**3GPP T****SG-RAN WG2 Meeting #116bis-e R2-220xxxx**

**Online, January 17th – January 25th, 2022**

**Agenda item: 8.1.3.1**

**Source: Qualcomm**

**Title:** **Report of [AT116bis-e][019][MBS] Multicast Handover and related reconfigurations (QC)**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution is aimed at providing a high level summary of specific issues and impacts as per below scope.

* [AT116bis-e][019][MBS] Multicast Handover and related reconfigurations (Qualcomm)

 Scope: Address FFSes on in which scenarios to support lossless handover and how to do that (including case of mobility to non-supporting node) and related high level implications to stage-3 if any not already covered.

 Determine expectations on when to use of full configuration vs delta configuration.

 Confirm expectations on MRB-DRB type reconfiguration. (see also P19 in R2-2200021).

 Can also include message sequence chart(s) for inclusion in Stage-2.

 Also: Collect comments on whether CHO and/or DAPS should be prevented or can be allowed for UE with Multicast / MRB configuration, and if allowed whether there are additional impacts.

 Intended outcome: Report

 Deadline: Online CB Friday W1

Following are key open issues identified by [1] related to Multicast loss-less HO.

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| FFS which detailed scenario but at least PTP-PTP. |
| A procedure flow for mobility will be provided in the future. |
| Lossless mobility and data forwarding to be updated along the progress of respective discussions in RAN2 and RAN3. |
| FFS whether the switching the traffic from delivery via MRB to delivery via DRB either before or during the handover. |
| Whether and how this can be done without data losses has to be further investigated and requires progress and input from other WGs, i.e. RAN3 and SA2. |

From RAN2#112e, following are agreements.

* R2 aim to support lossless handover for MBS-MBS mobility for service that requires this (TBD which detailed scenario but at least PTP-PTP)
* In order to support the lossless handover for 5G MBS services, at least DL PDCP SN synchronization and continuity between the source cell and the target cell should be guaranteed by the network side to realize. The design of specific approach to realize this can be involved with WG RAN3.
* From network side, the source gNB may forward the data to the target gNB and the target gNB will deliver the forwarding data. Meanwhile, the SN STATUS TRANSFER should be extended to cover the PDCP SN for MBS data; Then (TBD after or in parallel) the UE receives the MBS in the target cell by the target cell according to target configuration.
* From UE side, PDCP status report may be supported as well.

Companies are invited to provide their views by January 21st (Friday), 2022, 12:00 UTC.

Note that this is not summary of all submitted contributions and due to limited time, focusing on few key issues to make reasonable progress at this meeting.

# 2 Participants

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| --- | --- |
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# 3 Discussion

## 3.1 Multicast Loss-less HO scenarios to be supported

*Address FFSes on in which scenarios to support lossless handover and how to do that (including case of mobility to non-supporting node) and related high level implications to stage-3 if any not already covered.*

In order to support Multicast loss-less HO from source cell to target cell (assuming both cells are supporting MBS), it is necessary to support PDCP status reporting, PDCP SN continuity and re-transmission of missing PDCP SN by target cell. Multicast MRB can be configured as PTM Only, PTP only and both PTM + PTP. For PTM, RAN2 agreed to support only RLC UM and PTP can be configured with either RLC UM or AM.

Companies contributions indicated that target cell MRB configuration has to support PTP RLC AM mode for supporting loss-less HO. Some companies indicated loss-less HO to be supported if both source and target cells are supporting PTP RLC AM configuration , which is similar to unicast loss-less HO. However, few companies also indicated that it should also be possible to support loss-less HO from source cell PTM to target cell having PTP RLC AM configuration.

Following are possible scenarios for supporting loss-less HO :

Scenario 1: PTM + PTP -> PTM + PTP

Scenario 2: PTM + PTP -> PTP only

Scenario 3: PTP only -> PTM + PTP

Scenario 4: PTP only -> PTP only

Scenario 5: PTM Only -> PTM + PTP

Scenario 6: PTM Only -> PTP only

**Q1: Do companies agree that both source and target cells supporting PTP RLC AM (i.e, scenario 1 to scenario 4) as baseline for supporting Multicast loss-less HO between MBS supporting cells ?**

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|  **Company** | **Yes/No** | **comments if any** |
| Lenovo, Motorola Mobility | No | We don’t see there is any additional limitation to support scenario 5&6. For scenario 5&6, data forwarding between source and target is still possible. And the UE can also report PDCP SR to target for retransmission. Furthermore, the PDCP re-ordering/reestabilshment function should be common for all the scenarios.  |
| CATT | Yes | In legacy, lossless handover can be supported only for the DRBs with RLC AM mode. The same principle should be applicable for multicast MRB. Since RLC AM is only supported for multicast PTP mode. So the existing of PTP leg is the precondition to support lossless handover for multicast. |
| vivo | Yes with comments | We agree that scenarios 1~4 should be considered as baseline.Moreover, in our understanding, as long as PTP RLC AM (e.g. scenarios 5 & 6) is configured on the target cell, supporting multicast loss-less HO between MBS supporting cells is also feasible. Specifically, the target cell may have already buffered some data (e.g. data that are supposed to be transmitted during the transmitting gap between the source cell and target cell). When UE accesses the target cell, it can receive retransmitted PDU after UL PDCP status reporting via PTP leg.Hence, we propose to consdier scenario 5 and scenario 6 as well. |
| Huawei, HiSilicon | Yes, but | We see no extra effort to support scenario 5 and scenario 6 as well. |
| Xiaomi | Yes |  |
| Samsung | Yes | Same principle as unicast DRB |
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**Summary:**

**Q2: Do companies agree to support Multicast loss-less HO from source cell PTM only configurtaion to target cell with PTP only or PTM + PTP configuration ?**

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|  **Company** | **Yes/No** | **comments if any** |
| Lenovo, Motorola Mobility | Yes | As the answer to Q1 |
| CATT | No | See commetns to Q1 |
| vivo | Yes | As our response for Q1. |
| Huawei, HiSilicon | Yes |  |
| Xiaomi | Yes |  |
| Samsung | Yes |  |
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**Summary:**

In case of HO from MBS supporting source node to MBS supporting target node, it should be possible to support delta configuration (without configuration) to avoid data loss during HO procedure.

**Q3: Do companies agree that it should be possible to support delta configuration during HO from R17 MBS supporting source node to R17 MBS supporting target node ?**

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|  **Company** | **Yes/No** | **comments if any** |
| Lenovo, Motorola Mobility | Yes |  |
| CATT | Yes | delta configuration is essential for lossless handover. |
| vivo | Yes | We think delta configuration for MBS service is beneficial for data lossless during HO procedure, which, although, may need some coordination between neighbor cells for unified configuration for same MBS service. |
| Huawei, HiSilicon | Yes |  |
| Xiaomi | Yes |  |
| Samsung | Yes |  |
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**Summary:**

## 3.3 Loss-less HO between MBS supporting node and Non-MBS supporting node

 *Determine expectations on when to use of full configuration vs delta configuration.*

 *Confirm expectations on MRB-DRB type reconfiguration. (see also P19 in R2-2200021).*

Other cases that need support of loss-less HO include

1. Source cell supporting MBS -> Target cell not supporting MBS
2. Source cell not supporting MBS -> Target cell supporting MBS

For supporting loss-less HO from Source cell supporting MBS -> Target cell not supporting MBS, this was discussed in [2] and below is summary proposal (this proposal was not discussed in previous RAN2 meeting).

***Proposal 19: In order to minimize data loss during a handover from MBS supporting node to a node not supporting MBS, the source gNB may provide multicast data via DRB shortly before the handover. FFS the details, e.g. whether/what changes are needed to support multicast data delivery over DRB. RAN3 should be informed about this agreement.***

Above proposal19 will be made without further seeking input again.

Next question is how to configure MRB to DRB in source cell. Below are potential solutions.

**Solution 1:** While the UE is still in source cell, source cell can reconfigure UE from MRB to DRB just before HO is initiated. One can argue that this type of reconfiguration by source cell causes additional signaling overhead , latency and potential enhancements needed to reduce loss of data during bearer type switch.

**Solution 2:** Perform the change from MRB to DRB during handover which addresses the issues of the previous solution.

From [13][4], In order to perform the change from MRB to DRB without full reconfiguration and thus support lossless handover, the network configures a “deactivated/dormant” DRB which is signalled to the target in the HandoverPreparationInformation.

From system level optimization perspective , both solution 1 and 2 can be optimized to avoid full configuration and RAN2 need to discuss about which solution to be used for switching from MRB to DRB.

**Q4: Which of the above two solutions to be adopted for MRB to DRB switch during loss-less HO from MBS supporting cell to Non-MBS supporting cell ?**

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| **Company** | **Solution 1, Solution 2 or both**  | **Comments if any** |
| Lenovo, Motorola Mobility | Both, slightly prefer solution 2 | Solution 1 needs the network reconfigures MRB to DRB before handover, which may introduce more handover delay. Solution 2 can avoid the unnecessary reconfiguration before handover.  |
| CATT | Solution 2 | Solution 1 is complicated and has more spec impact.And we also agree with the drawbacks of solution 1 listed by moderator. |
| vivo | See comments | According to TS23.247, UP data transmission is as follows:Figure 6.7‑1: Schematic showing user plane data transmissionIn our understanding, MRB and DRB are completely two independent radio bearers, i.e. MRB is associated with shared MBS PDU session while DRB is associated with UE individual PDU session. These two CN PDU sessions/tunnels are different and data packet async is inevitable.Hence, solution 1 seems not feasible. The source cell can not reconfigure UE from MRB to DRB before HO since it is unknown which CN PDU session/tunnel is used for this DRB, e.g. UE individual PDU session is not activated now. If we have to resolve these issues, additional interaction complexity between nodes and the potential increased probability of HO failure should be also considered. Solution 2 is preferable but SA2 should agree to support packets sync solution between MBS PDU session and UE individual PDU session first. |
| Huawei, HiSilicon | Neither | Not sure about the intention of this question. This was discussed in the post-RAN2#115 e-mail discussion and there seems to be a clear majority to agree that the source gNB may provide multicast data via DRB shortly before the handover, i.e. proposal 19 as indicated by the rapporteur. Therefore we suggest to take this as baseline and further discuss the details of this approach.  |
| Xiaomi |  | We would prefer to have MRB and DRB configured at the same time at the source node before the handover to avoid the packet loss. |
| Samsung | Solution 1 | Non-MBS supporting target gNB does not understand the source’s MRB configuration. Thus gNB has no choice to indicate full configuration. Thus, Solution 2 does not work in case that the target node does not understand MRB configuration, e.g. earlier release or RRC version mistmatch. Solution 2 would work only if non-MBS supporting node understands the source’s MRB configuration but MBS is not supported. We think the use case is limited. |

**Summary:**

From [12], when MBS non-supporting gNB is from an earlier release, full configuration is expected as normal. All AS context of radio configurations need to be cleared. This cannot be avoided. Full configuration is designed to be forward compatible and the Full configuration flag is set by the target gNB to the UE if ASN.1 from the source gNB cannot be comprehended. The target gNB does not need to know any information on the source gNB when using full configuration option. Hence, even the source gNB is aware of the MBS support of the target gNB before handover (as mentioned in R3-216222), the full configuration still cannot be avoided, as it is decided by the target gNB according to the full configuration procedure.

**Q5: Do companies agree that for handover from MBS-supporting node to non-MBS supporting node which cannot comprehend ASN.1, full configuration should be used.**

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|  **Company** | **Yes/No** | **comments if any** |
| Lenovo, Motorola Mobility |  | If the target can not comprehend ASN.1, full configuration should be used. Full configuration will impact all DRBs and MRBs. With the abover solution 1&2, full configuration can be avoided. |
| CATT | No | Full configuration can be avoided by e.g. providing the configuration of dormant DRB to UE before handover. Other means are not precluded. |
| vivo | Yes  |  |
| Huawei, HiSilicon | No | If a DRB can be setup before handover, then also an MRB can be released and the handover to target can be based on legacy handover to minimize the data loss, without the need for the target node to perform full-config.Note that in the LS from RAN3 (R3-216222), they have made a WA: *- WA: It is assumed that if the source gNB is aware of the MBS support of the target gNB before the handover, the source gNB may also avoid full configuration at the non-supporting gNB.* |
| Xiaomi |  | Maybe we should say that the full configuration is used when the source MRB configuration is kept and forwarded to the target gNB not comprehending the MRB configuration (i.e. non-MBS supporting node). |
| Samsung | Yes | The target node is not 100% sure about UE’s configuration. Full configuration is the only a possible option. |
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**Summary:**

From [4], for both solution 1 and solution2, indicated that it is possible to avoid full configuration during loss-less HO from MBS supporting node to Non-MBS supporting node.

*There are two solutions on how to avoid “full configuration” during HO from MBS supporting node to MBS non-supporting node:*

***Solution 1: The MRB is reconfigured to unicast DRB before handover to MBS non-supporting node.***

*In the solution 1, in order to avoid full configuration, the network reconfigures the MRB to unicast DRB before handover to MBS non-supporting node. During handover phase, the legacy handover and data forwarding procedures are performed using the associated PDU session resource context, associated unicast QoS flow, and unicast DRB related RRC context. The reconfiguration of MRB to DRB before handover may include the following information:*

*-* *Option 1: the PTP transmission of MRB is reconfigured to DRB with change the MRB ID to DRB ID. And the MBS session ID is replaced by the associated PDU session ID in the SDAP-Config. The gNB includes the newly allocated DRB ID in the RRC Reconfiguration message. The UE replaces the MRB ID with the DRB ID in the RLC-BearerConfig or in the DRBtoAddMod IE. The UE continues to reuse the SDAP and PDCP entities of the MRB and may reuse the lower layer entity and configuration of PTP transmission of the MRB. The UE may reestablish the PDCP entity e.g. for the security mechanism may be applied to DRB.*

*-* *Option 2: the new DRB is established with reusing the SDAP/PDCP entity of the MRB. The gNB provides the associated SDAP entity and/or PDCP entity information and new DRB configuration to the UE. The UE shall reuse the associated SDAP entity and/or PDCP entity of MRB (the PDCP entity may be reestablished) and establish a new lower layer entity with new configuration.*

***Solution 2: The MRB is switched to DRB during handover without full configuration.***

*In this solution, a DRB associated with MRB is pre-configured in the source gNB, that is MBS supporting gNB. From UE point of view, the MRB is switched to DRB without full configuration and with supporting service continuity, while the switch from MRB to DRB is transparent to the target gNB. The DRB associated with MRB has the following characteristics:*

*- The DRB associated with MRB is pre-configured in the source gNB before handover. The unicast DRB shares same SDAP and PDCP entities with MRB. The source gNB may allocate a DRB ID different from MRB ID for the DRB.*

*- The unicast DRB is deactivated in the source gNB, i.e. the source gNB does not use the DRB for data transmission.*

*- The DRB is activated during handover to the target gNB, that is MBS non-supporting node.*

*- During handover preparation, the source gNB sends the RRC Context of the DRB to target gNB. The target gNB decides to reconfigure the DRB based on the RRC Context. The source gNB will not send the RRC Context of MRB to the target gNB in order to avoid full configuration.*

*- When UE receives the DRB configuration without MRB configuration in handover command, the UE shall activate the DRB with reusing and reestablishing the PDCP entity and release the remaining lower layer configurations (Cell Group or RLC bearer configurations) of the MRB.*

From [12], it argues that no optimization is needed for switching from MRB to DRB.

*For MBS non-supporting gNB is Rel-17 gNB (i.e. no MBS session), full configuration is not applied if both gNBs are from the same release. Some companies proposed to establish a temporary DRB before handover to the target gNB. However, the establishment of temporary DRB which accommodates MBS non-supporting configuration at the source gNB depends on the fact the source gNB has the knowledge of target gNB’s capability/supported feature. Moreover, in email discussion “[Post115-e][091][MBS] Remaining control plane issues”[1], it was discussed whether the source gNB may provide multicast data via DRB shortly before the handover, in order to minimize data loss during handover from MBS-supporting node to non-MBS supporting node. However, there is no guarantee that MRB can be switched to DRB in a lossless manner. In current MBS RRC running CR R2-2111658, MRB is separately configured from DRB, as below:*

*MRB-ToAddMod-r17 ::= SEQUENCE {*

 *tmgi-r17 TMGI-r17 OPTIONAL, -- Cond MRBSetup*

 *mrb-Identity-r17 MRB-Identity-r17,*

 *reestablishPDCP-r17 ENUMERATED{true} OPTIONAL, -- Need N*

 *recoverPDCP-r17 ENUMERATED{true} OPTIONL, -- NEED N*

 *pdcp-Config-r17 PDCP-Config OPTIONAL, -- Cond PDCP*

 *...*

*}*

*It is challenging to minimize data loss when switching from MRB to DRB, as procedurally the MRB should be released and DRB should be added. The only possible way to minimize data loss is to specifically design a new procedure for MRB to DRB switching without explicit release of MRB. This causes additional standardization effort, and there is a risk of RLF/HOF since the switching of MRB to DRB delays handover due to following procedures:*

* *Switching from MRB to DRB in the source cell needs further discussion on how the changeover happens – whether there is an overlap when both are established or not. For the overlap case, further discussion is needed on potential duplication of data. For non-overlap case, discussion is needed on the details of the sequence for the release of the MRB and set up of the DRB.*
* *Switching from MRB to DRB requires signalling exchange with 5GS. MRB is associated with a MBS session using 5GS shared delivery method, and DRB is associated with PDU session using 5GS individual delivery method. Switching from MRB to DRB requires changing delivery method, and signalling exchange with 5GS is needed for such change.*

RAN2 need to discuss whether to persue this optimization or not. Without this optimization, it is not possible to support delta configuration and which cause potential data loss.

 **Q6: Do companies agree to optimize MRB to DRB switching procedure to avoid full configuration for both Solution 1 and Solution 2 during loss-less HO from MBS supporting cell to Non-MBS supporting cell ?**

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| **Company** | **Yes/No** | **Comments if any** |
| Lenovo, Motorola Mobility | Yes | Full configuration will impact all DRBs and MRBs, that should be avoided.We understand the issue raised in [12] is only about detailed signlling issue on how to switch MRB to DRB. On the other direction handover from MBS non-supporting to MBS supporting node, the reconfiguration from unicast DRB to MRB cannot be avoided. If so, the reconfiguration from MRB to unicast DRB should also be supported without extra standard effort. A common PDCP entity is used when the source node switches the MRB/DRB to a DRB/MRB before or during the handover to minimize the data loss. |
| CATT | Yes | Delta configuration is helpful to minimize data loss during handover from MBS supporting cell to non-MBS supporting cell.Nevertheless, we don’t support Option 1 of Solution 1. |
| vivo | See comments | Need to wait for SA2 and RAN3’s further progress and conclusion. |
| Huawei, HiSilicon | See comments | From our perspective, both solution 1 and solution 2 may not work as the signaling struction of DRB is not fully reused for MRB and there are some significant differences between these two types of RBs, e.g. security configuration. A possible way forward based on Proposal 19 that is accepted by the majority in last meeting is to establish a DRB before HO and deliver multicast data via MRB as well as DRB concurrently for a short time and not delivered the data received from DRB to upper layer until transmissions via MRB are finalized. Details can be referred to R2-2200816.  |
| Xiaomi | See comments | We would slightly prefer the solution provided by Huawei, i.e. deliver multicast data via MRB as well as DRB concurrently for a short time. |
| Samsung | No | The reconfiguration from MRB to DRB is under gNB control. The source gNB can initiate the type chang when the packet loss is not expected (or minimized) by gNB implementation. We think MRB to DRB change can be based on release and add without optimization [15] |
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**Summary:**

For supporting loss-less HO from Source cell not supporting MBS to Target cell supporting MBS, contributions indicated that legacy HO procedure (DRB based loss-less HO) can be performed from source to target cell and then target cell can switch from DRB to MRB via RRC reconfiguration procedure.

**Q7: For supporting loss-less HO from source cell not supporting MBS to target cell supporting MBS, two step procedure can be used.**

**Step 1: perform legacy DRB based loss-less HO (with delta configuration) , Step 2: after HO, target cell with reconfigure UE from DRB to MRB via RRC Reconfig procedure.**

**Do companies agree with this procedure?**

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| **Company** | **Yes/No** | **Comments if any** |
| Lenovo, Motorola Mobility | Agree | We would prefer a common PDCP entity is used for the DRB and MRB to support loss-less. |
| CATT | Yes | The legacy handover procedure is used for this case. |
| vivo | Yes |  |
| Huawei, HiSilicon | Yes | This should be the baseline. And further enhancement can be studied in Step 2 if lossless is required during the reconfiguration. |
| Xiaomi | Yes |  |
| Samsung | Yes |  |
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**Summary:**

## 3.3 CHO and DAPS HO for R17 MBS UEs.

Both [12][16], discussed about supporting CHO for R17 MBS UEs. CHO can be supported for R17 MBS UEs without much specification impact. RAN3 also discussed about CHO and they depriorized support of CHO for R17 MBS UEs. [10] suggested not to support CHO for R17 MBS UEs and [15] suggested to consider CHO only if time permits.

Assuming there are not many specification changes needed, rapporteur thinks it is reasobable to support CHO for R17 MBS UEs if time permits.

For supporting DAPS HO, it may involve lot of additional effort and for MRB configured UEs, it is possible to configure MBS bearer as non-DAPS bearer.

**Q8: Do companies agree to support CHO for R17 MBS UEs assuming there is not much additional specification work needed if any?**

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| **Company** | **Yes/No** | **Comments if any** |
| Lenovo, Motorola Mobility | Yes | We tend to support CHO for MBS. If time is not allowed, we are also fine to support it in Rel-18. |
| CATT | No | We prefer not to open the discussion on this at this very late phase as the spec impact is unclear.  |
| vivo | Yes | RAN2 can consider CHO if working time is sufficient. |
| Huawei, HiSilicon | Yes, but | We should first focus on basic mobility procedure and CHO should be deprioritized. |
| Xiaomi | Yes | We see no extra standard efforts needed in RAN2. Optimization can be considered in the later release. |
| Samsung | No | It’s clear that MBS services do not require such short latency. In our view we can de-prioritize and see which additional impact is expected for CHO with MBS. |
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**Summary:**

**Q8: Do companies agree that DAPS HO is not supported for MRB and is configured as non-DAPS bearer for R17 MBS UEs?**

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| **Company** | **Yes/No** | **Comments if any** |
| Lenovo, Motorola Mobility | Yes |  |
| CATT | No | See comments to Q7. |
| vivo | Yes | DAPS HO is not configured to a MRB but can be configured to a legacy DRB for R17 MBS UEs. |
| Huawei, HiSilicon | Yes |  |
| Xiaomi | Yes |  |
| Samsung | Yes |  |
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**Summary:**

# 5 Conclusion

The contribution is summarized with proposals as follows,

# 6 Reference

1. R2-2200022 NR MBS open issue list Huawei, HiSilicon
2. R2-2200021 Untreated proposals from offline discussion: [AT116-e][051][MBS] CP continuation Huawei, HiSilicon
3. R2-2200534: NR Multicast loss-less HO enhancements with service continuity Qualcomm Inc
4. R2-2200756: Service Continuity for handover from MBS Supporting Node to MBS non-Supporting Node Lenovo, Motorola Mobility
5. R2-2200235: Open Issues on Multicast Service Continuity CATT, CBN discussion
6. R2-2200576: Service continuity for multicast mode TD Tech, Chengdu TD Tech discussion
7. R2-2200641: Discussion on Multicast service continuity during mobility Spreadtrum Communications
8. R2-2200816: MBS service continuity and notification for multicast Huawei, HiSilicon
9. R2-2200828: Mobility and Service continuity for NR Multicast MediaTek inc.
10. R2-2200857: Discussion on Mobility with Service Continuity CMCC
11. R2-2200978: Multicast Service Continuity Aspects Ericsson discussion
12. R2-2201175: Multicast service continuity and discussion on RAN3 LS Intel Corporation
13. R2-2201256: Mobility with non-supporting nodes Nokia, Nokia Shanghai Bell discussion
14. R2-2201258: Mobility for NR MBS vivo
15. R2-2201365: Multicast Service Continuity Samsung
16. R2-2200539: Discussion on MBS with conditional handover Futurewei
17. R2-2201412: Mobility Between MBS Supporting Nodes ZTE, Sanechips
18. R2-2200785: MBS Mobility Nokia, Nokia Shanghai Bell