of the GCSE group in the group setup signaling.

14. The GCSE AS decides whether to use the pre-established eMBMS bearers for downlink.
When the E-UTRAN detects the data is coming from the network, the E-UTRAN modifies the MSI to indicate the schedule to the UE. The UE receives the MSI and tunes to the MTCH.

6.1.2.2 Service continuity during unicast and MBMS switching

6.1.2.2.1 General

The clause provides flows for switching from MBMS to unicast and vice-versa.

6.1.2.2.2 Switching from MBMS to unicast - make-before-break

Figure 6.1.2.2.2-1 shows the procedures for service continuity when the UE is about to move from a cell (eNB1) transmitting (e)MBMS bearer service to a cell (eNB2) which does not transmit the same (e)MBMS service, i.e. when the UE is about to move out of MBSFN area.

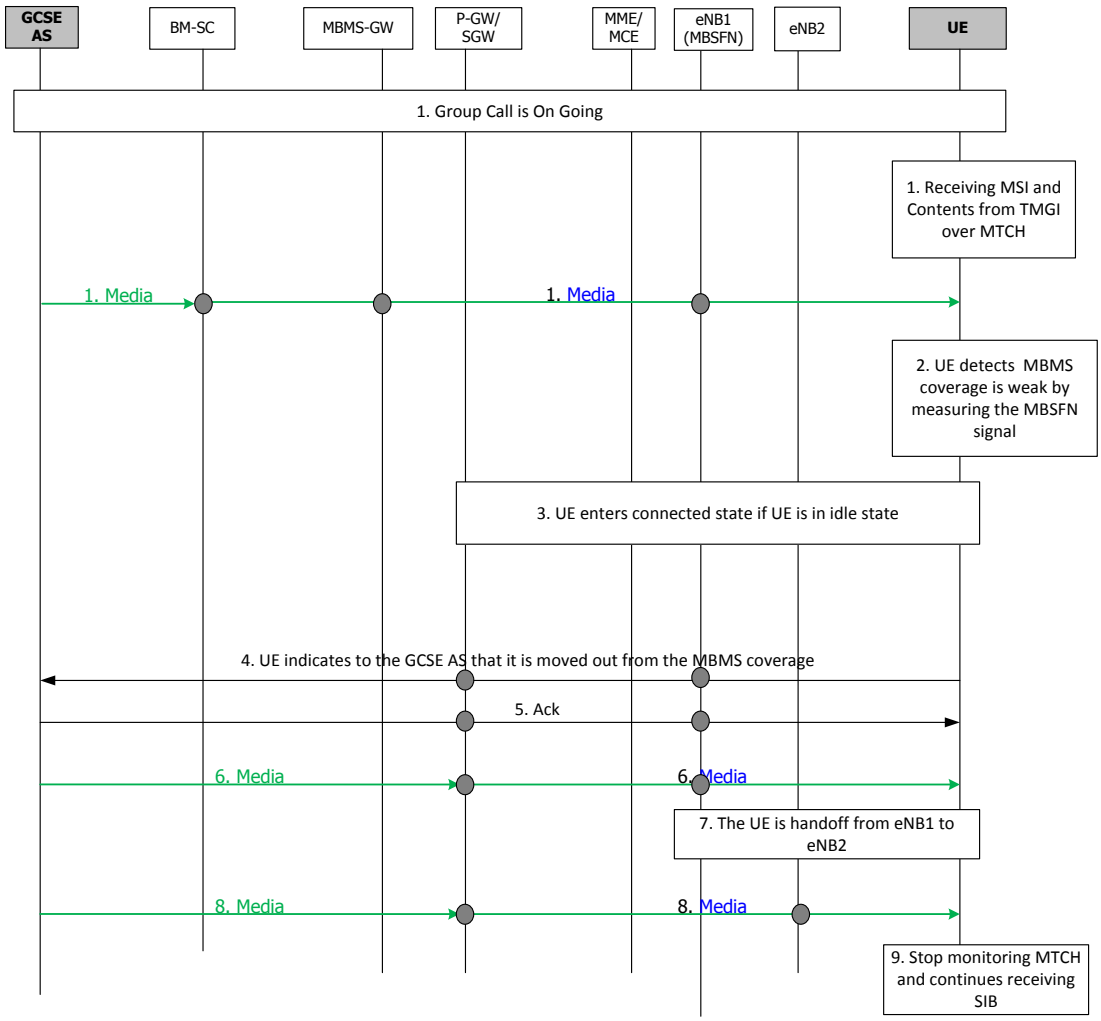


Figure 6.1.2.2.2-1: Service continuity when moving out from eMBMS coverage (Make-Before-Break)

The following steps are performed:

- In Step 1 the group call is on going. The UE receives the GC service data/media from the content provider (GCSE-AS) via an eMBMS bearer service.
- In Step 2, for make-before-break switching procedures, the UE detects that it is about to move out from the eMBMS coverage through the following implementation-specific methods (but not limited to):
  - The UE detects that MBSFN signal strength becomes weak;

- The UE detects that packet data loss rate is increased.

Editor's note: It is FFS whether UE can reliably detect that it is moving out of MBSFN coverage by measuring MBSFN signal strength or packet error rate.

- In Step 3, If the UE is in idle state, the UE enters connected state by performs RRC connection procedures with eNB1.
- In Step 4, the UE indicates the GCSE-AS that it is moved out from the eMBMS coverage through application signalling.
- In Step 5, the GSCE-AS sends ack to the UE through application signalling.
- In Step 6, the UE receives the GC service data/media from the content provider (GCSE-AS) via the unicast bearer through eNB1.
- In Step 8, the UE is handoff from eNB1 to eNB2.
- In Step 9, the UE receives the GC service data/media from the content provider (GCSE-AS) via the unicast bearer through eNB2.
- In Step 10, the UE stops receiving current MTCH and continues receiving SIBs.

6.1.2.2.3 Switching from MBMS to unicast - Non make-before-break

Figure 6.1.2.2.3-1 shows the procedures for service continuity when the UE moves from a cell (eNB1) transmitting (e)MBMS bearer service to a cell (eNB2) which does not transmit the same (e)MBMS service, i.e. when the UE moves out of MBSFN area.

Editor's Note: It is FFS if the non make-before-break can satify the service continuity requirements.

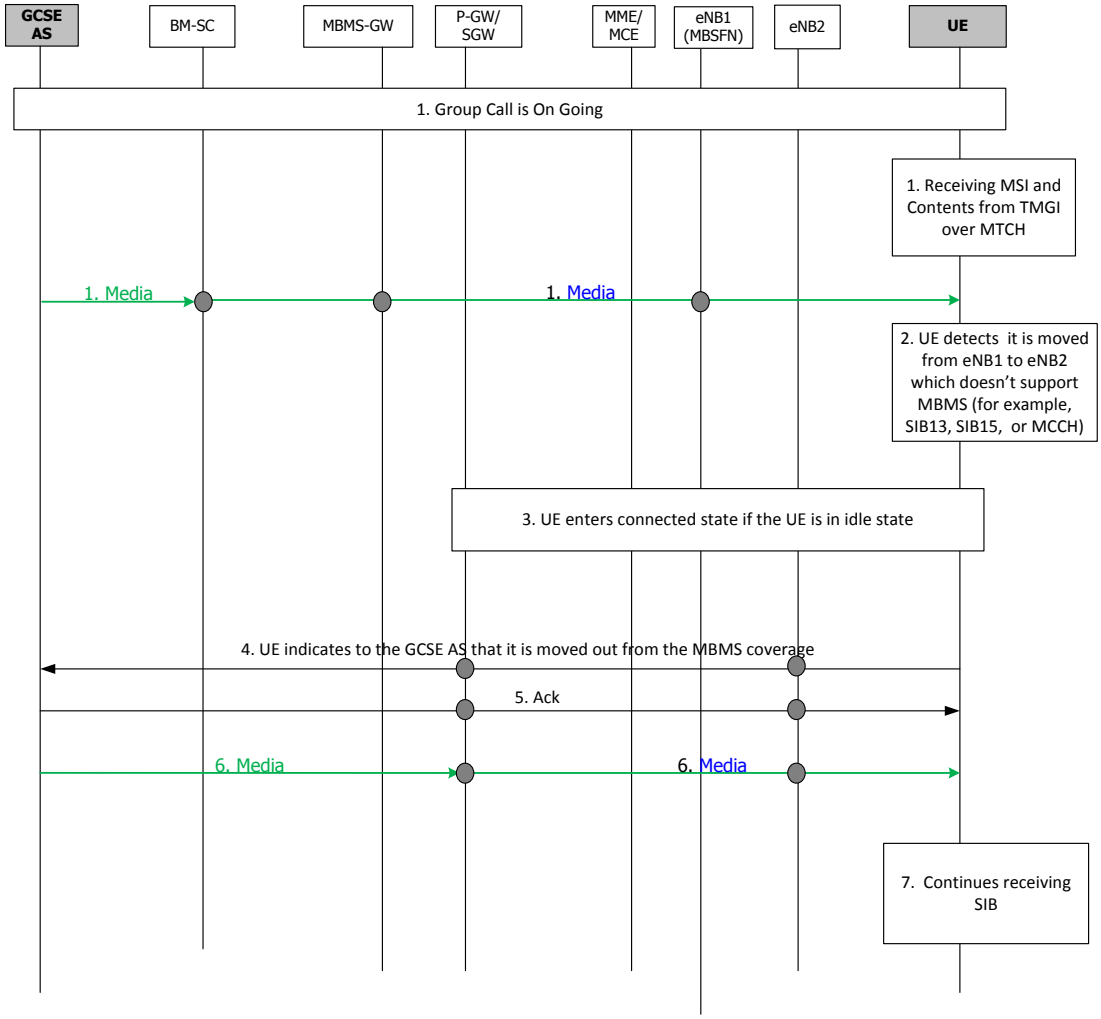


Figure 6.1.2.2.3-1: Service continuity when moving out from eMBMS coverage (non make-before-break)

The following steps are performed:

- In Step 1 the group call is on going. The UE receives the GC service data/media from the content provider (GCSE-AS) via an eMBMS bearer service.
- In Step 2, the UE detects that it is already moved from eNB1 to eNB2 which doesn't support GC service data/media over the MBMS session by monitoring SIB (SIB2/SIB13/SIB15 etc.) messages or MCCH.
- In Step 3, the UE enters Connected State if the UE is in Idle State.
- In Step 4, the UE indicates the GCSE-AS that it is moved out from the eMBMS coverage through application signalling.
- In Step 5, the GSCE-AS sends ack to the UE through application signalling.

- In Step 6, the UE receives the GC service data/media from the content provider (GCSE-AS) via an EPC unicast bearer through eNB2.
- In Step 7, the UE continues receiving the SIB messages.

6.1.2.2.4 Switching from unicast to MBMS

Figure 6.1.2.2.4-1 shows the procedures for service continuity when the UE moves into MBMS coverage.

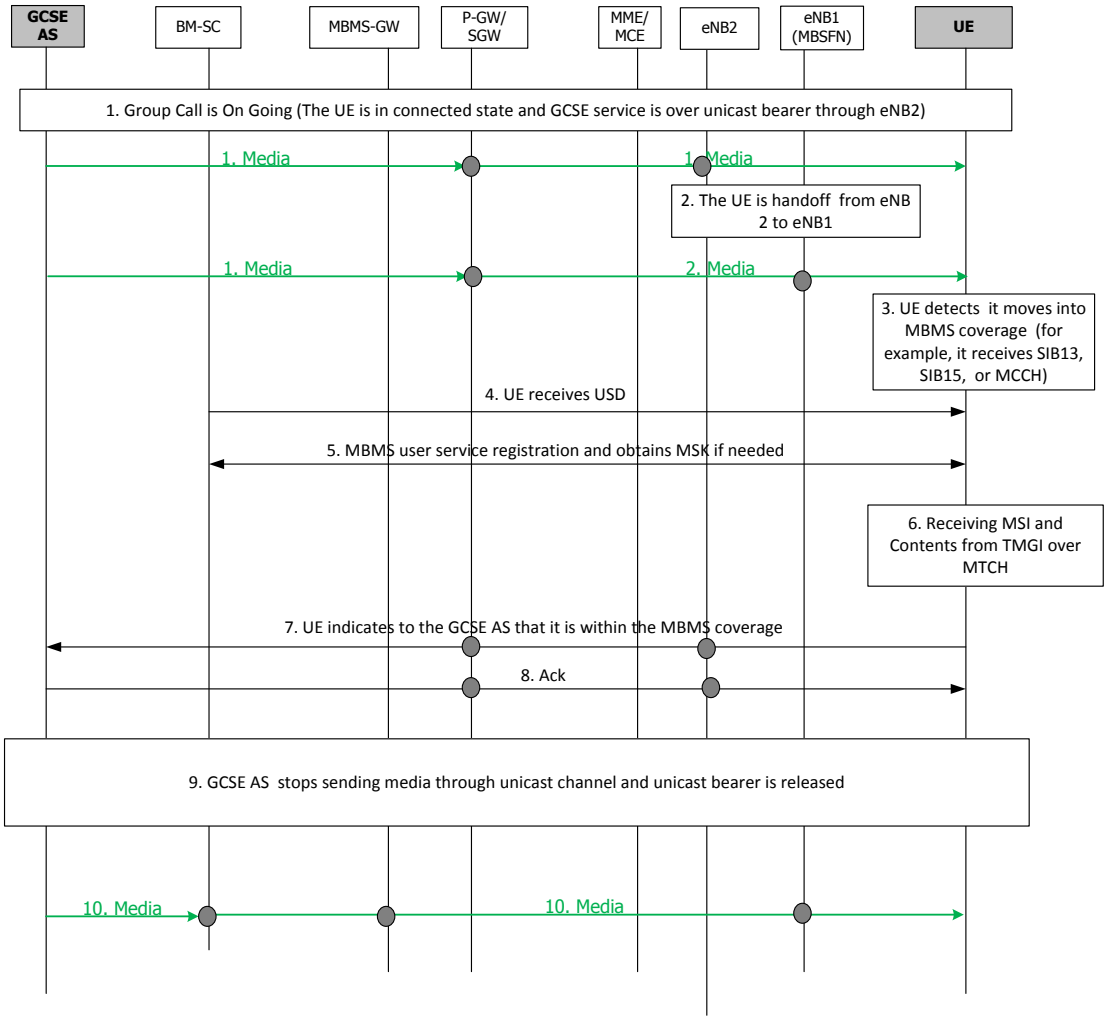


Figure 6.1.2.2.4-1: Service continuity when moving into eMBMS coverage

The following steps are performed:

- In Step 1 the group call is on going. The UE is in connected state and receives the GC service data/media via an unicast bearer through eNB2 which doesn't support MBMS.
- In Step 2, the UE is handoff from eNB2 to eNB1 which supports MBMS and the UE continues to receive the GC service data/media via theunicast bearer through eNB1.
- In Step 3, the UE detects that it is moving into the eMBMS coverage by monitoring SIB (SIB2/SIB13/SIB15 etc.) messages or MCCH.
- In Step 4, the UE performs service discovery procedures if needed. The UE receives USD from eMBMS channel or from unicast channel.
- In Step 5, the UE performs MBMS service registration procedures and receive MBMS service key if needed.
- In Step 6, the UE receives the GC service data/media from the content provider (GCSE-AS) via an eMBMS bearer service.
- In Step 7, the UE indicates the GCSE-AS that it is moved into the eMBMS coverage through application signalling.

- In Step 8, the GSCE-AS sends an ack to the UE through application signalling.
- In Steps 9, the GCSE- AS stops sending the GC service data/media via an EPC unicast bearer. The unicast bearer can be released.
- In Step 10, the UE continues to receive the GC service data/media from the content provider (GCSE-AS) via an eMBMS bearer service.

6.1.3 Impact on existing entities and interfaces

Editor's Note: Impacts on existing nodes or functionality will be added.

6.1.4 Solution evaluation

Editor's Note: The fulfilment of requirements in clause 4.2 needs will be evaluated.

6.2 Solution 2 - Permanently RRC connected

6.2.1 Functional description

This solution builds on the eMBMS service description provided in Solution 1.

a) At the start of the Public Safety User's shift, the user "clocks on" and IMS-style signalling is used to register the user/device, AND to inform the device of TMGI(s) and decryption keys that may be used if eMBMS is encountered.

NOTE: the term "IMS-style signalling" indicates, for example, the use of SIP messages, and/or, IMS authentication and/or the use of QCI 5 as a bearer for SIP signalling, etc.

b) The MME [and SGSN] to instruct the RAN to keep this UE in RRC connected state. Either the subscription record from the HLR, a dedicated APN for GC, or an indication from the GCSE AS (e.g. via Rx/Gx/S5-S8/S11 messages), can give instruction to the MME so as to inform the RAN to keep the UE in RRC connected state.

c) RFSP/SPID functionality is used to group Emergency Service Users on the same frequency/RAT.

d) The PDN GW activates ULI report procedure with Cell based granularity. This activation may be based on the APN, or, could be controlled across interface(s) between the PDN GW and the GCSE AS via Rx/Gx. The latter option may permit relaxed location reporting (e.g. TA based) to be used for devices that are in a TA-list/PLMN that is excluded from the Group Call area.

e) With each User Location report, the 'GCSE AS' increments and decrements counters on how many users are in each group in each cell.

f) dependent upon the number of users in a cell (and the cell's RAT), the 'GCSE AS' decides whether to distribute future media/data in that cell via:

- the existing established point to point bearer, and/or,
- an eMBMS broadcast bearer (at this point step 6 in solution 1 occurs)

It is anticipated to be normal that the Group spans many cells and when media is sent out to that Group some cells use point to point bearers; some cells use an eMBMS bearer; and, at least in transient mobility cases, some cells will have both point to point bearers and an eMBMS bearer.

Activation of an eMBMS bearer needs to occur about 10 seconds before it can be used to reliably distribute media.

Editor's Note: it is believed that Rel-10 changes enable Rel-10 and newer UEs to be scheduled to receive point to point data on LTE subframes that are indicated (e.g. in SIB messages) as being for MBMS data. If this is the case (RAN WG input needed) then, if the network has a significant percentage of Rel-10 mobiles, it may be interesting to configure MBMS sub frames (with each eNodeB in its own MBSFN area) in all cells of the "coverage layer" used for Public Safety users. This would decrease the time taken to 'activate' the use of MBMS and might well simplify operational procedures. Guidance from RAN WGs on this topic would be useful.

g) even when eMBMS is in use, the UEs can use uni-cast uplink transmissions to the GCSE AS to ack/nack the downlink transmissions. If the eMBMS link quality is insufficient for a specific UE, then the GCSE AS may use the point to point downlink bearer to send the media to that UE.

As an additional complementary component to the above procedure, if the service used within that group has a fast response time requirement (e.g. 300ms), then (at step b), the subscription record from the HLR informs the MME [and SGSN] to instruct the RAN to keep this UE in RRC connected state with "a short connected mode DRX".

6.2.2 Procedures

Editor's Note: Describes the high-level operation, procedures and information flows for the solution.

6.2.3 Impact on existing entities and interfaces

Editor's Note: Impacts on existing nodes or functionality will be added.

6.2.4 Solution evaluation

Editor's Note: The fulfilment of requirements in clause 4.2 needs will be evaluated.

6.3 Solution 3 - Group Communications with MuSe (eNB centric)

6.3.0 Overview

For Multicast Delivery, this solution reuses the eMBMS architecture as defined in 3GPP TS 23.246 [8] for media distribution in the core network level toward the associated eNB(s). At the eNB level, this solution expects that the eNB to make a decision to determine whether the radio delivery mechanism toward a particular UE should be using PtP or PtM transmission and the type of radio transmission being used by eNB is transparent toward the core network.

For Unicast Delivery, this solution does not alter the current EPS procedure as defined in TS 23.401 [xx] for handing GBR/non-GBR.

In high level, the following steps describe how this Multicast Delivery works in the system level.

1. For a particular GC session, eNB receives the media/TMGI from MBMS-GW. eNB broadcasts the TMGI over the air. Media is not transmitted over the radio.
2. UE detects this TMGI from the serving eNB and indicates to eNB (become RRC Connected if not already) that it wants to join to the Mulitcast Delivery session pointed by this TMGI.
3. eNB then maintains a group-call context (e.g., remember UE-TMGI relationship).
4. eNB starts sending the media over the radio and indicate to UE the corresponding radio related parameter so the UE can start listening in to the DL media using Multicast Delivery.
5. For mobility handling, source eNB indicates to target eNB the TMGI(s) associated with the UE so target eNB can prepare the radio resource during the HO process.

Editor's Note: This procedure requires new eMBMS RAN radio transmission scheme and procedures and is therefore subject to future study by RAN WG.

6.3.1 Functional description

Figure 6.3.1-1 shows a high level interaction between the UE, Application layer, and MuSe function, and the RAN nodes for invoking multipoint service for GC.

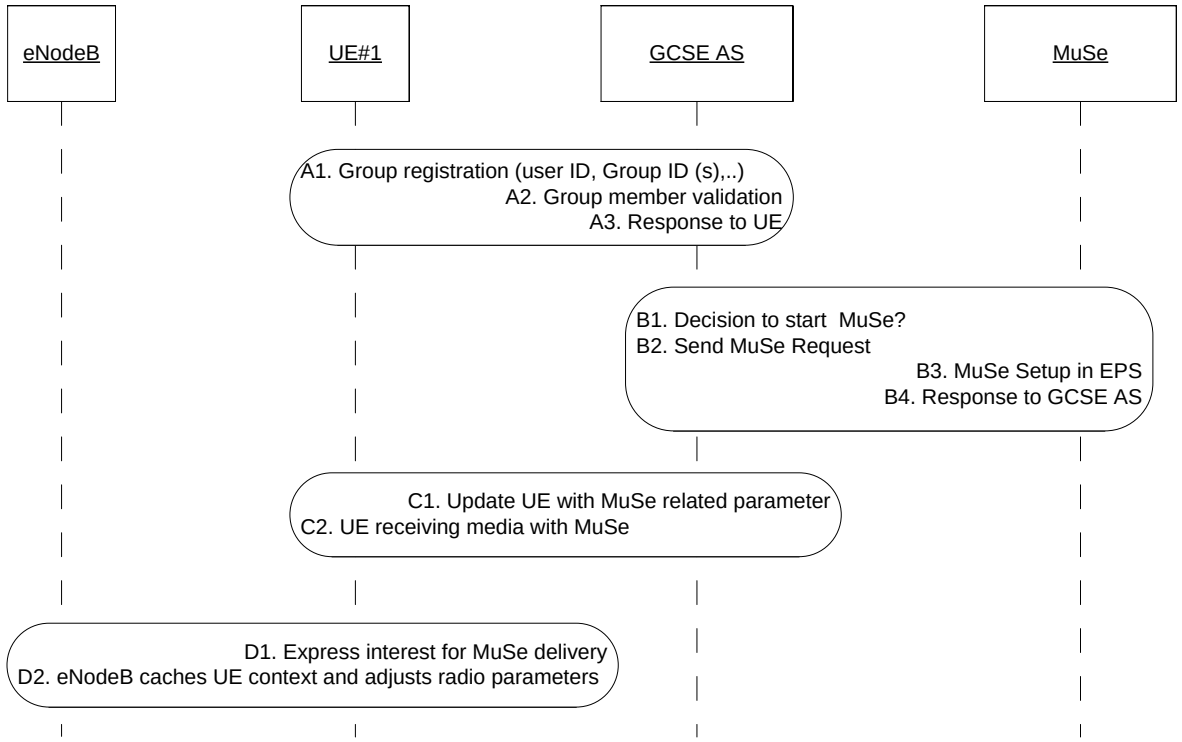


Figure 6.3.1-1: high-level interaction for GCSE functions

At high level, the interaction can break into 4 areas:

A1 to A3: UE expresses its interest for joining to certain GC(s) to become Receiver group member. GCSE AS needs to validate the user request and response to the request accordingly. This is communicated over GC1.

B1 to B4: GCSE AS made a decision to use Multicast Delivery offered by the EPS for GC so it sends a request to MuSe. MuSe coordinates the setup within the EPS and response to GCSE AS accordingly. This is communicated over GC2.

C1 to C2: UE needs to be updated with certain Multicast related parameter (e.g MBMS service announcement information) in order to use the multipoint service offered by the EPS. This is communicated over GC1.

D1 to D2: UE expresses its interest for MuSe Delivery (i.e. provide TMGI) to eNodeB. The eNodeB caches UE context (e.g. mapping between UE and TMGI), and adjusts the radio parameters to keep the UE in long connected state. The eNodeB determines whether to use PtP/PtM to send DL group traffic media, based on the knowledge of cached UE context and RAN node situation.

6.3.2 Procedures

6.3.2.1 Multicast Delivery Setup

Prior to Multicast Delivery setup, UE is participating to a GC using a Unicast Delivery. At some point, GCSE AS decided to involve Multicast Delivery for media distribution so it invokes the MuSe function via GC2.

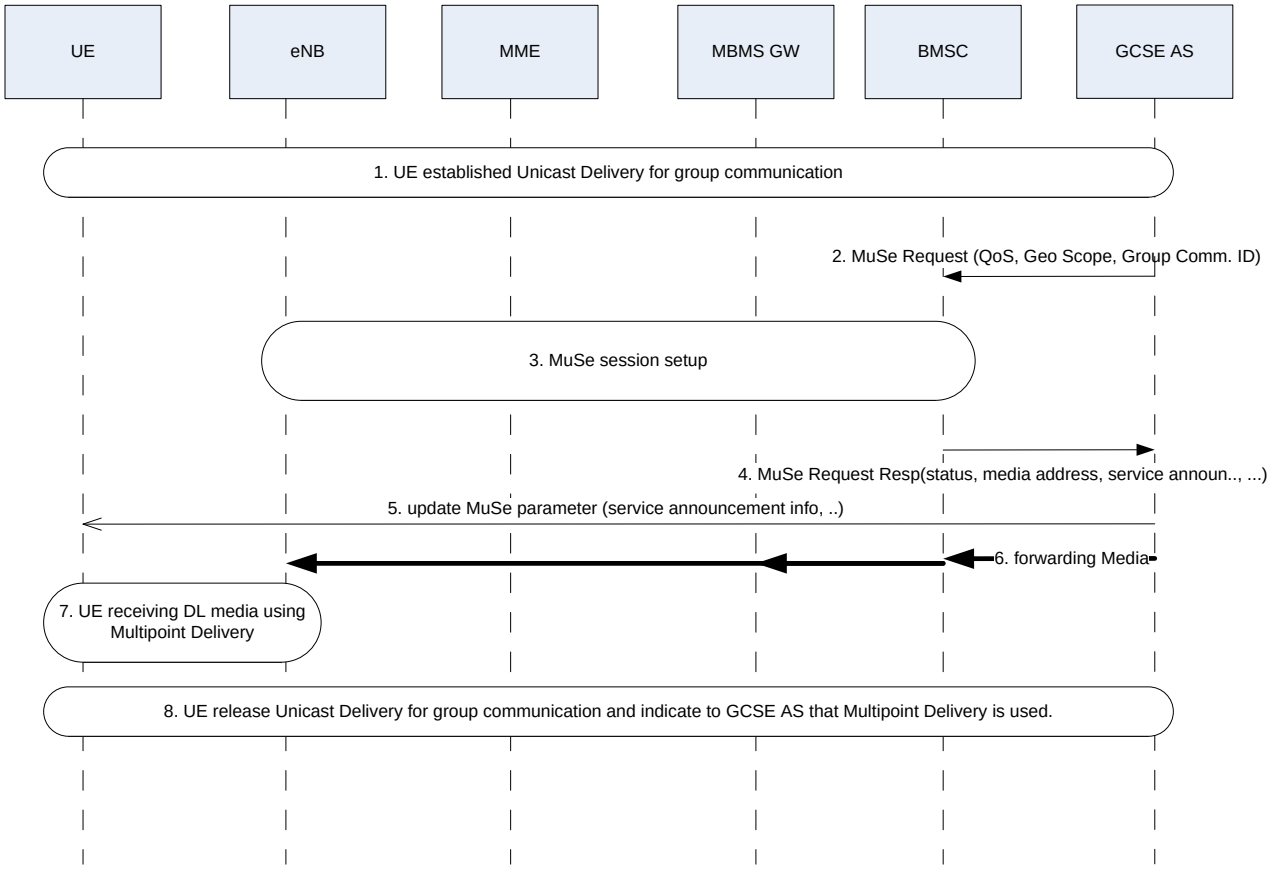


Figure 6.3.2.1-1: MuSe Setup

1. UE has expressed its interest to participate into a GC and GCSE AS has granted the access. The media is received via a dedicated EPS bearer toward the group server (i.e, Unicast Delivery).

2. GCSE AS determines that Multicast Delivery is needed and sends a request to BMSC. It includes the QoS information for the DL media, and GC ID that points to this GC. QoS indicates information similar to ARP and QCI in order to define the characteristic of the media. It may also include a Geographical Scope to define the area where the DL media distribution is confined.

3. MuSe setup to corresponding eNb using the procedure defined for eMBMS in TS 23.246 [8] subclause 8.3.2 – MBMS Session Start Procedure for E-UTRAN step 1 to 6.

4. BMSC responds to GCSE AS with the address where the DL media is sent, service announcement /Service ID information for joining the MBMS service (see TS 26.346 [11]). UE expresses interest for a certain service identified by its service ID. BMSC authenticates the UE and provides the TMGI, MSK, codec, etc. Status is used to indicate to GCSE AS if this request is accepted or not. BMSC also keeps internally the allocated TMGI with the GC ID received from step 2.

5. GCSE update the Receiver group members with service announcement information.

6. Based on the DL media reception address received from step 5, GCSE AS forwards the media related to this GC.

   NOTE 1: step 5 and 6 can be performed in parallel.

7. UE monitors the system broadcast for the interested TMGI. When detected, UE expresses its interest to eNb to receive the DL media. The eNB adjusts radio parameters to keep the UE in long connected state, and sends the DL media to UE. RAN can determine the best transmission scheme to forward the media to UE (i.e., PtP/PtM).

   NOTE 2: Currently, eNB does not determine PtP/PtM transmission for eMBMS bearer. Only PtM is supported.

8. When UE can receive the DL media using Multicast Delivery, it releases the Unicast Delivery session to the group server and indicates to GCSE AS that GC media is now using Multicast Delivery.

After Multicast Delivery Setup has been performed (i.e., GCSE AS has received service announcement information from BMSC), then GCSE AS can return the service announcement information to the subsequent UE(s) who wanted to participate to this GC without further interaction with MuSe function.

6.3.2.2 MuSe and Mobility handling

This solution requires the eNB to keep track of the UE Group Communication context (e.g., like TMGI and UE relationship) in order to start the Multicast Delivery at the target cell.

When a Multipoint Service (MuSe) is setup with Geographic Scope requirement, it is expected only those cell(s) which belongs to the geographical restricted area can perform the Multicast Delivery. When UE moves around those cells within the geographical restricted area, it is expected the multicast delivery session is not disrupted. As Geographic Scope is optional and may not be required for this MuSe then the Multicast Delivery session is maintain across the whole PLMN. When the UE moves outside the geographical restricted area, it will no longer receive the multicast delivery from the serving cell, and the UE may request the GCSE AS directly via GC1 to rejoin the GC if needed. If UE was using Unicast Delivery and moved into the serving cell where Multicast Delivery is possible (based on the UE detecting the TMGI is being broadcasted by the serving cell), the UE then informs the eNB of the TMGI(s) that it wishes to receive in order for the eNB to create the UE Group Communication context, and eNB then starts the DL delivery toward that UE using Multicast Delivery. When UE can receive the DL media using Multicast Delivery, it releases the Unicast Delivery to the group server and indicates to GCSE AS that GC media is now using Multicast Delivery.

The following are the high level steps for the mobility procedure:

1. During the Multicast Delivery setup procedure as defined in clause 6.3.2.1, the MBMS Session Start Message is sent only toward those eNBs that are within the geographical restricted area.
   Those eNBs receive the TMGI and IP multicast address for this multicast delivery session.

2. UE which is participating in a multicast delivery session is always RRC connected. When a UE expresses its interest for Multicast Delivery, the eNB adjusts the radio parameters to keep the UE in long connected state.

3. Intra RAT PS HO is used for mobility procedure. Source eNB indicates the multicast delivery session(s) (i.e, TMGI(s)) that the UE is currently participating to the target eNB.

4. If target eNB has received the MBMS Session Start during the MuSe Setup procedure (step 1) then the received TMGI is known and can allocate the corresponding radio level parameter in the HO CMD for PtP/PtM reception at this target cell. Otherwise, the HO CMD will not contain any radio parameter for any of the TMGI and multicast delivery session will not be continued when UE is moved to this target eNB.

Figure 6.3.2.2-1 shows the above principles.

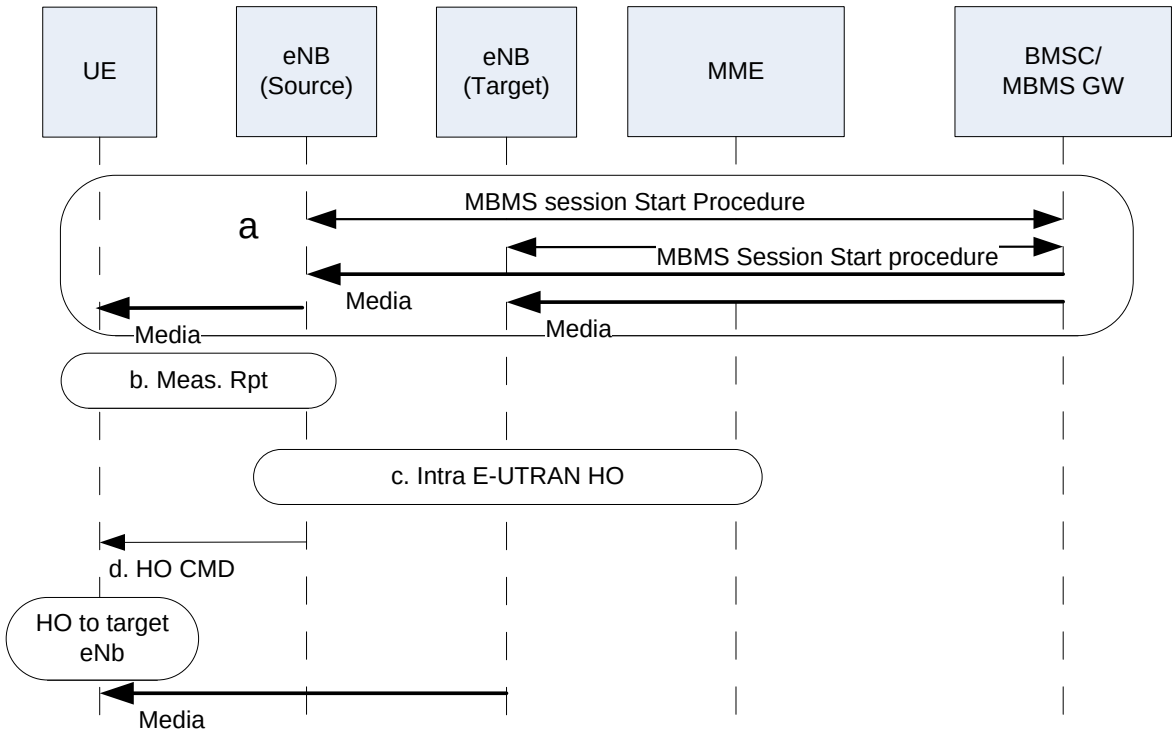


Figure 6.3.2.2-1: Mobility Signalling flow within Group Ccommunication area

a. During the MuSe setup procedure, the eNBs that are serving the GC are given the IP multicast address to receive the media from BMSC GW for DL distribution. Active GCSE UE is receiving the media from source eNB.

b-c. At some point, source eNB needs to invoke the intra E-UTRAN handover procedure based on e.g, Meas. Report, and with the following additions:

- Source eNB includes the TMGI(s) of the MBMS Services that the UE is currently receiving to target eNB in eNB to eNB transparent container.
- Target eNB, based on the received TMGI, responds back with the corresponding radio parameters for each TMGI in HO CMD for PtP/PtM reception at the target cell.

d. HO CMD is sent to UE and UE uses the radio parameters for each TMGI(s) to continue the receiving of the DL media from target cell for each GC.

6.3.2.3 MuSe with voice and video media handling

When a Multipoint Service requires different media type (e.g., voice and video) for the same Group Communication, a different Multicast Delivery session is allocated for each media type. Each of the Multicast Delivery session can have different QoS and bit rate requirements. However, they are linked to the same MuSe and can be independently removed at any time by the GCSE AS. The UE which has registered to this Group Communication will be given all the TMGI(s) and their corresponding media type via GC1; hence the UE can determine if certain Multicast Delivery session can be ignored.

The following are the high level steps for this procedure:

1. GCSE AS determines that a MuSe for a particular Group Communication will consist of more than one Multicast Delivery sessions in order to carry different media type.
2. GCSE AS setup a Multipoint Service with MuSe. It gives the QoS/bit-rate requirements for each Multicast Delivery session separately based on the requirement of the media type to be carried in each Multicast Delivery session.

3. MuSe creates the number of Multicast Delivery sessions as requested by GCSE AS.
   Each Multicast Delivery session has its own TMGI which will be indicated to GCSE AS.

4. When UE registers to GCSE AS for this Group Communication, the GCSE AS informs the UE of all the related TMGIs and their associated component type. For Multicast Delivery, UE can then decide which TMGIs to monitor from the serving cell. It means that the UE can choose which Multicast Delivery sessions it wants to be a part of within the Group Communication.

5. If a particular Multicast Delivery session for a GC is no longer needed, GCSE AS requests the MuSe to remove this Multicast Delivery session from this GC. GCSE AS can make that decision based on e.g., input from the group member and/or administrator who oversees this GC.

The above procedure can introduce delay toward the receiving group member who is using Multicast Delivery because the UE relies upon acquiring the information about the newly added media component from the MCCH. The MCCH can only be modified once every 5 or 10 seconds dependent upon the MBMS configuration (the rate of MCCH repetition is configurable between 320ms and 2560ms (see TS 36.331 [10])). This means that reception of the newly added component (e.g., video toward an existing voice group session) will be delayed until UE is able to decode the MCCH and acquires its radio configuration. The following new procedure allows the eNB to directly inform the current participating UEs of the Multicast Delivery radio configuration necessary to receive the newly added media; thus, eliminating any delays that are due to the UE relying upon changes to the MCCH and the constraints of the MCCH modification period.

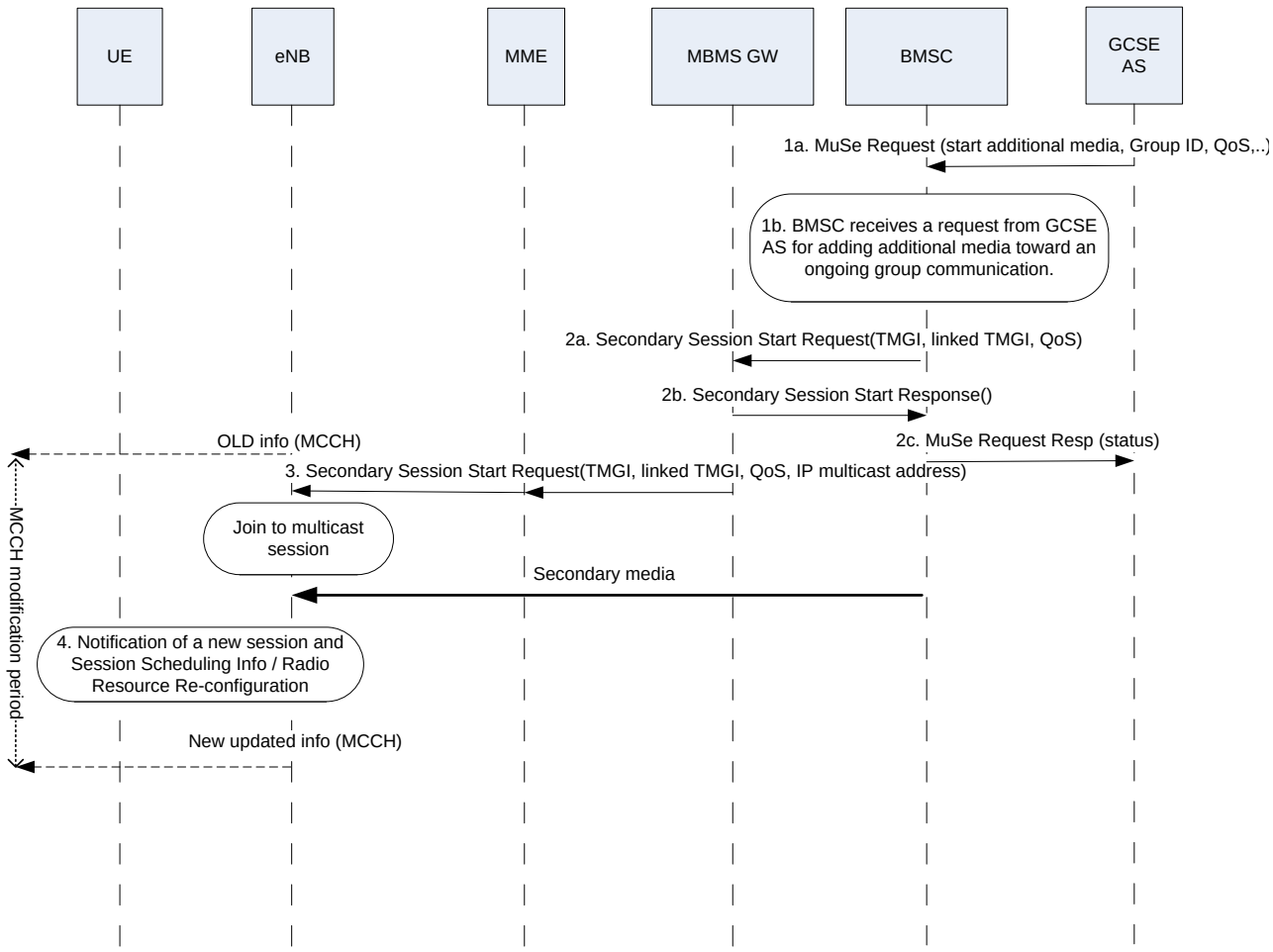


Figure 6.3.2.3-1: adding an additional media toward an on-going Multicast Delivery session

1a-b. BM-SC receives a request from an GCSE AS for adding a media (e.g, video) on the existing GC session. BM-SC creates secondary MBMS session with the MBMS-GW. It allocates a new TMGI for the new session and also identifies the current active MBMS session by its TMGI which is referred to as "linked TMGI".

2a-c. BMSC creates a secondary MBMS session toward the MBMS GW.

3. The MBMS GW sends a secondary session request (TMGI, linked TMGI, QoS, IP multicast address for the new secondary MBMS session,) to the eNb that is serving the current active MBMS session. eNb joins the multicast session for secondary MBMS session and starts receiving the new media.

4. In this solution, UEs which are participating in a GC via Multicast Delivery is always in RRC connected state. When eNB is aware of the secondary session due to step 3, eNB notifies each of those UEs via RRC signaling with the new radio related configuration of the secondary MBMS session (i.e., for the new media) such that UE can immediately start receiving the additional media via Multicast Delivery mechanism. eNB identifies the relevant UEs based on its internal stored context from the ongoing active session (i.e., UE and TMGI correlation).

NOTE: MCCH modification period is shown in the figure for completeness only.
It has no bearing with the above proposal.

6.3.3 Impact on existing entities and interfaces

Editor's Note: Impacts on existing nodes or functionality will be added.

6.3.4 Solution evaluation

Editor's Note: The fulfilment of requirements in clause 4.2 needs will be evaluated.

6.4 Solution 4 – GCSE architecture using IMS and eMBMS

6.4.1 Functional description

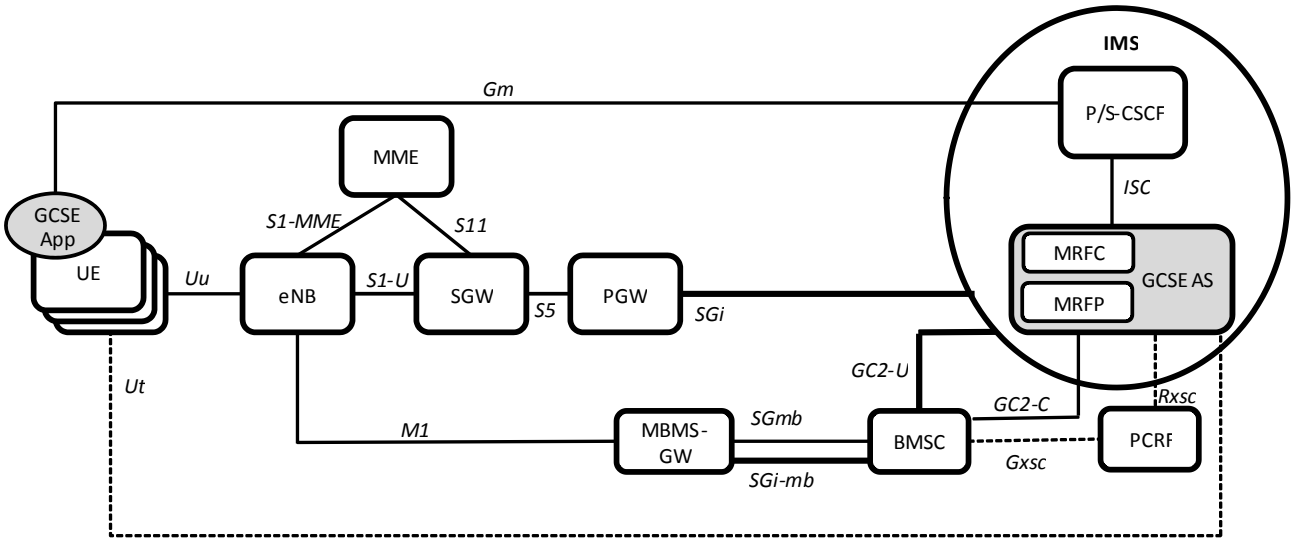
6.4.1.1 Solution description

The following are the salient features of this solution:

1. GCSE AS is an Application Server in the IMS;
2. SIP signalling is used for establishment, modification and release of GCSE GC sessions. It is also used for joining and leaving pre-established GCSE GC sessions;
3. eMBMS is an optional feature for the RAN. If available, eMBMS is used for MuSe delivery on the downlink. The BM-SC function is may be stand-alone or collocated with the GCSE AS;
4. The solution allows for switching between unicast and eMBMS delivery for an ongoing GCSE group communication session;
5. Unicast bearers are used for uplink communication. In cells where eMBMS channel is not available, unicast is also used for the downlink;
6. In the context of this solution "GCSE group communication" is synonymous with a SIP session that is associated with *GCSE Group ID* i.e. a globally unique GCSE Group-specific SIP URI (e.g. fire.brigade75@firstresponder.com or a conference factory URI). The SIP session can be either pre-established or set up on the fly;
7. In one alternative of this architecture the GCSE AS is used as an IMS conference server as specified in TS 24.147 [9]. The "GCSE group communication" is synonymous with an IMS conferencing session;
8. The GCSE Application Server exchanges eMBMS-related control information with the BM-SC either via new reference point (GC2-C) or via the PCRF.

Editor's Note: The use of PCRF and the functions provided by PCRF for interfacing between GCSE AS and BM-SC is FFS.

6.4.1.2 Architecture reference model



New or enhanced reference points:

Gm: This is an enhanced Gm. It relies on SIP signalling for establishment, modification and release of GCSE group communication sessions, or for joining and leaving pre-established GCSE group communication sessions. Floor control is performed using BPCF [7] as specified in [z] or RTCP messages (e.g. like those defined in [6]).

GC2-U: This is the user plane reference point between GCSE AS and BM-SC for eMBMS delivery.

GC2-C: This reference point may be used for exchange of control plane information between GCSE AS and BM-SC for eMBMS delivery.

Rxsc/Gxsc: This reference point may be used for exchange of control plane information between GCSE AS and BM-SC for eMBMS delivery.

Ut: In the IMS conferencing architecture alternative Ut is used to update group related information in the GCSE AS e.g. group membership.

Figure 6.4.1.2-1: GCSE architecture based on IMS and eMBMS

6.4.2 Procedures

6.4.2.1 General

The procedures in the present clause are provided as examples only. The detailed call flows depend on the architecture alternative.

6.4.2.2 GCSE group communication procedures

6.4.2.2.1 Switching from unicast to eMBMS delivery for an ongoing GCSE group communication session

Outlined in Figure 6.4.2.2.2-1 is the control plane procedure for switching between unicast and eMBMS delivery for an on-going GCSE group communication session. It is up to Stage 3 to decide which IMS procedures to use.

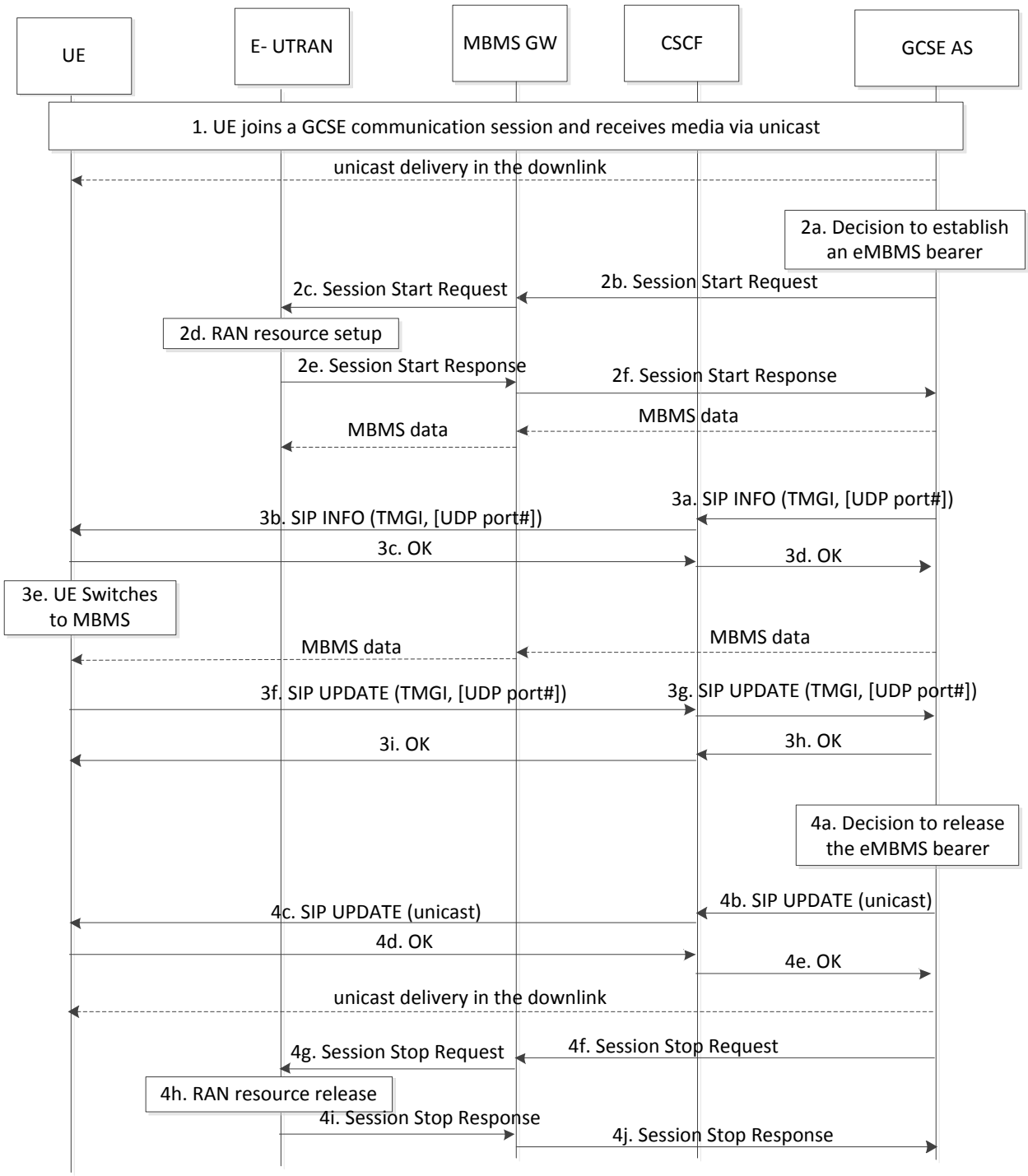


Figure 6.4.2.2.1-1: Switching from unicast to eMBMS delivery for an ongoing GCSE group communication session

1a.-1d. UE joins a GCSE group communication session. It is assumed that at this point there is no eMBMS channel for this GCSE Group in the cell where the UE resides. GCSE AS uses unicast delivery in the downlink (e.g. via the same EPS bearer that UE uses for the uplink or via a different EPS bearer).

2a.-2f. At some point GCSE AS decides to establish an eMBMS channel for this GCSE Group in this cell. In the user plane a specific GC is identified by the TMGI (if each GCSE Group is assigned a unique TMGI) or the combination of a TMGI and a UDP port number (in case GCs from several GCSE Groups are multiplexed on the

same TMGI). As soon as the eMBMS channel is established, the GCSE AS starts sending data using eMBMS delivery. In parallel GCSE AS keeps unicast delivery to the UE over the EPS bearer as long as the UE has not switched to eMBMS.

3a.-3d. GCSE AS uses SIP INFO to inform the UE about the availability of eMBMS delivery in the cell. The SIP INFO contains media description for delivery via the eMBMS channel i.e. a TMGI and possibly a UDP port number.

3e.-3i. UE acquires the eMBMS channel and acknowledges the channel acquisition to GCSE AS using SIP UPDATE. At this point GCSE AS may stop the parallel unicast delivery for this UE.

4a.-4j. At some point after step 3 GCSE AS may decide that there are not enough users in the cell anymore to justify eMBMS delivery. GCSE AS re-starts unicast delivery to the UE and informs the UE to switch to unicast delivery providing media description for unicast delivery over the EPS bearer.

Editor's Note: In steps 2a and 4a, the decision function in the GCSE-AS whether to use establish or release eMBMS bearer and the correspondingly needed information are FFS.

6.4.2.3 GCSE Group membership procedures

6.4.2.3.1 Subscribing to a GCSE group

Subscribing to a group membership can be done through a SUBSCRIBE / NOTIFY mechanism. GCSE group identifier is a SIP URI identifier. UE's that are part of the group can SUBSCRIBE to that group.

Editor's Note: Other mechanisms are FFS.

6.4.2.3.2 UE joining Group Communication

A UE device may join a pre-established GCSE group either by direct request or at the invitation of the GCSE AS.

Editor's Note: The method through which the join is done is FFS.

6.4.3 Impact on existing entities and interfaces

Editor's Note: To be completed.

6.4.4 Solution evaluation

Editor's Note: The fulfilment of requirements in clause 4.2 needs will be evaluated.

6.5 Solution 5 - Group communications with pre-established MBMS broadcast Bearers and multicast/unicast switching

6.5.1 Functional description

These are the functional principles of this solution

- It is assumed the Public Safety device uses LTE only within the scope of this solution (the device may have other radio interfaces but these are out of the scope of this clause).
- Handling of GCs and group management at the application layer
- Mapping of group of users to IP multicast addresses performed based on application layer criteria as a result of BMSC and application interaction.
- Distribution of traffic for multicast IP addresses via eMBMS broadcast to specific areas based on application layer criteria
- As defined in TS 23.246 [8], UE's are not expected to use IGMP to receive multicast data on the eMBMS bearer.
- UEs can participate in application layer GCs either by receiving IP multicast packets by listening to the eMBMS broadcast associated to a TMGI the application notifies to the group members, or by receiving IP unicast packets.
- The UE may directly notify the application when the TMGI-related channel is available in a cell or not and therefore cause the application to deactivate or activate unicast transmission to the UE, respectively.
- It is assumed that the broadcast groups are long term or could be created on demand. The UE can receive notification of groups available to it on the Unicast channel (using dedicated signalling with the applications) or by listening on a dedicated broadcast channel available over the whole PS network (e.g. a channel associated to a well known TMGI devoted to advertising the available communications groups in a particular area and related TMGI's)
- The system remains application neutral, except it may provide some PS optimizations for eMBMS
- The support of inter-operator roaming is built into the solution as the PS applications are a third party to every operator the PS agency needs to have access to.
- Different PS applications may be available via the same PDN connection or different PDN connections
- Optional optimization: UEs could be provisioned with Cell ID's constituting the boundary of the group distribution via application layer interaction (FFS) so that when the UE arrives at a cell where the switch between unicast and multicast is possible, the application may assist the UE to decide to switch the UE to/from BROADCAST from/to UNICAST reception, depending on criticality of not missing any communication or based on any exceptional cell load reported to the applications by the operator. This provisioning avoids the need of the UE to always report the cell where it is to the application and to report just when it enters or exist boundary cells. Alternately, ULI reporting may be active for the device and the location information reported to the application via Rx, however this assumes the UE is in RRC connected state for as long as this is needed to make this optimization work.
- Application layer signalling between the UE and the GC application is out of the scope of GCSE-LTE work item and shall be part of the definition of the applications using GCSE-LTE capabilities. However GCSE-LTE work item can provide application developers with guidance on how applications shall be designed, e.g. by means of informational flows.

In order to implement a solution with these attributes the following system architecture for GCSE-LTE is proposed

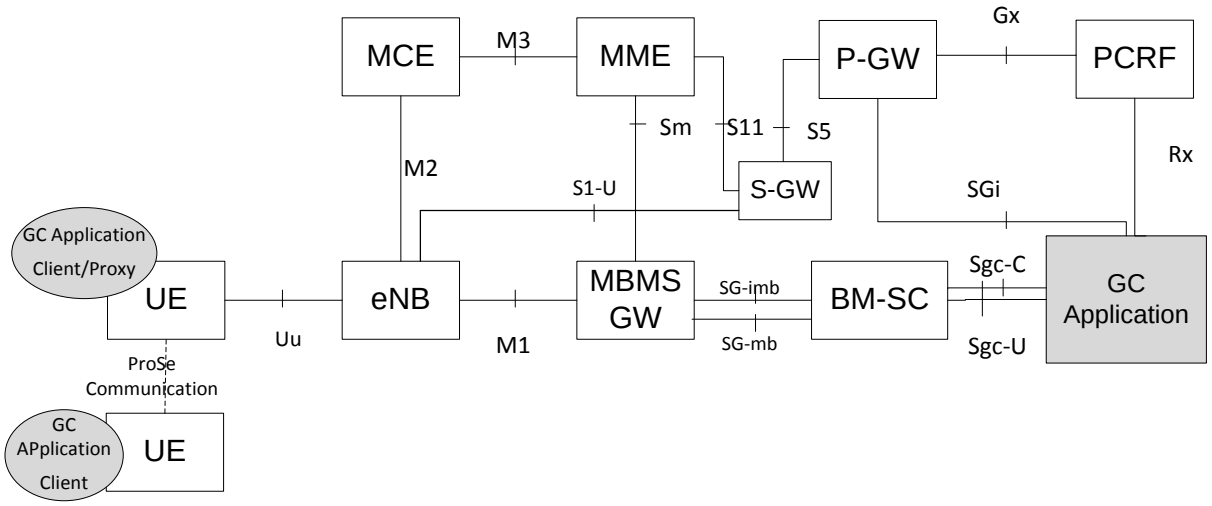


Figure 6.5.1-1:

When the UE uses unicast communications for DL traffic, the path is via the PGW SGi and the PCRF is providing the application with means to interact with the infrastructure via Rx inteface.

When the UE uses multicast for DL traffic, then the BMSC is providing the application with means to interact with the infrastructure on the C-plane interface identified by Sgc-C., and the user plane is in the DL via the BMSC over the Sgc-U interface.

The uplink user traffic and both DL and UL application signalling with the UE is via the SGi. Optionally, available group advertisement can also take place on the broadcast channel.

The application may establish dedicated unicast bearers to deliver content in unicast mode via the PCRF.

6.5.2 Procedures

These flows are examples of UE-network interaction for this solution.

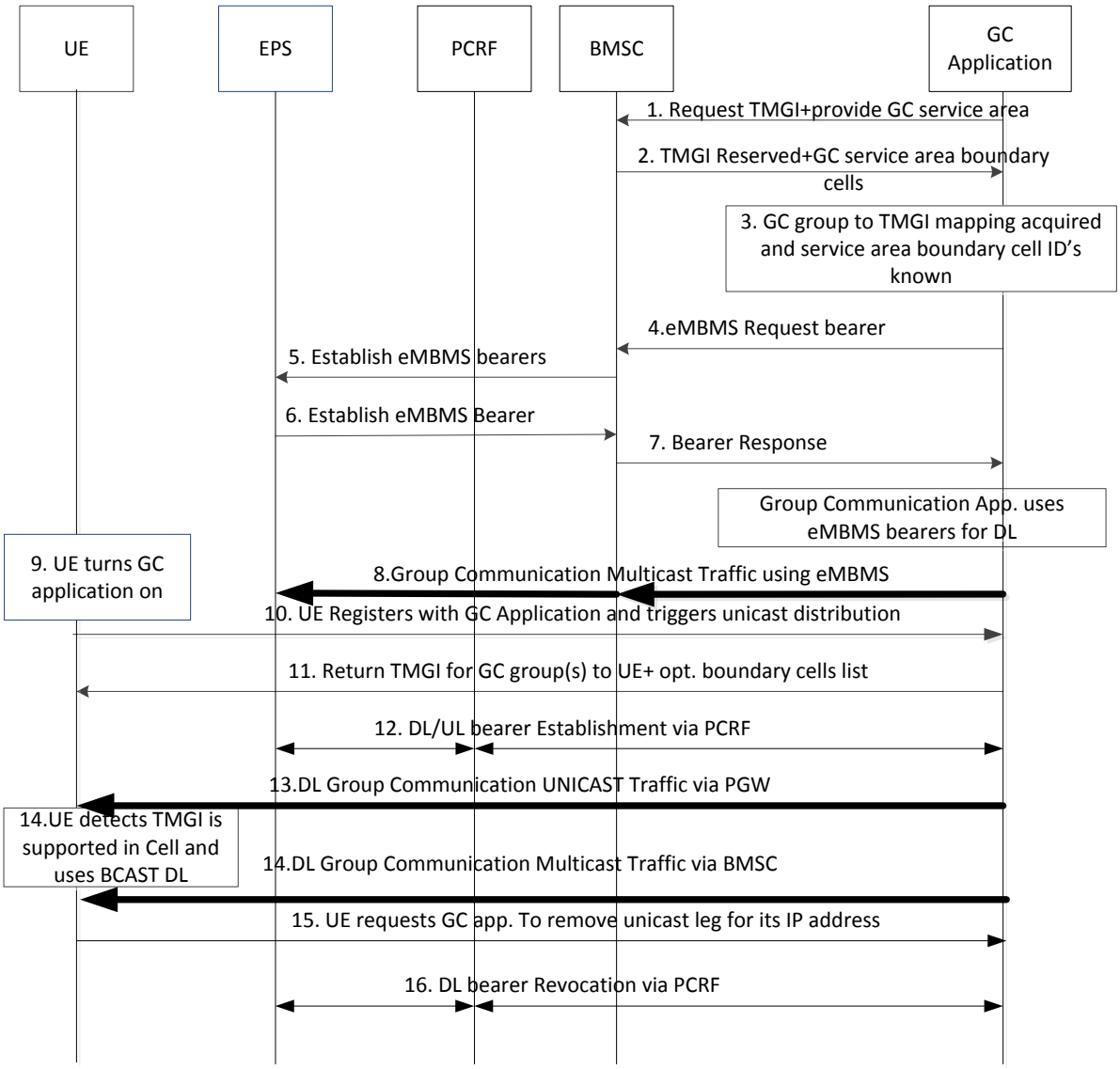


Figure 6.5.2-1: The UE initiates an application and eventually uses MBMS

In this Figure 6.5.2.1, the application is shown to set up the broadcast transmission path for the GC distribution, by interacting with the BMSC. The BMSC provides the Application with a TMGI, used over the radio to identify the broadcast transmission for the Group communication, and optionally a list of Cell ID's at the boundary of the service area of the broadcast communications. At this point the application has:

1) The mapping of the multicast IP address used for GC and the TMGI

2) A list of cells at the boundary of the broadcast service area.

With this, the application can start sending DL data to the EPS via the BMSC over the Sgc-U interface. This interface is simply a user plane interface and the only way the GC application interacts with the BMSC is by providing the Multicast address in the IP packets it sends. So, it is really a purely user plane interface.

In step 9 the UE is powered on and it registers on the user plane with the application server for the GC, using protocols and procedures outside 3GPP scope. As part of these procedures, at step 11 the UE obtains the TMGI of the used for broadcast communications, and optionally a list of the cells it is required to report to the application upon entering and exiting.

For sake of argument we suppose the UE was not in coverage area where the Broadcast communication was available, so the application server was triggered to send DL packets using a DL bearer it can establish via the PCRF (if a dedicated bearer was required, otherwise the UE shall receive the DL traffic on the default bearer already available).

Upon mobility, the UE enters a cell where broadcast transmission of the TMGI provided to it by the GC application is available. So at that stage the UE decides to join the broadcast distribution and asks the network to release distribution via its unicast IP address.

Using similar approaches, the flow in the figure 6.5.2.2 here below describes the switching between broadcast and unicast mode, based solely on TMGI detection in the cell.

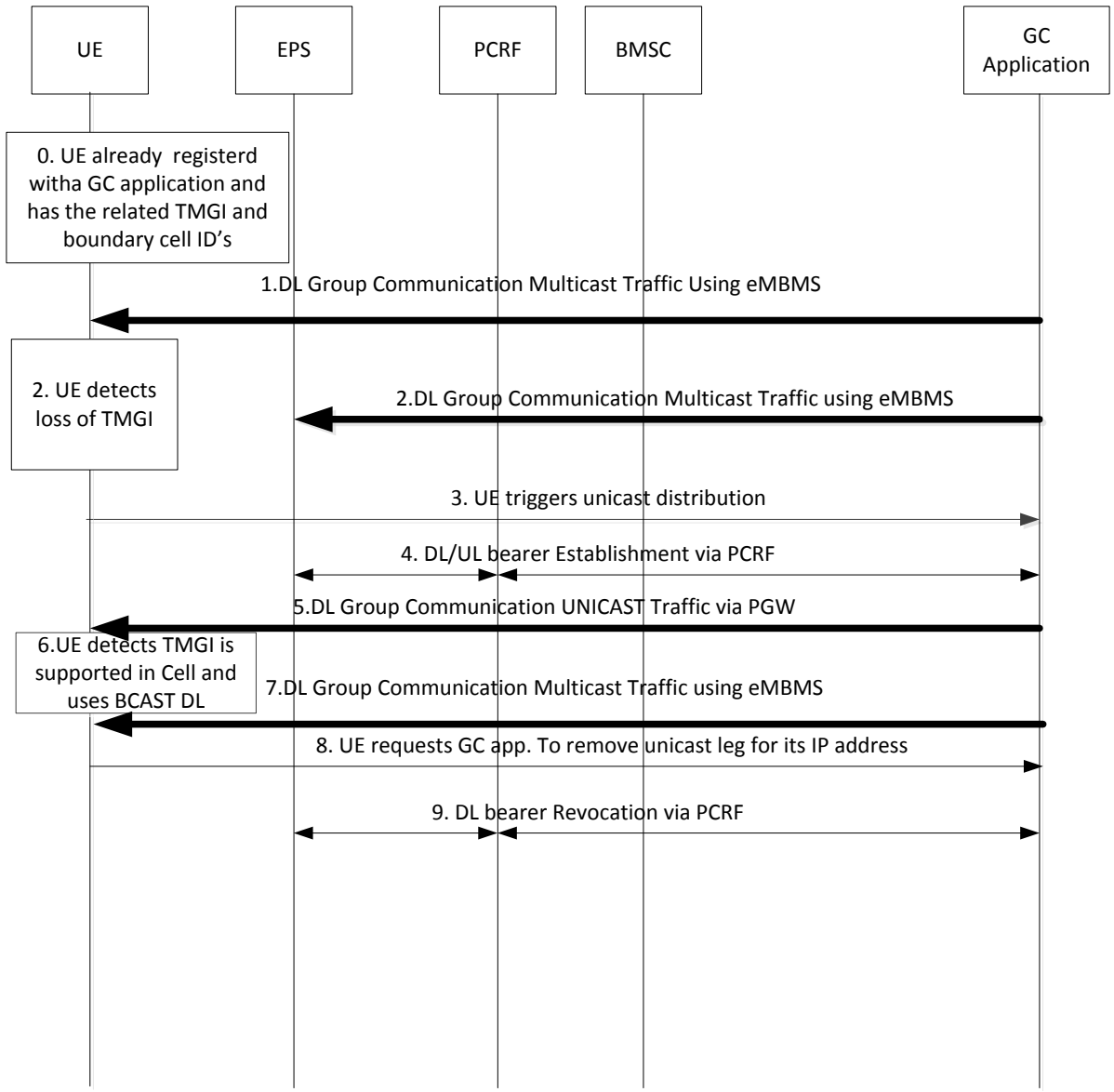


Figure 6.5.2-2: The UE switches from broadcast to unicast and vice-versa

The detection of loss of TMGI is an event that can potentially cause disruption of communication. Unlike in the case where the UE is using unicast traffic and then it switched to eMBMS, there is potentially a time interval (up to 5-10 second in the worst case) where the UE may lose the DL data. This may not be too critical in certain application, but in some others it could be critical. Therefore a potential optimization is based on the UE detecting the boundary of a service area beyond which the TMGI is not offered. This is via a cell ID list provisioned on the UE or provided at registration time (or downloaded in the UE upon registration triggering it). This list may also be updated dynamically or also broadcasted on the MBMS channel specific to an application.

If the UE was using MBMS and arrives at a cell in the boundary list, as it triggers the application to assist it in whether it should switch to unicast or not, it may take decisions to proactively switch to unicast. Also, the UE notifies the

application when it leaves the cell and whether it moves to a cell with TMGI support or not. The application, based on consideration related to load from this cell (maybe also based on counting the number of UE's that triggered the assistance and have not yet updated the application they have left the boundary cell, but also maybe based on cell congestion feedback from the PCRF - if any was available after the UPCON work is complete), criticality of not losing data in DL, and other possible criteria related to the specific application, could decide to hint or request the UE to switch to unicast while it is still receiving the broadcast data. Here is an example flow in figure 6.5.2.3:

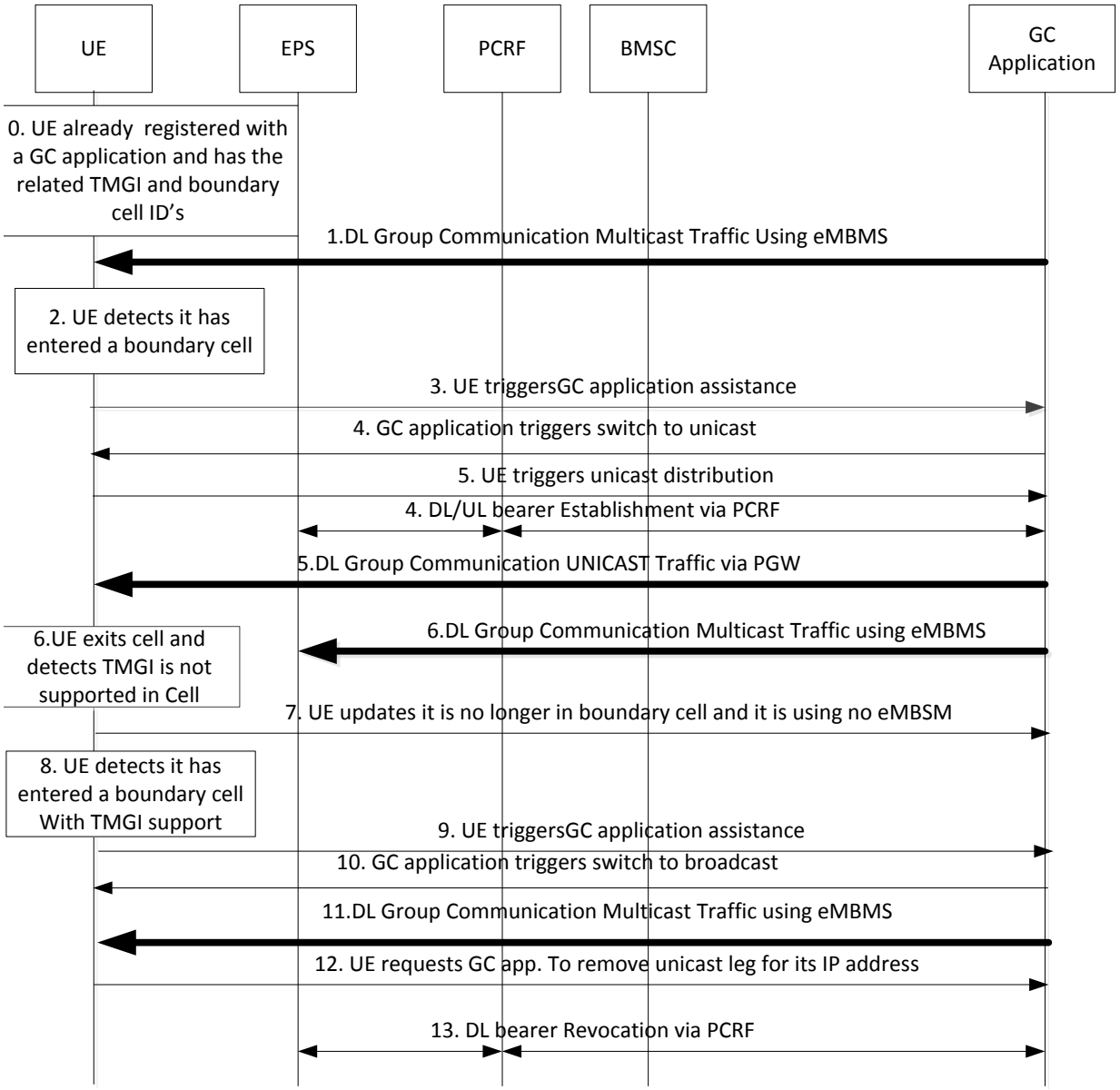


Figure 6.5.2-3: The UE switches from Broadcast to Unicast and vice-versa using application assistance

The amount of messages required when the applications provide more intelligence in switching is greater, however the advantage is that the decision to switch to unicast/broadcast is controlled by the application. If the application server is also shared by many applications, it allows coordinated decisions for multiple applications. It should also be noted the UE may take unilateral decisions in the direction unicast- broadcast if network control was not necessary in this direction, but still the need to update the GC application on this decision would be relevant to keep accounting of the number of users in a cell.

6.5.3 Impact on existing entities and interfaces

This solution has minimal impact on the existing system:

The only impact identified is that the interface between the BMSC and GC applications needs to be standardised

6.5.4 Solution evaluation

Editor's Note: The fulfilment of requirements in clause 4.2 needs will be evaluated.

6.6 Solution 6: MuSe with configurable geographic scope

6.6.1 General description

This solution addresses the requirements relating to the geographical scope of GCSE Group Communications as specified in clause 5.2.2, TS 22.468 [3]. In addition, the following requirement relating to the Key Issue #3: MuSe with Geographical Scope, is also addressed by this solution:

- When requested, a notification shall be sent to a requesting entity when the group member ceases to participate in the communications from the GCSE group, i.e. in case of a group with restricted geographic scope when the group member leaves the Group's Service Area.

This solution builds over the "GCs using pre-established eMBMS bearers" solution described in clause 6.1.

The solution in clause 6.1 proposes the use of PCRF as the interface between the GCSE AS and the BM-SC for the exchange of MBMS control information. This solution does not have such restrictions on the placement of the PCRF. The methods for the implementation of the C-Plane and U-Plane components of the GC2 reference point is FFS.

Editor's Note: Implementation of GC2 reference point is FFS.

The signalling procedures between the UE and the GCSE AS (over GC1 reference point) can be based on IMS-style signalling as described in the solution in clause 6.4.

6.6.2 Procedures

6.6.2.1 Group Communication within configured Geographic Service Area

This solution provides the following capabilities in addition to the capabilities provided by the solution in clause 6.1:

1. By default, each GCSE Group is of system wide scope. This solution provides the capability (e.g., to the Users) to configure Geographic Service Areas for each GCSE Group within which GC services are to be provided.

2. It is also possible for the Users to reconfigure the Geo Service Areas for the GCSE Group(s).

3. This solution assumes that the Users (such as Public Safety, Dispatch Services) have a relationship with the 3GPP system operator whereby Geo Service Areas have a predefined *mapping* with the corresponding EPS MBMS Service Areas, such as in terms of the lists of MBMS Service Areas. For example, a Geo Service Area may comprise of sub-Areas A, B, C .., each of which is pre-mapped to a corresponding List A, List B, List C of MBMS Service Area Identities (MBMS SAIs).

Editors Note: How Geo Service Areas are mapped to MBMS Service Areas is FFS.

4. Such mapping of Geo Service Areas to EPS specific MBMS Service Areas is done by appropriate configurations within the EPS. Such configurations ensure that MBMS Service Areas are not larger than the corresponding Geo Service Areas.

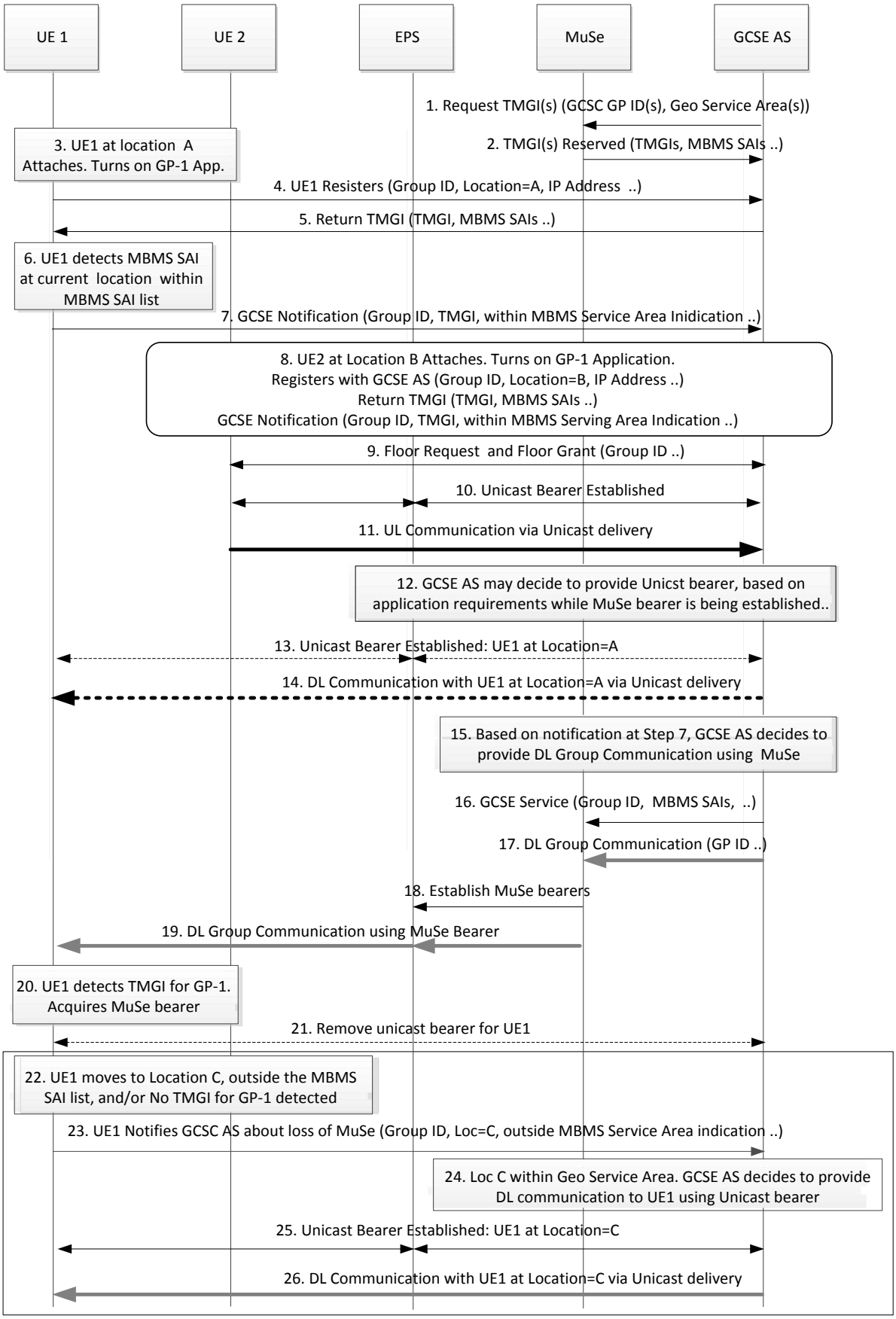


Figure 6.6.2.1-1: Geographic Service Area configured for a GCSE Group

Some salient enhancements of this solution over the solution described in clause 6.1 are as follows:

1. (Steps 1-2): When requesting the TMGIs for GCSE Group(s) from the MuSe function, the GCSE AS includes the Geo Service Area(s) for the respective GCSE Group (s) also in the request message. The mapping of Geo Service Area(s) to the corresponding MBMS Service Area(s) and associated TMGI(s) are made available to the GCSC AS. The GCSE AS maintains such mapping of the GCSE Group IDs with their associated TMGIs and MBMS Service Areas(s) e.g., in the terms of the lists of MBMS SAIs.

2. (Step 3-4): After a UE attaches to the EPS, turns on a GCSE application and registers with the GCSE AS; in addition to sending the GCSE Group ID to the GCSE AS, the UE includes its location information also in the registration message.

NOTE 1: The location information passed by the UE to the GCSE AS can be in terms of Geo Area A, Area B etc. that is understood by the GCSE AS.

NOTE 2: It is assumed that the GCSE Group ID(s) corresponding to the GCSE Application(s) is preconfigured at the UE. The details of such configuration procedures is FFS.

3. (Step 5): The GCSE validates that the requesting UE is located within the allowed Geo Service Area before returning the TMGIs for the GCSE Group(s) and the associated MBMS Service Area information to the UE. In addition to saving the TMGIs for the GCSE Group(s), the UE saves the associated MBMS Service Area information also. This way, the UE can know when it moves out of the configured MBMS Service Area.

NOTE 3: Validation of the location of the registering UE ensures that the Transmitting and the Receiving Members are within the configured Geo Service Area.

4. If the Geo Service Area(s) of a GCSE Group(s) is/are reconfigured, the GCSE AS updates its cached mapping of the new Geo Service Area(s) to the respective new MMBS Service Area(s) by performing the TMGI request procedure again with the MuSe function. The GCSE AS pushes such new/updated MBMS Service Area(s) information to all registered GCSE Group Members using the procedure such as those described in Step 5.

5. (Steps 6-7): UE reads the TMGI Information and determines that it is currently located within the MBMS Service Area for the GCSE Group of interest. UE notifies GCSE AS accordingly, including the within MBMS Service Area indication and the TMGI.

6. (Step 12-14): The solution in clause 6.1 proposes the pre-establishment of the MBMS bearers over the MBMS Service Area(s). As a difference, this solution does not propose such pre-established MBMS bearers. The GCSE AS can provide DL communications to the UEs via unicast bearers till such time that MBMS bearers are established and acquired by the respective UEs.

NOTE 4: The time taken for the setting up the MBMS bearers, the nature of the applications, latency requirements, number of receiving members etc. can be the factors for consideration by the GCSE AS for making the decision about when to set up the MBMS bearers.

7. (Steps 16-18): Once the GCSE AS decides to provide DL GCs via MuSe; the GCSE AS passes MBMS Service Area information (e.g., list of MBMS Service Area Identities) where MBMS based services are to be provided to the MuSe function via. GC2 reference point. The MBMS Service Area information ensures that DL MBMS based GC is restricted to a geographic area of interest.

8. (Steps 22-23) When a UE moves to a new location and determines that it is out of the MBMS Service Area, the UE notifies the GCSE AS of its new location and the loss of MBMS transmission indication for the GCSE Group of interest. On verifying that the UE at the new location is still within its configured Geo Service Area or that the UE is authorized to continue in this GC from the new location, the GCSE AS can decide to provide DL GC using unicast bearer(s).

9. If the GCSE AS determines that UE at the new location has moved outside the Geo Service Area; such information can be used by the GCSE AS for generating Notification to the requesting entities, informing that the UE (group member) has left group's Service Area. This addresses the requirement related to sending notification to the requesting entity, as has specified for Key issue #3.

6.6.2.2 Group Communication with geographic service area override and filtering

This solution provides the following capabilities in addition to the capabilities provided by the solution in clause 6.1:

1. It is possible for the system to override geographic area restrictions for a GCSE Group for a particular GC transmission for its Receiving Members. A Transmitting Member initiates modify Geo Area Request that includes parameters such as "override location:abc", to the GCSE AS. Alternatively, such "override" request can be initiated by the "dispatcher" entity at the GCSE AS.

2. The system also provides a mechanism to restrict a particular GC to a sub-geo area within the geographical scope of that group. In this case only the Receiving Members that are within the sub-geo area receive the GC. Such restriction for Receiving within a sub-geo-area can be initiated by the "dispatcher" entity at the GCSE AS also.

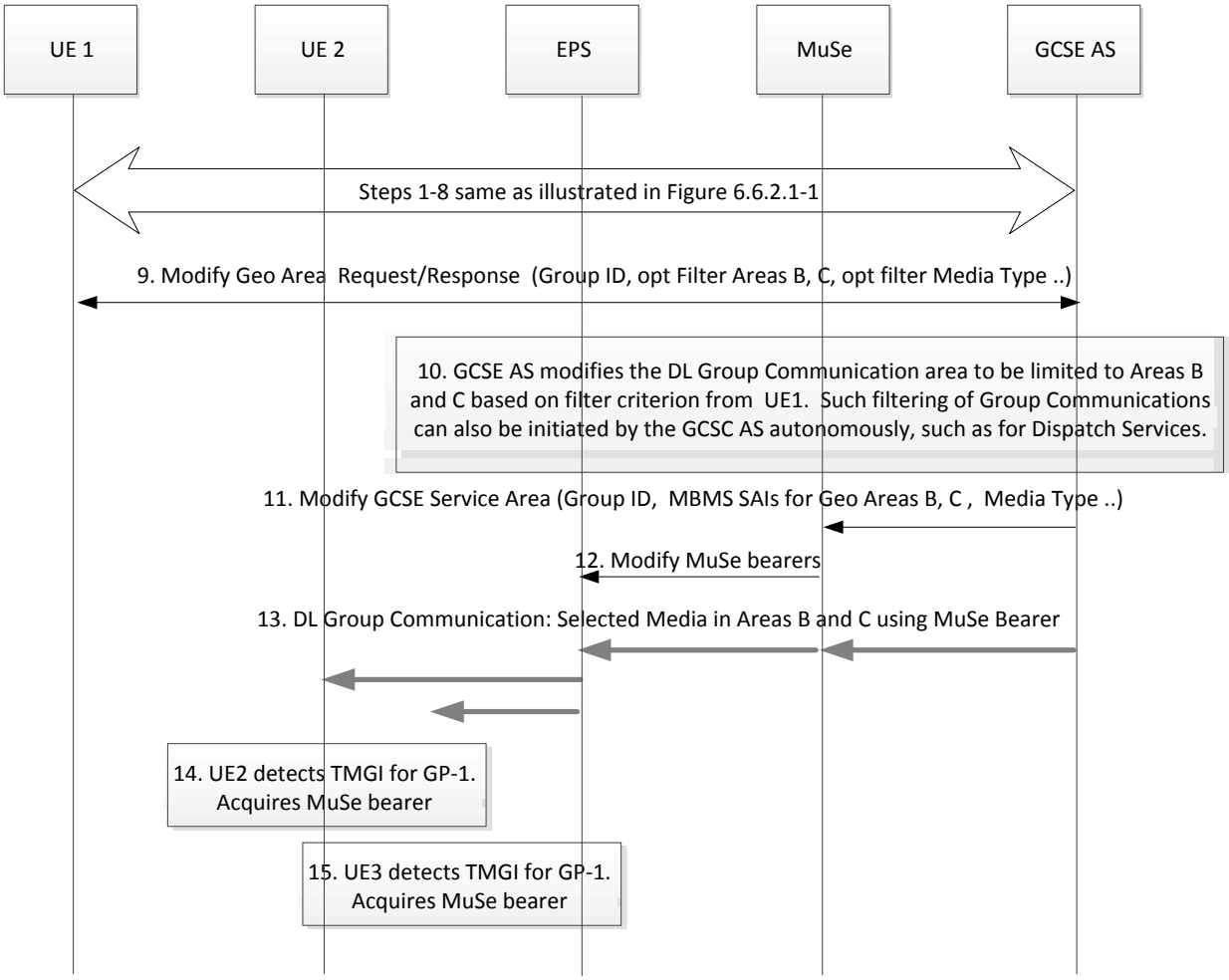


Figure 6.6.2.2-1: GC with Geographic Service Area filter

Some salient enhancements of this solution over the solution described in clause 6.1 are as follows.

1. (Steps 9-11): In the Modify Geo Area Request signalling to the GCSE AS, the UE includes parameters such as "Filter Areas: B, C" asking for the following instances of GC transmissions to be limited to Geo Areas B and C only. The request may include filter-Media Type(s) information also indicating the types of the media that need to be delivered in the limited Geo Area(s). On validating that the UE is authorized to make such a request, and that Geo Areas B and C are a subset of the Geo Service Area for this Group, the request is granted.

2. For the case of overriding the geographic area restrictions, the UE includes parameters such as "Override location:abc" in the Modify Geo Area Request signalling to the GCSE AS. On validating that the UE is authorized to make such an override request at the location identified by "location:abc:, the request is granted. Such "override" procedure is not detailed in this illustration.

3. (Step 12): The GCSE AS decides to provide DL GC within the filtered-Geo Service Area (Geo Areas B and C) based on filter criterion received from the UE. Alternatively, the GCSE AS may apply geographic filtering on specific instances of GC based on local policy. Such DL GC within "filtered Geo areas" can also be initiated by the GCSE AS autonomously, such as for Dispatch Services. Knowing that certain UEs are registered within the filtered Geo Area, and other factors such as number of registered users etc., the GCSE AS decides to provide DL GC via MuSe.

4. (Step 13): The GCSE AS passes MBMS Service Area information for Geo Areas B and C (e.g., list of MBMS Service Area Identities for Geo Areas B and C) where MBMS based services are to be provided and the desired Media Type information, to the MuSe function via. GC2 reference point.

Editor's Note: Describes the high-level operation, procedures and information flows for the solution.

6.6.3 Impact on existing entities and interfaces

Editor's Note: Impacts on existing nodes or functionality will be added.

6.6.4 Solution evaluation

Editor's Note: The fulfilment of requirements in clause 4.2 needs will be evaluated.

6.7 Solution 7: Assign and Re-assign Priority and Pre-emption capability for the GC

6.7.1 Solution description

This solution addresses key issue 8 and clarifies how to assign/re-assign Priority and Pre-emption for GC.

The priority level defined on the application level is for priority and pre-emption purpose. In the EPS QoS model the ARP parameter is used for the same purpose and contains information about the priority level, pre-emption capability and pre-emption vulnerability. So the application level priority is mapped to the ARP parameter under the consideration of the specific GC. The concrete mapping is specific to the respective EPS network and operator.

The priority level mapping between application and EPS is performed in the EPS network based on policy information preconfigured in the BM-SC, PCRF or a group related subscription. All can provide the linkage between the priority level(s) of the GC and the associated ARP parameter(s).

Group Members within a GCSE Group are permitted to have different priorities. It is required that the uplink traffic, i.e. the traffic from UE to GCSE AS, also reflects the user priority in the GC. If the GCSE AS informs the EPS about group member related priorities, the EPS shall take this into account when mapping to the ARP parameters for the uplink traffic. For the downlink traffic only the GC priority needs to be reflected.

GC may have different media, e.g. voice/image. In such case, the media belonging to the same GC may have different priorities. If the GCSE AS informs the EPS about media related priorities, the EPS shall take this into account when mapping to the ARP parameters. For a particular downlink media within a PLMN the priority level should however be the same no matter which transport path (i.e. unicast or multicast) is selected.

One UE can join multiple GCs simultaneously. All the signalling traffic from UE to the GCSE AS may share the same connection. In such case it is required that the bearer transferring the signalling traffic always reflects the priority of the highest ongoing uplink traffic.

- Based on the above analysis, it is proposed that: For the unicast delivery the Application Function sends the application level priority, the communication group ID, user priority to the PCRF via Rx interface. Based on those parameters PCRF maps the received application layer priority to the EPS level ARP parameter and sends to the PGW.
- For the muliticast delivery, the GCSE AS need to send the application level priority, the communication group ID, to the BM-SC via the GC2 interface. Based on those parameters the BM-SC maps the received application layer priority parameter into the EPS level ARP parameter. When the eMBMS bearer is to be setup, the mapped ARP parameter is included.

6.7.2 Impact on existing entities and interfaces

For Rx interface the following parameters need be sent from AF to PCRF,

- Application level priority
- Communication group ID
- User priority

For GC2 interface the following parameters need be sent from AF to PCRF,

- Application level priority
- Communication group ID

6.7.3 Solution evaluation

Editor's Note: The fulfilment of requirements in clause 4.2 needs will be evaluated.

6.8 Solution 8: Service continuity from unicast to multicast delivery

This solution is related to Key issue #5 "Service Continuity".

6.8.1 Functional Description

This solution for service continuity from unicast to MBMS delivery proposes a 3GPP network-oriented approach to inform the UE about the established MBMS bearer service related to the GC received currently over unicast delivery.

The following are the main principles of this solution:

- The MME maintains UE context containing the GC service ID (GC-ID).
- The MME maintains MBMS bearer context containing GC service ID (GC-ID).
- Upon a handover of a UE into a cell which supports MBMS delivery for the GC service currently received over unicast, the MME indicates to the UE the TMGI of the GC service, so that the UE can join the MBMS delivery.

6.8.2 Procedures

Figure 6.8.2-1 shows the procedures for service continuity when the UE is connected to a cell which provides multicast delivery (i.e. eMBMS bearer service) of the GC service which is currently received via unicast delivery. It is proposed that the MME maintains a UE's context including the GC service identifier (GC-ID or APN). Upon handover, the MME determines that the GC service currently received over unicast bearer is distributed over eMBMS bearer in the target cell.

The thick arrows in Figure 6.8.2-1 show the data flow and the thin arrows show the signalling flow between the functional entities.

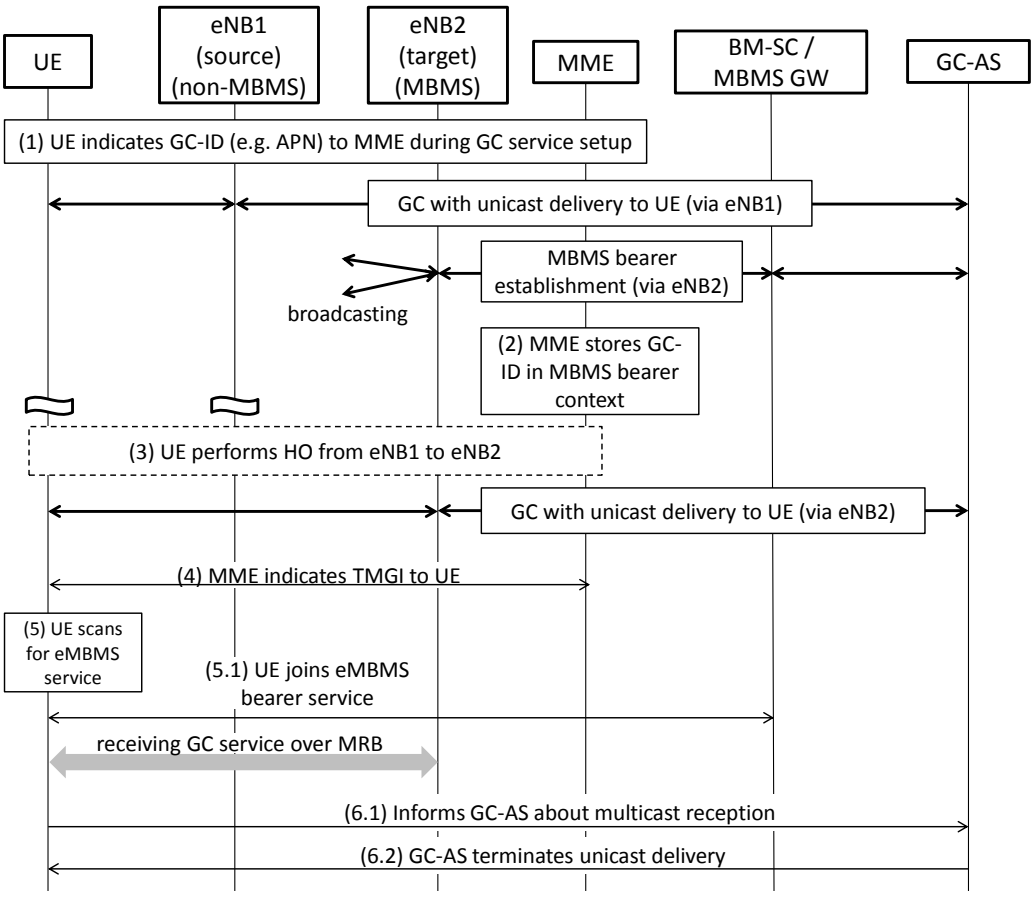


Figure 6.8.2-1: Service continuity when UE moves into eMBMS service area

The following steps are performed:

- In step (1) the UE establishes GC service over eNB1. The UE learns the GC service ID form the GC-AS and informs the MME with GC-ID over NAS exchange. As eNB1 is not part of the eMBMS bearer service (or no eMBMS bearer service has been established yet), the GC service delivery is via unicast bearer. The MME stores in the UE's context the GC service identifier (GC-ID, e.g. APN, session ID). Optionally the UE may indicate a GC-ID for the specific GC service. From the UE's point of view, the eMBMS bearer service can be seen as pre-established prior to the handover procedure.

- In step (2), the MME stores in the MBMS context the Group service identifier (GC-ID). The MME is able to map the relation of the GC-ID of the unicast bearers with the multicast MBMS bearer identifier.

Editor's Note: It is FFS how the MME is provided with the GC-ID in the MBMS bearer context.

- In step (3) the UE performs an inter-eNB handover from eNB1 to eNB2 according to 3GPP TS 23.401. After the handover procedure the UE receives the GC service data over unicast delivery via eNB2.

- In step (4), the MME determines that the GC service, which the UE receives over unicast EPS bearer, is provided by the eMBMS bearer in this cell. The MME indicates to the UE that the GC service can be obtained via eMBMS bearer service, e.g. MME indicates the TMGI of the eMBMS bearer service.

- In step (5) the UE starts scanning the broadcasted cell system information (SIB) to discover the radio resources for the eMBMS bearer service.
  In step (5.1) The UE initiates procedures to join the eMBMS bearer service as described in 3GPP TS23.246 [8].
  After steps (5) and (5.1) the UE is able to receive the GC service via eMBMS bearer service.

- In steps (6.1) the UE uses application-level signalling to inform the GC-AS about the ability to receive GC service data over multicast delivery. In step (6.2) the GC-AS can acknowledge the reception of the message in step (6.1) and to terminate the transmission of GC service data over unicast delivery.

The procedures described in Figure 6.8.2-1 are also applicable to the case where the eMBMS bearer service is established after or during the UE receives the GC service data over unicast delivery. After the eMBMS bearer service is set up, similar to step (4) in Fig. 10, the MME determines that the unicast EPS bearer established for GC service over eNB1 is used for the same service as the newly established eMBMS bearer service in eNB1's cell. The MME indicates to the UE that the GC service can be obtained via eMBMS bearer service, and more specifically the MME indicates the TMGI of the eMBMS bearer service.

6.8.3 Impact on existing entities and interfaces

Impacts to UE:

- Support transfer of MBMS-related information (TMGI) over NAS protocol.

Impacts to MME:

- Support transfer of MBMS-related information (TMGI) over NAS protocol to UE.
- Supports the reception and storing of Group session ID in the MBMS bearer context.

Impacts to BM-SC / MBMS-GW:

- Support the forwarding of Group session ID to the MME over SGmb and Sm interfaces.

6.8.4 Solution evaluation

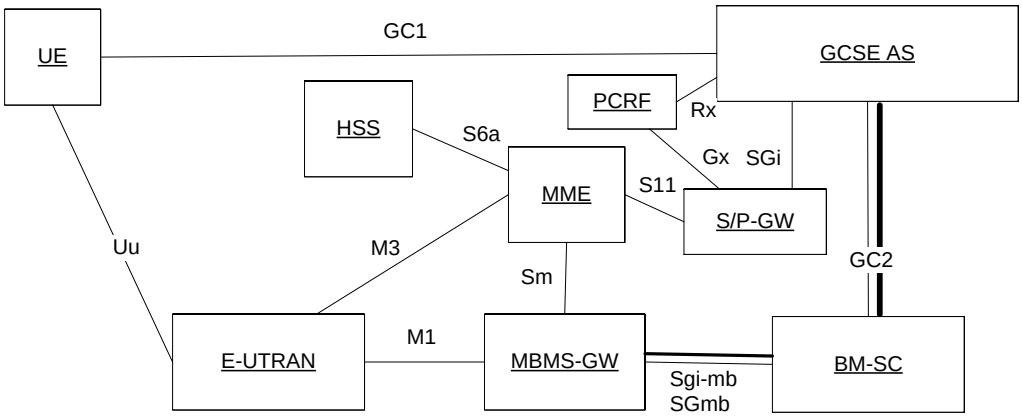
Editor's Note: The fulfilment of requirements in clause 4 needs will be evaluated.

7 Evaluation

Editor's note: this clause contains the overall evaluation of various solutions.

7.1 Common approach

The following architecture diagram shows a composite view of different solutions from clause 6.1 to 6.5.



NOTE 1: The usage of PCRF in lieu of GC2 is not depicted in this figure as the needs for this interface is still FFS.

Figure 7.1-1: Composite view of different solutions on GCSE

When analyzing the different solutions from the present document (clauses 6.1 to 6.5), the following principles were common among those and shall be used to form the base-line solution.

1. Use of BM-SC and MBMS-GW in the core network for Multipoint Service.
2. GC2 is used to request the setup of the Multipoint Service. GC2 consists on both user plane and control plane components.
3. GC1 is used by the UE for GCSE group registration and to relay eMBMS related info, and for signalling to the GCSE AS for the purpose of service continuity.. No protocol work is expected on GC1. It is shown for completeness only.
4. GCSE AS determines if DL media for a particular GCSE group communication (or UE/Receiving group member) is using Unicast Delivery or Multicast Delivery.
5. UL traffic is always done via unicast.
6. Multipoint Service is to be realized using eMBMS (TS 23.246 [8]).

7.1.1 Information exchanged between GCSE AS and BM-SC

The following information needs to be exchanged between the GCSE AS and BM-SC on the GC2 control plane interface:

From BM-SC to GCSE AS

- Service information (e.g., TMGI(s), IP address(es)/port(s) of the eMBMS media)
- Information regarding the bearer state (for e.g,, if the bearer was successfully established etc)
- Information needed to route media packets from GCSE AS to the BM-SC (e.g., IP address(es), port(s))

From GCSE AS to BM-SC

- MBMS Service area where the group call is targeted
- Session information (e.g., session start time, QoS etc)

Editor's Note: Other Information that can be conveyed via GC2 is FFS

Editor's Note: The need for exchanging id of group call from GCSE AS to BM-SC is FFS.

Editor's Note: The impacts to GC2 related to eMBMS security will be studied by SA3.

8 Conclusions

Editor's Note: The clause will capture agreed conclusions from the Key issues and Architecture Solutions clauses.

- The GCSE_LTE applications will use a mix of Unicast and eMBMS bearers. Any evolution of eMBMS or unicast bearers in rel-12 is assumed to be mostly impacting RAN layers only.
- In Rel-12 no UE-to-GCSE_LTE application-specific interface will be standardized by 3GPP (SP-130506). 3GPP still need to decide how TMGIs and associated security credentials are allocated. As no specification impact is expected, in Rel-12 some application developer guideline will be provided to document the kind of information applications and UE's need to exchange to use the unicast and the eMBMS bearers correctly.
- GCSE_LTE applications interact with the BMSC to enable for specific GCSE_LTE groups the establishment of eMBMS bearers for specific distribution areas, and with specific QoS level for specific IP flows.
  The BMSC provides the applications with the eMBMS service information for the various GCSE_LTE groups using eMBMS. As such, in Rel-12 it is expected the GC2 interface shall be standardized.
- Multiple GCSE Groups may be multiplexed on the same eMBMS bearer.
- The media distribution in DL for unicast is on SGi (no GC5 required).
- GC3 shall be the M1 interface.
- The functionality required to support the MUSE function is assumed to be split between the BMSC and the MBMS GW. Due to GCSE there are no (or only limited if any) expected change on the MBMS GW and on SGmb _
- GC4 is the Sm interface
- It is up to the application layer to deal with packet loss / duplication / not in sequence delivery of packets (e.g. related with switching between point-to-point and eMBMS delivery).

Annex A:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2013-04	SA2#96	-	-	-	TR skeleton generated for submission at SA2#96 (S2-131054) and the approved P-CRs (S2-131484, S2-131536, S2-131509). Editorial clean up.	-	0.1.0
2013-05	SA2#97	-	-	-	S2-132128, S2-132271, S2-132270, S2-132154, S2-132316, S2-132317, S2-132274, S2-132275, S2-132155, S2-132219, S2-132220, + editorial	0.1.0	0.2.0
2013-07	SA2#98	-	-	-	S2-132918, S2-133031, S2-133032, S2-133034, S2-132971, S2-132549, S2-133035, + editorial	0.2.0	0.3.0
2013-09	SA2#99	-	-	-	S2-133776, S2-133777, S2-133781, S2-133780, S2-133650, S2-133826, S2-133827, S2-133582, S2-133583, S2-133775, S2-133654, S2-133779, + editorial	0.3.0	0.4.0
2013-10	-	-	-	-	MCC clean-up	0.4.0	0.4.1