**3GPP TSG RAN Meeting #92-e RP-21XXXX**

e-Meeting, June 14th – 18th, 2021

Agenda Item: 9.7.2.1

Title: Summary of email discussion [92-e-15-IIoT-URLLC-Scope]

Source: Samsung (RAN1 Chairman)

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 three WG meetings until the deadline of the stage-3 completion.

A number of companies have submitted contributions [1] ~ [10] discussing the potential downscoping of the work item considering the limited time until the completion deadline and the level of progress in the relevant working groups. The status report [11] on the work item also indicates that progress is behind schedule and RAN plenary intervention may be needed. In particular, all companies who submitted on this issue suggest downscoping of some sort on the RAN1-led objectives. One company [1], [2] discusses downscoping of RAN2-led objectives as well.

The purpose of the email thread [92-e-15-IIoT-URLLC-Scope] is to collect company views and if possible, converge on a way forward on how to downscope the Rel-17 work item on *Enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR*.

# Initial phase

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

For your reference, the detailed objectives in the WID [12] 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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## Company views on whether downscoping on Enhanced IIoT and URLLC is necessary in RAN#92-e

**Question1: Considering the latest progress in working groups, is it necessary for RAN to provide guidance, including possible downscoping, for the Rel-17 work item on Enhanced IIoT and URLLC in RAN#92-e? It should be assumed that Rel-17 schedule will be maintained as previously endorsed (stage-3 completion for RAN1 by Q4 of 2021 and other working groups by Q1 of 2022).**

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| **Company** | **Views** |
| Nokia, NSB | **Yes, necessary**As detailed in our contribution in RP-211112 (also presented during the early topics GTW call), from rapporteurs’ perspective we think some action need to be taken during RAN#92 to guarantee the timely completion of the WI.  |
| OPPO | We think the plenary guidance is needed for CSI, for which RAN1 cannot proceed with the majority view. But for remaining URLLC items, plenary can wait for another quarter to get clearer view of situation. |
| Ericsson | Yes. It is necessary. |
| InterDigital | Yes, it is necessary for CSI enhancement. But, for other topics, we can wait until September plenary so that RAN1 may discuss potential down-scoping in the next quarter or progress enough to cover all the identified schemes in Rel-17 |
| FUTUREWEI | Ok to downscope. |
| Samsung | Progress in RAN1 can benefit from RAN guidance. In particular, for CSI enhancements, RAN may guide subsequent RAN1 work based on the proposal in the Chairman’s minutes from RAN1#105-e (without discussing potential fine tuning of the wording – guidance for the direction of further RAN1 discussions would be sufficient).  |
| Huawei, HiSilicon | Guidance on the focus of CSI feedback enhancements from RAN plenary would be helpful. Based on the discussions in RAN1, there are too many candidate solutions and it seems really a deadlock on what direction to take for CSI enhancements. Therefore, some guidance on the focused direction would be helpful and then RAN1 can achieve more progress in the following meetings. Some guidance from RAN plenary on propagation delay compensation enhancements would be good also if possible. Even though we have achieved agreements on it, it is mostly on evaluation assumptions and so far not being able to touch the technical enhancements. The challenge for this topic is that it is relevant to several working groups, i.e. RAN2 and RAN4, and with only 3 e-meetings left it seems no sufficient time to exchanges views among different working groups on the potential enhancements we can do in Rel-17.For HARQ-ACK feedback enhancements and intra-UE multiplexing and prioritization, it seems not that critical/urgent for this RAN plenary, since sufficient agreements have achieved in RAN1 to move forward, and we can reassess in next RAN plenary.  |
| Apple | URLLC features have big impacts on modem implementation, and consequential decision on them should be taken with care. Focusing features with well-defined use cases and finishing their design with high quality is key.RAN plenary guidance can be helpful for CSI feedback. Since the technical discussions with all the details can be better handled in RAN1, RAN plenary can decide whether CSI feedback is pursued further in RAN1 or not, selecting a specific solution or a combination of solutions may require taking all the technical discussions to RAN. Following the same reasoning, if HARQ-ACK enhancements need to be down-scoped, it is better to exclude the whole HARQ skipping feature rather than making secondary choice such as whether to support bundling/compression under RAN. As for intra-UE multiplexing & prioritization enhancements, UCI multiplexing has progressed reasonably well in recent meetings. It seems DG/CG enhancements can be a first candidate for downscoping: DG/CG enhancements have to be built over the Rel-16 design. Yet the UL skipping with L1/L2 prioritization has been discussed at Rel-16 maintenance for multiple meetings (including DG/CG behavior in Rel-16), and issues involving RAN1/RAN2 design have been revealed in the process, and it is clear companies hold fundamentally different understandings on some issues. It is increasingly elusive when the design on UL skipping with L1/L2 prioritization can be finalized. We should avoid rushing into adding another floor to a building while its foundation is shaky. |
| Telecom Italia | Downscoping at RAN#92 is essential to ensure timely completion of Rel 17 (and hopefully good quality of the specifications) |

## Company views on potential areas for downscoping

For those companies who have indicated that downscoping of the Rel-17 work item on Enhanced IIoT and URLLC in RAN#92-e is necessary, please provide additional details by answering the following question.

**Question2: Which objectives in the Rel-17 work item on Enhanced IioT and URLLC would need to be downscoped in RAN#92-e? And how?**

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| **Company** | **Views** |
| Nokia, NSB | 1. **CSI feedback enhancements (High need):** As pointed out in our contribution in RP-211112 and also pointed out by other companies – there is a need for down-scoping to guarantee some enhancement to be specified in Rel-17. We propose to focus on case-1 reporting – and (i) exclude the case-2 reporting (as this is also not in line with the WI objective) and exclude the study area of new triggering methods for A-CSI and/or SRS
2. **Intra-UE multiplexing & prioritization enhancements (High need):** We are now 1 year into the WI, this objective was clearly spelled out in the WID and still there had only be very minor progress. Therefore, we think there is little to no chance of completing the 3 different features of this objectives in Rel-17. As explained in RP-211112, we suggest excluding ‘*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*’ from the WID and RAN1 to stop the related work. RAN1 to instead focus its future work as part of RAN1 AI 8.3.3 on the two remaining items of simultaneous PUCCH/PUSCH of different PHY priorities (at least for inter-band CA) and overlapping CG and DG PUSCH enhancements.
3. **Propagation delay compensation enhancements (High need):** All companies agree that at least some enhancements will be needed to fulfil the requirements of the targeted Rel-17 use cases. Two different methods (TA-based and Rx-TX based PDC) are discussed which hampers the progress due to the different opinions of the two camps on which seem is to be selected in the end. From rapporteur perspective, we therefore think RAN should take some action to sort out the current deadlock and thereby enabling the support of such TSN services based on Rel-17 specifications.

As discussed in Sec. 3.1 of RP-211112, we therefore suggest as a compromise to support 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 as well as Rx-Tx measurement based propagation delay compensation in Rel-17. Moreover, it is suggested to focus the further work on propagation delay compensation performed at the UE side (i.e. UE-based propagation delay compensation).1. **UE feedback enhancements for HARQ-ACK (Medium need):** First, there is definitely much less need for RAN down-scoping of this objective (especially compared to the three others above). So, this could maybe be left to RAN#93 based on the RAN1#106 progress.
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| OPPO | For HARQ-ACK, the question is whether/how to down-scope the last sub-bullet in the following remaining issues listed in SR (RP-211111): * **UE feedback enhancements for HARQ-ACK** (RAN1 AI 8.3.1.1)
	+ Remaining details of deferral of dropped SPS HARQ-ACK due to cancelled PUCCH for TDD
	+ Remaining details of HARQ-ACK re-transmission
	+ Remaining details of (sub-slot based) PUCCH repetition enhancements
	+ Remaining details of Type 1 HARQ-ACK codebook for sub-slot PUCCH
	+ Remaining details of PUCCH carrier switching for HARQ-ACK feedback
	+ Study and specify if needed method(s) to enable the following:
		- SPS HARQ-ACK skipping for ‘skipped’ SPS PDSCH
		- SPS HARQ-ACK payload size reduction

If down-scoping on HARQ-ACK is indeed desired by majority, we prefer to remove the whole scope of the last sub-bullet on “study and specify if needed” (highlighted), given RAN1 is already tasked with 5 items as shown above for the next three RAN1 meetings; otherwise the decision should be made in RAN1. For CSI, we support RAN1 FL proposal in RP-211297, to narrow down to one solution for case-1 and one solution for case-2, given that is clearly the majority view in RAN1.For intra-UE multiplexing/prioritization:It seems the Rapporteur’s suggestion is to remove the item for which RAN1 spent most of focus and time, and meanwhile to add new item of “simultaneous transmission” that is not yet in current WID scoping. Our preference is not to add anything if the intention of this discussion is down-scoping. Another thing to note is that, the RAN1 progress on overlapping CG/DG enhancement is somehow depending on some RAN1 decisions for Rel-16 URLLC, such as PUSCH skipping, which was not yet fully solved as of RAN1 May meeting in maintenance agenda. So if there should be something to be down-scoped for Rel-17, we think it would rather be the one that RAN1 has not fully started and meanwhile has more difficulties to move forward due to uncertainties coming from the earlier release. For PDC: We are ok to remove TA-based PDC for Rel-17, but we do not agree to settle down on RTT-based PDC only. Currently there is another solution called implicit PDC proposed in both RAN1 (R1-2102396) and RAN2 (R2-2105565). In our view, RTT-based PDC still has the risk to generate new impacts to UE hardware requirements in RAN4 and meanwhile to potentially have more RAN1 spec impacts even than TA-based. The following two issues were raised in RAN1 but not fully discussed to justify the RTT-based PDC. * One is that the RTT\_based PDC is effectively a 2-step solution including PD estimation and PD compensation, both of which generate timing errors. RAN1 is still in discussion to determine how close to each other in time these two steps are controlled to lower the total timing error to its minimum; in contrast, implicit PDC has only one step and accesses Tx/Rx timings in gNB/UE only once, and therefore avoid the corresponding issue in RTT-based PDC.
* The 2nd issue is the RTT-based PD estimation. It has not been discussed in RAN1 how to ensure the avoidance of RTT measurement sync-up issue (e.g. the RTT measurements at gNB and UE do not happen at the same time, especially one can happen before TA interval change and the other after TA interval change), which could generate new needs of spec impacts. This RTT measurement sync-up issue does not exist for implicit PDC by nature.

So it is our concern that selecting RTT-based PDC in plenary may risk to lock on more potential WGs work and more unnecessary UE hardware implementation impacts. Our suggestion is to leave the technical decision to WG level and to wait for one more quarter, given RAN1 has two weeks in Aug meeting comparing to zero TU for PDC in May meeting.  |
| Ericsson | CSI enhancements:* **Down-scoping in this plenary is essential.**
* We are supportive of FL proposal (InterDigital) in [RP-211297](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_92e/Docs/RP-211297.zip)

PDC:* Guidance from RAN plenary would be helpful to progress the work.
* We are supportive of Nokia’s proposal **that Rx-Tx based method should be the (main) Rel-17 PDC enhancement,** since TA-based method cannot satisfy the requirements of all targeted scenarios. For TA-based method, minimum work related to signaling aspect to support Rel-15/16 can be done.

Other topics (HARQ-ACK enhancements and Intra-UE multiplexing)* We are supportive of Nokia’s proposal. Guidance from RAN plenary would be helpful to progress the work.
	+ However, potential down scoping of these topics can be deferred to Sept plenary if it is preferred by majority of companies.
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| InterDigital | CSI enhancements:* Support the WF ([RP-211297](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_92e/Docs/RP-211297.zip)) to confirm the RAN1 proposal as the guidance
* RAN should not reopen the discussion whether case 2 and A-CSI on PUCCH triggered by DL DCI need to be excluded or not in the WID.

HARQ-ACK enhancement/Intra-UE multiplexing:* Any down-scoping for these topics could be discussed in RAN1 if necessary based on some technical analysis
* RAN can revisit in September whether any guidance/down-scoping is needed for these topics based on the progress in the next RAN1 meeting
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| FUTUREWEI | For CSI enhancement, the proposed scheme(s) need to be first justified by performance benefits. As we detailed in our contribution RP-211430 and based on the Feature Lead summary in RAN1 (R1-2106177), case 1-1/1-3 provides significant performance benefits, case 1-8 provides little to no gain or even loss for majority cases, and case 2-3 provides little to no gain and in some cases even results in performance loss. RAN should not just count supporting companies while ignoring evaluation results that RAN1 agreed to perform. Therefore, our proposal is to have RAN1 continue investigating case 1-1 and 1-3 so that we can potentially specify something useful in Rel-17. |
| Samsung | 1. For CSI enhancements, we support for RAN1 to continue by focusing (not necessarily specifying) on the schemes identified by the proposal in the RAN1#105-e chairman minutes (and in [RP-211297](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_92e/Docs/RP-211297.zip)).
2. For intra-UE multiplexing, Samsung was a primary proponent for supporting simultaneous PUSCH and PUCCH transmissions as it is a simple mechanism to avoid dropping LP PUSCH/PUCCH due to overlapping with HP PUCCH/PUSCH and as a general enhancement for NR to match the LTE functionality. However, in Rel-17, potential support will be too limited to be beneficial (only for UEs supporting UL CA and only when LP/HP collisions happen under inter-band CA). Therefore, the feature can be considered for down-scoping, particularly if it would have non-trivial specification impact, and may be more broadly revisited in Rel-18.
3. For HARQ-ACK enhancements, we generally support some down-scoping but it is probably better to revisit the whole objective in RAN#93-e, based on the status after RAN1#106-e, than to discuss some minimal/trivial down-scoping now.
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| Huawei, HiSilicon | As shown in our reply above, if possible some guidance on CSI feedback enhancements and propagation delay compensation enhancements would be good.For CSI feedback enhancements, based on the discussion in RAN1, it seems the proposal from RAN1#105-e meeting is the most promising direction to go for progress. However, from RAN plenary perspective, we think it is sufficient to give guidance on high-level direction and leave details for each direction to RAN1. An example of the potential guidance as below: Potential guidance on CSI feedback enhancements from RAN#92-e *(i.e.* *WF* [*RP-211297*](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_92e/Docs/RP-211297.zip) *with removing the last sub-bullet on the details of how to calculate delta-MCS):****RAN1 to further investigate the following for CSI enhancements for IIoT/URLLC:**** ***Increasing the number of bits used for the reported subband CQI (3-bits differential subband CQI or 4-bits CQI)***
* ***Reporting of delta-MCS:***
	+ ***Report consists of delta-MCS for a TB received with MCS index IMCS***

For propagation delay compensation enhancements, for TA-based PDC enhancements and RTT-based PDC enhancements, though RAN1 are still assessing whether TA-based PDC enhancements is able to meet the budget for control-to-control case, it is expected that it would be challenging since much reduction are needed for Te (e.g. down to 1/4) and TA command indication granularity, which actually also needs RAN4 and/or RAN2 to check the feasibility. Therefore, considering much work from all working groups on TA-based PDC enhancements and also there might be some risk that in the end the conclusion is that even with enhancements TA-based PDC is impossible to meet the budget for control-to-control case, probably we can consider to stop the related enhanced work for TA-based PDC enhancements and focus on RTT-based PDC enhancements in the following 3 RAN1 meetings. An example of the potential guidance as below:*Potential guidance on propagation delay compensation enhancements from RAN#92-e:* **For propagation delay compensation enhancements,** * **Support TA-based propagation delay compensation based on the Rel-15 / 16 timing advance procedure in Rel-17 without changes on existing TA requirements/procedures.**
* **RAN1/2/4 focus on RTT-based propagation delay compensation enhancements in Rel-17.**

If we are not able to preclude TA-based PDC in this RAN plenary, companies should be more constructive when we discuss in RAN1 on the potential LSs to ask other working groups to check the feasibility of reducing Te and TA command indication granularity for TA-based PDC enhancements, this kind of LSs were under discussion for 2 RAN1 meetings but no consensus achieved due to strong concern from a few companies. Probably RAN can give some guidance to RAN1 on the deadline to send the LS, then other working groups can have sufficient time to check and discuss. Some example can be: **For propagation delay compensation enhancements, RAN1 should send out the LS(s) if any in RAN1#106-e on the issues that need feedback or inputs from other working groups, e.g. LS to ask RAN4 to check the feasibility and potential enhanced value for Te and TA command indication granularity.**  |
| Apple | URLLC features have big impacts on modem implementation, and consequential decision on them should be taken with care. Focusing features with well-defined use cases and finishing their design with high quality is key.RAN plenary guidance can be helpful for CSI feedback. Since the technical discussions with all the details can be better handled in RAN1, RAN plenary can decide whether CSI feedback is pursued further in RAN1 or not, selecting a specific solution or a combination of solutions may require taking all the technical discussions to RAN. Following the same reasoning, if HARQ-ACK enhancements need to be down-scoped, it is better to exclude the whole HARQ skipping feature rather than making secondary choice such as whether to support bundling/compression under RAN. As for intra-UE multiplexing & prioritization enhancements, we share a similar understanding as OPPO. UCI multiplexing has progressed reasonably well in recent meetings. It seems DG/CG enhancements can be a first candidate for downscoping: DG/CG enhancements have to be built over the Rel-16 design. Yet the UL skipping with L1/L2 prioritization has been discussed at Rel-16 maintenance for multiple meetings (including DG/CG behavior in Rel-16), and issues involving RAN1/RAN2 design have been revealed in the process, and it is clear companies hold fundamentally different understandings on some issues. It is increasingly elusive when the design on UL skipping with L1/L2 prioritization can be finalized. We should avoid rushing into adding another floor to a building while its foundation is shaky. |
| Telecom Italia | We are in general supportive of the Nokia proposal.As a minimum, all the “study and specify if needed” objectives should be removed from the WID |

# Intermediate phase

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# Fine tuning phase

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# Conclusion

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# References

[1] RP-211112 Rapporteur views on Rel-17 URLLC/IIoT WI focus Nokia, Nokia Shanghai Bell

[2] RP-211113 Revised WID: Enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR Nokia, Nokia Shanghai Bell

[3] RP-211154 Discussion on Rel-17 enhanced NR IIoT/URLLC progress and WID scope revision vivo

[4] RP-211210 Discussion on scope of Rel-17 enhanced IIoT and URLLC CATT

[5] RP-211257 On CSI Feedback Enhancements for Enhanced URLLC/IIoT Ericsson

[6] RP-211297 Way forward on CSI feedback enhancements for enhanced URLLC/IIoT InterDigital, Inc., Ericsson, Motorola Mobility, OPPO, Qualcomm, Samsung, SONY, Spreadtrum

[7] RP-211430 On CSI feedback enhancements for URLLC/ IIoT Futurewei

[8] RP-211436 Views on WI scope of Rel-17 Enhanced IIoT and URLLC ZTE, Sanechips

[9] RP-211462 Discussion on CSI feedback enhancements for URLLC/IIoT MediaTek Inc.

[10] RP-211187 Discussion on status of Rel 17 work Samsung

[11] RP-211111 Status report for WI: Enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR RAN2

[12] 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