3GPP TSG-RAN WG2 Meeting #119bis-e R2-22xxxxx

Online, October 10 - 19th, 2022

Agenda: 7.2.3

Source: Ericsson

Title: Summary [AT119bis-e][106][IoT NTN] UP corrections (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

In this document we summarize and discuss the contributions from the agenda item 7.2.3 for the email discussion:

**\* [AT119bis-e][106][IoT NTN] UP corrections (Ericsson)**

Initial scope: Discuss UP corrections in AI 7.2.3

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)

Deadline (for companies' feedback):  Thursday 2022-10-13 18:00 UTC

Deadline (for rapporteur's summary in R2-2210847):  Thursday 2022-10-13 22:00 UTC

Proposals marked "for agreement" in R2-2210847 not challenged until Friday 2022-10-14 10:00 UTC will be declared as agreed via email by the session chair (for the rest the discussion might continue online).

Status: Ongoing

Please provide your answers before **Thursday 2022-10-13 18:00 UTC.**

The contribution concerns six different issues:

* Calculation of UE-eNB RTT
* Modify TA report MAC CE and Differential Koffset MAC CE
* DRX Active Time when *mpdcch-UL-HARQ-ACK-FeedbackConfig* is configured
* Setting the UL HARQ RTT Timer for eMTC
* Setting the HARQ RTT Timer for eMTC
* Setting the HARQ RTT Timer for NB-IoT

First, please enter you contact information.

**Contact Information**

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# 2 UE-eNB RTT calculation

The document [1] was noted as withdrawn by the chair during the online session on Monday 2022-10-10.

In [2] which is the same as [1] but based on the latest version of the MAC spec, it is noted that RAN1 has made this agreement at RAN1#108:

**Agreement**

For IoT NTN, calculate UE-eNB RTT using the following equation:

where *Tf* = subframe duration (1ms).

The floor function is missing when comparing the text of calculation of UE-eNB RTT which was agreed in R2-2209041. It is proposed to update in MAC spec 3.1:

**UE-eNB RTT:** For non-terrestrial networks, the sum of the floored UE's Timing Advance value (see TS 36.211 [7], clause 8.1) and *k\_Mac* in units of subframe.

## 2.1 Rapporteur’s analysis of UE-eNB RTT calculation

The rapporteur notes that the RAN1 agreement was made with the motivation that it was required for the MAC spec as it refers to the RAN1 spec:

#### SECOND ROUND Discussion on Calculation of UE-eNB RTT

Responding companies have divergent views with following options

1. Specification in RAN1 spec – use floor(.): Sony, MediaTek, CATT, Mavenir, Ericsson?
2. Specification in RAN1 spec – use ceil(.): Nokia, Intel, CMCC, Samsung,
3. Further discuss including whether needed in RAN 1 spec: Qualcomm, Huawei, Samsung, Ericsson

For the 3 and as indicated by MediaTek, RAN2 has a CR to 36.321 [R2-2202051] which is as follows:

If the UE is a BL UE or a UE in enhanced coverage:

- if the random access preamble was transmitted in a non-terrestrial network:

-     RA Response window starts at the subframe that contains the end of the last preamble repetition plus 3 + UE-eNB RTT subframes, as specified in TS 36.2XX [6] clause X.X and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level;

If the UE is an NB-IoT UE:

- if the random access preamble was transmitted in a non-terrestrial network:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus X + UE-eNB RTT subframes, as specified in TS 36.2XX [6] clause X.X

This suggests that RAN2 is expecting a clause in a RAN 1 spec that specifies how UE-eNB RTT is calculated.

Where RAN1 discusses the meaning of word “subframes” in the “UE-eNB RTT subframes” and concludes that RAN2 need a definition of UE-eNB RTT in units of subframes. The text that RAN1 referred to when making the agreement was however later changed by RAN2 to the current text:

If the UE is a BL UE or a UE in enhanced coverage:

- if the random access preamble was transmitted in a non-terrestrial network:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus 3 + UE-eNB RTT subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level;

…

If the UE is an NB-IoT UE:

- if the random access preamble was transmitted in a non-terrestrial network:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus X + UE-eNB RTT subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level, where value X is determined from Table 5.1.4-1 based on the used preamble format and the number of NPRACH repetitions;

Further there was discussions to include the RAN1 agreement on UE-eNB RTT in the RAN1 specifications for Random Access (at RAN1”108 and later RAN1 meetings), but eventually RAN1 only mention the start of PDCCH monitoring with a reference to the RAN2 specification.

The RA Response window is expressed in subframes, from 36.331:

***ra-ResponseWindowSize***

Duration of the RA response window in TS 36.321 [6]. Value in subframes. Value sf2 corresponds to 2 subframes, sf3 corresponds to 3 subframes and so on. The same value applies for each serving cell (although the associated functionality is performed independently for each cell).

Say the subframe that contains the end of the last preamble repetition ends at time T0 at the UE. T0 is obviously based on the UEs UL transmission timing.

The RA Response window shall then start at T0 + 3 subframes + UE-eNB RTT for eMTC (or at T0 + X subframes + UE-eNB RTT for NB-IoT).

Below we make an example of an eMTC NTN with propagation RTT = 8.5 ms, UL/DL aligned in satellite (reference point, RP), Kmac=4, with this notation:

Notation:

Nw Tx Timing at NW when transmitting the DL

RP DL Timing of the DL at the reference point (where UL and DL are aligned)

UE Rx Timing at UE when receiving the DL

UE Tx Timing at UE when transmitting the UL

RP UL Timing of the UL at the reference point

Nw Rx Timing at NW when receiving the UL

A Processing time between preamble rx and DCI for RAR, 4 subframes

PRE Preamble

Drar DCI for RAR

RAR PDSCH for RAR

TA the timing advance, assumed to be 4.5 ms

Koffset The UE specific Koffset, assumed to be TA+1.5 = 6 ms

Kmac The broadcasted Kmac, assumed to be 4 ms

First in figure 1 we illustrate using a time continuous UE-eNB RTT:

Figure 1: eMTC start of drx-RetransmissionTimer in current MAC spec



In this case, when the timer 3+UE-eNB RTT has elapsed after T0, we are always at a subframe border of the DL received PDCCH in the UE.

When using the floor of the UE-eNB RTT in figure 2:

Figure 2: eMTC start of drx-RetransmissionTimer with UE-eNB RTT = floor(TA) + Kmac



In this case, when the timer 3+UE-eNB RTT has elapsed after T0, we are only rarely at a subframe border of the DL received PDCCH at the UE.

Now it is ambiguous if the UE need to monitor PDCCH in the subframe where RA Response window is stared or not, as well as if the UE need to monitor PDCCH in the subframe where RA Response window expires or not.

The situation is the same for all the MAC timers that are started based on an UL transmission, that is for RA Response window, mac-ContentionResolutionTimer, PUR response window, and UL HARQ RTT Timer.

## 2.2 Summary of UE-eNB RTT calculation

**Q2: Do you agree that the changes proposed in R2-2210571 are not aligned with the current MAC modelling for timers started based on the UL transmission timing at the UE?**

**If ‘Disagree’ please indicate how the ambiguity of the start and end of PDCCH monitoring for RA Response window, mac-ContentionResolutionTimer, PUR response window, and UL HARQ RTT Timer shall be resolved.**

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| Company | Agree/Disagree | Remarks |
| Qualcomm | Disagree | eMTC/NB-IoT UEs work on subframe basis. PDCCH search space does not start from the middle of the subframe so it can be from the next subframe boundary. If following RAN1 agreement is issue, then we should check with RAN1. |
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# 3 TAR MAC CE and Differential Koffset MAC CE

In [6] the following changes are proposed

#### 6.1.3.20 Timing Advance Report MAC Control Element

The Timing Advance MAC CE is identified by MAC subheader with LCID as specified in Table 6.2.1-2.

It has a fixed size and consists of two octets defined as follows (Figure 6.1.3.20-1):

- R: Reserved bit, set to 0;

- Timing Advance: The Timing Advance field indicates the least integer number of subframes greater than or equal to the Timing Advance value (see TS 36.211 [7] clause 8.1). The length of the field is 14 bits.



Figure 6.1.3.20-1: Timing Advance MAC CE

#### 6.1.3.21 Differential Koffset MAC Control Element

The Differential Koffset MAC CE is identified by MAC subheader with LCID as specified in Table 6.2.1-1.

It has a fixed size and consists of a single octet defined as follows (Figure 6.1.3.21-1):

- R: Reserved bit, set to 0;

- Differential Koffset: This field indicates the differential Koffset in subframes (see TS 36.213 [2]). The length of the field is 6 bits.



Figure 6.1.3.21-1: Differential Koffset MAC CE

**Q3.1: Do you agree with the changes to 6.1.3.20 proposed in R2-2210697?**

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**Q3.2: Do you agree with the changes to 6.1.3.21 proposed in R2-2210697?**

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# 4 DRX Active Time when *mpdcch-UL-HARQ-ACK-FeedbackConfig* is configured

In [4] it is noted that when *mpdcch-UL-HARQ-ACK-FeedbackConfig* is configured and repetitions within a bundle are being transmitted according to UL\_REPETITION\_NUMBER, then the UE is in Active Time - and no adaptation for NTN have been made.

In NTNs, the Active Time can be delayed by the UE-eNB RTT to allow UE to save power.

The following change is proposed:

## 5.7 Discontinuous Reception (DRX)

The MAC entity may be configured by RRC with a DRX functionality that controls the UE's PDCCH monitoring activity for the MAC entity's C-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, Semi-Persistent Scheduling C-RNTI (if configured), UL Semi-Persistent Scheduling V-RNTI (if configured), eIMTA-RNTI (if configured), SL-RNTI (if configured), SL-V-RNTI (if configured), CC-RNTI (if configured), SRS-TPC-RNTI (if configured), and AUL C-RNTI (if configured). When in RRC\_CONNECTED, if DRX is configured, the MAC entity is allowed to monitor the PDCCH discontinuously using the DRX operation specified in this clause; otherwise the MAC entity monitors the PDCCH continuously. When using DRX operation, the MAC entity shall also monitor PDCCH according to requirements found in other clauses of this specification. RRC controls DRX operation by configuring the timers *onDurationTimer*, *drx-InactivityTimer*, *drx-RetransmissionTimer* (for HARQ processes scheduled using 1ms TTI, one per DL HARQ process except for the broadcast process), *drx-RetransmissionTimerShortTTI* (for HARQ processes scheduled using short TTI, one per DL HARQ process), *drx-ULRetransmissionTimer* (for HARQ processes scheduled using 1ms TTI, one per asynchronous UL HARQ process), *drx-ULRetransmissionTimerShortTTI* (for HARQ processes scheduled using short TTI, one per asynchronous UL HARQ process), the *longDRX-Cycle*, the value of the *drxStartOffset* and optionally the *drxShortCycleTimer* and *shortDRX-Cycle*. A HARQ RTT timer per DL HARQ process (except for the broadcast process) and UL HARQ RTT Timer per asynchronous UL HARQ process is also defined (see clause 7.7).

When a DRX cycle is configured, the Active Time includes the time while:

*- onDurationTimer* or *drx-InactivityTimer* or *drx-RetransmissionTimer* or *drx-RetransmissionTimerShortTTI* or *drx-ULRetransmissionTimer* or *drx-ULRetransmissionTimerShortTTI* or *mac-ContentionResolutionTimer* (as described in clause 5.1.5) is running; or

- a Scheduling Request is sent on PUCCH/SPUCCH and is pending (as described in clause 5.4.4); or

- an uplink grant for a pending HARQ retransmission can occur and there is data in the corresponding HARQ buffer for synchronous HARQ process; or

- a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the preamble not selected by the MAC entity (as described in clause 5.1.4) ; or

- *mpdcch-UL-HARQ-ACK-FeedbackConfig* is configured and repetitions within a bundle are being transmitted according to UL\_REPETITION\_NUMBER. If this Serving Cell is part of a non-terrestrial network, the Active Time starts after the first repetition within the bundle plus the UE-eNB RTT when repetitions within the bundle are being transmitted.

**Q4: Do you agree with the changes to MAC section 5.7 proposed in R2-2210094?**

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| Company | Agree/Disagree | Remarks |
| Qualcomm | Agree |  |
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# 5 UL HARQ RTT Timer for eMTC

In [9] it is noted that one of the agreements from RAN2#115e / RAN2#116e have not been implemented for eMTC.

Agreement from RAN2#115e

1. UE-eNB RTT is taken into account when calculating the (UL) HARQ RTT timer.

Agreement from RAN2#116e

1. An offset equal to UE-eNB RTT is added to the formula used for calculating the (UL) HARQ RTT timer in IoT NTN.

These agreements have not been implemented for eMTC.

Therefore [9] proposes to add RTToffset to the UL HARQ RTT Timer for BL UEs and UEs in enhanced coverage, see text proposal for 7.7 in MAC spec below

Except for NB-IoT and for HARQ processes scheduled using Short Processing Time and for short TTI, UL HARQ RTT Timer length is set to 4 + RTToffset subframes for FDD and Frame Structure Type 3, and set to kULHARQRTT + RTToffset subframes for TDD, where kULHARQRTT equals to the kPHICH value indicated in Table 9.1.2-1 of TS 36.213 [2] if the UE is not configured with upper layer parameter *symPUSCH-UpPts* for the serving cell, otherwise the kPHICH value is indicated in Table 9.1.2-3.

**Q5: Do you agree with the text proposal to MAC section 7.7 proposed above?**

**If ‘Disagree’ please indicate how “UE-eNB RTT is taken into account when calculating the UL HARQ RTT Timer of eMTC”.**

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| Company | Agree/Disagree | Remarks |
| Qualcomm | Agree |  |
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# 6 HARQ RTT Timer for eMTC

The HARQ RTT Timer for eMTC was discussed in [3], [5], [7] (Issue#1), and [9] (with a corresponding CR in [8]).

## 6.1 Supporting HARQ RTT Timer update

In [9] it is noted that this agreements from RAN2#115e

1. UE-eNB RTT is taken into account when calculating the (UL) HARQ RTT timer.

was followed with this agreement at RAN2#116e that copies the agreement from NR NTN:

1. An offset equal to UE-eNB RTT is added to the formula used for calculating the (UL) HARQ RTT timer in IoT NTN.

And this was specified in MAC section 7.7:

For BL UEs and UEs in enhanced coverage, when single TB is scheduled by PDCCH the HARQ RTT Timer corresponds to 7 + N + RTToffset, where N is the used PUCCH repetition factor, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for N. In case of TDD, HARQ RTT Timer corresponds to 3 + k + N + RTToffset, where k is the interval between the last repetition of downlink transmission and the first repetition of the transmission of associated HARQ feedback, and N is the used PUCCH repetition factor, where only valid UL subframes are counted for N as indicated in clauses 10.1 and 10.2 of TS 36.213 [2].

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is not configured, the HARQ RTT Timer corresponds to 7 + m \* N + RTToffset, where N is the used PUCCH repetition factor and m is the number of scheduled TBs as indicated in PDCCH, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for m \* N.

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is configured the HARQ RTT Timer corresponds to 7 + M \* N + RTToffset, where N is the used PUCCH repetition factor and M is the number of TB bundles as specified in clause 7.3 of TS 36.213 [2], where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for M \* N.

There is however a problem ([5], [7], and [9]) with the specified HARQ RTT Timer for eMTC:

* HARQ RTT Timer is started based on the last DL subframe where PDSCH is received in eMTC
* drx-HARQ-RTT-TimerDL is started based on the UL slot where HARQ feedback is transmitted in NR NTN

The solution from NR NTN was to add UE-gNB RTT to the drx-RetransmissionTimerDL, and this was copied to eMTC by adding UE-eNB RTT to the legacy HARQ RTT Timer.

Because of the difference in starting time, this makes for a misalignment between the UEs and the eNBs start of the drx-RetransmissionTimer, please see [5], [7], and [9] for the exact analysis of the misalignment.

The misalignment becomes worse if there is a large difference between the Koffset that the UE applies (Cell specific or UE specific) and the TA.

Further [9] notes that the HARQ RTT Timer has a definition in section 3.1:

**HARQ RTT Timer**: This parameter specifies the minimum amount of subframe(s) before a DL assignment for HARQ retransmission is expected by the MAC entity.

The currently specified HARQ RTT Timer for eMTC violates this definition, as HARQ RTT Timer is not the minimum amount of subframe(s) before a DL-assignment for HARQ retransmission.

There is a simple modification that removes the misalignment between the UE and the eNB:

**In NTNs, for BL UEs and UEs in enhanced coverage, the offset added to the formula used for calculating the HARQ RTT timer shall be Koffset+Kmac instead of RTToffset, see text proposal below**

For BL UEs and UEs in enhanced coverage, when single TB is scheduled by PDCCH the HARQ RTT Timer corresponds to 7 + N + DLoffset, where N is the used PUCCH repetition factor, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for N. In case of TDD, HARQ RTT Timer corresponds to 3 + k + N + DLoffset, where k is the interval between the last repetition of downlink transmission and the first repetition of the transmission of associated HARQ feedback, and N is the used PUCCH repetition factor, where only valid UL subframes are counted for N as indicated in clauses 10.1 and 10.2 of TS 36.213 [2].

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is not configured, the HARQ RTT Timer corresponds to 7 + m \* N + DLoffset, where N is the used PUCCH repetition factor and m is the number of scheduled TBs as indicated in PDCCH, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for m \* N.

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is configured the HARQ RTT Timer corresponds to 7 + M \* N + DLoffset, where N is the used PUCCH repetition factor and M is the number of TB bundles as specified in clause 7.3 of TS 36.213 [2], where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for M \* N.

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NOTE 1: RTToffset = 0 in terrestrial networks and RTToffset = UE-eNB RTT in Non-terrestrial networks.

NOTE 2: DLoffset = 0 in terrestrial networks and DLoffset = *k-Offset* + *k-Mac* in Non-terrestrial networks.

Note, this modification will give gains for all UEs whether they have a UE specific Koffset or Cell specific Koffset or if there is TA reporting or not. The eNB and the UEs will be aligned in the start of drx-RetransmissionTimer and the UE monitor PDCCH only for the correct number of subframes, and the UE energy consumption is minimized.

In the figure 3 below, see [9] for the explanations of all details, we have an example for the current specified HARQ RTT Timer where it is obvious that the drx-RetransmissionTimer is not started for the same DL subframe in the eNB **1** and the UE **2**.

Figure 3: eMTC HARQ RTT Timer in current MAC spec



4v

3v

2

1

While in Figure 4 below we have illustrated an updated HARQ RTT Timer where UE and eNB always start the drx-RetransmissionTimer for the same DL subframe.

Figure 4: Updated eMTC HARQ RTT Timer



## 6.2 Non-support of HARQ RTT Timer change

It is possible to not make the proposed change above, and instead rely on mitigation techniques.

In [3] they argue that NW can implement one such mitigation technique, where each UE can be provided with a UE specific Koffset that minimizes the start time difference between UE and eNB and increase the drx-RetransmissionTimer to account for any remaining misalignment.

The rapporteur notes that in this case 1) UE specific Koffset always need to be configured to be TA+1 to avoid risk of UE not having sufficient processing time between reception and transmission when the satellites moves (especially if TA is increasing), 2) not all UEs will have TA reporting (as it is an optional feature), and 3) this do not minimize the monitoring of MPDCCH and 4) the current HARQ RTT Timer for eMTC still violates the definition of the HARQ RTT Timer.

Alternatively they argue that the difference between Cell specific Koffset and the minimum TA in each cell is small, such that a small increase of the drx-RetransmissionTimer will cover any misalignment between the UEs and the eNBs start of drx-RetransmissionTimer.

## 6.3 Summary HARQ RTT Timer for eMTC

**Q6.1: Do you agree that the current HARQ RTT Timer for eMTC is not in line with the intention to copy the solution from NR NTN and it violates the definition of HARQ RTT Timer in MAC section 3.1?**

**If ‘Disagree’, please describe how the current HARQ RTT Timer “specifies the minimum amount of subframe(s) before a DL assignment for HARQ retransmission” in eMTC NTNs.**

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| Company | Agree/Disagree | Remarks |
| Qualcomm | Disagree | If network is not aware of UE’s TA, it should always consider worst case UE’s TA and hence worst case HARQ RTT timer length and schedule the retransmission accordingly.  DRX retransmission timer length should be greater than difference between best and worst case UE’s TA.  If DRX retransmission timer length is too small, then there is next scheduling opportunity in DRX ON duration. |
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**Q6.2: Do you agree that using UE specific Koffset adapted to a varying TA cannot minimize misalignment between UEs and eNBs start of the drx-RetransmissionTimer for all cases (for example for UEs without the optional TA reporting capability) and require using a longer drx-RetransmissionTimer giving higher UE energy consumption?**

**If ‘Disagree’, please indicate how using UE specific Koffset adapted to the UEs TA without TA reporting is possible and how it minimizes the UE energy consumption.**

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| --- | --- | --- |
| Company | Agree/Disagree | Remarks |
| Qualcomm | Partly agree | First of all, this is only for the case of retransmission when UE didn’t decode MAC PDU. So it is not necessary that larger DRX retransmission meant larger power consumption.  The formula for HARQ RTT already includes constant value 7 which will reduce the severeness of the issue. “7” already covers the max cell differential delay (2\*3.12 = 6.24 ms) in LEO 600km.  Network should update the cell specific Koffset and common TA parameters when feeder link RTT changes by a threshold of network implementation. In IOT NTN, network is allowed to update cell specific Koffset without notifying UE. For connected mode UE, it can send SIB31 via dedicated RRC.  UE specific Koffset is likely slightly larger than UE’s TA so this issue should not be big problem.  UE will trigger TA report when TA is changed so the network should be able to update the Koffset.  Network may schedule the retransmission assuming HARQ RTT timer with RTToffset ~UE’s TA + delta. If UE specific TA is used, delta will be small so ok.  If cell specific Koffset is used, this “delta” will be too large for UEs supporting UE specific Koffset and problematic. |
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**Q6.3: Do you agree that the misalignment between the UEs and eNBs start of drx-RetransmissionTimer shall be resolved, for example, by modifying the offset added to the formula for calculating the HARQ RTT timer to be Koffset+Kmac instead of RTToffset?**

**If ‘Disagree’ please state the technical reason for violating the definition of HARQ RTT Timer and for having higher UE energy consumption than necessary.**

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| Company | Agree/Disagree | Remarks |
| Qualcomm | See comments | Network can set larger value of DRX retransmission timer such as 40psf as it is introduced for eMTC.  In this case, UE probably wastes 2\*max differential delay subframes with unnecessary PDCCH monitoring. This is not violation.  But if we need to resolve it properly, then the correct solution is to move the start of HARQ RTT timer to the very first repetition of ACK transmission. This should be ok as now any change will be inconsistent with the previous release. |
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**Q6.4: Do you agree with the text proposal for MAC section 7.7 below?**

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| Company | Agree/Disagree | Remarks |
| Qualcomm | Disagree | See our response in Q6.5. We can consider same as NR to move the start of HARQ RTT timer. |
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For BL UEs and UEs in enhanced coverage, when single TB is scheduled by PDCCH the HARQ RTT Timer corresponds to 7 + N + DLoffset, where N is the used PUCCH repetition factor, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for N. In case of TDD, HARQ RTT Timer corresponds to 3 + k + N + DLoffset, where k is the interval between the last repetition of downlink transmission and the first repetition of the transmission of associated HARQ feedback, and N is the used PUCCH repetition factor, where only valid UL subframes are counted for N as indicated in clauses 10.1 and 10.2 of TS 36.213 [2].

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is not configured, the HARQ RTT Timer corresponds to 7 + m \* N + DLoffset, where N is the used PUCCH repetition factor and m is the number of scheduled TBs as indicated in PDCCH, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for m \* N.

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is configured the HARQ RTT Timer corresponds to 7 + M \* N + DLoffset, where N is the used PUCCH repetition factor and M is the number of TB bundles as specified in clause 7.3 of TS 36.213 [2], where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for M \* N.

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NOTE 1: RTToffset = 0 in terrestrial networks and RTToffset = UE-eNB RTT in Non-terrestrial networks.

NOTE 2: DLoffset = 0 in terrestrial networks and DLoffset = *k-Offset* + *k-Mac* in Non-terrestrial networks.

# 7 HARQ RTT Timer for NB-IoT

During the online session there was a comment that we need to discuss also the HARQ RTT Timer for NB-IoT.

The contribution [7] present Issue#2 (RTT of NTN network has been considered twice in the time length of HARQ RTT timer).

For NB-IoT over NTN and also TDD case for eMTC over NTN. In these cases, the factor k has been considered in the time length of HARQ RTT timer, one example is as below:

*“For NB-IoT, when single TB is scheduled by PDCCH or when multiple TBs are scheduled for the interleaved case when HARQ-ACK bundling is configured the HARQ RTT Timer is set to k+3+N + RTToffset +deltaPDCCH subframes, where k is the interval between the last subframe of the downlink transmission and the first subframe of the associated HARQ feedback transmission and N is the transmission duration in subframes of the associated HARQ feedback, and deltaPDCCH is the interval starting from the subframe following the last subframe of the associated HARQ feedback transmission plus 3+ RTToffset subframes to the first subframe of the next PDCCH occasion.”*

As mentioned by proponent company of [R2-2208664], factor k already can reflect DL/UL timing relationship, e.g., Koffset, which in NTN also is related to the RTT. Therefore, if we further expand the above example formula “k+3+N + RTToffset +deltaPDCCH”as: k (Koffset) +3+N + RTToffset (TA+Kmac) +deltaPDCCH, we can find the RTT of NTN network has been considered twice in the time length of HARQ RTT timer. This is also incorrect and may cause unnecessary large scheduling delay (Issue #2).

## 7.1 Rapporteur’s analysis of HARQ RTT Timer for NB-IoT

The rapporteur notes that for NB-IoT we have for example

For NB-IoT, when single TB is scheduled by PDCCH or when multiple TBs are scheduled for the interleaved case when HARQ-ACK bundling is configured the HARQ RTT Timer is set to k+3+N + RTToffset +deltaPDCCH subframes, where k is the interval between the last subframe of the downlink transmission and the first subframe of the associated HARQ feedback transmission and N is the transmission duration in subframes of the associated HARQ feedback, and deltaPDCCH is the interval starting from the subframe following the last subframe of the associated HARQ feedback transmission plus 3+ RTToffset subframes to the first subframe of the next PDCCH occasion.

Looking at the k+3+N + RTToffset +deltaPDCCH we have

k is the interval between the last subframe of the downlink transmission and the first subframe of the associated HARQ feedback transmission which in this case will be = Koffset – TA + Tproc (Tproc is 3 ms = the UE minimum processing before sending a HARQ feedback [not including the PDSCH subframe], imagine perfect Koffset=TA to see why Tproc is needed)

3 is the eNB processing time of HARQ feedback before sending a new assignment (not including the subframe where the HARQ feedback is received)

N is the duration where HARQ feedback is sent

RTToffset is the UE-eNB RTT

deltaPDCCH is the time between [last HARQ feedback transmission + 3 + RTToffset] and first PDCCH occasion.

If the last subframe of the PDSCH transmission ends at time T1 at the UE,

then first HARQ feedback is sent after T2 = T1 + k = T1 + Koffset – TA + 3 at the UE

and last HARQ feedback ends at T3 = T2 + N = T1 + Koffset – TA + 3 + N at the UE

then last HARQ feedback ends at T4 = T3 + (UE-eNB RTT)/2 at the eNB

then a new eNB assignment can earliest be transmitted T5 = T4 + 3 + deltaPDCCH at the eNB

then the eNB assignment arrives at T6 = T5 + (UE-eNB RTT)/2 = T3 + 3 + UE-eNB RTT + deltaPDCCH at the UE

At T6, the drx-RetransmissionTimer shall ideally be started at the UE, and thus the HARQ RTT Timer shall end.

T6 = T1 + Koffset – TA + 3+ N + 3 + UE-eNB RTT + deltaPDCCH

If we have “perfect” Koffset = TA, N = 1 and deltaPDCCH is zero we get:

T6 = T1 + 7 + UE-eNB RTT

To the rapporteur, current HARQ RTT Timer for NB-IoT seems correct and RTT is only considered once as it should be.

## 7.2 Summary HARQ RTT Timer for NB-IoT

**Q7: Do you agree that the there is a need to update the HARQ RTT Timer for NB-IoT?**

**If ‘Agree’ please indicate the technical analysis.**

|  |  |  |
| --- | --- | --- |
| Company | Agree/Disagree | Remarks |
| Qualcomm | Disagree | We also think there is no issue for NB-IoT. |
|  |  |  |
|  |  |  |
|  |  |  |
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|  |  |  |

# 8 Summary

Here we will summarize proposals from the discussions…

# 9 References

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