**3GPP TSG RAN Meeting #93-e RP-21XXXX**

e-Meeting, September 13th – 17th, 2021

Agenda Item: 9.3.2.1

Title: Summary of email discussion [93e-17-IIoT-URLLC-Scope]

Source: Samsung (RAN1 Chair)

Document for: Discussion and Decision

# Introduction

As part of Rel-17 NR, there is an ongoing work item on *Enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR*. The work item is due for stage-3 completion by Q4 of 2021 in RAN1 and Q1 of 2022 in other working groups. For RAN1, there are only two WG meetings until the deadline of the stage-3 completion.

A number of companies have submitted contributions on how to move forward on multiple IIoT/eURLLC topics. A summary of the topics discussed in relevant contributions [1] ~ [6] is as follows:

* Intra-UE multiplexing and prioritization enhancements [1], [2], [3], [5]
* UE feedback enhancements for HARQ-ACK [2], [3]
* CSI feedback enhancements to allow for more accurate MCS selection [2], [3], [4]
* Enhancements for support of time synchronization [1], [2], [5], [6]
* Enhancements based on new QoS related parameters [1]

The purpose of the email thread [93e-17-IIoT-URLLC-Scope] is to collect company views and if possible, converge on a way forward on how to more efficiently progress the Rel-17 work on *Enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR*. For your reference, the detailed objectives in the WID [7] are provided below:

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| 1. Study, identify and specify if needed, required Physical Layer feedback enhancements for meeting URLLC requirements covering
	* + UE feedback enhancements for HARQ-ACK [RAN1]
		+ CSI feedback enhancements to allow for more accurate MCS selection [RAN1]

Note: DMRS-based CSI feedback is not in scope of this WI 1. Uplink enhancements for URLLC in unlicensed controlled environments [RAN1, RAN2]:
	1. Specify support for UE-initiated COT for FBE with minimum specification effort
	2. Harmonizing UL configured-grant enhancements in NR-U and URLLC introduced in Rel-16 to be applicable for unlicensed spectrum
2. Intra-UE multiplexing and prioritization of traffic with different priority based on work done in Rel.16 [RAN1]:
3. Specify multiplexing behavior among HARQ-ACK/SR/CSI and PUSCH for traffic with different priorities, including the cases with UCI on PUCCH and UCI on PUSCH.
4. Specify PHY prioritization of overlapping dynamic grant PUSCH and configured grant PUSCH of different PHY priorities on a BWP of a serving cell including the related cancelation behavior for the PUSCH of lower PHY priority, taking the solution developed during Rel-16 as the baseline
5. Enhancements for support of time synchronization:
6. RAN impacts of SA2 work on uplink time synchronization for TSN, if any. [RAN2]
7. Propagation delay compensation enhancements (including mobility issues, if any). [RAN2, RAN1, RAN3, RAN4]
8. RAN enhancements based on new QoS related parameters if any, e.g. survival time, burst spread, decided in SA2. [RAN2, RAN3]
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# Initial phase

To kick off the initial discussions, the following sub-sections provide general questions for collecting views on the Rel-17 work item on Enhanced IIoT and URLLC. The views collected will be used to come up with moderator proposals to focus the follow up discussions in the next phase to more specific issues.

## Intra-UE multiplexing and prioritization enhancements

With only two RAN1 meetings left, intra-UE multiplexing and prioritization enhancements still has significant amount of work to be done. All four contributions to RAN#93-e discussing this topic propose a downscoping of the relevant work.

**Question/Request#1: Moderator would like to check company views on possible downscoping of intra-UE multiplexing and prioritization enhancements. Whether or not downscoping is necessary? And if so, which part of the objective should be downscoped?**

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| **Company** | **Views** |
| OPPO | We think down-scoping could help RAN1 to complete the WI in time. Further, the following functionalities could be deprioritized first if any down-scoping should be considered on intra-UE multiplexing/prioritization: - *Simultaneous Tx of PUCCH/PUSCH*: RAN1 agreed to support this for inter-band CA only. So its value in real deployment is lower than other features.  - *Overlapping between CG and DG PUSCH*: The RAN1 discussion on this part has been heavily dependent on corresponding Rel-16 maintenance discussion, so we expect it would be either controversial or with very limited time when the essential part of Rel-17 discussion starts.   |
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## UE feedback enhancements for HARQ-ACK

RAN1 made good progress on UE feedback enhancements for HARQ-ACK. However, there was one contentious issue with reference to PUCCH carrier switching: whether or not PUCCH carrier switching should include SUL and if so, which cases are supported.

**Question/Request#2: Moderator would like to check company views on SUL and PUCCH carrier switching with reference to HARQ-ACK feedback enhancements.**

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| **Company** | **Views** |
| CMCC | RAN1#106-e was trying to clarify/discuss the scenarios for PUCCH carrier switching, specifically the following 4 cases were under discussion:**Case 1: PUCCH carrier switching among different cells not being configured with SUL****Case 2-1: PUCCH carrier switching among different cells where at least one cell is configured with SUL. For the cells having SUL configured, PUCCH is only configured either for NUL or SUL.****Case 2-2: PUCCH carrier switching among different cells where at least one cell is configured with SUL. For cells having SUL configured, PUCCH may be configured for NUL carrier, SUL carrier or both****Case 3: PUCCH carrier switching for a single cell configured with SUL and having PUCCH configured for NUL and SUL**Based on the discussion in RAN1, it seems some companies have concern on the cases involving SUL. ***From our perspective, both CA case and SUL related cases should be supported for PUCCH carrier switching***. From CMCC perspective, both CA and SUL are important features and deployment scenarios, therefore we should do the enhancements for both, especially when there might be only very minor additional specification effort to support all the cases. Therefore, we proposal the following:**For PUCCH carrier switching, the following switching scenarios are supported in Rel-17:****Case 1: PUCCH carrier switching among different cells not being configured with SUL****Case 2-1: PUCCH carrier switching among different cells where at least one cell is configured with SUL. For the cells having SUL configured, PUCCH is only configured either for NUL or SUL.****Case 2-2: PUCCH carrier switching among different cells where at least one cell is configured with SUL. For cells having SUL configured, PUCCH may be configured for NUL carrier, SUL carrier or both****Case 3: PUCCH carrier switching for a single cell configured with SUL and having PUCCH configured for NUL and SUL** |
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## CSI feedback enhancements to allow for more accurate MCS selection

RAN1 made the following conclusion on delta-MCS in RAN1#106-e after discussing the topic in GTW sessions and over emails.

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| **Conclusion**There is no consensus in RAN1 on the support of delta-MCS in Rel-17. |

Given the conclusion, no further discussions on delta-MCS will take place in RAN1 unless RAN decides otherwise.

During the RAN1 discussions in RAN1#106-e (August), the general thinking among all interested companies was that if delta-MCS needs to be supported in Rel-17, the decision would have to be made in RAN1#106-e in order to secure enough time for follow up specification details on delta-MCS (only two more RAN1 meetings left).

In RAN#93-e, Qualcomm, DOCOMO, Sony, CATT, ZTE, and Ericsson submitted RP-212107 [4] which proposes to re-open the discussions on delta-MCS in RAN1.

**Question/Request#3: Moderator would like to check company views on re-opening the discussions on delta-MCS in RAN1.**

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| **Company** | **Views** |
| CMCC | We do not think it is a good idea to re-open the discussion on delta-MCS in RAN plenary meeting, especially considering that some companies observed the benefit brought by the it is not significant, and cannot justify the related enhancement. |
| OPPO | We are supportive to the principle as proposed in RP-212107 to re-open RAN1 discussion on delta-MCS. Meanwhile, we do not think plenary discussion should go to a detailed level as in RAN1 discussion; for example, the number of bits in delta-MCS report should be discussed and determined in RAN1. The guidance from RANP should be just on high-level.  |
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## Enhancements for support of time synchronization

Enhancements for support of time synchronization was discussed in RAN#92-e for possible RAN guidance but without any outcome. While some progress has been made in the working groups in Q3, there is still no formal decision on which scheme(s) is to be supported in Rel-17. Given the limited time left until the completion of Rel-17, the rapporteur for Rel-17 IIoT and URLLC has proposed the following compromise in [1]:

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| **Proposal 2: For propagation delay compensation enhancements, RAN to agree the following compromise proposal:** * **Support for baseline TA-based propagation delay compensation based on the Rel-15 / 16 timing advance procedure (i.e. Alt. 1) in Rel-17 without changes on existing TA requirements.**
* **Support for Rx-Tx measurement based propagation delay compensation as the (main) Rel-17 PDC enhancement.**
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The above proposal is also made in [2]. From moderator’s point of view, the above proposal seems to be a reasonable way forward to ensure that Rel-17 has proper support of time synchronization for the envisioned use cases.

**Question/Request#4: Are there any strong concerns on the above proposal from the work item rapporteur on enhancements for support of time synchronization?**

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| **Company** | **Views** |
| CMCC | **For propagation delay compensation enhancements**Since current LMF-based RTT method involves CN, RAN and UE which costs long delay, it is not suitable for IIOT, which requires ultra-low delay. Hence, the design of enhanced RTT-based method only involved gNB and UE is needed. This means that the current NAS signaling for positioning needs to be adapted into AS signaling for the TSC PDC, which will require significant discussion for details. From our perspective, RTT-based PDC method is not so simple that can reduce the work load of the WID. Additionally, RAN1 has sent LS to RAN4 and RAN4 is involved in the discussion. Therefore, we prefer not to so rush to preclude the TA-based PDC solution in RAN plenary and continue the evaluation and discussion in RAN1/4/2. Maybe, a joint session of RAN1, RAN2 and RAN4 for this topic can be added into the slot. |
| OPPO | Yes, we do have the concern. As mentioned in GTW, RAN1 has not yet completed the analysis for RTT-based PDC to confirm its capability to meet RAN2 Uu interface error budget. On the other hand, thanks to focused efforts in RAN1 #106e, now RTT-based PDC becomes the PDC candidate having the largest spec impacts (examples including configuring/defining PRS outside of positioning protocol from RAN2, defining new CSI-RS-based timing sync performance requirements in RAN4, copying gNB Rx-Tx time difference report from wired link between gNb and positioning server to wireless link between gNB and UE, and etc). Therefore, if RTT-based PDC is selected now, the risk is either RAN1 finds out later it cannot meet RAN2 error budget even with feasible RAN4 performance requirement improvement, or RAN1 confirms RTT-based PDC can meet RAN2 error budget but RAN1/RAN2/RAN4 have hard time to complete all spec work in Rel-17 time frame.[1] mentions a “deadlock” between companies supporting RTT-based PDC and companies supporting TA-based PDC. We have different view on this statement. In our view, the real “deadlock” comes from the fact that RAN1 has three error models for TA-based PDC and another three error models for RTT-based PDC, so RAN1 cannot even agree upon a numerical comparison between the two error performances for RTT-based PDC and TA-based PDC respectively. Such “deadlock” is technical and should be solved in RAN1, for example, to narrow down to one single error analysis formula for each PDC candidate. Our preference is to continue the discussion in RAN1, e.g. to determine the error performance formula for all PDC solutions currently on the table (RAN1 may need to do this anyway in the end for the chosen PDC solution). If RANP intervention is indeed desired, we think RANP could give the following guidance * to make RTT-based PDC thinner, e.g., by picking just one DL-RS between PRS and CSI-RS, in order to make RAN2/RAN4 load lighter if RTT-based PDC is finally chosen by RAN1.
* whether to allow the capability of meeting RAN2 error budget being SINR dependent (So far there is argument that the one-way propagation delay estimation performance can be made better in RTT-based PDC by utilizing specific DL-RS but such improved performance in error budget calculation has to be SINR dependent [per RAN4 outcome]; in contrast, other PDC solutions such as TA-based PDC still stay with SINR-independent error budget calculation -- so the comparison among PDC solutions in this way does not seem to be applet-to-apple, due to different SINR conditions for timing error upper-bounds).

Finally, we would like to remind the group: OPPO provided a solution called implicit PDC in the past RAN1/RAN2 meetings since April, also mentioned in the last RANP. We showed this solution can have no impacts to RAN1/RAN4; RAN2 signaling modification could be sufficiently make it to meet RAN2 error budget. If the major interest here in RANP is to find a solution that can simply ensure timely completion of WI objective on PDC, we do not see a reason why this solution has been put out of consideration.  |
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## Enhancements based on new QoS related parameters

The work item rapporteur made the following proposal in [1] to ensure timely completion of the enhancements based on new QoS related parameters.

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| **Proposal 3: For the objective on New QoS parameter, RAN should provide the following guidance to RAN2:*** **Sharpen the focus and concentrate on the specification work for survival time solution based on “HARQ NACK” that RAN2 has agreed to work/study.**
* **Other options should be dropped for the time being.**
* **If no consensus can be reached by the end of Rel-17, RAN2 should postpone the discussion to future releases.**
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**Question/Request#5: Companies are requested to provide their views on the above proposal for RAN guidance to RAN2 on enhancements based on new QoS related parameters.**

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| **Company** | **Views** |
| CMCC | We support this proposal and prefer that RAN2 only focus on the fast feedback mechanism, i.e. HARQ NACK or UL retransmission triggering the adjustment of resource usage, e.g. PDCP duplication triggering.  |
| OPPO | We are generally fine with the first two bullets. But wonder why the last bullet is needed. To our best knowledge, there is a chance that Rel-18 does not have URLLC item. So the last bullet provides almost nothing but some confusion because it is a rare practice to promise a “postponed feature” to show up by a delay of more than one release. If the intention is just to say “**If no consensus can be reached by the end of Rel-17, the objective on new QoS parameter should be removed from WID**”, this can be discussed in December RANP. Anyhow “No consensus, no support in the release” is a common practice in 3GPP.  |
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# Intermediate phase

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# Fine tuning phase

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# Conclusion

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# References

[1] RP-211939 Rapporteur views on status of Rel-17 URLLC/IIoT WI Nokia, Nokia Shanghai Bell

[2] RP-212002 Discussion on progress in Rel-17 URLLC/IIOT Intel Corporation

[3] RP-212024 Scope discussion on Rel-17 IIOT/URLLC vivo

[4] RP-212107 Views on RAN1 scope for URLLC/IIOT Qualcomm, DOCOMO, Sony, CATT, ZTE, Ericsson

[5] RP-212235 Progress and scope of Rel-17 enhanced IIoT and URLLC CATT

[6] RP-212349 Propagation Delay Compensation for URLLC/IIoT Ericsson

[7] RP-210854 Revised WID: Enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR Nokia, Nokia Shanghai Bell