3GPP TSG-RAN WG2 Meeting #111e R2-20xxxxx

Online, 17-28 August 2020

**Agenda item: 6.5.1**

**Source: Nokia, Nokia Shanghai Bell**

**Title: [DRAFT] Summary of e-mail discussion: [AT111-e][043][IIOT] Stage 2, DC CA duplication clarifications**

**WID/SID: NR\_IIOT - Release 16**

**Document for: Discussion and Decision**

# 1 Introduction

This document aims to collect views from companies for the following email discussion during RAN2 #111e:

* [AT111-e][043][IIOT] Stage 2, DC CA duplication clarifications (Nokia)

 Scope: take into account online discussion, Treat R2-2006918, 6919, 7133, 7891, 8056, 6637, 7138, 7387, 7149, 7150, Determine agreeable parts. Agree CRs

 Deadline: Aug 26 0900 UTC. Intermediate deadlines by Rapporteur if needed.

In the online session, all three proposals from [1] are agreed, while the text proposals in [2] and [3] will be the baseline CR for TS 38.300 and TS 38.321 respectively:

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| [R2-2006917](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_111-e%5Cdocs%5CR2-2006917.zip) LCH Mapping Restriction issues with DC+CA PDCP Duplication Nokia, Nokia Shanghai Bell discussion Rel-16 NR\_IIOT-CoreDISCUSSION - Samsung agree with all proposals. - Ericsson agree with 1 and 2, but for 3, there are more cases to consider.  e.g.) when 3 CA legs are configured, and one is deactived, the restriction should be lifted as well. LG think that in this case the restriction shall not be lifted for the 2 remaining and for the 1 deactived LCH it will not be used so there is no issue. Ericsson think the issue is that there will still be data in the L2 buffers for the deactived LCH, and this will cause issues on activation. Apple think the transmission can continue until buffers are empty. Nokia think after deactivated we can still keep restriction, and likely the data can be transmitted anyway. Mediatek think this is not an issue if the serving cell is still active, but timers can handle corner cases. - vivo thikn 2 need to be complemented, such that if all CA legs are deactivated, CA duplication is deactivated. Nokia don’t understand the point as duplication no longer exists- Oppo think one case is missing, if 3 legs are configured to a CG and all are deactivated then, duplication restriction should be lifted. For DC duplication, if a CG has a single logical channel and this leg is deactiveated, then restriction should be kept. Nokia think there is no issue to resolve at all on this. Huawei think that for this second issue, the cell restriction can be configured for different purpose, but think the issue might not be there, but this may be the behaivour already. Nokia agrees, they are served by different MAC entities. MTK think that wil Cell groups with zero legs ther eis no issue, there will be no transmissions. - LG think this is simple, if there are > 1 LCH active for duplication the restrictions applies, and if =1 then restriction shall be lifted. - Apple Agrees with LG. Nokia as well. Huawei agrees as well. Mediatek agrees as well. Lenovo agrees as well. - CATT think that R15 behaivour is different. Nokia think that we just lift restriction in the cell group for which the condition applies, not for other cell groups (which may have CA duplication as well). Nokia think this case didn’t exist in R15. LG agrees, and a restriciton is just for one MAC entity. Intel agrees as well. Huawei also agrees with Nokia, and think the proposals seem consistent with r15. CATT still think there is a difference. - Intel think that if PDCP duplication is deactived then the remaning data is discarded. LG think that for segments of a PDU for which transmission has started will continue, they are not discarded. Huawei think this data buffering is not an issue. - vivo still wonder what happens if also the last leg is deactived, shall the cell restriction be restored or not? Based on given comments, Chair think this it not the key point and can be discuss when discussing the CR(s). Huawei agrees this can be discussed. Lenovo thikn current spec is clear, the R15 behaviour when CA duplication is deactivated (altogether). - Samsung think MAC TS should also be updated. Nokia agrees. - OPPO think we can have a deactived leg that is used for split bearer transmission. Nokia think that we only apply split bearer operation when the whole duplication is deactivated. Nokia think that for split bearer, the restriction does not apply at all, and Nokia thikn this is the current behavior. ZTE agrees with Nokia, and think R16 the situation is indeed different. We can discuss in detail by email. Chair think indeed if we find problems with this they can be addressed by email. LG think current specification is crystal clear. - Nokia and Huawei confirms the intention that these proposals only apply when CA duplication is configured.- Ericsson wonder if a timer can resolve the buffering. MTK think that for SDUs, they are immediately discarded, and for sgements, also for RLC UM there are timers. * P1, P2, P3 are agreed (can still take into accont additional aspects acc to discussion above by email)
* CR for 38300 (6918 is the baseline), 38321 (6919 is the baseline) by email.
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In particular, the agreed proposals from [1] are:

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| ***🡪 Allow lifting LCH mapping restriction in the cell group that is not associated to the primary RLC, and further define the conditions where the LCH mapping restrictions can be lifted.******🡪 CA-duplication in a cell group can be deemed as deactivated if only one logical channel for the DRB remains activated in the cell group, regardless of whether the cell group is associated to the primary RLC or not.******🡪 For CA-duplication in a cell group, LCH mapping restriction of allowed serving cells is lifted when only one logical channel remains active in the cell group for a duplicated DRB, regardless of whether the cell group is associated to the primary RLC or not.*** |

Essentially, these agreements have confirmed that LCH mapping restriction of CA duplication in the cell group without primary path can be lifted, at least in the cases where only one LCH remains active in this cell group (in this case CA duplication in this cell group is considered as deactivated). In our understanding, these agreements have at least already captured the intentions of papers including [4], [5], and [6]. However, during the online discussion (as well as in some of the submitted papers such as [7], [8], [9], [10] and [11]), some companies have raised further behaviour about LCH mapping restrictions lifting and/or other PDCP duplication issues in general, including:

1. The LCH mapping restriction of allowed serving cells for a deactivated LCH should also be lifted, even if there are still more than one active LCHs remained in the cell group [7].
2. When all LCHs in the cell group are deactivated, LCH mapping restriction of allowed serving cells in the cell group should be lifted.
3. In DC+CA duplication, for the MAC entity associating with a single LCH, the LCH mapping restriction for the LCH is kept after duplication deactivation [11].
4. NG-RAN should ensure that at least one serving cell is activated for each logical channel of the DRB which is associated with RLC entity activated for duplication. Also, NG-RAN should ensure that duplication for the RLC entity is also deactivated if the deactivation of SCell leave no serving cell activated for the logical channel which is associated with that RLC entity. [9][10]
5. RLC failure reporting is triggered in case of RLC failure if there are multiple active RLC entities for a DRB with PDCP duplication configured in this cell group. [7]
6. The description of *primaryPath* should be updated in TS 38.331. [7]

This email discussion will be conducted in two phases:

* Phase-1: Identify further agreements from the issues listed above
* Phase-2: Capture agreements from Phase-1 and finalize CR (with [2] and [3] as baseline) along with any comments on the text proposals.

# 2 Discussion: Phase-1

## 2.1 Lifting LCH Mapping Restriction for Deactivated LCH

In [7], it proposed another condition wherein the LCH mapping restriction should be lifted: if a LCH within a cell group is deactivated (and there are still LCHs remain active in the same cell group), the LCH mapping restriction of this deactivated LCH should be lifted. The intention is to allow this deactivated LCH to clear up the data in its buffer (if any) via transmission on any cell, in cases there are still some data stuck in the LCH buffer after it is deactivated.

**Question 1: Do you agree RAN2 should specify the behavior of lifting LCH mapping restriction of allowed serving cell for a LCH, upon deactivation of duplication over its corresponding RLC entity?**

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| **Company** | **YES/NO** | **Comments** |
| LG | NO | There would not be many buffered data in the deactivated RLC entity, and they could be transmitted via the cell to which the LCH is mapped. There is no critical problem to send the buffered data. |
| Samsung | No | If one of allowedServingCells of the deactivated LCH (RLC entity) is still active, there will be no data stuck in the buffer. |
| Nokia | No | The RLC entity is deactivated but its allowed serving cells are still active, so in the end this LCH still has resources to finish transmitting the buffered data. So there is no need to lift LCH mapping restriction for a deactivated LCH.  |
| CATT | No | We don’t see this as a critical issue, provided that R15 mechanisms (e.g. PDCP PDU discard) will help flushing the remaining data in the cell and gNB can also provide grants accordingly. |
| Ericsson | Yes | According to current specification, only RLC data not yet “in flight” is discarded when PDCP duplication is deactivated for this RLC entity. This is from Section 5.4 from TS 38.322: When indicated from upper layer (i.e. PDCP) to discard a particular RLC SDU, the transmitting side of an AM RLC entity or the transmitting UM RLC entity shall discard the indicated RLC SDU, if neither the RLC SDU nor a segment thereof has been submitted to the lower layers.A typical case would be that PDCP duplication is deactivated for an RLC entity for which **all** the associated Scell(s) do not perform anymore, in which case, if not discarding all RLC data (including the data in flight) the data would remain stuck with maintaining LCH restrictions to those SCell(s). There is no use in maintaining this mapping anyway, so we propose to remove it as long as the RLC entity remains deactivated for PDCP duplication. This way, it is avoided that this remaining data is first transmitted once the Scell becomes available again, at which time the data is outdated and its transmission blocks other data transmission.The case that PDCP duplication is deactivated for an RLC entity for which all the associated Scell(s) do not perform anymore (i.e., which require de-activation) is exactly what is described in the stage 2 correction in section 2.4, and thus not a corner case. Lastly, any further clarification on how to use timers to solve this issue is appreciated.  |
| Apple | No | Based on Rel-15 behaviour, for deactivated RLC entities, data will not be stuck in the RLC buffer, since UE will discard the packets that are not being transmitted, and continue with the on-going transmission. Therefore, there is no need to lift the LCH mapping restriction.  |
| Sharp | No | It is a corner case that the SCells associated with the RLC entity are deactivated immediately when the RLC entity is deactivated. There is no much buffered data in the deactivated RLC entity and can be transmitted via activated SCells associated with the deactivated RLC entity. |
| OPPO | No | As mentioned, the sub-clause is to clarify the case that more than one leg activated which are associated to the cell group with more than 2-leg configured for duplication. In this case, there are indeed some packets left in RLC buffer when the associated LCH is deactivated. Even the LCH mapping restriction is still kept for this LCH, the LCH can use the allowed severing cell configured for this LCH, if the serving cell is not deactivated simultaneously. Thus, the packets in the deactivated RLC may not be stuck and no issue exist.  |
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## 2.2 Lifting LCH Mapping Restriction for Cell Group without Active LCH

During the online discussions, some companies think we should also lift LCH mapping restriction when all LCHs in a cell group are all deactivated. From our point of view, the only problematic situation would be the case when the cell group “miss out” the state with only one active LCH to lift the LCH mapping restriction, before PDCP duplication of the DRB is deactivated as a whole. For example, originally there are two active LCHs in a cell group without primary path (so LCH mapping restriction is imposed), but then the gNB sends a MAC CE to deactivate duplication of the DRB, so the UE has to deactivate both LCHs in this cell group directly without experiencing the state of “lifting LCH mapping restriction” (i.e. one LCH remains active). So, the LCH mapping restriction may remain effective in this cell group after the PDCP duplication is deactivated and fallback to split bearer operation. However, it is questionable whether RAN2 needs to capture this case in specification or we can simply assume this is a nature UE behavior to lift LCH mapping restriction in both cell groups when PDCP duplication of the DRB is deactivated. There could be several options for the way forward:

* **Option 1:** Nothing has to be captured for this case
* **Option 2:** Specify the behavior of lifting LCH mapping restriction in a cell group when all LCHs in the cell group are deactivated.
* **Option 3:** Specify the behavior of lifting LCH mapping restriction in both cell groups when PDCP duplication of the DRB is deactivated as a whole.
* **Option 4:** Others

**Question 2: Which option do you prefer regarding the proposal of lifting LCH mapping restriction for cell group without any active LCH ?**

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| **Company** | **Option**  | **Comments** |
| LG | Option 1 | Current specification is clear that the LCH mapping restriction is lifted if CA duplication is deactivated within one MAC entity.*allowedServingCells*, if configured, includes the Cell information associated to the UL grant. Does not apply to logical channels associated with a DRB configured with PDCP duplication within the same MAC entity (i.e. CA duplication) for which PDCP duplication is deactivated;We may need to change “for which PDCP duplication is deactivated” to “for which CA duplication is deactivated” to make it clear.Regarding 38.300 CR, the Nokia’s proposal is not correct.When CA duplication is deactivated for a MAC entity (i.e. only one logical channel associated to the DRB in the MAC entity remains active),“CA duplication is deactivated” is not equal to “only one logical channel remains active”. The text in parenthesis should be removed. |
| Samsung | Option 2 / Option 1 | The exact behavior that we agreed is option 2. But, LG’s suggestion is the same as option 2 in our understanding. It’s ok to us. |
| Nokia | Option 1/2 | We can simply change the CR in [2] to capture this case:When CA duplication is deactivated for a MAC entity (i.e. none or only one of the logical channels associated to the DRB in the MAC entity remains active),This provides more clarifications on what “deactivation of CA duplication” really means. |
| CATT | Option 2 | This behavior needs to be clarified as follows:- when only one RLC entity is configured in the MAC entity and it is deactivated, the R15 behavior applies: the LCH mapping restriction is kept.- when more than one RLC entity is configured in the MAC entity (CA duplication) and they are deactivated, then the LCH mapping restrictions are lifted.We think the above TP proposed by Nokia correctly addresses the above behaviors. |
| Ericsson | Option 2 | The issue described above is valid and the correct behavior (e.g., listed in option 2) must be captured. The confusion comes from the original TP by Nokia. The updated one captures this behavior, but we believe it is not sufficient and does not address the issues in other sections yet. We prefer working on the TP once the supported functionalities are agreed.  |
| Apple | Option 2 |  |
| Sharp | Option 2 | We agree with CATT:- when only one RLC entity is configured in the MAC entity and it is deactivated, the R15 behavior applies: the LCH mapping restriction is kept.- when more than one RLC entity is configured in the MAC entity (CA duplication) and they are deactivated, then the LCH mapping restrictions are lifted. |
| OPPO | Option2 | From our perspective, we do not need to consider the status of another cell group, if multiple RLC entities are configured for this cell group for duplication, since we can preferably consider it as CA duplication for this cell group. According to stage-2 spec, the intention to configure LCH mapping restriction of CA duplication is to ensure the data of different logical channels associated to one MAC entity are not sent on the same carrier. To us, even though all legs are deactivated for this cell group, we still need to consider whether to keep LCH mapping restriction since one of them may continue been used for split transmission. Since the architecture of this cell group can be seen as CA duplication and there is no leg activated for this cell group, there is no need to keep LCH mapping restrictions for the LCHs considering the intention of LCH mapping restriction configuration of CA duplication. Also, one additional benefit of lifting LCH mapping restriction for the LCHs, the LCH used for split bearer can choose more and earlier resource for data transmission. |

## 2.3 Keeping LCH Mapping Restriction for Cell Group with only one LCH after Deactivation of PDCP Duplication

In [11], it has mentioned that LCH mapping restriction should be kept for a LCH even after deactivation of PDCP duplication, if the LCH is the only leg within a cell group.

**Question 3: Do you agree we should specify the behavior of keeping LCH mapping restriction after deactivation of PDCP duplication, if this is the only LCH configured in the cell group ?**

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| **Company** | **YES/NO** | **Comments** |
| LG | Disagree | Current specification is clear that the LCH mapping restriction is lifted if CA duplication is deactivated within one MAC entity.If there is only one LCH in the cell group, it is equal to the case of CA duplication deactivated within one MAC entity, and the LCH mapping restriction is lifted. |
| Samsung | Yes | Scenario: one RLC is configured in this CG and no RLC is activated in this cell groupThis restriction is for QoS purpose. It should be kept.  |
| Nokia | No | There is no issue of LCH mapping restriction for an isolated LCH in a cell group, because from the very beginning it can always use any cell in that cell group anyway. In our understanding, LCH mapping restriction is only applicable to CA duplication, and when there is only one LCH in the cell group, this is not CA duplication at all. |
| CATT | No | First we understand the question in Samsung’s sense (only one LCH *configured* in the CG). Hence it’s either a DC or DC+CA scenario falling back to split bearer when duplication is deactivated. When only one LCH is configured in a cell group, there is no CA duplication in the cell group hence the cell restrictions, when configured, apply in any case, which is R15 behavior. Since we agree with LG that in both stage-2 and MAC specs we only specify the cases when the LCH mapping restrictions are lifted, this case where they are kept falls in the “all other cases” side, and therefore needs no explicit specification.  |
| Ericsson | No | LCH mapping restriction for duplication RLC entities makes sense only when there are more than one duplication RLC entities in one MAC entity so that the data from multiple RLC entities are transmitted on different cells to achieve diversity gain.  |
| Apple | Yes | It is possible for the network to configure the LCH restriction for only one LCH in one CG in DC duplication. This is not for CA, but for restrictions on QoS. UE therefore should keep up with its R15 behavior and consequently the LCH restriction in DC duplication case.  |
| Sharp | No | We agree to keep LCH mapping restriction for the LCH which is the only leg within a cell group. But this is clear in the specification, nothing has to be captured. |
| OPPO | Yes | As mentioned in [11], if CA+DC duplication is configured, it is unclear how to handle LCH mapping restriction for the cell group associating to only one configured LCH. From our perspective, it is the case similar as DC duplication deactivation. Refer to the design on DC duplication deactivation, the most straightforward way is to keep LCH mapping restrictions for this LCH, for avoid the packets of the specific logical channels to transmit on some carriers. According to views listed above from different companies, if we understand correctly, we think companies have different opinions on whether to keep LCH mapping restrictions. From our perspective, at least we need to have a consensus on this issue, and capture it no matter in chairman notes or specification. |

## 2.4 Assurance of Serving Cell Activation for Active RLC Entities

In both [9] and [10], CRs of Stage-2 specifications are provided with an intention to mandate the network behavior of ensuring serving cells are activated for active RLC entities for PDCP duplication. The intention is to extend the relationship between SCell activation/deactivation and duplication activation/deactivation to cases with more than two RLC entities that can be dynamically switched on and off. The text proposal from [9] and [10] are shown below:

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| **R2-2007150 [9]:**When activating duplication for a DRB, NG-RAN should ensure that at least one serving cell is activated for each logical channel of the DRB which is associated with RLC entity activated for duplication; and when the deactivation of Scells leaves no serving cells activated for a logical channel of the DRB, NG-RAN should ensure that duplication for the RLC entity which is associated with that logical channel is also deactivated.**R2-2006637 [10]:**When activating duplication for a DRB, NG-RAN should ensure that at least one serving cell is activated for each logical channel associated with an activated RLC entity of the DRB; and when the deactivation of Scells leaves no serving cells activated for a logical channel of the DRB, NG-RAN should ensure that duplication is also deactivated for the RLC entity associated with the logical channel. |

**Question 4: Do you agree we should capture in Stage-2 specification the network behavior of ensuring activation of Scells for active RLC entities ?**

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| **Company** | **YES/NO** | **Comments** **(if the answer is YES, companies may further indicate their preference on text proposal, e.g. [9], [10], or others)** |
| LG | NO | We don’t see any problem with the current text. |
| Samsung | Yes | No strong view, up to the rapporteur. |
| Nokia | Yes/No | OK to change if majority of companies agree |
| CATT | Yes | Otherwise, with legacy text, the network is requested to activate at least one serving cell for each logical channel associated with the RLC entity configured for duplication even if this RLC entity is deactivated, which is quite inefficient. Even worse, if any of the configured RLC entities (even inactive) is left with no activated cells, while cells are available on other activated RLC entities, the network is requested to deactivate the duplication as a whole at DRB level. |
| Ericsson | Yes | Since this restriction has been captured in Rel-15, to be consistent, it is better to capture for the Rel-16 enhancement. |
| Apple | Yes  | The current specification should be enhanced to capture activation/deactivation of serving cells and PDCP duplication with more than two RLC entities for Rel-16. |
| Sharp | Yes | The restriction is not necessary for the logical channel associated with the RLC entity deactivated for PDCP duplication. |
| OPPO | No | No much problem is foreseen even without changing. |

## 2.5 RLC Failure Reporting

In [7], some issues relating to RLC failure reporting have been mentioned. The issues are described as following:

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| The second issue is related to RLC failure reporting in case of SCell failures when PDCP duplication is applied. The question is whether the failure information is also triggered in scenarios where multiple RLC entities are involved in the cell group and whether it depends on RLC entities of the DRB in the other cell group. Since there is also MCG/SCG failure information in DC, the SCell failure information should only be triggered when there are multiple RLC entities active in the cell group, independent of the other cell group.  |

It is proposed that, RLC failure reporting is triggered in case of RLC failure if there are multiple active RLC entities for a DRB with PDCP duplication configured in this cell group.

**Question 5: Do you agree the proposal relating to RLC failure reporting in [7] ?**

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| **Company** | **YES/NO** | **Comments**  |
| LG | YES/NO | Proposal itself is correct, but the proposed change in the procedure text is not needed. The only change that may be needed is:“if multiple logical channels terminate in the same cell group.” |
| Samsung | Yes | Generalization of Rel-15 RLC failure reporting for multiple legs.  |
| Nokia | Yes | Agree with the intention. The details about how to capture it can be further discussed in RRC CR. |
| CATT | Yes | It is consistent with legacy behavior. |
| Ericsson | Yes | This is the extension of the Rel-15 behavior. For Rel-15, the wording “CA duplication” means two active RLC entities in one cell group. Such wording is not precise for Rel-16 anymore. We are fine to revise the TP to capture the common understanding.  |
| Apple | Yes | Need to capture the details more accurately after further discussion. |
| Sharp | Yes | Extension of the Rel-15 behavior is preferred. |
| OPPO | Yes | Agree with the intention.  |

## 2.6 Description of *primaryPath*

Also in [7], it is noted that the following description of *primaryPath* in TS38.331 is outdated:

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| ***primaryPath***Indicates the el group ID and LCID of the primary RLC entity as specified in TS 38.323 [5], clause 5.2.1 for UL data transmission when more than one RLC entity is associated with the PDCP entity. In this version of the specification, only el group ID corresponding to MCG is supported for SRBs. The NW indicates *cellGroup* for split bearers using logical channels in different el groups. The NW indicates *logicalChannel* for CA based PDCP duplication, i.e., if both logical channels terminate in the same cell group. |

In particular, current text implies only two LCHs are configured in a cell group (as the word “both” is used), while in Rel-16 we can support up to 4 LCHs in a cell group.

**Question 6: Do you agree the description of *primaryPath* should be updated in TS38.331 ?**

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| **Company** | **YES/NO** | **Comments**  |
| LG | YES | “both” should be changed to “multiple”. |
| Samsung | Yes |  |
| Nokia | YES |  |
| CATT | Yes |  |
| Ericsson | Yes |  |
| Apple | Yes |  |
| Sharp | Yes |  |
| OPPO | Yes |  |

# 3 Discussion: Phase-2

# 4 Conclusion

Based on the email discussion, we conclude with the following proposals:

TBD

# References

1. R2-2006917*, LCH Mapping Restriction issues with DC+CA PDCP Duplication*, Nokia, Nokia Shanghai Bell, RAN2 #111-e, Online, Aug 2020.
2. R2-2006918, *Stage-2 CR for clarifications of DC+CA PDCP Duplication*, Nokia, Nokia Shanghai Bell, RAN2 #111-e, Online, Aug 2020.
3. R2-2006919, *MAC CR for clarifications of DC+CA PDCP Duplication*, Nokia, Nokia Shanghai Bell, RAN2 #111-e, Online, Aug 2020.
4. R2-2007891, *Corrections on Packet Duplication*, LG Electronics, RAN2 #111-e, Online, Aug 2020.
5. R2-2008056, *Cell Restriction Lifting in CA+DC Duplication*, Samsung, RAN2 #111-e, Online, Aug 2020.
6. R2-2007387, *Clarification on definition of DC+CA duplication*, Huawei, HiSilicon, RAN2 #111-e, Online, Aug 2020.
7. R2-2007133, *Corrections on differentiating CA and DC duplication*, Ericsson, RAN2 #111-e, Online, Aug 2020.
8. R2-2007149, *Clarification on CA duplication*, vivo, RAN2 #111-e, Online, Aug 2020.
9. R2-2007150, *Clarification on the relationship between PDCP duplication and SCell activation/deactivation*, vivo, RAN2 #111-e, Online, Aug 2020.
10. R2-2006637, *Clarify Packet Duplication in 38.300*, CATT, RAN2 #111-e, Online, Aug 2020.
11. R2-2007138, *Consideration on LCH mapping restriction when duplication deactivation,* OPPO, RAN2 #111-e, Online, Aug 2020.