3GPP RAN WG2 Meeting #116bis-e R2-2201748

eMeeting January 17th – 25th, 2022

Agenda Item: 8.10.2.2

Source: InterDigital (summary rapporteur)

Title: Summary of [AT116bis-e][107][NTN] Other MAC aspects: Phase 2

Document for: Discussion, Decision

# Introduction

This document is a discussion paper to obtain company input to the Phase 2 of the following offline discussion:

* [AT116bis-e][107][NTN] Other MAC aspects (InterDigital)

Initial scope: Discuss remaining MAC open issues, focussing on DRX timers, CG/SPS and remaining HARQ state aspects

Updated scope: Discuss remaining issues from R2-2201739

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

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

The following deadline for company feedback has been provided:

* Initial deadline (for companies' feedback): **Monday 2022-01-24 1800 UTC**
* Initial deadline (for rapporteur's summary in R2-2201748): Monday 2022-01-24 2000 UTC

Please also note the following chair guidance:

* Proposals marked "for agreement" in R2-2201748 not challenged until **Tuesday 2022-01-25 0800 UTC** will be declared as agreed via email by the session chair (for the rest the discussion might continue in the GTW session).

# Remaining issues from first round

## ConfiguredGrantTimer extention

For a configured grant (CG) configuration, the network may optionally configure a *configuredGrantTimer*. While the *configuredGrantTimer* is running, the corresponding HARQ process will not be used for a new CG transmission. This facilitiates network scheduling of retransmissions for that HARQ process ID. To ensure the length of *configuredGrantTimer* can cover the larger round trip delay in NTN for smaller values of periodicity, in RAN2#116e it was agreed that the *configuredGrantTimer* may be extended, however the method of extension remains FFS:

* *configuredGrantTimer can be extended in NTN. FFS details of when extension is applicable and method of extention.*
* *FFS:RAN2 to down-select between the following options to extend configuredGrantTimer: 1) Introducing value(s) of configuredGrantTimer larger than 64; 2) Value of the configuredGrantTimer is extended by UE-gNB-RTT;”*

Below is a summary of technical arguments provided via contributions submitted to RAN2#116bis-e:

**configuredGrantTimer extended by UE-gNB RTT [1, 2, 3, 6, 8, 11, 17]:**

Proponents of extending the *configuredGrantTimer* by UE-gNB RTT note that introducing additional values of CGT would lead to unnecessary signaling overhead [1, 2] and it would be difficult to configure values which properly match the RTT [2, 11]. This may lead to a waste of CG resources for some UEs near cell center [6], and it would be simple and efficient to extend by UE-gNB RTT similar to the HARQ RTT Timer [3, 8, 11].

**configuredGrantTimer extended by additional values [4, 13, 14, 15, 16, 18]:**

Proponents of extending the CGT by additional values note that this method is simple [4, 13], and that extension by UE-gNB RTT may be complicated as this value changes over time [14, 15]. Furthermore, current specification allows network to configure values of CGT lower than RTT to enable e.g. blind retransmission, which would not be possible by UE-gNB extension methods [15, 16]. Furthermore, the need for many additional values may also be limited as there is little benefit in covering more than one RTT in GEO due to unreasonably long delays [18].

Out of 17 companies participating in Phase 1 discussion, the following table presents a summary of responses (companies are encouraged to refer to the original discussion document in R2-2101739 for detailed summary):

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| ***Preferred method to extend configuredGrantTimer in NTN?*** | | |
| Extend by UE-gNB RTT | Values larger than 64 | Both |
| 8 | 9 | 1 |

Based on company input, the following is noted:

* **Option 1:**
  + Advantages are that it can accurately offset the timer with a value already used/maintained to offset other timers (e.g. the HARQ RTT Timers) without additional signalling overhead.
  + Concerns are that use of the UE-gNB RTT could lead to a mismatch between UE and gNB regarding the value, possibly leading to missed CG transmission.
* **Option 2:**
  + Advantages are that it is simple with minimal specification impact, and gNB would be in full control of the timer avoiding UE-gNB mismatch.
  + Concerns are that it would require additional signalling overhead, and would be difficult to accurately compensate the UE-gNB RTT.

The following questions are intended to address the above issues:

**Question 1a: Would extension of CGT by UE-gNB RTT (Option 1) possibly lead to mismatch between UE and gNB regarding timer duration? If “Yes”, please describe possible impacts to system performance (if any).**

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| **Company** | **Yes/No** | **Additional comments** |
| OPPO | No | Extension by UE-gNB RTT applies to various timers in NTN. The mismatch issue between UE and gNB has not been identified for the other timers such as drx-HARQ-RTT-TimerUL/DL. For configuredGrantTimer the situation is the same, and there is no reason to consider it problematic. |
| Xiaomi | Yes | Case 1:If network considers a CG resource recurring before the CG timer expiry but UE doesn’t, network may schedule the CG resource for DG while UE may use this CG for new transmission;  Case 2: If network considers a CG recurring after the CG timer expiry but UE doesn’t, network may wait for new UL transmission on the CG resource while UE will not send new UL transmission on the CG resource.  However, for case 1, if network think there may be state mismatch, network can simply not schedule the CG resource for other purpose; Compared with option 2, this resource waste is less severe. Because option 2 uses semi-static configuration of the CG timer, which will cause much severe mismatch of RTT with CG timer, leading to more CG resources unable to use for new transmission. For case 2, if network doesn’t receive new transmission on CG resource, network considers it as UL skipping.  Thus, we do not see any issues. |
| LG | Yes | Same view as Xiaomi. |
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**Question 1b: To address issues described in Q1a (if any):**

* **Option 1: Rely on existing specification (e.g. TA update mechanism is sufficient);**
* **Option 2: Additional specification impact is necessary (please describe).**

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| **Company** | **Preferred Option** | **Additional comments** |
| OPPO | Option 1 | TA update mechanism is sufficient, and we don’t need the further optimization. |
| Xiaomi | Option 1 | By TA update, the mismatch can be reduced a lot, and leads to less resource waste compared with option 2. Because option 2 uses semi-static configuration of the CG timer, which will cause much severe mismatch of RTT with CG timer, leading to more CG resources unable to use for new transmission. |
| LG | Option 1 |  |
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**Question 2: Could values in Option 2 be selected to balance additional overhead and approximately compensate UE-gNB RTT?**

* **If “Yes”, please describe how such a tradeoff can be accomplished.**
* **If “No”, please describe possible impacts to system performance (if any).**

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| **Company** | **Yes/No** | **Additional comments** |
| OPPO | No | RTT is quite different for LEO/GEO scenarios with different altitude and is constantly changing. In order to match diffrent RTT, many different values need to be introduced, which leads to extra signalling overhead. Note that the unit of configuredGrantTimer is periodicity of CG. The length of configuredGrantTimer depends not only on the value of configuredGrantTimer but also on the length of periodicity. Hence, it would limit the configuration on periodicity, if we choose to balance additional overhead and approximately compensate UE-gNB RTT. |
| Xiaomi | No | We do not see how this works |
| LG | No |  |
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In Phase 1, one company suggests that as a compromise, both options may be specified and left to NW implementation.

**Question 3: As a compromise, could both Option 1 and 2 be specified and left to NW configuration?**

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| **Company** | **Yes/No** | **Additional comments** |
| OPPO | No | This leads to extra spec effort. We only needs to choose one. |
| Xiaomi | No |  |
| LG | No |  |
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## HARQ/LCP configuration for CG/SPS

In RAN2 #115e and RAN2#116e a new LCP mapping restriction *allowedHARQ-DRX-LCP* was agreed for dynamic grant in NTN, however it is not clear whether this restriction also applies to configured grant case.

Below is a summary of technical arguments provided via contributions submitted to RAN2#116bis-e:

**New restrictions apply to CG [1, 2, 7, 18]**

Proponenets of applying *allowedHARQ-DRX-Mode* to CG note there is no potential use case to keep two different HARQ states between DG and CG, since the QoS requirement of a LCH is same [1, 7]. For simplicity, we can reuse *uplinkHARQ-DRX- Mode* and *allowedHARQ-DRX-Mode* to set mapping restrictions for configured grants, even though there is the existing *allowedCG-List* [18].

**New restrictions do not apply to CG [10, 13, 14, 15, 16]**

Proponents of not applying *allowedHARQ-DRX-Mode* to CG note that there are existing LCH restrictions in place which can accomplish the same thing [10, 13, 15, 16] and that the maximum number of configure grant configurations per BWP and MAC can provide granularity for different LCHs to be configured to different CG with different retransmission scheme [13]. Furthermore, there is common understanding that all HARQ processes associated to a CG configuration shall have the same UL HARQ state. It means one CG should have only one retransmission scheme and the *allowedCG-List* can be reused to perform LCP for different retransmission scheme in NTN [13, 14].

Based outcome of Phase 1, the following relevant agreement and understanding where reached in RAN2#116bis-e:

Agreements online:

1. It is up to network implementation to ensure proper configuration of HARQ mode for HARQ processes used by a CG configuration (no Stage 3 specification impact). FFS if a note in Stage 2 is needed

RAN2 understanding:

1. RAN2 understanding is that: in general, all HARQ processes used by a CG configuration are configured with the same HARQ state (e.g. A or B). No specification impact

Considering the existing LCP restriction *allowedCG-List* maps a LCH to allowed configured grant(s), if all HARQ processes used by a CG configuration are configured with the same HARQ state, based on the above RAN2 understanding in the general case *allowedCG-List* and *allowedHARQ-DRX-Mode* may accomplish the same thing.

**Question 4:** **Do you agree that in the general case (i.e. all HARQ processes used by a CG configuration are configured with the same HARQ state) *allowedHARQ-DRX-Mode* and *allowedCG-List* accomplish the same thing?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| OPPO |  | In our understanding, we don’t need to discuss whether this two fields accomplish the same thing or not. It is fully up to network’s implementation to ensure they can work properly. |
| Xiaomi | Disagree | We do not think they are used for the same purpose. The *allowedCG-List can also take into account other parameters of CG resources, e.g. period.* But if network only considers HARQ state when configuring *allowedCG-List*, then it has the same function as *allowedHARQ-DRX-Mode.* |
| LG | Disagree | We do not see the benefit to apply the allowedHARQ-DRX-LCP to the CG instead of allowedCG-List. |
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However, if it is agreed *allowedHARQ-DRX-Mode* applies to CG and all HARQ processes used by a CG configuration are ***not*** configured with the same HARQ state, a conflict may arise if *allowedCG-List* is also configured. It is noted that based on Phase 1 Q5) outcome companies largely disagreed that *allowedCG-List* overrules *allowedHARQ-DRX-Mode*, so this option is excluded from consideration.

**Question 5: If *allowedHARQ-DRX-Mode* applies to CG and all HARQ processes used by a CG configuration *are not* configured with the same HARQ state, what is the preferred method of handling a conflict between *allowedHARQ-DRX-Mode* and *allowedCG-List, if configured*?**

* **Option 1: NW cannot simultaneously configure *allowedHARQ-DRX-Mode* and *allowedCG-List*;**
* **Option 2: *allowedHARQ-DRX-Mode* overrules *allowedCG-List*;**
* **Option 2a: *allowedCG-List overrides allowedHARQ-DRX-Mode;***
* **Option 3: Other, please describe.**

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| **Company** | **Preferred Option** | **Additional comments** |
| OPPO | Option 3 | We should trust the network to do the right thing, i.e., for a correct network configuration, all HARQ processes used by a CG configuration should be configured with the same HARQ state. |
| Xiaomi | Option 2a | If *allowedCG-List is configured, it takes all the parameters related to CG into account, including HARQ mode. In this sense, UE should only follow allowedCG-List, instead of allowedHARQ-DRX-Mode.* |
| LG | Option 2a |  |
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## PUSCH transmission scheduled by RAR

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

Below is a summary of technical arguments provided via contributions submitted to RAN2#116bis-e:

**Up to NW implementation [1, 10, 16]:**

Proponents of leaving this issue up to network implementation/not addressing this issue note that PDCCH monitoring behaviour during RA procedure is perfectly controlled by RAR window and the running of *ra-ContentionResolutionTimer*, and DRX timer running or not has no extra contribution to the PDCCH monitoring during RACH [1, 16]. Regarding LCP, we can simply leave proper configuration up to NW implementation without any specification impact [1, 10, 16].

**Ignore HARQ/LCP configuration [2, 3]**

Proponents of addressing this issue note that there may be multiple ways of solving the issue, for example *uplinkHARQ-DRX-LCP-Mode-r17* does not applies to HARQ process 0 carring PUSCH transmission scheduled by RAR or PUSCH payload of MsgA; or for UL grant in RAR or UL grant associated with MsgA PUSCH resource, LCP restriction of HARQ state does not apply [2]. From the perspective of [3], this should be discussed case by case where the triggering event should to be considered. A general principle is that we could make sure what needs to be transmitted to the gNB during RACH can be carried in the UL grant in RAR (In other words, the LCH that can use the UL grant in RAR is related with the triggering events. And for this LCH, the LCP restriction is not applied)

Out of 17 responding companies, the following table presents a summary of responses to the above question (companies are encouraged to refer to the original discussion document in R2-2101739 for detailed summary)::

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| ***Preferred option for the cases that HARQ process 0 carries PUSCH transmission scheduled by RAR or PUSCH payload of MsgA?*** | | | |
| NW implementation | *uplinkHARQ-DRX-LCP-Mode-r17* does not applies | LCP restriction of HARQ state does not apply | Other |
| 11 | 1 | 6 | 1 |

After subsequent discussion via reflector the following two proposals were suggested:

**Proposal A:     *allowedHARQ-DRX-LCP* shall not apply to LCP for Msg3/MsgA PUSCH. FFS whether this can be left to NW implementation, or explicitly specified.**

**Proposal B: For the cases that HARQ process 0 carries PUSCH transmission scheduled by RAR or PUSCH payload of MsgA, configuration of HARQ mode is up to NW implementation, and UE always follows it.**

Rapporteur understands advantage of Proposal A is that will guarentee new LCP restriction does not interfere with legacy transmission of Msg3/MsgA PUSCH (with FFS addressing whether the network can handle this via configuration or there needs to be an exception captured in the MAC spec). The advantage of Proposal B is that there is less specification impact and additional NW flexibility by leaving it fully to NW configuration to avoid impact to legacy procedure.

**Question 6:** **For the cases that HARQ process 0 carries PUSCH transmission scheduled by RAR or PUSCH payload of MsgA, what is your preferred option?:**

1. ***allowedHARQ-DRX-LCP* shall not apply to LCP for Msg3/MsgA PUSCH FFS whether this can be left to NW implementation, or explicitly specified.**
2. **Configuration of HARQ mode and *allowedHARQ-DRX-LCP* is up to NW implementation, and UE always follows it.**

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| **Company** | **Preferred Option** | **Additional comments** |
| OPPO | Option 2 | The LCP impact on PUSCH transmission scheduled by RAR or PUSCH payload of MsgA can be avoided by NW’s proper configuration with the least spec impact. |
| Xiaomi | Option 1 | First, we need to clarify whether the configuration of “No HARQ state” is per HARQ process or per UE? We think it should be per UE since it will apply no RTT offset for DRX which only relates to satellites height.  Second, if network configure HARQ process #0 with no HARQ state, dynamic scheduling may not be able to use this HARQ process since DRX RTT timer can not be extended by RTT.  Third, if network configure HARQ process #0 with harq state, it means the LCHs configured with other HARQ state can not use it even if the RACH is triggered by them due to data arrival. It will greatly increase the delay. |
| LG | Option 2 | The smart network would not configure the wrong HARQ state to the HARQ PID0. Thus, the UE should follow the configuration configured by the network. |
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**Question 7:** **If “Option 1” in Q6, what is the preferred method of ensuring *allowedHARQ-DRX-LCP* shall not apply to LCP for Msg3/MsgA PUSCH?**

1. **Left to NW implementation;**
2. **Explicitly specified.**

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| **Company** | **Preferred Option** | **Additional comments** |
| Xiaomi | Option 2 | NW implementation can not ensure it unless “no HARQ state” is configured for HARQ process #0. However, if “no HARQ state” is configured per UE, it will lead to other HARQ processes configured with “no HARQ state”. If “no HARQ state” is only configured for HARQ process #0, dynamic scheduling may not be able to use HARQ process #0 since DRX RTT timer can not be extended by RTT. |
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# Summary

<To be generated pending company feedback>

# Conclusion

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

<To be generated pending company feedback>

# References

1. [R2-2200244](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200244.zip) Remaining issues on other MAC aspects in NTN – OPPO
2. [R2-2200271](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200271.zip) Remaining issues related to HARQ retransmission state – Xiaomi
3. [R2-2200348](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200348.zip) Remaining issues about other MAC aspects – Huawei, HiSilicon
4. [R2-2200444](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200444.zip) HARQ process for SPS and CG – Qualcomm Incorporated
5. [R2-2200618](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200618.zip) Remaining issues on disabling uplink HARQ retransmission – MediaTek Inc.
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7. [R2-2200628](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200628.zip) Discussion on HARQ and LCP remaining issues – Spreadtrum
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9. [R2-2200787](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200787.zip) Remaining issues on HARQ related timer handling for NR NTN – vivo
10. [R2-2200788](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200788.zip) Remaining issues on LCP aspects – vivo
11. [R2-2200870](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200870.zip) Further Considerations on CG/SPS for NR NTN – CMCC
12. [R2-2200911](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2200911.zip) CG enhancements in NTN – Sony
13. [R2-2201008](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2201008.zip) Discussion on left issues on MAC aspects – Nokia, Nokia Shanghai Bell
14. [R2-2201163](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2201163.zip) Remaining MAC open issues in NTN – InterDigital
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16. [R2-2201364](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2201364.zip) Discussion on other MAC aspects – LG Electronics Inc.
17. [R2-2201480](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2201480.zip) HARQ State A/B for CG/SPS aspects – ITL
18. [R2-2201629](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2201629.zip) On configured scheduling, DRX, LCP, HARQ and SR/BSR in NTNs – Ericsson