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) – closed: the discussion may be based on company contribution.**

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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. |
| ZTE | Yes | Critical issue?  We cannot agree to say “only address the critical issues which would result in broken features” now (maybe it’s too early to say broken feature as we even have no a complete feature). Due to tight time budget in e-meetings, it is foreseeable that we will have to resolve several imperfections or incompleteness even after R17 release freezes, e.g., in the early stage of CR. Furthermore, to handle “the issues that would result in broken features” would be the main task in the late stage of CR.  Since the R17 WID stage is not over yet and also considering that no enhancement for this topic is in the scope of R18, we strongly suggest to make this enhanced QoS feature as complete as possible the first time it's done. Therefore, we think it is important to deal with the remaining issues, e.g.:   1. **Unnecessary waste of resources caused by entering survival time too early or too aggressively and;** 2. **Unreliable or untimely triggering survival time state due to loss of HARQ-NACK.**   Please note, for simplicity, several compromises have already been made, e.g., we already move forward the timing of enabling higher reliable transmission from the beginning of next packet to the retransmission of the current packet. That will make the 1) issue more serious, right? So we disagree to say “it’s no harm with N=1”. Too early triggering (re)transmission on more legs would not only cause more UE power consumption but also cause negative impact on the resource scheduling of the entire network (that may means less URLLC users/services can be supported).  Based on gNB implementation?  We generally agree with Samsung.  We also don’t think the mentioned gNB implementation, e.g., “*gNB may choose to only provide the retransmission grant when the third consecutive error is observed*”, is reasonable. The retransmission based on HARQ-NACK is essential function and should be kept as usual. We think without introducing other corresponding enhancement, the scheme of deliberately not sending (some) HARQ-NACK from gNB would be very risky. If the final HARQ-NACK is lost, the packet has no chance to be retransmitted. The main intention of “N>1” is different as it’s mainly to avoid “too early” triggering transmission with higher reliability. The legacy retransmission are not affected.  We already see the hope of a complete UE-based scheme which can also be suitable to other cases with a bit loose survival time requirement. UE-based scheme can trigger high reliable transmission at the just right timing, with less delay, higher reliability and robustness. The thought is, yes, the gNB-based scheme may be workable in some cases but UE-based scheme is anyway better. That also means a common scheme in any case and less implementation complexity in UE and gNB. We see no reason to stress the use of gNB-based scheme in those cases and further take this as a reason to prevent the necessary work on the accomplishment of the UE-based scheme.  The agreements for PDCP duplication is already activated?  Finally, we want to reiterate that, the issue of N>1 (Please note the current solutions for N>1 are mainly for one leg) is totally different from the issue of PDCP duplication is already activated (multiple legs). For the latter issue, the RAN2 agreement is quickly achieved without enough discussion. During offline discussion, several companies have indicated it’s unreasonable to just base on HARQ-NACK on only one leg. Even N=1, such logic is unreasonable. If transmission in another leg is successful, again, unnecessary waste of resources would be caused. Therefore, this is another compromise for simplicity. It cannot be the reason to block the discussion on N>1. |
| MediaTek | No | Agree with others above that the N>1 case is not a critical issue. The complications that arise from introducing such a feature as raised by Qualcomm above (and the time needed to address them) outweigh the potential gains. |
| Apple | Yes | We support the introduction of N>1 as an optional configuration for a DRB in survival time. If RAN2 can agree to stage this work to evaluate and build solutions into the spec we are ok to do this at a slightly later phase but as a next step. Moreover, we do not think Rel-17 should be confined to N=1 only. To focus on just the most stringent IIoT use-cases (the top rows in the table in 22.104) has the implication that RAN2 might end up ignoring what is probably a wider set of use-cases. We would like those to be applicable as useful ingredients that can work efficiently as part of the IIoT/URLLC framework, and one might think of the survival time state as a useful feature. |
| Xiaomi | Yes | The HARQ feedback timing could be much less than the survival time requirement, which can be up to 60 seconds according to 3GPP TS 22.104.    Only using “N=1” HARQ-NACK to trigger the entering of the survival time state will lead to the unnecessary uplink resource consumption for services with survival time longer than the HARQ feedback timing. |
| Lenovo/Motorola Mobility | No | Agree with others above that the N>1 case is not a critical issue. The expected gain don’t justify the issues that come with the introduction of such feature and the required specification efforts in our understanding. |
| Intel | Yes | In TS 22.104, there are use cases with survival time requirement larger than 500us, and we think such use cases should be supported. In these use cases, HARQ retransmission can be utilized for reliability, and only supporting “N=1” results in unnecessary resource consumption. |
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< Summary >

5 companies supported to discuss it in this discussion.

8 companies did not agree.

🡪 This issue may be discussed based on company contribution.

## 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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| **Company** | **Option** | **Comment** |
| Samsung | 2 (1 is ok) | Option 2 is a clean approach. (Re-)Starting many RTT timers at the same time is not so necessary.  We think Option 4 is not so useful for the retransmission. It’s still possible that Type-3 HARQ ACK Codebook can be transmitted almost at the end of *DRX-RetransmissionTimer* period (as shown below). Then, Option 4 does not extend the Active Time at all. This is not aligned to the intention of discussion. Considering typically used value range between 10-20slots, this case frequently happens    Option 3 may have another side effect. In the current DRX behaviour, if HARQ RTT Timer is started, running DRX Retransmission Timer is stopped immediately. It means that if gNB wants to send a new data for any other HARQ process, the gNB has to wait until the beginning of the next Active Time by DRX Retransmission Timer. It may further increase the transmission delay.  In short, if companies really want to extend Active Time for the one-shot feedback, Option 2 is a simpler and better solution. |
| Xiaomi | 3 | We think that Option 3 is sufficient, and it follows the legacy UE behaviour of starting the *drx-HARQ-RTT-TimerDL* for each HARQ once the HARQ feedback is transmitted. |
| Nokia | 1 or 3 | It does not seem to be a major issue even if the HARQ-RTT timer does not start in this case. If anything is needed, then we prefer a simpler solution where the HARQ-RTT timers are started only for HARQ processes whose ACK status are reported.  From our perspective, it is more important to ensure that the common mechanism is adopted for both situations described in Q1-1 and Q1-2, in order to reduce the specification complexity. |
| Lenovo/Motorola Mobility | 3 or 4 | Option 3 is similar to the legacy behaviour, whereas Option 4 provides some optimization depending on whether current *drx-HARQ-RTT-TimerDL* nor the *drx-RetransmissionTimerDL* are running. We think that both options would work. |
| CATT | Option 3 | We prefer a unified solution for the three types of one-shot feedback. To align the timers (***drx-HARQ-RTT-TimerDL*** and ***drx-RetransmissionTimerDL***) in gNB side and UE side, start/restart of *drx-HARQ-RTT-TimerDL* for one-shot feedback is necessary.  For option 2, no need to introduce a new parameter. |
| OPPO | 1 or 3 | We understand that DRX is a timer-combined mechanism. Even if the HARQ RTT timer is not started, we can rely on other timers’ running status. Up to NW implementation is sufficient for us. However, if the majority agrees to have something, we prefer Option 3. It is similar to the legacy UE behaviour of starting the *drx-HARQ-RTT-TimerDL* for the corresponding HARQ process whose HARQ feedback is transmitted.  In addition, we share a similar view as Nokia, i.e. consider a common mechanism for the cases described in Q1-1 and Q1-2. |
| Qualcomm | Option 3 | Prefer to extend the legacy behaviour to include One-shot-feedback and not introduce new timers. |
| Apple | Option 2 | We are ok to address scenarios for features of both NR-U and IIoT in the Rel-17 specification.  Option 1: Not to add any changes (i.e., to ignore this case) may lead to a situation where the HARQ retransmission could get postponed to the next DRX ON cycle. Depending on the length of the DRX cycle the added delay can be rather long (40ms, 80ms) or not quite suitable for URLLC.  Option 3 and option 4 both imply to start or restart HARQ RTT timers of multiple HARQ processes in a loop, which contributes to UE processing load. Furthermore, there is a risk for the UE and the gNB to end up with a different understanding of the DRX timer status for some of the involved HARQ processes. For one-shot HARQ-ACK in option 3 the drx-RetransmissionTimerDL should not be stopped as pointed out by Samsung. Option 3 is going to have other side-effects as we discussed earlier in Rel-16 IIoT where companies could not reach consensus. Nevertheless, it seems a bit premature to conclude based on the limited information associated with options 1-4 above. We would not exclude option 4 at this stage.  In our view option 2 is clean and easy. There is not much complexity added and there is no messing around with timers of uninvolved HARQ processes. |
| LGE | Option 4 | All options work, but the question would be which option properly run the RTT timer to minimize unnecessary power consumption while ensuring scheduling opportunity. Relying on other DRX timers to be in active time, i.e., option 1, is least preferred considering the intention of one-shot feedback. |
| Fujitsu | 1 > 3 | Option 1 is similar approach with Rel-16, where this case is not addressed. If some update of MAC spec needed, Option 3 is simple and aligns with legacy timer behaviour. |
| Ericsson | 2 | V24 update:  We understand that ACK status is reported means that a HARQ ACK-NACK for the DL transmission is reported, but not that the (positive) HARQ-ACK is transmitted.  We prefer option 2. The type-3 HARQ-ACK codebook transmission can be triggered with DCI without DL assignment, and this needs to be captured in the spec. The clearest way to capture this is introducing a *drx-HARQ-RTT-TimerDL*dedicated for one-shot feedback.  If companies cannot converge to one solution, we are okay for option 1. It can rely on other DRX timers to be able to reach the UE.  Neither Option 3 nor 4 are acceptable because the UE cannot make any assumption on the gNBs strategy for scheduling a particular UE.  The gNB may send assignments based on the received feedback, or if gNB happens to have very high prio data that is more important than any old data it may send a new assignment. This is regardless of the UE earlier having reported ACK or NACK, or if any drx timer for the corresponding HARQ process is running or not. |
| Intel | 3 | Option 3 is a simpler approach. |
| MediaTek | 3 | We prefer to reuse legacy timers rather than the introduction of new timers |
| Huawei, HiSilicon | 1 (can accept 2) | Agree with Samsung and Ericsson. |
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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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| **Company** | **Option** | **Comment** |
| Samsung | 3 | It’s just a retransmission of HARQ-ACK feedback. The HARQ RTT timer for the same HP can be started. |
| Xiaomi | 3 |  |
| Nokia | 1 or 3 | It does not seem to be a major issue even if the HARQ-RTT timer does not start in this case. If anything is needed, then we prefer a simpler solution where the HARQ-RTT timers are started only for HARQ processes whose ACK status are reported.  From our perspective, it is more important to ensure that the common mechanism is adopted for both situations described in Q1-1 and Q1-2, in order to reduce the specification complexity. |
| Lenovo/Motorola Mobility | 3 |  |
| CATT | 3 | Same as Q1-1 |
| Ericsson | Option 3 | The Type-1/2 codebook is per HARQ process and so the option 3 is okay, since gNB knows which HARQ process it indicates. |
| OPPO | 1 or 3 | Similar response to Q1-1 |
| Qualcomm | Option 3 | Same as last question |
| Apple | Option 3 | In our understanding one-shot HARQ-ACK (Q1-1) and HARQ-ACK retransmission (Q1-2) are different cases where each of them requires a slightly different treatment. For example, the HARQ-ACK retransmission without scheduling a DL transmission may not necessarily link with a non-numerical K1 in an earlier PDCCH.  We would prefer to cover this feature in the MAC specification to support the Rel-17 HARQ-ACK retransmission enhancements including, for example, the case of the next DL transmission (following the HARQ-ACK retransmission) to happen in a timely manner. Option 1 seems not suitable to us.  Option 2 (which uses a timer not linked to any HARQ process) would complicate things and option 4 is not suitable either.  As the HARQ-ACK retransmission is for a dedicated HARQ process option 3 seems straightforward. |
| LGE | Option 3 |  |
| Fujitsu | 1 > 3 | It is aligned with Q1-1. |
| Intel | 3 | Same view as Q1-1. |
| MediaTek | 3 | Same as Q1-1 |
| Huawei, HiSilicon | 1 or 2 | Same preference as for Q1-1 |
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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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| **Company** | **Option** | **Comment** |
| Samsung | 2 and/or 3 | No strong view |
| Xiaomi | 2 or 3 | We are the proponent of Option 2, but are also ok for Option 3. |
| Nokia | 1 | This does not seem to be a major issue since current MAC specifications specify to start the timer “after the end of the corresponding transmission carrying the DL HARQ feedback” which seems to already take the deferral procedure into account (note that the MAC procedure for starting the timer does not refer in any way to the ‘original slot’ for PUCCH transmission indicated via k1 value in DCI) |
| Lenovo/Motorola Mobility | 2 or 3 |  |
| CATT | 2 | Or combine the first part in option3 and last part in option 2:  NOTE X: When the HARQ feedback is subject to SPS HARQ-ACK deferral 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].  Because it is possible that the HARQ feedback can not be transmitted in the end if no available resource can be found in the maximum defer range. |
| Ericsson | Option 2/3 with a clarification when maximum deferral is reached | Since there is already a NOTE 3 for non-numerical k1, it might be better to clarify where the HARQ feedback is transmitted. On the other hand, the NOTE itself is not clear on what if the maximum SPS deferral is reached, i.e., the HARQ ACK-NACK is eventually dropped.  RAN1 agrees that   * The maximum SPS HARQ-ACK deferral value in terms of k1+k1def per SPS configuration is RRC configured from a value range of {1…32}.   The UE checks the validity of a target slot/sub-slot for deferral, one slot/sub-slot by one slot/sub-slot and in a sequential order and after the maximum is reached, the HARQ ACK-NACK is dropped.  Thus, we propose to add the below highlight clarification:  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 or occurs at the maximum deferral slot if the HARQ feedback is dropped.  Note: The term “the corresponding transmission carrying the DL HARQ feedback” has been used since Rel-15 which covers TDD. It is our understanding for Rel-15 that the corresponding transmission may be dropped by PHY layer, but the timer will start. The note above is to clarify that the timer still starts even if the SPS HARQ-ACK is eventually dropped. |
| OPPO | 1 | We share the similar view as Nokia. |
| Qualcomm | 2 | UE might not find the 1st available PUCCH resource for deferral, e.g. due to maximum deferral time being reached, or due to Type 3 HARQ CB request from the network cancelling/stopping the deferral. From the wording of option 2, it seems that not finally transmitting the deferred SPS HARQ can be covered by this option. It seems also that not finally transmitting the deferred SPS HARQ is not covered by option 3. Hence why option 2 is preferred. |
| Apple | 3 | Proponent of option 3. We prefer not to reference TS 38.213 twice. In Ericsson’s extension “if the HARQ feedback is dropped” may be slightly ambiguous because the UE may as well send a HARQ feedback at the very last instance, that is, at the maximum deferral slot itself. There are other HARQ deferral stop conditions as well. So perhaps “at the next available resource” could implicitly cover all cases.  One combination of option 2 and option 3 (as also mentioned by CATT) might be: 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 at the next available resource. |
| LGE | 1 | No strong view but tend to agree with Nokia. The condition to start the *drx-HARQ-RTT-TimerDL* is already clear even without the NOTE. It seems not so necessary to specify SPS HARQ-ACK deferral again in MAC. |
| Fujitsu | 1 > 2 | The current spec is fine, but if some additional NOTE is needed, Option 2 is better than Option 3. The statement in Option 3 “in a later slot” is unclear, but Option 2 is clear with the statement “deferred to the next available resource”. |
| Intel | 1 | Agree with Nokia that current MAC specification is general enough to handle SPS HARQ-ACK deferral. |
| MediaTek | 1 | Agree with Nokia and Intel |
| Huawei, HiSilicon | 1 | Both Notes proposed do not bring further clarification beyond the current spec. |
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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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| **Company** | **Option** | **Comment** |
| Samsung | 1 | In our view, there’s no room for misunderstanding the timing even in PUCCH Cell switching. The current description does not specify anything about PUCCH cell. |
| Xiaomi | 1 | Agree with Samsung. |
| Nokia | 1 | From MAC perspective it does not really matter which carrier conveys the PUCCH, so nothing has to be captured in TS 38.321 |
| Lenovo/Motorola Mobiltiy | 1 |  |
| CATT | 1 | Same understanding as Nokia. |
| Ericsson | 1 | Agree with above |
| OPPO | 1 | Agree with Samsung and Nokia. |
| Qualcomm | 1 |  |
| Apple | 2 | Proponent of option 2 (but ok with option 1 if majority prefers this). |
| LGE | 1 |  |
| Fujitsu | 1 |  |
| Intel | 1 | Agree with Samsung. |
| MediaTek | 1 | Agree with Samsung and Nokia |
| Huawei, HiSilicon | 1 |  |
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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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| **Company** | **Option** | **Comment** |
| Samsung | 1 | We think the TP is simple enough, rather than specifying all conditions agreed in RAN1, e.g. different priority, inter-band CA, etc.. |
| Xiaomi | 1 |  |
| Nokia | 1 | We think the TP from R2-2201368 can be the baseline to clarify this. |
| Lenovo/Motorola Mobility | 1 |  |
| CATT | 1 |  |
| Ericsson | Option 1 | Agree with above |
| OPPO | See comments | We would like to confirm the companies’ understanding of the overlapping between the PUCCH resource for the SR transmission occasion and a UL-SCH resource. (The following is just an example)  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 nor an SL-SCH resource; or  If the overlapping mentioned above means either the PUCCH resource for the SR overlaps with the PUSCH on the same serving cell, or, the PUCCH resource for the SR overlaps with the PUSCH on a different serving cell of the same PUCCH group, we are fine with Option 1. It is because the latter case is aligned with RAN1’s agreement of “Support simultaneous PUCCH/PUSCH transmissions **on different cells**” and we need to have a general/adaptive change of MAC.  However, if companies consider the former case is included only, we understand nothing is needed. |
| Qualcomm | 1 |  |
| LGE | 1 | For clarity, we may refer to the RRC parameter *simultaneousPUCCH-PUSCH-r17* at the end of the proposed sentences:  whose simultaneous transmission with the SR is not allowed by *simultaneousPUCCH-PUSCH-r17*  and its simultaneous transmission with the SR is not allowed by *simultaneousPUCCH-PUSCH-r17* |
| Fujitsu | 1 |  |
| Intel | 1 |  |
| MediaTek | 1 |  |
| Apple | 1 | We are ok to clarify this case in the specification. Agree with LGE that configuration of *simultaneousPUCCH-PUSCH* could be referenced. |
| Huawei, HiSilicon | 1 |  |
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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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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Samsung | No | Considering URLLC transmission, we think highest priority LCH should be prioritized. But no strong view. |
| Xiaomi |  | No strong view. The could be left to the UE implementation. |
| Nokia | No | We do not think this is a critical issue for WI completion. Even if the UL transmission for COT initialization is de-prioritized, we think this is intentional because higher priority data is ought to be transmitted more rapid anyway (this is why LCH-based prioritization is configured in the first place). |
| Lenovo/Motorola Mobility | No | nO strong opinion, however we don’t consider as some critical issue. |
| CATT | No |  |
| Ericsson | No | This problem only occurs when a lower priority data is in the COT initiating transmission and overlaps with a higher priority data that is not initiating the COT. Prioritizing the lower priority data breaks the prioritization feature. Network can configure accordingly, e.g., not to have this overlap.  This case was brought up in RAN1 discussion and agreed that RAN1 does not expect low priority (LP) COT initiating grant to be prioritized over high priority (HP) grant. |
| OPPO | No | It may not be a critical issue. We can leave it to the UE implementation. |
| Qualcomm | No | Agree with Ericsson |
| LGE | No | We can leave it up to NW implementation such that this kind of overlap does not happen. |
| Fujitsu | No | We also think that highest priority LCH should be prioritized. |
| Intel | No | We prefer to follow existing prioritization rule. |
| MediaTek | No | We prefer not to change the existing prioritization rules. |
| Apple | No | In principle the LCH with the highest priority can be prioritized as LCH-based prioritization and cg-RetransmissionTimer can be configured together. On the other hand, whether the UE succeeds channel access in FBE is transparent to prioritization in MAC and there is no RAN2 part for these changes in the WID. We agree with Ericsson and others that prioritizing lower priority over higher priority breaks the intra-UE prioritization feature. |
| Huawei, HiSilicon | No | No UCE related optimization |
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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 Q3-1 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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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Samsung | Yes |  |
| Xiaomi |  | Can be left to the UE implementation. |
| Nokia |  | This depends on if LCH-based prioritization is configured for the MAC entity. If not, then we think this is an UE implementation issue. |
| Ericsson | See comments | Regardless of the previous proposal, if multiple COT initiating UL grants overlap, the prioritization is based on LCH-based prioritization only if it is configured. Otherwise, it is up to the UE implementation. We do not need any specification change for this. |
| OPPO |  | Agree with Nokia and Ericsson |
| Qualcomm |  | No spec change needed, agree with Ericsson |
| LGE |  | Basically, LCP-based prioritization rule can be used (if configured). Otherwise, it can be left up to UE implementation. |
| Fujitsu | Yes | No spec change needed, agree with Ericsson. |
| Intel |  | Our understanding is that there is no additional specification impact. |
| MediaTek |  | Agree with others that there should be no impact to the existing specification. |
| Apple | Yes |  |
| Huawei, HiSilicon |  | No spec impact, existing prioritization rules would apply. |
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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** |
| Samsung | 2 | It’s aligned with RAN2 agreement. Although we have only condition of ST-state entry, this 2-step modelling is useful for future extension. |
| Xiaomi | 1 | We think that Option 1 is clean, as Option 2 would also require extra sentence to activate the PDCP duplication. |
| Nokia | 2 | We prefer Option 2 for the following reasons:   * The terminology of “Survival Time State” is used in RAN2 agreement, the running CR of TS 38.300, and the running CR of TS 38.331 (the parameter “SurvivalTimeStateSupport”). So we prefer to align this. * “activation of PDCP duplication” is a bit vague because duplication may already be activated before receiving this PDCCH (e.g. 2 out of 4 RLC entities are already activated) |
| Lenovo/Motorola Mobility | 2 | Agree with Nokia |
| CATT | 2 | Same arguments as Nokia. We are fine with the current MAC model in the running CR. |
| Ericsson | Option 1 | We do not prefer adding new terminology in the MAC spec and prefer to leave this feature more generally applicable for use cases beyond survival time. One example is URLLC/IIoT, it does not appear in MAC or RRC spec. It would be okay though to mention in the stage-2 specs.  Not sure about the arguments on future extension. It does not seem easy to extend the activation of survival time state by another mechanism, as it is fixed to the retransmission grant as in option 2.  Not sure either on the wording. PDCP duplication activation perhaps means more generally as the activation of PDCP duplication and, if already activated, for the indicated secondary RLC entity(ies). |
| OPPO | 2 | Option 2 is more aligned with the RAN2 agreement. Also, as indicated by Nokia, the terminology of “Survival Time State” is already used in the running CR of TS 38.300, it would be better to keep the alignment among specs. |
| Qualcomm | 1 | Prefer 1 for simplicity and because its more straightforward since PDCP duplication activation already has a precise meaning in the spec. If we go with option 2, we have to make sure that “survival time state” is precisely defined in MAC and RRC spec to make them self-contained. |
| LGE | 1 | Currently, we discussed only PDCP duplication activation when entering to Survival Time. Even if there can be other new mechanism for Survival Time in the future, it may not be exactly same as PDCP duplication, i.e., based on UL grant and per DRB. Thus, we don’t think option 2 is needed for now.  For step 1 in S5.4.1, instead of trigger, it would be more aligned to say "indicate the activation of PDCP duplication of the DRB to upper layers" and the HARQ buffer should be for the corresponding HARQ process.  3> if a logical channel associated with a DRB configured with *survivalTimeStateSupport* is multiplexed in the MAC PDU stored in the HARQ buffer for the corresponding HARQ process:  4> indicate activation of PDCP duplication for the DRB. |
| Fujitsu | 2 | It is better to introduce the wording STS. From MAC perspective, it is true that PDCP duplication activation is the behaviour during STS. On the other hand, there may be other means e.g. power boosting, PUSCH repetition in time domain. STS is good wording to generalization of PUSCH boosting to meet the survival time. |
| Intel | 1 | Option 1 is simpler. We can combine the change from clause 5.10 to clause 5.4.1 as below:  3> if a logical channel associated with a DRB configured with *survivalTimeStateSupport* is multiplexed in the MAC PDU stored in the HARQ buffer:  4> indicate the activation of PDCP duplication for all configured RLC entities of the DRB to upper layers.  Future extensibility can be anyway discussed when such extension is needed. |
| MediaTek | 1 | It is simpler to specify trigger and action. We see no reason to introduce a new state in the MAC spec given that there is only one trigger and one action. |
| Apple | 2 | To reference ‘entry to Survival Time State’ is more aligned with the general concept of the ST enhancement including the RAN2 agreements and other CRs, PDCP duplication is just a specific part of it. |
| Huawei, HiSilicon | 2 | Agree with Nokia. It is good for further work based on a Survival Time framework. |
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# 5 Conclusion