**3GPP TSG-RAN WG2 Meeting #110-e R2-200xxxx**

**E-meeting, June 1 – June 12, 2020**

**Agenda item:**6.7.4.1 (NR\_IIOT-Core)

**Source:** LG Electronics Inc.

**Title:** [AT110e][045][IIOT] PDCP Duplication and PDCP CRs

**Document for:** Information

# 1. Introduction

This document is to report the result of the following email discussion in RAN2#109bis-e Meeting, based on R2-2005723.

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| * [AT110e][045][IIOT] PDCP Duplication and PDCP CRs (LG)

Scope: Treat R2-2005723, determine agreeable parts and and make agreements. Implement meeting agreements in updated CRs. Part 1: Agreements (rapporteur sets the deadline) Part 2: Agreed CRs 38323 36323 Deadline: June 11 0700 UTC |

It is suggested to progress the discussion with the following schedule.

- Part 1 discussion: June 4 0700 UTC (identify easy agreements and controversial issues)

- Part 2 discussion: June 10 0700 UTC (resolving controversial issues)

- Agreeable CRs on 38.323 and 36.323: June 11 0700 UTC (rapporteur will provide the CRs)

FYI, the issues are summarized from documents submitted in this meeting, as follows.

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| # | Tdoc | Title | Source |
| 1 | R2-2004740 | Clarification on the RRC-based activation of PDCP duplication | vivo |
| 2 | R2-2004958 | [E225] On simplification for PDCP-duplication | Ericsson |
| 3 | R2-2005506 | Indication of PDCP duplication configuration | LG Electronics Inc. |
| 4 | R2-2005649 | Radio Bearer with More than Two RLC Entities for Downlink Duplication or Split [E225] | Samsung |
| 5 | R2-2004887 | Configuration of PDCP duplication (discuss issues raised in E225) | SHARP |
| 6 | R2-2004589 | Control of Duplication by Rel-16 Duplication MAC CE | CATT |
| 7 | R2-2004924 | Issues with Network Coordination for PDCP Duplication | Nokia, Nokia Shanghai Bell |
| 8 | R2-2004590 | [C601] PDCP Duplication Configuration in MR-DC | CATT |
| 9 | R2-2004892 | MAC update on R15 MAC CE not used for moreThanTwoRLC | Fujitsu |
| 10 | R2-2005068 | Clarification of DC+CA duplication definition | Huawei, HiSilicon |
| 11 | R2-2005650 | Clarification on Initial State of PDCP Duplication in IIOT | Samsung |
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# 2. Issue summaries

## 2.1 Indication of PDCP duplication configuration

The Tdocs [1]~[5] address this issue.

In PDCP specification, it is required to indicate whether the PDCP entity is configured with PDCP duplication. In Rel-15, the *pdcp-Duplication* plays that role. However, in Rel-16, the *pdcp-Duplication* is absent when *moreThanTwoRLC* is configured, and it cannot be used to indicate that the PDCP entity is configured with PDCP duplication when more than two RLC entities are associated. Instead of *pdcp-Duplication*, the *moreThanTwoRLC* is used to indicate the PDCP duplication configuration when more than two RLC entities are associated. The configuration according to current RRC running CR is summarized below.

- For DRBs with two RLCs entities and SRBs

- the presence of *pdcp-Duplication* indicates the PDCP duplication configuration

- the value of *pdcp-Duplication* indicates the state of the PDCP duplication

- for SRBs, the value of *pdcp-Duplication* is always set to TRUE

- For DRBs with more than two RLC entities

- the presence of *moreThanTwoRLC* indicates the PDCP duplication configuration

- the value of *duplicationState* indicates the state of each RLC entities

- the *pdcp-Duplication* is absent

To remove the above discrepancies, [1]~[4] suggest that the *pdcp-Duplication* is also used to indicate PDCP duplication configuration for DRBs with more than two RLC entities. However, [5] suggest to stick to the current RRC running CR because there is no technical issue.

**Question 1. Which option should be used to indicate the PDCP duplication configuration for DRBs with more than two RLC entities.**

**- Option 1. The presence of *pdcp-Duplication* indicates the PDCP duplication configuration (i.e. *pdcp-Duplication* is always used to indicate the PDCP duplication configuration for both DRBs and SRBs)**

**- Option 2. The presence of *moreThanTwoRLC* indicates the PDCP duplication configuration (i.e. keep the current running CR)**

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| --- | --- | --- |
| **Company** | **Preferred option** | **Comment** |
| Nokia | 1 | This seems cleaner to align how Rel-15 and Rel-16 duplication are configured, therefore we prefer to enable this feature with a common parameter for better consistency.  |
| LG | Option 1 | It would be better to always use *pdcp-Duplication* to indicate the configuration of PDCP duplication. |
| Sharp | 2 | With option 1, additional signalling overhead will be introduced for that pdcp-Duplication should always be configured and alignment between pdcp-duplication and duplicationState needs to be specified. |
| Huawei, Hisilicon | Either way | No strong opinion. |
| Samsung | 1 | For an SRB configured with more than two RLC entities and not configured with duplication, pdcp-Duplication is necessary. |
| OPPO | Either way | No strong view, but current version is correct, we are not sure whether we really need to make some modification? |
| Spreadtrum | Either way | No strong opinion. |
| Ericsson | 1 | Clearer PDCP specification by using single field. See also [2]. |
| MediaTek | 1 | This would ensure that the specification is clear. |
| Qualcomm | Either way | Okay for RRC rapporteur to pick based on overall consistency. |
| Futurewei | 1 | Although the current spec is technically correct, it is always a good practice to use the same parameter for consistency. |
| ZTE | Either way | It can not be found any technical reason to support specific one. |
| Intel | Either way | No strong opinion. |
| III | Not sure | No strong opinion. |
| Apple | Option 1 | It is more clearer |
| NEC | Option 1 | This is cleaner and consistent with Rel-15 duplication. Also, it would be nice for readers/implementation people having Rel-15 knowledge to understand Rel-16 enhancements easier without confusing due to difference between releases. |

## 2.2 Control of PDCP duplication status of DRB in other node by Rel-16 MAC CE

The Tdoc [6] address this issue.

The Rel-16 Duplication RLC Activation/Deactivation MAC CE includes a DRB ID field, which indicates the identity of DRB configured for the UE. Thus, theoretically, one node can control the PDCP duplication status of DRBs belonging to other node.

However, [6] suggest that one node does not control the PDCP duplication status of DRBs belonging to other node with following reasons:

- No new reason triggers gNB to control CA duplication in the other node.

- It is impossible to control CA duplication in LTE side by the Rel-16 duplication MAC CE in gNB side in EN-DC.

- RAN2 decision about control of duplication by Rel-16 duplication MAC CE has essential impact on RAN3 discussion.

**Question 2. Do you think one node is allowed to control the PDCP duplication status of DRBs of CA duplication belonging to other node?**

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| **Company** | **Yes/No** | **Comment** |
| Nokia | Not sure | We are not too sure about what it means by “DRBs belonging to other node”. For a DC+CA duplication scenario, both MCG and SCG host some RLCs of a DRB. In this case the DRB is belonging to only one node or both of the nodes ?However, based on our understanding of [6], it is relating to controlling CA-only duplication in another node. If our understanding is correct, it seems to be relevant to Q3, and in that case we are fine with the proposal where a node cannot control RLC entities hosted another node for duplication of the same DRB - This is aligned with Option 2 of Q3 in our view. |
| LG | No | It would be simpler not to allow such controllability. Also, there is no clear need to support it. |
| Sharp | Yes | We already agreed to support network coordination for Rel-16 UL PDCP duplication in DC+CA architecture, so we do not think control the PDCP duplication status of DRBs belonging to other node should be forbidden. |
| Huawei, Hisilicon | Yes/No | It can be up to network to decide if it is possible to control PDCP duplication status of a node. We need to consider different radio bearer types, including MN terminated SCG bearers and SN terminated MCG bearers. Sometimes it is difficult to say if a DRB belongs to MN or SN, because PDCP entity may be placed at MN (or SN) but their RLC entities are placed at SN(or MN). |
| Samsung | No | Which node controls the duplication is totally up to NW and it is out of RAN2 scope. From RAN2 perspective, we do not need any restriction. |
| OPPO | Not sure | In our understanding, the scenario what we are discussing right now is related to the split DRB for which both of MN and SN hold related RLC legs. In such cases, co-ordination between MN and SN might be needed, which is right now discussed by the RAN3. We prefer postponing the discussion after RAN3 makes progress. |
| Spreadtrum | Yes/No | This is up to NW implementation. And if one node is allowed to control the PDCP duplication status of DRBs of CA duplication belonging to other node, network coordination may be needed. |
| Ericsson  | No | RLC activation status for duplication can be kept node-internal.  |
| MediaTek | Yes/No | This can be left to NW implementation |
| Qualcomm | Not sure | Let RAN3 decide based on complexity assessment in RAN3. There is no impact to RAN2 specs.  |
| Futurewei | Not sure |  |
| ZTE | Based on the discussion outcome from RAN3 | If my recollection is correct, we have already sent a LS to RAN3 to trigger the discussion of inter-node corporation for PDCP duplication enhancement. Thus we shall leave it to RAN3 and do not touch this issue in RAN2 before the reception of RAN3 discussion outcome.. |
| Intel | Not sure | This seems to be a network implementation issue, and it might be better to be decided by RAN3. |
| III |  | We would prefer to take this issue for further study in Rel-17 |
| Apple | Not Sure | R3 can decide and network can implement |
| NEC | No | agree with LG and Ericsson  |

## 2.3 Handling of RLCi field belonging to other node in Rel-16 MAC CE

The Tdoc [7] address this issue.

It is argued in [7] that if network coordination for Rel-16 UL PDCP duplication in DC+CA architecture is not specified or not feasible, it would be ambiguous for the UE to know whether the MAC CE should be applicable to all legs associating to the targeted DRB, or only applicable to the leg subset hosted by the issuing node. To resolve this ambiguity, it might be needed for the UE to know whether the received MAC CE is also applicable to RLC entities corresponding to the node other than the node issuing this MAC CE.

Therefore, [7] proposed two options as follows:

- Option 1. Adding an indication in Rel-16 MAC CE to indicate whether the MAC CE is applicable to all RLCs or only a subset of RLCs of a DRB

- Option 2. The UE shall ignore indication relating to RLC(s) in another node in Rel-16 MAC CE.

**Question 3. How the RLCi field belonging to other node in Rel-16 MAC CE is handled if network coordination is not supported?**

**- Option 1. Adding an indication in Rel-16 MAC CE to indicate whether the MAC CE is applicable to all RLCs or only a subset of RLCs of a DRB**

**- Option 2. The UE shall ignore indication relating to RLC(s) in another node in Rel-16 MAC CE.**

**- Option 3. The UE shall follow the indication in Rel-16 MAC CE.**

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| **Company** | **Preferred option** | **Comment** |
| Nokia | 1 or 2 | We think Option 1 has better scalability, but Option 2 is also okay considering that we are approaching the end of the WI.Option 3 only works if RAN3 confirms that dynamic coordination between MN and SN is possible. Otherwise it may end up misalignment of active legs between UE and network. |
| LG | Option 3 | We think network coordination should always be supported when using DC duplication. |
| Sharp | 3 | We already agree to support network coordination for Rel-16 UL PDCP duplication in DC+CA architecture, we should keep the behavior captured in the current running CR if the agreement is not revert. |
| Huawei, Hisilicon | Option 3 | We should assume that if the network cannot control the PDCP duplication of a DRB, the network will not send Rel-16 duplication MAC CE for the DRB. Actually, this is one of the motivations to apply per-DRB based MAC CE, rather than per UE based MAC CE like Rel-15. Otherwise, we need to consider a lot of unexpected case.  |
| Samsung | Option 3 | Agree with HuaweiNumber of copies should be determined by at least current reliability of each RLC bearers and corresponding cells. Two network nodes cannot independently activate its RLC entities. Thus we do not see any separate signaling.  |
| OPPO | Option 3 | Agree with Huawei and Samsung. |
| Spreadtrum | Option 3 | If network coordination is not supported, one node will not control the DRB whose PDCP entity is placed at the other node. For the DRB whose PDCP entity is placed at the sending node, PDCP duplication state of all the RLC entities belonging to the DRB can be controlled by this node. |
| Ericsson  | 2 | RLC activation for duplication status can be kept node internal. Otherwise coordination between the nodes would be required, which is infeasible to act upon RLC activation status changed made by MAC CEs in the nodes.  |
| MediaTek | Option 3 | Agree with Huawei and Samsung. |
| Qualcomm | Option 3 | It should not be UE responsibility to check for lack of coordination in network nodes. Also, reason provided by Huawei looks good. |
| Futurewei | Option 3 | Agree with Huawei and Samsung. |
| ZTE | Option 3 |  |
| Intel | Option 3 | Agree with Huawei and Samsung. |
| III |  | We would prefer to take this issue for further study in Rel-17 |
| Apple | Option 3 | Agree with Huawei |
| NEC | 1 or 2 | it is our preference, while considering the majority view, option 3 is acceptable with clarification for motivation/background of this decision, i.e. companies in RAN2 assume that option 3 needs network coordination which should be ensured by RAN3 (at least their scope). Otherwise, it may not work. |

## 2.4 PDCP Duplication Configuration in MR-DC

The Tdoc [8] address this issue.

As the RAN2 decided at the last meeting that Rel-15 Duplication MAC CE is not used for Rel-16 Duplication configuration (with more than two RLC entities configured), [6] suggest that DC duplication with more than two RLC entities are not configured for MR-DC including EN-DC, NGEN-DC, and NE-DC. The reason is that Rel-16 MAC CE is not supported by the LTE MAC.

Therefore, [8] suggest to explicitly specify in 37.340 and 38.331 that DC duplication with more than two RLC entities is not supported for MR-DC.

**Question 4. Do you think the DC duplication with more than two RLC entities should be supported for MR-DC?**

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| **Company** | **Yes/No** | **Comment** |
| Nokia | No | In RAN2 #105 we have already made the following agreement:* The architectural combinations supported for the work on *PDCP duplication enhancements* are CA, DC(NR only) and DC+CA(NR Only)

Therefore we have already confirmed that it should be supported only in NR-DC. We agree with the suggestions in [8] to clarify this. |
| LG | No | We agree that the LTE MAC cannot support DC duplication with more than two RLC entities. |
| Sharp | No |  |
| Huawei, Hisilicon | Depends | Definitely we cannot support more than two RLC entities for LTE side. But in (NG)EN-DC and NE-DC, there seems no problem to support more than RLC entities for NR side, especially considering that EN-DC is a popular deployment architecture.Regarding the agreement captured by Nokia, I am not sure if “DC+CA(NR Only)” was previously meant to be “NR side only”. Anyway, we are open to see more views. |
| Samsung | No |  |
| OPPO | No | Even though for EN-DC, duplication of more than two RLC entities could be configured on NG-RAN node only, EPC cannot provide end-to-end IIOT services. |
| Spreadtrum | No |  |
| Ericsson | No | Rel-16 duplication targets advanced use-caes with ultra-reliability and can be left to NR only operation.  |
| MediaTek | No for (NG)EN-DC and NE-DC | NR-DC should obviously be allowed. |
| Qualcomm | No |  |
| Futurewei | Not sure |  |
| ZTE | No | Agree with Nokia |
| Intel | No |  |
| III | No | Agree with Nokia |
| Apple | No |  |
| NEC | No |  |

## 2.5 MAC update on R15 MAC CE not used for *moreThanTwoRLC*

The Tdoc [9] address this issue.

[9] argues that the text “The PDCP duplication for all or a subset of associated RLC entities for the configured DRB(s)” may be misleading that Rel-15 MAC CE can be used for Rel-16 PDCP duplication configuration, and propose to make a correction on MAC specification as follows

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| 5.10 Activation/Deactivation of PDCP duplicationIf one or more DRBs are configured with PDCP duplication, the network may activate and deactivate the PDCP duplication for all or a subset of associated RLC entities for the configured DRB(s).If the MAC entity is configured with *moreThanTwoRLC*, the PDCP duplication for the configured DRB(s) is activated and deactivated by:- receiving the Duplication Activation/Deactivation MAC CE described in clause 6.1.3.11;- receiving the Duplication RLC Activation/Deactivation MAC CE described in clause 6.1.3.32;- indication by RRC.If the MAC entity is configured with *pdcp-Duplication*, the PDCP duplication for all or a subset of associated RLC entities for the configured DRB(s) is activated and deactivated by:- receiving the Duplication RLC Activation/Deactivation MAC CE described in clause 6.1.3.32;- indication by RRC. |

**Question 5. Do you think the text “the PDCP duplication for all or a subset of associated RLC entities” needs further clarification, as provided above?**

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| **Company** | **Yes/No** | **Comment** |
| Nokia | No | The current text is already very clear, we do not see the need to change. Besides, we think the proposed TP is not correct, as a MAC entity cannot be configured with *moreThanTwoRLC* or *pdcp-Duplication* - These are PDCP layer parameters. On the other hand, we have agreed that Rel-15 MAC CE should not be used to control Rel-16 configuration with more than 2 legs, then why Duplication Activation/Deactivation MAC CE described in clause 6.1.3.11 is still applicable when *moreThanTwoRLC* is configured ? |
| LG | No | We don’t think there is any point of mis-interpretation. |
| Sharp | No | Agree with Nokia. |
| Huawei, Hisilicon | No | We didn’t see any ambiguity here. |
| Samsung | No |  |
| OPPO | No | The TP is not correct. The first paragraph applies to the R15 duplication, and the next paragraph applies to the R16 duplication. If we would like to make it clearer, an additional note is a better way. |
| Spreadtrum | No | We don’t think there is any ambiguity with the current text. |
| Ericsson | No | No need to further clarify. Note also that the text proposal changes are the wrong way around.  |
| MediaTek | No |  |
| Qualcomm | No |  |
| Futurewei | No |  |
| ZTE | No |  |
| Intel | No | We don’t see ambiguity in current specifications. |
| III | No |  |
| Apple | No |  |
| NEC | No |  |

## 2.6 Clarification of DC+CA duplication definition

The Tdoc [10] address this issue.

[10] argues that the definition of DC+CA duplication is not clear, and propose to clarify in 38.300 that the DC+CA duplication is one kind of DC duplication, and the duplication within each cell group is seen as CA duplication. The Text proposal in [10] is captured below.

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| 16.1.3 Packet DuplicationWhen duplication is activated, the original PDCP PDU and the corresponding duplicate(s) shall not be transmitted on the same carrier. The logical channels associated with a same radio bearer can either belong to the same MAC entity (referred to as CA duplication) or to different ones (referred to as DC duplication). CA duplication can be configured together with DC duplication when duplication over more than two RLC entities is configured in the UE, which is called DC+CA duplication. DC+CA duplication is also DC duplication, and in DC+CA duplication, the duplication within each cell group (if configured) is CA duplication. In CA duplication, logical channel mapping restrictions are used in MAC to ensure that different logical channels are not sent on the same carrier. When CA duplication is configured for an SRB, one of the logical channels associated to the SRB is mapped to SpCell.When CA duplication in a MAC entity is deactivated for a DRB, the logical channel mapping restrictions of the logical channels associated with the MAC entity are lifted for as long as the CA duplication remains deactivated. |

**Question 6. Do you agree to clarify in 38.300 that the DC+CA duplication is one kind of DC duplication, and the duplication within each cell group is seen as CA duplication, as provided above?**

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| **Company** | **Yes/No** | **Comment** |
| Nokia | No | There could be cases where we have 3 legs in one node and 1 leg in another node. For the node with only 1 leg, it is not really CA duplication because there is no duplication can be conducted for this RB in this node at all. In such cases the term “CA duplication” is rather confusing. So we think such definition is not appropriate. |
| LG | Yes/No | We are ok to clarify DC+CA duplication clearly in 38.000. However, the added text is also misleading, and want to see more improved text. |
| Sharp | Yes | The current specification is not clear, clarification is needed. |
| Huawei, Hisilicon | Yes | There really is some ambiguities in the definition. When it says “CA duplication can be configured together with DC duplication”, it basically means that DC+CA duplication is also DC duplication and CA duplication in a cell group. We need to align the understanding here. |
| Samsung | Yes | We are ok to clarify DC+CA duplication clearly in 38.300.  |
| OPPO | No | Agree with Nokia the TP is not correct for the 3+1 duplication scenario. |
| Spreadtrum  | Yes | We are ok to clarify DC+CA duplication clearly in 38.300. |
| Ericsson | Yes | Eases understanding of implication of CA duplication to behavior within one MAC entity.  |
| MediaTek | No | Agree with Nokia, the proposed text does not provide any clarity. |
| Qualcomm | No | The proposed change is not providing much improvements |
| Futurewei | Yes | Agree that the proposed text helps to make it clearer.Suggest changing the word “called” in “which is called DC+CA duplication” to “referred to as”, to be consistent with the earlier instances of the same phrase. |
| ZTE | Yes/NO | We have no strong point of view to clarify DC+CA duplication, if we want to do this, we need to update the wording to include the case mentioned by Nokia.  |
| Intel | Yes/No | We have no strong view on whether to clarify. If RAN2 agrees to clarify, we agree with Nokia’s concern regarding 3+1 duplication scenario, so some improvements of the TP might be needed. |
| III |  | Agree with Nokia and LG. |
| Apple | No | Agree with Nokia |
| NEC | Yes | Agree to clarify the stage 2, while the wording may be improved |

## 2.7 Clarification on Initial State of PDCP Duplication

The Tdoc [11] address this issue.

During RAN2#109bis-e meeting, for Rel-15 RRC corrections, RAN2 agreed not to use “initial state” for description of duplication state indicated by RRC. Instead, it is agreed to use “the state of PDCP duplication at the time of (re-)configuration” for *pdcp-Duplication*. In Rel-16 IIOT, RAN2 introduced another state indication by RRC, i.e. *duplicationState*, but whose descriptions in both RRC and stage-2 specifications still use expression “initial”.

Therefore, [11] proposed to remove “initial” from the description of *duplicationState*, and use the similar description as we agreed for *pdcp-Duplication*.

The rapporteur think this could be easily agreed, because the proposal is aligned with the agreement made in RAN2#109bis-e meeting.

**Question 7. Do you agree to remove “initial” from the description of *duplicationState*, and use “at the time of receiving this IE” similar to description agreed for *pdcp-Duplication*?**

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| **Company** | **Yes/No** | **Comment** |
| Nokia | Yes | We agree this change, as it is more consistent with Rel-15 and it also captures the cases such as handover. |
| LG | Yes |  |
| Sharp | Yes |  |
| Huawei, Hisilicon | Yes |  |
| Samsung | Yes |  |
| OPPO | Yes |  |
| Spreadtrum | Yes |  |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| Qualcomm | Yes | Proposed change improves clarity (though not really an essential change) |
| Futurewei | Yes |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| III |  | We would slightly prefer to add some text for clarification for the re-configuration scenario. |
| Apple | Yes |  |
| NEC | Yes |  |

# 3.Proposals

To be filled later