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

Elbonia, 21 February – 03 March 2022

**Agenda item: 8.5.4**

**Source: Nokia, Nokia Shanghai Bell**

**Title: [DRAFT] Summary of [AT117-e][504][IIoT] QoS Additional Open Issues (Nokia)**

**WID/SID:** **NR\_IIOT\_URLLC\_enh – Release 17**

**Document for: Discussion and Decision**

# 1 Introduction

This document is the report of the following email discussion:

* [AT117-e][504][IIoT] QoS additional open issues (Nokia)

 Remaining Tsynch open issues

Deadline: Proposals by rapporteur by Friday (intermediary deadlines for comments to be set by rapporteur)

In Rel-17 RAN2 has agreed to introduce a mechanism to support the new QoS requirement of survival time for uplink periodic traffic. Specifically, when the UE receives a retransmission grant relating to a configured grant associating to a LCH of DRB with survival time requirement, all the RLC entities configured for that DRB should be activated for duplication of subsequent packet(s), in a bid to prevent consecutive error that would eventually result in survival time violation. Although this scheme should work in principle and could be considered completed for Rel-17 (apart from Stage-3 details), some companies think some further enhancement to the feature is needed. Since these further enhancements are not considered as critical issues for WI completion in either UP or CP email discussions of open issues ([16] and [17]) they can be treated via company contributions. This document aims to summarize and resolve the remaining issues identified by the submitted papers. **The companies should provide their comments before 1200 UTC on Friday 25/Feb.**

Based on the review conducted by the rapporteur on the papers submitted to the Agenda Item 8.5.4 for RAN2 #117e ([1]-[15]), the identified issues are classified into either **Category-A** or **Category-B**, as enumerated below.

**Category-A: The issues that are either highlighted by more companies, or has direct impacts to Stage-3 implementation**

1. Whether survival time state could be triggered with N>1 consecutive retransmission grants,
2. Whether survival time state entry/exiting can be controlled by a timer, and
3. Whether retransmission grant addressed to C-RNTI can trigger survival time state (i.e. if survival time can be supported by dynamic grants).

**Category-B**: **The issues that receive relatively less attentions (mentioned by only one or two companies) and is proposed mainly for optimization**

1. Whether RAN2 should consider survival time support during the measurement gaps,
2. Whether adaptive L1/L2 configuration should be considered on top on PDCP duplication,
3. Whether prioritization mechanisms can be adapted to support timely transmission for survival time,
4. How survival time is supported in unlicensed band operation,
5. How to avoid unnecessary PUSCH retransmission, and
6. Coordination with RAN3 for DC-based duplication

This email discussion will specifically ask companies to provide their views on the issues in **Category-A**. For the issues in **Category-B**, companies may only respond if they see a critical need to address.

Moreover, this email discussion will also cover some of the U-Plane open issues that have been raised during the online session for the NR IIoT/URLLC WI in Week 1, including UE behaviour on *drx-HARQ-RTT-timerDL* in cases of HARQ codebook retransmission and SPS HARQ feedback dropping.

# 2 Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

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| --- | --- | --- |
| Company | Name | Email Address |
| Nokia (Rapporteur) | Ping-Heng Wallace Kuo | Ping-Heng.Kuo@nokia.com |
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# 3 Discussions for Category-A Issues

## 3.1 Survival Time State Triggering with N>1 NACK

According to RAN2 #116bis-e agreements, it is confirmed that RAN2 will support survival time state entry upon reception of N=1 retransmission grant. However, there is an FFS on whether the value of N can be (configured to be) greater than 1:

We will support the case where N=1. FFS if cases with N>1 are supported

 In that case, when PDCP duplication is already activated in dual connectivity, in order to minimize dependencies between MAC entities in a configuration with survival time the UE enters Survival Time upon reception of one HARQ NACK at either MCG or SCG.

 Within a MAC entity, the determination of HARQ-NACKs does not incur interaction between different CCs. When PDCP duplication is already activated in CA duplication for a configuration of survival time, the UE enters Survival Time upon reception of one HARQ NACK at any CC.

During the email discussion on UP open issues [16], 9 out 14 companies did not agree this is a critical issue, and hence this is to be discussed based on company Tdocs. A host of companies have expressed the views on this issue in their papers, and the following two camps are identified:

* **Survival Time State can be configured to be triggered with N>1 consecutive retransmission grants:**
	+ R2-2202523 (Apple) [5]
	+ R2-2202751 (ZTE, Sanechips, China Southern Power Grid Co., Ltd, TCL Communication Ltd., vivo) [8]
	+ R2-2203125 (Xiaomi) [12]
	+ R2-2203144 (Samsung) [13]
* **Survival Time State is only triggered with N=1 consecutive retransmission grants (or N>1 should be deprioritized):**
	+ R2-2202283 (Fujitsu) [1]
	+ R2-2202438 (OPPO) [3]
	+ R2-2202709 (Huawei, HiSilicon) [6]
	+ R2-2202726 (CMCC) [7]
	+ R2-2202785 (CATT) [9]
	+ R2-2203198 (Nokia, NSB) [14]

In general, the companies supporting N>1 think “early entry” to survival time state is very inefficient it may be triggered too frequently and unnecessarily, especially for the use cases where the transfer interval is particularly large (e.g. up to 60 seconds) or the use cases with relatively relaxed survival time requirement, which leaves some time for two (or more) transmission before survival time triggering that could be successful. On the other hand, the companies, that do not support N>1 think this is not necessary to further complicate the agreed scheme to optimize only a few use cases especially the WI is approaching the end, and N=1 is anyway sufficient to accommodate all use cases in terms of meeting survival time requirement even if there could be some resource efficiency degradation. Besides, resource efficiency optimization is not included as the objective of this WI, and such use cases could be handled by gNB implementation rather than relying on the adopted survival time mechanism. In this email discussion, we will first check if majority of companies intend to support “N>1” cases in Rel-17.

**Question 1: Do you agree that RAN2 should further pursue survival time state triggering with N>1 retransmission grants in Rel-17 (i.e. the NW can further configure the value of N per DRB) ?**

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| Answers to Question 1 |
| Company | Yes/No | Technical Arguments |
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According to the agreement in RAN2 #116bis-e, it is apparent that RAN2 considers the cases where PDCP duplication is already activated in either CA or DC configurations before survival time state entry (i.e. at least two RLC entities are already activated for the DRB). If N>1 is supported, then it is unclear how the value of N is defined in this case. On one hand, the value of N could be the number of consecutive retransmission grants received for one of the already-activated LCH. On the other hand, the value of N could be the sum of the number of consecutive retransmission grants received for all of the already-activated LCHs. The rapporteur thinks this should be clarified if RAN2 intends to support N>1 cases.

**Question 1a: If your answer to Q1 is YES, how is the value of N defined for cases where duplication is already activated before survival time state entry ?**

* **Option 1: The value of N is defined as the number of consecutive retransmission grants received for one of the already-activated LCHs for the DRB.**
* **Option 2: The value of N is defined as the total number of consecutive retransmission grants received across all already-activated LCHs for the DRB.**
* **Option 3: Other (Please explain)**

**Note: If possible, please also suggest the value range of N.**

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| Answers to Question 1a |
| Company | Option | Technical Arguments (with value range of N) |
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Additionally, R2-2202438 (OPPO) [3] has proposed a timer catering to cases where survival time state triggering N>1 HARQ NACK is supported. Specifically, the proposed timer assists the UE to determine when it should reset the number of HARQ NACK counting. However, it is worth highlighting that R2-2202438 (OPPO) [3] has also proposed that “N>1” cases should be de-prioritized in Rel-17.

**Question 1b: if RAN2 decides to support “N>1”, do you agree to introduce a timer that assists the UE to determine when to reset the number of HARQ NACK counting?**

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| Answers to Question 1 |
| Company | Yes/No | Technical Arguments |
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## 3.2 Timer-Controlled Survival Time State Entry/Exiting

In addition to the reception of a retransmission grant, quite a few companies are interested in the concept of controlling survival time state entry or exiting based on a timer. In particular, the timer is said to be useful for the cases where the UE fails to receive the retransmission grant from the gNB and hence cannot enter the survival time state when it is needed. These papers are summarized below:

* **R2-2202751 (ZTE, Sanechips, China Southern Power Grid Co., Ltd, TCL Communication Ltd., vivo) [8]**
	+ In this paper, it is proposed that a timer should start when a PDCP PDU is submitted to the lower layer, or when a new packet arrives from the upper layer. The timer should be stopped when N retransmission grant is received when it is running, and the DRB should enter the survival time state. The DRB should also enter the survival time state when the timer is expired regardless if N retransmission grants have been received. The detailed proposel from [8] is:

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| **Proposal 2: To introduce a combined Tx-side timer for the HARQ-NACK-based option. The following details can be further discussed and agreed:*** **The Tx-side timer could be configurable by the network if a scenario requires it.**
* **The Tx-side timer is configured with length equal or less than AN PDB.**
* **The Tx-side timer is started when a PDCP PDU is delivered to lower layer or upon being received from the upper layer.**
* **When the Tx-side timer is running:**
	+ **If a new transmission grant is received, the Tx-side timer should be stopped.**
	+ **If N retransmission grants or explicit HARQ-NACKs have been received, UE should trigger ST state. And the Tx-side timer should be stopped.**
	+ **In unlicensed spectrum case, if HARQ-ACK is received, the Tx-side timer should also be stopped.**
* **When the Tx-side timer expires:**
	+ **If a retransmission grant is received after expiration of timer, MAC entity in UE would trigger ST state, regardless of whether the counting on retransmission grants reaches the threshold N (or even no any retransmission grant has been received during timer is running). Otherwise, UE doesn’t trigger ST state.**
	+ **In unlicensed spectrum case, UE should trigger ST state.**
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* **R2-2202523 (Apple) [5]**
	+ A mechanism similar to [8] has been proposed (i.e. Survival Time State entry upon timer expiration). Moreover, it also considers an “exiting timer” which allows the UE to leave the survival time state upon timer expiration. In particular, the timer value can be set to take “Application Recovery Time” into account.
* **R2-2203144 (Samsung) [13]**
	+ This paper mentioned that there could be issues of delayed indication to PDCP if N>1 is adopted, and hence survival time state entry based on the timer can be complementary. On the other hand, akin to R2-2202523, it also supports autonomous survival time state exiting based on a timer.
* **R2-2203460 (InterDigital) [15]**
	+ This paper suggests that the UE (re)starts a timer whenever a confirmation of successful transmission is received, and the UE should enter the survival time state when the timer expires. However, the paper has explicitly indicated that its preference is to exit survival time state based on network control signaling.

For exiting from survival time state, it is mentioned in R2-2203198 (Nokia, NSB) [14] that leaving from survival time state is basically equivalent to changing duplication pattern of the DRB, and currently it is entirely possible for gNB to dynamically control the duplication state using Rel-16 MAC CE. Thus, when the DRB should leave survival time state is an implementation issue and no specification enhancement is needed. Other than these, not many companies have expressed their views on whether the timer-controlled survival time state entry/exit should be supported in Rel-17. Hence, the rapporteur think it is worth checking with RAN2 whether the companies think it is beneficial to have a TX-side timer for survival time state entry in addition to HARQ NACK, as well as if a UE can leave survival time state autonomously based on a timer status or we can simply rely on network signalling. Furthermore, some details about the timer operations (if to be supported) should be clarified.

**Question 2: Do you agree that RAN2 should further pursue timer-controlled survival time state entry/exit in Rel-17 (i.e. the DRB enters or leaves the survival time state upon expiration of the corresponding timer(s))?**

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| Answers to Question 2 |
| Company | Yes/No | Technical Arguments |
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**Question 2a: If your answer to Question 2 is NO, do you think any specification change is needed to define exiting condition of survival time state? (It is based on gNB implementation if no specification change is foreseen)**

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| Answers to Question 2a |
| Company | Yes/No | Technical Arguments |
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**Question 2b: If your answer to Question 2 is YES, which option do you prefer:**

* **Option 1: Both survival time state entry and survival time state exiting can be controlled by timer(s).**
* **Option 2: Only survival time state entry can be controlled by a timer, as survival time state exiting can be controlled by the gNB.**
* **Option 3: Other (Please explain)**

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| Answers to Question 2b |
| Company | Option | Technical Arguments |
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**Question 2c: If your answer to Question 2 is YES, what should be the condition(s) for the survival time entry state timer to start/restart ?**

* **Option 1: The timer start/restart when the DRB is outside the survival time state and a new packet arrives at the upper layer**
* **Option 2: The timer start/restart when the DRB is outside the survival time state and a packet is submitted to the lower layer**
* **Option 3: The timer start/restart when the DRB is outside the survival time state and confirmation(s) of successful transmission is received.**
* **Option 4: The timer start/restart when the DRB is outside the survival time state and at least one retransmission grant for the data from this DRB is received.**
* **Option 5: Others (please explain)**

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| Answers to Question 2c |
| Company | Option | Technical Arguments |
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**Question 2d: If your answer to Question 2 is YES and you have selected Option 1 for Question 2b, what should be the condition(s) for survival time state exiting timer to start/restart ?**

* **Option 1: The timer start/restart when the DRB is in the survival time state and a new packet arrives at the upper layer**
* **Option 2: The timer start/restart when the DRB is in the survival time state and a packet is submitted to the lower layer**
* **Option 3: The timer start/restart when the DRB is in the survival time state and confirmation(s) of successful transmission is received.**
* **Option 4: The timer start/restart when the DRB is in the survival time state and at least one retransmission grant for the data from this DRB is received.**
* **Option 5: Other (Please explain)**

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| Answers to Question 2d |
| Company | Option | Technical Arguments |
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## 3.3 Survival Time State Entry based on Retransmission Grant addressed to C-RNTI

The baseline mechanism for the agreed survival time feature essentially assumes the related services are dedicated to configured grant resources, and therefore retransmission grant addressed to CS-RNTI can be used as the trigger for survival time state entry. It is still unclear whether the agreed survival time scheme can be supported using dynamic grant, i.e. if a retransmission grant addressed to C-RNTI can be used as the trigger. R2-2202709 (Huawei, HiSilicon) [6] has argued that this should not be allowed as it is more difficult for the network to know what LCHs are mapped to a dynamic grant, as the existing LCP restrictions may not be sufficient. Conversely, R2-2203144 (Samsung) [13] claims that there is no need to intentionally restrict the usage of dynamic grants for survival time support. Although this issue has been mentioned by two companies only, the rapporteur tends to think this is important to clarify as it may directly impact how Stage-3 specification is implemented for WI completion. Therefore, companies in RAN2 are asked to provide their views on the following question.

**Question 3: Do you agree that retransmission grant addressed to C-RNTI can be used to trigger survival time state entry (i.e. if data from a DRB configured with survival time state support can be transmitted on dynamic grants)?**

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| Answers to Question 3 |
| Company | Yes/No | Technical Arguments |
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# 4 Discussions for Category-B Issues

Based on the review of all submitted papers, the rapporteur has identified the following issues that seem to be more optimization-oriented, and have been raised by only one or two companies in their papers.

* **Issue 1: Survival Time State Triggering in Measurement Gaps**

Both R2-2202284 (Fujitsu) [2] and R2-2202445 (Lenovo, Motorola Mobility) [4] have highlighted a potential problem where the survival time state is triggered but the PUSCH for the next message overlaps with a measurement gap, and hence it cannot be delivered in a timely manner to fulfil survival time requirement. From the rapporteur perspective, the mentioned issues of measurement gap could be applicable to URLLC/IIoT use cases in general (not only for survival time), but none of the enhancement introduced in Rel-15 or Rel-16 has targeted to tackle measurement gaps. Thus, it is questionable why RAN2 should specifically consider such issue for survival time in Rel-17.

* **Issue 2: Adaptive L1/L2 Configuration**

It has been suggested by R2-2202523 (Apple) [5] that adaptive L1/L2 configuration can be added as an optional approach to support survival time, in addition to PDCP duplication. Meanwhile, R2-2202709 (Huawei, HiSilicon) [6] has expressed its opposition to consider adaptive L1/L2 configurations in Rel-17. Although the rapporteur generally agrees that PDCP duplication is not the only way to boost the required reliability target, and L1/L2 adaptation may also be applied to reach the same goal, ultimately it is up to gNB implementation how the target is met. Therefore, it is probably not worthwhile for RAN2 to further pursue specification change catering to adaptive L1/L2 configurations at this late stage.

* **Issue 3: Adaptive Prioritization**

R2-2202284 (Fujitsu) [2] has proposed that LCH priority can be re-assigned in survival time state to make sure the urgent transmission is not de-prioritized. Similarly, R2-2202834 (III) [10] think the L1 grant prioritization mechanism may need to be revisited to make sure survival time support can be fulfilled. The rapporteur thinks all these may be some forms of L1/L2 adaptation, and therefore akin to Issue 2, it does not seem to be a critical issue that should be pursued.

* **Issue 4: Unlicensed Band Operation**

RAN2 has previously agreed that optimization for survival time is not needed for unlicensed band operation, but there is also an FFS relating to how the baseline scheme based on retransmission grant can work in unlicensed band. R2-2202438 (OPPO) [3] has suggested that the survival time state can be explicitly triggered by DFI-NACK or implicitly triggered by expiration of configured grant retransmission timer. On the other hand, R2-2203198 (Nokia, NSB) [14] has mentioned that survival time can be anyway supported by gNB implementation in unlicensed band even though it may be less efficient. R2-2202709 (Huawei, HiSilicon)[6] also prefers not to consider survival time support in unlicensed band.

* **Issue 5: Avoidance of Unnecessary PUSCH retransmission**

Previously RAN2 has discussed briefly about how to avoid unnecessary retransmission that is caused by retransmission grant solely as a survival time state trigger. For this issue, R2-2202445 (Lenovo, Motorola Mobility) [4] has suggested that some explicit indication in the retransmission grant DCI can be added, such that the UE knows if a PUSCH retransmission can be skipped. From the rapporteur point of view, such proposal may involve RAN1 and it is not desirable to bring huge impacts to HARQ framework at this late stage of the WI.

* **Issue 6: LS to RAN3 for DC-based PDCP duplication**

The survival time mechanism introduced in Rel-17 is based on PDCP duplication. When it is applied in DC-based duplication, R2-2202895 (vivo) [11] observes that one of the associated network nodes may not have sufficient information about survival time triggering by another node, and therefore it cannot guarantee the resource availability. Hence, it is suggested to send a LS to RAN3 for potential enhancement in the network interfaces. Nonetheless, it is the rapporteur’s understanding that resource provisioning is not a problem as long as survival time state support is based on configured grant. Besides, in fact RAN3 is already working on potential message exchange between MN and SN for survival time support, there is no need to further complicate their scope at this late stage.

The rapporteur would like to check if any company sees the critical need to address any of the Category-B issues listed above. If so, the company should indicate the issue they want to address in Rel-17 and provide technical argument.

**Question 4: Which of the Category-B issues listed above (1-6) should be addressed for Rel-17 WI completion ? Please provide technical arguments to justify your selection. (You can simply indicate “none” if you think none of these issues should be further pursued in Rel-17)**

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| Answers to Question 4 |
| Company | Issue(s) out of the list 1-6 that should be addressed | Technical Arguments |
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Finally, the rapporteur would like to see if there is any other issue (not listed above) that any company would like to address for Rel-17 WI completion.

**Question 5: Is there any other issue that should be addressed for the New QoS objective to complete this Rel-17 WI ? Please provide your technical argument for the issue(s) you would like to raise.**

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| Answers to Question 5 |
| Company | Issue | Description & Why it should be addressed in Rel-17 |
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# 5 Additional U-Plane Open Issues

## 5.1 HARQ CB retransmission without latest copy of HARQ Process

During the online session in Week 1, the following agreement has been reached in RAN2:

Upon One-shot HARQ-ACK retransmission request, UE starts drx-HARQ-RTT-TimerDL for the HARQ process(es) whose ACK/NACK status is reported.

For this agreement, Qualcomm has proposed to add the following FFS:

* **FFS: UE behavior if the retransmitted HARQ CB does not contain the latest copy of a HARQ Process.**

The reasoning for such proposal is that, there is ambiguity with regards to *drx-HARQ-RTT-timerDL* starting when the UE transmits a copy of the cancelled HARQ CB and some new data occupy some of the HARQ processes of the cancelled HARQ CB, since the initial content of the HARQ CB that is finally transmitted is modified and there would not be any further action from gNB that should affect the DRX timers.

**Question 6: Do you agree RAN2 should further discuss the UE behaviour for cases where the retransmitted HARQ CB does not contain the latest copy of a HARQ process ?**

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| Answers to Question 6 |
| Company | Yes/No | Technical Arguments |
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## 5.2 UE Behaviour for SPS HARQ-ACK Dropping

During the online session in Week 1, the following agreement has been reached in RAN2:

RAN2 to confirm that the current MAC specification already captures the behaviour upon SPS HARQ-ACK deferral. FFS whether to capture a NOTE for clarification, similar to non-numerical k1.

According to TS 38.321, the UE should start the *drx-HARQ-RTT-TimerDL* timer immediately after the HARQ feedback is transmitted:

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| When DRX is configured, the MAC entity shall:1> if a MAC PDU is received in a configured downlink assignment:2> 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;2> stop the *drx-RetransmissionTimerDL* for the corresponding HARQ process.…… |

However, Ericsson has raised a question about how the UE should behave when the HARQ feedback for SPS could not be transmitted, due to collision with a DL slot in TDD. Note that RAN1 has introduced SPS HARQ feedback deferral in Rel-17, which allows the UE to defer HARQ feedback to the next available UL slot if such collision occurs. However, the HARQ feedback may still be dropped if the time interval of deferral has reached the pre-configured maximum allowed value. In such cases, it is not clear if the UE should still start the *drx-HARQ-RTT-TimerDL* timer if the corrsponding SPS HARQ feedback is dropped. Hence, RAN2 is asked to clarify the intended UE behavior, which should be aligned with Rel-15 baseline.

 **Question 7: To clarify the intended UE behaviour on the *drx-HARQ-RTT-TimerDL* timer when the SPS HARQ feedback is dropped,** **which option do you prefer?**

* **Option 1: The UE does not start the *drx-HARQ-RTT-TimerDL* timer if the HARQ feedback is dropped**
* **Option 2: The UE still starts the *drx-HARQ-RTT-TimerDL* timer after the HARQ feedback is dropped**
* **Option 3: Others (Please explain)**

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| Answers to Question 7 |
| Company | Option  | Technical Arguments |
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# 6 Conclusion

TBC

# 7 References

[1] R2-2202283, Analysis on N>1, Fujitsu

[2] R2-2202284, Survival Time Mode and Measurement Gap, Fujitsu

[3] R2-2202438, Remaining issues on survival time, OPPO

[4] R2-2202445, Remaining issues on the support of survival time, Lenovo, Motorola Mobility

[5] R2-2202523, Remaining issues on RAN enhancements for new QoS, Apple

[6] R2-2202709, Discussion about UE behaviours for Survival Time state operation, Huawei, HiSilicon

[7] R2-2202726, Remaining Issues on QoS enhancement, CMCC

[8] R2-2202751, N and combined Tx-side timer for IIoT QoS, ZTE, Sanechips, China Southern Power Grid Co., Ltd, TCL Communication Ltd., vivo

[9] R2-2202785, On the support of N>1 for Survival Time solution, CATT

[10] R2-2202834, Additional aspects on resource in Survival Time, III

[11] R2-2202895, Discussion on Radio Resource for the duplicated legs in ST, vivo

[12] R2-2203125, Remaining issues of survival time requirements, Xiaomi Communications

[13] R2-2203144, Finalising Survival Time related enhancements, Samsung Electronics GmbH

[14] R2-2203198, On Closure of Survival Time Objective, Nokia, Nokia Shanghai Bell

[15] R2-2203460, Remaining issues on the support of survival time, InterDigital

[16] R2-2202686, Report of [POST116bis-e][512][IIoT] UP open issue, Samsung

[17] R2-2203302, Summary of [POST116bis-e][513][IIoT] CP open issues (Ericsson), Ericsson