3GPP RAN WG2 Meeting #115e R2-2108896

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: Phase 2

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)

Updated Scope: Continue the discussion on p3 from R2-2108883 and to see if additional details based on company comments can be agreed:

* 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:

* Updated deadline (for companies' feedback): **Monday 2021-08-23 1600 UTC**
* Updated deadline (for rapporteur's summary in R2-2108896): **Monday 2021-08-23 2000 UTC**

The following guidance has been further provided by session chair:

*Proposals marked "for agreement" in R2-2108896 not challenged until Tuesday* ***2021-08-24 0800 UTC*** *will be declared as agreed via email by the session chair (for the rest the discussion might continue online during the CB session).*

A summary of phase 1 discussion may be found in [R2-2108883](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Inbox/R2-2108883.zip), and a summary of company contribution to RAN2#115e is provided in [R2-2109031](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Inbox/R2-2109031.zip). Companies are encouraged to review these document for relevant background.

# Continuation of P1A/P1B

## UL HARQ retransmission state: definition and indication

In Phase 1, the following was agreed regarding introduction/configuration of an UL HARQ retransmission state:

* For at least dynamic grants, the network may optionally configure an UL HARQ retransmission state per HARQ process. Two UL HARQ retransmission states are defined in NTN: HARQ state A and HARQ state B (FFS whether "HARQ state A" and "HARQ state B" should be renamed)
* HARQ state A/B are defined as follows:
* HARQ state A: length of drx-HARQ-RTT-TimerUL is extended by UE-gNB RTT (i.e. UE PDCCH monitoring is optimized to support UL retransmission grant based on UL decoding result).
* HARQ state B: drx-HARQ-RTT-TimerUL is not started.
* Configuration of UL HARQ retransmission state is semi-static, signalled via RRC, and the decision and criteria to configure UL HARQ retransmission state is under network control.
* If HARQ process has not been configured with an UL HARQ retransmission state, new LCH mapping rule has no effect (i.e. UE applies legacy behaviour).
* UE determines drx-HARQ-RTT-TimerUL behaviour per HARQ process based on configured UL HARQ retransmission state.
* For HARQ process(es) not configured with an UL HARQ retransmission state, drx-HARQ-RTT-TimerUL and drx-RetransmissionTimerUL behave as per legacy.

Although there was significant support for configuration of multiple UL HARQ retransmission states in Phase 1, there remains some divergence in the details of how each state should be defined. Due to this divergence, the following has been captured in chair notes:

* *Continue the discussion to see if additional details based on company comments can be agreed*

The following questions have been derived based on company comment to Phase 1:Q1 in an attempt to find further commonality in the definition of HARQ state A and HARQ state B.

**Question 1: What are the primary reasons for configuring an UL HARQ retransmission state? Companies may select one or more of the following:**

1. **Configure proper *drx-HARQ-RTT-TimerUL* behaviour.**
2. **Support new LCH mapping rule.**
3. **Restrict network scheduling behaviour (i.e. prevent network from scheduling according to one or more scheduling strategies).**
4. **Other, please describe.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Qualcomm | Option1, Option2 and Option 3 | In our understanding, all options are somewhat applicable.  Network is not supposed to blindly schedule UL grant with HARQ state A and behave as like HARQ state B (as explained in details in responses below). |
| Huawei, HiSilicon | Mainly Option 2 | The movitation for introducing HARQ retransmission state is to facilitate LCP procedure. For instance, if the gNB is performing scheduling with UL retransmission disabled, the UE is not supposed to put the data with reliability requirement on the UL grant.  Of cource, DRX timer behaviours and network scheduling behaviour should be in line with the HARQ retransmission state configuration, but not the primary reason. |
| vivo | 1 and 2 with comment | On top of 1 and 2, we think the root motivation is to enable different services to be transmitted respectively via proper HARQ retransmission scheme(s) (adaptive to their requirements) and proper DRX timer handling accordingly. |
| MediaTek | 1 and 2 | Because of the high RTT in NTN, in order to sustain high throughput with the same number of HARQ processes, it is necessary for the network to send new transmission grants (with NDI toggled) without processing the previous UL grant for the same HARQ process. However, some data might require high reliability and might not require high throughput. Therefore, some HARQ processes might continue using the “legacy” HARQ mechanism, and some LCH data may be transmitted on these HARQ processes. Therefore, reason 2 seems to us as the primary reason.  If the network is not expected to send UL retransmission grants for some HARQ processes, then the functionality in DRX where the UE waits for a possible retransmission UL grant from the network may not be required for those HARQ processes. This can save some UE power. This results in reason 1.  Regarding 3, there is no need to restrict the network behaviour. If the UE is in active time (for any reason), the network can send a retransmission grant or a new transmission grant for any HARQ process and the UE can process it. |
| InterDigital | 1 and 2 | For 1: Based on Phase1 agreement UE determines *drx-HARQ-RTT-TimerUL* behaviour based on configured UL HARQ retransmission state, so configuration of HARQ state is necessary for proper timer configuration.  For 2: New LCH mapping rule maps LCH to one or more HARQ processes indirectly via UL HARQ retransmission state, so configuration of HARQ state is necessary to support new mapping rule.  For 3: There is no strong motivation to introduce scheduling restrictions on top of new LCH mapping rule, especially considering it is generally understood UE should always act as indicated in grant/assignment regardless of HARQ state configuration anyways. |
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In Phase 1, it was proposed that HARQ state A and B be defined as “high reliability” and “low latency”. However, based on question response a majority of companies did not agree with this classification. Companies are therefore asked to identify the primary differentator of State A/B to help with definition/naming.

**Question 2: The primary differentiator of UL HARQ retransmission state A and B is:**

1. **Possible delay associated with UL retransmission grant reception.**
2. **Reliability.**
3. **Other, please describe.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Qualcomm | Option 1 and 2 | In NTN, delay associated with RTT is reasonable. HARQ state A in addition deserves to be able to offer reliability with a retransmission when previous PUSCH decoding fails. |
| Huawei, HiSilicon | Option 1 and 2 | Both reliability and latency should be taken into consideration when determining a HARQ retransmission state. However, these do not need to be reflected in the spec. In NTN, there’s no real low latency, only relatively low latency. |
| vivo | 3 | We think both 1 and 2 are reasons/motivations for such differentiation. On the other hand, we don’t think the differentiation should be made by performance, at least in the Spec. Instead, we prefer differentiating HARQ states by the HARQ retransmission scheme(s) actually supported by each state (as it does not look normal to specify what performance is expected by which scheme(s) in the AS spec). |
| MediaTek | 1 and 2 | In our view, the main difference is the reliability. It is true that reliability can be improved by blind retransmissions or by other means (repetitions, MCS, etc.), but excluding these additional mechanisms, from normal HARQ operation point of view, the main difference is the reliability. This is because of the delay associated with UL retransmission grant, so in a way 2 is a result of 1. |
| InterDigital | 1 and 2 | We assume HARQ state A will generally use the “retransmission grant based on UL decoding result” scheduling as DRX timer configuration is optimized for this. In this case it seems likely that if decoding fails a retx grant will be provided ensuring reliability, but at the expense of requiring at least a delay of UE-gNB RTT.  For HARQ state B it is assumed that any retransmission will most likely be blind retransmission. Ensuring reliability via this method may lead to unnecessary retransmission since based on target BLER it is likely most packets will be successfully received. So in HARQ state B retransmissions can be performed with less delay but since it wastes channel resources will most likely not be done for every packet. On average this will cause HARQ state B not be as reliable as HARQ state A. |
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From response to Phase 1 Q3 there appears to be general understanding that UE shall always act as indicated in a grant/assignment regardless of whether an UL HARQ retransmission state is configured or not. However, an UL HARQ retransmission state may be better suited to support a subset of UL HARQ retransmission types, for example, by optimizing when UE is monitoring PDCCH.

Note: Q3/Q4 does NOT intend to restrict network scheduling strategy. It is only meant to clarify whether based on existing definitions of HARQ state A/B (i.e. differentiated HARQ RTT Timer behaviour) UE behaviour is better suited to receive an UL retransmission grant according one possible strategy vs another.

**Question 3: HARQ state A (i.e. extending the *drx-HARQ-RTT-TimerUL* by UE-gNB RTT) best supports which UL HARQ retransmission type(s)?**

1. **UL retransmission based on UL decoding result.**
2. **Blind UL retransmission.**
3. **No UL retransmission.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Qualcomm | Option 1 | We think option 1 is the main retransmission type, but we are open to discuss on how to support option 2 in certain cases as described in Q6. |
| Huawei, HiSilicon | Option 1 | That should be clear based on the phase 1 agreements. |
| vivo | 1 | We think by having non-zero RTT timer values, intuitively the related HARQ process is intended for the decoding-based retransmission scheduling, as the configured HARQ RTT timer is expected to earn power saving gain from the UE-gNB RTT time. This intention may even more apply in NTN, with RTT time/timer extended but other DRX timers not. However, this does not intend to place a restriction that the NW must schedule in this way. |
| MediaTek | 1 | In our understanding, this is normal HARQ operation, except for the extension to DRX RTT timer. |
| InterDigital | 1 | As stated in HARQ state A definition: “*(i.e. UE PDCCH monitoring is optimized to support UL retransmission grant based on UL decoding result).*” |
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**Question 4: HARQ state B (i.e. not starting the *drx-HARQ-RTT-TimerUL*) best supports which UL HARQ retransmission type(s)?**

1. **UL retransmission based on UL decoding result.**
2. **Blind UL retransmission.**
3. **No UL retransmission.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| Qualcomm | Option 3 | We think option 3 is the primary characteristic of HARQ state B. However, in this case also, we are open to discuss how to support option 2, whether to support blind retransmission in both HARQ state A and B or only one of them. |
| Huawei, HiSilicon | Option 3 | Blind retransmission is another issue, it can have its own solutions: e.g. larger *drx-InactivityTimer*. |
| vivo | 3 and 2 | Since power saving gain based on HARQ RTT timer may not be expected in this case, Option 2 and 3 apply. Specifically, for blind UL retransmission in option 2, if companies intend to depend on inactivity timer to cover its retx scheduling (though there was an agreement on no modification to *drx-InactitiyTimer* in previous meetings), it eventually ends up with having no extra impacts on DRX timer handling, thus being able to be simply included in State B as well. |
| MediaTek | 3 | State B can be most accurately described as no (expected) UL retransmission. |
| InterDigital | 3 | Not starting the *drx-HARQ-RTT-TimerUL* means the *drx-RetransmissionTimerUL* timer is not started, and retransmission grant reception has to rely on UE being in DRX Active time by other means (e.g. the drx-InactivityTimer). This is clearly not optimal for grant reception so behaviour best supports no UL retransmission (but does not mean it can’t happen e.g. via blind retransmission). |
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Based on the above questions, companies are asked to provide initial naming suggestions to facilitate stage 3 discussions.

**Question 5: How should HARQ state A/B be named? Companies are invited to provide suggestions below:**

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| **Company** | **Suggested naming for HARQ state A/B** |
| Qualcomm | No strong view. As it is also fine to us. |
| Huawei, HiSilicon | No strong view as long as the behaviours are clear. Maybe HARQ state retx and HARQ state non-retx. |
| vivo | We think the decoding-based HARQ retransmission may be named “adaptive UL HARQ”. Along with our comments to Q3 and Q4, we suggest HARQ state A named “Adaptive HARQ enabled”, and HARQ state B named “Adaptive HARQ disabled”. If finally “No UL retransmission” is made into one separate category, whereas the other two HARQ schemes are in the other category, we are fine to follow Huawei’s suggestion above.  As another finding, if state A/B are finally defined directly by the corresponding DRX timer handling as in the agreed P1B, it seems somewhat contradictory to the majority’s view that reached the agreed P7, for which the majority’s view was not to apply an *Explicit* indication that directly configures intended DRX timer behaviour as in P1B (see Q8 of Phase1 disc).  Proposal 1B: HARQ state A/B are defined as follows:  - HARQ state A: length of drx-HARQ-RTT-TimerUL is extended by UE-gNB RTT (i.e. UE PDCCH monitoring is optimized to support UL retransmission grant based on UL decoding result).  - HARQ state B: drx-HARQ-RTT-TimerUL is not started.   * P1B is agreed   Proposal 7: UE determines drx-HARQ-RTT-TimerUL behaviour per HARQ process based on configured UL HARQ retransmission state. (14/20)   * Agreed |
| MediaTek | No strong view. We are fine with State A/B with some description in the specs for the expected behaviour. |
| InterDigital | No strong view. Perhaps suggestion by MTK may be a good way to avoid prolonged discussion. |
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# Continuation of P3

In Phase 1 of discussion, based on large majority support for Q3/Q4, the following was proposed:

Proposal 3: UE shall always act as indicated in a grant/assignment regardless of whether an UL HARQ retransmission state is configured or not (as in legacy). (18/20)

In subsequent discussion one company had concerns with grant assignment while the *drx-HARQ-RTT-TimerUL* is running, stating that network should not try to assign a grant for the same HARQ process for which the *drx-HARQ-RTT-TimerUL* citing the following text from MAC specification:

“drx-HARQ-RTT-TimerUL (per UL HARQ process): the minimum duration before a UL HARQ retransmission grant is expected by the MAC entity”

Companies which did not agree with this interpretation note that text states “expected” which does not necessary imply a restriction. Apart from RAN1 timing restrictions there is no explicit text which prevents network scheduling a HARQ retransmission for a HARQ process while drx-HARQ-RTT-TimerUL is running.

Rapporteur would like to note the following:

1. The issue is UE behaviour while drx-HARQ-RTT-TimerUL is running, so there should be no concerns for when UE is configured with HARQ state B (i.e. timer is not started).
2. It has already been confirmed by RAN2 in RAN2#113bise 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.
3. Under NTN, considering that in HARQ state A the drx-HARQ-RTT-TimerUL is extended by UE-gNB RTT, if network is prevented from assigning a grant to a HARQ process while timer is running the HARQ process can be locked up for a significant duration and could result in HARQ stalling state.
4. If an UL HARQ retransmission state is not configured the duration of drx-HARQ-RTT-TimerUL can only be up to a maximum 56 symbols. If no UL HARQ retransmission state is configured this issue may be considered unlikely (at least compared to HARQ processes configured with HARQ state A).

Given the above points, Rapporteur would like to focus discussion on the primary issue: expected UE behaviour for HARQ processes configured with HARQ state A.

**Question 6: Do you agree for HARQ process(es) configured with HARQ state A, UE in DRX active time may receive a grant/assignment while *drx-HARQ-RTT-TimerUL* is running and UE will act as indicated in grant/assignment?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| Qualcomm | Agree with revision | We also think this is mainly to address the HARQ stalling issue.  HARQ state A deserves the possibility to offer reliability with a retransmission if needed (in case network fails to decode PUSCH). This cannot be turned off by network whenever it wants by blindly sending a UL grant for new transmission while drx-HARQ-RTT-TimerUL is running. Therefore, conditions when this can happen should be clarified. We think a reasonable scenario is to allow scheduling new UL grant when all the HARQ processes configured with HARQ state A are stalled (i.e., all *drx-HARQ-RTT-TimerUL* timers are running for all HARQ processes configured with HARQ state A).  Without any additional condition, we fail to see the reason to even have two HARQ states because both A and B states would be same otherwise.  Note that in current MAC spec, there is a reason why “restart” and “stop” of *drx-HARQ-RTT-TimerUL* is not specified while “restart” and “stop” events of other timers such as *drx-InactivityTimer* is specified. That is because according to current spec, no UL grant is expected for the same HARQ process when the timer is already running as clearly captured in the definition of the timer that rapporteur have shown above (thereby ruling out any restart/stop situations, only possibility being the expiration of the timer and that is already specified.)  2> if the PDCCH indicates a UL transmission:  3> start the *drx-HARQ-RTT-TimerUL* for the corresponding HARQ process in the first symbol after the end of the first transmission (within a bundle) of the corresponding PUSCH transmission;  3> stop the *drx-RetransmissionTimerUL* for the corresponding HARQ process.  2> if the PDCCH indicates a new transmission (DL or UL) on a Serving Cell in this DRX group:  3> start or restart *drx-InactivityTimer* for this DRX group in the first symbol after the end of the PDCCH reception.  Therefore, we also need to add the “restart” condition of *drx-* *HARQ-RTT-TimerUL* for the case when a new UL grant is received for the same HARQ process as result of potential agreement here in NTN.  Therefore, we think the following proposals are clear and sufficient and hope they are acceptable:  **Proposal 3A: For a HARQ process configured with HARQ state A, if all HARQ process(es) configured with HARQ state A are stalled, UE in DRX active time may receive a grant/assignment while *drx-HARQ-RTT-TimerUL* is running and UE will act as indicated in grant/assignment.**  **Proposal 3B: If UE receives** **a UL grant while *drx-HARQ-RTT-TimerUL* is running, restart the *drx-HARQ-RTT-TimerUL* for the corresponding HARQ process.** |
| Huawei, HiSilicon | Disagree | In our understanding, if a HARQ process is configured with an UL HARQ retransmission state, the UE shall not receive grant with an unexpected NDI value (e.g. for a high reliability HARQ process, NDI indicating new transmission before UE-gNB RTT).  For the original P3 in phase 1 discussion, it only says UE shall not go against NW scheduling, which is acceptable to us (though we would prefer not having any proposal at all, because there’s no need to emphasize what would only happen in error config):  Proposal 3: UE shall always act as indicated in a grant/assignment regardless of whether an UL HARQ retransmission state is configured or not (as in legacy). (18/20)  But the suggested wording in this quesion (“may receive a grant/assignment while drx-HARQ-RTT-TimerUL is running”) makes the inappropriate configuration even more emphasized.  The newtork implementation will anyway guarantee the NDI value shall not go against HARQ retransmission state, and no changes are needed to the spec.  HARQ stalling is another issue, blind retransmission can be used to solve the problem.  We suggest not have any proposal or simply clarify that:  **RAN2 confirms that NW implementation will guarantee the NDI value will not go against HARQ retransmission state.** |
| vivo | Agree with comment | Possible, as when drx-HAQR-RTT-TimerUL is running, it is possible that other DRX timers (e.g. Inactivity timer and/or Onduration timer) are running in parallel, keeping the UE still in DRX Active time for PDCCH monitoring. But we wonder whether this is a case normally happening in NTN, as drx-HARQ-RTT-TimerUL length is extended and would be very long, but Onduration timer and Inactivity timer were not expected to be extended as per previous agreements. |
| MediaTek | Agree, but | This should not result in any spec changes. The DRX/UL grant processing mechanisms are unchanged from legacy (i.e. Rel-16). The only difference between legacy and NTN for State A is the extension of the DRX RTT timer with UE-gNB RTT.  If a HARQ process is configured with State A (UL retransmission/new transmission grant only after decoding the previous PUSCH), then it is normal for that HARQ process to stall during the RTT, so we don’t understand why this is an unexpected problem. The network has the freedom not to configure and HARQ process with State A and configure all with State B if it wants to.  If the intention is to solve a potential issue on if and how to support blind retransmission in State A, we prefer to discuss that question separately. |
| InterDigital | Agree | It is also our understanding that this is legacy behaviour and should not result in specification change. However, considering there seems to be divergent views on legacy behaviour this could perhaps be captured as a clarifying note in MAC spec.  We agree with the comment by QC that this problem is most critical when all HARQ processes in HARQ state A are stalled. However, we wonder about the proposed revision ““**if all HARQ process(es) configured with HARQ state A are stalled**”. Why we need to get to the worst-case scenario before network can do anything about it?  The suggestion by HW does not seem very useful as based on current definition HARQ states A/B only control DRX timer behaviour and places no restriction on scheduling. There is therefore no NDI value which will go against “go against HARQ retransmission state” |
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# Conclusion

<To be generated pending company input>

# References

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5. [R2-2107450](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2107450.zip) Impact on LCP with disabled UL HARQ retransmission in NTN – vivo
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13. [R2-2108319](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108319.zip) Round trip delay offset for configured grant timer – MediaTek Inc
14. [R2-2108351](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108351.zip) Considerations on HARQ aspects – ZTE Corporation, Sanechips
15. [R2-2108452](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108452.zip) On DRX, LCP, HARQ, SR/BSR, and configured scheduling – Ericsson
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21. [R2-2108662](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_115-e/Docs/R2-2108662.zip) Impact of UE-gNB RTT determination on MAC – InterDigital
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