13GPP TSG-RAN WG2 Meeting #119bis-e R2-2210863

Electronic Meeting, 10 – 19 October, 2022

**Agenda item: 8.6.2.1**

**Source: CMCC**

**Title: Report for [AT119bis-e][120][IoT NTN Enh]** **HARQ enhancements (CMCC)**

**WID/SID: IoT\_NTN\_enh**

**Document for: Discussion and Decision**

# Introduction

This document aims at address the remaining open issues for HARQ enhancements for IoT NTN.

* [AT119bis-e][120][IoT NTN Enh] HARQ enhancements (CMCC)

Scope: Continue the discussion on p4, p5 from [R2-2210152](file:///C:\Data\3GPP\Extracts\R2-2210152%20Discussion%20on%20the%20HARQ%20enhancement%20for%20IoT-NTN.docx) as well as p6 and p8 from [R2-2210036](file:///C:\Data\3GPP\Extracts\R2-2210036%20Discussion%20on%20disabling%20of%20HARQ%20feedback.doc)

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)

Initial deadline (for companies' feedback): Tuesday 2022-10-18 1000 UTC

Initial deadline (for rapporteur's summary in R2-2210863): Tuesday 2022-10-18 1200 UTC

2 Contact Information

|  |  |  |
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# 3 Discussion

## 3.1 DRX impacts

### 3.1.1 For DL HARQ process

In Rel-17 NR NTN, RAN2 agreed the following agreements on enabling/disabling DL HARQ feedback.

|  |
| --- |
| * For HARQ process with DL HARQ feedback disabled, the UE will not start drx-HARQ-RTT-TimerDL. * For HARQ process with DL HARQ feedback enabled, the UE will extend the value of drx-HARQ-RTT-TimerDL by UE-gNB RTT and start the timer.   For HARQ process not configured with DL HARQ feedback enabled/disabled, drx-HARQ-RTT-TimerDL behaves as per legacy. |

And RAN2-119 meeting agreed to support HARQ feedback enabling/disabling for DL and two HARQ modes for UL in both NB-IoT and eMTC.

|  |
| --- |
| Agreements:   1. Disabling DL HARQ feedback is supported for NB-IoT and eMTC NTN. FFS on UE capability 2. For UL HARQ operation, introduce two HARQ modes, i.e., HARQ mode A and HARQ mode B in IoT NTN (both NB-IoT and eMTC NTN), similarly to NR NTN 3. From RAN2 perspective, at least for eMTC, enabling/disabling HARQ feedback can be configured per DL HARQ process at least via UE specific RRC signalling. FFS for NB-IoT (and especially for CP solution for NB-IOT). |

Meanwhile, for NB-IoT DL transmission, RAN1 is discussing the HARQ feedback enabling/disabling for DL transmission with below agreement:

|  |
| --- |
| Agreement :  For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select one or more from the following options:   * Option 1: per HARQ process via UE specific RRC signaling * Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field) * Option 4: implicitly indicated by existing configured/indicated/combined parameter(s) in the DCI (e.g., repetition number, TBS) * Option 6: combinations of some options above |

As no data retransmission will be expected by UE based on HARQ feedback when the corresponding HARQ processes with DL HARQ feedback is disabled, the UE needn’t wait RTT timer to receive PDCCH for retransmission. Therefore, not start drx*-HARQ-RTT-TimerDL* can work for this purpose.

However, during online discussion, there is no consensus on the DRX impacts for HARQ process with DL HARQ feedback disabled, as there are concerns on whether there are some different behaviours are needed for NB-IoT with single HARQ process.

Since there is no new arrival data expected by the UE with single HARQ process when a last transmission grant has been just received, new transmission grant will not trigger the start of drx-InactivityTimer while the timer will be started if a HARQ RTT timer expires, and the timer is stopped when receiving the UL/DL assignment.

Then, as explained in [12], company thinks if we follow the NR NTN solution, the *HARQ RTT Timer* is not started upon the last PDSCH transmission in IoT NTN. This implies both the *drx-inactivityTimer* and the retransmission timer (when the transmission is not successful) will not be started for IoT NTN with single HARQ process. It forces the NW only schedule blind retransmissions and new data transmission relying on on-duration timer. Generally, the on-duration timer will be started periodically which means it is not always close to initial DL transmission in time domain. In this case, UE has to stay on RRC Connected state and wait for next on duration timer for blind retransmission and following new data transmission. Obviously, it will reduce the schedule opportunities and restrict the NW scheduling flexibility. In the end, the UE’s power consumption will be wasted since it has to stay in RRC Connected mode for quite long time for data transmission.

Therefore, how to specify the UE behaviour on the DRX timer when the corresponding HARQ processes with DL HARQ feedback disabled requires being determined:

**Q1: Do you agree to take R17 NR NTN DRX solution as baseline for IoT NTN, e.g. for HARQ process with DL HARQ feedback disabled, the UE will not start the corresponding DL HARQ RTT timer? Other enhancements (if any) can be further discussed.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Nokia | Yes with comment | It also depends on the enhancements discussed in Q3. If Option 2 in Q3 is agreed then the HARQ RTT timer will not be started. Otherwise (if Option1 in Q3 is agreed), then the HARQ RTT timer is set to 0 while the timer should be regarded as started to trigger the start of following drx-inactivity timer and retransmission timer. |
| Transsion Holdings | Yes |  |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |
| MediaTek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
| InterDigital | Yes |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| CATT | Yes |  |
| Apple | Yes |  |
| Samsung | Yes |  |
| Ericsson | Yes |  |

**Q2: Do you agree to enhance the DRX for NB-IoT NTN with single HARQ process when the HARQ feedback is disabled?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | Currently, for NB-IoT NTN with single HARQ process, drx-inactivityTimer is started upon HARQ RTT timer expiry. If the HARQ process is configured with disabled HARQ feedback, as the corresponding DL HARQ RTT timer is not started, we should consider the start condition of drx-inactivityTimer in this case, otherwise drx-inactivityTimer would not be started. |
| Nokia | Yes |  |
| Transsion Holdings | Yes |  |
| Xiaomi | Yes | Otherwise, drx-inactivityTimer cannot be restarted. |
| Lenovo | Yes |  |
| MediaTek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes | Blind retransmission can be enhanced, i.e., start DRX retransmission timer. |
| InterDigital | Yes |  |
| ZTE | Yes | We have sympathy with the issue for NB-IoT NTN with single HARQ process mentioned by Nokia. |
| Intel | Yes |  |
| CATT | Yes | We think it is possible that the HARQ feedback disable is needed even the UE is configured with single HARQ process. Therefore, in order not to impacts the performance greatly, enhancements are needed. |
| Apple | Yes |  |
| Samsung | Yes | Agree with OPPO |
| Ericsson | Yes |  |

**Q3: if Q2 is confirmed, which option is your preference?**

* **Option1: set HARQ RTT Timer=0;**
* **Option2: start/restart drx-inactivity timer in the subframe containing the last repetition of the corresponding PDSCH reception;**
* **Option3: others…**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| OPPO | Option 2 | Both option 1 and option 2 can work, but for option1, impact on legacy drx-RetransmissionTimer should be carefully considered. Option 2 is more straightforward. We prefer option 2. |
| Nokia | Option1 or Option2 | For Option1, the retransmission timer and drx-inactivity timer will be started after last repetition of PDSCH (same as legacy when RTT timer expired), in which UE will in DRX active for following data transmission, e.g., blind retx or new transmission of RRC, MAC CE or data.  For Option2, the drx-inactivity timer will be started after last repetition of PDSCH , in which UE will in DRX active for following data transmission , e.g., blind retx or new transmission of RRC, MAC CE or data. |
| Transsion Holdings | Option2 | Option 2 seems is more straightforward |
| Xiaomi | Option 1 | option 1 is simpler. And it has the advantage that drx-RetransmissionTimer is used for blind scheduling, drx-inactivity timer is used for new data, network can set different values for the two timers.  Option 2 is over designed. Option 2 can be updated to follow the trigger condition of starting drx-inactivity timer for other cases(eMTC, normal UE, NB-IOT with more HP):  - if the PDCCH indicates a new transmission (DL, UL):  - start or restart *drx-InactivityTimer*. |
| Lenovo | Option 2 preferred  Option 1 acceptable |  |
| MediaTek | Option 2 | Without HARQ feedback, NW would not know the decode result, hence UE does not expect the retransmission when the decode is not successful. Therefore, UE should not start the retransmission timer.  Option 2 is preferred as it exclude the need of the retransmission timer. |
| Huawei, HiSilicon | Option 2 |  |
| Qualcomm | Option 3 | Option 1 is not possible according to Q1.  Simply start DRX retransmission timer in Option 2.  Its just single HARQ, why do we need DRXinactivity timer? The DRX retransmission timer will keep UE up. Blind retransmission is also supported and new transmission is also possible. |
| InterDigital | Option 2 | Agree with Mediatek, retransmission timer shouldn’t be started. |
| ZTE | Option 2 | Agree with Mediatek. |
| Intel | Option 2 |  |
| CATT | Option 2 | We share the same view that retransmission timer should not be started. |
| Apple | Option 2 | Option 2 is more straightforward. |
| Samsung | Option 2 | Option 2 does seem more straightforward |
| Ericsson | Option 1 | NB-IoT does not have a drx-RetransmissionTimer, instead drx-InactivityTimer is (re)started.  Setting HARQ RTT Timer = 0 means drx-InactivityTimer will be (re)started immediately because of note in 3.1 of 36.321:  NOTE: A timer is running once it is started, until it is stopped or until it expires; otherwise it is not running. A timer can be started if it is not running or restarted if it is running. A Timer is always started or restarted from its initial value.  Is Option 1 and 2 the same? |

### 3.1.2 For UL HARQ process

For UL HARQ operation, RAN2#119-e agreed to introduce HARQ mode A and HARQ mode B in IoT NTN similarly to NR NTN.

In Rel-17 NR NTN, the following agreements are achieved:

* For HARQ mode A, the UE will extend the length of drx-HARQ-RTT-TimerUL by UE-gNB RTT.
* For HARQ mode B, the UE will not start drx-HARQ-RTT-TimerUL.
* Configuration of UL HARQ re-transmission mode is semi-static, signalled via RRC, and the decision and criteria to configure UL HARQ re-transmission mode is under network control.

During online discussion, company suggests to use HARQ mode A/B for further discussion.Similar issues to DL HARQ process, how to specify the UE behaviour on the DRX timer when the corresponding HARQ processes in HARQ mode B requires being determined:

**Q4: Do you agree to take R17 NR NTN DRX solution as baseline for IoT NTN, e.g. for HARQ process in HARQ mode B, the UE will not start the corresponding UL HARQ RTT timer? Other enhancements (if any) can be further discussed.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Nokia | Yes with comment | It also depends on the enhancements discussed in Q6. If Option 2 in Q3 is agreed then the UL HARQ RTT timer will not be started. Otherwise (if Option1 in Q3 is agreed), then the UL HARQ RTT timer is set to 0 while the timer should be regarded as started to trigger the start of following drx-inactivity timer and retransmission timer. |
| Transsion Holdings | Yes |  |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |
| MediaTek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
| InterDigital | Yes |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| CATT | Yes |  |
| Apple | Yes |  |
| Samsung | Yes |  |
| Ericsson | Yes |  |

**Q5: Do you agree to enhance the DRX for NB-IoT NTN with single HARQ process in HARQ mode B?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | See our comments on Q2. |
| Nokia | Yes |  |
| Transsion Holdings | Yes |  |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |
| MediaTek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
| InterDigital | Yes |  |
| ZTE | Yes |  |
| Intel | Yes |  |
| CATT | Yes | Similar as Q2 |
| Apple | Yes |  |
| Samsung | Yes |  |
| Ericsson | Yes |  |

**Q6: If you are positive to the proposal in Question 2, companies are expected to provide your preference?**

* **Option1: set UL HARQ RTT Timer=0;**
* **Option2: start/restart drx-inactivity timer in the subframe containing the last repetition of the corresponding PUSCH reception;**
* **Option3: others…**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| OPPO | Option 2 | See our comments on Q3. |
| Nokia | Modified Option1 or Option2.  Option1 should be *set UL HARQ RTT Timer=0*. | For Option1, the retransmission timer and drx-inactivity timer will be started after last repetition of PUSCH (same as legacy when RTT timer expired), in which UE will in DRX active for following data transmission, e.g., blind retx or new transmission of RRC, MAC CE or data..  For Option2, the drx-inactivity timer will be started after last repetition of PUSCH in which UE will in DRX active for following data transmission , e.g., blind retx or new transmission of RRC, MAC CE or data. |
| Transsion Holdings | Option2 |  |
| Xiaomi | Option 1 | See our comments on Q3 |
| Lenovo | Option 2 preferred  Option 1 acceptable |  |
| MediaTek | Option 2 | See our comments on Q3. |
| Huawei, HiSilicon | Option 2 |  |
| Qualcomm | Option 2 | See our comments in Q3. |
| InterDigital | Option 2 |  |
| ZTE | Option 2 | There may be a typo:  **Option2: start/restart drx-inactivity timer in the subframe containing the last repetition of the corresponding PUSCH transmission;** |
| Intel | Option 2 |  |
| CATT | Option 2 |  |
| Apple | Option 2 |  |
| Samsung | Option 2 |  |
| Ericsson | Option 2 | If concerning Q5 and UL HARQ RTT Timer. |

## 3.2 LS to RAN1

R2-2210036 proposed to send LS to RAN1 that RAN2 has agreed to introduce new HARQ state for uplink transmission, and ask RAN1 to take it into consideration when deciding on DCI based enabling/disabling HARQ feedback for downlink transmission.

**Q3: Do you agree to send LS to RAN1 about the new introduced HARQ state for UL? Please provide your view in the table below.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| OPPO | No, at least not now | For UL, we think RRC configuration for HARQ mode A/B (e.g. in Msg4) could be sufficient as unlike DL, we don’t have MAC CE action time issue for UL. |
| Nokia | Yes | RAN1 is discussing how to disable HARQ feedback for DL HARQ operation. In our understanding, it should be RAN1 to discuss how to inform UE about UL HARQ mode, in which UE can execute the corresponding DRX and LCP (if agreed) behaviour.  Furthermore, if RAN1 decides the solution for DL, we prefer to have the same solution for UL. |
| Transsion Holdings | Yes |  |
| Xiaomi | Yes | Whether DCI based HARQ mode A/B configuration is introduced should be firstly discussed in RAN1.  As RAN1 is only working on HARQ feedback disabling for DL transmission. RAN2 need to tell RAN1 to take HARQ mode A/B configuration into consideration. |
| Lenovo | Yes |  |
| MediaTek | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | No | For UL, we are not sure what is RAN1 impact. |
| InterDigital | Yes |  |
| ZTE | Neutral | We also think RRC configuration for HARQ mode A/B (e.g. in Msg4) could be sufficient.  If we only want to inform RAN1 about new introduced HARQ states for UL, we think no need of LS to RAN1. Anyway RAN1 guys would also be aware of RAN2 progress.  But we can inform RAN1 that, **from RAN2 perspective**, we see no reason to support dynamical UL HARQ mode configuration. Please note, for NR NTN with high performance requirement, DCI options are not supported. |
| Intel | Yes |  |
| CATT | Yes |  |
| Apple | Yes |  |
| Samsung | Neutral | We are not certain if RAN1 is discussing this since it does not impact their procedures. The reasons why we have UL HARQ state is because of DRX and LCP, which is exclusively in RAN2 scope. |
| Ericsson | Yes |  |

**TBA**

## 3.3 LCP restriction

R2-2210036 proposed to introduce LCP restriction on allowed HARQ mode for IoT-NTN. Some companies are also interested in this issue. According to the contributions, [2,11] propose that the similar mechanism to NR NTN can be introduced for IoT NTN in order to avoid LCH mapping to unsuitable HARQ mode and allow different logical channels to be mapped to different HARQ types. However, [3] think that there is no strong motivation to introduce the LCP restriction for IoT NTN since most services for NB-IoT and eMTC are delay-tolerant, and LCP resriction is not supported in LTE. [R2-2210088](file:///C:\Data\3GPP\Extracts\R2-2210088%20-%20Discussion%20on%20HARQ%20enhancement%20for%20IoT%20NTN.doc) [10] also proposes there is no need to introduce LCP restriction for NB-IoT, because data and signaling are carried over the same radio bearer which means that LCP cannot perform prioritization between data and control signalling. Anyway, more discussion is needed.

**Q4: Do you agree the solutions of LCP restriction on allowed HARQ mode in NR NTN can be reused for IoT NTN? Companies are expected to provide your preferred design in the table below:**

**Option 1: only for eMTC over NTN;**

**Option 2: both eMTC and NB-IoT over NTN;**

**Option 3: None**

|  |  |  |
| --- | --- | --- |
| **Company** | **Options** | **Comments** |
| OPPO | Option 3 | For low complexity, we think LCP restriction may not need to be applied to both eMTC and NB-IoT UEs considering their typically simple traffic characteristic. |
| Nokia | Option 1 | In our view (as explained in contribution [12]), the LCP restriction is not needed for NB-IoT. This is because all logical channels belong to one LCG and Long BSR is not supported. Hence, the total amount of data available across all logical channels should be considered in one buffer size computation and be reported to the network. The network can’t know the buffer status of each logical channel which may need different QoS requirement. So, it is difficult for NW to schedule the grant with different HARQ mode for the different logical channels.  For eMTC, diverse services including voice can be supported in legacy TN network. Different LCH may require different QoS requirements according to the latency and reliability. For eMTC over NTN, it is reasonable to reuse the NR NTN LCP mechanism to restrict the data from LCH mapping to the allowed HARQ. The effort is quite limited to copy the solution from NR. |
| Transsion Holdings | Option1 | We think for NB-IoT，the LCP restriction is no need as the service is quit sample and Qos requirement is not much different. |
| Xiaomi | Option 1 | Agree with Nokia |
| Lenovo | Option 1 | Agree with Nokia |
| MediaTek | Option 1 | Agree with Nokia’s comment, LCP restriction on allowed HARQ mode is not suitable for NB-IoT |
| Huawei, HiSilicon | Option 1 | Agree with Nokia |
| Qualcomm | Option 1 | Agree, eMTC can follow the NR NTN approach. |
| InterDigital | Option 1/2 | Agree with Nokia, for LCP restriction based purely on logical channel as in NR, this may not be needed for NB-IoT. However if we consider other restrictions e.g. RLC PDU type then this would be applicable to NB-IoT (see proposal 3a in [11]) |
| ZTE | Option 1 | Agree with Nokia on the necessity of the solutions of LCP restriction on allowed HARQ mode for eMTC over NTN. |
| Intel | Option 1 |  |
| CATT` | Option 1 | We share the same view that the traffic for NB-IoT is simple. There is no necessity to introduce LCP restriction on allowed HARQ mode for NB-IoT. |
| Apple | Option 1 | Agree with Nokia. |
| Samsung | Option 1 | Agree with the reasoning of Nokia. Further add that in Rel-18 we are supposed to target longer connection times. |

# 4 Conclusion

TBA:

# 5 References

1. R2-2210152 Discussion on the HARQ enhancement for IoT-NTN CMCC
2. R2-2210036 Discussion on disabling of HARQ feedback Xiaomi
3. R2-2210702 On HARQ enhancements for IoT NTN Samsung R&D Institute UK
4. [R2-2209410](file:///C:\Data\3GPP\Extracts\R2-2209410.docx) Discussion on the HARQ disabling in IoT NTN CATT
5. [R2-2209442](file:///C:\Data\3GPP\Extracts\R2-2209442_Discussion%20on%20disabling%20HARQ%20feedback%20in%20IoT-NTN.docx) Discussion on disabling HARQ Feedback in IoT-NTN MediaTek Inc.
6. [R2-2209666](file:///C:\Data\3GPP\Extracts\R2-2209666%20Discussion%20on%20disabling%20DL%20HARQ%20feedback.docx) Discussion on disabling DL HARQ feedback Huawei, HiSilicon
7. [R2-2209717](file:///C:\Data\3GPP\Extracts\R2-2209717%20IoT%20HARQ%20process.doc) Enhancement for UL and DL HARQ processes Qualcomm Incorporated
8. [R2-2209750](file:///C:\Data\3GPP\Extracts\R2-2209750%20Discussion%20on%20performance%20enhancement%20for%20IoT%20NTN.docx) Discussion on performance enhancement for IoT NTN Transsion Holdings
9. [R2-2209834](file:///C:\Data\3GPP\Extracts\R2-2209834%20Further%20discussion%20on%20HARQ%20enhancements.docx) Further discussion on HARQ enhancements ZTE Corporation, Sanechips
10. [R2-2210088](file:///C:\Data\3GPP\Extracts\R2-2210088%20-%20Discussion%20on%20HARQ%20enhancement%20for%20IoT%20NTN.doc) Discussion on HARQ enhancement for IoT NTN OPPO
11. [R2-2210195](file:///C:\Data\3GPP\Extracts\R2-2210195%20(R18%20IoT-NTN%20WI%20AI%208.6.2.1)%20-%20disabling%20HARQ%20feedback.docx) Disabling HARQ feedback for IoT-NTN Interdigital, Inc.

1. [R2-2210643](file:///C:\\Data\\3GPP\\Extracts\\R2-2210643%20On%20HARQ%20enhancements%20for%20IoT%20NTN.docx" \o "C:Data3GPPExtractsR2-2210643 On HARQ enhancements for IoT NTN.docx) On HARQ enhancements for IoT NTN Nokia, Nokia Shanghai Bell
2. [R2-2210761](file:///C:\Data\3GPP\Extracts\R2-2210761%20-%20R18%20IoT%20NTN%20performance%20enhancement.docx) R18 IoT NTN performance enhancement Ericsson