3GPP RAN WG2 Meeting #115e R2-2108883

eMeeting August 9th – 27th, 2021

Agenda Item: 8.10.2.2

Source: InterDigital (summary rapporteur)

Title: [DRAFT] Summary of [AT115-e][101][NTN] Other MAC aspects

Document for: Discussion, Decision

# Introduction

This document continues discussion on agenda item 8.10.2.2 – Other MAC aspects as per the following:

* [AT115-e][101][NTN] Other MAC aspects (InterDigital)

Scope: Continue the discussion on a revision of p1-p6 and p8 from R2-2109031

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

* List of proposals for agreement (if any)
* List of proposals for further discussion
* List of proposals that should not be pursued (if any)

The following deadlines have been provided:

* Final deadline (for companies' feedback): **Thursday 2021-08-19 1600 UTC**
* Final deadline (for rapporteur's summary in R2-2108883): **Thursday 2021-08-19 2200 UTC**

The following guidance has been further provided by session chair:

*Proposals marked "for agreement" in R2-2108883 not challenged until* ***Friday 2021-08-20 1000*** *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).*

A summary of discussion topics based on company contribution to RAN2#115e is provided in [Pre115e][101][NTN] (R2-2109031). Companies are encouraged to review this document for relevant background.

# UL HARQ retransmission and LCP

## UL HARQ retransmission state: definition and indication

In RAN2#113bis-e, it was agreed to avoid NTN UE in HARQ stalling state, the NW can continuously schedule UE using one or a combination of scheduling strategies including: without HARQ retransmissions, with blind retransmissions, or with HARQ retransmissions based on UL decoding result.

Due to the different scheduling strategies, HARQ processes with different delay/reliability attributes may coexist. For example, HARQ retransmissions based on UL decoding result may take one or more RTTs to complete retransmisson, possibly causing excessive delay. Transmissions without HARQ retransmission risks packet loss if the data was not successfully decoded and higher-layer retransmissions (e.g. RLC) are not available.

In RAN2#113bis-e, RAN2 confirmed that in NTN if the UE is in DRX Active Time for any reason, the UE should monitor the PDCCH regardless of whether *drx-HARQ-RTT-TimerUL* is running or not. This allows UE to receive an UL retransmission grant blindly (i.e not based on UL decoding result) while UE is in DRX Active Time for other reasons (as long as RAN1 restrictions are satisfied). Blind retransmission can provide additional reliability via retransmission, but is also beneficial from a latency perspective as retransmission grant is received before the UL decoding result (i.e. less that one RTT).

For UE to know: 1) reliability/delay characteristics of a HARQ process at time of LCP; and 2) proper *drx-HARQ-RTT-TimerUL* behaviour, a large majority of companies support semi-static configuration of an UL HARQ retransmission state per HARQ process. To ensure that high-reliability data and low latency data are suitably mapped, two HARQ retransmission states may be defined.

**Question 1: Do you agree the following UL HARQ retransmission states are defined and optionally configured per HARQ process?:**

1. **“High reliability HARQ process”: supports scheduling strategies “with HARQ retransmissions based on UL decoding result” and “with blind retransmissions”;**
2. **“Low-latency HARQ Process”: supports scheduling strategies “without HARQ retransmissions” and “with blind retransmissions”.**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Xiaomi | Disagree | We do not agree with the classification, the main differentiator should be delay rather than reliability, as delay is the motivation of introducing HARQ enable/disable. Reliability can be dynamically implemented based on gNB blind scheduling strategy without HARQ differentiation, similar to the current UL grant for IIOT/URLLC. Thus, we prefer the following classification:   1. High latency HARQ process: supports scheduling strategies “with HARQ retransmissions based on UL decoding result” 2. Low latency HARQ process: supports scheduling strategies “without HARQ retransmissions” and “with blind retransmissions” |
| CATT | Agree with comments | The blind retransmission can be used to increase reliability without bringing any delay, so the blind retransmission can be applied to HARQ process with requirement of “high reliability” or “low-latency”. Thus, we prefer the following description.  1. High latency HARQ process: supports scheduling strategies “with HARQ retransmissions based on UL decoding result”  2. Low latency HARQ process: supports scheduling strategies “without HARQ retransmissions”  The HARQ process in above two strategies can also be configured with blind retransmission. |
| Lenovo | Agree with comments | UL HARQ retransmission states are better to be aligned with whether UL HARQ retransmission enabled/disabled for less complexity. Therefore blind retransmission is better to be included in just one state. That is, for example, if “UL HARQ retransmission enabled” includes “HARQ retransmissions based on UL decoding result” and “blind retransmissions”, the “high reliability HARQ process” supports scheduling strategies “with HARQ retransmissions based on UL decoding result” and “with blind retransmissions”. |
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For DL, HARQ feedback is enabled/disabled in Rel-17, but HARQ processes remain configured. The criteria and decision to enable/disable HARQ feedback is under network control and is signalled to the UE via RRC in a semi-static manner. If UL HARQ retransmission state is configured, A similar agreement may also apply.

**Question 2:** **If “agree” to Question 3, do you agree** **UL HARQ retransmission state configuration is semi-static, signalled via RRC, and the decision and criteria to configure UL HARQ retransmission for a HARQ process is under network control?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Xiaomi | Yes | Semi-static manner via RRC is enough |
| CATT | Yes | semi-static manner is more better. |
| Lenovo | Yes | Semi-static manner via RRC is sufficient. |
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Assuming a HARQ process may be configured with an UL HARQ retransmission state which supports a subset of scheduling strategies (exact supported strategies are pending on outcome to Q3), UE should expect that for UL grants assigned to that HARQ process network will schedule according to those strategies. However, UE may receive a grant with an unexpected NDI value (e.g. for a high reliability HARQ process, NDI indicating new transmission before UE-gNB RTT, or for low-latency HARQ process NDI indicating retransmission after UE-gNB RTT). In this case, UE behaviour is to be determined.

**Question 3:** **If a HARQ process is configured with an UL HARQ retransmission state and UE receives grant with an unexpected NDI value (e.g. for a high reliability HARQ process, NDI indicating new transmission before UE-gNB RTT), what is preferred UE behaviour?**

1. **UE shall** **act as indicated in the grant/assignment (as in legacy);**
2. **UE shall ignore UL grant;**
3. **Other, please describe**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Xiaomi | Option 1 | No need to change |
| CATT | Option 1 | The scheduling strategies is based on network implementation, if the above scenario in Q3 is happened, the UE should act as indicated in the grant/assihnment. |
| Lenovo | Option 1 | No spec change needed. |
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In RAN2#114e, a compromise proposal was suggested by the vice chair which allows both semi-staitc configuration of HARQ process(es) and legacy behaviour via configuration. In [AT114-e][103][NTN] Other MAC aspects: Phase 2, this proposal (as is or minor modifications) were acceptable to 15/17 companies. Rapporteur therefore suggests a similar proposal which allows both semi-statically configured UL HARQ retransmission and the option to schedule as per legacy behaviour.

**Question 4:** **Do you agree if a HARQ process is not configured with an UL HARQ retransmission state, the network may schedule according to any scheme (i.e. as in legacy)?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Xiaomi | Agree | Legacy behaviour applies |
| CATT | Agree |  |
| Lenovo | Agree | No spec change needed. |
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## Details of new mapping restriction

From the agreement in RAN2#115e, it is currently FFS how an LCH is mapped to one or more HARQ process(es):

*For dynamic grants, each LCH can optionally be semi statically configured (by RRC) to be mapped to one or more HARQ processes (FFS if it's possible to map to more than one HARQ process/ process type. FFS on mapping method). If there is no RRC configuration for this, this mapping has no effect (legacy behaviour applies).*

In general there are two methods proposed to map LCH to one or more HARQ process(es): directly to a HARQ process, or indirectly via mapping to an UL HARQ retransmission state. A simplified example of each can be seen below:



**Figure 1:** Possible mapping rules for new mapping restriction (simplified).

In Option 1, an LCH is mapped directly to one or more HARQ process(es). If UE receives a grant assigned to a HARQ process that the LCH is mapped to, the mapping restriction is satisfied. The advantage of this method is that it is simple. The downside is that it may be restrictive. For example, a suitable UL grant may arrive and be assigned to a HARQ process which the LCH is not mapped to. Even though the the grant may support the LCH’s QoS requirements, the UE will be prevented from multiplexing data from that LCH due to the LCP restriction.

In Option 2, an LCH is mapped to an UL HARQ retransmission state. Upon arrival of an UL grant, UE will check the UL HARQ retransmission state (if configured) of the HARQ process the grant is assigned to. If the UL HARQ retransmission state matches the allowable UL HARQ retransmission state provided by the mapping, the mapping restriction is satisfied. The advantage of this method is that it is flexible. The disadvantage is that it requires two configurations: LCH to a UL HARQ retransmission state, and a HARQ process to a UL HARQ retransmission state (it is noted however that this additional configuration may be necessary anyways e.g. for configuration fo *drx-HARQ-RTT-TimerUL*).

**Question 5:** **Which of the following methods do you support for new mapping rule?:**

1. **An LCH can be optionally mapped directly to one or more HARQ process(es).**
2. **An LCH can be optionally mapped to an UL HARQ retransmissions state.**
3. **Other, please describe.**

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| **Company** | **Supported option(s)** | **Additional comments** |
| Xiaomi | Option 2 | We do not see the benefit of per HARQ process granularity, which further limit the number of available HARQ processes. Thus, we prefer retransmission state granularity. |
| CATT | Option 2 | Option 2 is more flexible. For the option 1, if the UL HARQ retransmission state is changed for the HARQ process by network, LCP mapping restriction regarding “HARQ process” of LCH configuration should also be updated. So, we prefer the UL HARQ retransmission state. |
| Lenovo | Option 2 | Option 2 is preferred for flexibility. |
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In the agreement from RAN2#115e, it is also stated that if no RRC configuration is provided (i.e. LCH is not configured with new mapping rule), the the mapping has no effect and legacy behaviour applies:

*For dynamic grants, each LCH can optionally be semi statically configured (by RRC) to be mapped to one or more HARQ processes (FFS if it's possible to map to more than one HARQ process/ process type. FFS on mapping method). If there is no RRC configuration for this, this mapping has no effect (legacy behaviour applies).*

However, Option 2 requires two RRC configurations: one RRC configuration mapping LCH to UL HARQ retransmission state, and the other mapping HARQ process to UL HARQ retransmission state. As can be seen in Figure 1, UE behaviour needs to be defined for the case when the new LCP restriction is configured for the LCH, but an UL HARQ retransmission state has not be configured for the HARQ process the UL grant is assigned to. To align with above agreement, it is suggested that UE may also apply legacy behaviour in this case (i.e. mapping has no effect).

**Question 6:** **Do you agree that if HARQ process has not been configured with an UL HARQ retransmission state, new mapping rule has no effect (i.e. UE applies legacy behaviour)?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| Lenovo | Yes |  |
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# DRX-HARQ-RTT-TimerUL

## Drx-HARQ-RTT-TimerUL

In RAN2#113e it was agreed that in NTN, the *drx-HARQ-RTT-TimerUL* is configured per UE DRX group and the behaviour can be configured per HARQ process. In RAN2#114e, the following agreement was made capturing possible supported behaviours:

*The following options are supported for drx-HARQ-RTT-TimerUL in NTN per HARQ process: 1) Timer length is extended by offset; 2) Timer set to zero and/or 3) Timer disabled (i.e. not started). FFS if this is based on explicit configuration or not. We can also come back to see whether both 2 and 3 are needed.*

Nearly all companies contributing to this topic [1, 10, 11, 14, 15, 17, 20]propose to support only two behaviours. This section presents a summary of company views regarding support of setting the *drx-HARQ-RTT-TimerUL* to zero vs. not starting the timer.

**Timer not started** [1, 4, 11, 14, 15, 20]

Proponenents of not starting the *drx-HARQ-RTT-TimerUL* mention that the UE has no need to monitor the PDCCH for retransmissions since it will never come, causing unnecessary power consumption [11, 20]. Though noted in [1] that to support the *drx-RetransmissionTimerUL* a moderate spec change is needed to receive blind retransmissions, this may not be necessary as the UE can rely on other timers such as the *drx-InactivityTimer* or *drx-onDurationTimer* [15]. Additional arguments are that not starting the timer is aligned with behaviour for *drx-HARQ-RTT-TimerDL* [4, 11], and that considering *drx-HARQ-RTT-TimerUL* value in current specs is configured per *DRX-Config*, to avoid too many spec impact it is proposed to reuse the same principle here that only one value for *drx-HARQ-RTT-TimerUL* is configured [14].

**Timer set to zero** [3, 10, 17]

In addition to less specification impact [3] the key motivation for setting the *drx-HARQ-RTT-TimerUL* is to facilitate reception of blind retransmission grant. According to [10], reliance on the DRX inactivity timer to receive blind retransmission grants may not be suitable, noting that retransmission scheduling will not restart the DRX inactivity timer and will thus will limit the number of scheduled retransmissions, especially when time diversity is applied in retransmission scheduling or when radio is overloaded. Furthermore, if the inactivity timer length is no less than DRX retransmission timer (it is possibly the case) there is no gain in not setting the timer to 0. [17] mentions that reliability may not be ensured because the reliability relies on one-shot transmission (i.e. due to reduced ability to schedule a retransmission). The requirement of the NTN service may therefore not be satisfied according to the LS in R2-2104622, which provides the requirement of packet error rate in NTN is 10-6.

To summarize: nearly all companies contributing to this topic propose that only two *drx-HARQ-RTT-TimerUL* behaviours are supported. All support offset to timer length as one option, and twice as many companies support option 3 (timer disabled). In pre-meeting email discussion it was therefore proposed that behaviour be downscoped to the following two behaviours: 1) Timer length is extended by offset; 2) Timer disabled (i.e. not started).

**Question 7:** **Do you agree the following behaviours are supported for *drx-HARQ-RTT-TimerUL* in NTN per HARQ process: 1) Timer length is extended by offset; 2) Timer disabled (i.e. not started)?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Xiaomi | NO | We prefer timer set to zero instead of disabling the timer. The drawback of timer disabled is that it relies totally on inactivity timer for scheduling retransmission. As discussed in RAN1, for DL, network cannot continuously schedule DL, a minimum gap Xms is required between two consecutive DL scheduling. Similar agreement may be adopted for UL. In that case, inactivity timer may not be able to accommodate enough blind schedulings.Furthermore, if DRX retransmission timer length is smaller than inactivity timer(which is often the case), the two timer overlaps, there is no additional power consumption. |
| CATT | Agree |  |
| Lenovo | Agree |  |
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## Configuration of drx-HARQ-RTT-TimerUL behaviour

In RAN2#114e there was an FFS whether configuration of the *drx-HARQ-RTT-TimerUL* behaviour is performed explicitly or not:

*The following options are supported for drx-HARQ-RTT-TimerUL in NTN per HARQ process: 1) Timer length is extended by offset; 2) Timer set to zero and/or 3) Timer disabled (i.e. not started). FFS if this is based on explicit configuration or not. We can also come back to see whether both 2 and 3 are needed.*

The following presents a summary of proposals addressing this FFS.

**Explicit configuration** [15, 17]

[15] and [17] proposes explicit signalling is added to configure per HARQ process behaviour. [15] additionally proposes that when this new signal is not present, legacy behaviour for drx-HARQ-RTT-TimerUL apply, whereas [17] proposes that network should explicitly configure the drx-HARQ-RTT-TimerUL in a semi-static manner, i.e., RRC signalling.

**Implicit configuration** [10, 20]

[10] and [20] propose that the *drx-HARQ-RTT-TimerUL* behaviour can be implicitly deduced from the configuration of HARQ retransmission scheme, e.g. enabled/disabled, As the configuration of HARQ retransmission scheme is anyway needed for many cases, e.g. LCP, there is no need to have redundant configuration of DRX behaviour. [20] additionally adds that whether the network may additionally choose to override the baseline timer behaviour for an individual HARQ process and configure a custom behaviour may be further considered once the baseline set of agreements are confirmed.

**Question 8:** **Which of the following option(s) do you support for configuration of** ***drx-HARQ-RTT-TimerUL* behaviour?:**

1. **Explicit configuration (i.e. behaviour configured per HARQ process via dedicated RRC signalling);**
2. **Implicit configuration (i.e. behaviour determined implicitely per HARQ process via configured UL HARQ retransmission state, if available);**
3. **Both;**
4. **Other, please describe.**

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| **Company** | **Supported option(s)** | **Additional comments** |
| Xiaomi | Option 1 | Since only two behaviour left, there is no need to have additional IE to explicitly configure the DRX RTT timer behaviour. |
| CATT | Option 2 | The HARQ process should be associated with one UL HARQ retransmission state, the drx-HARQ-RTT-TimerUL behaviour of the HARQ process can be indicated by UL HARQ retansmission state implicitly. |
| Lenovo | Option 2 | The configuration of HARQ retransmission scheme can indicate. |
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In pre-meeting email discussion, Proposal 8 attempted to clarify default *drx-HARQ-RTT-TimerUL* and *drx-RetransmissionTimerUL* behaviour when a UL HARQ retransmission state has not been configured for a HARQ process. Companies are invited to comment on the following proposal:

**Question 9:** **Do you agree for HARQ process(es) not configured with an UL HARQ retransmission state, *drx-HARQ-RTT-TimerUL* (unless explicitly configured with** **a different behaviour) and *drx-RetransmissionTimerUL* behave as per legacy?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| Lenovo | Yes |  |
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# Summary

<To be generated based on discussion outcome>

# Conclusion

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# References

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10. [R2-2107986](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2107986.zip) Consideration on HARQ aspects – Beijing Xiaomi Mobile Software
11. [R2-2108115](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108115.zip) Discussion on remaining MAC issues for NR NTN – Nokia, Nokia Shanghai Bell
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