3GPP RAN WG2 Meeting #113e R2-2102013

eMeeting January 25th – February 5th, 2021

Agenda Item: 8.10.2.2

Source: InterDigital (email discussion rapporteur)

Title: [DRAFT] [AT113-e][103][NTN] HARQ aspects

Document for: Discussion, Decision

# Introduction

This discussion document is intended to enable continuation of user plane discussions from RAN2#113e, specifically relating to HARQ-related aspects as per the offline description below:

* [AT113-e][103][NTN] HARQ aspects (InterDigital)

Scope: Discuss HARQ timer aspects from [R2-2101573](file:///C:\Data\3GPP\Extracts\R2-2101573%20(R17%20NTN%20WI%20AI%208.10.2.2)%20HARQ%20RTT%20Timers.docx) as well as disabling UL HARQ aspects

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 deadlines have been provided by the session chair:

* Initial deadline (for companies' feedback): **Monday 2021-02-01 17:00 UTC**
* Initial deadline (for rapporteur's summary in R2-2102013): **Monday 2021-02-01 23:00 UTC**

Please also note the following additional deadline for comment to rapporteur summary and conclusions:

* Proposals marked "for agreement" in R2-2102013 not challenged until **Tuesday 2020-02-02 11:00** UTC will be declared as agreed by the session chair. For the rest the discussion will continue online.

# DL HARQ Feedback

## drx-HARQ-RTT-TimerDL

From RAN2#112e [1] it was agreed that for UE with pre-compensation capability and for HARQ processes where DL HARQ feedback is enabled, *drx-HARQ-RTT-TimerDL* is offset by UE-specific RTT (UE-gNB delay). It is currently FFS if the offset is applied to 1) the start of the timers or 2) the timer value range (i.e. existing values within value range increased by offset).

In TS 38.321 [2], *drx-HARQ-RTT-TimerDL* is defined as the minimum duration before a DL assignment for HARQ retransmission is expected at the MAC entity. In NTN, this minimum duration is increased due to larger propagation delay, which is represented by the UE-specific RTT offset.

In [3], it is suggested that any increase in minimum duration should be reflected by an increase in the timer. Therefore, the existing values of *drx-HARQ-RTT-TimerDL* within the value range should be increased proportional to the UE-gNB delay for HARQ processes with HARQ feedback enabled.

**Question 1: Do you agree that for HARQ processes with DL HARQ feedback enabled, *drx-HARQ-RTT-TimerDL* length is increased by UE-specific RTT offset (i.e. existing values within value range increased by offset)?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| APT | Agree | To extend the value of the timer can achieve less specification impact since the change on the timing of timer’s start is not needed. |
| Panasonic | Agree | Extending current value range of drx-HARQ-RTT-TimerDL is simplest option. |
| Huawei, HiSilicon | Agree | As the intention of *drx-HARQ-RTT-Timer* is for UE to avoid monitoring PDCCH during HARQ RTT, the offset should be applied to the timer value range. Otherwise if the offset is applied to delay the start of the timer, the UE behaviour during the offset (i.e. before the timer is started) will be vague and will need extra clarification. |
| Lenovo | Agree | Extending *drx-HARQ-RTT-TimerDL* length with UE-specific RTT offset will ensure avoidance of unnecessary PDCCH monitoring for UE in NTN. |
| CATT | Agree | If *drx-HARQ-RTT-TimerDL* length is increased by UE-specific RTT offset, the UE does not need to monitor the PDCCH for DL assignment before the *drx-HARQ-RTT-TimerDL* expires. This means more power saving. |
| Spreadtrum | Agree | It is good to power saving if *drx-HARQ-RTT-TimerDL* is extended with UE-specific RTT offset. |
| Samsung | Agree with clarification | We would like to clarify that this “value extension approach” will not alter the existing parameter settings in relevant Information Elements and that the UE would simply use a formula shown below as Eq. (1).  We suggest that RAN2 utilize the same generic framework for parameters such as drx-HARQ-RTT-TimerDL, drx-HARQ-RTT-TimerUL, ra-ResponseWindow, ra-ContentionResolutionTimer, and sr-ProhibitTimer instead of treating them seperately. All of these parameters need the UE-gNB RTT offset in an NTN. So the UE can use Eq. (1) to calculate the effective value of these timers.  NTN R17 Parameter Value= (NTN\_delay + R16 Value) Eq.(1),  where NTN\_delay is (i) the UE-specific UE-gNB RTT when accurate or reliable value of UE-gNB RTT is available or (ii) the RTT between the gNB and a hypothetical Reference Point (RP) associated with the location on the cell corresponding to the minimum RP-gNB delay (“minimum NTN delay”) when accurate or reliable value of UE-gNB RTT is unavailable. The Case (ii) applies in the following situations:  (A) A UE does not GNSS-based location available (e.g., due to poor GNSS visibility such as un urban canyons and indoors),  (B) A future (e.g., Release 18) low-complexity and low-cost NTN UE does not have a GNSS capability.  The gNB broadcasts suitable information (e.g., “common” service link delay and feeder link delay) to enable the UE to estimate the RP-gNB RTT in support of Case (ii).  This framework does not need any modification to the Information Elements that define the parameter values in R16. Furthermore, this framework does not need any changes to the start of timers as mentioned by other companies. |
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Behaviour of *drx-HARQ-RTT-TimerDL* for a given HARQ process when DL HARQ feedback is disabled is currently FFS. Referring to MAC specification [2], the condition for starting *drx-HARQ-RTT-TimerDL* is defined as follows:

1> if a MAC PDU is received in a configured downlink assignment:

2> start the *drx-HARQ-RTT-TimerDL* for the corresponding HARQ process in the *first symbol after the end of the corresponding transmission carrying the DL HARQ feedback;*

If HARQ feedback is disabled for a HARQ process, UE will not transmit DL HARQ feedback. According to current specification *drx-HARQ-RTT-TimerDL* is not started.

However, the start condition for *drx-RetransmissionTimerDL* is upon expiry of the corresponding *drx-HARQ-RTT-TimerDL*. If the HARQ RTT Timer not started when DL HARQ feedback is disabled, then neither will the retransmission timer. Previous discussion in [4] has noted this may place limitations on other mechanisms to increase reliability in the absence of DL HARQ feedback such as blind retransmission. Therefore, an alternative proposed is to set *drx-HARQ-RTT-TimerDL* to zero.

To summarize, the following options regarding *drx-HARQ-RTT-TimerDL* behaviour when DL HARQ feedback is disabled are:

**Option 1: *drx-HARQ-RTT-TimerDL* is not started:**

* According to current specification, where the timer is only started upon HARQ feedback transmission.
* May require new start condition to *drx-RetransmissionTimerDL* to enable blind retransmission solution (if agreed).

**Option 2: *drx-HARQ-RTT-TimerDL* is set to zero:**

* Requires new start condition to *drx-HARQ-RTT-TimerDL* to be defined when DL HARQ feedback is disabled.
* Results in *drx-HARQ-RTT-timerDL* being assigned a different value depending on whether HARQ is enabled or not;
* If agreed, no specification change required for *drx-RetransmissionTimerDL* to enable blind retransmission solution.

Considering blind retransmission solutions have yet to be defined and having diverging values based on HARQ feedback state would complicate specification, rapporteur suggests that Option 1 be adopted as per legacy specification.

**Question 2a: Do you agree that for HARQ processes where DL HARQ feedback is disabled, *drx-HARQ-RTT-TimerDL* is not started (as per current specification, where the timer is only started upon HARQ feedback transmission)?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| APT | Agree | If blind retransmission is not supported, option 1 can avoid introducing any specification impact.  If blind retransmission is supported, how to monitor the possible retransmission scheduling can be further considered, e.g., not only the *drx-RetransmissionTimerDL* can be used, but also other methods for monitoring the PDCCH are feasible. |
| Panasonic | Agree | Even if blind retransmission is enabled, UE would rely on drx-InactivityTimer to receive blind retransmission as mentioned in our paper (R2-2101067). Furthermore, this option has minimal specification impact. Therefore, we prefer UE would not start drx-RetrasnmissionTimerDL when DL HARQ feedback is disabled. |
| Huawei, HiSilicon | Agree | No strong view on the two options, but option 1 is simpler for the moment. |
| Lenovo | Agree | Option 1 is simpler as it will no additional start condition to *drx-HARQ-RTT-TimerDL* will be introduced. |
| CATT | Agree | The *drx-HARQ-RTT-TimerDL* should not be started for NTN when the HARQ-feedback is disabled. |
| Spreadtrum | Agree | Option 2 is simpler, with least specification modification. |
| Samsung | Agree | In the network does not want to use blind retransmission for a given UE/HARQ process, this option will be simple to implement.  RAN2 can seek and discuss candidate mechanisms to support blind retransmissions. |
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If *drx-HARQ-RTT-TimerDL* is not started for a HARQ process, according to current specification *drx-RetransmissionTimerDL* will not be started. The *drx-RetransmissionTimerDL* would be beneficial to allow for blind retransmissions. Referring to agreements from RAN1#103e, the following is captured [5]:

*For a DL HARQ process with disabled HARQ feedback, the UE is not expected to receive another PDSCH or set of slot-aggregated PDSCH scheduled for the given HARQ process that starts until [X] after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process.*

* *FFS: value of X and units in which it is defined.*
* *FFS: Whether TB of the two PDSCHs needs to be different*

Therefore, for a HARQ process with disabled DL HARQ feedback, the earliest a blind retransmission could be received after initial PDSCH reception is at least until [X] units have elapsed. One possible option to enable blind retransmission would be to directly start *drx-RetransmissionTimerDL* [X] units after the end of the reception of the last PDSCH or slot-aggregated PDSCH.

**Question 2b: Do you agree for HARQ processes where HARQ feedback is disabled, one option to enabled blind retransmission is to start *drx-RetransmissionTimerDL* [X] units after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process? (RAN1 to define value and units of X).**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| APT | Disagree | Agree with the intention. However, per RAN1 agreement above, it’s still FFS on whether TB of the two PDSCHs is same or different. Probably we can wait for RAN1’s confirmation on retransmission case. On the other hand, some other methods for monitoring PDCCH can also be taken into account. |
| Panasonic | Disagree | As mentioned, our answer in Q2a, UE would rely on drx-InactivityTimer to receive blind retransmission when DL HARQ feedback is disabled. |
| Huawei, HiSilicon | Postpone | This issue can wait for more RAN1 progress. |
| Lenovo | Postpone | Need to wait for RAN1 decision on FFS. |
| CATT | Postpone | RAN2 can postpone this discussion until RAN1 has some conclusions. |
| Spreadtrum | Postpone | RAN1 conclusion is necessary for further RAN2 discussion. |
| Samsung | Suggestion | We suggest that RAN2 discuss pros and cons of all candidate options to support blind retransmission. |
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# UL HARQ Retransmission

## drx-HARQ-RTT-TimerUL

From the previous meeting, the following was agreed considering the possibility for enabling/disabling HARQ UL retransmission:

*From RAN2 perspective, for dynamic grant, one possibility for "enabling"/"disabling" HARQ uplink retransmission at UE transmitter is without introducing an additional mechanism (i.e. gNB can send grant with NDI not toggled/toggled without waiting for decoding result of previous PUSCH transmission). FFS on the handling of RTT timers. Other solutions for enabling/disabling HARQ UL reTX are not precluded*

Interpretation of this agreement is that “enabling” HARQ uplink retransmission requires the gNB to receive the TB, attempt to decode it, and if unsuccessful provide the UE with an UL retransmission grant as in legacy operation. This would take at least one UE-specific RTT. Though discussed, no agreement has been made regarding modification of *drx-HARQ-RTT-TimerUL* when UL HARQ retransmission is “enabled”.

As in DL, MAC specification defines *drx-HARQ-RTT-TimerUL* as the minimum duration before a UL HARQ retransmission grant is expected by the MAC entity. It is suggested in [3] that considering this minimum duration requires at least one RTT, the existing values of *drx-HARQ-RTT-TimerUL* within the existing value range should be increased proportionally for HARQ processes where UL HARQ retransmission is enabled.

**Question 3: Do you agree that for HARQ processes with UL HARQ retransmission ‘enabled’, *drx-HARQ-RTT-TimerUL* length is increased by UE-specific RTT offset (i.e. existing values within value range increased by offset)?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| APT | Agree | Same as *drx-HARQ-RTT-TimerDL.* |
| Panasonic | Agree | Same as drx-HARQ-RTT-TimerDL |
| Huawei, HiSilicon | Agree |  |
| Lenovo | Agree | Same as *drx-HARQ-RTT-TimerDL*. |
| CATT | Agree |  |
| Spreadtrum | Agree | Same as *drx-HARQ-RTT-TimerDL* |
| Samsung | Agree with clarification | Please see our response to Question 1. Thanks. |
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By similar reasoning “disabling” HARQ uplink retransmission allows the gNB to provide a grant assigned to the HARQ process before waiting on the decoding results of the previous PUSCH transmission, with the intention to enable the HARQ PID to be reused faster than one RTT and avoid HARQ stalling.

One implication of this is that the network may provide the UE a grant at any time immediately after the PUSCH transmission up until at least one RTT, which may introduce considerable power consumption due to continuous monitoring.

**Question 4: Is the common understanding that the network can schedule subsequent grants without any restrictions if HARQ UL retransmission is disabled?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| APT | Agree | The scheduling aspect is dependent on NW implementation. |
| Panasonic | Agree | The blind retransmissions are control by NW so NW can schedule blind retransmission based on its implementation. (for e.g. according to channel condition, system load and service requirement) |
| Huawei, HiSilicon | Agree | Same view as APT and Panasonic. |
| Lenovo | Agree | NW implementation is OK. |
| CATT | Agree | It is up to network implementation. |
| Spreadtrum | Agree | gNB implementation is enough. |
| Samsung | Agree | Yes- this scheduling is up to the gNB. |
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How HARQ timers (i.e. *drx-HARQ-RTT-TimerUL*) are handled when HARQ UL retransmission is ‘disabled’ is currently FFS. There are several options on how to handle the timer:

* **Option 1:** Timer is offset by UE-gNB RTT (as per question 3)
* **Option 2:** A different set of values is used for timer if UL retransmission is enabled/disabled (e.g. offset applied to enabled case, but not disabled)
* **Option 3:** Timer is not started if UL retransmission is disabled:
* **Option 4:** Timer is set to ‘0’ if UL retransmission is disabled:

Option1 would provide consistent timer behaviour between enabled/disabled HARQ UL retransmission but is undesirable as the UE may miss any subsequent grants sent during the offset time.

Option 2 would enable flexibility on the network side in the case that restrictions are introduced on when the gNB can send a retransmission grant (pending outcome of Question 4). Option 3 would require additional specification of *drx-RetransmissionTimerUL* start condition, however pending outcome of Question 2a may provide consistent HARQ RTT timer behaviour between disabling of DL HARQ feedback and UL HARQ retransmission.

For Option 4, if HARQ UL retransmission is disabled, there should be no reason to restrict the network to schedule a subsequent grant as soon as possible, thus no need to wait for HARQ RTT timer expiry. In this case, *drx-HARQ-RTT-TimerUL* could be set to zero, with *drx-RetransmissionTimerUL* starting at expiry of RTT Timer.

**Question 5: What is the preferred option for handling *drx-HARQ-RTT-TimerUL*** **when HARQ UL retransmission is ‘disabled’ (i.e. gNB can send grant with NDI not toggled/toggled without waiting for decoding result of previous PUSCH transmission)?**

* **Option 1: Timer is offset by UE-gNB RTT**
* **Option 2: A different set of values is used for timer if UL retransmission is enabled/disabled**
* **Option 3: Timer is not started if UL retransmission is disabled**
* **Option 4: Timer is set to ‘0’ if UL retransmission is disabled**
* **Option 5: Other (please describe)**

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| **Company** | **Preferred Option** | **Additional comments** |
| APT | Option 3 | It’s better to align the behavior with *drx-HARQ-RTT-TimerDL*. Moreover, how to monitor the subsequent UL scheduling can be FFS. |
| Panasonic | Option 3 | UE would rely on drx-InactivityTimer to receive blind UL retransmission when UL retransmission is disabled. |
| Huawei, HiSilicon | Option 3 | We also prefer to align the DL/UL behaviour.  Besides, since it is still FFS whether semi-statically configuring a HARQ process with enabled/disabled UL retransmission via RRC signalling will be introduced, we think the discussion on handling drx-HARQ-RTT-TimerUL when HARQ UL retransmission is ‘disabled’ can be postponed a bit. |
| Lenovo | Option 3 | We prefer a simpler option aligning with DL. |
| CATT | Option 3 | It’s better to align the DL/UL behaviour.  If the *drx-HARQ-RTT-TimerUL* is not started for NTN when HARQ UL retransmission is disabled, the new start condition of *drx-RetransmissionTimerDL* to enable blind retransmission can be considered (the transmission of PUSCH). |
| Spreadtrum | Option4 | Option 4 introduces least specification modification |
| Samsung | Option 3 |  |
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Support for the above options may require additional signalling/configuration for the UE to know whether HARQ UL retransmission is enabled or disabled (e.g. to know which value range to apply or to not start the timer). This can be further discussed, as per agreement “*Other solutions for enabling/disabling HARQ UL reTX are not precluded”.*

**Question 6: If we go with option 2-4 in Question 5, is it necessary to explicitly indicate to the UE whether HARQ UL retransmission is enabled/disabled? (NOTE: it is assumed indication is on a per-HARQ process granularity).**

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| **Company** | **Yes/No** | **Additional comments** |
| APT | Yes | UE should know whether the corresponding HARQ process is enable/disable. |
| Panasonic | Yes | In order to start HARQ-RTT-Timer, UE should know in advance whether HARQ feedback is enabled or disabled for the corresponding HARQ process. |
| Huawei, HiSilicon | Yes | We prefer to adopt the same solution as DL: via RRC signalling in a semi-static manner |
| Lenovo | Yes | UE needs to know whether a HARQ process is enabled/disabled for e.g. starting *HARQ-RTT-TimerUL*. |
| CATT | Yes | Similar view as APT and Lenovo. |
| Spreadtrum | Yes | UE shall be configured the type of HARQ process. |
| Samsung | Yes | If the UE knows which HARQ process enabled or disabled, it can properly place signaling and data traffic on suitable HARQ processes. |
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**Question 7: Are there any other NTN-specific HARQ timer/HARQ UL retransmission aspects RAN2 needs to discuss?**

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| **Company** | **Yes/No** | **Other Aspects** |
| Samsung | Yes | HARQ stalling was mentioned in TR38.821 but we have not seen any discussion on that topic yet. HARQ stalling can occur when the UE is continuously receiving information or operating in the DRX mode. For example, a UE in the DRX mode would unnecessarily monitor PDCCHs when HARQ stalling occurs, leading to the waste of precious battery power. Since a limited number of HARQ processes (e.g., 32) cannot cover long propagation delays for GEOs and LEOs in higher orbits and since user resource allocation per user in a slot may need to limited to support more users per slot, HARQ stalling may occur frequently.  We would like to seek opinions of contributing companies about this topic. |
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# Summary

<To be generated pending company input>

# Conclusion

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# Contact Information

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# References

1. Draft\_RAN2\_112-e\_Meeting\_Report\_v2
2. 3GPP TS 38.321 v16.3.0 Medium Access Control (MAC) protocol specification
3. R2-2101573 HARQ timer aspects – InterDigital
4. R2-2008188 Summary of [AT111][107][NTN] Pre-compensation and other MAC issues - InterDigital
5. Draft\_Minutes\_report\_RAN1#103-e\_v020