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| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on architectural enhancements for 5G multicast-broadcast services;  Phase 2  (Release 18) | |
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# 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:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

This Technical Report studies and evaluates further enhancements to the 5G Multicast/Broadcast Architecture in order to provide the following features.

- Enabling UE's receiving Multicast MBS Session data in RRC Inactive state.

- Study feasible and efficient resource utilization for the same broadcast content to be provided to 5G MOCN network sharing scenarios (i.e. multiple CNs are connected to the same NG-RAN).

- Study whether and how to support on demand multicast MBS session triggered by AF, and efficient resource utilization via 5GC choosing multicast and/or unicast delivery for a certain service.

- Study whether and how to support group message delivery for capability-limited devices, including NEF enhancement, coexistence of existing power saving mechanisms and MBS.

- Study whether there are any identified performance issues for high number of public safety UEs, and if yes study necessary enhancements to 5MBS for that scenario.

# 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 23.501: "System Architecture for the 5G System; Stage 2".

[3] 3GPP TS 23.502: "Procedures for the 5G system; Stage 2".

[4] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services; Stage 2".

[5] 3GPP TR 26.850: "MBMS for Internet of Things (IoT)".

[6] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications".

[7] 3GPP TS 23.280: "Common functional architecture to support mission critical services; Stage 2".

[8] 3GPP TS 24.379: "Mission Critical Push To Talk (MCPTT) call control; Protocol specification".

[9] 3GPP TS 22.179: "Mission Critical Push To Talk (MCPTT); Stage 1".

[10] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[11] 3GPP TS 26.502: "5G Multicast-Broadcast User Service Architecture".

# 3 Definitions of terms and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms 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] and TS 23.247 [4].

**example:** text used to clarify abstract rules by applying them literally.

## 3.2 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] and TS 23.247 [4].

<ABBREVIATION> <Expansion>

# 4 Architectural Assumptions and Principles

## 4.1 Common architectural requirements and principles

Editor's note: This clause will document any architectural assumptions and principles for the study

- Solutions shall build on the 5G System architectural principles as in TS 23.501 [2], including flexibility and modularity for newly introduced functionalities.

- The system shall provide an efficient transport for a variety of multicast and broadcast services.

- Only NR of NG-RAN connected to 5GC is considered as RAT.

- Architecture reference models defined in TS 23.247 [4] clause 5.1 are used as the baseline architecture for this study. Enhanced Architecture and Solutions in this study shall enable UEs with Rel-17 MBS capability to receive MBS data from Rel-18 architecture/solutions.

Editor's note: The impact on RAN is to be analysed by and coordinated with the relevant RAN WGs.

Editor's note: This study may also include the potential enhancements identified by other WGs or other SIDs (e.g. FS\_ 5GSAT\_ARCH\_Ph2) in their MBS work that need SA WG2 cooperation.

## 4.2 Specific architectural requirements and principles for public safety service in a cell with large number of UEs

Public Safety specific architectural requirements and principles:

- Solutions shall enable simultaneous reception of MBS session data for a higher number of UEs in a cell than can be operating in RRC\_CONNECTED state, to participate in public safety group calls using MBS-based service.

- Solutions shall ensure that the pre-emption and admission control mechanisms result in public safety UEs being able to complete the setup of the MBS services and then operate according to regulation and operator policy, when a mix of UEs participating in one or more services and/or one or more sessions within each service is present in the cell.

NOTE 1: This issue, which involves other Working Groups, deals with aspects like recognizing which UEs may be moved to RRC\_INACTIVE (service continues via MBS) vs. moved to RRC\_IDLE (service may fail), not impacting the UE while the UE is setting up connections or waiting for the floor (permission to talk), ability to override user settings in order to be able to pre-empt, if necessary, etc.

- Solutions shall enable provision of assistance information to NG-RAN from the application function (AF) via 5GC, if required/needed.

Editor’s note: Solutions may require information to NG-RAN and application function (AF) to enable proper provisioning. This includes, e.g., the SA6 and RAN WGs deciding on, what information to be provided on, which members of a public safety group should stay in RRC\_CONNECTED and which one(s) are candidates for being transitioned to RRC\_INACTIVE.

- If MBS sessions are temporarily deactivated and are subject to subsequent (re)activation, resulting in UEs in e.g., RRC\_INACTIVE state which need to be (re)-awakened to receive MBS service, solutions may enable simultaneously wake up (for MBS reception) for all the UEs associated with the session.

NOTE 2: For active MBS Session, it is assumed that public safety applications (under the remit of SA6) will initiate minimum number and frequency of requests to transition to RRC\_CONNECTED state to perform uplink transmissions, while Public Safety UEs are in RRC\_INACTIVE state.

- Whether there is a need for additional solutions to minimize packet loss during MBS reception, this should be addressed together with RAN WGs.

# 5 Key Issues

## 5.1 Key Issue #1: Multicast MBS data reception in RRC Inactive state

### 5.1.1 Description

In order to provide MBS service to more UEs in a cell, NG RAN could enable UEs within an MBS multicast session to receive MBS session data while in CM-CONNECTED with RRC Inactive state.

The following aspect will be studied for multicast:

- Whether, how and what MBS assistance information to provide from 5GC to RAN for an MBS session allowing UEs in CM-CONNECTED with RRC Inactive state to receive MBS content, including the aspect which 5GC NF(s) determine the MBS assistance information and how they do so;

- Whether and how to enhance the current procedures (including mobility related procedures) for MBS session with member UEs in RRC Inactive state.

NOTE 1: During the study of this key issue, coordination with RAN WGs is needed before final conclusion.

NOTE 2: RAN WG will determine how the switching for the UEs belonging to MBS session from CM-CONNECTED state to CM-CONNECTED with RRC Inactive state (and vice versa) is performed by the RAN node.

## 5.2 Key Issue #2: 5MBS MOCN Network Sharing

### 5.2.1 Description

According to clause 5.18 of TS 23.501 [2], in a 5G Multi-Operator Core Network (5G MOCN), multiple CNs are connected to the same NG-RAN.

When the same broadcast content is to be delivered to multiple CNs, the AF will set up multiple broadcast MBS sessions towards those CNs, each CN delivering the same content towards the same shared NG-RAN node. Therefore, for a broadcast MBS Session, the consumed radio resource will be (N-1) times more than needed, where N is the number of CNs involved.

To investigate the feasibility of avoiding allocating more radio resource than needed, the following aspects need to be considered:

- Whether and how to assist NG-RAN node to determine the same content is delivered by broadcast MBS Sessions from different 5G CNs?

- Whether and how to assist NG-RAN node to determine which PLMN is used to broadcast the MBS session data?

- Which entity (e.g. AF or other NFs) could provide the assistance parameters to the shared NG-RAN if needed?

- Whether and how to enable the UE to receive the broadcast content from the broadcast PLMN when the UE camps on cells of other PLMNs?

NOTE 1: The feasibility of radio resource utilization optimization will be determined by RAN WGs.

NOTE 2: Collaboration with SA3 is required regarding the security issue.

## 5.3 Key Issue #3: On demand multicast MBS session

### 5.3.1 Description

For services shared by a group of users, e.g. background audio/video streams, status/warning update during the game, shared streaming of collaborative interactive application, enabling temporary multicast group for the service would be beneficial for operators to be more flexible to provide services with resource efficiency, i.e. dynamically creating multicast session when required by the service, and releasing them when not required.

Based on the triggers provided by the AF, e.g. information or request provided by the AF which allows multicast transport for a specific service, and other factors, on demand multicast MBS session may be created by the 5GS for the service. A similiar example in eMBMS is MBMS operation on Demand (MooD) defined by SA4.

The following aspects are to be studied:

- Use cases for on demand MBS multicast sessions and related requirements and potential gaps in Rel-17 MBS multicast procedures

- Whether and how to enhance the Release-17 MBS procedures to enable the on-demand multicast MBS session management. If needed, what information can be exposed by the 5GC to the AF or be provided by the AF, to enable on demand multicast MBS session management by AF.

NOTE: Coordination with SA4 is needed for study of this KI.

## 5.4 Key Issue #4: Group message delivery

### 5.4.1 Description

In previous Releases, group-based enhancements were introduced to enable an optimised handling of groups of UEs/subscriptions. In clause 5.5 of TS 23.682 [6], the group message delivery is specified via MB2 and xMB interfaces over eMBMS. This key issue will study whether and how to support Group Message Delivery over MBS for feature parity.

For this key issue, the following aspects will be studied:

- Whether and how to enhance the MBS functionality to provide a similar group message delivery as available in eMBMS.

- Whether group message delivery applies to MBS broadcast, MBS multicast, or both.

- Whether and how to provide a unified group message delivery applicable to both 5GS using MBS and EPS using eMBMS.

NOTE 1: Collaboration with SA4 is needed.

NOTE 2: Control plane cell broadcast is not included.

## 5.5 Key Issue #5: Coexistence with existing power saving mechanisms for capability-limited devices

### 5.5.1 Description

Capability-limited devices may use power-saving mechanisms to extend their battery live. Existing power saving mechanisms include MICO (Mobile Initiated Connection Only) mode, DRX (Discontinuous Reception), eDRX (Extended Discontinuous Reception).

MBS content should be transmitted to all devices at the same time to save transmission resources. However, the existing power saving mechanisms may prevent devices from receiving MBS content (for instance group messages).

This KI will study the following issue:

- Whether and how to support MBS content (for instance group message) delivery for capability-limited devices by considering coexistence of existing power saving mechanisms and MBS.

NOTE: In SA4, co-existence between power saving mechanism and eMBMS has been studied in TR 26.850 [5]. The study result in TR 26.850 [5] could be taken into consideration during the solution study of this KI.

## 5.6 Key Issue #6: Improvement for potential performance issues related to high numbers of public safety UEs

### 5.6.1 Description

Public safety requirements are documented in TS 22.179 [8] and related procedures are documented in TS 23.280 [7] and TS 24.379 [9].

Specific 5MBS requirements for public safety are documented in Clause 4.2.

Based on the 5MBS requirements for public safety documented in Clause 4.2, this Key issue will study whether there are any performance issues for high number of public safety UEs, and for identified performance issues related enhancements to 5MBS.

NOTE: Coordination with RAN WGs and SA6 WG will be required.

# 6 Solutions

## 6.0 Mapping of Solutions to Key Issues

Editor's note: This clause describes the mapping between solutions and key issues.

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Key Issues | | | | | |
| Solutions | 1  MBS session reception in RRC Inactive | 2  MOCN network sharing | **3**  On demand multicast MBS session | 4  Group Message Delivery | 5  Coexistence with existing power saving mechanisms for capability-limited devices | X  Improvement on performance issues for public safety UEs |
| 1 | X |  |  |  |  |  |
| 2 |  | X |  |  |  |  |
| 3 | X |  |  |  |  | X |
| 4 | X |  |  |  |  |  |
| 5 | X |  |  |  |  |  |
| 6 | X |  |  |  |  |  |
| 7 |  | X |  |  |  |  |
| 8 |  | X |  |  |  |  |
| 9 |  | X |  |  |  |  |
| 10 |  |  | X |  |  |  |
| 11 |  |  | X |  |  |  |
| 12 |  |  |  | X |  |  |
| 13 |  |  |  | X |  |  |
| 14 |  |  |  |  | X |  |
| 15 |  |  |  |  | X |  |
| 16 |  |  |  |  |  | X |
| 17 |  |  |  |  |  | X |

## 6.1 Solution #1: Procedures for RRC Inactive MBS data reception

### 6.1.1 Introduction

This solution addresses Key Issue #1.

### 6.1.2 Functional description

It is assumed to reuse the current architecture defined in Rel-17 MBS work (see TS 23.247 [4]). In other words, MB-SMF is used to handle MBS session-level management while SMF performs per-UE MBS session management, e.g. authorization, multicast session information provisioning, managing 5GC Individual MBS traffic delivery.

An AF creating a multicast session should be able to influence the service quality (more UEs vs. higher reliability) talking into consideration the specific needs of the service it offers. Thus the AF can enable or disable the transmission mode for inactive reception. However, the decision whether to apply that transmission mode if it is enabled remains with the RAN nodes.

Editor’s Note: Whether and how the AF can enable or disable the transmission mode for inactive reception is FFS. Whether the new term “transmission mode” can be avoided is FFS.

Procedures in the following clauses focus on the following functionalities:

- 5GC provisioning necessary parameters to NG-RAN node(s).

- Switching between RRC Connected and RRC Inactive modes.

There are two levels of priority as a part of 5GC-provided parameters, namely:

- MBS session priority: the MBS session priority denotes the priority level of an MBS session, and the priority level defines the relative importance of an MBS session. This allows the NG-RAN nodes deciding (the members of) which MBS session can be switched to RRC Inactive state, to free up resources of NG-RAN node upon e.g., congestion. NG-RAN node may also use it to decide (the members of) which MBS session can be switched to RRC Connected state, once the resources are regarded as sufficient.

The details of how the 5GC provides MBS session priority to NG-RAN node are further described in clause 6.1.3.2.

Editor’s Note: Whether the existing QoS parameters (e.g. ARP, 5QI) of the MBS QoS Flow(s) can be used for the MBS Session priority is FFS.

- UE session priority: the UE session priority denotes the priority level of a certain UE within a certain MBS session, and the priority level defines the relative importance of a UE for an MBS session. This allows the NG-RAN nodes deciding if the UE of an MBS session can be switched to RRC Inactive state, to free up resources of NG-RAN node upon e.g., congestion. NG-RAN node may also use it to decide if the UE of an MBS session can be switched to RRC Connected state, once the resources are regarded as sufficient.

The details of how the 5GC provides UE session priority to NG-RAN node are further described in clause 6.1.3.2.

Editor’s Note Whether and how the NG-RAN use the assistant information will be determined by RAN WGs.

Editor’s Note: Whether the MBS session priority or UE session priority is stored in MBS data or UE subscription data in the UDR/UDM is FFS.

Whether the transmission mode for inactive reception is applied depends on multiple factors:

- Backward compatibility with Rel-17 5MBS UEs not capable of receive 5MBS data while in RRC-inactive state. If such UEs that joined an 5MBS session are in a cell, MBS data need to be transmitted using the Rel-17 transmission mode for RRC-connected reception.

- UE preferences: UEs could prefer to receive MBS data in RRC inactive state to reduce their battery consumption, or in RRC connected state to increase the service quality.

Editor’s Note: Whether the decision to receive MBS data in RRC\_INACTIVE should be a RAN decision or can be UE preference is FFS.

- MBS session priority.

- UE session priority.

- Whether the transmission mode for inactive reception is allowed for specific multicast MBS service(s).

Editor's note: Those assumptions need to be confirmed by RAN WGs.

### 6.1.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

#### 6.1.3.1 General

NOTE: The message names in the procedures below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

#### 6.1.3.2 MBS session creation, multicast session join and session establishment procedure

 Figure 6.1.3.2-1: Enhancement to current MBS procedures for session creation and join

0. When UE registers, it indicates its capability to receive MBS multicast using the transmission mode for RRC inactive. It may also indicate a preference. This information is propagated to NG-RAN via AMF.

Editor’s Note: Whether UE preference is needed in FFS.

1.-2. When an AF requests the creation of a multicast MBS session, it indicates whether inactive/idle reception of multicast shall be enabled for that session. AF also provides the MBS session priority to MB-SMF, optionally via NEF or MBSF

Editor’s Note: Whether the existing QoS parameters (e.g. ARP, 5QI) of the MBS QoS Flow(s) can be used for the MBS Session priority is FFS.

3. The AF may also indicate in the service announcement towards the UE whether inactive/idle reception of multicast is enabled

4.-14 The information whether the inactive transmission mode is enabled for an MBS session is propagated from MB-SMF towards NG-RAN, via PDU session and/or via shared delivery of a multicast session. SMF provides the UE session priority to NG-RAN. In step 7, SMF includes UE session priority as a part of N2 SM information in Nsmf\_PDUSession\_UpdateSMContext response to AMF. In step 8, AMF sends the N2 SM information received from SMF to NG-RAN node during the shared tunnel establishment procedure, MB-SMF provides the MBS session priority to NG-RAN node. In step 13, since MB-SMF receives the MBS session priority in step 2, MB-SMF includes MBS session priority in the N2 SM information of Nmbsmf\_MBSSession\_ContextUpdate response message. And AMF sends N2 MBS Session response message to NG-RAN node in step 14.

15. The NG-RAN decides the transmission mode to apply for the MBS multicast session in a cell.

Editor's note: How SMF gets the UE session priority within the MBS session is FFS.

#### 6.1.3.3 Moving a UE to RRC Inactive state



Figure 6.1.3.3-1: NG-RAN node moves a UE to CM-CONNECTED with RRC Inactive state

0. 5GC provides assistance information of RRC Inactive multicast MBS data reception to NG-RAN node, details see clause 6.1.3.2. UE receives multicast MBS data in CM-CONNECTED mode.

Editor's Note: Whether/what assistance information is needed is to be coordinated with RAN WGs. It is ffs if some UEs in the same cell can receive MBS data in RRC Inactive reception mode and other UEs can receive MBS data in Rel-17 reception mode.

1. RAN determines to move UE in multicast MBS session to RRC Inactive state and the transmission mode to apply for the MBS multicast session in a cell taking the assistance information into consideration.

Editor's note: Determination of switching to RRC Inactive will be confirmed by the RAN WGs.

2. NG-RAN node releases the RRC connection and moves the UE to CM-CONNECTED with RRC Inactive state.

Editor's note: How to release the UEs belongs to multicast MBS session will be determined by RAN WGs.

3. UE receives multicast MBS data in CM-CONNECTED with RRC Inactive mode.

Editor's note: RAN WGs will determine the configuration of UE receiving multicast MBS data in RRC Inactive.

#### 6.1.3.4 Moving a UE to RRC-CONNECTED from RRC Inactive state



Figure 6.1.3.4-1: NG-RAN node moves a UE to RRC-CONNECTED state

0. 5GC provides assistance information of RRC Inactive multicast MBS data reception to NG-RAN node, details see clause 6.1.3.2. UE receives multicast MBS data in CM-CONNECTED with RRC Inactive mode.

Editor's note: Whether/what assistance information is needed is to be coordinated with RAN WGs.

1. RAN determines to move UE in multicast MBS session to RRC-CONNECTED state based on the assistance information as described in clause 6.1.2.

Editor's note: Determination of switching to RRC Inactive will be confirmed by the RAN WGs.

2. NG-RAN node informs related UEs to RRC-CONNECTED state.

Editor's note: How to inform the related UEs belonging to multicast MBS session will be determined by RAN WGs.

3. UE receives multicast MBS data in RRC-CONNECTED mode.

Editor's note: RAN WGs will determine the configuration of UE receiving multicast MBS data in RRC-CONNECTED mode.

### 6.1.4 Impacts on services, entities and interfaces.

Editor's note: This clause describes impacts to existing services, entities and interfaces.

Functional entities defined in clause 5.3.2 of TS 23.247 [4] is reused.

AF:

- The AF includes the MBS session priority and information whether the transmission mode for inactive reception is enabled in the message sent to MB-SMF.

MB-SMF:

- The MB-SMF stores MBS session priority and information whether the transmission mode for inactive reception is enabled as a part of multicast context, and provides MBS session priority and information whether the transmission mode for inactive reception is enabled to the NG-RAN node.

SMF:

- SMF fetches the UE MBS priority and provide to the NG-RAN node during PDU Session modification/establishment procedure.

NG-RAN:

- Determine the transmission mode for an MBS session in a cell and which UE can be switched RRC Inactive/Connected mode based on the UE MBS priority and MBS session priority from SMF/MB-SMF, respectively.

UE:

- Indicate capability and preference for multicast reception in RRC inactive state.

Editor's note: Additional impacts are FFS.

## 6.2 Solution #2: Procedures for MOCN network sharing

### 6.2.1 Introduction

This solution addresses Key Issue #2.

### 6.2.2 Functional description

Editor's note: This clause outlines solution principles and documents any assumptions made.

It is assumed to reuse the current architecture and TMGI definition in Rel-17 MBS work (see TS 23.247 [4]). In other words, MB-SMF is used to handle MBS session-level management while SMF performs per-UE MBS session management, e.g. authorization, multicast session information provisioning, managing 5GC Individual MBS traffic delivery.

the

It is assumed that for the MBS sessions identified by the same "identifier of the broadcast MBS service", the NG-RAN node will use the same radio resources, but still broadcast the TMGIs for different PLMNs. In other words:

- UE: UEs of different PLMNs behave the same as Rel-17, i.e., listen to the control channel of the TMGIs broadcasted by the NG-RAN node and receive the broadcast data.

- NG-RAN node: NG-RAN node behave the same as Rel-17, i.e., broadcasts the TMGIs of different PLMNs, but the NG-RAN node also use the same radio resources for transmitting the MBS data of different TMGIs but with the same "identifier of the broadcast MBS service".

### 6.2.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

#### 6.2.3.1 General

NOTE: The message names in the procedures below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

Editor's note: It will be confirmed by the RAN WG that whether the additional identifier is needed,

Editor's note: Support of the encrypted content reception is FFS.

Editor's note: The format of this non-PLMN specific identifier, and how to ensure its uniqueness is FFS.

#### 6.2.3.2 Broadcast Session Establishment



Figure 6.2.3.2-1: Broadcast Session Establishment for MOCN network sharing

The following additions apply compared to clause 7.3.1 of TS 23.247 [4]:

1. AF performs TMGI allocation and MBS session creation as specified in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4]. The AF further includes the identifier of the broadcast MBS service in MBS session creation request.

2. MB-SMF invokes Namf\_MBSBroadcast\_ContextCreate Request with further including identifier of the broadcast MBS service in the N2 SM container received in step 1.

4. NG-RAN node creates a Broadcast MBS Session Context, stores the TMGI, the QoS Profile and the identifier of the broadcast MBS service in the MBS Session Context, if the Broadcast MBS Session Context does not exist (i.e. the other PLMN network sharing the NG-RAN node has not requested for the same broadcast MBS service to be established at the NG-RAN node).

If the NG-RAN node already exists, i.e., NG-RAN nodes stores the same "identifier of the broadcast MBS service" in the MBS Session Context of other MBS session, then the NG-RAN node reuses the previously allocated radio resources of the MBS session identified by the same "identifier of the broadcast MBS service", as the one for the newly requested MBS session. In other words, all MBS sessions having the same "identifier of the broadcast MBS service" shares the radio resources. When the NG-RAN node receives the DL MBS data of the requested MBS session afterwards, it will not send the received data in the air interface.

9. NG-RAN broadcasts the TMGI representing the MBS service over radio interface.

NOTE: This step is same as the session start procedure in TS 23.247 [2]; it is included here for the sake of clarity.

Editor's note: Details will be confirmed by the RAN WGs.

#### 6.2.3.3 Broadcast Session Release



Figure 6.2.3.3-1: Broadcast Session Release for MOCN network sharing

The following additions apply compared to clause 7.3.2 of TS 23.247 [4]:

4. After NG-RAN node receives multiple N2 message to release the MBS Session for the TMGI (e.g. from several AMFs the NG-RAN is connected to), if there is no other PLMN requesting to the broadcast MBS service, the NG-RAN node performs step 5 and step 6.

If the MBS session is about to be released, and 1) the NG-RAN nodes uses its MBS data as the one sending in the air interface, and 2) there are other MBS sessions identified by the same "identifier of the broadcast MBS service", then the NG-RAN node will select DL data of one other MBS session of the same "identifier of the broadcast MBS service" and send its data using the previous allocated radio resources.

Editor's note: Details will be confirmed by the RAN WGs.

### 6.2.4 Impacts on services, entities and interfaces

Editor's note: This clause describes impacts to existing services, entities and interfaces.

Functional entities defined in clause 5.3.2 of TS 23.247 [4] is reused exception for the following additions:

AF, NEF:

- Support to provide/process the identifier of the broadcast MBS service during broadcast session establishment procedure.

MB-SMF:

- Include the identifier of the broadcast MBS service to the N2 SM container sent to NG-RAN node.

NG-RAN:

- Support to identify the broadcast MBS service from 5GC and use the same resources for the same broadcast MBS service.

- Support to configure radio bearer of the MBS sessions with the same "identifier of the broadcast MBS service" with the same radio resources.

- Refrain from sending the data of the subsequently established MBS session with the same "identifier of the broadcast MBS service" to the UEs.

Editor's note: UE impacts and other additional impacts are FFS.

## 6.3 Solution #3: AF providing assistance information

### 6.3.1 Introduction

This solution addresses the following bullet in Key Issue #1.

- Whether, how and what MBS assistance information to provide from 5GC to RAN for an MBS session allowing UEs in CM-CONNECTED with RRC Inactive state to receive MBS content, including the aspect which 5GC NF(s) determine the MBS assistance information and how they do so.

### 6.3.2 Functional description

After the multicast MBS session is created, the AF may provide to the 5GC the group member information (e.g., whether a member belongs to a “privileged” category in a multicast group) so that the group members’ UEs are not sent to RRC\_INACTIVE state and those members get the best possible service (e.g., voice quality, response time, assurance of not getting pre-empted, etc.).

The 5GC then forward this information to NG-RAN to assist the RAN in the decision which UEs can be sent to RRC\_INACTIVE when needed.

The group member information consists of the following:

- MBS Session ID,

- group member category (e.g., privileged, non-privileged)

### 6.3.3 Procedures

The following existing procedures specified in TS 23.502 [3] are reused for the AF to provide assistant information, i.e., group member information (e.g., whether a member belongs to a “privileged” category in a multicast group):

- 4.15.6.6 AF session with required QoS Create procedure

- 4.15.6.6a AF session with required QoS update procedure

- 4.16.5.2 PCF initiated SM Policy Association Modification

- 4.3.3.2 UE or network requested PDU Session Modification (non-roaming and roaming with local breakout)

Compared to clause 4.15.6.6 AF session with required QoS Create procedure of TS 23.502 [3], the additional group member information may be included in the following service operations:

- Step 1: Nnef\_AFsessionWithQoS\_Create request

- Step 3: Npcf\_PolicyAuthorization\_Create request

Compared to clause 4.15.6.6a AF session with required QoS Update procedure of TS 23.502 [3], the additional group member information may be included in the following service operations:

- Step 1: Nnef\_AFsessionWithQoS\_Update request

- Step 3: Npcf\_PolicyAuthorization\_Update request

Compared to clause 4.16.5.2 PCF initiated SM Policy Association Modification, there is following addition:

- Step 4 In Npcf\_SMPolicyControl\_UpdateNotify service operation may include group member information.

Compared to clause 4.3.3.2 UE or network requested PDU Session Modification (non-roaming and roaming with local breakout), there are following additions:

- Step 3b PCF initiated SM Policy Association Modification, same as step 4 of clause 4.16.5.2

- If the UE has joined the MBS Session and the PDU Session UP activated, the SMF provides the group member information via PDU Session Modification towards the NG-RAN.

If the UE has not joined the MBS Session or the UE has joined the MBS Session but does not have PDU Session UP activated, the SMF stores the group member information. The SMF sends the information to NG-RAN next time when PDU Session UP is activated for UE that has joined the MBS Session.

### 6.3.4 Impacts on services, entities and interfaces.

AF:

- See clause 6.3.3

NEF

- See clause 6.3.3

PCF:

- See clause 6.3.3

SMF:

- See clause 6.3.3

UPF:

- No impact. The new parameter of MBS member priority is only used in NG-RAN.

NG-RAN:

- The NG-RAN receives the group member information in PDU Session setup or modification.

Editor’s Note: How the group member information is used by NG-RAN requires collaboration with RAN WGs.

## 6.4 Solution #4: MBS session management for RRC Inactive MBS data receiving UE

### 6.4.1 Introduction

This solution addresses Key Issue #1, especially on the enhancement of MBS session management for RRC Inactive MBS data receiving UE.

### 6.4.2 Functional description

This solution builds on top of solution 1. The multicast session management include following procedures:

* MBS session activation, the group-based paging may be executed. If a UE in RRC-INACTIVE state is allowed to receive multicast data in that state, a paging reaction is not needed due to it does not need to resume the RRC connection for receiving the MBS data. But paging reaction for other group member UE, which are in RRC-IDLE state or which need to receive the MBS data in the RRC connected state, is still needed.
* Multicast session deactivation/multicast session update, no impact to the existing procedure as define in TS 23.247 [4]. If the UE is in the CM-IDLE state and need be notified, the paging is per UE paging.
* Multicast session release, the group-based paging may be executed. Paging reaction is needed for all UE as they all need go back to CM-CONNECTED with RRC-CONNECTED state.

Per above consideration, it is suggested to focus on how to page UE due to the MBS session activation and MBS session release. The intention is to avoid RRC-INACTIVE group member UE, which supports receiving multicast service in RRC-inactive state, resume the RRC connection blindly if the paging event is for activation.

Editor´s Note: Paging procedures are under remit of the RAN groups and any related enhancements need to be confirmed by RAN groups.

### 6.4.3 Procedures



**Figure 6.4.3.1-1: Multicast Session Activation/Release Procedure.**

1. UE joins the multicast MBS session via the procedure as defined in clause 7.2.1.3 of TS 23.247 [4].
2. In some cases, e.g., due to radio resource congestion, NG-RAN could move one or multiple multicast group member UEs to RRC-INACTIVE state and those UEs are still able to received multicast MBS data.
3. The multicast MBS session becomes inactive via the procedure as defined in clause 7.2.5.3 of TS 23.247 [4]. The group member UE can be moved to CM-IDLE or CM-Connected with RRC Connected/Inactive state.
4. After some time, MB-SMF triggers the multicast session activation or multicast session release.
5. MB-SMF sends Nmbsmf\_MBSSession\_ContextStatusNotify to SMF(s), same as step 2 of clause 7.2.5.2 or step 1a of clause 7.2.2.3 of TS 23.247 [4], which also includes the MBS session status, i.e. activation or release.

NOTE: Step 1, 3-5 are same as the one defined in TS 23.247 [4].

1. Based on the event information, the SMF determines whether the event is for MBS session activation or MBS session release. If the RRC inactive state MBS receiving function is supported at the network and the notification is for MBS session activation, the SMF includes the event information in Namf\_MT\_EnableGroupReachability Request to AMF. Other parameters in the Namf\_MT\_EnableGroupReachability Request to AMF are same as specified in TS 23.247 [4].

Editor´s Note: Whether SMF needs to know that the function that RRC-INACTIVE UE can receive the MBS data is supported or not is FFS.

1. If AMF determines that there are UEs in CM-IDLE state among the UEs provided by the SMF in step 6, based on the event information received from SMF, the AMF includes the MBS session ID and a paging cause in the paging message sent to NG-RAN, the paging case is used to indicate the paging is for MBS session activation.
2. The NG-RAN performs the group paging by sending the MBS session ID and paging cause.

For RRC-inactive UE(s) that joined the MBS session and receive multicast service in RRC-INACTIVE state, if the paging cause indicate the paging is for MBS session activation for MBS session they are receiving, those UE(s) may still keep in RRC-INACTIVE state and do not perform RRC connection resumption. Otherwise, i.e. group paging is not for MBS session activation for MBS session they are receiving, those UE(s) send RRC connection resumption message to NG-RAN.

Editor´s Note: It needs to be confirmed that RRC-INACTIVE UEs also listen to the paging for RRC IDLE UEs, and not only to RAN paging.

Editor´s Note: It is FFS whether and how UEs, NG-RAN nodes, or AMF also need to consider the transmission mode used in the cell where the UEs are comping to decide whether they can remain in RRC-INACTIVE state.

For the UE(s) joined the MBS session and need receive multicast service in RRC-Connected state, the UE initiates the Service Request as usual.

1. For MBS session activation, step 6-15 of clause 7.2.5.2 of TS 23.247 [4] is executed with the following difference:

* For the UE(s) joined the MBS session and allowed to receive multicast service in RRC-INACTIVE state, step 6-10 are skipped.

Editor’s Note: After receive step 12 in clause 7.2.5.2, it is FFS whether the NG-RAN need page the UE if the UE is in RRC Inactive state.

For MBS session release, step 3-9 of clause 7.2.2.3 of TS 23.247 [4] is executed.

### 6.4.4 Impacts on services, entities, and interfaces

UE:

* Aware whether the group paging is for multicast session activation.

AMF:

* Support receive the event information from SMF and generate the corresponding paging cause.

SMF:

* For MBS session activation, sends the event information (i.e. MBS session activation) to AMF.

NG-RAN:

* Support adding paging cause for group paging.

## 6.5 Solution #5: Mobility Procedures for UE supporting RRC Inactive MBS data reception

### 6.5.1 Introduction

This solution addresses Key Issue #1, especially on the mobility handling for UE supporting RRC Inactive state MBS data receiving.

### 6.5.2 Functional description

The procedures in clause 6.5.3.1 and 6.5.3.2 are used for the UE receiving the MBS data in RRC-inactive state, under the following mobility cases:

* Moving out of RNA and within the RA.

NOTE 1: The procedure includes a UE initiated service request handling, which can also be used for the case without mobility.

* Moving out of the RA.

NOTE 2: The target NG-RAN node could be either RRC-inactive MBS data reception supporting NG-RAN or non RRC-inactive MBS data reception supporting Node:

The procedures in clause 6.5.3.3 is used for RRC-connected multicast group member UE moves to RRC-inactive MBS reception supporting NG-RAN.

### 6.5.3 Procedures

#### 6.5.3.1 RRC-inactive multicast group member UE move out of RNA and within RA

Editor’s Note: In this clause, the NG-RAN behavior (e.g., interaction with UE) is to be determined by RAN WGs.

For the UE joined the multicast MBS session and allowed receiving MBS data in RRC-inactive state, if the UE moves out its RNA and within RA, it triggers the RNA update procedure as usual. Based on that procedure, the network configures the UE either still in the RRC Inactive state or in the RRC IDLE state per whether the UE context can be retrieved successfully or not.

* If the UE is in the RRC Inactive state and the network indicate support RRC Inactive MBS data reception, the UE is aware that the multicast service can be received in RRC Inactive state and not need perform Service Request.
* If the UE is in the RRC Inactive state and the network does not support RRC Inactive state MBS data reception, or in RRC Idle state, the UE invokes the Service Request to activate the user plane of the associated PDU session ID. During the user plane activation procedure, the SMF notifies the MBS session ID UE joined and the RRC inactive assistance information for MBS data receiving parameter in the N2SM Info to the NG-RAN. Per the received information, the individual or shared delivery path between the NG-RAN node and MB-UPF is established if needed. Later per NG-RAN configuration, the UE may be changed to RRC Inactive state to receive the MBS data.

RRC inactive assistance information for MBS data receiving parameter in the N2 SM Info to the NG-RAN. Per the received information, the individual or shared delivery path between the NG-RAN node and MB-UPF is established. Later per NG-RAN configuration, the UE may be changed to RRC Inactive state to receive the MBS data.

#### 6.5.3.3 RRC-connected multicast group member UE move to RRC-inactive MBS reception supporting NG-RAN

For the UE joined the multicast MBS session and in RRC-connected state to receive the MBS data, if the UE moves to a RRC inactive MBS reception supporting NG-RAN, the following additions applies compared to clause 7.2.3 of TS 23.247 [4]:

* For Xn handover, after the SMF receives the path switch request transfer information from target NG-RAN via AMF, the SMF includes the RRC inactive assistance information for MBS data receiving parameter in path switch request ACK (i.e., the N2SM Info) and sent to target NG-RAN.
* For N2 handover, after the SMF receives the Handover Required information from the source NG-RAN via the AMF, the SMF includes the RRC inactive assistance information for MBS data receiving parameter in the N2SM Info and sent to target NG-RAN within the Handover Request message via the AMF.
* After the handover procedure, based on the received RRC inactive assistance information for MBS data receiving parameter, the UE may be configured to RRC inactive state to receive the multicast MBS data same as defined in solution 1.

### 6.5.4 Impacts on services, entities, and interfaces

UE:

* When the UE receives the MBS data in RRC Inactive state and move to a new cell but not receive the MBS data, the UE need activate the associated PDU session via the service request or registration procedure.

SMF:

* Include the RRC inactive assistance parameter in N2 SM Info and sent to target NG-RAN during handover procedure.

6.6 Solution #6: Reusing the existing assistance info and Qos for RRC Inactive MBS data reception decision

6.6.1 Introduction

This solution it to address the Key Issue #1: Multicast MBS data reception in RRC Inactive state.

6.6.2 Functional description

In the TS 23.501 [2] clause 5.3.3.2.5, it defines "RRC Inactive Assistance Information" sent by AMF to NG-RAN. It includes DRX, eDRX, RA, Periodic Registration Update timer, MICO mode, Information from the UE identifier, Paging Cause Indication for Voice, PEIPS Assistance Information.

From the above Assistance information, there is no service related parameters except voice. In this solution, it keep the same principle, i.e. there is no service related parameters added to "RRC Inactive Assistance Information".

When the UE receives the multicast data in the RRC inactive, the major impact is the NG-RAN cannot receive the feedback, i.e. HARQ. It may cause the higher PER.

Editor’s Note: When there is need to differentiate the UEs involving in multicast MBS Sessions, how to achieve such differentiation is FFS.

So in addition to "RRC Inactive Assistance Information", the QoS parameters, e.g. PER in the 5QI can be used by NG-RAN to determine whether the UE can be sent to RRC Inactive state to receives the multicast MBS session data.

Editor’s Note: It is FFS whether the QoS parameters is received during the establishment of shared delivery procedure as defined in clause 7.2.1.4 of TS 23.247 [4].

NOTE: The NG-RAN can use the physical channel status to determine whether the UE can be sent to RRC Inactive state meanwhile meeting the QoS requirement of the multicast service. Decision based on the channel status is out of SA2 scope.

6.6.3 Procedures

None

6.6.4 Impacts on services, entities and interfaces.

None

## 6.7 Solution #7: MOCN RAN Sharing

### 6.7.1 Introduction

This solution addresses the following aspect in Key Issue #2.

### 6.7.2 Functional description

This solution utilizes the first allocated TMGI to be the identifier to associate broadcast MBS sessions from different CNs which transmitting the same content.

The AF gets the TMGI from the broadcast MBS session which is created first. The AF provides it as an associated TMGI to the other CNs when creating other broadcast MBS sessions with the same broadcast content. In other CNs, MB-SMF provides the associated TMGI to the NG-RAN via AMF. And then, NG-RAN can utilize the associated TMGI to associate those broadcast MBS sessions.

NG-RAN establishes the user planes for all broadcast MBS sessions. Based on the association information, the NG-RAN deliver only one broadcast MBS session over the air (the broadcast MBS session which is created firstly) and drop the packets from other broadcast MBS sessions.

Editor's note: It is FFS whether NG-RAN should avoid establishing UP resources for the second and later broadcast MBS sessions for more saving.

In the service announcement for all broadcast MBS sessions delivering the same content, AF provides all the relevant TMGIs to the UEs. The UEs can check SIB to listen to any of the TMGIs to receive content.

Editor's note: It is FFS whether the UEs can avoid the scanning of all TMGIs when receiving contents.

Editor's note: Support of the encrypted content reception is FFS.

### 6.7.3 Procedures

#### 6.7.3.1 General

NOTE: The message names in the procedures below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

#### 6.7.3.2 MBS Session Creation



Figure 6.7.3.2-1: MBS Session Creation for MOCN RAN sharing

In the service announcement for all broadcast MBS sessions delivering the same content, AF provides all the relevant TMGIs to the UE.

AF creates the first broadcast MBS session as clause 7.1.1.2 of TS 23.247 [4], and AF utilizes the TMGI of this broadcast MBS session to the associated TMGI.

The following additions apply compared to clause 7.1.1.2 of TS 23.247 [4] when AF creating the second and later broadcast MBS sessions:

8. The AF provides the TMGI of the broadcast MBS session which is created first as the associated TMGI to the NEF/MBSF when invoking Nnef\_MBSSession\_Create Request.

11. The NEF/MBSF provides the associated TMGI to the MB-SMF when invoking Nmbsmf\_MBSSession\_Create Request. The MB-SMF stores the associated TMGI as a part of the MBS session context to be further distributed to NG-RAN in clause 6.7.3.3.

The same updates apply to clause 7.1.1.3 of TS 23.247 [4].

#### 6.7.3.3 MBS Session Start for Broadcast



Figure 6.7.3.3-1: MBS Session Start for Broadcast for MOCN RAN sharing

The following additions apply compared to clause 7.3.1 of TS 23.247 [4] when MBS Session Start for the second and later broadcast MBS sessions:

2-3. The MB-SMF provides the associated TMGI in the N2 SM container to the NG-RAN via AMF.

4. The NG-RAN creates the Broadcast MBS Session context including the associated TMGI.

9. If the NG-RAN understands the broadcast MBS Session is associated with another Broadcast MBS Session identified by the associated TMGI whose content has been delivered over the air, the NG-RAN will not further advertise the TMGI of this broadcast MBS Session.

15. If the NG-RAN understands the broadcast MBS Session is associated with another Broadcast MBS Session identified by the associated TMGIwhose content has been delivered over the air, the NG-RAN can silently drop packets received in this broadcast MBS session, and do not deliver them again.

Editor's note: Details will be confirmed by the RAN WGs.

Editor's note: It is FFS whether NG-RAN should avoid establishing UP resources for the second and later broadcast MBS sessions for more saving.

#### 6.7.3.4 MBS Session Release for Broadcast



Figure 6.7.3.4-1: MBS Session Release for Broadcast for MOCN RAN sharing

The following additions apply compared to clause 7.3.2 of TS 23.247 [4] when MBS Session Release for the broadcast MBS session which is created firstly:

5. If the NG-RAN determines there are other associated broadcast MBS sessions available, while the first broadcast MBS session is going to be released, it selects another broadcast MBS session. For this selected broadcast MBS session, the NG-RAN stop dropping the packets, advertise the TMGI of the selected session and deliver the packets over the air.

Editor's note: Details will be confirmed by the RAN WGs.

Editor's note: It is FFS whether the random selection in the NG-RAN can be improved.

### 6.7.4 Impacts on services, entities and interfaces.

Functional entities defined in clause 5.3.2 of TS 23.247 [4] are reused exception for the following additions:

AF:

- Use the TMGI for the broadcast MBS session which is created first and provide it as the associated TMGI to 5GC when creating MBS session for the second and later broadcast MBS sessions.

- In the service announcement, include all the relevant TMGIs whose broadcast sessions are used to deliver the same content.

NEF:

- Provides the associated TMGI to the MB-SMF if received in MBS Session Creation.

MB-SMF:

- Provides the associated TMGI to the NG-RAN if received in MBS Session Start for Broadcast.

NG-RAN:

- Support the associated TMGI and understand the association among those broadcast MBS sessions which delivers the same content.

- If the content is delivered in one broadcast MBS session over the air, drop the packets received from other broadcast MBS sessions and do not further advertise other TMGIs.

- If the broadcast MBS session that is used to deliver the content is released and there are other associated broadcast MBS sessions available, select another broadcast MBS session, stop dropping the packets of this broadcast MBS session, advertise the TMGI of the selected session and deliver the packets over the air.

Editor's note: UE impacts and other additional impacts are FFS.

## 6.8 Solution #8: Allocating and using MOCN TMGI

### 6.8.1 Introduction

This solution addresses key issue #2 "5MBS MOCN Network Sharing".

### 6.8.2 Functional description

The proposed solution introduces a MOCN TMGI used for MBS session when the related MBS service needs to be provided over PLMNs sharing NG-RANs. A MOCN TMGI is allocated by one of the PLMNs and the MBS session identified by the MOCN TMGI is established only with the PLMN that has allocated the MOCN TMGI. The AF transmits the DL media stream to the PLMN that the MBS session was established. Therefore, the NG-RAN shared by the multiple PLMNs receives the DL media stream only from the 5GC of the PLMN that the MBS session was established and transmits the media stream by using the MOCN TMGI.

For the MOCN TMGI, a Shared PLMN ID needs to be created and used by the PLMNs sharing NG-RANs. All the MB-SMFs in the PLMNs sharing NG-RANs are configured with the Shared PLMN ID so that the MB-SMFs can allocate the MOCN TMGIs.

Figure 6.8.2-1 shows an MBS example scenario including MOCN network sharing, specifically:

- The AF wants to provide MBS service over PLMN-A, PLMN-B, PLMN-C and PLMN-D, i.e. to the UEs that are served by these PLMNs.

- UE-A, UE-B, UE-C and UE-D are served by PLMN-A, PLMN-B, PLMN-C and PLMN-D, respectively.

- NG-RAN#1 is shared by PLMN-A, PLMN-B and PLMN-C while NG-RAN#2 belongs only to PLMN-D.

- NG-RAN#1 and NG-RAN#2 covers the MBS service area for the MBS service provided by the AF.

- The AF is configured about which PLMNs share the NG-RAN, i.e. PLMN-A, PLMN-B and PLMN-C.



Figure 6.8.2-1: MBS example scenario including MOCN network sharing

The outline of the proposed solution for allocating and using MOCN TMGI is as below:

- The AF performs TMGI allocation with only one PLMN among PLMNs sharing the NG-RANs to obtain a TMGI to identify new MBS session by indicating that MOCN TMGI allocation is requested (e.g. with PLMN-A in Figure 6.8.2-1).

- The MB-SMF allocates a MOCN TMGI and returns it to the AF.

- The AF performs MBS session establishment with the PLMN that has allocated the MOCN TMGI.

- The AF transmits the DL media stream to the PLMN that the MBS session was established.

### 6.8.3 Procedures

#### 6.8.3.1 Procedure for Broadcast using MOCN TMGI

Figure 6.8.3.1-1 shows the procedure for Broadcast using MOCN TMGI. This procedure is based on the MBS example scenario depicted in Figure 6.8.2-1.



Figure 6.8.3.1-1: Procedure for Broadcast using MOCN TMGI

1. The AF requests TMGI allocation with one of PLMNs that it wants to provide broadcast service over. In this figure, the AF performs TMGI allocation with PLMN-A to obtain a TMGI to identify new MBS session.

Steps 1 to 6 in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4] are performed with the following differences:

- In step 1, the following information is provided by the AF when requesting TMGI allocation.

a) A list of PLMNs that the AF wants to provide MBS service (i.e. PLMN-A, PLMN-B, PLMN-C in this fugure).

b) Indication that MOCN TMGI allocation is requested.

- In step 5, the MB-SMF allocates a MOCN TMGI based on the information provided by the AF and local configuration related to MOCN network sharing. In this figure, the local configuration related to MOCN network sharing is that PLMN-A, PLMN-B and PLMN-C share NG-RANs.

- In step 5, the following information is provided by the MB-SMF when returning the TMGI.

i) Indication that MOCN TMGI is allocated.

2. The AF may perform a Service Announcement towards UE-A, UE-B and UE-C.

3. The AF performs TMGI allocation with PLMN-D to obtain a TMGI to identify new MBS session as specified in steps 1 to 6 in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4].

The MBS session identified by the MOCN TMGI allocated in step 1 and the MBS session identified by the TMGI allocated in this step are for the same broadcast service.

4. The AF may perform a Service Announcement towards UE-D.

5. The AF performs MBS session creation with PLMN-A by providing description for the MBS session for a previously allocated MOCN TMGI in step 1, as specified in step 8 in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4].

6-7. The MBS session is established in PLMN-A as specified in steps 9 to 20 in clause 7.1.1.2 or steps 9 to 33 in clause 7.1.1.3 of TS 23.247 [4].

The AF may also perform a Service Announcement towards UE-A, UE-B and UE-C at this stage.

8. The AF performs MBS session creation with PLMN-D by providing description for the MBS session for a previously allocated TMGI in step 3, as specified in step 8 in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4].

9-10. The MBS session is established in PLMN-D as specified in steps 9 to 20 in clause 7.1.1.2 or steps 9 to 33 in clause 7.1.1.3 of TS 23.247 [4].

The AF may also perform a Service Announcement towards UE-D at this stage.

11. The AF starts transmitting the DL media stream to PLMN-A as specified in step 13 in clause 7.3.1 of TS 23.247 [4].

12. The MB-UPF of PLMN-A transmits the media stream to NG-RAN via N3mb multicast transport or point-to-point transport.

13. NG-RAN#1 shared by PLMN-A, PLMN-B and PLMN-C transmits the received DL media stream using DL PTM resources.

UE-A, UE-B and UE-C can receive the media stream.

14. The AF starts transmitting the DL media stream to PLMN-D as specified in step 13 in clause 7.3.1 of TS 23.247 [4]. The DL media stream is same to that in step 11 which means the AF transmits the same DL media stream to PLMN-A and PLMN-D.

Step 11 and step 14 can be performed in parallel.

15. The MB-UPF of PLMN-D transmits the media stream to NG-RAN via N3mb multicast transport or point-to-point transport.

16. NG-RAN#2 of PLMN-D transmits the received DL media stream using DL PTM resources.

UE-D can receive the media stream.

### 6.8.4 Impacts on services, entities and interfaces

AF:

- supports MOCN TMGI allocation request.

MB-SMF:

- supports MOCN TMGI allocation.

NEF:

- Nnef\_MBSTMGI\_Allocate service operation supports additional parameters related to MOCN TMGI allocation.

UE:

- supports MOCN TMGI.

NG-RAN:

- supports MOCN TMGI.

## 6.9 Solution #9: Broadcast services considering MOCN RAN

### 6.9.1 Introduction

Editor's note: This clause lists the key issue(s) addressed by this solution.

This solution addresses Key Issue #2.

### 6.9.2 Functional description

Editor's note: This clause outlines solution principles and documents any assumptions made.

It is assumed to reuse the current architecture in Rel-17 MBS specification (see TS 23.247 [4]).

A TMGI is assigned and used for a broadcast service in an operator’s network. However, if an NG-RAN is shared among operators, a primary TMGI may be selected and used instead of the TMGI in the shared NG-RAN if MOCN operators share a same broadcast service.

### 6.9.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

#### 6.9.3.1 General

When a broadcast service is shared among operator’s networks, the contents provider may recognize the using TMGI for each operator. So that if the operators share some NG-RAN(s) (call MOCN NG-RAN), AF/ contents provider may provide the TMGI list for the broadcast service to 5GS.

Then, the MOCN NG-RAN decides to use a primary TMGI out of the TMGI list, and the primary TMGI and its usage area (i.e. NG-RAN location or Cell IDs) is notified to AF so that such information can be announced to the UEs.

NOTE: Security (i.e. en/decryption of content) is assumed to be not supported in 5GS, but possible by application layer.

#### 6.9.3.2 Broadcast Session Start procedure



Figure 6.9.3.2-1: Broadcast Session start for MOCN NG-RAN

The following additions apply compared to clause 7.3.1 of TS 23.247 [4]:

0-3. AF performs TMGI allocation and MBS session creation as specified in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4]. The AF provides additionally the TMGI list for the broadcast service which each operator uses in MBS session creation request.

5-6. MB-SMF invokes Namf\_MBSBroadcast\_ContextCreate Request including AF may provide the TMGI list for the broadcast service which each operator uses in the N2 SM container.

7. NG-RAN node creates a Broadcast MBS Session Context. If the NG-RAN is MOCN NG-RAN, it selects a primary TMGI out of the TMGI list.

NOTE: How to select a primary TMGI follows local policy or NG-RAN implementation.

8-12. NG-RAN responds the primary TMGI and its location(e.g. Cell ID(s)) if the NG-RAN is MOCN NG-RAN, where such information is delivered to AF.

13. MOCN NG-RAN advertises the primary TMGI for the broadcast service instead of using the TMGI for operator’s network.

Editor's note: Details will be confirmed by the RAN WGs.

14. Service announcement to UEs includes the primary TMGI and its usage area (i.e. NG-RAN location or Cell IDs) as well as the TMGI for operator’s network.

15. Broadcast service media stream is delivered to MOCN NG-RAN.

Editor's note: Whether the broadcast service media stream is delivered to MOCN NG-RAN via the primary TMGI only or via each operator’s TMGI is FFS.

16. MOCN NG-RAN uses the primary TMGI only instead of TMGI for the same broadcast service.

17. UE receives the broadcast service via the primary TMGI when it is in the MOCN NG-RAN.

#### 6.9.3.3 Broadcast Session update procedure

Editor's note: To be added.

#### 6.9.3.3 Broadcast Session Release procedure

Editor's note: To be added.

### 6.9.4 Impacts on services, entities and interfaces

Editor's note: This clause describes impacts to existing services, entities and interfaces.

Functional entities defined in clause 5.3.2 of TS 23.247 [4] is reused exception for the following additions:

AF, NEF:

- Support to provide the TMGI list for the broadcast service which each operator uses in MBS session creation request only when there exists a MOCN NG-RAN among operators.

- obtain a primary TMGI which will be used in the MOCN NG-RAN and announce to UEs the primary TMGI and its usage area.

MB-SMF:

- send TMGI list of other networks for a same broadcast service to NG-RAN node.

NG-RAN:

- In case of MOCN NG-RAN, decide the primary TMGI for a same broadcast service, which will be used for the broadcast service in the MOCN NG-RAN.

UE:

- receive the broadcast service via the primary TMGI in the MOCN NG-RAN.

Editor's note: other additional impacts are FFS.

6.10 Solution #10: AF triggered MBS session management

6.10.1 Introduction

This solution addresses Key Issue #3.

This solution addresses the case that AF dynamically demands 5GC to use multicast transport for the content delivery, e.g., due to publisher dynamically provides the service and APP in UE interacts with AF for content fetching of the service, and according to the response from 5GC to select unicast mode for content delivery, e.g., UE does not support multicast transport (out of the scope of this study). The service may contain multiple media streams but only part of the media streams is demanded to use multicast transport.

6.10.2 Functional description

It is most popular today that content provider provides video to users via APP in UE, but in unicast transport style. Live stream dramatically grows today, which also uses unicast transport. The video services provided by AF can not only be published by the content provider, but also can be published by users of the content provider dynamically. The consumer will not only be a receiver in today’s video stream services, but also a participant to interact with the services, such as sending message to interact with the live stream salesperson, sending message when watching a video to share with all the viewers.

In most cases, the users visit the portal for requesting the content, and the AF holds most business logic for providing the services, e.g., the location related operations, the user authentication and authorization per the AF instead of the service, etc. And the service, in most cases, will contain multiple media streams that only part of the steams is demanded to be delivered via multicast transport. This business model is consistent for services provided by AF.

In order to use multicast transport for multicast streams of those services, the 5GC needs to identify the multicast data and uses multicast transport for the delivery and do not impact the AF service logic. And in order to not limiting the consumers based on the UE capability, the 5GC and AF needs to prepare unicast mode in case the UE does not support receiving data with multicast transport (this is out of the scope of this study).

Release 17 5MBS uses the model that most service logic is done by 5GC although provisioned by AF (e.g., area restriction per user or per MBS Session, authorization logic no matter whether it can map to R17 5MBS authorization method or not, etc.), which means the AF shall hand over lots of logic to operator. This solution reuses the current unicast business model to provide an alternative solution for content providers.

Editor´s note: The following text is FFS and valid examples and more explanation needs to be provided: Release 17 5MBS uses the model that most service logic is done by 5GC although provisioned by AF, which means the AF shall hand over lots of logic to operator. This solution reuses the current unicast business model to provide an alternative solution for content providers.

Editor´s note: Further explanation is required why the use cases in this clause cannot be addressed with Rel-17 MBS procedures.

Editor´s note: The functional description needs to be enhanced to cover not only use cases but also key technical ideas.

6.10.3 Procedures

6.10.3.1 General

Following figure 6.10.3.1-1 shows the general concept of the solution:



**Figure 6.10.3.1-1: General concept**

The AF delivers the multicast data of different multicast sessions to the 5GC, which may be in a tunnel between the AF and the 5GC if the transport network between the AF and 5GC does not support multicast. The AF can send multiple MBS Session data in one tunnel, the 5GC distinguishes the multicast session based on the mapping between the packet filters and the MBS Session ID. The content delivery is requested by the UEs over application layer, and the AF handles the service logic.

The content provider may use a portal to publish the services, which may be dynamically published, e.g., a live stream arranged by a live streamer, a live interview for breaking news, etc. The user may visit the portal via an APP in the UE and request the content of an MBS service, which may be interactive MBS service, i.e., contains multicast service data and unicast service data. Although service announcement for MBS Session is supported, but currently most content providers still want to use web portal, which is consistent as unicast service announcement.

The AF of the content provider sends the flow descriptions per UE, which includes different multicast services, to the 5GC for asking transport for the services just like currently used for unicast services, but the flow descriptions includes multicast information.

Editor´s note: More explanation about the difference to existing MBS procedures is required. The MBS AF can already provide service announcements and it is ffs whether the above procedure can be regarded as service announcement.

6.10.3.2 MBS Session Configuration procedure

This is an optional procedure, and the purpose to for negotiate the information for establishing the tunnel for multicast data delivery for the AF. The Ingress address of MB-UPF/MBSTF may be preconfigured for an AF or multiple AFs, in this case the procedure is not needed to be performed. This procedure does not create MBS Session, clause 7.1.1.2 and 7.1.1.3 of TS 23.247 [4] can be used for the MBS Session Creation. Considering the multicast content may be dynamically published, the AF wants to have on-demand multicast service delivery, so this procedure only configures the transport for all multicast service data.

The differences between this procedure and the MBS Session Creation procedures in clause 7.1.1.2 and 7.1.1.3 of TS 23.247 [4] are as following:

- The request from AF does not include MBS Session ID, Service type, QoS requirement, which are related to an MBS Session.

- The PCC is not involved if deployed.

- No TMGI allocation procedure in prior.

- The MB-SMF is discovered and registers per AF.



**Figure 6.10.3.2-1: MBS Session Configuration management procedures**

1. For creating the configuration for MBS services, the AF sends MBS Session Configuration Create Request (AF ID, [Area Info]) towards the NEF/MBSF. For updating the configuration for MBS services, the AF sends MBS Session Configuration Update Request (AF ID, Area Info) towards the NEF/MBSF. For deleting the configuration for MBS services, the AF sends MBS Session Configuration Delete Request (AF ID) towards the NEF/MBSF.

If the AF only provides services in a limited area, the Area Info may be included, which may be a geographic area or civic address information.

2. The NEF/MBSF authorizes the AF.

3. If authorization succeeds, the NEF/MBSF first discovers the MB-SMF from the NRF by providing the AF ID, The NRF selects the MB-SMFs configured for the AF and responds with the information of the MB-SMFs. For creation, if no MB-SMF is found, the NEF/MBSF then discovers the MB-SMF by the Area Info, the Area Info is received from step 1, or is locally configured for the AF. For update, if the returned MB-SMFs is not able to cover the Area Info, the NEF/MBSF then discovers the MB-SMF by an appropriate Area Info. The NRF selects the appropriate MB-SMFs according to the Area Info and responds with the information of the MB-SMFs.

4. For creation and update, the NEF/MBSF selects the MB-SMFs, according to the Area Info if needed, and invokes MBS Session Configuration Create Request (AF ID, [Area Info]) or MBS Session Configuration Update Request (AF ID, Area Info) towards the MB-SMFs. For deletion, the NEF/MBSF invokes MBS Session Configuration Delete Request (AF ID) towards the MB-SMFs.

5. For creation and update, if the MB-SMF has not registered AF ID to the NRF, the MB-SMF registers the AF ID to the NRF. For deletion, the MB-SMF deregisters the AF ID from the NRF.

6-7. For creation, the MB-SMF selects MB-UPF, according to the received Area Info if received, and may interact with the MB-UPF to create an Ingress address for the AF. For update, the MB-SMF selects MB-UPF that does not serve the AF and may interact with the MB-UPF to create an Ingress address of the AF. For deletion, the MB-SMF may interact with the MB-UPF that serves the AF to release the connection resources.

8. The MB-SMF responds to the NEF/MBSF, for creation and update, the MB-SMF sends the Ingress address and corresponding Area Info to the NEF.

9-10. For creation and update, if MBSF decides to involve MBSTF, the MBSF interacts with the MBSTF with the received Ingress address, and MBSTF returns Ingress address of the MBSTF. For deletion, if MBSTF is involved in creation, the MBSF interacts with the MBSTF to release the connection resources.

11. The NEF/MBSF responds to the AF. For creation and update, the NEF/MBSF sends the Ingress address and optional corresponding Area Info to the AF. The Area Info is used by the AF to determine which Ingress address is used to deliver the MBS data based on UE location.

Editor´s note; More explanation about the meaning of MBS connection is required. How does it related to MBS sessions? What is the purpose to establish it separately? How is the MBS session established?

6.10.3.3 AF triggered MBS Session management procedures with PCC

This procedure is for AF triggered MBS Session Join or Leave when dynamic PCC is deployed.



**Figure 6.10.3.3-1: AF triggered MBS Session management procedures with PCC**

1. The UE established a PDU Session as described in clause 7.2.1.2 of TS 23.247 [4], during the PDU Session Establishment procedure, the UE indicates the MBS capability to SMF. The content provider may use a portal to publish the services, which may be dynamically published, e.g., a live stream arranged by a live streamer, a live interview for breaking news, etc. The user may visit the portal via an APP in the UE and request the content of an MBS service or stops the content of an MBS service, which may be interactive MBS service, i.e., contains multicast service data and unicast service data. The APP sends UE address and the UDP port for receiving the multicast data to the AF.

The AF may perform procedure as described in clause 6.10.3.2 for creating or removing the tunnel between the AF and some MB-UPFs.

NOTE: In case UE has multiple PDU Sessions, the URSP in the UE needs to make sure that the APP uses the associated PDU Session for unicast traffic delivery.

2-5. The steps are same as described in TS 23.502 [3] clause 4.15.6.6 and 4.15.6.6a with following differences:

- The name of service operations exposed by NEF is different, and the flow description(s), if included, includes some packet filters that additionally contains IP multicast address to indicate that the data of the unicast flow can be alternatively sent via multicast (in case unicast transport is used, the network can know that it is for a multicast service).

- The flow description(s) sent to PCF includes some packet filters that additionally contains IP multicast address.

- If the MBS Session has not been created, the steps 10-17 in clause 7.1.1.2 or steps 10-26 in clause 7.1.1.3 of TS 23.247 [4] are performed to create the MBS Session.

If the AF is in trust domain, the AF can perform step 3, 5, and 16 directly.

6. The PCF invokes Policy Update Notify towards the SMF, which includes unicast QoS information and flow description(s) that additionally contains IP multicast address (i.e., multicast flow descriptions).

7. The SMF may initiate PDU Session Modification procedure for updating unicast QoS flows.

8. **MBS Session Join**: For multicast flow creation, the steps 2-4 in clause 7.2.1.3 of TS 23.247 [4] are performed with following differences:

- If the authorization fails, go to step 10 and SMF indicates cause value to the PCF. The AF can use unicast transport for the multicast data delivery.

**MBS Session Leave**: For multicast flow releasing, the steps 3-6 in clause 7.2.1.4 of TS 23.247 [4] are performed with following differences:

- If the MB-SMF does not serve the MBS Session any more (i.e., all SMFs unsubscribed the MBS Session Context Status), steps 6-8 in clause 7.1.1.4 or 7-11 in clause 7.1.1.5 of TS 23.247 [4] are performed to delete the MBS Session.

9. **MBS Session Join**: For multicast QoS information creation, steps 5-12 described in TS 23.247 [4] clause 7.2.1.3 are performed with following differences:

- The step 5 is Namf\_Communication\_N1N2MessageTransfer. If the MBS capability of UE is received and multicast streams are demanded, the SMF includes QoS rules for DL only in the N1 Message Container in step 5, which will include MBS Session ID as a parameter in the QoS rules for DL only. The QoS rules for DL only can be used by the UE to transfer the IP multicast address in the received packets to the UE address, and to transfer the destination UDP port in the received packets to the UE UDP port.

- If the MBS capability of UE is not received, the SMF does not include MBS Session related information in the N2 SM info send to NG-RAN (i.e., individual delivery is selected), as well as instructs the UPF to perform NATP as described in above bullet for the incoming multicast data of the MBS Session towards the UE (i.e., unicast mode is selected).

- If unicast QoS parameters are received in step 6, the SMF also update the unicast QoS flows during the PDU Session Modification procedure.

Editor´s note: User consent for this operation and procedures if it is denied are ffs.

**MBS Session Leave**: For multicast QoS information removal, steps 3-11 and 13 described in TS 23.247 [4] clause 7.2.2.2 are performed with following differences:

- The step 7 is Namf\_Communication\_N1N2MessageTransfer, and the SMF also update the unicast QoS flows during the PDU Session Modification procedure if unicast QoS flows need to be updated.

10. The SMF notifies the PCF.

11. The PCF Notifies the NEF with cause value related to MBS.

12. The NEF notifies the AF with the cause value. If the PCF does not support MBS (i.e. no corresponding cause value indicated), the corresponding unicast QoS flow will be established, the AF can use unicast transport for the multicast data delivery.

6.10.3.4 AF triggered MBS Session management procedures without PCC

This procedure is for AF triggered MBS Session Join or Leave when dynamic PCC is not deployed.



**Figure 6.10.3.4-1: AF triggered MBS Session management procedures without PCC**

0. After the PDU Session Establishment procedure, the SMF create the SMF-NEF connection with the NEF similar as described in TS 23.502 [3] clause 4.25.2 and 5.2.6.15, during which the SMF sends the UE address, i.e., IP address, to the NEF. The difference is that the subscription of the UE includes the NEF ID for MBS, the NIDD information in the request to the NEF is changed to MBS information with same content, i.e., GPSI, AF ID, and additional UE address is included.

1. Same as steps 1-2 in clause 6.10.3.3.

2. The NEF invokes the MBS On-demand Session Create/Update with AF ID and SSM towards the SMF.

3. Same as steps 7-8 in clause 6.10.3.3.

4-5. The SMF responds to the NEF. The NEF responds to the AF.

6. Same as steps 9 in clause 6.10.3.3.

7-8. The SMF notifies to the NEF. The NEF notifies to the AF.

6.10.4 Impacts on services, entities and interfaces.

**UE:**

- May support indicating MBS capability to SMF during PDU Session Establishment.

- May support NATP performance for incoming multicast data.

**NEF/MBSF:**

- Support handling MBS AF Session service to AF (similar as AF Session with QoS service).

- May support additionally handling UE address during SMF-NEF connection establishment procedure as described in TS 23.502 [3] clause 4.25.2, which is used to find out the serving SMF.

- May expose MBS 5GC-AF Connection service to AF, discovering MB-SMF from NRF by AF ID and Area Info, and invoke MBS AF Connection service towards MB-SMF.

**SMF:**

- Support discovering MB-SMF from NRF by AF ID and/or Area Info.

- Support receiving AF ID, SSM, and multicast flows information from PCF or NEF and sending them to MB-SMF for multicast flows handling.

- Support determining delivery method and instructs UPF to perform NATP for multicast data based on UE MBS capability.

- May support sending UE address during the SMF-NEF connection establishment procedure to NEF after associated PDU Session Establishment.

**MB-SMF:**

- Support MBS Session Context Status subscribe with AF ID and SSM, and allocate/deallocate TMGI accordingly.

- Support register to NRF with AF ID.

- May support interacting with MB-PCF with multicast flows information.

- May support handling MBS 5GC-AF Connection service to NEF.

**NRF:**

- Support selecting MB-SMF and responding information of MB-SMF queried by AF ID or Area Info.

- Support MB-SMF registration with AF ID.

**PCF:**

- Support sending AF ID, SSM, and multicast flows information to SMF for multicast flows handling.

- Support sending cause value for handling multicast flows to NEF/AF.

Editor's note: Additional impacts are FFS.

## 6.11 Solution #11: Solution on enabling the on-demand multicast MBS session management

### 6.11.1 Introduction

This solution addresses Key Issue #3: On demand multicast MBS session.

### 6.11.2 Functional description

#### 6.11.2.1 Use cases

The use case for on demand MBS multicast session can be described as follows.

One typical use case for KI #3 is the content provider delivering its content. Before a content provider (CP) delivers content, its subscriber needs to firstly request the content by sending application level request (e.g., clicking the "view" link). Such framework doesn't take into consideration of the scale of the amount of subscribers.

As analysed by S2-2006311,

|  |
| --- |
| *if the requested content is real-time, popular, and high data rate (e.g. World Cup Soccer matches, American Football games or Chinese Spring Festival Gala), a huge number of viewers simultaneously watching will put a huge burden on the network service providers (SPs).*  *As more and more people watch content on their UEs, this will also impact MNOs because many duplicate copies of the same content will be delivered by the MNOs.* |

One way to resolve the large scale delivery of real-time high data rate content is to enable on-demand multicast MBS session management triggered by the AF.

The trigger by the AF for enabling the on-demand multicast MBS session management, can be further based on network analysis result. To this end, the AF or CP subscribes to or requests the network analytics information from the NWDAF as specified in TS 23.288 [10]. Based on the analytics information, e.g. Observed Service Experience analytics defined in clause 6.4 of TS 23.288 [10], the AF decides to set/update the multicast related service parameters.

For one AF session, the AF uses "AF session with required QoS update" procedure" defined in clause 4.15.6.6a or "Service specific parameter provisioning" procedure defined in clause 4.15.6.7 of TS 23.502 [3] to provide multicast related service parameters, including a multicast indication which indicates that the service data flows of the AF session can be transmitted over a multicast MBS session identified by an MBS session ID, to the PCF via the NEF/UDR. Based on multicast related service parameters, the PCF provides the multicast service related policy in PCC rules to the SMF or the UE. Then the SMF or the UE decides to initiate a multicast MBS session join/establishment procedure based on the multicast service related policy.

The following procedures is on top of the procedures specified in clause 7.2.1.3 in TS 23.247 [4].

### 6.11.3 Procedures

#### 6.11.3.1 on-demand multicast MBS session management



Figure 6.11.3.1-1: on-demand multicast MBS session establishment

The key steps of the procedure for this solution are as follows:

1. MBS Session Creation with PCC procedure is performed as specified in clause 7.1.1.3 of TS 23.247 [4], where the AF may perform a Service Announcement towards the UEs.

2. The AF decides to set or update multicast related service parameters, including the multicast indication, for specific services/applications. The AF may, based on local configuration or triggered by e.g. event report from the NEF, subscribe to or requests network analytics information (e.g., Observed Service Experience analytics) from the NWDAF as specified in TS 23.288 [10], and decide to update the multicast related service parameters based on the analytics information.

The AF provides updated service parameters, which include the multicast indication and a MBS Session ID for the multicast MBS session to be established, to the PCF via the NEF/UDR by using Nnef\_AFsessionWithQoS\_Update request (as defined in clause 4.15.6.6a of TS 23.502 [3]) or Nnef\_ServiceParameter\_Create/Update/Delete (as defined in clause 4.15.6.7 of TS 23.502 [3]). The "AF session with required QoS update" procedure or "Service specific parameter provisioning" procedure continues as defined in TS 23.502 [3] and the PCF receives the updated service parameters.

3. The PCF retrieves the MBS data in the UDR and gets the list of UEs which subscribe to the multicast MBS service identified by the MBS Session ID.

4a. If "AF session with required QoS update" procedure is performed in step 2, the PCF initiates SM Policy Association Modification procedure as defined in clause 4.16.5.2 of TS 23.502 [3] to notify the SMF, with the multicast MBS session ID and the list of UEs.

4b. If " Service specific parameter provisioning" procedure is performed in step 2, the PCF initiates UE Policy delivery procedure as defined in clause 4.16.6.7 of TS 23.502 [3] towards these UEs. The UE policy includes parameters instructing the UE to joining the multicast session, which include the MBS Session ID and optionally conditions for joining this multicast MBS session (e.g. "immediately" or a time window).

5a. If "AF session with required QoS update" procedure is performed in step 2, steps 2-19 specified in clause 7.2.1.3 in TS 23.247 [4] are reused to complete on-demand multicast MBS session establishment, for the UEs subscribed to the multicast MBS Session and with an associated PDU Session established for the multicast MBS Session. The UE is informed of successfully joining the multicast MBS session upon receiving the PDU Session Modification Command which contains the MBS Session ID.

5b. If " Service specific parameter provisioning" procedure is performed in step 2, steps 1-19 specified in clause 7.2.1.3 in TS 23.247 [4] are reused to complete on-demand multicast MBS session establishment, by the UEs subscribed to the multicast MBS Session and with an associated PDU Session established for the multicast MBS Session. Here the UE decides to join the multicast MBS session identified by the MBS Session ID based on the UE policy received in step 4b.

### 6.11.4 Impacts on services, entities and interfaces.

AF:

- The AF needs to support triggering the on-demand multicast MBS Session establishment, based on e.g., the network analytics information provided by the NWDAF.

PCF:

- The PCF is enhanced to provide to the SMF(s) the multicast service related policy, i.e., MBS session ID that the AF request UE to join, for triggering the SMF(s) to complete the on-demand multicast MBS session establishment.

## 6.12 Solution #12: Group Message Delivery

### 6.12.1 Introduction

This solution addresses the following aspect in Key Issue #4: Whether and how to enhance the MBS functionality to provide a similar group message delivery as available in eMBMS.

### 6.12.2 Functional description

This solution describes a NEF-based group message delivery via MBS method, which is comparable to the SCEF-based group message delivery via MBMS.

This solution utilizes the Object Delivery Method in MBSTF specified in TS 26.502 [11] for the group message delivery via MBS. The Object Delivery Method in MBSTF is equivalent to the File Delivery Method in eMBMS. The Object Delivery Method can benefit from Application Layer Forward Error Correction (AL-FEC) to achieve the reliable delivery, which is essential for group message delivery.

The NEF is responsible to handle Group Message Delivery request from the AF. It transforms the group message into a file and determine the meta data information of the file. In control plane, it performs Application Service Provisioning including MBS User Service creation and MBS User Data Ingest Session creation, which triggers the MBS session creation and MBS session start for broadcast towards 5GC and NR. In user plane, it is responsible for ingesting the file to the MBSTF, so that MBSTF can deliver the file to UE via 5GC shared traffic delivery and NR broadcast.

### 6.12.3 Procedures

#### 6.12.3.1 General

NOTE: The message names in the procedures below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

#### 6.12.3.2 Group Message Delivery via MBS Broadcast



**Figure 6.12.3.2-1: Group Message Delivery via MBS Broadcast.**

NOTE 1: In the procedures referred to the TS 26.502 [11], the NEF is the MBS Application Provider.

1. The AF sends Group Message Request to the NEF, containing the Group Message Payload, MBS service area, Group Message Delivery Start Time, Stop Time.

Editor's note: The other parameters in Group Message Request is FFS.

1. The NEF checks authorization of AF. If geographical area information or civic address information was provided by the AF as MBS service area, the NEF translates the MBS service area to Cell ID list or TAI list.

NOTE 2: The NEF is mandated for group message delivery.

1. The NEF transforms the group message payload into a file, and determines the meta data information of the file (e.g. File URL, etc.).

If Application Service Provisioning hasn’t been performed, step 4 to step 8 needs to be executed. Otherwise, they can be skipped.

1. The NEF performs Application Service Provisioning towards the MBSF as specified in step 1 in clause 5.2 of TS 26.502 [11], which including invoking Nmbsf\_MBSUserService\_Create and Nmbsf\_MBSUserDataIngestSession\_Create on the MBSF.

* The *Target service area* is set to MBS Service Area.
* The *Distribution method* is set to *Object Distribution Method* which is used for file delivery.
* The *Distribution Operating Mode* is set to *File* or *Carousel* depends on the decision of the NEF.
* The *Object acquisition method* is set to *Push* or *Pull* depends on the decision of the NEF.

1. The MBSF performs MBS Session Creation as specified in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4].
2. The MBSF performs Distribution Session Provisioning as specified in step 2 in clause 5.2 of TS 26.502 [11]. The MBSF invokes Nmbstf\_MBSDistributionSession\_Create on the MBSTF, passing the parameters of the MBS Distribution Session received in step 4 to the MBSTF.
3. The MB-SMF initiates the MBS Session Start for Broadcast procedure as specified in step 2 to step 9 in clause 7.3.1 of TS 23.247 [4].
4. If the MBSF performs the service announcement, it initiates the MBS User Service Announcement as specified in step 3 in clause 5.2 of TS 26.502 [11]. The application may receive the appropriate information through the MBS-6 API from the MBS Client (see TS 26.502 [11]).

Editor's note: How MBSF sends the service announcement information to the NEF which act as AF, depends on TS 26.502 defined by SA4.

1. The NEF sends Group Message Response to the AF. If the AF performs the service announcement, the service announcement information containing the file meta data can be optionally included in the Group Message Response.
2. If the AF needs to perform the Service Announcement, the AF sends the application service announcement to the UE as specified in step 4 in clause 5.2 of TS 26.502 [11].
3. The NEF performs the User Data Ingestion towards the MBSTF as specified in step 5 in clause 5.2 of TS 26.502 [11]. The NEF may push the file to the MBSTF or let MBSTF pull the file from the NEF.
4. The MBSTF performs packetization and optionally FEC encoding as specified in clause 4.3.3.2 of TS 26.502 [11].
5. The MBSTF delivers the packets to the MB-UPF to NG-RAN, and NG-RAN broadcast to the UE as specified in step 13 to step 15 in clause 7.3.1 of TS 23.247 [4].
6. Based on the service announcement information received in step 8 or step 10, the UE receives the packets, is required performs FEC decoding to restore the file, and gets the group message from the file, using the MBS Client as specified in clause 4.3.5 of TS 26.502 [11]. The MBS Client can expose the file towards the application in the UE using the MBS-7 API (see TS 26.502 [11]).

#### 6.12.3.3 Modification of previously submitted Group message

Editor's note: It is FFS how the modification of previously submitted group message can be implemented.

### 6.12.4 Impacts on services, entities and interfaces.

Functional entities defined in clause 5.3.2 of TS 23.247 [4] and clause 6.2 of TS 23.501 [2] are reused exception for the following additions:

NEF:

- Support group message delivery interface towards AF, and optionally include the service announcement information in the group message delivery response to the AF.

- Transform the group message into a file and determine the meta data information of the file.

- Create MBS User Service and MBS User Data Ingest Session to the MBSF.

- Ingest file to the MBSTF.

Editor's note: Additional impacts are FFS.

6.13 Solution #13: Group message delivery for broadcast

6.13.1 Introduction

This solution addresses Key Issue #4.

6.13.2 Functional description

Editor's note: This clause outlines solution principles and documents any assumptions made.

It is assumed to reuse the current architecture and TMGI definition in Rel-17 MBS work (see TS 23.247 [4]). In other words, MB-SMF is used to handle MBS session-level management while SMF performs per-UE MBS session management, e.g. authorization, multicast session information provisioning, managing 5GC Individual MBS traffic delivery.

For group message delivery, it mainly targeted for the Machine type communication services. The group message delivery has limited applicability and does not support all the scenarios, e.g. UEs not supporting MBS, UEs located in areas where MBS is not deployed.

Compared with Rel-17 defined mechanism, the case that UEs located in areas where MBS is not deployed needs to be considered for broadcast.

Editor's note: Further evidence that the outlined problem and solution is specific to group message delivery would be desirable.

Editor's note: How to ensure reliable delivery in transport-only mode (without AL-FEC) over MBS broadcast delivery is FFS.

NOTE: This solution assumes that the AF is aware of the exact location of UEs

6.13.3 Procedures

Editor's note: This clause describes high-level procedures and information flows for the solution.

6.13.3.1 General

NOTE: The message names in the procedures below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

6.13.3.2 Broadcast Session Establishment



**Figure 6.13.3.2-1: Broadcast Session Establishment for Group message delivery**

The procedure is based on clause 7.3.1 and 7.1.1.1/7.1.1.2 of TS 23.247 [2], and the delta parts is highlighted at following:

1. AF performs TMGI allocation and MBS session creation as specified in clause 7.1.1.2 or clause 7.1.1.3 of TS 23.247 [4]. The AF may later further request to establish the MBS session with including the requested MBS service area in Nnef\_MBSSession\_Create request.

2. NEF figures out the area which does not support MBS.

3. NEF continues the MBS Session Creation procedure with include the area supporting MBS as the MBS service area in Nmbsmf\_MBSSession\_Create Request message sent to MB-SMF.

4. MB-SMF continues the MBS Session Creation and MBS Session Start procedure as defined in TS 23.247 [2].

4b. NEF responses AF with including the areas in the requested MBS service area that do not support MBS.

5. MB-SMF responses NEF by sending Nmbsmf\_MBSSession\_Create Response message.

6. NEF responses AF with Nnef\_MBSSession\_Create response. As an alternative of 4b, the NEF can include the areas in the requested MBS service area that do not support MBS in this step.

6.13.4 Impacts on services, entities and interfaces

Editor's note: This clause describes impacts to existing services, entities and interfaces.

Functional entities defined in clause 5.3.2 of TS 23.247 [4] is reused exception for the following additions:

**NEF**:

- Support differentiating the area with supporting MBS and non-supporting MBS.

- Support responding AF with the information that not supporting MBS.

Editor's note: UE impacts and other additional impacts are FFS.

## 6.14 Solution #14: MBS coexistence with power saving mechanisms of 5GS

### 6.14.1 Introduction

This is a solution for Key Issue #5.

TS 23.682 [6] clause 4.5.18 defines the mechanisms for co-existence between eMBMS and the power saving mechanisms that exist in EPS. The basic premise is that the time intervals the UE stays awake to receive MBMS user service or to discover if there is any MBMS user service scheduled for delivery, should not necessarily be the same as the reachable intervals negotiated for extended idle mode DRX or PSM.

Editor’s Note: This solution covers the case of extended idle mode DRX and MICO with active time. Support for reception of MBS in RRC-Inactive with or without eDRX> 10.24 is FFS and will depend on conclusions of the FS\_RedCAP\_Ph2 SID.

### 6.14.2 Functional description

Same as in EPS, for 5GS also this solution proposes that the time intervals the UE needs to be awake for MBS service may not coincide with the wake up time windows mandated by eDRX (PTW) and/or MICO with active time (periodic Registration Update + active time) configuration.

For those intervals the UE needs to be awake for MBS user service, the following cases can be identified:

**Scenario 1:** When the UE needs to be awake due to MBS coinciding with the UE already being in connected mode due to other reasons, the UE follows normal connected mode procedures.

**Scenario 2:** When the UE needs to be awake due to MBS coinciding with the UE already being in idle mode and reachable (e.g. in active time for MICO or PTW for eDRX) the UE follows normal idle mode procedures.

**Scenario 3:** When the UE needs to be awake due to MBS coinciding with the UE being in idle mode and in deep sleep, i.e. unreachable for paging to the network, the UE leaves the deep sleep for MBS service only.

- If the MBS service does not require the UE to transition to connected mode, i.e. the UE can receive the specific MBS service in idle mode using MBS broadcast, then the UE does not update the AMF to become reachable for paging. In other words, the UE would still be considered unreachable for paging in the core network. This minimizes the signalling between the UE and the network.

- If the MBS service requires the UE to transition to connected mode (e.g. MBS service that requires MBS multicast mode) then the UE performs regular procedures for CM connected mode. This would therefore make the UE become reachable.

**Scenario 4:** When the UE is in the middle of an MBS data transfer, and the UE is scheduled to move to deep sleep due to power saving, e.g. end of PTW for eDRX, expiration of active time for MICO or the UE transitioning from CM-CONNECTED to CM-IDLE in the case of MICO with no active time, then the UE does not go to deep sleep during the remainder of the MBS data transfer.

- If at the end of MBS data transfer, the UE knows there is another MBS data transfer scheduled soon, in that case depending of the time between MBS data transfers, the UE may not go to sleep between MBS data transfers.

- The UE may in fact not go to deep sleep while in an MBS broadcast session.

### 6.14.3 Procedures

With extrapolation of the procedures defined in TS 23.682 [6] to 5GS power saving mechanisms and MBS the following is defined:

1. When the UE needs to be awake due to MBS coinciding with the UE already being in connected mode due to other reasons, the UE follows normal connected mode procedures.

2. When the UE needs to be awake due to MBS coinciding with the UE already being in idle mode and reachable (e.g. in active time in MICO or PTW for eDRX) the UE follows normal idle mode procedure.

3. When the UE needs to be awake due to MBS coinciding with the UE being in idle mode and in deep sleep, i.e. unreachable for paging to the network, the UE leaves the deep sleep state only to perform procedures related to MBS service.

- If the MBS service does not require the UE to transition to connected mode, i.e., the UE receives MBS service in broadcast mode and therefore can be in idle mode, then the UE does not update the AMF to become reachable for paging. The UE would therefore still be considered unreachable for paging in the AMF. This minimizes the signalling between the UE and the network.

- If the MBS service requires the UE to transition to connected mode (e.g. reception in MBS multicast mode) then the UE performs regular procedures for MBS multicast mode defined in TS 23.247 [4]. This would therefore make the UE become reachable in the network for other unicast services.

4. When the UE is in the middle of an MBS data transfer, and the UE is scheduled to move to deep sleep due to power saving, e.g. end of PTW for extended idle mode DRX, expiration of active time for MICO or the UE transitioning from CM-CONNECTED to CM-IDLE in the case of MICO with no active time, then the UE does not go to deep sleep during the remainder of the current MBS data transfer.

NOTE 1: If at the end of the current MBMS data transfer, the UE knows there is another MBMS data transfer scheduled soon, in that case depending of the time between MBS data transfers, the UE can decide to go to sleep between MBS data transfers.

There are two possible ways the UE can be notified of an upcoming MBS broadcast session start:

1. If MBS User Services defined in TS 26.502 [11] is used, the UE needs to receive MBS service announcement while awake (i.e. while in connected mode, or while idle mode during PTW for extended idle mode DRX, or active time for MICO). The UE wakes up if not already awake for MBS service reception based on the schedule received in the service announcement. For this option, the MBS service announcement may be provided via MBS broadcast service announcement or via any of the possible unicast service announcement delivery mechanisms. In case the MBS service announcement is provided in application layer, similar mechanisms need to be provided.

NOTE 2: In order to allow all UEs using power saving function to receive the service announcement in time to be able to receive the MBS broadcast data delivery, the application server needs to be aware of the maximum unreachable period of the UEs.

2. The UE may be configured by the application server with specific times to perform MBS procedures, and wakes up from deep-sleep if needed at those times. The UE may also receive MBS service announcements and/or MBMS broadcast delivery at those times (if needed).

NOTE 3: The configuration (e.g. TMGI, start time) is out of scope of 3GPP and assumed to be performed between application server and UE at application layer. The application server needs to initiate MBS bearer service procedures during those time intervals.

### 6.14.4 Impacts on services, entities and interfaces.

In UE:

- Handle potential wake up out of deep sleep due to power saving (e.g. eDRX, MICO with active time) for MBMS user service session/data transfer when it knows a scheduled broadcast it is interested in receiving.

- Remain awake during reception of MBMS data transfer, even when power saving function would trigger moving to deep sleep (e.g. end of PTW in eDRX, end of active time in MICO).

- (The UE can already be configured by application server with maximum allowed delay tolerance, in this case it would be for MBMS service, which can translate to UE requesting specific eDRX cycle or periodic TAU).

- Configuration for periodic wake ups for MBMS and UE behaviour when waking up only for MBMS service.

In NW:

- No standards impacts.

- Service announcement needs to be started at least an eDRX cycle or periodic Registration Update length earlier than the actual data broadcast.

In AS:

- The application server needs to trigger start for service announcement at least an eDRX cycle or periodic Registration Update length earlier than the actual data broadcast.

## 6.15 Solution #15: Solution for coexistence of MBS delivery and power saving mechanisms

### 6.15.1 Functional description

This solution addresses Key Issue #5 (Coexistence with existing power saving mechanisms for capability-limited devices).

Capability-limited devices may use power-saving mechanisms to extend their battery live. Existing power saving mechanisms include MICO (Mobile Initiated Connection Only) mode, DRX (Discontinuous Reception), eDRX (Extended Discontinuous Reception).

When an MBS Session data delivery is required (e.g., for software/firmware update) is required, service announcement is needed. The service announcement using MBS Session data delivery may not be efficient from the network perspective since the capability-limited devices are not expected to be awake throughout the day, but only infrequently. Furthermore, the capability-limited devices do not wake-up at the same time and they are not reachable while being in power saving mode.

This solution proposes to inform the capability-limited devices about a newly scheduled MBS Session data delivery during their wake-up periods when the devices are reachable. When MBS Session data delivery is required, the MBS Session data delivery time can be scheduled as follows:

- When a new MBS delivery schedule for capability-limited devices become available, the network will send a service announcement to inform the UEs about the new schedule when they are reachable.

- The time interval from when MBS Session data delivery schedule is announced to when the first MBS Session data delivery as announced by that schedule will start can be shorter than the minimum power saving period of all capability-limited devices.

- The network may schedule multiple MBS deliveries. If at the end of the current MBS Session data delivery, the UE knows there is another MBS Session data delivery scheduled soon, in that case depending on the time between MBS Session data deliveries, the UE can decide to go to power saving between MBS Session data deliveries.

Editor’s Note: Regarding the coexistence of multicast MBS Session data delivery with capability-limited devices, the dependency with KI#1 is FFS.

### 6.15.2 Procedures

Existing procedure for 5MBS is used.

Editor’s Note: SA4 collaboration is required.

### 6.15.3 Impacts Analysis

UE: The UE needs to wake up according to the time scheduled for MBS delivery received in service announcement.

## 6.16 Solution 16: Public Safety services offered over both Broadcast and Multicast transport

### 6.16.1 Description

#### 6.16.1.1 General

5G Broadcast and 5G Multicast services cater and are optimal in different scenarios:

- The more sparse the UEs receiving a same content are, the larger the service area, the more attractive using 5G Multicast is.

- The more concentrated in an area the UEs receiving a same content are, the more attractive using 5G Broadcast may become.

This solution consists on identifying areas of concentrated number of UEs for which 5G Broadcast services would be the optimal transport, areas of sparse UEs receiving the same public safety service for which multicast transport would be useful. Configuring Broadcast service and Multicast service for the same public safety service, and allow the UE to decide whether to receive the public safety MBS content via broadcast service if available, or multicast session.

Editor´s note: This solution requires that UEs provide accurate location information to the GCS AS to enable the GCS AS to determine where UEs are concentrated. Those location reports require that UEs are in connected state and may lead to capacity bottlenecks. It is ffs if this problem can be mitigated.

#### 6.16.1.2 Functional description

NOTE 1: The use of GCS AS in reference to this solution refers to stage-2 procedures defined in TS 23.468 and are used for public safety IMS procedures defined in SA6 specifications for GC-1/MCPTT-1 interface. The interface between GCS AS and 5GC is not restricted to be MB2 only. Possible enhancements to other interfaces e.g. xMB, Nmb8 and Nmb10 are possible.

NOTE 2: The term GCS AS is currently used in EPS only and not same in the context of this solution, the name to be used in 5GS only architecture is FFS.

The functional description of the solution is as follows:

1. GCS AS requests to establish a Broadcast service in a "Broadcast" Service Area to 5GC via MBS Session Start for Broadcast procedure (see TS 23.247 [4] clause 7.3.1), where the Broadcast Service Area is an identified area where of concentrated large number of UEs.

2. GCS AS also requests to establish a Multicast Service in a "Multicast" Service Area to 5GC via MBS Session Creation Procedure (see TS 23.247 [4] clause 7.1.1.2 or 7.1.1.3), where the Multicast Service Area is an identified area for Public Safety service that is larger than the Broadcast Service Area. Multicast and Broadcast service areas may overlap.

3. GCS AS configures the UE with both the Multicast service information (with its respective MBS session ID/TMGI) and the Broadcast service information (with its respective MBS Session ID/TMGI) and indicates to the UE that they correspond to the same public safety service. This can for example be done by allowing to include 2 TMGIs instead of one in service description that is sent to the UE in SIP.

Editor's Note: whether the indication to the UE is needed/feasible is FFS.

4. Both Broadcast Service Area (as in Service announcement) and Multicast Service Area (as part of Service announcement or NAS signaling) may be known to UE.

5. The UE may join the Multicast session based on the received information from the GCS AS.

6. When UE is in Broadcast Service Area, and the UE detects the Broadcast Service is available, the UE enables reception of Broadcast MBS session ID, and if already joined ignores reception of Multicast MBS session ID internally.

Editor's Note: How this procedure can be optimised as the multicast reception provides higher quality and the network is not aware that the UE drops data and will continue to apply procedures for multicast distribution to the UE and reserve related resources is FFS.

7. When the UE is outside Broadcast Service Area, and in Multicast Service area the UE receives MBS service in multicast mode. If not already joined, the UE initiates UE join procedure for the Multicast Session.

### 6.16.2 Procedures

#### 6.16.2.1 GCS AS configuration of both Broadcast and Multicast Services



Figure 6.16.2.1-1 GCS AS configuration of both Broadcast and Multicast Services

Figure 6.16.2.1-1 shows the order of procedure execution for a GCS AS to provide a same public safety service via broadcast session in a specific service area and via Multicast session in a larger service area.

NOTE: In Figure 6.16.2.1-1 the 5GC CP (control plane) denotes for simplicity all transport 5GC NFs relevant to MBS procedures, e.g. MB-SMF, MB-PCF, SMF, AMF, NRF, etc.

1. In order to establish a Multicast session, the GCS AS initiates MBS Session Creation as defined in either TS 23.247 [4] clause 7.1.1.2 (for case without PCC) or TS 23.247 [4] clause 7.1.1.3 (for case with PCC). The GCS AS receives Multicast Session information.

2. The GCS AS may provide to UE(s) the Multicast session information necessary for the UE to join the Multicast session (i.e. TMGI for Multicast session).

3. UE may trigger UE join and Session establishment procedure (see TS 23.247 [4] clause 7.2.1) using the TMGI for Multicast provided by GCS AS.

4. When there is MBS data the GCS AS initiates MBS Session Activation for the Multicast TMGI (see TS 23.247 clause [4] 7.2.5.2). Step 4 may occur in parallel with steps 5 to 7.

5. The GCS AS may decide to establish a Broadcast session in a specific service area, e.g. based on UE reports in GC1/MCPTT-1 interface and detection of large number of UE receiving the same public safety service in a same area.

6. Based on the decision of step 5, the GCS AS initiates MBS session start for broadcast procedure as defined in TS 23.247 [4] for a Broadcast TMGI.

7. The GCS AS provides to UEs the information for broadcast reception, including the TMGI allocated for the Broadcast session.

8. A UE that has received both the Broadcast session information (including TMGI for Broadcast session) and Multicast session information (including TMGI for Multicast session) for the same service, determines whether to receive the public safety data via broadcast session or multicast session.

8.a. If the UE detects that the Broadcast session is available, UE enables reception of Broadcast for the TMGI allocated for the broadcast session, and if already joined ignores reception of Multicast internally. The UE may ignore a paging with the TMGI allocated for the Multicast session.

8.b. If the UE does not detect that Broadcast session is available, and the UE joined the multicast MBS session in step 3, when it receives paging during MBS session activation for the TMGI allocated for Multicast, the UE follows the behavior defined in TS 23.247 [4] clause 7.2.5.

#### 6.16.2.2 UE switching from Broadcast Reception to Multicast Reception

When a UE that is receiving public safety data via Broadcast session detects that it has moved to a cell that is not providing the broadcast session, i.e. the UE detects it has stepped out of the Broadcast service data, the UE proceeds as follows:

1. If the UE had not joined yet the corresponding Multicast session, the UE triggers MBS join and Session establishment procedure (see TS 23.247 [4] clause 7.2.1.3) using the TMGI allocated for Multicast session.

2. If the UE had already joined the corresponding Multicast session, the UE follows the procedures defined in TS 23.247 [4].

#### 6.16.2.3 UE switching from Multicast Reception to Broadcast Reception

When a UE that is receiving public safety data via Multicast session detects that it has moved to a cell that is providing the broadcast session, i.e. the UE detects it has stepped inside of the Broadcast service area, the UE proceeds as follows:

1. While the UE is in CM-CONNECTED receiving the Multicast data, the UE should maintain this Multicast reception if still available. This avoids ping pongs when the UE steps in and out of the Broadcast service area.

2. Following a CM-CONNECTED to CM-IDLE transition, the UE may decide to receive public safety data via Broadcast session, e.g. at next Broadcast Session Start.

Editor's Note: Details are FFS, e.g., whether UE needs to trigger the leave procedure defined in TS 23.247, clause 7.2.2 after it determines to use broadcast.

### 6.16.3 Impacts on services, entities and interfaces.

On GCS AS:

- Decision of delivery method, between multicast, broadcast and unicast with potentially different service areas.

- Use of on UE reports in GC1/MCPTT-1 interface for decision.

- Configuration of UE of both Broadcast and Multicast session for same service.

On UE:

- Receive configuration from GCS AS of both Broadcast session with a TMGI and Multicast session with another TMGI for the same public safety service.

- Decide between reception of public safety data over Broadcast session of over Multicast session.

- Trigger switch from broadcast reception of public safety data and multicast reception of public safety data.

- Trigger switch from multicast reception of public safety data and broadcast reception of public safety data.

On 5GC and NG-RAN:

- No impacts.

## 6.17 Solution #17: Performance Improvements for Public Safety

### 6.17.1 Introduction

This solution addresses leverages the improvements in KI#1 and further improves the call setup time for high number of public safety UEs for Key Issue #6.

### 6.17.2 Functional description

This solution enables AMF to get UE join/leave information of a multicast MBS session, so that AMF can maintain the complete group paging information for the joined CM-IDLE UEs when multicast MBS session is inactive.

When the MBS session activation request is received, AMF understands the multicast MBS session is activated. The AMF sends group paging request to MBS supporting NG-RAN nodes and individual paging request for non-MBS supporting NG-RAN nodes for those joined CM-IDLE UEs in the AMF. Usually, the MBS session activation request will reach the AMF prior to the enable group reachability request. In case the enable group reachability request reaches the AMF before the MBS session activation request, AMF can also trigger the group paging and individual paging. The AMF triggers paging once for one multicast MBS session activation procedure. The enable group reachability request or MBS session activation request received afterwards will not trigger the paging again.

NOTE: RRC\_Inactive UEs will be paged using the typically quicker MBS session activation request. They will also not need to send a service request and will thus not benefit from this solution in most cases.

NG-RAN triggers RAN paging based on MBS session activation request, which is supported in Rel-17.

Editor's note: It is up to RAN WG to determine whether RAN paging can be performed upon receiving group paging request, if the MBS session activation request has not been received.

In this way, CM-IDLE UEs and CM-CONNECTED UEs with RRC\_INACTIVE state can be notified for the multicast MBS session activation as early as possible.

When multicast MBS session is activated, NG-RAN is expected to provide a method for those CM-CONNECTED UEs with RRC\_INACTIVE state to enable them to receive multicast MBS session data without being RRC-CONNECTED.

Editor's note: It is up to RAN WG to determine how the method can provided (e.g. NG-RAN updates SIBx/MCCH) when the multicast MBS session is activated.

When CM-CONNECTED UEs with RRC\_INACTIVE state are notified by the RAN paging, they can utilize the method provided by NG-RAN or locally stored RRC configuration which was configured by NG-RAN before, to receive the multicast MBS session data, in parallel with sending RRC RESUME to the network.

Editor's note: It is up to RAN WG to determine whether RRC RESUME is needed for RRC\_INACTIVE UE to receive the MBS data.

### 6.17.3 Procedures

#### 6.17.3.1 General

NOTE: The message names in the procedures below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

#### 6.17.3.2 UE join multicast MBS session



Figure 6.17.3.2-1: UE join multicast MBS session

The following additions apply compared to clause 7.2.1.3 of TS 23.247 [4]:

5. In Nsmf\_PDUSession\_UpdateSMContext response, the SMF includes UE join information including the associated PDU Session ID and MBS Session ID outside the N2 SM information. The AMF stores the information and maintains the joined UE list of the MBS session with its associated PDU Session ID.

Editor's note: Different AMFs may interact with the same RAN nodes for different PDU sessions. AMF also store information when the shared delivery is established. Thus information about the same multicast session may reside on multiple AMFs. Whether and how they synchronize their information about MBS sessions is FFS.

#### 6.17.3.3 UE leave multicast MBS session



Figure 6.17.3.3-1: UE leave multicast MBS session

The following additions apply compared to clause 7.2.2.2 of TS 23.247 [4]:

7. In Nsmf\_PDUSession\_UpdateSMContext response, the SMF includes UE leave information outside the N2 SM information. The AMF remove the UE from the joined UE list of the MBS session.

#### 6.17.3.4 Multicast session leave requested by the network or MBS session release



Figure 6.17.3.4-1: Multicast session leave requested by the network or MBS session release

The following additions apply compared to clause 7.2.2.3 of TS 23.247 [4]:

3. In Namf\_Communication\_N1N2MessageTransfer request, the SMF includes UE leave information outside the N2 SM information. The AMF remove the UE from the joined UE list of the MBS session.

#### 6.17.3.4 MBS Session Activation



Figure 6.17.3.4-1: MBS Session Activation

The following additions apply compared to clause 7.2.5.2 of TS 23.247 [4]:

Paging:

* At step 5 (enable group reachability request is received) or after step 11 (MBS session activation request is received), AMF performs group paging and individual paging based on joined UE list in the AMF, if the paging for the multicast MBS session hasn’t been performed. The paging will be performed once per MBS session activation procedure. The enable group reachability request or MBS session activation request received afterwards will not trigger the paging again.

Editor's note: It is up to RAN WG to determine whether RAN paging can be performed upon receiving group paging request in step 5, if the MBS session activation request has not been received.

Editor's note: Whether a joined UE list in the AMF has any significant advantage compared to sending the UE list in step 3 (Rel-17 procedure) requires further study. The required signalling interactions may remain the same. It is FFS whether the service requests in step 6, which are separate per UE, constitute the most significant bottleneck in this procedure.

NG-RAN provide a method to allow UEs to receive multicast MBS session data without being RRC-CONNECTED:

* After step 12, NG-RAN needs to provide a method for those CM-CONNECTED UEs with RRC\_INACTIVE state to enable them to receive multicast MBS session data without being RRC-CONNECTED

Editor's note: It is up to RAN WG to determine whether and how the method can provided (e.g. NG-RAN updates SIBx/MCCH) when the multicast MBS session is activated.

UE receives multicast MBS Session data without being RRC-CONNECTED

* The CM-CONNECTED UE with RRC\_INACTIVE state is notified by CN-Paging in step 5 (if share the same Paging Occasion) or RAN-Paging in step 12. It utilizes the method provided by NG-RAN or utilizes the locally stored RRC configuration if it has such information and receives multicast MBS session data, in parallel with sending RRC RESUME to NG-RAN.

### 6.17.4 Impacts on services, entities and interfaces.

Functional entities defined in clause 5.3.2 of TS 23.247 [4] are reused exception for the following additions:

SMF:

- Provide UE join information to the AMF when UE join the multicast MBS session

- Provide UE leave information to the AMF when UE leave the multicast MBS session or when multicast session leave requested by the network or MBS session release

AMF:

- Receive UE join/leave information from the SMF and maintain the joined UE list and the group paging information of the multicast MBS session with the associated PDU session ID.

- Trigger group paging and individual paging, when multicast MBS session activation request or enable group reachability request is received, if the paging for the MBS session activation hasn’t been performed.

NG-RAN:

- NG-RAN provides a method to configure those CM-CONNECTED UEs with RRC\_INACTIVE state to enable UEs to receive multicast MBS session data without being RRC-CONNECTED

Editor's note: It is up to RAN WG to determine how the method can provided (e.g. NG-RAN updates SIBx/MCCH) when the multicast MBS session is activated.

Editor's note: It is up to RAN WG to determine whether RAN paging should be performed upon receiving group paging request, if the MBS session activation request has not been received.

UE:

- For CM-CONNECTED UEs with RRC\_INACTIVE state, when they are notified upon MBS session activation, they should utilize the method provided by NG-RAN or utilize the locally stored RRC configuration to receive multicast MBS session data, in parallel with sending RRC RESUME to NG-RAN.

Editor's note: Other additional impacts are FFS.

# 7 Evaluation

Editor's note: This clause will provide evaluation of different solutions.

# 8 Conclusions

Editor's note: This clause will list conclusions that have been agreed during the course of the study item activities.

Annex A (Informative):   
Public Safety use cases of large number of UEs in a single cell

This Annex covers the case when the mission critical enabled UEs are concentrated in a single cell.

A general public safety use case, for example, can assume that:

- a cell with UEs receiving a mix of public safety and non public safety services: some UEs receive only non public safety services, other UEs receive only public safety services, being engaged in one or more mission critical one-to-one call or on single or multiple simultaneous group calls (e.g., PTT and video), and yet other UEs receive both public safety and non-public safety services at the same time;

- the number of UEs in RRC\_CONNECTED state in the cell is at, or very near to, the limit of the number of UEs in RRC\_CONNECTED state that can be accepted in that cell due to various limiting factors;

- at that moment, a number of mission critical enabled UEs (e.g., the occupants of a fire truck) interested in participating in group calls associated with a specific public safety group arrive roughly simultaneously in the cell with their UEs in various RRC states (or possibly, powered off) and attempt to perform the necessary connection steps to the RAN, CN and AF, to be able to connect and associate themselves to the public safety group of interest;

- this situation results in a larger number of UEs being or attempting to get in RRC\_CONNECTED state than can be admitted in the cell in that state. The admission control to the cell and/or pre-emption mechanisms will be activated, resulting in some UEs already in RRC\_CONNECTED state being transitioned to RRC\_IDLE or RRC\_INACTIVE to “make room” for some of the newly arrived mission critical enabled UEs to get to the RRC\_CONNECTED state necessary to start/complete their association with the public safety group of interest;

- some (or all) of the mission critical enabled UEs associated with public safety group(s) of interest which use or intend to use MBS for downlink communication may have to be transitioned to RRC\_INACTIVE or RRC\_IDLE state to ensure that the total number of UEs in the cell in RRC\_CONNECTED state does not exceed the limit for that cell;

NOTE 1: The transition from RRC\_CONNECTED state should not happen for just arrived public safety UEs before their association with the public safety group of interest is complete, which is needs to be ensured by public safety applications. Some application-function (AF) provided information about specific public safety participants in group calls (e.g., privilege status, priority) may be used to identify which UEs should be kept in RRC\_CONNECTED state and which UEs are candidates for being transitioned to RRC\_INACTIVE or RRC\_IDLE state.

- whether an MBS Session for public safety is active or inactive, a UE in RRC\_INACTIVE or RRC\_IDLE state, may request transition to RRC\_CONNECTED state to perform unicast uplink transmissions (e.g., to request the floor, send user data, send location reports, etc.). Since the number of UEs already in RRC\_CONNECTED state in the cell may be at or near the cell admissibility limit, one or more UEs already in RRC\_CONNECTED state may need to first be moved to RRC\_INACTIVE or RRC\_IDLE state, in order to “make room” for the UE wanting to transmit;

- while in RRC\_INACTIVE state receiving user data via MBS under a session, a mission critical enabled UE may request (see bullet above), and be able to additionally start receiving public safety service via MBS, in parallel, under another session.

NOTE 2: Treatment of failure by public safety UEs in RRC\_INACTIVE state to receive MBS downlink transmissions when expected to do so, is left to implementation.

Annex B:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2022-02 | SA2#149E | S2-2201354 |  |  |  | TR skeleton (approved in S2-2201354) | 0.0.0 |
| 2022-02 | SA2#149E |  |  |  |  | Inclusions of documents agreed in SA2#149:  S2-2200602, S2-2200901, S2-2201355, S2-2201357, S2-2201359, S2-2201360, S2-2201361, S2-2201356, S2-2201358 | 0.1.0 |
| 2022-04 | SA2#150E |  |  |  |  | Inclusions of documents agreed in SA2#150:  S2-2203096, S2-2203097, S2-2203593, S2-2203098, S2-2203099, S2-2203100, S2-2203101, S2-2203102, S2-2203103, S2-2203104, S2-2203105, S2-2202359, S2-2203106, S2-2203107, S2-2203108, S2-2203109, S2-2202012, S2-2202155, S2-2203110, S2-2203111 | 0.2.0 |