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)?**

|  |  |  |
| --- | --- | --- |
| **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. |
| Intel | agree |  |
| MediaTek | Agree |  |
| LG | Disagree | We prefer to apply the offset to start of the timers.  RAN2 agreed that the offset is introduced in order to delay the start of the ra-ContentionResolutionTimer. Thus, the same principle can be applied to the HARQ drx-HARQ-RTT-TimerDL., e.g., if the offset is introduced for HARQ drx-HARQ-RTT-TimerDL, the value of drx-HARQ-RTT-TimerDL should not be changed.  Regarding Huawei’s concern on extra clarification:  We see no need of extra clarification. Even today, we do not specify the UE behaviour for out of Active Time. The important thing is when Active Time starts/ends and offset period is definitely not Active Time. |
| Nokia | Disagree | We think how to apply offset to *drx-HARQ-RTT-TimerDL* should follow the same way as *ra-ResponseWindow,* to keep the overall NTN solution simple. Since how to apply offset to *ra-ResponseWindow* is not decided yet (it is postponed until further progress in RAN1 regarding UE pre-compensation method and TA estimation accuracy, according to RAN2-112e agreement),we prefer to keep it as FFS. |
| OPPO | Disagree | Apply the offset to the start of *drx-HARQ-RTT-TimerDL* could be specified in a simple way, and the UE behaviour during the offset does not need to be specified. |
| ZTE | Agree, and | In general we agree that that an offset equals to UE-specific RTT shall be used to extend the *drx-HARQ-RTT-TimerDL* length for power saving consideration. But it is uncertain from this proposal whether this value is configurable by NW or is automatically adjusted by UE. From our perspective, it is important that NW and UE’s understanding on the RTT timer length shall be aligned, therefore this offset shall be configured by NW. |
| Qualcomm | Agree | But in our view both are same. Start offset would be used as a timer to delay the RTT timer. If we do not define anything, UE is not considered to be in active time solely because of this timer. |
| Xiaomi | Agree | Extend the timer has less spec impact. |
| Ericsson | Disagree, wait RAN1 progress on pre-compensation and TA estimation. | The agreement at RAN2#112e was not correct. UE specific RTT offset needs to be defined in the agreement and it is not the UE-gNB delay.  The offset depends on when the timer is started, and it also depends on the alignment between UL and DL, which is an issue still being discussed in RAN1.  We think the timer shall be started AFTER the offset time has passed.  Currently the UE do not expect a retransmission while the HARQ RTT Timer is running (we suggest removing this restriction in R2-2101493), thus adding an offset to the value of the timer will severely increase the time when a retransmission assignment cannot be sent to the UE. As noted by LG, during the offset time the UE will not be in the Active Time (if not for other reasons, like the *drx-InactivityTimer* running), thus the offset time do not affect the UE power consumption.  In legacy, the *drx-HARQ-RTT-TimerDL* is started “in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback”. It does not say if this is the first UL symbol or the first DL symbol after transmission of HARQ feedback.  In legacy, it did not make much difference as the UL and DL were not much shifted versus each other in the UE. We think the reasonable interpretation is to base the starting of the timer on the DL timing, as it controls the monitoring of PDCCH in the DL.  We propose to clarify that *drx-HARQ-RTT-TimerDL* shall be started based on the DL symbol. That is, *drx-HARQ-RTT-TimerDL* is started on the first DL symbol that has the same system frame number, the same slot number and the same symbol number as the first UL symbol after the end of the HARQ feedback transmission, for example:  2> start the *drx-HARQ-RTT-TimerDL* for the corresponding HARQ process in the downlink symbol that has the same symbol number, slot number and system frame number as the first uplink symbol after the end of the corresponding transmission carrying the DL HARQ feedback;  If UL and DL are aligned in the gNB, starting *drx-HARQ-RTT-TimerDL* based on the DL timing requires an offset of zero before starting the timer.  If UL and DL are aligned in the satellite (or some reference point), starting *drx-HARQ-RTT-TimerDL* based on the DL timing requires an offset equal to the RTT between the satellite and the gNB (still being discussed in RAN1 exactly what the common TA is and how it shall be provided to the UE) before starting the timer (corresponding adjustments for other reference points than the satellite).  We agree with Nokia, this discussion is difficult to conclude before we have the RAN1 agreements. Therefore we propose to postpone this unti RAN1 have concluded. |
| Apple | Agree, but | We prefer to wait for RAN1s progress on pre-compensation and TA accuracy to decide on this as suggested by Nokia and Ericsson. |
| China Telecom | Agree | It is simpler compared with changing the start time with offset. |
| Vodafone | Agree |  |

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)?**

|  |  |  |
| --- | --- | --- |
| **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. |
| Intel | agree |  |
| MediaTek | Agree |  |
| LG | Prefer common solution for UL and DL | We want to make a common solution for the DL and UL.  - Option 1. drx-HARQ-RTT-TimerDL/ drx-HARQ-RTT-TimerUL is not started  For DL, we see no spec impact unless blind retransmission is supported. To support blind retransmission, a new start condition is required for drx-RetransmissionTimerDL.  For UL, it requires a new condition of not starting drx-HARQ-RTT-TimerUL because, currently, drx-HARQ-RTT-TimerUL always starts when the MAC PDU is transmitted on PUSCH.  - Option 2. drx-HARQ-RTT-TimerDL/ drx-HARQ-RTT-TimerUL are set to zero  For DL, it requires a new start condition because, currently, drx-HARQ-RTT-TimerDL does not start when feedback is not transmitted.  For UL, we see no spec impact. Furthermore, blind retransmission can be naturally supported.  Considering the specification impact and support of blind retransmission, we prefer option 2. |
| Nokia | Agree | Option1 has less specification impact. How to start *drx-RetransmissionTimerDL* for blind retransmission can be further discussed. |
| OPPO | Agree | *drx-HARQ-RTT-TimerDL* is not needed when HARQ-feedback is disabled, and introducing a new start condition to *drx-RetransmissionTimerDL* is straightforward and optional for blind retransmission. |
| ZTE | Disagree | Either option 1 and option 2 requires specs impact, and from our perspective option 2 is simper to allow blind retransmission which is beneficial to improve transmission reliability. |
| Qualcomm | Agree | We are ok just to define the start of DRX retransmission timer. |
| Xiaomi | Disagree | Option 2 is better, it has less spec change. Besides, network can configure non-zero value to enable time diversity and save UE power, i.e. UE doesn’t need to monitor PDCCH during the RTT timer. |
| Ericsson | Agree | About blind retransmissions:  Even if *drx-HARQ-RTT-TimerDL* is not running, the RAN1 spec limits the sending of an assignment on the same HP ID until the HARQ feedback is sent – RAN1 is discussing how this shall be interpreted in the case HARQ feedback is disabled, see question 2b.  Note that the *drx-InactivityTimer* in the UE will be started/restarted by the received PDCCH when NDI is toggled for dynamic scheduling and this can support blind retransmissions instead of using *drx-RetransmissionTimerDL*.  For DL SPS, it defeats the purpose to use blind retransmissions – instead the gNB can reconfigure the DL SPS, e.g., according to a new propagation situation, including configuring pdsch-AggregationFactor if multiple slots are needed for coverage/reliability. |
| Apple | Agree | No strong preference on 1 or 2. |
| China Telecom | Agree |  |
| Vodafone | Agree | Option 1 is preferred |

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).**

|  |  |  |
| --- | --- | --- |
| **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. |
| Intel | postpone | Wait for RAN1 for more detail |
| MediaTek | Disagree | Agree with that we need to wait for RAN1’s progress and confirmation. |
| LG | Disagree | Regardless of RAN1 decision, there is no problem to start *drx-RetransmissionTimer* immediately. Delaying start of *drx-RetransmissionTimer* by[x] units may have least impact on power saving and we prefer to make the DRX operation as simple as possible. |
| Nokia | Disagree | Similar view as APT. |
| OPPO | Disagree | In our understanding, the intention of [X] is to let UE have enough time to process the received PDSCH considering the UE’s process capability.  It is possible that UE receives the DL assignment on PDCCH indicating the next PDSCH during the time interval [X]. Therefore, after receiving the previous PDSCH, UE can expect the monitoring of PDCCH.  For a DL HARQ process with disabled HARQ feedback, RAN2 can wait for RAN1 conclusion to further discuss when UE starts *drx-RetransmissionTimerDL* for the corresponding HARQ process. |
| ZTE | Postpone | Agree with other companies more RAN1 input is needed for this topic. |
| Qualcomm | Agree | RAN2 already agreed that even HARQ feedback is disabled, HARQ process is assumed configured. This is to allow to use the DRX retransmission timer. For network to schedule new transmission or retransmission, the DRX retransmission timer keeps UE up. Also, expiry of DRX retransmission timer tells UE how long it should wait before flushing the HARQ buffer. |
| Xiaomi | Disagree | We prefer to reuse current behaviour, that is RTT timer triggers retransmission timer. |
| Ericsson | Disagree | This introduce new functionality that is already supported. We shall not introduce two ways to do the same thing.  X will probably be a few slots, the *drx-RetransmissionTimerDL* will also be a few slots, thus there is no need to implement a complicated timer starting as we already have the *drx-InactivityTimer* that is usually in the order of tens of milliseconds and will be started at the reception of a new assignment. |
| Apple | Postpone | Until RAN1 discussion is completed. |
| China Telecom | Postpone | Wait for RAN1 conclusion. |
| Vodafone | Postpone | Wait for RAN1 analysis |

# 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)?**

|  |  |  |
| --- | --- | --- |
| **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. |
| Intel | Agree |  |
| MediaTek | Agree |  |
| LG | Disagree | Same as *drx-HARQ-RTT-TimerDL*. |
| Nokia | Disagree | It is not clear about the definition of HARQ processes with UL HARQ retransmission ‘enabled’ in the Question.  In our view, the UL HARQ retransmission ‘enabled’ includes two cases which both support UL HARQ retransmissions. E.g. Case#1) HARQ with retransmissions relying on previous/initial transmission packet decoding result in gNB. Case#2) HARQ with blind retransmissions which is NOT relying on previous/initial transmission packet decoding result in gNB (i.e. no matter previous PUSCH transmission can be decoded successfully or not, gNB will schedule retransmission).  For Case#1, the RTT delay (i.e. duration to wait for initial transmission decoding result) should be considered in gNB retransmission scheduling. Thus how to apply RTT offset should be discussed. Our view is same as Question1.  For Case#2, gNB will blindly schedule uplink retransmission after initial transmission without RTT delay (i.e. no need to wait initial transmission decoding result). It is not needed to apply RTT offset to *drx-HARQ-RTT-TimerUL*. |
| OPPO | Disagree | Same as Q1. We agree to introduce UE-specific RTT as an offset for *drx-HARQ-RTT-TimerUL*, but for the start of *drx-HARQ-RTT-TimerUL.* |
| ZTE | Agree | As we commented in Q1, this offset shall be configured by NW. |
| Qualcomm | Agree | See our response in Q1. |
| Xiaomi | Agree | See our response in Q1 |
| Ericsson | Disagree | The simplest solution is that the gNB configure *drx-HARQ-RTT-TimerUL* and *drx-RetransmissionTimerUL* to the value zero regardless of if gNB intends to do HARQ retransmissions or not. Then the UE can be reached based on the other drx timers like *drx-InactivityTimer* and *drx-OnDuration* which in NTNs will (in worst case) give increased delay but relative the RTT this relative increase will be minor (when drx timers are correctly configured).  For any value other than zero, *drx-HARQ-RTT-TimerUL* shall be started AFTER an offset time have passed (to avoid same issue as for *drx-HARQ-RTT-TimerDL* see Q1), and it shall be started based on the DL timing (same as *drx-HARQ-RTT-TimerDL*):  2> start the *drx-HARQ-RTT-TimerUL* for the corresponding HARQ process in the downlink symbol that has the same symbol number, slot number and system frame number as the first uplink symbol after the end of the first transmission (within a bundle) of the corresponding PUSCH transmission;  If UL and DL are aligned in the gNB, starting *drx-HARQ-RTT-TimerUL* based on the DL timing requires an offset of zero before starting the timer.  If UL and DL are aligned in the satellite (or some other reference point), starting *drx-HARQ-RTT-TimerUL* based on the DL timing requires an offset equal to the RTT between the satellite and the gNB (still being discussed in RAN1 exactly what the common TA is and how it shall be provided to the UE) before starting the timer (corresponding adjustments for other reference points than the satellite). |
| Apple | Agree. |  |
| China Telecom | Agree |  |
| Vodafone | Agree |  |

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?**

|  |  |  |
| --- | --- | --- |
| **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. |
| Intel | Agree |  |
| MediaTek | See comment | There are some specific rules and restrictions, mentioned by RAN1 that restrict when a DCI can be sent (e.g. between scheduling DCI and UL transmissions). These restrictions must still be met. |
| LG | Agree | We would like to raise a naming issue though.  When we say ‘HARQ UL retransmission’ is disabled, it really is not clear what it means because HARQ feedback was not there and HARQ retransmission by gNB implementation was already possible. |
| Nokia | Agree | How to schedule subsequent new transmission grants is up to NW. |
| OPPO | Agree | NW implementation is fine. |
| ZTE | Agree | Can already been supported with current mechanism. |
| Qualcomm | Agree |  |
| Xiaomi | Agree |  |
| Ericsson | Disagree | There is no “**HARQ UL retransmission is disabled**”.  RAN1 have restrictions (see 38.214 clause 6.1) on when a grant can be sent to the UE using the same HP ID, a few symbols or slots need to pass before it is allowed (depends on UE processing capability Tproc2, CORSET, timing advance and SCS), this restriction still needs to be met.  RAN2 also have restrictions, today it says UE do not expect retransmission grant while *drx-HARQ-RTT-TimerUL* is running (we suggest removing this restriction in R2-2101493), this restriction need to be met. Using the value zero for *drx-HARQ-RTT-TimerUL* avoids this restriction.  About the rapporteurs comment on power consumption, the UE shall follow the Active Time based on all the drx timers (in this case *drx-InactivityTimer* will allow gNB to schedule until it expires), this will NOT introduce considerable power consumption. |
| Apple | Agree |  |
| China Telecom | Agree |  |
| Vodafone | Agree |  |

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)**

|  |  |  |
| --- | --- | --- |
| **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 |  |
| Intel | Option 4 | This may be a simpler solution without spec impact. |
| MediaTek | Option 3 | We prefer the same technique for DL and UL. |
| LG | Option 3 or Option 4 | See our comment in Question 2a. |
| Nokia | Option 3 | We prefer to keep same solution for UL and DL.  Same as Question4, it is not clear about the definition of “HARQ UL retransmission is ‘disabled’.”  If it means no UL retransmission for this HARQ, we assume the gNB should send grant with NDI toggled (instead of NDI not toggled/toggled in the question).  If it includes both no UL retransmission case and HARQ with blind retransmissions which is NOT relying on previous/initial transmission packet decoding result in gNB, then it should be HARQ UL retransmission relying on decoding result is ‘disabled’. |
| OPPO | Option 3 | In our understanding, UE does not need to start *drx-HARQ-RTT-TimerUL* when UL retransmission is disabled, which could be achieved with either option 3 or option 4.  Given that option 3 aligns the DL behaviour, we prefer option 3. |
| ZTE | Option 4 | Agree with Spreadtrum that option 4 cause less specs impact. We don’t see the point to align UL/DL as in legacy the UL/DL behavior is already not aligned. |
| Qualcomm | Option 4 | Unlike in DL, in case of UL HARQ, the HARQ RTT is started after the end of PUSCH transmission, it is simple to assume *drx-HARQ-RTT-TimerDL* = 0. |
| Xiaomi | Option 2 | network can configure either zero value or non-zero value. None zero value is to enable time diversity and save UE power, i.e. UE doesn’t need to monitor PDCCH during the RTT timer. |
| Ericsson | Disagree with question statement | Not possible to answer such a question at this time, there is nothing like “**HARQ UL retransmission is ‘disabled’**”, the UE shall always follow the grant it receives, period.  The simplest handling of *drx-HARQ-RTT-TimerUL* is for gNB to configure the value zero, regardless of if the gNB intends to have retransmissions based on PUSCH decoding results or not. |
| Apple | Option 4 | With preference to option 4 which results in less specification impact. |
| China Telecom | Option 3 | Align between DL and UL |
| Vodafone | Option 3 | Agree with comments above: UL and DL solutions to be kept a same |

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).**

|  |  |  |
| --- | --- | --- |
| **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. |
| intel | Yes/no | Depending if we are disabling per-HARQ process, if yes, then network will need to indicate which HARQ is to disable. |
| MediaTek | Yes | We prefer the explicit indication. |
| LG | Yes | The UE should know whether the UL HARQ retransmission for a UL grant is disabled or not when receiving the UL grant. |
| Nokia | Yes | UE should know the HARQ UL retransmission scheme (retransmission relying on initial decoding result, blind retransmissions, or no retransmission) to facilitate different setting on *drx-HARQ-RTT-TimerUL* and *drx-RetransmissionTimerUL*. However, it is FFS how to explicitly or implicitly indicate the scheme to UE. |
| OPPO | Yes | Enabling/disabling HARQ uplink retransmission configured by RRC in a semi-static manner for UL is consistent to DL.  In this way, the grants for these two kinds of HARQ processes could be allocated to LCHs with different requirements of delay and reliability.  Meanwhile, if no explicit indicator, on one hand, *drx-HARQ-RTT-TimerUL* should be configured as legacy, and there is no need to introduce an offset for *drx-HARQ-RTT-TimerUL*. On the other hand, the *drx-RetransmissionTimerUL* may need to be configured with a large value, e.g. larger than UE-gNB RTT, in order to support HARQ uplink retransmission with and without waiting for decoding result of previous PUSCH transmission, which is not beneficial for UE power saving. |
| ZTE | No | As answered in Q5, NW can configure 0 value for drx-HARQ-RTT-TimerUL( can already supported by current specs), then there is no UE behavior change required, which has the lease specs impact.  One thing we want to clarify here is that UE will anyway monitor the PDCCH as long as there are RTT timer of one HARQ process is not started no matter the HARQ RTT timer is running or not for the other HARQ process. Therefore, I am not sure whether we need a per HARQ process indication for this  Another drawback of introducing semi-static method to disable UL retransmission is it will damag both the scheduling flexibility and latency since it is impossible for NW to dynamically adjust blind retransmission and normal retransmission based on service requirement and channel conditions. |
| Qualcomm | Yes | UE must have prior knowledge for a particular HARQ process if network is allowed to disable HARQ retransmission. We can discuss what method, i.e., LCH to HARQ process mapping or repurpose existing *allowedPHY-PriorityIndex* or new indication in DCI. Note in any case RRC has to provide this prior knowledge to UE via LCH configuration. |
| Xiaomi | Yes | UE needs to know this information to do LCP and to know the right behavior of RTT timer and retransmission behavior. |
| Ericsson | No | The UEs shall follow the grants they receive, period.  We shall not make the NTNs unnecessary complex by making complicated schemes that will in turn require other more complicated schemes (like differentiating the UL drx timers or changing LCP).  The unnecessary signalling to enable/disable UL HARQ retransmissions will limit the flexibility of the gNB scheduling.  If the UE report a big buffer, and gNB do not receive new SR/BSR changing the buffer estimates, the gNB can schedule the UE continuously using a few HARQ processes (reused before a full RTT), and close to the end of the burst the gNB may decide that some of the HARQ processes shall be retransmitted (to increase reliability of last few transmissions when resource situation allows it, that is no other high prio users need the resources). |
| Apple | Yes | UE needs to know which HARQ process is enabled/disabled. Explicit indication is therefore preferred. |
| China Telecom | Yes |  |
| Vodafone | Yes | The UE needs to be made aware that the UL HARQ has been disabled |

**Question 7: Are there any other NTN-specific HARQ timer/HARQ UL retransmission aspects RAN2 needs to discuss?**

|  |  |  |
| --- | --- | --- |
| **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. |
| LG | Yes | If the explicit indication is introduced for HARQ UL retransmission, we need to discuss whether it can be indicated in a semi static manner or in a dynamic manner.  In addition, we should discuss whether disabling HARQ feedback and UL HARQ retransmission can be configured per HARQ process or per UE. |
| Nokia | Yes | HARQ related LCP restriction should be considered when gNB supports different retransmission scheme in UL, to satisfy different services (logical channels) requirements in one NTN UE. |
| Ericsson | Yes | 1) From a RAN2 perspective, retransmission grants, not only new transmission grants, can be expected using the same HARQ process ID while *drx-HARQ-RTT-TimerUL* is running (reusing HP ID will still be limited by the RAN1 limits).  2) From a RAN2 perspective, retransmission assignments, not only new transmission assignments, can be expected using the same HARQ process ID while *drx-HARQ-RTT-TimerDL* is running (reusing HP ID will still be limited by the RAN1 limits).  3) RAN2 confirm that the DL SPS deactivation DCI is not associated with any HARQ process ID, and thus the HARQ feedback for DL SPS deactivation shall always be sent. |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# Summary

<To be generated pending company input>

# Conclusion

<To be generated pending company input>

# Contact Information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email** |
| APT | HsinHsi Tsai | hsin-hsi.tsai@fginnov.com |
| Panasonic | Rikin Shah | rikin.shah@eu.panasonic.com |
| Huawei, HiSilicon | Lili Zheng | zhenglili4@huawei.com |
| Lenovo | Min Xu | xumin13@lenovo.com |
| CATT | Jianxiang Li | lijianxiang@datangmobile.cn |
| Samsung | Nishith Tripathi | nishith.t@samsung.com |
| Intel | Candy Yiu | Candy.yiu@intel.com |
| MediaTek | Abhishek Roy | Abhishek.Roy@mediatek.com |
| LG | Geumsan Jo | Geumsan.jo@lge.com |
| Nokia | Ping Yuan | Ping.1.Yuan@nokia-sbell.com |
| OPPO | Haitao Li | lihaitao@oppo.com |
| ZTE | Zhihong Qiu | Qiu.zhihong@zte.com.cn |
| Ericsson | Robert Karlsson | robert.s.karlsson AT ericsson.com |
| Apple | Sarma Vangala | [svangala@apple.com](mailto:svangala@apple.com) |
| China Telecom | Jiaxiang Liu | liujiaxiang6@chinatelecom.cn |

# 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