**3GPP TSG-WG SA2 Meeting #144E e-meeting *S2-210xxxx***

**Elbonia, April 12 – 16, 2021 (revision of S2-210xxxx)**

**Source: Huawei, HiSilicon**

**Title: Signalling efficiency of the MBS procedures**

**Document for: Discussion**

**Agenda Item: 8.9**

**Work Item / Release: 5MBS / Rel-17**

*Abstract: This discussion paper aims at explaining… and proposes to…*

# 1. Background

## 1.1 SA2 discussion

Latest SA2 MBS TR 23.757 adopted the agreed S2-2101413 [1], in which the state diagram was introduced.

Nevertheless, in the meeting (SA2#143E), participants could not reach the consensus on how to address the signaling efficiency issue for group paging, as mentioned in the cover page of FS\_5MBS (S2-2101122 [2]):

|  |
| --- |
| **Outstanding Issues:** The disagreement between S2-2100343r02 and S2-2101017 on how to address the signalling efficiency issue for group paging will be resolved in the normative phase in coordination with RAN groups. |

As such, the related documents S2-2100343 and S2-2101017 were both postponed, and the signaling efficiency issue became the open issue in the normative phase.

## 1.2 Session activation and deactivation procedures

Section 8 of TR 23.757 (conclusion) includes the state machine of MBS session.



**Figure 1.2-1 State machine related to signalling efficiency.**

The MBS session can be “Active” or “Inactive”:

- **Active**: Multicast data are transmitted to UEs that joined the multicast session. 5GC resources for the multicast session are reserved. Corresponding Radio resources are reserved depending on participating UE locations. UEs that joined the multicast session are in CM-CONNECTED state.

- **Inactive**: Established multicast session in inactive state. No multicast data are transmitted. UEs that joined the multicast session may be in CM-CONNECTED or CM-IDLE state.

It is possible to change the Session state for a certain multicast session by Multicast Session Activation or Multicast Session Deactivation:

- **The Multicast Session Activation:** will trigger the MBS session state transit from Inactive to Active. UEs that joined the multicast session with CM-IDLE state are paged. Activation can be triggered by AF request or reception of multicast data.

- **The Multicast Session Deactivation:** will trigger the state transition from active to inactive multicast session. The Deactivation can be triggered by AF request or no reception of multicast data.

This document provides analyses on the session activation/deactivation procedure.

# 2. Discussion

## 2.1 MBS Session activation

### 2.1.0 Overview

As mentioned above, MB Session activation is used for re-establishing the resources for a certain MBS session in the network. Companies had disagreements on how to deal with such issue. In this section the procedures are analyzed.

### 2.1.1 Agreed Principles

The following principles were agreed in SA2#143E meeting, which are related to session activation:

* Group-based paging is beneficial, but details depends on RAN.
* When MBS Session is deactivated, MBS Session context is kept in 5GC, but changed to Inactivate state. MBS QoS Flows are kept in 5GC. UEs that have joined that multicast session can become IDLE.
* When the MBS Session needs to be activated, the AF/NEF or MB-UPF sends a message to the MB-SMF, the MB-SMF notifies the session activation to NG-RANs via SMFs/AMFs serving UEs within the multicast session. UEs are notified by NG-RAN about the session activation.

### 2.1.2 Possible session activation solutions

According to S2-2100343 [3] and S2-2101017 [4], the possible session activation solutions are demonstrated as follows:

**UE**

UE

**RAN**

RAN

**AMF**

AMF

**SMF**

SMF

**MB-SMF**

MB-SMF

**MB-UPF**

MB-UPF

**AF**

AF

0a. AF request

0b. Data Notification

3a. Group-based paging

1b. N16 message (TMGI)

2b. SMF finds UEs and AMFs

3b. N11 message ()

4b. AMF figures out the paging area

2a. AMF figures out the paging area

1a. N11 message ()

5b. Group-based paging

**Solution of S2-2100343, or option #3 of S2-2101017**

**Solution of option #1, or #2 of S2-2101017**

DL data

**Figure 2.1.2-1 Session activation solutions.**

The above figure demonstrates the two possible way forwards:

0a and 0b: MB-SMF receives notification from MB-UPF or AF (possibly via NEF).

**MB-SMF directly communicates with AMF (**Solution of S2-2100343 or option #3 of S2-2101017):

1. MB-SMF sends an Activate message toward the AMF.
	* For option #3 of S2-2101017, the Activate message includes the service area of the MBS Session;
2. AMF generates the paging area of the MBS Session.
	* For S2-2100343, AMF determines a group paging area based the involved RAs and triggers a group paging to this group paging area;
	* For option #3 of S2-2101017, the group paging area is equal to the service area;
3. AMF pages the UE(s), and UE replies with service request to get connected. The PDU session is setup again.

**MB-SMF communicates with SMF** (Solution of option #1 or #2 of S2-2101017):

1. The MB-SMF identifies the SMF(s) involved in the MBS session and sends an Activate message to each of these SMFs.
2. SMF finds the UE(s) and associating AMF(s). Each SMF identifies the deactivated MBS-related PDU sessions.
3. SMF identifies the UE(s), and sends N11 message(s) to the AMF(s) to activate the UP resources. For option #2 of S2-210107, it could further include the list of UE IDs.
4. AMF generates/retrieves the paging area of the MBS Session:
	* For option #1 of S2-2101017, the legacy paging is used;
	* For option #2 of S2-2101017, AMF determines a group paging area corresponding to the union of the involved RAs and triggers a group paging to this group paging area;
5. AMF pages the UEs, and UE replies with service request to get connected. The PDU session is setup again.

## 2.2 Comparison and analyses

### 2.2.1 Similarities and differences

There is no disagreement on the 1) triggers of the session activation; and 2) the behaviour of the UEs after receiving the paging. As shown in Figure **2.2.1-1.**

**UE**

**AF**

**MB-SMF**

AF request

**MB-UPF**

Incoming DL MBS data

Data notification

Paging

Service request

**AMF**

**Figure 2.2.1-1 Common parts of the solutions (exact paging procedures are different though).**

The above similarities are also mentioned in conclusion (see 2.1.1) therefore they shall be used as the baseline.

On the other hand, the differences are:

* + **Interaction between the 5GC NFs** (AMF, MB-SMF, and possibly SMF):
		- Proposal of S2-2100343 assumes the AMF having the group member information, and MB-SMF knows the AMF(s) at the multicast context request procedure. Therefore, when MB-SMF is about to activate the session, it can send the message to AMF(s) and AMF(s) then paging the UE.
		- Proposal of S2-2101017 option #1 choses to page the UEs individually: After SMF(s) receive the notification, the interactions between SMF(s) and AMF(s) are the same as the legacy paging.
		- Proposal of S2-2101017 option #2 assumes AMF does not have the UE information, and during session activation, MB-SMF firstly notify (or request) the SMF(s), and SMF(s) provides the UE list to the AMFs so as to let AMF figure out the paging.
		- Proposal of S2-2101017 option #3 lets MB-SMF provide the service information – Service Area (SA) information to the AMF therefore no UE information is needed for AMF. AMF pages the UEs based on the SA.
	+ **Paging attempts for the activation notification**:
		- S2-2100343 and S2-2101017 option #2 assumes the AMF understands the list of UE, and then the paging would be the group-based paging.
		- Option #1 of S2-2101017 uses individual paging to page the UE.
		- Option #3 assumes the MB-SMF provides Service Area of the MBS session to AMF and the paging would be group-based paging of which the paging area is equal to Service Area regardless of the UEs’ potential locations.

Figure **2.2.1-2** demonstrates the different parts among the potential solutions mentioned-above.

**S2-2100343**

**S2-2101017, option #2**

**S2-2101017, option #1**

**S2-2101017, option #3**

**MB-SMF**

**AMF 1**

**AMF 2**

N11 message (TMGI)

N11 message (TMGI)

Group paging

**MB-SMF**

**AMF 1**

**AMF 2**

N11 message (Service area)

N11 message (Service area)

Group paging

**AMF 3**

N11 message (Service area)

Group paging

**Wasted paging**

**MB-SMF**

**SMF 1**

**SMF 2**

N16 message (TMGI)

N16 message (TMGI)

N11 message

**AMF 1**

**AMF 2**

Legacy paging

**MB-SMF**

**SMF 1**

**SMF 2**

N16 message (TMGI)

N16 message (TMGI)

N11 message (UE list)

**AMF 1**

**AMF 2**

Group paging

**Figure 2.2.1-2 Different parts of the solutions regarding AMF-SMF interaction.**

### 2.2.2 Analyses

Option #3 of S2-2101017 assumes the Service Area information is mandatory, which leads to a major change towards the current multicast. In addition, signalling waste should not be neglected: RANs are still involved in the paging even though they are not within any RAs of the UEs. And it contradicts with the agreed principles:

|  |
| --- |
| *“MB-SMF notifies the session activation to NG-RANs via SMFs/AMFs serving UEs within the multicast session.”* |

Option #1 of S2-2101017 assumes to use legacy paging, and the number of paging is the same as the number of UEs, therefore the paging load is considerable.

Compared with option #2 of S2-2101017, S2-2100343 assumes AMFs have the UE information and the UE list is not needed.

To have a quantitative view, if we have the following assumptions:

* + One interaction between two NFs consumes a unit signalling, the paging message per RAN node per cell consumes a unit signalling.
	+ There are *M*1 RAN nodes in UEs’ RAs, *M*2 RAN nodes in the Service Area, *N*1 AMF nodes serving UEs, *N*2 AMF nodes in the Service Area, *K* SMF nodes, and *J* UEs.
	+ The number of cells within a single RAN node is *α*.
	+ UE’s RA would typically associate with *β* RAN nodes.
	+ In typical scenario, *J >> M*2 > *M*1*, J >>N*2 *> N*1*, J >>K*.

We can estimate the rough signalling complexities (upper bound and lower bound) of each alternatives:

**Table 2.2.2-1 Solutions comparison.**

|  |  |
| --- | --- |
| **Solution** | **upper bound (O)** |
| S2-2100343 | O (*N*1 + *M*1 + *αM*1)\* |
| S2-2101017, option #1 | O (*K* + *J* +*βJ* +*αβJ*) = O (*J* +*βJ* +*αβJ*) |
| S2-2101017, option #2 | O (*K* + *N*1 + *M*1 + *αM*1)\*\* |
| S2-2101017, option #3 | O (*N*2 + *M*2 + *αM*2) |

\*SMF forwards UE join request to AMF for each UE, therefore *J* times interaction between SMF and AMF are assumed.

\*\* The interaction between SMF and AMF contains the UE list, which volume is *J*.

**Observation:** In light of the upper bound of Table **2.2.2-1**, there is no significant difference on the signaling between S2-2100343 and option #2 of S2-2101017.

# 4. References

[1] S2-2101413: “23.757: KI#1: Conclusion update: Clarification of MBS Session Start/Activation, Stop/Deactivation”, Ericsson, Nokia, Nokia Shanghai-Bell, Huawei.

[2] S2-2101122: “Cover Sheet for TR 23.757 for Approval to TSG SA”, Huawei.

[3] S2-2100343: “23.757: KI#1 Conclusion update: Roaming, ETSUN and Signalling Efficiency”, Ericsson.

[4] S2-2101017: “23.757: KI#1: Conclusion update for MBS Session activation/deactivation and UE join/leave.”, Nokia, Nokia Shanghai Bell.