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**Source: Huawei, HiSilicon**

**Title: KI#1 Sol.3: Resolving multiple SMFs and UPFs issue**

**Document for: Approval**

**Agenda Item: 8.9**

**Work Item / Release: FS\_5MBS / Rel-17**

*Abstract: This contribution resolves some editor's notes of Solution 3 for MBS session management.*

# 1. Introduction

The basic procedure of integrated multicast and unicast transport was agreed as Solution #3 in TR 23.757 during SA2#136AH in Incheon. The procedure in Solution #3 accommodates the capability of multicast data transmission for each UE, and limits the impact on 5GS.

Since the essence of the solution is to have a per-UE control plane signalling, it is possible that the SMF handling the unicast request from a given UE is different from the one handling the multicast context. The following documents such issue:

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| --- |
| Each Multicast session context is managed by one SMF.Editor's note: How to handle the case where a UE requests to establish a Multicast session context associated with a PDU session, but the Multicast session context is managed by a different SMF, is FFS. |

Furthermore, different SMFs may lead to different anchor UPFs for each PDU Session. As a result, whether and how to build a unicast QoS Profile counterpart of Multicast Context, and deal with the multicast data transmission between multicast anchor and unicast PDU Session Anchor (PSA).

This document addresses the issues mentioned above.

# 2. Analysis

## 2.1 Selection of the SMF(s) handling a multicast session

The SMF handling multicast sessions can be determined in two ways, pre-selected or the selected on demand.

1. The pre-selected alternative is mainly aiming at the case when the DN cannot support IP Multicast transmission, and the entrance of the multicast data needs to be provided by the 5GC to the Content Provider beforehand. In this case, the multicast anchor UPF needs to be determined before the UE sends a join request via CP/UP. The identifier(s) of the selected SMFs could be stored in the UDR.

2. The other alternative is to let the first SMF (i.e., the SMF associated to the first UE sending a request for a given multicast session) be the one handling the Multicast session. When the SMF is notified by the UDR that it is selected as the one handling a given Multicast session its identifier is stored in UDR for the associated multicast group.

Note that these two alternatives are not mutually exclusive and could be implemented at the same time.

## 2.2 Multicast Data Transmission

The N3 tunnel or M1-N3 tunnel could be used to transmit multicast data in 5GC. Moreover, to better support flexible multicast/unicast bearer selection and efficient unicast/multicast switching, the associating context for unicast shall be established as well. As a result, the SMF handling the unicast request from UE needs to consider the following aspects:

- The (unicast) SMF creates a QoS Profile for unicast based on the Multicast Context received from the multicast SMF. This is based on the requirement of switching between unicast and multicast, the associating QoS treatment of the data should be determined in the similar way.

- The (unicast) SMF interacts with the multicast SMF to establish a DL transmission path for a certain UE. In the other words, besides the shared N3 tunnel or M1-N3 tunnel, there is another UE specific DL data transmission path (i.e., from the multicast anchor UPF to PSA UPF of the unicast PDU session, and from the PSA UPF of the unicast PDU session to the RAN) to be established during PDU Session modification procedure for a certain UE. That path can be also established later when the UE switch to the RAN does not support multicast transmission.

## 2.3 N1N2 Message transfer from SMF to AMF

Below step 6 of the multicast flow setup procedure in clause 6.3.2.1 there is an EN indicating whether the existing N1N2 message transfer service operation can be reused or not for establishing/modifying QoS flows in MBS sessions. In our understanding the existing N1N2 message transfer service operation can be easily extended to support the handling of multicast QoS flows. We therefore propose to delete that part of the EN.

# 3. Text Proposal

It is proposed to capture the following changes vs. TR 23.757.

\* \* \* \* First change \* \* \* \*

## 6.3 Solution #3: Integrated Multicast and Unicast Transport

### 6.3.1 Functional Description

#### 6.3.1.1 System Architecture

This solution addresses Key Issue 1 and proposes a system architecture that reuses as much as possible the system architecture and procedures of current 5GS unicast system architecture. The architecture functional entities are described in Annex A.1 "5G MBS system architecture based on unicast 5GC".

#### 6.3.1.2 Multicast Session Context and Multicast flow characteristics

The proposed multicast communication service session management is an extension of the existing solution for IPTV in TS 23.316 [7].

The Multicast Session context is identified by a Multicast Session context ID and is used to represent information about the group of UEs receiving Multicast flows with the same Multicast Session context ID.

In case of IP PDU session type, the Multicast session context ID represents one IP multicast group address (i.e. any source multicast or source specific multicast). The packet filters for all Multicast flows within the Multicast context shall have the same destination and, in case of source specific multicast, also source IP addresses. The default Multicast flow shall allow for any source and destination ports and any protocols. An AF may request the PCF/NEF to create policies for Multicast flows within the Multicast Session context to meet the needs of application service flows that use different ports and protocols.



Figure 6.3.1.2-1: Multicast Session Context, UE group and Multicast flow model

On N3 or MB-N3, the Multicast flows within one Multicast Session context use the same shared tunnel.

At the NG-RAN, the Multicast flow identifier maps to radio bearer. If the QoS characteristics of Multicast flows allow, NG-RAN can also map several Multicast flows within a Multicast Session context to one radio bearer. The characteristics of the radio bearer depends on RAN decision on whether to deliver the Multicast flow content via unicast or point-to-multipoint (PTM) transmission.

The 5G QoS model is extended to support Multicast flow. At Session Management level for a particular UE the Multicast session context may exist in association with at least one PDU session, and can be set-up during the PDU session establishment or modification procedure. It may be modified at any point via PDU session modification procedure. Note that the Multicast session context is common to all UEs configured with the Multicast session context, but the associated PDU session context is specific to each UE.

The Multicast context ID and Multicast flow ID are assigned by the SMF. The SMF provides the Multicast flow information (packet filters, etc.) to the UPF.

If point-to-point (PTP) tunnelling is used in N3, the SMF provides RAN with Multicast context ID, Multicast flows and associated QoS information. The RAN responds with downlink tunnel information for the Multicast context. The SMF configures UPF with Multicast flows, associated QoS information and the downlink tunnel information.

If point-to-multipoint tunnelling is used (MB-N3), the SMF provides the UPF with MB-N3 tunnelling information. The SMF provides Multicast flow Id and associated QoS information and MB-N3 tunnel information to the RAN.

Editor's note: Whether both point-to-point and point-to-multipoint tunnelling in N3 needs to be supported or only one of the two variants is FFS.

Figure 6.3.1.2-1 depicts the user plane path for a Multicast flow.



Figure 6.3.1.2-1: Multicast context / multicast flow user plane model

When multicast traffic is established, there is no need for unicast transport in N3. In AS, when RAN decides to switch to PTM transmission, the DRB previously allocated to the QoS Flow is not used anymore.

An UPF, based on configuration received from SMF, identifies a packet as belonging to a Multicast flow, in which case it delivers it to one or multiple RAN nodes via a shared tunnel identified by a shared TEID associated with the Multicast session context to which the Multicast flow belongs to.

The AN delivers download data for the Multicast flow via broadcast or unicast over the air.

Each Multicast session context is managed by one SMF.

Editor's note: How to handle the case where a UE requests to establish a Multicast session context associated with a PDU session, but the Multicast session context is managed by a different SMF, is FFS.

### 6.3.2 Procedures

#### 6.3.2.1 Multicast context and Multicast flow setup/modification via PDU Session Modification procedure

The Multicast context and Multicast flow setup/modification uses an enhanced PDU session modification procedure for unicast traffic defined in TS 23.502 [8].



Figure 6.3.2-1: PDU Session modification for multicast

1. The content provider announces the availability of multicast using higher layers (e.g., application layer). The announcement includes at least the multicast address of a multicast group that UE can join.

The content provider may also send a request to reserve resources for the corresponding multicast session to the NEF and communicate the related multicast address.

 The content provider may invoke the services provided by the PCF or NEF to provision the multicast information. The multicast information is used to identify (e.g., IP Address of multicast data) and reserve resources for the multicast. Multicast information may further include: QoS requirements, UE authorization information, service area identifying the service scope, and start and end time of MBS. The existing procedure defined in TS 23.502 [8], clause 4.15.6.2 could be used as starting point.

 If IP multicast is not used in the external network, the content provider will send the request to the NEF with the multicast information (e.g., IP Address of the multicast data) to get the IP address and port number of the multicast anchor UPF (i.e., UPF2 in Figure 6.3.2-1). The SMF and the UPF handling the multicast transmission (i.e., SMF2 and UPF2) will be selected in this step as well and the associating identifiers could be stored in the UDR.

Editor's note: Other parameters provided by content provider are FFS.

Editor's note: Signalling interactions between the content provider and PCF for multicast session policies is FFS.

NOTE 1: The request to reserve resources for the corresponding multicast session is optional and can be replaced by configured data based on commercial agreements. If IP multicast is used in the external network, the content provider does not require information where to send the multicast data.

2. The UE registers in the PLMN (see clause 4.2.2.2 of TS 23.502 [8]) and request the establishment of a PDU session (see clause 4.3.2.2 of TS 23.502 [8]). The AMF obtains information from the UDM whether the UE can join multicast sessions as part of the SMF Selection Subscription data. If so, for direct discovery, the AMF selects an SMF capable of handling multicast sessions based on locally configured data or a corresponding SMF capability stored in the NRF.

3. Alternative 1: user plane signalling:

3a. The UE joins the multicast group.

3b. The UPF is a multicast capable router. The reception of the join message triggers the UPF to notify the SMF. The UPF can be optimized to send the notification only when the UE's status in regard to number of multicast groups UE has joined changes, i.e., when the UE joins or leaves a group. The SMF initiates PDU session modification procedure upon the reception of the notification from the UPF.

4. Alternative 2: control plane signalling:

4a. The UE sends the PDU Session Establishment/Modification Request either upon a request from higher layers or upon a detection by lower layers of UE joining a multicast group (i.e., detection of IGMP or MLR and detection of the change of content of these messages). The PDU Session Modification Request shall include information about multicast group, which UE wants to join, such as multicast addresses listed in the IGMP and MLR messages. This information is needed for configuration of the UPF with appropriate packet filters.

4b. The AMF invokes Nsmf\_PDUSession\_UpdateSMContext (SM Context ID, N1 SM container (PDU Session Modification Request with the multicast information)).

5a. The SMF sends request to UDR with the information about multicast group received from UE, and get the identification of the SMF creating the multicast context (i.e., SMF2). If this is the first UE joining the multicast group, the SMF creates the Multicast Context and stores such information in the UDR (and will act as SMF2 for processing the subsequent UE request to receive the multicast data), and steps 5a/b as well as steps 10a/b/c/d/ and 11 may be omitted.

5b. The SMF sends an N16 message to SMF2, including the information about multicast group to enable SMF2 locates the multicast group and associating Multicast Context.

5c. Based on the information about multicast group, SMF2 replies with the multicast context including the QoS parameters for multicast transmission.

5d. The SMF generates the Unicast QoS Flow profile based on QoS Profile of the multicast.

6. The SMF requests the AMF to transfer a message to the RAN node carrying transparently to RAN node a Multicast Context including the indication that the UE joined the multicast session identified by the multicast group identity using the Namf\_Communication service. Such N11 message includes the QoS Profile for unicast. The N1N2 message transfer service operation is used.

Editor's note: The related Session Management signalling towards the UE, e.g., providing information regarding Multicast Context and Multicast Flows is also FFS. It is up to RAN WGs to decide if additional dedicated signalling towards the RAN node to establish a multicast distribution session is required.7. The session modification request is sent to the RAN. The request is sent in the UE context using the currently standardized message enhanced with multicast related information, which includes a multicast group identity (e.g., multicast address itself, Multicast Session context ID, or multicast flow information such as multicast QoS Flow ID and associating QoS information). The RAN is using the multicast group identity to determine that the session modification procedures of two or more UEs correspond to one multicast group. In other words, the RAN learns what UEs are receiving the same multicast from the multicast group identity. When the RAN receives a session modification request for previously unknown multicast group identity, the RAN is configured to serve this multicast group.

Editor's note: It is FFS which information is used by NG-RAN to determine the mapping between a Multicast flow ID and a (unicast) DRB of a specific UE.

Editor's note: It is FFS whether RAN awareness about the group of UEs receiving the same multicast traffic poses an issue for certain Public Safety scenarios.

8. The RAN performs the necessary access network resource modification such as configuration of broadcast bearers.

Editor's note: The details of this procedure should be studied in the RAN WGs.

9. The RAN sends the session modification response that may include downlink tunnel information dedicated for multicast transmission if it receives the Multicast Context at the first time.

10. The AMF transfers the possible downlink tunnel information dedicated for multicast transmission received in step 9 to the SMF if sent by RAN. The SMF stores the information about the multicast distribution session towards the RAN node serving the UE and the possible received downlink tunnel information if it did not previously store that information when handling a multicast service request of another UE served by the same RAN node.

10a. SMF sends N16 Message to SMF2, including the information of the unicast PDU Session Anchor (i.e., UPF) to establish the multicast transmission path between UPF and UPF2.

10b. SMF2 sends UPF2 N4 message to configure the multicast transmission, and UPF2 responses to the SMF2. The UPF2 may further send join message to the content provider.

10c. SMF2 responses to the SMF with the configuration of multicast transmission.

10d. If it is the first UE joining the multicast group, the SMF creates the configuration of multicast transmission including the downlink tunnel information dedicated for multicast transmission received from AMF.

NOTE 2: Steps 10a - 10b are used to establish the transmission path for multicast data from UPF2 to UPF for the sake of completeness of the transmission path of unicast, and these steps could be executed in later procedures, e.g., UE handovers to the other RAN.

Editor's note: Whether the Nsmf\_PDUSession\_UpdateSMContext service operation or a response to the Namf\_Communication service operation is used is FFS.

11. The SMF sends an N4 message to UPF including the configuration of multicast transmission.

12. The UPF(2) receives multicast PDUs according to the configuration in step 11.

13. The UPF(2) sends multicast PDUs in the N3/N9 tunnel associated to the multicast distribution session to the RAN. There is only one tunnel per multicast distribution session and RAN node, i.e., all associated PDU sessions share this tunnel.

14. The RAN selects multicast or unicast radio bearers to deliver the multicast PDUs to UEs that joined the multicast group.

15. The RAN performs the transmission using the selected bearer.

### 6.3.3 Impacts on services, entities and interfaces

**SMF**: The SMF must handle a multicast context and the enhanced PDU session procedures.

**UPF**: If the UE joins multicast group via user plane, the UPF must support a new capability to trigger a user plane event in a response to the reception of a join message. The UPF should also act as multicast capable router but this functionality was already introduced in TS 23.316 [7].

**RAN**: The RAN must support the PDU session procedures and store UEs' association with multicast group in a context as received from the SMF. The RAN should be able to select PTP or PTM bearers that are used for multicast data transmission to UEs.

**N3**: A tunnel on this interface, which is configured when the first UE joins a multicast group and PDU session modification is performed, should be used to deliver multicast data from the UPF to the RAN.

**PCF**: The PCF interacts with Content Provider to receive QoS requirements, UE authorization information, service area, and start and end time of MBS sessions.

**UE**: It needs to indicate the MBS service information as part of the user plan join message (e.g., IGMP join), or of the control plan message (e.g., PDU Session modification request).

**NEF**: The NEF interacts with the Content Provider to provide it with IP address and port number of the multicast anchor UPF. It needs to further select the SMF handling multicast transmission and fetch the information of multicast anchor UPF by proving information about multicast to such SMF.

\* \* \* \* End of changes \* \* \* \*