**3GPP TSG-RAN WG2 Meeting #109e R2-200xxxx**

**E-meeting, February 24 – March 6, 2020**

**Agenda item:**6.7.4 (NR\_IIOT-Core)

**Source:** LG Electronics Inc.

**Title:** Discussion on PDCP duplication enhancements

**Document for:** Information

# 1. Introduction

This document is to facilitate the discussion on AT109e#037 PDCP Duplication Enhancement for IIOT.

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| * [AT109e][037][IIOT] PDCP Duplication Enhancements (LG)   Scope: Treat summary on PDCP Duplication Enhancements.  Intended outcome: Resolve issues, Describe Open Issues accurately.  Deadline: Mar 3 1200 CET (conclusions on “easy agreements” by Feb 27 1200 CET) |

The discussion should be based on the summary document submitted to this meeting.

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| R2-2001286 Summary of PDCP duplication enhancements LG Electronics Inc. report Rel-16 NR\_IIOT-Core Late |

This document tries to make easy agreements and resolve open issues identified in the R2-2001286.

# 2. Potential easy agreements

Potential agreements 1

- Rel-16 PDCP duplication is applied to SRBs.

- For SRBs, all secondary RLC entities are activated when configured.

- MAC CE based activation/deactivation of PDCP duplication is not supported for SRBs.

**Question 1: Are companies ok with the potential agreements 1?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Nokia | Yes |  |
| LG | Yes |  |
| Ericsson | Yes |  |
| OPPO | Yes |  |
| Apple | Yes |  |
| Samsung | Yes |  |
| Spreadtrum | Yes |  |
| Sharp | Yes |  |
| MediaTek | Yes |  |
| CATT | Yes |  |
| Fujitsu | Yes |  |
| Huawei, Hisilicon | Yes |  |
| Qualcomm | Yes |  |
| Futurewei | Yes |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| vivo | Yes |  |

All companies support potential agreements 1.

**Proposal 1: Agree on the followings.**

**- Rel-16 PDCP duplication is applied to SRBs.**

**- For SRBs, all secondary RLC entities are activated when configured.**

**- MAC CE based activation/deactivation of PDCP duplication is not supported for SRBs.**

Potential agreements 2

- When a secondary RLC entity is deactivated (but PDCP duplication is still activated), the UE shall discard duplicated PDCP PDUs in the deactivated secondary RLC entity.

**Question 2: Are companies ok with the potential agreements 2?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Nokia | Yes |  |
| LG | No | We think this behavior is not essential with following reasons:  - if any segment of a PDCP PDU is transmitted, the RLC entity will keep transmitting the PDCP PDU even if the discard indication is provided to the RLC entity. The transmission of the PDCP PDU does not cause any problem in the receiving side.  - for AM DRB, even if a PDCP PDU is stored in the deactivated UM RLC entity without transmission, the discard indication will be provided to the RLC entity when the successful delivery of a PDCP PDU is confirmed by one of the associated AM RLC entities.  - for UM DRB, if a PDCP PDU is stored in the deactivated UM RLC entity for long time without transmission, and if the UM RLC entity is reactivated after the long time, the transmission of the PDCP PDU after reactivation may cause HFN de-synch problem in the receiving side. However, this is theoretical problem, because the traffic we are considering is URLLC traffic, and discard timer would be set to a small value for the URLLC traffic.  Therefore, we think additional discard behavior is not needed when an RLC entity is indicated to deactivate PDCP duplication. The current discard behavior is deemed enough for Rel-16. |
| Ericsson | Yes |  |
| OPPO | Yes | Prefer similar principle as Rel-15 duplication. |
| Apple | No | We agree with LG that the transmission of the PDCP PDU does not cause any problem in the receiving side. Hence this behavior update is not essential. |
| Samsung | Yes | Prefer similar principle as Rel-15 duplication |
| Spreadtrum | Yes | Prefer similar principle as Rel-15 duplication |
| Sharp | Yes | Prefer similar principle as Rel-15 duplication |
| MediaTek | Yes |  |
| CATT | Yes |  |
| Fujitsu | Yes | 1. Prefer similar principle as Rel-15 duplication. 2. Also discarding does not cause any problem. |
| Huawei, Hisilicon | Yes |  |
| Qualcomm | Yes |  |
| Futurewei | Yes |  |
| ZTE | No | Direct discard of duplicated PDU is a under-thinking option. Not similar with R-15, there maybe more than 2 RLC entities associated with one PDCP. gNB may use MAC CE to activate/deactivate one or more RLC entity based on its intention.  For example, a DRB is configured with PDCP duplication and the primary path and RLC entity#2 is activated , once a MAC CE is received which indicates that RLC entity#3 is activated and RLC entity#2 is deactivated, ***the gNB’s intention is to switch a leg with a poor performance to another better leg****.* For this case, if UE discard the duplicated PDU in the RLC entity#2 immediately, all these discarded PDU only can be sent via **primary path,** Obviously, all of these PDUs will be suffering from more serious transmission problem.  For simplicity, we think the duplicate PDU shall not be discarded. |
| Intel | Yes |  |
| vivo | Yes |  |

14 companies support potential agreement 2, and 3 companies does not support. As clear majority support the potential agreement 2, it is propose to agree on potential agreement 2.

**Proposal 2: When a secondary RLC entity is deactivated (but PDCP duplication is still activated), the UE shall discard duplicated PDCP PDUs in the deactivated secondary RLC entity.**

# 3. Open issues

Open issue 1

Can the Rel-15 Duplication MAC CE be used for Rel-16 Duplication configuration?

- Option 1: Rel-15 MAC CE can be used for Rel-16 Duplication configuration.

- Option 2: Rel-15 MAC CE can be used for Rel-16 Duplication configuration only when the number of leg = 2.

- Option 3: Rel-15 MAC CE is not used for Rel-16 Duplication configuration.

- Option 4: Rel-15 MAC CE is used to activate/deactivate PDCP duplication, and Rel-16 MAC CE is used to activate/deactivate RLC entities.

**Question 3: Which option do you prefer in open issue 1?**

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| Nokia | 1 | Rel-15 MAC CE can be used in the following way:   * Activation: Reset to initial state * Deactivation: deactivate PDCP duplication (switch off all secondary RLC entities) |
| LG | 1 |  |
| Ericsson | 1 |  |
| OPPO | 1 |  |
| Apple | 2 | We would suggest that we can use Rel15 MAC CE for deactivation as the solution is simple (duplication is disabled on all legs). For activation, there are additional complexities if there are more than 2 legs. Hence, either we go with option 2 for activation or fall back to option 3 otherwise. |
| Samsung | 3 | We think Rel-16 MAC CE provides the finer control. Rel-15 is not needed. |
| Spreadtrum | 1 |  |
| Sharp | 1 |  |
| MediaTek | 2 | If there are 2 legs configured for duplication use Rel-15 MAC CE. If there are more than 2 legs configured for duplication use Rel-16 MAC CE. |
| CATT | 1 | Same view as Nokia except that activation would keep the RLC entities unchanged if the duplication is already activated for that DRB. This is because Rel-15 MAC CE contains all DRBs always, hence when used to activate duplication for one (or more) specific DRB(s), other already activated DRBs should not be affected (RLCs activation/de-activation status should remain the same) if their bit is set to 1. |
| Fujitsu | 3 | We have contribution R2-2000776. We don’t see the benefit but we see drawbacks. |
| Huawei, Hisilicon | 3 | We don’t see any additional value to apply Rel-15 MAC CE to Rel-16 duplication enhancements. |
| Qualcomm | 3 | Rel-16 MAC CE provides all related functionality and provides even more flexibility.  This option reduces specification effort. Other options will require specifying actions related to Rel-15 MAC CE (e.g., see issues being discussed in next question). |
| Futurewei | 3 | Rel-16 MAC CE can already provide all necessary controls.  Mixing use of Rel-15 and Rel-16 MAC CEs would require more specification works, without tangible benefits. |
| ZTE | 3 | No more specification work |
| Intel | 3 | In RAN2#108 meeting, one of the main reasons to select the per DRB approach (as in current MAC running CR) instead of all DRB approach (similar to Rel-15 MAC CE) is to minimize the network coordination. Using Rel-15 MAC CE to turn on and off Rel-16 PDCP duplication configurations is not consistent with the agreement of per DRB MAC CE due to the required network coordination. In addition, per DRB approach was agreed in RAN2#108 meeting with the understanding that ignalling overhead of multiple Rel-16 MAC Ces is not an issue. Therefore there is no clear benefit of using Rel-15 MAC CE to turn on and off Rel-16 PDCP duplication configurations. |
| vivo | 1 |  |

8 companies support option 1, 2 companies support option 2, and 7 companies support option 3. As there are no clear majorities between option 1 and option 3. It may be difficult to conclude on this issue.

However, the rapporteur attempts to agree on option 3 with following reasons:

- The Rel-16 MAC CE can be used alone without the help of the Rel-15 MAC CE. The Rel-15 MAC CE is a kind of optimized ignalling.

- Introducing the Rel-15 MAC CE requires further discussion like open issue 2.

**Proposal 3: Rel-15 MAC CE is not used for Rel-16 Duplication configuration.**

Open issue 2

If Rel-15 MAC CE can be used for Rel-16 Duplication configuration, what if Rel-15 MAC CE indicates “duplication activation”?

- Option 1: All secondary RLC entities are activated.

- Option 2: All secondary RLC entities are set to initial state configured by RRC.

**Question 4: Which option do you prefer in open issue 2?**

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| Nokia | 2 | The secondary RLC entities should go to initial state in an absolute manner, when “activation” command is received with Rel-15 MAC CE. |
| LG | 1 | RRC configures “initial” state of PDCP duplication of each RLC entity. The Rel-15 MAC CE indicates activate or deactivate state of PDCP duplication, not the initial state of PDCP duplication. |
| Ericsson | 2 | Activate acc. To RRC config of activated RLC entities. |
| OPPO | 1 | Actually, we have no strong views on this issue. However, considering duplicationState is an optional IE, we need to cover the case that this IE is absent. Thus, Option 1 is slightly preferred. |
| Apple | 2 | The secondary RLC entities can be set to the initial state configured by RRC in case Rel15 MAC CE is used for Rel16 duplication configuration. |
| Samsung | 1 | UE does not need to store the initial RRC configuration. Once RLC activation status is changed by MAC CE, UE does not need to keep the old configuration. |
| Spreadtrum | 1 | The Rel-15 MAC CE duplication activation is applicable for one DRB. If the DRB has more than one secondary RLC legs, the “duplication activation” should indicate the status of all the legs of this DRB. Furthermore, the UE does not need to store the initial RRC configuration. |
| MediaTek | 1 | Agree with the previous comments. |
| CATT | 2 | Most of the time, not more than two legs are needed, even though a higher number would be configured. Activating all legs by default with Rel-15 MAC CE is overkill resource-wise and contradicts the concept of having an initial state configured by RRC. It would then require sending an adjustment by Rel-16 MAC CE which is inefficient.  Note that when the duplication is already activated for that DRB, the RLC entities should remain unchanged, see our comment to Q3. |
| Fujitsu | 1 | It is simple. |
| Qualcomm |  | No strong views |
| Futurewei | 2 | Agree with CATT’s analysis. |
| vivo | 1 |  |

7 companies support option 1, 5 companies support option 2, and 1 company has no strong view. As there is no clear gain/pain in each option, the rapporteur attemps to agree on option 1 if Rel-15 MAC CE is used for Rel-15 duplication configuration.

**Proposal 4: If Rel-15 MAC CE can be used for Rel-16 Duplication configuration, all secondary RLC entities are activated when Rel-15 MAC CE indicates “duplication activation”.**

Open issue 3

What if Rel-16 MAC CE indicates all secondary RLC entities are deactivated?

- Option 1: Deactivate PDCP duplication.

- Option 2: PDCP duplication is kept activated, but only primary RLC entity is used for transmission.

**Question 5: Which option do you prefer in open issue 3?**

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| Nokia | 1 |  |
| LG | 2 | With a good radio condition, the network may want to order the UE to transmit PDCP PDUs on only one transmission path. Thus, we think activating only the primary RLC entity is a still valid option with “duplication”. |
| Ericsson | 1 |  |
| OPPO | 1 |  |
| Apple | 1 |  |
| Samsung | 1 | No strong opinion on option1/2. It seems a modelling issue. No different UE behaviour is expected from NW point perspective. |
| Spreadtrum | 1 | Option1 looks clearer than option2. |
| Sharp | 1 |  |
| MediaTek | 1 |  |
| CATT | 1 |  |
| Fujitsu | 1 | It is simple. |
| Huawei, Hisilicon | 1 |  |
| Qualcomm | 1 |  |
| Futurewei | 1 | Not sure what’s functional difference/benefit of 2. |
| ZTE | 1 |  |
| Intel | 1 |  |
| vivo | 1 |  |

16 companies support option 1, and 1 company support option 2. As clear majority support option 1, it is proposed to agree on option 1.

**Proposal 5: If Rel-16 MAC CE indicates all secondary RLC entities are deactivated for a DRB, the UE shall deactivate PDCP duplication for the DRB.**

Open issue 4

How to set DRBdup ID in Rel-16 MAC CE?

- Option 1: 5bits full DRB ID is included.

- Option 2: 3~4bits indexed DRB ID is included (similar to Rel-15).

**Question 6: Which option do you prefer in open issue 4?**

|  |  |  |
| --- | --- | --- |
| Company | Preferred option | Comments |
| Nokia | 1/2 | No strong view from our side. |
| LG | 2 or 1 | No strong view |
| Ericsson | 2 or 1 | No strong view, slight preference towards 2 |
| OPPO | 2 | Slightly prefer the option similar as Rel-15. |
| Apple | 1/2 | No strong view |
| Samsung | 2 or 1 | No strong view, slightly prefer option 2 |
| Spreadtrum | 2 or 1 | No strong view, slightly prefer option 2 |
| Sharp | 1 | Slightly prefer option 1 which can reduce UE complexity without increasing overhead. |
| MediaTek | 2 or 1 | No strong view (slight preference for 2) |
| CATT | 2 | We see more that Rel-16 enhances the duplication feature but we don’t expect that necessarily more DRBs will be needed for duplication, so we are OK to stick to Rel-15 format. |
| Fujitsu | 2 > 1 | Similar as Rel-15. |
| Huawei, Hisilicon | 1 | Full DRB ID is simple and can avoid the possible ambiguity caused by DRB index. |
| Qualcomm | 1 | In addition to simplicity, inclusion of DRB ID reduces MN-SN co-ordination requirements.  Associated overhead increase is negligible for a network using PDCP duplication. |
| Futurewei | 1 | Agree with Huawei and Qualcomm. |
| ZTE | 2 or 1 | No strong view |
| Intel | 2 | We think Rel-15 approach can be used. In addition, a full DRB ID has the length of 5 bits, which removes the reserved bits in Rel-16 MAC CE. Therefore using DRBdup Index has the benefit of better future extensibility. |
| vivo | 1 | Agee with Huawei and Qualcomm |

There are no strong views between option 1 and option 2. Each option has following gains.

- Option1: Full DRB ID is simple and can avoid the possible ambiguity caused by DRB index, and thus can reduce UE complexity. In addition, MN-SN coordination could be reduced.

- Option2: Similar to Rel-15 format, and can reserve one or two reserved bits.

The rapporteur think that the gain of option 1 is slightly larger than option 2, and attempts to agree on the option 1.

**Proposal 6: DRBdup ID in Rel-16 MAC CE is set to 5bits full DRB ID.**

# 4. Summary

The rapporteur think that RAN2 can easily agree on followings:

**Proposal 1: Agree on the followings.**

**- Rel-16 PDCP duplication is applied to SRBs.**

**- For SRBs, all secondary RLC entities are activated when configured.**

**- MAC CE based activation/deactivation of PDCP duplication is not supported for SRBs.**

**Proposal 2: When a secondary RLC entity is deactivated (but PDCP duplication is still activated), the UE shall discard duplicated PDCP PDUs in the deactivated secondary RLC entity.**

**Proposal 5: If Rel-16 MAC CE indicates all secondary RLC entities are deactivated for a DRB, the UE shall deactivate PDCP duplication for the DRB.**

Please indicate in the table below if you object to any of the above proposals.

|  |  |  |
| --- | --- | --- |
| Company | Unacceptable proposal | Reason and alternative proposal |
|  |  |  |

Following proposals do not have clear majority, but the rapporteur propose to agree on them for the sake of progress. Please note that if P3 is agreed, the P4 will disappear.

**Proposal 3: Rel-15 MAC CE is not used for Rel-16 Duplication configuration.**

**Proposal 4: If Rel-15 MAC CE can be used for Rel-16 Duplication configuration, all secondary RLC entities are activated when Rel-15 MAC CE indicates “duplication activation”.**

**Proposal 6: DRBdup ID in Rel-16 MAC CE is set to 5bits full DRB ID.**

Please indicate in the table below if you object to any of the above proposals.

|  |  |  |
| --- | --- | --- |
| Company | Unacceptable proposal | Reason and alternative proposal |
|  |  |  |