**3GPP TSG-RAN WG2 Meeting #112-e R2-200xxx**

Online, 2-13 November 2020

Agenda Item: 8.1.2.2

Source: CMCC

Title: Summary of email discussion [Post111-e][905][MBS] Connected Mode Mobility with Service Continuity

Document for: Discussion and Decision

# 1 Introduction

This document is for the following offline discussion, particularly for topics in 8.1.2.2:

**[Post111-e][905][MBS] Connected Mode Mobility with Service Continuity (CMCC)**

 Scope: Aim to understand what proposals are on the table, what can potentially be reused from existing mobility functions, and identify potential consequences / characteristics of options.

 Intended outcome: Report

 Deadline: Long

The final deadline of this email discussion is Wednesday, 2020-10-15, 23:59 Pacific Time. Earlier inputs are appreciated so that the rapporteur can have time to prepare the summary.

The Connected Mode Mobility with Service Continuity related aspects were discussed in many company contributions submitted to RAN2#111-e meeting [1]-[16]. Based on the discussions during the meeting, RAN2 made the following agreements with respect to connected mode mobility with service continuity:

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| * Focus on MBS-MBS scenario initially (i.e. shared delivery), including both PTM and PTP (if applicable). Other scenarios later, TBD.
* Requirements for lossless mobility are TBD. Assume for now that R2 will anyway discuss service continuity functionality for low or no data loss.
* R2 assumes that for Rel-17 NR multicast Mobility in Connected mode, handover (including variants) is the baseline, TBD exactly which variants.
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Meanwhile, RAN3#109-e had an email discussion regarding the topic of connected mode mobility with service continuity, and RAN3 made the following conclusions:

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| * We Define MBS session resource in analogy with PDU session resource, e.g. including radio part, CP part, NG-UP part, MBS context in RAN
* MBS session resource establishment is requested by 5GC (similarly to the PDU session establishment for unicast)
* RAN may request MBS session resource UP establishment, e.g. in handover (FFS). The signalling procedure (e.g. nested in handover signalling or new procedure, whether a single procedure is used or not, … ) is FFS.
* Prioritize work on support of mobility scenarios of UEs moving from a cell with established MBS session resource to another cell with established or to be established MBS session resource.
* For the prioritized scenario, intra-CU mobility and Xn/NG based inter-gNB mobility will be considered.
* WA: the UE Context to be transferred to the target gNB contains information about the MBS Session(s) the UE joined. Details are FFS.
* Next meeting: start with message flows and start deriving protocol functions on all impacted interfaces.
* To be continued...
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To progress the topic of connected mode mobility with service continuity, this email discussion will cover the following scope:

* **Progress TBD related to requirements for lossless mobility under the MBS-MBS scenario;**
* **Progress the down-selection of approaches for Minimization of data loss**
* **Progress the handover procedure enhancement for Mobility with service continuity**

# 2 Discussion

As descripted in [1]-[16], the scenarios are identified for MBS mobility are as follows:

1. **MBS to Unicast Handover.**
2. **Unicast to MBS Handover.**
3. **MBS to MBS handover.**

And in RAN2#111-e, the following text is agreed:

1. **Focus on MBS-MBS scenario initially (i.e. shared delivery), including both PTM and PTP (if applicable). Other scenarios later, TBD.**

Hence, this email discussion will use this agreement as the basis, which means RAN2 will start with the basic mobility scenario, i.e. a UE moving from a cell where an MBS Session is ongoing to another cell which is able to support that MBS Session. And other left scenarios will be discussed later and FFS. If 5GC delivers the MBS traffic in the shared delivery manner, either PTM or PTP transmission for the UEs can be selected over air interface. Therefore, there are the following possible cases during MBS to MBS handover, as figure 1 [6]:

* **Scenario 1: PTP->PTP;**
* **Scenario 2.1: PTP->PTM with PTP;**
* **Scenario 2.2: PTP->PTM;**
* **Scenario 3.1: PTM with PTP->PTP;**
* **Scenario 3.2: PTM ->PTP;**
* **Scenario 4.1: PTM with PTP->PTM with PTP;**
* **Scenario 4.2: PTM ->PTM;**
* **Scenario 4.3: PTM ->PTM with PTP;**



**Scenario 4.3**

**Figure 1 Scenarios to support service continuity during handover** [6]

## Minimization of data loss

### Scenarios Supporting Handover Lossless

As mentioned above, in RAN2#111-e, the following text is agreed:

* Requirements for lossless mobility are TBD. Assume for now that R2 will anyway discuss service continuity functionality for low or no data loss.
* R2 assumes that for Rel-17 NR multicast Mobility in Connected mode, handover (including variants) is the baseline, TBD exactly which variants.

And in RAN3#109-e, the following text is agreed:

* Working Assumption: NG-RAN protocols shall support minimization of data loss. Discussion on using or adapting existing protocol functions for support of lossless mobility is deprioritized due to expected issues with scalability.

Several papers have proposed that RAN2 should strive to minimize data loss in the MBS-to-MBS Handover scenario. For example, in [1], [3], [5], [7], [16], [15], it mentioned that in the WID, an important objective for NR MBS is the service continuity during mobility, i.e. the MBS service is still available after mobility. And use cases of NR MBS mainly consist of public safety and mission critical, V2X applications, transparent IPv4/IPv6 multicast delivery, IPTV, software delivery over wireless, group communications and IoT applications. Most of these use cases involve MBS service reception during inter-node mobility, e.g. public safety, V2X applications and so on. Obviously, the above use cases require high reliability, for example, according to 5GAA, V2X applications require up to 99.9999% reliability. Regarding public safety, the MCPTT service also requires up to 99.9999% reliability.

On the other hand, some companies have different understanding:

* For example, as expressed in [9], they concerns that the cost of optimization to achieve lossless in some case is very high, e.g. Handover in PTM to PTM manner.
* Meanwhile, as mentioned in [8] , refer to [16], there was already an evaluation and discussion on the possible packet loss due to the unsynchronized SC-PTM scheduling between two adjacent cells during the standardization of SC-PTM solution. The conclusion is that the possible data loss due to the unsynchronized SC-PTM scheduling over the radio link between two adjacent cells is not a serious problem to address. The potential packet loss could be avoided/minimized by network implementation.

**Question 1: Companies are requested to express their view whether RAN2 should support handover lossless in the MBS-to-MBS Handover scenario and justify shortly the choice. Or, which of the above scenarios should support the handover lossless (scenario 1- scenario 4)?**

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| **Company** | **Support or not/ Alternatively, which of the above cases should support the handover lossless?** | **Comment / alternative proposal** |
| CMCC | Yes |  |
| Mediatek |  | Lossless is more of a QoS requirement. For certain services, lossless HO should be supported, while for other services, lossless HO is not required. For the services having tight reliability requirement, PTM with unicast channel or PTP transmission with RLC AM mode would be configured for the corresponding MRB. While for the services having loose reliability requirement, PTM or PTP transmission with RLC UM mode can be configured. Therefore, the same reliability requirement should be maintained for the MRB during mobility. Based on this logic, if the MBS services doesn’t have high reliability requirement and are delivered in PTM transmission without unicast channel, lossless handover doesn’t need to be supported. Therefore, lossless handover doesn’t need to be supported for the following scenarios:* Scenario 2.2: PTP->PTM without unicast;
* Scenario 3.2: PTM without unicast->PTP;
* Scenario 4.2: PTM without unicast->PTM without unicast.

Lossless handover can be supported for the following scenarios:* Scenario 1: PTP->PTP;
* Scenario 2.1: PTP->PTM with unicast;
* Scenario 3.1: PTM with unicast->PTP;
* Scenario 4.1: PTM with unicast->PTM with unicast.

But from specification point of view, we should have a unified procedure with flexible configurations to support those scenarios.  |
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As mentioned above, in RAN2 conclusion, assumption for now is that R2 will anyway discuss service continuity functionality for low or no data loss. Based on this, preferred approaches need to be down-selected among the possible solutions. For example in [1], [3], [4], [12], there are some solutions to minimize the data gap related to the unsynchronized MBS data transmission between source cell and target cell. In summary, there could be some possible solutions to address the related issue, e.g., as described in [3], [7], [9], [6] and [8], [14].

### Issue 1# How to synchronize the MBS data transmission between source cell and target cell

In summary, the potential approaches related to this issue are as follows:

**Option 1:** Synchronized delivery over the radio between cells could be provided with employing SFN operation at NG-RAN side:

**1-1:** The SFN operation could be implemented at network side without standardization;

**1-2:** Introduction of SYNC which is to support SN synchronization among the RAN nodes which perform PTM transmission for the same 5G MBS service by enabling gNBs to identify the timing for radio frame transmission and detect packet loss. Based on this, gNB can buffer MBMS packet and wait for the transmission timing indicated in the SYNC protocol.

**Option 2:** DL PDCP SN synchronization and continuity between the source cell and the target cell should be guaranteed by the network side to realize the lossless handover for 5G MBS services, e.g. common PDCP or one PDCP in charge of PDCP SN assignment for both source cell and target cell.

**Question 2: Companies are requested to indicate their preferred approach, or provide new approaches.**

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| **Company** | **Preferred Option** | **Comment / alternative proposal** |
| CMCC | Option 2;Option 1-1 ? | In our understanding, usage of DL PDCP SN synchronization and continuity is more compatible to the existing protocol design during handover and possible protocol split way for dynamic switch between PTM and PTP.  |
| Mediatek | Option 2? | In order to support lossless HO, DL PDCP SN synchronization and continuity should be guaranteed by the network. This is a requirement instead of solution. How to realize PDCP SN synchronization and continuity should be discussed by RAN3. Maybe a sync protocol needs to be introduced for SN synchronization, or it can be left to network implementation.  |
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### Issue 2# How to guarantee the minimize data loss during handover

In summary, the potential approaches related to this issue are as follows:

**Option 1**: the UE will receive the multicast MBS of source and target multicast MBS simultaneously until the UE receive the all the data in the data gap.

**Option 2:** the source gNB will forward the data to the target gNB and the target gNB will deliver the forwarding data via unicast. After that, the UE will receive the MBS in the target cell via multicast. Meanwhile, the SN STATUS TRANSFER should be extended to cover the PDCP SN for MBS data.

**Option 3:** MBS can be configured as AM bearer, then lossless packet delivery based on PDCP status report and PDCP re-establishment/recovery can be supported as well.

**Question 3: Companies are requested to indicate their preferred approach, or provide new approaches.**

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| **Company** | **Preferred Option** | **Comment / alternative proposal** |
| CMCC | Option 1-3 | The three options are different but complementary. |
| Mediatek |  | First of all, I have one question for clarification: do the above options assume that PDCP SN is synchronized between the source cell and the target cell?In my understanding, the above options make sense only we assumes that the PDCP SN is synchronized between the source and the target. Otherwise, the there is no SN reference for SN status transfer in option 2 or PDCP status report in option 3. If I understand correctly, option2+option 3 is the legacy procedure to realize lossless HO for the DRB with RLC AM mode. So option 2 or option 3 alone can’t minimize the data loss during HO. For PTP transmission during HO, the legacy mechanism i.e. option2 (at the network side)+option3 (at the UE side) can be used to guarantee lossless HO. For PTM transmission during HO, the MBS services may being broadcast at the target cell during HO. For the basic HO procedure, UE will miss the packets which are being transmitted at the target side when UE perform HO procedure. One solution is that the network always cache some amount of DL packets for MBS services in case some UEs performs HO from other cells. Option 4: Option 2+option 3+ network caching |
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## Procedure of MBS to MBS handover

As mentioned above, RAN2 made the following agreement with respect to connected mode mobility with service continuity:

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| * R2 assumes that for Rel-17 NR multicast Mobility in Connected mode, handover (including variants) is the baseline, TBD exactly which variants.
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Meanwhile, RAN3#109-e had an email discussion regarding the topic of connected mode mobility with service continuity, and RAN3 made the following conclusions:

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| * RAN may request MBS session resource UP establishment, e.g. in handover (FFS). The signalling procedure (e.g. nested in handover signalling or new procedure, whether a single procedure is used or not, … ) is FFS.
* WA: the UE Context to be transferred to the target gNB contains information about the MBS Session(s) the UE joined. Details are FFS.
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According to RAN2 conclusion, the existing mobility functions defined in Rel-16 handover can be reused as baseline, and this subsection is to progress the handover procedure enhancement for Mobility with service continuity, for example in [2], [7],[8], [9], [11], [13], [14],. For UEs in RRC\_CONNCETED receiving (a) Multicast session, the high level mobility procedure can be as shown in Figure2, during the mobility of the UE moving from the source gNB to the target gNB, which are both support MBS:



**Figure 2: High level procedure of inter-gNB handover for NR MBS**

### Issue 3#: Necessity of reporting interested MBS services by UE in RRC\_CONNECTED state

As in illustrated in [2] [8], in LTE SC-PTM and eMBMS, in order to support service continuity during handover, when UE is interested to receive or receiving broadcast service(s) it sends RRC MBMS interest indication message to eNB indicating broadcast service(s) UE is interested to receive, service area Information, frequencies supporting the services as assistance information for eNB to handover the UE to the correct neighbouring cell(s) supporting the MBMS services if possible. However, in case of Rel-17 NR Multicast service, UE is expected to join multicast session by using either NAS session management based mechanism or IGMP user plane based method, which requires UE to establish RRC Connection. Both 5GC and NR RAN knows which multicast services the UE is interested in. This means to support NR multicast service continuity during handover, there is no need for multicast UE to send LTE-like MBMS interest indication to gNB, which indicates MBS service(s) UE is interested to receive.

On the other hand, other companies, e.g., as mentioned in [9], they think that it will bring benefit to allow the UE to report and update its interested or receiving MBS service(s) to its Pcell/Spcell upon change of interest/session/permission. Furthermore, priority information between MBS service(s) and unicast service(s) can also be reported by UE for the case where MBS service and unicast service cannot be supported simultaneously.

**Question 4: Companies are requested to express your position on the necessity of reporting interested MBS services by UE in RRC\_CONNECTED state to NG-RAN.**

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| **Company** | **YES/NO** | **Comment / alternative proposal** |
| CMCC | No | In case of Rel-17 NR MBS service, UE is expected to join multicast session by using either NAS session management based mechanism or IGMP user plane based method which requires UE to enter into RRC Connection firstly. Both 5GC and NR RAN are aware of which multicast services the UE is interested in. |
| Mediatek | No | UE doesn’t need to report interested MBS services for service continuity during HO.  |
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### Issue 4#: Necessity of forward the information of supported MBS/ongoing MBS/interested MBS service information of UE to the target by Source

In LTE MBMS, for handover preparation, the source eNB forwards the MBMS interest of the UE, if available, to the target eNB, while in NR, based on the SA2 discussion, the source gNB may know the multicast service information, which is received by UE in RRC-CONNECTED state. With this information, it could be helpful for the target node to perform access control or decide the transmission mode. Therefore, in NR MBS handover, it’s better for the source node to transfer on-going or interested MBS service information to target node, if possible. Of course, RAN3 should be involved together with RAN2 to develop a unified solution addressing the mobility issue for the connected mode UE.

**Question 5: Do you agree that the source gNB is allowed to forward the information of supported MBS/ongoing MBS/interested MBS service information to the target gNB?**

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| **Company** | **YES/NO** | **Comment / alternative proposal** |
| CMCC | Yes | Carry the on-going or interested MBS service information during the handover request message could help the target node perform access control odecide the transmission mode. And RAN3 had achieved the working assumption that the UE Context to be transferred to the target gNB contains information about the MBS Session(s) the UE joined. |
| Mediatek | Yes | In order to support the service continuity, the source node needs to transfer the information related to the interested MBS service to the target node in HQ request, and then the target node responds HO request ACK carrying the configuration for the MBS service, which is delivered to UE through HO command.  |
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### Issue 5#: Necessity of delivery the MBS bearer configuration of the target cell to UE via source cell during handover

In SC-PTM, there were discussions that SC-PTM control info of the target cell could be provided to the UE by handover command to minimize the service interruption time. For MBS in NR, we should reconsider whether to deliver the MBS bearer configuration to the UE by RRC signaling due to the new requirement and new architecture.

**Question 6: Do you agree that the MBS bearer configuration of the target cell can be delivered by source cell to UE in RRC Reconfiguration message?**

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| **Company** | **YES/NO** | **Comment / alternative proposal** |
| CMCC | Yes | This enhancement allows the UE to be able to continue receiving ongoing MBS service(s) in a new cell/gNB, without the phase of acquisition of the MBS configuration upon accessing the new cell/gNB, which can effectively reduce the interruption time. |
| Mediatek | Yes | In order to support service continuity during HO, the MBS bearer configuration of the target cell should be delivered to the UE through HO command. |
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### Issue 6#: MBS capable NG-RAN node can request the establishment of the N3 multicast tunnel

If there’s no MBS session in the target node, when and which entity trigger the MBS session establishment should be taken into consideration. For example, RAN triggers the MBS session establishment. The target node could trigger the procedure after it receives the handover request with the service information that UE is receiving or interested in as soon as possible, while the other way is the core network entities, such as UPF or SMF triggers the procedure. Compared the two kinds of method, RAN triggering approach has the advantage that the MBS session may early be prepared for UE, which may help to improve the robustness of handover and avoid extra handover delay due to MBS session establishment. Meanwhile, as discussed in [8], MBS capable NG-RAN node can request the establishment of the N3 multicast tunnel according to the solutions agreed in SA2 SI for MBS. If MBS session could be established on demand in NG-RAN, NG-RAN/5GC can request N3 multicast tunnel establishment or MBS session resource setup towards the target RAN, thereby enabling multicast transport. With this mechanism, RAN3 impact such as impact to NG, Xn interface could be expected. Though we may also need to investigate the potential impact to RAN2.

**Question 7: Companies are requested to indicate your view on whether MBS capable NG-RAN node can request the establishment of the N3 multicast tunnel and if required, corresponding potential** **RAN2 impact on mobility with service continuity based on the assumption that N3 multicast tunnel could be established on demand in MBS capable target cell.**

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| **Company** | **YES/NO** | **Comment / alternative proposal** |
| CMCC | Yes | Target node triggering approach may help to improve the robustness of handover and avoid extra handover delay due to MBS session establishment. |
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### Issue 7#: Necessity of measurement and reporting enhancement for MBS

As mentioned in [7], existing measurement and reporting framework can be fully reused. It means that additional enhancement is not necessary.

On the other hand, as mentioned in [2], for single cell broadcast/multicast, existing measurement for unicast can be used. For MRB carried over small area SFN with a given DU, the unicast measurement does not reflect the SFN signal quality. For this case, MBS specific measurement may need to be specified and it is up to RAN1 to decide how small area SFN is to be supported as network implementation choice. The MRB configuration has to be exchanged between gNBs using non-UE specific signalling for gNB to accurately configure MBS measurement for UE. The information is also used for target cell/gNB selection by source for handover.

**Question 8: Do you agree to enhance the measurement configuration or/and reporting mechanism for MBS, e.g. SFN based measurement configuration and reporting?**

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| **Company** | **YES/NO** | **Comment / alternative proposal** |
| CMCC | No | But, it may depend on how to support small area SFN with a given DU discussed in RAN1/RAN3. |
| Mediatek | No |  |
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### Other issues and/or enhancements need to be considered

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| **Company** | **Issues/Motivations** | **Corresponding Enhancements** |
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# **3 Conclusion**

TBD

# 4 References

1. R2-2001627 Impact of CG/SPS with periodicities non dividing HF length Sequans CommunicationsR2-2007027 Service continuity during mobility for MBS Huawei, HiSilicon discussion Rel-17 NR\_MBS-Core
2. R2-2006796 NR Multicast mobility enhancements with service continuity Qualcomm Inc discussion Rel-17 NR\_MBS-Core
3. R2-2006802 Discussion on mobility with MBS Service continuity OPPO discussion Rel-17 NR\_MBS-Core
4. R2-2007414 Discussion on MBS mobility with service continuity CMCC discussion Rel-17 NR\_MBS-Core
5. R2-2006984 Service Continuity for Connected mode UE NEC discussion
6. R2-2006827 Scenarios and Requirements for Mobility with Service Continuity MediaTek Inc. discussion
7. R2-2008061 MBS Mobility for Connected Mode UEs Samsung discussion Rel-17 NR\_MBS-Core
8. R2-2006595 Discussion on Mobility with Service Continuity in RRC\_CONNECTED CATT discussion Rel-17 NR\_MBS-Core
9. R2-2007035 MBS Service Continuity for RRC Connected UE vivo discussion
10. R2-2007054 Discussion on Mobility with Service continuity for connected UE Spreadtrum Communications discussion
11. R2-2007444 Discussion about basic mobility support in NR MBS ZTE, Sanechips discussion Rel-17
12. R2-2007467 PDCP Count Value Alignment to support of Loss-less handover for 5G MBS Lenovo, Motorola Mobility discussion Rel-17
13. R2-2007552 Support MBS service continuity with mobility Futurewei discussion Rel-17 NR\_MBS-Core
14. R2-2007628 Mobility for NR MBS Ericsson discussion Rel-17 NR\_MBS-Core
15. R2-2007991 MBS service continuity LG Electronics Inc. discussion

# **6 Proposals in summary contribution**