3GPP RAN WG2 Meeting #116e R2-2111339

eMeeting November 1st – 12th, 2021

Agenda Item: 8.10.2.2

Source: InterDigital (summary rapporteur)

Title: Summary of [AT116-e][101][NTN] Other MAC aspects

Document for: Discussion, Decision

# Introduction

This document is a discussion paper to obtain company input to the following offline discussion:

* [AT116-e][101][NTN] Other MAC aspects (InterDigital)

Initial scope: Continue the discussion on remaining aspects of timers, HARQ, and LCP including CG/SPS aspects, based on the proposals in R2-2111331

Initial intended outcome: Summary of the offline discussion with e.g.:

* List of proposals for agreement (if any)
* List of proposals that require online discussions
* List of proposals that should not be pursued (if any)

The following deadline for company feedback has been provided:

* Initial deadline (for companies' feedback): **Thursday 2021-11-04 1000 UTC**
* Initial deadline (for rapporteur's summary in R2-2111339): Thursday 2021-11-04 1600 UTC

Please also note the following chair guidance:

* Proposals marked "for agreement" in R2-2111339 not challenged until **Friday 2021-11-05 0800 UTC** will be declared as agreed via email by the session chair (for the rest the discussion will further continue offline until the CB session in Week2).

# DRX Timers and SR-Prohibit Timer

## Drx-RetransmissionTimerUL

Based on agreement in RAN2#115e, for HARQ processes configured with HARQ state B it is FFS whether to start *drx-RetransmissionTimerUL* to support blind UL retransmission.

**Additional start conditions for HARQ state B:** [1] [7] [9] [12] [18] [19]

Companies which support additional start criteria for *drx-RetransmissionTimerUL* note relying on UE being in Active Time due to other HARQ processes for blind retransmission would be not stable [1] and UE may miss UL grant for assignment for retransmission [9]. For example, [7] notes that since retransmission scheduling will not restart the DRX inactivity timer, the number of blind retransmissions that can be scheduled during inactivity timer will be limited, especially when time diversity is applied in retransmission scheduling or when radio is overloaded. [19] states that if UE start the drx-retransmissionTimerUL on HARQ process configured with HARQ state B, UE has more opportunities to receive blind retransmissions.

Furthermore, [1] and [18] state that the length of drx-InactivityTimer needs to be configured longer, which would lead to unnecessary power consumption and reduced flexible on configuration since the same drx-InactivityTimer is used for all HARQ processes.

Regarding that additional start duration, two options have been proposed via contribution:

* **Option1:** start drx-RetransmissionTimerUL at the end of PUSCH transmission
* **Option2:** start drx-RetransmissionTimerUL with offset indicated by NW after the end of PUSCH transmission

As noted in [1], from UE’s point of view, after the UE finishes the PDSCH reception or PUSCH transmission for the HARQ process, the UE should be ready to receive another PDCCH indicating retransmission or new transmisson for the same HARQ process. [7] states the common understanding is that the DCI is expected to be received after the end of the last PUSCH.

However in [12], it is noted starting the *drx-RetransmissionTimerUL* with offset indicated by network is beneficial compared with starting immediately after the end of reception of the last PDSCH for blind retransmission, because the UE can sleep in between blind HARQ (re)transmissions in the case network schedule time scattered blind retransmission (e.g. for GEO where the blind retransmission may happen in between the 540ms RTT ).

**No additional start conditions for HARQ state B:** [3] [13] [16]

In [3], [13], and [16] it is noted that blind retransmissions can be handled by the *drx-InactivityTimer,* since as long as UE is kept in DRX Active time UE will monitor PDCCH and will act as indicated in DCI. [3] further mentions that starting the *drx-RetransmissionTimerUL* in State B for blind retransmission case would require the UE to know if a HARQ process supports blind retransmission or not, which is unnecessary and introduces additional complexity. [16] notes the UE will anyway start (or restart) drx-InactivityTimer when receiving a grant for a new transmission (as well as when receiving an assignment for new transmission) allowing plenty of opportunities for opportunistic blind retransmissions.

Furthermore, as described in [16] in case the RTT is very long as in GEO – it is not efficient to extend drx-RetransmissionTimerUL (nor drx-InactivityTimer), to allow blind retransmissions at any time (this would be similar to not configure DRX at all), as this will waste UE power. In such cases, we can utilize the drx-onDurationTimer for blind opportunistic retransmissions to reduce the energy consumption. If drx-RetransmissionTimerUL is started after each PUSCH transmission to allow for further blind retransmissions after a blind retransmission, lots of UE energy will be wasted as most of the time there is no blind retransmission.

**Question 1:** **Which of the following option(s) do you support to enable reception of blind UL retransmission grant for HARQ process(es) configured with HARQ mode B:**

1. **Rely on UE being in DRX Active Time via other means (e.g. Inactivity Timer);**
2. **Start *drx-RetransmissionTimerUL* at the end of PUSCH transmission;**
3. **Start *drx-RetransmissionTimerUL* at offset indicated by NW after the end of PUSCH transmission;**
4. **Other, please describe**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Apple | 2 | Seems cleaner and more power efficient to have a separate timer for retransmissions rather than relying on the DRX Inactivity Timer. |
| Xiaomi | 2 | Since retransmission scheduling will not restart the DRX inactivity timer, the number of blind retransmissions can be scheduled during inactivity timer will be limited, especially when time diversity is applied in retransmission scheduling or when radio is overloaded. Some companies indicate that if network doesn’t want to schedule blind retransmission, starting drx-RetransmissionTimerUL will cause UE monitoring PDCCH unnecessarily. However, typically the inactivity timer length is larger than DRX retransmission timer. Although DRX retransmission timer is started, it falls into the time window of DRX inactivity timer, it will not cause UE additionally monitor PDCCH. |
| Nokia | Option3 or leave it for future enhancement | For option1, we agree that it will either limit the blind retransmission opportunities/NW implementation (e.g. can happen only in DRX active time triggered by other HARQ processes or in UE’s drx-inactivity timer), *or* consume more UE power (e.g. configure extended drx-inactivity timer to cover the RTT) which is not the intention of DRX. This is not good especially for GEO where the blind retransmission may happen in between the 540ms RTT. So, we think some enhancements should be considered.  For option2, it reuses the legacy concept that a per-HARQ based DRX retx timer to support the retransmissions of a HARQ. Compared to DRX-inactivity timer (which is a per-UE timer), it can save UE’s power since the timer may only start for the HARQ process with blind retransmission instead of all HARQ processes of the UE.  However, if the DRX retx timer is only started after a new transmission, the DRX inactivity timer (start only after a new transmission as well) may cover the retx timer which means the timer start is not necessary. If the DRX retx timer is started after a retransmission (where the DRX inactivity timer is not started), it makes sense to trigger the timer to support blind retransmissions without extra power consumption. But, this needs the UE knows if a HARQ process supports blind retransmission or not, to avoid unnecessary DRX retx timer start in the case a HARQ process is configured in state B but without any retransmission.  For Option3, since NW can indicate the offset to UE, it can support sparse blind retransmissions in GEO to achieve time diversity gain and UE can sleep in between blind HARQ (re)transmissions to save power consumption. Furthermore, the NW can also indicate to UE a HARQ processes with blind retrx or not, which can avoid unnecessary DRX retransmission timer start as mentioned in Option2. |
| Huawei,  HiSilicon | 1) | The DRX Inactivity timer is designed for detecting subsequent PDCCHs indicating UL or DL transmissions after one PDCCH occasion. Thus this timer can naturaly be used for blind retransmissions and gNB implemetaiton can ensure blind retransmission coverd by DRX Inactivity timer or other active periods. There is no need to start an additional timer for this purpose. |
| OPPO | Option 2 | As we stated in our contribution, running the *drx-RetransmissionTimerUL* for HARQ processs with state B to enable blind retransmission would be stable on opportunity and flexible on the configuration of drx-InactivityTimer.  For the case that RTT is very long as in GEO mentioned above the Question, it is not the intention to allow blind retransmissions for HARQ mode B at any time by running an enxtended drx-RetransmisisonTimerUL, and running drx-RetransmissionTimerUL would give proper opportunity for blind retransmissons without unnecessary energy consumption since the length of drx-RetransmisisonTimerUL for HARQ mode B is same as that for HARQ mode A.  In our understaning, we suggest to support starting drx-RetransmissionTimerUL for the reception of blind UL retransmission for HARQ process with HARQ mode B. |
| vivo | 2 | If relying on the active time due to other HARQ process, the retranssmion scheduling is not flexible and cannot be guaranteed, especially under the case that the DL/UL retransmission timers of other HARQ processes are not running. If mainly relying on the inactivity timer, NW should configure this timer with long value, which is not good for power saving. Thus, it is better to use a separate timer (i.e., drx-RetransmissionTimerUL) to monitor the possible blind retransmission scheduling for a given HARQ process.  Since there is no scheduling restriction between consecutive PUSCH for given HARQ process, UE can start the drx-RetransmissionTimerUL at the end of PUSCH transmission. |
| MediaTek | 1 | We can rely on the Inactivity timer for blind retransmissions. We see no power saving gains with the other mechanisms, because the Active Time will be extended in both solutions. |
| Qualcomm | 2 or 1 | If network enables blind retransmission (say PHY parameters are not set to meet the target BLER), we think option (2) can be used. Otherwise, we can rely on option (1). |
| Samsung | 2 |  |
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## Drx-RetransmissionTimerDL

Similar arguments supporting additional start conditions for the *drx-RetransmissionTimerDL* are also made in [1] [7] [18], and against additional start conditions for the *drx-RetransmissionTimerDL* in [13]. For a detailed discussion, companies are referred to contributions [12] and [16] respectively.

However, as noted in [7], based on RAN1 agreement (i.e. incorporation of X = T\_proc,1) the start condition for the *drx-RetransmissionTimerDL* may be slightly different than in the UL case. The following options have been proposed regarding start time of *drx-RetransmissionTimerDL* in [7] and [12]*:*

* **Option 1:** start the DRX retransmission timer in the first symbol after the end of the reception of the last PDSCH or slot-aggregated PDSCH. [7]
* **Option 2:** start the DRX retransmission timer in the first symbol after the end of the reception of the last PDSCH or slot-aggregated PDSCH plus X (X = T\_proc,1). [7]
* **Option 3:** Start drx-RetransmissionTimerDL with offset indicated by NW after the end of the reception of the last PDSCH. [12]

**Question 2:** **Which of the following option(s) do you support to enable reception of blind retransmission for HARQ process(es) configured with disabled HARQ feedback:**

1. **Rely on UE being in DRX Active Time via other means (e.g. Inactivity Timer);**
2. **Start *drx-RetransmissionTimerDL* in the first symbol after the end of the reception of the last PDSCH or slot-aggregated PDSCH;**
3. **Start *drx-RetransmissionTimerDL* in the first symbol after the end of the reception of the last PDSCH or slot-aggregated PDSCH plus X (X = T\_proc,1);**
4. **Start *drx-RetransmissionTimerDL* with offset indicated by NW after the end of the reception of the last PDSCH;**
5. **Other, please describe.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Apple | Option 3 | Seems unnecessary to monitor PDCCH during X. |
| Xiaomi | Option 3 | The same view as Apple |
| Nokia | Option 4 or leave it for future enhancement | Similar comment as Question1. |
| Huawei,  HiSilicon | 1) | See our reply to Q1. |
| OPPO | Option 3 | Agree with Apple. |
| vivo | Option 3 | Same reason with Q1，it is better to use a separate timer (i.e., drx-RetransmissionTimerDL) than the inactivity timer to monitor the possible blind retransmission scheduling for a given HARQ process.  Since there is scheduling restriction between consecutive PDSCH reception for a given HARQ process which was agreed in RAN1, UE can start the drx-RetransmissionTimerDL with a offset after the end of last PDSCH transmission, as per previous RAN1 agreement. The offset is defined as X (X = T\_proc,1). |
| MediaTek | 1 | We can rely on the Inactivity timer for blind retransmissions. With the same reasons above for UL blind retransmissions. |
| Qualcomm | 2 or 1 | Please see our response in Q1. |
| Samsung | 3 or 4 |  |
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## HARQ RTT Timers

For UL HARQ mode, RAN2 has agreed that if a mode is not configured, UE applies legacy behaviour for *drx-HARQ-RTT-TimerUL*. However, similar agreements were not made for DL HARQ process. Based on current MAC running CR, if a HARQ process is not configured with enabled/disabled DL HARQ feedback, then the *drx-HARQ-RTT-TimerDL* is extended by UE-gNB RTT. [1] and [18] note that if the MAC entity is not configured with *downlinkHARQ-FeedbackDisabled*, the intention is not to increase the *drx-HARQ-RTT-TimerDL* but to use the original length as it is.

[18] further notes that if the network intends to increase the *drx-HARQ-RTT-TimerDL*, there is already an option to do so, i.e., to configure *downlinkHARQ-FeedbackDisabled* and set DL HARQ feedback for the corresponding HARQ process enabled. So, there is no reason to have duplicate option for this.

**Proposal 3:** **For HARQ process(es) not configured with DL HARQ feedback enabled/disabled, what is the intended *drx-HARQ-RTT-TimerDL* behaviour?**

1. ***drx-HARQ-RTT-TimerDL* is extended by UE-gNB RTT;**
2. ***drx-HARQ-RTT-TimerDL* is not changed (i.e. legacy behaviour applies).**

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| **Company** | **Supported Option** | **Additional comments** |
| Apple | Option 1 | Seems cleaner this way |
| Xiaomi | Option 1 | If HARQ process(es) not configured with DL HARQ feedback enabled/disabled, it should defaultly assume that DL HARQ feedback is enabled, then drx-HARQ-RTT-TimerDL should be extended by UE-gNB RTT. |
| Nokia | Option 2 | If the network intends to increase the drx-HARQ-RTT-TimerDL, there is already an option to do so. |
| Huawei,  HiSilicon | Option 2 | Should be aligned with what is agreed for UL. |
| OPPO | Option 2 | The intended behaviour for the configuraton of DL HARQ state should be aligned as that for UL.  Furthermore, for some NTN scenarios, e.g. HAPS, if DL HARQ mode is not configured, it should mean the legacy behaviour of DL HARQ DRX can work well for this network, so we should not preclude the legacy. |
| vivo | Option 2 | We think Option 2 is the intended behaviour when the corresponding HARQ process is not configured with DL HARQ feedback enabled/disabled. Based on this understanding, we do not think there is a need to define legacy behaviour for a HARQ process in NTN as it anyway cannot adapt to the larger propagation delay in NTN scenario. |
| MediaTek | 1 | In an NTN cell, if downlinkHARQ-FeedbackDisabled is not present (not configured), then drx-HARQ-RTT-TimerDL is extended by UE-gNB RTT. |
| Qualcomm | 1 | For LEO/MEO/GEO, agree with MediaTek. There should be two states: disabled indication vs rest/default is enabled. |
| Samsung | 2 | For UL, UL HARQ can be configured with feedback enabled/disabled, and if not configured, legacy behaviour applies. For DL, DL HARQ can be configured with feedback enabled/disabled, and if not configured, it will be good to have same principle as UL. We don’t understand the reason why we need to define the UE behaviour in different. |
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## SR-Prohibit Timer

To accommodate increased propagation delay in NTN, it was agreed in RAN2#113bise that the sr-ProhibitTimer be extended, with details FFS. In RAN2#116e the following was agreed:

*The extended values for sr-ProhibitTimer in NTN can include values less than UE-gNB RTT (as in legacy). FFS on the actual values and how this is extended*

[14] states that the simplest solution to both compensate for additional RTT while maintaining the possibility to configure values less that RTT would be including additional values (similar to t-Reassembly timer), with a candidate set of values provided in [18]. However, it is noted in [14] this would require a range of values to accommodate the different propagation delays of LEO and GEO, and may need to be further expanded in the future as additional scenarios (e.g. MEO, HAPS) are defined.

[16] proposes that the timer be extended with a factor times an RTT offset value where the factor may take values below one, and [14] proposes that an additional bias K may be introduced to reduce the overall offset to below the UE-gNB RTT.

**Question 4:** **What is your preferred method to extend values for the *sr-ProhibitTimer* in NTN*?***

1. **Additional values;**
2. **Offset existing values by UE-gNB RTT \* *K*, where *K* can be < 1;**
3. **Offset existing values by UE-gNB RTT – *K*, where K is < UE-gNB RTT;**
4. **Other, please describe.**

**Note: If the preferred option is 1) please provide examples of possible new values. If it is 2) or 3) please provide potential values for *K.***

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| **Company** | **Supported Option(s)** | **Additional comments (including possible new values or values of *K)*** |
| Apple | Option 2 |  |
| Xiaomi | Option 1 | The design will consider the maximum RTT, we do not think too much additional values are needed, and further enhancement in future is necessary. The use of additional value is some kind of optimization, we do not see too much gain to over design this and the potential to introduce further values is not so big. |
| Nokia | Option1 | We prefer simple solution to extend the value range with additional IE. |
| Huawei,  HiSilicon | Option 1 | Adding additional values is simple and some spare values can be saved for future use as there would not be too many use cases. |
| OPPO | Option 2 | For Option 2, a factor within [0,1] would be suitable for each scenarios (e.g. LEO, GEO, and HAPS, etc) with different range of delay. |
| vivo | No strong view | Option 2 and option 3 are both acceptable to us. |
| MediaTek | 4 | Offset existing values by UE-gNB RTT |
| Qualcomm | 1 | Seems adding additional value range is simple. |
| Samsung | 1 |  |
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# Remaining HARQ/LCP Aspects

## Configuration of HARQ mode

**Issue 1) PUSCH transmission scheduled by RAR**

As described in [10], the PUSCH transmission scheduled by RAR during the random access procedure (msg2), is a dynamically scheduled PUSCH transmission (e.g. in the 4-step contention based random access procedure the RAR schedules PUSCH msg3 transmission and for CFRA RAR schedules a “normal” PUSCH transmission). The HARQ process used for PUSCH scheduled by RAR is fixed in specifications, i.e. HARQ process zero is used for PUSCH transmission scheduled by RAR UL grant.

Since the HARQ process cannot be dynamically selected for a PUSCH transmission scheduled by RAR as for other dynamic PUSCH transmissions, NW has no tight control on the HARQ retransmission state applied for the data transmitted in the PUSCH and accordingly the corresponding UE DRX behaviour. This may lead to a situation that the allocated PUSCH resources cannot be efficiently used by the UE, i.e. the configured LCH restriction may prevent UE from using such allocated PUSCH resources or DRX behaviour is not suitable for the data transmitted on the PUSCH.

It is therefore proposed in [10] that no HARQ retransmission state and related LCH restriction should be applied for a PUSCH scheduled by RAR. In more detail, UE should ignore the HARQ process configuration, i.e. HARQ retransmission state configuration, configured for HARQ process=0 for the case of a PUSCH transmission scheduled by RAR. Even though NW may configure HARQ process=0 with a certain HARQ retransmission state, e.g. HARQ state A or B, UE assumes for a PUSCH transmission scheduled by RAR UL grant, e.g. RACH Msg3, that no HARQ retransmission state is configured. This ensures that no LCH restrictions apart from the legacy LCH restrictions are applied for a PUSCH scheduled by RAR.

**Question 5:** **Do you agree UE ignores HARQ process configuration (e.g. configured HARQ mode) for the case of a PUSCH transmission scheduled by RAR as proposed in [10]?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Apple | Agree |  |
| Xiaomi | Disagree | The configuration of HARQ state for HARQ #0 is to indicate the behaviour of Msg3 transmission. Given the specialty of HARQ #0, it is more reasonable that network can configure the behaviour of HARQ #0, rather than using a HARD coded behaviour as suggested by the proposal. Note that ignore the configuration of HARQ state equals default configuration. As we explained in Q3, the default behaviour is to assume that HARQ is not enabled. |
| Nokia | FFS | In our understanding, the issue is only related to RACH for UE in RRC\_Connected mode, because there is no HARQ state configured for UE in RRC Idle mode. The impact caused by DRX and LCP in HARQ state need further discussion. |
| Huawei,  HiSilicon | Agree |  |
| OPPO | Disagree | We can rely on NW always not configuring HARQ ID 0 with state B, in which case we don’t need to define any UE requirement. |
| vivo | Maybe no | We share the view of Nokia above that this issue is only related to RACH during RRC\_CONNECTED. However, we currently don’t see the need of a specified UE behaviour as shown in the question. Perhaps the potential issue raised above can be avoided by NW implementation (e.g. proper NW configuration or proper scheduling of the UL grant). |
| MediaTek | Agree |  |
| Qualcomm | Disagree | Network should avoid HARQ state issue for RACH in connected more. It should be clarified. |
| Samsung | FFS | We’re not clear what “UE ignores HARQ process configuration” really means. Does it mean i) UE acts as if HARQ process or LCH is not configured with feedback enabled/disabled or ii) UE can send a data from any LCH over PUSCH scheduled by RACH msg2? As mentioned by Nokia, we’re also not clear the target scenario is whether for connected UE only or both connected and idle UEs. |
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**Issue 2) Configuration of Legacy and Mode A/B vs. Legacy or Mode A/B**

In the current RRC running CR, the fields *downlinkHARQ-FeedbackDisabled* and *uplinkHARQ-DRX-LCP-Mode-r17* use a 32-bit bitmap type with optional presence.

[1] notes that this may have some issues for both UL and DL HARQ. For example, if *uplinkHARQ-DRX-LCP-Mode-r17* field is absent, all of UL HARQ process would be legacy; while if *uplinkHARQ-DRX-LCP-Mode-r17* field is present, each bit of the 32-bit bitmap would be either 1 or 0, which means that all of UL HARQ processes would be either state A or B. The network cannot configure some UL HARQ process as state A, some as state B and some others as legacy behaviour at the same time. This seems to be an unnecessary restriction for network’s configuration.

Alternatively, [3] states that in NTN, the legacy operation will not work properly because of the large UE-gNB RTT. If neither State A nor State B is configured in NTN, the duration of the *drx-HARQ-RTT-TimerUL* would be smaller than the UE-gNB RTT, and therefore it would not give enough time to the UE to receive a possible UL retransmission grant from the network. This opinion is shared by [9], which states there is no benefit to configure the legacy HARQ state to a HARQ process of NTN cell, because both HARQ based retransmission and blind retransmission are not supported well by this HARQ state. If legacy HARQ state is excluded, the bitmap is suitable to configure the HARQ state. [16] adds that if legacy behaviour is wanted it can only be used for all HARQ process IDs.

**Question 6:** **If *uplinkHARQ-DRX-LCP-Mode-r17* is configured, what possible values can a HARQ process be mapped to?**

1. **‘HARQ mode A’ or ‘HARQ mode B’;**
2. **‘HARQ mode A’ or ‘HARQ mode B’ or ‘Legacy’.**

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| **Company** | **Preferred Option** | **Additional comments** |
| Apple | 1 | Our understanding is that HARQ mode A is legacy with enhancements for supporting large RTT |
| Xiaomi | 1 | For NTN, such kind of legacy behaviour is meaningless. |
| Nokia | Option 1 | We don’t see the motivation to configure HARQ Mode A, Mode B and legacy HARQ simultanesouly. If legacy behaviour is wanted it can only be used for all HARQ process IDs. |
| Huawei,  HiSilicon | 1) | The parameter is introduced to solve NTN problems. So there is no need to indicate “legacy” extrally. Besides, it already has been agreed that If the parameter is not configured, UE will follow legacy behaviour.  And we don’t think a smart NTN gNB would like UE to follow legacy behaviour in a NTN cell as legacy may not work. |
| OPPO | Option 2 | Option 2 would be flexible for the NW’s configuration. |
| vivo | 1 | We understand the “legacy state” for a HARQ process is that UE handles the related HARQ RTT timer and HARQ retransmission timer as UE does in TN scenario. We do not think this is needed as it anyway cannot adapt to the larger propagation delay in NTN scenario. |
| MediaTek | 1 | ‘Legacy’ behaviour can be achieved by the absence of this field (*uplinkHARQ-DRX-LCP-Mode-r17*). There is no need to configure some HARQ processes with Mode A/B and others with ‘Legacy’ within one cell.  Note that we think downlinkHARQ-FeedbackDisabled-r17 and uplinkHARQ-DRX-LCP-Mode-r17 should be configured per cell, not cell group, see below. |
| Qualcomm | 1 | Agree with others. |
| Samsung | 2 | We think it is good to allow to configure HARQ mode A, HARQ mode B and legacy HARQ mode per HARQ process. |
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## LCH-HARQ Process mapping details

As noted in [13], it is optional to configure HARQ with a state and a LCH with new LCP, thus coexistence of HARQ process wt/wo a states and coexistence of LCH wt/wo new LCP is possible in NTN. All possible LCP restrictions with consideration on HARQ states are listed as below:

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| --- | --- | --- | --- |
|  | HARQ mode A | HARQ mode B | No HARQ mode |
| Case 1 | Y | N | N |
| Case 2 | N | Y | N |
| Case 3 | N | N | Y |
| Case 4 | Y | Y | N |
| Case 5 | Y | N | Y |
| Case 6 | N | Y | Y |
| Case 7 | Y | Y | Y |

* Case 1 & 2) LCH mapped only to HARQ process configured with the same HARQ mode;
* Case 3) LCH mapped only to HARQ process not configured with a HARQ mode;
* Case 4) LCH mapped to HARQ process configured with either HARQ mode A or B;
* Case 5 & 6) LCH mapped only to HARQ process configured with the same HARQ mode or not configured with a HARQ mode;
* Case 7) LCH mapped to any HARQ process (HARQ Mode A or B or without configuration)

For an analysis of each option, companies are invited to refer to the pre-meeting summary in R2-2111331 or to the original contribution.

**Question 7:** **Which of the following are valid LCH to HARQ process mapping configurations?**

1. **LCH mapped only to HARQ process configured with the HARQ mode A;**
2. **LCH mapped only to HARQ process configured with the HARQ mode B;**
3. **LCH mapped only to HARQ process not configured with a HARQ mode;**
4. **LCH mapped to HARQ process configured with either HARQ mode A or B;**
5. **LCH mapped only to HARQ process configured with HARQ mode A or not configured with a HARQ mode;**
6. **LCH mapped only to HARQ process configured with HARQ mode B or not configured with a HARQ mode;**
7. **LCH mapped to any HARQ process (HARQ Mode A or B or without configuration). This may be realized by not configuring mapping rule for an LCH.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Apple | Option 7 | An LCH without configuration can be used with all HARQ processes |
| Xiaomi | Option 7 | It should be allowed that LCH is mapped to either HARQ mode A or HARQ mode B, or no HARQ mode is configured for the LCH, in this case the LCH is allowed to be transmitted on any HARQ state. |
| Nokia | Case1, Case2, and modified Case7 | As commented in Question6, if HARQ mode is configured, then all the HARQ process should be configured to either HARQ mode A or B.  So, we think case7 should be modified to:  LCH mapped to any HARQ process (HARQ Mode A or B). This may be realized by not configuring mapping rule for an LCH. |
| Huawei,  HiSilicon | 1) 2) 4) 7) | There should be no restriction to map a LCH **only** to HARQ processes “not configured with a HARQ mode”. |
| OPPO | Option 1/2/7 | If HARQ mode A or B is configured for a logical channel, data from this logical channel can only be mapped to the HARQ processes with the same HARQ mode. This kind of one-to-one mapping is simpler for UE implementation.  And we have agreed in RAN2#115-e meeting that if a logical channel is not configured any HARQ mode, the mapping has no effect, i.e., legacy behaviour applies. |
| vivo | Option 7 | If a LCH is not configured with a HARQ state, it means that there is no LCP restriction of HARQ state. Then, this LCH can use the UL grant associated with any HARQ process. |
| MediaTek | Option 1, 2, 4, 7 | We do not see a use case for 3, 5, 6.  Note that in an NTN cell all HARQ processes would be configured with either Mode A or Mode B, whereas in a TN cell no HARQ process would be configured with Mode A or B.  If the intention is to restrict a LCH to transmit on an NTN or TN cell, this is already possible since Rel-15 using *allowedServingCells* parameter. |
| Qualcomm | Option 7 | Agree with Xiaomi. When not configured, the LCH can be allowed to use any HARQ state. |
| Samsung | Option 7 |  |
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## RRC parameter details

In the 38.331 running CR for NTN, the fields *downlinkHARQ-FeedbackDisabled* and *uplinkHARQ-DRX-LCP-Mode-r17* are added in the IE *MAC-CellGroupConfig*. [1] argues that for better forward compatibility, e.g. when considering NTN CA in Rel-18, it is better to place these two fields under *PDSCH-ServingCellconfig* and *PUSCH-ServingCellConfig*, since different serving cells don’t have to have the same configurations, for better flexibility. [16] further notes that “*uplinkHARQ-DRX-Mode*” or “*uplinkDRX-Mode*” may be configured in the *MAC-CellGroupConfig* as all HARQ processes are shared in a cell group and setting it individually per serving cell by including the parameter in *PUSCH-ServingCellConfig*.

**Question 8:** **Should *uplinkHARQ-DRX-Mode* be included in *MAC-CellGroupConfig* or *PUSCH-ServingCellConfig*?**

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| **Company** | **Preferred Option** | **Additional comments** |
| Apple | PUSCH-ServingCellConfig |  |
| Xiaomi | PUSCH-ServingCellConfig | For better forward compatibility, it is better to place it in PUSCH-ServingCellConfig |
| Nokia | PUSCH-ServingCellConfig | No need to restrict the same configuration for all the cells in a CellGroup. |
| Huawei,  HiSilicon | PUSCH-ServingCellConfig |  |
| OPPO | *PUSCH-ServingCellConfig* | It would be flexible for future release to place this field under PUSCH-ServingCellConfig.  Besides, the field downlinkHARQ-FeedbackDisabled also needs to be discussed, since the issue is the same. We propose the following updated proposal:  **Fields *uplinkHARQ-DRX-Mode* and *downlinkHARQ-FeedbackDisabled* are included in *PUSCH-ServingCellConfig* and *PDSCH-ServingCellconfig*, respectively*.*** |
| vivo | PUSCH-ServingCellConfig |  |
| MediaTek | PUSCH-ServingCellConfig | These should be configured per cell, not cell group.  Same applies for downlinkHARQ-FeedbackDisabled and PDSCH-ServingCellConfig |
| Qualcomm | PUSCH-ServingCellConfig |  |
| Samsung | PUSCH-ServingCellConfig |  |
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# Configured Grant/SPS aspects

## HARQ/LCP configuration for CG/SPS

As noted in [5], [6], and [17] The HARQ-processes ID of both CG and SPS are calculated from parameters of radio resource allocation in time domain, e.g. configured periodicity, start off in time domain, configured HARQ process number. This is different from dynamic scheduling, where there is no relationship between HARQ ID and radio resource allocation in time domain.

Currently, for dynamic grant only the granularity of HARQ process is supported for enabling/disabling HARQ feedback and configuration of UL HARQ mode.

**Issue 1) Configuration of DL HARQ feedback enable/disable for SPS**

In the SPS case, if the HARQ process mechanism specified for the dynamic DL grant is followed, it may result in the UE transmitting HARQ feedback for a logical channel data that is received in SPS occasion X but NOT transmitting HARQ feedback for the same logical channel data that is received in the SPS occasion Y [6] , where:

* SPS occasion X belongs to HARQ process ID with HARQ feedback enabled
* SPS occasion Y belongs to HARQ process ID with HARQ feedback disabled.

[6] notes that this is not the expected behaviour for a logical channel data. The network would have to make sure this won’t happen, i.e., for a given logical channel data that requires HARQ reliability, network will skip transmitting PDSCH in the SPS occasions Y. This incurs additional delay to data.

The following two options are proposed to handle the HARQ retransmission for DL SPS:

* **Option 1**: DL HARQ feedback is enabled/disabled per HARQ process (as in DG): Whether UE should send HARQ feedback for the DL PDSCH reception in SPS occasion is determined by the HARQ behaviour configured by RRC for the dynamic DL grant.
* **Option 2:** DL HARQ feedback is enabled/disabled per SPS configuration: for the SPS occasions belonging to a DL SPS configuration, all the HARQ processes are considered either HARQ feedback disabled or enabled.

**Question 9:** **How should enabled/disabled DL HARQ feedback be configured for SPS?**

1. **DL HARQ feedback is enabled/disabled per HARQ process (as in DG);**
2. **DL HARQ feedback is enabled/disabled per SPS configuration;**
3. **Other, please describe**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Apple | Option 2 |  |
| Xiaomi | Option 1 | Option 2 means that UL HARQ retransmission state is configured per HARQ ID pool, i.e. coarser granularity than option 1. However, coarser granularity can not save signalling. Because 32 bits are always needed for indicating DL HARQ feedback state for dynamic grant since it needs to accommodate the case that all the 32 HARQ processes are configured for DG. And this 32bits work for DG and CG at the same time. Thus, using option 1 has finer granularity but no extra signalling overhead than option 2. |
| Nokia | Option1 | The HARQ process for a SPS configuration is determined, thus NW can disable/enable HARQ feedback per HARQ process as in DG. It is NW implementation to guarantee that the calculated HARQ processes for the SPS configuration have the same HARQ feedback mode; |
| Huawei,  HiSilicon | Option 2 | See our reply in Q10. |
| OPPO | Option 2 |  |
| vivo | Option 2 | It is preferable that all the HARQ processes allocated to a SPS config have the same HARQ state. |
| MediaTek | Option 1 | Option 1 is sufficient, Option 2 could lead to further complications if there are conflicts between different configurations, and there is no need for further optimizations. |
| Qualcomm | Option 2 without spec change. | Considering multiple configurations, it is simple to use Option 2. Option 1 leads to additional delay because some occasions cannot be used because of either HARQ state or being occupied by HARQ of other configuration.  Such delay is problematic.  Network can simply do this without any change in spec. It is just about clarification. |
| Samsung | Option1 |  |
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**Issue 2) Configuration of UL HARQ mode for CG**

[5] describes a similar issue for CG, where for the same set of configured grants different transmission occasions may result in using HARQ processes configured with different HARQ states after calculation. Using HARQ processes with different HARQ states for different transmission occasions can lead to out-of-order reception.

[5] notes this is obviously not reasonable as the same set of configured grants are usually configured for the same traffic, and proposes that RAN2 should therefore study UL HARQ mode configuration for configured grant besides dynamic grant, starting with the following candidate solutions:

* **Option 1:** Independent signalling is used to configure HARQ mode for configured grant, i.e., HARQ State A/B is configured per CG.
* **Option 2:** Signalling of HARQ mode for dynamic grant (i.e. per HARQ process) also applies to configured grant and NW implementation guarantees that the calculated HARQ processes for configured grant have the same HARQ mode, i.e. through the parameters such as nrofHARQ-processes, harq-ProcID-Offset and harq-procID-offset2.
* **Option 3:** Signalling of HARQ mode for dynamic grant (i.e. per HARQ process) also applies to configured grant and configured grant is mapped to the HARQ processes with the same HARQ mode. This can be realized if we allow that the calculated HARQ process IDs can be different from the HARQ process IDs actually used.

**Question 10:** **How should UL HARQ mode (e.g. A or B) be configured for configured grant?**

1. **HARQ mode is configured per configured grant;**
2. **HARQ mode is configured per HARQ process and NW implementation guarantees that the calculated HARQ processes for configured grant have the same HARQ mode;**
3. **HARQ mode is configured per HARQ process and configured grant is mapped to the HARQ processes with the same HARQ mode;**
4. **Other, please describe.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Apple | Option 1 |  |
| Xiaomi | Option 2 | If the HARQ mode for all the HARQ process associated with one CG should be the same, network can implement this by setting the bits corresponding to CG HARQ processes to the same value. We do not see any need to introduce additional signalling for per CG HARQ mode configuration, which is less flexible and consumes more signalling than just have a common 32 bits HARQ state for CG and DG. |
| Nokia | Option2 |  |
| Huawei,  HiSilicon | Option 1 or Option 3 | Both option 1 and option 3 can work.  Option 2 only applies for UEs that support R16 NRU/URLLC/IIOT and may lead to lower throughput for the services whose HARQ mode is different from that of the configured grant. |
| OPPO | Option 1 |  |
| vivo | Option 1 or Option 2 | It is preferable that all the HARQ processes allocated to a CG config have the same HARQ state. |
| MediaTek | Option 2 | Option 2 is sufficient, other options could lead to further complications if there are conflicts between different configurations, and there is no need for further optimizations. |
| Qualcomm | Option 1 | As we mentioned in Q10, network can already do this without spec change. But we need clarification, network will do this.  Otherwise, assume CG1 is voice packet and CG2 or CGx for other traffics. There is no point to enable retransmission for voice packet (retransmitted voice packet after 500 RTT is useless).  Voice packet will suffer hugely because of HARQ state or because the CG occasion belongs to a HARQ process that is occupied by the CG2 or CGx. |
| Samsung | Option2 |  |
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**Issue 3) Applicability of LCH mapping configuration to CG**

In RAN2 #115e a new LCP mapping restriction as agreed for dynamic grant in NTN, however it is not clear whether this restriction also applies to configured grant case.

Applicability of the new LCP restriction to configured grant case is supported in [7] and [9], where in [7] it is argued that if UL HARQ retransmission state is agreed to be configured per HARQ process for CG, then HARQ retransmission state configuration is not related to DG/CG, thus LCH to HARQ state mapping should be agnostic to DG/CG. [9] also does not see a reason to preclude new LCP restriction for configured grant.

Alternatively, [10] [12] and [13] do not support applying the new LCP restriction to configured grant, stating in that for configured grant, the existing *allowedCG-List* is configured to a logical channel, MAC SDUs from the logical channel can only be mapped to the indicated configured grant configuration, so the network can control the allowed CG type and CG to be used for transmission of certain LCHs. Furthermore [12] mentions that if per-CG HARQ retransmission scheme is used, it means one CG should have only one retransmission scheme and allowedCG-List can be reused to do LCP for different retransmission scheme in NTN. It is reasonable since the LCHs with similar QoS can be mapped to the same CG .

**Question 11:** **Do you agree new LCP mapping restriction introduced for dynamic grant also applies to configured grant?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Apple | No | Desired beavior can be achieved by existing LCP restrictions |
| Xiaomi | Yes | If all the HARQ processes of a CG are configured with the same HARQ state, then allowedCG-List may indeed can be reused. But let us consider the case that one LCH only allows to use disabled HARQs but does not care which CG is used, network can simply configure the HARQ state for the LCP, and no need to configure the allowedCG-List, it will save signalling. Besides, it is network implementation to decide whether all the HARQ processes are mapped to the same HARQ state or not. If network choose to use different HARQ states for different HARQ state, the HARQ state restriction in LCP is still needed. |
| Nokia | No | The existing *allowedCG-List* configured to a logical channel can provide enough granularity for different LCHs which are mapping to CG with different retransmission scheme. |
| Huawei,  HiSilicon | FFS | It depends on the discussion of Q10:  if configured grant is mapped to the HARQ processes with the same HARQ mode, lagacy restriction *allowedCG-List* can be reused.  Otherwise, the new LCP mapping restriction should be used to ensure that data from the same LCH uses the same HARQ mode for transmission. |
| OPPO | Agree | But no CG-specif LCP restrictions. |
| vivo | No strong view | We are open to discuss this issue. |
| MediaTek | Agree | LCH to HARQ mode mapping can be agnostic of DG/CG. |
| Qualcomm | Agree but | However, it should be understood that *allowedCG-List* can override it. |
| Samsung | FFS | We would like to discuss LCP once UL HARQ mode configuration to CG in Q10 is decided. |
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## ConfiguredGrantTimer

As described in [16], for a configured grant configuration, the network may configure *configuredGrantTimer* or not:

* If *configuredGrantTimer* is configured for a CG-config: HARQ processes will not be used for a new CG transmission while it is running, and this allows the gNB to schedule retransmissions of that HARQ process ID (HP ID), if needed.
* If *configuredGrantTimer* is not configured for a CG-config and the periodicity is less than the HARQ RTT, then the HARQ process IDs will be reused before a HARQ RTT has elapsed when the UE has UL data to transmit.

When *configuredGrantTimer* is configured for a CG-config and periodicity is lower than the HARQ RTT, new CG transmissions may reuse a HARQ process ID before a HARQ RTT has elapsed. If *configuredGrantTimer* is not configured for a CG-config and the periodicity is longer than the HARQ RTT, retransmission of a HARQ process ID is possible based on the UL decoding result.

**Issue 1) configuredGrantTimer extension**

As noted in [7], for a HARQ process configured with configured grant, since there is no ACK feedback from the gNB, UE needs to know when the HARQ process can use the configured grant to transmit new data again.

According to the current specification, the unit of *configuredGrantTimer* is in multiples of *periodicity*, the value range is 1-64, where for smaller value of *periodicity* the length of *configuredGrantTimer* may not be sufficient to cover the UE-gNB-RTT. To ensure that the HARQ process is able to receive re-scheduling, the periodicity of configured grant will take into account the UE-gNB RTT. In RAN2#116e, the following was agreed:

*configuredGrantTimer can be extended in NTN. FFS details of when extension is applicable and method of extention.*

There have been two options proposed via contribution:

* **Option 1**: Introducing value of *configuredGrantTimer* larger than 64.
* **Option 2:** value of the *configuredGrantTimer* is extended by UE-gNB-RTT (similar to how the *drx-HARQ-RTT-TimerUL* is extended).

**Question 12a:** **What is your preferred method to extend *configuredGrantTimer* in NTN?**

1. **Introducing value(s) of *configuredGrantTimer* larger than 64;**
2. **Value of the *configuredGrantTimer* is extended by UE-gNB-RTT;**
3. **Other, please describe.**

**Note: if preferred option is 1), please provide one or more possible value(s) to be added.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Xiaomi | Option 2 | Please note that the unit of configuredGrantTimer is the periodicity of configured grant, if we choose option 1, it is very difficult to cover all the UE-gNB RTTs, then network is not able to configure a very suitable configuredGrantTimer to offset just exactly UE-gNB-RTT. As a result, a much larger value is configured and leads to unecessary delay. |
| Nokia | Option 1 | Extend the value range to cover the UE-gNB RTT in the case of small CG periodicity. |
| Huawei,  HiSilicon | Option 2 |  |
| OPPO | Option 2 | Introducing value(s) of configuredGrantTimer larger than 64 would lead to unecessary signalling overhead. |
| vivo | 2 | The CG timer is started at the beginning of the first symbol of the PUSCH transmission for a given HARQ process, and is used to monitor the possible retransmission scheduling. In order to adapt to the large propagation delay, it is suggested to extend the CG timer by UE-gNB-RTT. |
| MediaTek | Option 2 | UE-gNB RTT is already available in MAC and will be used for extension of other timers (e.g. drx-HARQ-RTT-TimerUL). It is a simple solution to apply the same offset to *configuredGrantTimer*.  Moreover, as explained in our contribution [4], if the offset (extension) is based on UE-gNB RTT, CG resources can be utilized more efficiently, i.e. some (near) UEs can benefit from a shorter CGT. |
| Qualcomm | Option 2 | Ok with option 2. |
| Samsung | Option 1 |  |
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**Question 12b:** **Please describe in which scenarios *configuredGrantTimer* should be extended (e.g. always; when *periodicity* is short; for GEO only etc.)?**

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| **Company** | **Applicable scenarios** |
| Xiaomi | For all the cases, there is no need to differentiate cases, similar to other timers. |
| Nokia | The scenarios to use the extended timer is NW implementation. |
| Huawei,  HiSilicon | Depends on the discussion of Q12a:  If Option 1 is agreed, it is up to gNB implementation which value to configure.  If Option 2 is agreed, UE should always extend the configured values by RTT. |
| OPPO | We don’t need to specify which scenarios it should be extended. |
| vivo | We prefer a simple way, e.g. UE always extends the CG timer in NTN. |
| MediaTek | This can be left to the network decision, e.g. by introducing a new field in ConfiguredGrantConfig. |
| Qualcomm | If blind retransmission is not used, this timer should always be extended by UE-gNB RTT for HARQ state A. But for HARQ state B, this timer does not need to be used. |
| Samsung | For all cases, no need to differentiate cases. |
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**Issue 2) Impact of UL HARQ mode to CG timer**

In [6] and [19] it is proposed that the configured HARQ mode be associated with the configuration of the CG timer, for example:

* For the configured grant for which the *configuredGrantTimer* is configured, the HARQ retransmission state is considered to be “mode A”.
* For the configured grant for which the *configuredGrantTimer* is NOT configured, the HARQ retransmission state is considered to be “mode B”.

It is further noted in both contributions that for the case the configuredGrantTimer is configured, the value of needs to be configured sufficiently long (e.g. extended by UE-gNB RTT [19]) however this is addressed in another Issue.

**Question 13:** **Do you agree UL HARQ mode is associated with *configuredGrantTimer* configuration (i.e., *configuredGrantTimer* configured = HARQ mode A and *configuredGrantTimer* NOT configured = HARQ mode B)?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Xiaomi | disagree | We do not see the relation between the configuration of configuredGrantTimer and HARQ mode |
| Nokia | Disagree | It is NW implementation to guarantee that the calculated HARQ processes for a configured grant configuration have the same HARQ mode, no need to specify it in CG level. |
| Huawei,  HiSilicon | Disagree | We see no reason to mix the configuration of CG timer with the configutation of CG HARQ mode. |
| OPPO | Disagree | We don’t want to couple the two configuration, because we haven’t reached any agreement that CG timer is not configured for mode B. |
| vivo |  | Seems a stage 3 issue. We suggest to postpone this issue after RAN2 concludes that HARQ state is also applied to CG. |
| MediaTek | Disagree | *configuredGrantTimer* is per CG configuration, but the HARQ mode A/B is on HARQ process basis. There is no need to map HARQ mode to CGT, the network should configure CGT appropriately.  For an NTN cell, CGT, if configured, should always be offset by UE-gNB RTT. |
| Qualcomm | Agree | What we understand the question is, for a CG associated with HARQ state B, the CG timer does not need to be used. As there is no retransmission expected, there is no point in running this time.  **Note:** running this CG timer means blocking transmission of same HARQ process ID for any other CG configurations. CG timer is per HARQ process regardless how many CG is configured. This delay is really worse in NTN due to large RTT. We request companies to consider this aspect. |
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# Summary

<To be generated pending company feedback>

# Conclusion

In this contribution the following proposals are suggested based on contributions submitted to RAN2#116e AI 8.10.2.2:

<To be generated pending company feedback>

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