3GPP TSG-RAN WG2 Meeting #115 Electronic R2-21xxxxx

Elbonia, 9 – 27 August 2021

**Agenda item: x.x.x**

**Source: Nokia (Rapporteur)**

**Title: (DRAFT)[Post114-e][509][URLLC/IIoT] Running Stage 2 CR review (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:

* [Post114-e][509][URLLC/IIoT] Running Stage 2 CR review (Nokia)

**Scope:** Review running stage 2 CR

**Intended outcome:** CR ready to be endorsed in RAN2115-e

**Deadline**: Long

# 2 Contact Points

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

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# 3 Discussions

## 3.1 URLLC in Unlicensed Controlled Environment

For URLLC in unlicensed band, RAN2 has reached the following agreements so far:

* **RAN2 #112e:**

**Agreements:**

**From RAN2 perspective**

1 It is assumed that LBT failures only happen infrequently in UCE (unlicensed controlled environment). A formal definition of UCE and its relationship to semi-static or dynamic access mode is not necessary in RAN2 specifications.

2 cg-RetransmissionTimer can be configured optionally for shared spectrum

3 When cg-RetransmissionTimer is configured, Rel-16 NR-U mechanism is used for HARQ process ID and RV selection.

4 When cg-RetransmissionTimer is not configured, Rel-16 URLLC mechanism may be used for HARQ process ID and RV selection.

5 As a baseline, HARQ processes sharing between multiple CGs are allowed when cg-RetransmissionTimer is configured as in Rel-16 NR-U.

6 HARQ processes sharing between multiple CGs are not allowed when cg-RetransmissionTimer is not configured.

7 FFS if LCH based prioritization can be configured with *cg-RetransmissionTimer*

8 The assumption for Rel-16 is that the network will not configure *autonomousTx and cg-RetransmissionTimer* simultaneously per cell. No optimizations will be pursued to allow the two features be configured together in Rel-16. No CR is needed for this for now.

9 If a configured grant is deprioritized and/or gNB didn’t get it (e.g. LBT failure and/or tx failure) then we should be able to autonomously re-transmit it. FFS how to achieve it (using existing mechanisms should be considered as baseline)

* **RAN2 #113e:**

**Agreements:**

1. LCH based prioritization and cg-RetransmissionTimer can be configured together in Rel-17 (consensus)
2. Option 1: AutoTx and CGRT are responsible for deprioritized MAC PDU and LBT-failed MAC PDU, respectively. If CGRT is not configured, LBT-failed MAC PDU is not retransmitted. If AutoTx is not configured, deprioritized MAC PDU is not retransmitted.
3. the MAC entity stops cg-RetransmissionTimer when the CG resource associated with the timer is deprioritized due to LCH-based prioritization.
4. FFS With cg-RetransmissionTimer and LCH-based prioritization configured, the MAC entity can prioritize between initial transmissions and retransmissions on a CG based on priority of multiplexed LCH(s) -or to be multiplexed
5. LBT failure is not considered when determining a grant priority for intra-UE prioritization (17/22)
6. Configuring a subset of HARQ processes as “restricted processes” for transmission of data from higher priority LCHs is not supported (18/22)
7. Enhancements for handling conflicting DG-CG transmissions of the same HARQ process are not supported (18/22)

* **RAN2 #114e:**

Agreements:

1. When both of lch-based Prioritization and cg-RetransmissionTimer are configured, HARQ processes sharing between multiple CG configurations are allowed. No specification change is required.
2. RAN2 confirm that neither autonomous transmission nor autonomous retransmission is triggered if UL grant is prioritized and LBT fails while AutonomousTx is configured and cg-RetransmissionTimer is not configured. No specification change is required.
3. RAN2 confirm that autonomous retransmission is triggered if UL grant is prioritized and LBT fails while AutonomousTx is not configured and cg-RetransmissionTimer is configured. No specification change is required
4. RAN2 confirm that autonomous retransmission is triggered if UL grant is prioritized and LBT fails while AutonomousTx and cg-RetransmissionTimer are configured. No specification change is required.
5. RAN2 confirm that autonomous transmission is triggered if UL grant is deprioritized while AutonomousTx is configured and cg-RetransmissionTimer is not configured. No specification change is required.
6. RAN2 confirm that autonomous transmission is triggered if the transmission of the obtained MAC PDU has not been completely performed and if UL grant is deprioritized while AutonomousTx and cg-RetransmissionTimer are configured. No specification change is required.
7. The HARQ process is kept as pending even if a CG is de-prioritized while the HARQ state of the associated HARQ process is pending (i.e. MAC PDU hasn’t been transmitted). No specification change is required

8. When cg-RetransmissionTimer and lch-basedPrioritization are configured, for overlapping CGs, the MAC entity prioritizes the initial transmission of higher priority data over autonomous retransmission of lower priority data. FFS how to implement this in Rel-17 after some of the Rel-16 discussion takes place

To illustrate the key agreements made in RAN2 while keeping the Stage-2 description at a high-level, the rapporteur tends to think the following text proposal can be added to TS 38.300:

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| --- |
| 16.1.X URLLC in Unlicensed Controlled Environment URLLC can be supported in unlicensed controlled environment (UCE) where LBT failure is assumed to be infrequent. In such cases NR-Unlicensed features including autonomous retransmission may be optionally configured. Autonomous transmission can be configured to address MAC PDU de-prioritization having occurred in configured grants, while configured grant retransmission timer can be configured to handle pending MAC PDU resulting from LBT failure in configured grants. The features of LCH-based prioritization and configured grant retransmission timer may co-exist. |

**Question 1**: Do you agree that the text proposal above can be included in TS 38.300 running CR to capture the status of URLLC in Unlicensed Controlled Environment ?

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| --- | --- | --- |
| Answers to Question 1 | | |
| Company | Yes/No | Comments (e.g. suggestions of re-wording) |
| Ericsson | Yes/No | Agree to have a session related with NR-U under URLLC specific clauses (i.e., clause 16). But we have a couple of wording suggestions:   1. The wording “shared spectrum” has been used throughout the stage 2 spec instead of “unlicensed”. It is better to use “shared spectrum”. 2. “Infrequent” is not very precise. It is better to use “negligible”. 3. The last sentence is redundant, compared to the sentence before. |
| Huawei, HiSilicon | Yes with comments | We understand that the sentence “In such cases NR-Unlicensed features including autonomous retransmission may be optionally configured” is based on agreement 2 in RAN2#112e, however “NR-Unlicensed features including autonomous retransmission” might be “over-generalized” from feature “cg-RetransmissionTimer”. “In such cases” can be changed into “in such case” as there are no multiple cases described. |
| Intel | Yes |  |
| OPPO | Yes with comments | We suggest to use “NR-Unlicensed features including cg-RetransmissionTimer” instead of “NR-Unlicensed features including autonomous retransmission”, to clear reflect our agreement. |
| Samsung | Yes with comments | - Except for texts on capability, 38.300 has not used “feature”. So, it would be better not to use it but indicate the exact function/feature directly if possible.  < Suggestion 1 >  ~~The features of~~ LCH-based prioritization and configured grant retransmission timer may co-exist.  - “Autonomous Retransmission” is not used anywhere in the spec, so we prefer a common terminology “configured grant retransmission timer”  < Suggestion 2 >  In such cases ~~NR-Unlicensed features including autonomous retransmission~~ configured grant retransmission timer may be optionally configured  - The last sentence is generally ok and the previous sentence is not needed as *autonomousTx* is a sub-feature of LCH-based prioritization.  < Suggestion 3 >  “Autonomous transmission can be configured to address MAC PDU de-prioritization having occurred in configured grants, while configured grant retransmission timer can be configured to handle pending MAC PDU resulting from LBT failure in configured grants.” can be removed. |
| Futurewei | Yes with comments | 1. Agree to using cg-RetransmissionTimer, instead of autonomous retransmission. 2. Agree to removing “The features of”. In addition, the word “co-exist” is not precise, because the scope of the co-existence is unclear (e.g., whether within a cell or on a same UE). Suggest that we use the same language as in the RAN2 agreement, i.e., be configured together (on a UE). |
| CATT | Yes with comments | We agree with Ericsson’s points 1 & 3.  We agree with Huawei that “such cases” -> “such case”.  We agree with Samsung’s suggestion 2 but disagree with Samsung’s suggestion 3 to remove the sentence “Autonomous transmission can be configured …”. Instead, considering that the NR-U autonomous retransmission is mentioned in 38.300 in Clause 5.3.5.4 as “*For operation with shared spectrum channel access, UE can also retransmit on configured grants*” we would rather clarify it as follows:  “Autonomous transmission can be configured to address MAC PDU de-prioritization having occurred in configured grants, while configured grant retransmission timer can be configured to allow UE retransmitting on a configured grant a ~~handle~~ pending MAC PDU resulting from LBT failure or failed transmission in a configured grant~~s~~”. |
| III | Yes |  |
| Qualcomm | See comments | Agree on the general structure of adding a UCE related (sub)-section to the URLLC clause. We have some suggestions for wording modifications:   1. Change “URLLC” to “URLLC services” to be consistent with the clause overview language. 2. Change “where LBT failure is assumed to be infrequent” to “where LBT failure is assumed to be not frequent”. We have not used the words “infrequent” or “negligible” in the spec, thus, it is prefereable to reuse the spec wording “frequent” in making the point of LBT failures. 3. Change “In such cases” to “For this scenario” for a more precise statement. 4. “Autonomous transmission” is not defined in TS 38.300, it is better to add reference the appropriate clause in TS 38.321 to refer to the proper definition and operation of Autonomous Transmission. 5. Change “Autonomous transmission can be configured to address MAC PDU de-prioritization having occurred in configured grants, while configured grant retransmission timer can be configured to handle pending MAC PDU resulting from LBT failure in configured grants.” To “Autonomous transmission can be configured to address MAC PDU de-prioritization having occurred in configured grants. Configured grant retransmission timer can be configured to handle LBT failures in configured grants” for a more concise statement. The “handle pending MAC PDU” detail here is redundant. 6. Change “The features of LCH-based prioritization and configured grant retransmission timer may co-exist.” To “The features of LCH-based prioritization and configured grant retransmission timer may can be configured simaltanuously.” to more accurately capture RAN2 agreements.   Agree with Ericsson on “The wording “shared spectrum” has been used throughout the stage 2 spec instead of “unlicensed”. It is better to use “shared spectrum””. |
| vivo | Yes with comments | In 10.3 of TS38300, *enhanced intra-UE overlapping resources prioritization* is used in stead of LCH-based prioritization. Hence, we have the following suggestion on the last sentence:  One UE may be configured with enhanced intra-UE overlapping resources prioritization and configured grant retransmission timer together. |
| TCL | Yes, with comments | Agree with Ericsson to use “shared spectrum” instead of “unlicensed controlled environment (UCE)”;  Agree with Qualcomm to change “URLLC” to “URLLC services”;  Agree to change “The features of LCH-based prioritization and configured grant retransmission timer may co-exist” to “LCH-based prioritization and the configured grant retransmission timer can be configured together”;  Agree with CATT’s change of the “Autonomous transmission can be …”;  Agree with Qualcomm to add related reference for the definition and operation of “Autonomous Transmission”;  But, we have several suggestions below:  1. Change “where LBT failure is assumed to be infrequent” to “where LBT failure is assumed to seldom occurs” to highlight that the LBT failure does not occur frequently;  2. Change “In such cases NR-Unlicensed features including autonomous retransmission may be optionally configured.” to “In this scenario, autonomous retransmission may be supported in NR-U with *cg-RetransmissionTimer* configured optionally”, *cg-RetransmissionTimer* is more likely to be a parameter/ie in the specification description other than a feature, use the “autonomous retransmission” instead of “NR-Unlicensed features” for there is only one case for now; |
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**Summary 1**: TBD.

**Proposal 1**: TBD.

## 3.2 TSC: Time-Synchronization and New QoS

For time-synchronization for TSC, RAN2 has made the following agreements so far:

* **RAN2 #112e:**

**Agreements**

1: RAN2 should consider the following three scenarios, with a focus on Scenario 2 and 3:

• Scenario 1: In the control-to-control communication use case, where TSC devices behind a target UE are synchronized to any TD, from a GM behind the CN. The 5GS introduced error is caused by the relative time-stamping inaccuracy at the NW-TT and the DS-TTs.

• Scenario 2: In the control-to-control communication use case, where TSC devices behind a target UE are synchronized to any TD, from a GM behind the UE. The 5GS introduced error is caused by the relative time-stamping inaccuracies at the involved DS-TTs.

• Scenario 3: In the smart grid use case, where the TSC devices behind a target UE are synchronized to the 5G GM TD. The 5GS introduced error is caused by the synchronization of the 5G clock to the DS-TT.

2 RAN2 should evaluate the synchronicity budget by dividing the 5GS E2E path into three parts: Network, Device, and Uu interface. Where the Uu interface is understood as the maximum 5GS time synchronization error between the UE and the gNB-DU (i.e. DU-CU interface error is not included)

3 RAN2 assumes the two Uu interfaces in Scenario 2 have the same time synchronization error budget.

4 The Uu interface budget for Scenario 1, 2 and 3 are respectively calculated as following:

• Scenario 1: Uu budget = 900ns – Device – Network scenario1

• Scenario 2: Uu budget = (900ns – 2xDevice – 2xNetwork scenario2)/2 (assumption is based on GPTP)

• Scenario 3: Uu budget = 1000ns – Device – Networkscenario3 (baseline assumption that this is based on GNSS)

5 The Device part time synchronization accuracy budget is assumed to be in the range ±50 to ±100ns, this applies to all three scenarios

6 The error caused by the limited granularity of referenceTimeInfo-r16 IE (±5ns) is to be included in the network part budget, and RAN1 should be informed not to include this error in Uu interface.

7 The Network part time synchronization accuracy budget for Scenario 1, 2, and 3 are assumed to be the following:

• Scenario 1: ±120 to ±200ns (NetworkScenario1) (*assuming 3-5 hops worst case scenario*

• Scenario 2: ±240 to ±400ns (2xNetworkScenario2) *(assuming 6-10hops worst case scenario)*

• Scenario 3: ±100ns (NetworkScenario3)

8 Based on Proposal 4, 5, 6 and 7, the per Uu interface time synchronization accuracy for Scenario 1, 2 and 3 are as following:

• Scenario 1: ±595ns to ±725ns

• Scenario 2: ±145ns to ±275ns

• Scenario 3: ±795ns to ±845ns

9 LS to RAN1 providing the scenarios and values. Indicate to RAN1 that they should aim to meet the most stringest requirements, but a number within the range is also acceptable

10 It is up to RAN1 to decide which PDC options should be supported for Scenario 1, 2 and 3 in Release-17.

* **RAN2 #113e:**

**Assumptions:**

- There is no UE clock drift issue to be addressed

- The source and target gNB are tightly synchronized to the same master clock within the budget and there is no need to optimize anything for HO.

**Agreements**

- gPTP message interruption during mobility is not considered in the Rel-17 IIoT WI (i.e. no further specification impact are considered)

- RAN2 to confirm which PDC option to choose is up-to RAN1 to decide

From the rapporteur perspective, the only agreements that can be captured at the Stage-2 level are:

* Scenarios including Control-to-Control and Smart Grid are considered for propagation delay compensation (PDC) in Rel-17
* Some forms of PDC enhancement will be introduced in Rel-17 (although it is still pending in RAN1 about which option to be adopted).

On the other hand, for the new QoS (in particular the TSCAI parameter of survival time), RAN2 has made the following agreements so far:

* **RAN2 #112e:**

**Agreements**

=> Time period during which “message loss” can be tolerated is adopted as the preferred format for Survival time. FFS how this will be achieved and what message loss means in RAN2

* **RAN2 #113e:**

**Agreements**

- Communication service availability (CSA) is not needed on top of survival time. Send a reply LS to SA2 to notify such confirmation

*-* RAN2 confirms that specification enhancement for survival time support may only needed for uplink. Downlink is addressed by implementation and no specification impacts.

*-* Support for survival time in UCE is up to network configuration.

- Continue discussing whether burst spread and burst ending time is beneficial from RAN2 perspective, but trigger the discussion after SA2 progress in February

- Communication service reliability (CSR) is not needed on top of survival time

- Only periodic traffic is considered for survival time work in Rel-17

- RAN2 assumes one application message is conveyed by one PDCP SDU, and may further consider the cases where one application message is conveyed by varying number of PDCP SDUs depending on the progress

* **RAN2 #114e:**

**Agreement:**

1. RAN2 does not consider the Burst Spread parameter in RAN
2. The Burst End Time parameter in RAN is out of scope for Rel-17 IIoT WI.
3. No specific enhancements in support of Survival Time in UCE will be studied in R17, but we should aim for solutions for Survival time that also work in UCE
4. When Survival Time information is provided in TSC AI, RAN action (gNB and/or UE) can utilize it to improve the associated link reliability so that the survival time requirement is met
5. Study fast mechanisms for survival time handling and the need

**Agreements:**

1 RAN2 takes the performance requirements of the top 3 rows of Table 5.2-1 from TS 22.104 (transfer interval = survival time = 0.5/1/2ms)

2 Survival Time triggered proactively based on Sequence Number is deprioritized

3 UE-based reactive solution based on RLC-NACK is not pursued

4 RAN2 will work/study UE-based reactive solutions to address survival time on top of gNB implementation. RAN2 assumes that gNB implementation solutions on their own are not sufficient.

Based on the agreements summarized above, the rapporteur tends to think the following text proposal can be incorporated into TS 38.300 to reflect the currents status of work relating to TSC:

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| --- |
| 16.8 Support for Time Sensitive Communications Time Sensitive Communications (TSC), as defined in TS 23.501 [3], is a communication service that supports deterministic communication and/or isochronous communication with high reliability and availability. Examples of such services are the ones in the area of Industrial Internet of Things, e.g. related to cyber-physical control applications as described in TS 22.104 [39].  To support strict synchronization accuracy requirements of TSC applications, the gNB may signal 5G system time reference information to the UE using unicast or broadcast RRC signalling with a granularity of 10 ns. Uncertainty parameter may be included in reference time information to indicate its accuracy. The UE may indicate to the gNB a preference to be provisioned with reference time information using UE Assistance Information procedure. Enhancements relating to propagation delay compensation (PDC) mechanisms may be applied to support time synchronization for scenarios including control-to-control and smart grid.  The gNB may also receive TSC Assistance Information (TSCAI), see TS 23.501 [3], from the Core Network, e.g. during QoS flow establishment, or from another gNB during handover. TSCAI contains additional information about the traffic flow such as burst arrival time, burst periodicity, and survival time for periodic traffic. TSCAI knowledge may be leveraged in the gNB's scheduler to more efficiently schedule periodic, deterministic traffic flows either via Configured Grants, Semi-Persistent Scheduling or with dynamic grants, and to improve the associated link reliability to meet the survival time requirement.  Editor’s Note: FFS more details of propagation delay compensation mechanisms  Editor’s Note: FFS RAN enhancement based on UE-based reactive solutions to address survival time, if any. |

**Question 2**: Do you agree that the text proposal above can be included in TS 38.300 running CR to capture the status of propagation delay compensation and survival time for TSC ?

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| Answers to Question 2 | | |
| Company | Yes/No | Comments (e.g. suggestions of re-wording) |
| Ericsson | Yes/No | Agree to have this session. But we have a couple of wording suggestions:   1. There is no PDC mechanism in Rel-16 and so there is no enhancement for that. 2. There is no need to add a restriction that PDC methods apply only for the two use cases, even though they are the main motivation. |
| Huawei, HiSilicon | Yes | The added “for periodic traffic” after “and survival time” might be redundant as “periodic, deterministic traffic flows…” are mentioned in the next sentence, yet not strong view on this. |
| Intel | Yes, with comments | We think adding “…for scenarios including control-to-control and smart grid” is not required but do not have strong view |
| OPPO | Yes | The adding “for periodic traffic” after “and survival time” might not be needed, but no strong view. |
| Samsung | Yes | - “Enhancements relating to” is not necessary.  - “for scenarios including control-to-control and smart grid” is not necessary. PDC can be applied for any use cases.- |
| Futurewei | No | The current text related to PDC mechanisms doesn’t add much information. Maybe we can make no change for now and revisit it later when we have sufficient details. In addition, stage 2 text should not specify a limit on the usage scenarios.  We are fine with adding text related to survival time with the following comments:   1. Agree that adding “for periodic traffic” after “and survival time” is unnecessary. 2. “and to improve” can be changed to “and/or to improve”, since “to more efficiently schedule” and “to improve reliability” may be two opposing requirements, of which the gNB scheduler may focus on meeting one but not both at the same time for a same UE. |
| CATT | Yes, with comments | RAN1 made the following agreements in RAN1#104-e:  Agreements:  •       Observation 1: Propagation delay compensation based on existing Rel-15/Rel-16 TA procedure and associated granularity, with no enhancements in RAN1, is sufficient for meeting the Uu interface synchronicity error budget in LS R2-2010837 for the smart grid scenario.  •       Observation 2: RAN1 needs to further study and specify the feasible enhancement (if any with RAN1 spec impact) for propagation delay compensation for control-to-control scenario, in order to meet the synchronicity budget of Uu interface in LS R2-2010837.  Therefore we think only the control-to-control time-sync scenario is useful to mention (as it was identified as reference scenarios for PDC design dimensioning purpose), but we would also agree with Ericsson and others that, once a PDC mechanism is specified in R17, it could also be used for other scenarios. So maybe it could be clarified as “for scenarios including, at least, control-to-control ~~and smart grid~~”. |
| III | Yes | We are okay with the change relative to survival time and don’t have strong view on the change relative to PDC. |
| Qualcomm | See Comments | Agree on adding the agreements to the specified clause with some wording changes suggestions:   1. Agree with the two points mentioned above by Ericsson.   Change “and survival time for periodic traffic” to “and survival time”. Periodic traffic is an SA level agreement, it need not be captured in the RAN scope even if this is an assumption for the use cases being considered currently. |
| Vivo |  | We are fine with the text proposal except for the following points:   1. The “Enhancements relating to” is not needed as there is no legacy PDC mechanism.   The “for periodic traffic” after survival time is redundant description as TSCAI is only for periodic traffic as specified in TS 23.501. |
| TCL | Yes, with comments | Agree with Ericsson that “Enhancements relating to” is not required;  Agree that “for periodic traffic” after “and survival time” is not necessary;  Suggestion below:  Change “including control-to-control and smart grid” to “requiring stringent synchronization accuracy, e.g. control-to-control”, the PDC is for a type of services with high synchronization accuracy requirement, i.e. TSN services, there is no need to restrict to only use cases; |
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**Summary 2**: TBD.

**Proposal 2**: TBD.

# 4 Conclusion

TBD.