3GPP TSG RAN WG2 Meeting #117-e R2-220xxxx

e-Meeting, 21st February – 3rd March, 2022

**Agenda item: 8.5.1**

**Source: Samsung**

**Title: Report of [POST116bis-e][512][IIoT] UP open issues**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution is a summary of the outcome of the open issue list discussion:

* [POST116bis-e][512][IIoT] UP open issues (Samsung)

Scope:

- List of critical open issues to be resolved for WI completion

- Updated CR 38.321 for information and review

NOTE: NO contributions on these critical open issues are expected

Deadline:

- Open issues list Jan. 28th

- Company inputs Feb. 15th

# 2 Issue List

The list contains critical issues for the completion of the WI. A separate email discussion will be organized to describe the issues in detail and to collect companies’ view.

There are some further issues described in various submitted 3GPP contributions, but there is no urgent/critical issue for the WI completion. Other remaining issues can be discussed based on company contributions in RAN2#117-e.

Time sync

**None** (no critical issues specified in UP specifications)

NR-U harmonization

**None** (There are some issues addressed by companies, but there is no urgent/critical issue for WI completion. Other remaining open issue will be discussed based on company contributions in RAN2#117-e.)

QoS

**None** (There are some issues addressed by companies, but there is no urgent/critical issue for WI completion. Other remaining open issue will be discussed based on company contributions in RAN2#117-e.)

TBD: Survival Time State with N>1 (check companies views at the beginning of the phase-2 discussion after RAN2 inactive period)

RAN1 features with potential UP impacts

**1. DRX Impact of enhanced HARQ feedback (SPS HARQ ACK deferral, Enhanced type 3 codebook, one-shot HARQ ACK retransmission, PUCCH cell switching) [R2-2200321, R2-2201131/2, R2-2201373]**

- Whether to enhance DRX features to support the one-shot feedback, especially HARQ RTT Timer control. RAN2 should first focus whether Rel-17 RAN1 features require RAN2 spec change.

- If RAN2 agreed to support, RAN2 should decide whether a unified solution covering both R16 and R17 one-shot feedback or only R17 enhancement.

**2. Prioritization between SR and UL-SCH considering simultaneous PUCCH-PUSCH transmission [R2-2201368]**

- Whether or how to support simultaneous PUCCH-PUSCH transmission in MAC spec which assumed it is not allowed.

**3. Prioritization of COT-initiated UL grant in LCH-based Prioritization [R2-2201226]**

- Whether to specify behavior considering UE-initiated COT. Rel-16/17 LCH-based Prioritization does not consider COT. (Note that the WID states that “a. Specify support for UE-initiated COT for FBE with minimum specification effort” RAN2 should first check whether RAN2 enhancement is the case.)

UP CR specific Issues

**1. Modeling of Survival Time State**

- In the current running CR, the survival time operation is modeled as two-step: 1) HARQ NACK -> entry to Survival Time State, 2) Survival Time State -> PDCP Duplication with all configured RLC entities. Whether this two-step approach is preferred by companies should be discussed. (Note that this issue is merely about MAC CR, whereas configuration survivalTimeStateSupport is already captured in both RRC and MAC CRs.)

# 3 Contact Information

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# 4 Discussion

## 4.0 Issue 0: Survival Time State with N>1

In RAN2#116bis-e, multiple companies supported to have N>1 for HARQ NACK triggering the survival time entry. This could be also to fulfil the real survival time requirement as provided in 3GPP TS 22.104, which could be up to even 60 seconds. However, some companies think this issue is not a critical issue for WI completion, so it can be discussed based on company contributions. The rapporteur would like to check companies’ view on where we discuss the issue.

**Q0) Do companies agree that ST state with N>1 should be treated in UP Open Issue discussion?**

* **Yes, it’s a critical/important issue we have to discuss in this discussion.**
* **No, it can be treated by company contribution.**

**(Deadline: Thursday 10th February 23:59UTC)**

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| **Company** | **Yes/No** | **Comment** |
| Nokia | No | First of all, from the WI rapporteur point of view, we think a “critical issue for WI completion” should be **a gap or a loophole that has to be fixed, otherwise it would result in broken features.** We believe such understanding is also aligned with the RAN2 guidelines in general.  With this in mind, we do not think “N>1” is a critical issue, because nothing is broken even if only N=1 is supported.  RAN2 has agreed to support N=1, and basically N=1 is sufficient to cover all survival time use cases regardless of the actual requirement without any problem. Even for an application that can tolerate up to 3 consecutive errors, it does not harm to prevent survival time violation by avoiding 2 consecutive errors with N=1.  Some companies may argue it is less efficient due to “early entry to survival time state”, but considering that HARQ NACK should be a rare event, we think such efficiency loss (if any) is negligible, so making N>1 is an overkill and we do not see any necessity for such optimization. Besides, the gNB can easily resolve this by implementation (e.g. the gNB may choose to only provide the retransmission grant when the third consecutive error is observed, if the retransmission of the previous two failed packets are anyway not important due to e.g. PDB expiry).  Hence, from our perspective this is an unnecessary optimization, and we do not think RAN2 should further spend time on it. |
| LG | No | Agree with Nokia. If the survival time is large enough to tolerate N>1 times of failure, the network has sufficient time to do some proper actions such as activating PDCP duplication or adjusting L1/L2 configurations. There is no urgent and critical reason for the UE to activate PDCP duplication based on UL grant. |
| Ericsson | No | Agree with above that this can be resolved by gNB implementation. More importantly, this has been discussed for some meetings without any consensus to support. |
| CATT | No | N>1 is only to address the 3rd usecase of Table 5.2-1 of TS22.104 [3], part of the selected target usecases for designing the Survival Time solution: in this usecase, the transfer interval is 2ms, which could leave time for two transmissions of a traffic message before triggering Survival Time. Hence, triggering Survival Time on the first HARQ-NACK would not leave a chance to the 2nd transmission to succeed. Therefore, it is proposed to count N >1 HARQ-NACKs before triggering Survival Time. But we agree with above companies that this extra complexity is not justified for addressing only this usecase. Indeed, we have a similar reasoning as for the cases where PDCP duplication is already activated and where RAN2 agreed that a single NACK in any leg is sufficient to trigger Survival Time. The extra effort for optimizing these cases is not justified by the – still rare – over-triggering of Survival Time. |
| Samsung | Yes | We do not agree with views from Nokia and LG that this can be resolved by gNB implementation, or that supporting N>1 means that the NW has sufficient time to react – even with N>1, time constraints are quite stringent for the 3 use-cases at the top of the Table.  Based on calculations done early on, N=1 is only needed for the most stringent case (at the top of the Table of use-cases). For the other two cases we would end up with over-triggering the entry to ST state. (CATT explained this above.) We do not agree however with the concerns to do with ‘complexity’ which we think is comparatively small, while introducing potentially significant efficiency improvement. Limiting N to 1 would be wasteful in many applicable scenarios, except the most stringent ones (which admittedly are the benchmark – but **not** the sole focus – of the ST framework). |
| Huawei, HiSilicon | No | We don’t think that the possible resource “waste” caused by N=1 would be critical for R17. For IIOT ST framework, the first priority is to make ST support solution workable and the resource used is secondary concern. |
| OPPO | No | We understand that the support of N >1 may prevent too early entering into the survival time state and avoid the ping-pong issue, but the extra complexity and benefit has not been clearly evaluated. Even if we do not support N>1, the ST mechanism still works since N=1 is already supported. Thus, the support of N >1 may not be a critical issue but can be treated by companies’ contribution if time allows. |
| Qualcomm | No | Agree with the above companies that argued that N>1 can be handled by implementation or by setting N=1 end entering survival time slightly more often. Otherwise for N>1, there should be more discussions on how the counter is maintained at the MAC, how is it reset, how does it operate with CA and ensuring it does not go out of sync with gNB counter which are non-trivial questions. In our view the complications added to the feature from N>1 are not justified by the very slight higher efficiency that optimizing N may provide. |
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## 4.1 Issue 1: DRX Impact of enhanced HARQ feedback

As Rel-17 URLLC/IIoT features, RAN2 introduced several enhanced mechanisms on HARQ feedback. Those enhancements may impact DRX defined in MAC specification, in particular, HARQ RTT timer (*drx-HARQ-RTT-TimerDL*) start condition.

The current behaviour (Rel-16 MAC) is summarized below:

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| 2> if the PDCCH indicates a DL transmission:  3> start the *drx-HARQ-RTT-TimerDL* for the corresponding HARQ process in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback;  NOTE 3: When HARQ feedback is postponed by PDSCH-to-HARQ\_feedback timing indicating a non-numerical k1 value, as specified in TS 38.213 [6], the corresponding transmission opportunity to send the DL HARQ feedback is indicated in a later PDCCH requesting the HARQ-ACK feedback. |

The HARQ RTT Timer is started 1) after a HARQ FB and 2) only if DL transmission is indicated. However, One-shot feedback may be triggered without scheduling DL transmission. Thus, in the current MAC specification, none of one-shot feedback starts the HARQ RTT timer.

One could argue that Rel-16 support one type of one-shot feedback (type-3 HARQ-ACK codebook) but it does not start the HARQ RTT timer, so Rel-17 enhancement may not be necessary. Also, a large value of *drx-InactivityTimer* does not make serious performance degradation.

However, it is true that *drx-HARQ-RTT-TimerDL* and *drx-RetransmissionTimerUL* extends Active Time when *drx-InactivityTimer* is not running.

The rapporteur would like to ask companies view for each enhancement. If companies prefer a common solution for all HARQ feedback enhancements, we may have a common mechanism. But in this first discussion, the question is asked case-by-case.

**< Rel-17 One-shot Feedback (enhanced type-3 HARQ-ACK codebook) >**

Rel-17 Enhanced Type-3 HARQ-ACK codebook can be configured for a subset of CCs or a subset of HARQ processes per CC and triggered by ‘*one-shot HARQ-ACK request’* as Type-3 HARQ-ACK codebook. It means the one-shot feedback reports the reception status for a subset of HARQ processes. Thus, for which HARQ process the timer is started is a main issue. We may have the following options on the table:

- Option 1: No enhancement (Up to NW implementation, no timer is started)

- Option 2: UE starts *drx-HARQ-RTT-TimerDL-OneShotFeedback* (dedicated timer for One-Shot feedback).

- Option 3: UE starts *drx-HARQ-RTT-TimerDL* for the HARQ process(es) whose ACK status is reported.

- Option 4: UE starts *drx-HARQ-RTT-TimerDL* for the HARQ process(es) whose ACK status is reported and neither the *drx-HARQ-RTT-TimerDL* nor the *drx-RetransmissionTimerDL*is running.

In the rapporteur’s understanding, all those options can be applicable for Rel-16 type-3 HARQ-ACK codebook (NR-U feature) which reports all HARQ processes. Since this discussion is about Rel-17 IIoT/URLLC, this discussion first focuses on Rel-17 only.

**Q1-1) Please provide your preference for type-3 HARQ-ACK codebook.**

**- Option 1: No enhancement (Up to NW implementation, no timer is started)**

**- Option 2: UE starts *drx-HARQ-RTT-TimerDL-OneShotFeedback* (dedicated timer for One-Shot feedback).**

**- Option 3: UE starts *drx-HARQ-RTT-TimerDL* for the HARQ process(es) whose ACK status is reported.**

**- Option 4: UE starts *drx-HARQ-RTT-TimerDL* for the HARQ process(es) whose ACK status is reported and neither the *drx-HARQ-RTT-TimerDL* nor the *drx-RetransmissionTimerDL* is running.**

**- Option 5: (please add)**

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**< One-shot HARQ-ACK retransmission >**

The main difference of the one-shot HARQ ACK retransmission is for Type-1/2 codebook, so a feedback for only one HARQ process can be reported. The retransmission can be requested by DCI without DL scheduling same as type-3 HARQ-ACK codebook. Thus, the same options are one the table.

**Q1-2) Please provide your preference for One-shot HARQ-ACK retransmission.**

**- Option 1: No enhancement (Up to NW implementation, no timer is started)**

**- Option 2: UE starts *drx-HARQ-RTT-TimerDL-OneShotFeedback* (dedicated timer for One-Shot feedback).**

**- Option 3: UE starts *drx-HARQ-RTT-TimerDL* for the HARQ process(es) whose ACK status is reported.**

**- Option 4: UE starts *drx-HARQ-RTT-TimerDL* for the HARQ process(es) whose ACK status is reported and neither the *drx-HARQ-RTT-TimerDL* nor the *drx-RetransmissionTimerDL* is running.**

**- Option 5: (please add)**

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**< SPS HARQ-ACK deferral >**

SPS HARQ-ACK deferral is used when the SPS HARQ-ACK in the initial slot/sub-slot cannot be transmitted as the resulting PUCCH resource for transmission using the PUCCH by *SPS-PUCCH-AN-List-r16* or *n1PUCCH-AN* is not valid. SPS HARQ ACK deferral may be similar to non-numerical k1, where the HARQ ACK feedback is deferred and transmitted later. Since the case of non-numerical k1 was already specified in the MAC specification as a NOTE, it seems that normative TP is not needed. Two companies proposed to add a similar NOTE.

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| NOTE for non-numerical k1 in 38.321  NOTE 3: When HARQ feedback is postponed by PDSCH-to-HARQ\_feedback timing indicating a non-numerical k1 value, as specified in TS 38.213 [6], the corresponding transmission opportunity to send the DL HARQ feedback is indicated in a later PDCCH requesting the HARQ-ACK feedback. |
| TP in [R2-2201373]  NOTE x: When SPS HARQ feedback is postponed by the transmission collision, as specified in TS 38.213 [6], the corresponding transmission opportunity to send the DL HARQ feedback is deferred to the next available resource as specified in TS 38.213 [6]. |
| TP in [R2-2201132]  NOTE X: When the HARQ feedback is subject to SPS HARQ-ACK deferral as specified in TS 38.213 [6], the corresponding transmission carrying the DL HARQ feedback occurs in a PUCCH resource with a PUCCH transmission in a later slot. |

**Q1-3) Please provide your preference for SPS HARQ-ACK deferral.**

**- Option 1) Nothing is needed. (the current spec is clear)**

**- Option 2) NOTE should be added (prefer TP in R2-2201373 as a baseline)**

**- Option 3) NOTE should be added (Prefer TP in R2-2201132 as a baseline)**

**- Option 4) (please add)**

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**< PUCCH Cell Switching >**

PUCCH carrier switching (aka PUCCH cell switching) helps reduce UCI or HARQ feedback latency for inter-band TDD as UCI can be sent on a different PUCCH carrier in an earlier PUCCH occasion. PUCCH carrier switching applies between two TDD cells with PUCCH configured on the NUL carrier in Rel-17. The feature comes in two flavors, semi-static (periodic) PUCCH carrier switching and dynamic PUCCH carrier switching. Only one of the two flavors is meant to be configured at a time. If PUCCH cell switching is applied, the corresponding HARQ-ACK happens on a different PUCCH carrier.

The MAC specification has not assumed PUCCH carrier switching so far. However, it does not specify anything about cell on which the HARQ feedback is transmitted. In DRX, the HARQ RTT timer is started immediately after the feedback transmission, irrespective of PUCCH cell switching. Thus, the normative text does not need to be changed.

[R2-2201131] proposed NOTEs to clarify the MAC behavior on PUCCH cell switching, to avoid further confusion.

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| TP in [R2-2201131]  NOTE Y: When the UE is configured with a periodic cell switching pattern for PUCCH transmissions as specified in TS 38.213 [6], the corresponding transmission carrying the DL HARQ feedback can happen on a different PUCCH cell.  NOTE Z: When PUCCH cell switching is configured as specified in TS 38.213 [6], the corresponding transmission carrying the DL HARQ feedback can happen on a different PUCCH cell. |

**Q1-4) Please provide your preference for PUCCH cell switching.**

**- Option 1) Nothing is needed. (the current spec is clear)**

**- Option 2) NOTE should be added (prefer TP in R2-2201131 as a baseline)**

**- Option 3) (please add)**

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## 4.2 Issue 2: Simultaneous PUCCH-PUSCH transmission

Currently, simultaneous PUCCH/PUSCH transmission is not allowed in NR according to TS 38.321. However, RAN1 agreed to support the simultaneous PUCCH/PUSCH transmission for some cases and the RRC running CR [R2-2202007] introduces a configuration *simultaneousPUCCH-PUSCH-r17* to enable simultaneous PUCCH and PUSCH transmissions with different priorities. But the impact to MAC spec does not support it at all, i.e. the MAC entity deliver either SR or MAC PDU, so the simultaneous transmission does not happen. RAN1 introduced some restriction of cell configuration but it may be better for RAN2 spec to have future proof umbrella condition, rather than specifying detailed condition or waiting for RAN1’s updates. Thus proposed TP from R2-2201368 is as follows:

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| 1> else, for the SR configuration corresponding to the pending SR:  2> when the MAC entity has an SR transmission occasion on the valid PUCCH resource for SR configured; and  2> if *sr-ProhibitTimer* is not running at the time of the SR transmission occasion; and  2> if the PUCCH resource for the SR transmission occasion does not overlap with a measurement gap:  3> if the PUCCH resource for the SR transmission occasion overlaps with neither a UL-SCH resource whose simultaneous transmission with the SR is not allowed nor an SL-SCH resource; or  3> if the MAC entity is able to perform this SR transmission simultaneously with the transmission of the SL-SCH resource; or  3> if the MAC entity is configured with *lch-basedPrioritization*, and the PUCCH resource for the SR transmission occasion does not overlap with the PUSCH duration of an uplink grant received in a Random Access Response or with the PUSCH duration of an uplink grant addressed to Temporary C-RNTI or with the PUSCH duration of a MSGA payload, and the PUCCH resource for the SR transmission occasion for the pending SR triggered as specified in clause 5.4.5 overlaps with any other UL-SCH resource(s), and the physical layer can signal the SR on one valid PUCCH resource for SR, and the priority of the logical channel that triggered SR is higher than the priority of the uplink grant(s) for any UL-SCH resource(s) where the uplink grant was not already de-prioritized and its simultaneous transmission with the SR is not allowed, and the priority of the uplink grant is determined as specified in clause 5.4.1; or  …  4> consider the SR transmission as a prioritized SR transmission.  4> consider the other overlapping uplink grant(s), if any, as a de-prioritized uplink grant(s);  4> if the de-prioritized uplink grant(s) is a configured uplink grant configured with *autonomousTx* whose PUSCH has already started:  5> stop the *configuredGrantTimer* for the corresponding HARQ process of the de-prioritized uplink grant(s). |

**Q2) Do companies support the MAC specification change to support simultaneous SR-PUSCH transmissions?**

* **Option 1) Yes, TP in R2-22021368 can be a baseline. (better wording is welcomed)**
* **Option 2) Yes, alternative TP is preferred. (please provide the TP in Comment section)**
* **Option 3) No, do nothing (MAC does not support the simultaneous transmission)**
* **Option X) (please add)**

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## 4.3 Issue 3: Prioritization of COT-initiated UL grant in LCH-based Prioritization

Based on the RAN1 agreements, the UE can initiate the COT in a UE FFP by sending an initiated UL signal to NW, if the UL transmission is performed (i.e LBT is successful), the COT period in this UE FFP is available for the UE to perform UL transmission. However, the UL transmission to initiate COT in one UE FFP period can be deprioritized by another UL transmission with a higher priority. It may result in contention failure for the UE initiated COT and some performance degradation. Thus, we may need to consider to prioritize the COT-initiated UL transmission if it collides with any other UL transmission not for initiating COT [R2-2201226].

On the other hand, Rel-17 IIoT/URLLC WID states that “a. Specify support for UE-initiated COT for FBE with minimum specification effort” RAN2 should first check whether this change can be considered as the minimum effort.

**Q3-1) Do companies support to prioritize the COT-initiated UL transmission if it collides with any other UL transmission not for initiating COT?**

* **Yes**
* **No**

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Assuming Q3-1 is agreed (depending on the company inputs), a follow-up question is the prioritization of multiple COT-initiated UL grants. [R2-2201226] proposed to use (the legacy) LCH-based Prioritization rule.

**Q3-2) If Q2-1 is supported, do companies agree that LCH-based Prioritization Rule selects the prioritized uplink grant for collision among multiple COT-initiated UL grants?**

* **Yes**
* **No**

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## 4.4 Issue 4: Modeling of Survival Time State in MAC CR

In the current running MAC CR [R2-2201990], the survival time operation is modeled as two-step:

**Step 1) HARQ NACK -> activation of PDCP duplication or entry to Survival Time State**

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| 5.4.1  1 > else if an uplink grant for this PDCCH occasion has been received for this Serving Cell on the PDCCH for the MAC entity's CS-RNTI:  2> if the NDI in the received HARQ information is 1:  3> consider the NDI for the corresponding HARQ process not to have been toggled;  3> start or restart the *configuredGrantTimer* for the corresponding HARQ process, if configured;  3> stop the *cg-RetransmissionTimer* for the corresponding HARQ process, if running;  3> deliver the uplink grant and the associated HARQ information to the HARQ entity;  3> if a logical channel associated with a DRB configured with *survivalTimeStateSupport* is multiplexed in the MAC PDU stored in the HARQ buffer:  4> trigger activation of PDCP duplication/entry to Survival Time State for the DRB. |

**Step 2) activation of PDCP duplication or Survival Time State -> PDCP Duplication with all configured RLC entities.**

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| 5.10  1> if a PDCP duplication/entry to Survival Time State is triggered for the DRB as specified in clause 5.4.1:  2> indicate the activation of PDCP duplication for all configured RLC entities of the DRB to upper layers. |

* Considering “entry to Survival Time State” is needed only for this 2-step modelling for now, someone could argue that PDCP duplication is sufficient.
* On the other hand, entry to Survival Time State is triggered is more aligned to the RAN2 agreement. Also, may be better for future extension (e.g. additional condition to entry or other UE action rather than duplication may be added on top of the concept of ST-state entry)
* From specification point of view, either way would work.

The rapporteur understands this is merely for the MAC CR modelling, it would be good to quickly check the companies’ view and go with majority unless there is any critical issue.

**Q4) Please provide your preference for MAC CR text.**

**- Option 1) PDCP duplication**

**- Option 2) entry to Survival Time State**

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| **Company** | **Preference** | **Comment** |
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# 5 Conclusion