**3GPP TSG-RAN WG2 Meeting #116 electronic *R2-211xxxx***

**Online, November 1st – November 12th, 2021**

**Agenda Item: 9.2.3**

**Source: OPPO**

**Title: Report of [AT116-e][028][IoT-NTN] User Plane Impact (OPPO)**

**Document for: Discussion and Decision**

# Introduction

This document is to report the outcome of the following email discussion at RAN2#116-e Meeting:

* [AT116-e][028][IoT-NTN] User Plane Impact (OPPO)

 Scope: Ph1 Treat documents under 9.2.3. Identify easy agreements, potential agreements (need discussion), potential alternatives, blocking points, Open issues (Note should only capture Open Issues that must be resolved in the end). Pave the way for on-line Discussion.

 Intended outcome: Report

 Deadline: Ph1 Monday W2

# Discussion

Proposals from companies [1-10] will be discussed in the following sections.

## 2.1 MAC

### 2.1.1 RACH

In RAN2#115e meeting, RAN2 discussed how to adapt RACH timers (i.e. ra-ResponseWindow and mac-ContentionResolutionTimer) to IoT NTN, and made the following agreements:

Agreements:

* Start of ra-ResponseWindow is delayed by an offset. Postpone discussion on the offset value until further agreements regarding RACH are made in RAN1.
* If the start of the RA Response window is accurately compensated by UE-eNB RTT and no extension of repetition is required, there is no need to extend the ra-ResponseWindowSize for IoT NTN.
* Start of mac-ContentionResolutionTimer is delayed by an offset, (assumed equal to UE-eNB RTT). This can be revisited if RAN1 decides something that requires to change this.
* If the start of mac-ContentionResolutionTimer is accurately compensated by UE-eNB RTT and no extension of repetition is required, there is no need to extend the mac-ContentionResolutionTimer for IoT NTN.

Since UE-eNB RTT is assumed to be used as the offset for the start of mac-ContentionResolutionTimer in IoT NTN, UE-eNB RTT should be known by the UE.

In RAN1#106e meeting, RAN1 has made the following agreements：

Conclusion:

For IoT NTN, no modifications are needed for the calculation in NR NTN for estimate of UE-eNB RTT.

|  |
| --- |
| Agreement:The following agreements from NR NTN are re-used for IoT NTN as working assumption.1. Timing Advance formula can be transposed to IoT-NTN with Ts used instead of Tc

The Timing Advance applied by an NR NTN UE in RRC\_IDLE/INACTIVE and RRC\_CONNECTED is given by:$$T\_{TA}=\left(N\_{TA}+N\_{TA,UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{s}$$ |

In NR NTN, RAN1 has agreed the following:

Agreement:

* The estimate of UE-gNB RTT is equal to the sum of UE’s TA and K\_mac.

Based on above RAN1 agreements, in [6], it is proposed that the estimate of UE-eNB RTT is equal to the sum of UE’s TA and K\_mac, where the UE’s TA is given by $T\_{TA}=\left(N\_{TA}+N\_{TA,UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{s}$. In [1], it is proposed that the K\_mac value is broadcasted by network.

Corresponding proposals are listed as below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2109505 | Proposal 1: The K\_mac value is broadcasted by network. | OPPO |
| R2-2110479 | Proposal 1: The estimate of UE-eNB RTT is equal to the sum of UE’s TA and K\_mac, where the UE’s TA is given by $$T\_{TA}=\left(N\_{TA}+N\_{TA,UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{s}$$ | Huawei, HiSilicon |

Since UE-eNB RTT would be used for adaptation of some MAC timers in IoT NTN, rapporteur thinks it would be good to confirm the following from RAN2’s perspective.

**Question 1: Do companies agree that the estimate of UE-eNB RTT is equal to the sum of UE’s TA and K\_mac, where the UE’s TA is given by** $T\_{TA}=\left(N\_{TA}+N\_{TA,UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{s}$**, and K\_mac value is broadcasted by network?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional comments** |
| MediaTek | Agree |  |
| Xiaomi | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |
| Nokia | Agree |  |
| Huawei, Hisilicon | Agree |  |
| Qualcomm | Agree | We should say, K\_mac and $+N\_{TA,common}$are broadcast by network. |
| Ericsson | Agree |  |
| ZTE | Agree |  |
| CMCC | Agree |  |
| Interdigital | Agree |  |
| Apple | Agree |  |
| Rakuten Mobile Inc | Agree | Agree with Qualcomm comment. |

**Rapporteur summary:**

TBA…

Unlike NR, for NB-IoT and eMTC, there is already an offset for the start of ra-ResponseWindow. For eMTC, the offset is fixed to 3 subframes, while for NB-IoT, the offset can be either 4 subframes or 41 subframes, depending on the NPRACH transmission duration. For different NTN deployment (e.g. GEO or LEO/MEO in different altitude), the UE-eNB RTT may vary from ~20ms to ~540ms. Therefore, the current NB-IoT offset value (e.g. 41ms) may be shorter or longer than UE-eNB RTT.

Regarding the offset value for the start of ra-ResponseWindow, there are the following two options based on the inputs from companies:

* Option 1: The offset is defined as max (current offset, UE-eNB RTT), where the current offset is fixed to 3 subframes for eMTC, and can be either 4 subframes or 41 subframes for NB-IoT as defined in TS36.321. [1]
* Option 2: The offset is defined as sum (current offset, UE-eNB RTT) and current offset is defined in TS36.321 as Option1. [6][8]

In [1], it is stated that the current offset (due to various transmission/reception gaps) starts from the last preamble repetition, and by the nature of propagation, the UE-eNB RTT also starts at the same time. Both time periods are actually the minumum time required for receiving the earliest PDCCH transmission. To take both time periods into account, it think it would be reasonable to use option 1 from UE’s perspective. While in [8], it is argued that for Option1, the eNB has no knowledge of the exact UE-eNB RTT before RACH, thus NW don’t know the value of max (current offset, UE-eNB RTT). If the UE delay the start of *ra-ResponseWindow* as suggested by option1, actually the NW don’t know when the UE will start monitor RAR. In both [6] and [8], it is suggested to follow the NR NTN agreement on the start of RAR window.

Corresponding proposals are listed as below.

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| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2109505 | Proposal 2: In IoT NTN, define the offset value for the start of ra-ResponseWindow as max (current offset, UE-eNB RTT). | OPPO |
| R2-2110479 | Proposal 2: In the MAC specification, delay the start of ra-ResponseWindowSize by the UE-eNB RTT, with the UE’s TA equal to T\_TA=(N\_TA+N\_(TA,UE-specific)+N\_(TA,common)+N\_(TA,offset) )×Ts with N\_TA=0. | Huawei, HiSilicon |
| R2-2110706 | Proposal 1: The offset to delay the start of ra-ResponseWindowSize is the sum (current offset, UE-eNB RTT), where the current offset is fixed to 3 subframes for eMTC, and can be either 4 subframes or 41 subframes for NB-IoT as defined in TS36.321. | Nokia, Nokia Shanghai Bell |

Rapporteur would like to ask the following question:

**Question 2: Regarding the offset value for the start of the ra-ResponseWindow, which is your preferred option?**

* **Option 1: The offset is defined as max (current offset, UE-eNB RTT), where the current offset is fixed to 3 subframes for eMTC, and can be either 4 subframes or 41 subframes for NB-IoT as defined in TS36.321.**
* **Option 2: The offset is defined as sum (current offset, UE-eNB RTT) and current offset is defined in TS36.321 as Option1.**
* **Option 3 for NB-IoT: There is issue with both option 1 and option 2 for NB-IoT for the case of 41 subfrmaes and UE-eNB RTT < 41 subframes. FFS for this case.**

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| --- | --- | --- |
| **Company** | **Option** | **Additional comments** |
| MediaTek | Option 2 |  |
| Xiaomi | Option 1 | Option 1 can reduce the unnecessary delay. |
| OPPO | Option 1 | From UE’s perspective, option 1 is reasonable since the minumum time required for receiving the earliest PDCCH for RAR is max (current offset, UE-eNB RTT). We understand the concern pointed out in [8] is that with option 1, NW may don’t know when UE starts *ra-ResponseWindow* to monitor PDCCH, since NW is not aware of UE-eNB RTT. In our understanding, with option 1:If UE-eNB RTT is longer than the current offset value, the offset value is determined as UE-eNB RTT. In this case, NW does not need to know UE-eNB RTT, since UE would never receive PDCCH for RAR until UE-eNB RTT has passed after sending preamble.If UE-eNB RTT is shorter than the current offset value, the offset value is determined as the current offset value. In this case, after receive preamble, NW needs to estimate how long it should wait at least (named T here) to send PDCCH for RAR based on the difference between current offset value and UE-eNB RTT. In order to avoid UE from missing RAR, one possible NW implementation is to determine T based on the minimum UE-eNB RTT in the NTN scenario.Based on the UE-eNB RTT shown in the table below, it can be observed that:In the GEO and MEO scenarios, UE-eNB RTT is always longer than the current offset value. Based on the analysis above, NW does not need to know UE-eNB RTT as UE would never receive PDCCH for RAR before it starts *ra-ResponseWindow*.In the LEO scenario, for NB-IoT with current offset value of 3 subframes and eMTC, UE-eNB RTT is always longer that the current offset value. This case is similar to GEO and MEO. For NB-IoT with current offset value of 41 subframes, UE-eNB RTT is always shorter or equal that the current offset value. In this case, even though NW does not know the exact value of UE-eNB RTT, based on the proper NW implementation, UE would also not miss RAR.**UE-eNB RTT in IoT NTN scenarios**

|  |  |  |
| --- | --- | --- |
| Scenarios | Maximum UE-eNB RTT | Minimum UE-eNB RTT |
| GEO (Scenario A) | 541.46ms | 520.86 |
| LEO with satellite altitude of 600 km(Scenario B&C) | 19.53ms | 25.77 ms |
| LEO with satellite altitude of 1200 km(Scenario B&C) | 35.41ms | 41.77ms |
| MEO(Scenario D) | 160.1 ms | 186.9 ms |

 So we think option 1 is workable from both UE and NW’s perspective. |
| Lenovo, Motorola Mobility | Option 1 | Option 1 is straight-forward in reflecting the minimum time duration until RAR reception. |
| Nokia | Option 2 | Option1 is not feasible. As mentioned by OPPO, if UE-eNB RTT is shorter than the current offset value, the offset value is determined as the current offset value. After receiving preamble, NW needs to estimate how long it should wait at least (named T here) to send PDCCH for RAR based on the difference between current offset value and UE-eNB RTT, to avoid UE from missing RAR. However, NW has no knowledge of the exact UE-specific UE-eNB RTT before RACH and after receiving preamble. The option1 is not feasible for NW.We prefer simple solution and follow the NR NTN way-forward. |
| Huawei. HiSilicon | Option 2 |  |
| Qualcomm | Option 2 for eMTC.Option 3 for NB-IoT. | We think it is simple just to extend it by RTT for eMTC.But we would like to highlight the issue for NB-IoT when gap needed is at least 41 subframes.Suppose UE1 transmits preamble at slot X and UE2 transmits preamble at slot Y. Why? It is because they have different UE specific TA.This means UE1 starts RAR at X + 41 and UE starts RAR at Y + 41 if UE-eNB RTT (say 25ms) < 41 in option 1.So eNB does not know from preamble it is UE1 or UE2 and does not know when the RAR window starts at (X+41) or (Y+41).Same issue happens with option 2. We need further discussion on this issue. |
| Ericsson | Option 1 | We are also fine with option 2 |
| ZTE | Option 2 | We have similar view as Nokia. As NW has no knowledge of the exact UE-specific UE-eNB RTT when sending RAR, with Option 1, it is difficult to align the RAR occasion between UE and eNB.We think companies can agree the issue mainly exist in the NB-IoT+ LEO scenario in which both the case of UE-eNB RTT larger than current offset and the case of UE-eNB RTT smaller than current offset may occur.With option 1, the basic assumption can be:* Sub-case-1: if UE-eNB RTT larger than current offset, UE would use UE-eNB RTT as offset for the start of the ra-ResponseWindow and eNB can directly start RAR transmission after reception of preamble.
* Sub-case-1: if UE-eNB RTT smaller than current offset, UE would use current offset as offset for the start of the ra-ResponseWindow. For eNB, after it receives preamble, it would wait for a time period with length of (current offset – real UE-eNB RTT) and then transmit the RAR.

However, firstly, as eNB cannot know the exact UE-specific UE-eNB RTT after receiving preamble, the eNB cannot even accurately distinguish the above two Sub-cases, that is, the eNB cannot know whether it can directly send the RAR or should wait for a while?Taking a step back, even if the eNB can distinguish (by some other way, configuration?) and eNB think it needs to wait (current offset – real UE-eNB RTT), as eNB doesn’t know the exact UE-eNB RTT value, eNB may only have the following choices:* Alt1: to use minimum UE-eNB RTT (instead of the real UE-eNB RTT). Then, (current offset - UE-eNB RTT) would be larger than the real one. That means eNB tend to wait more time before sending RAR. That would further cause the arrival of RAR later than UE’s start of RAR window. It’s easy to cause expiration of RAR window.
* Alt2: to use maximum UE-eNB RTT. Then, (current offset - UE-eNB RTT) would be smaller than the real one. That means eNB tend to wait less time before sending RAR. That would further cause the arrival of RAR earlier than UE’s start of RAR window. The UE may miss part of RAR transmission.

In a summary, for Option 1, we see no good way to address the misalignment between UE and eNB in NB-IoT+LEO scenario.If with Option 2, eNB don’t need to care about the UE-eNB RTT. The eNB can always wait for time period with length of current offset and then send the RAR. No misalignment would occur. We can know the issue of Option 2 is delay. So we are wondering, is it any possible to apply Option 2 in NB-IoT + LEO scenario and apply Option 1 in other scenarios? |
| CMCC | Option 2 | The offset should be extended on the basis of the existing mechanism, instead of taking the max (current offset, UE-eNB RTT). |
| Interdigital | Option 2 |  |
| Apple | Option 2 | Since delay is not a concern, option 2 may be acceptable. |
| Rakuten Mobile Inc | Option 2 | We are agreeing the Nokia & ZTE comments. Since eNB is not aware of UE-eNB RTT before RACH, there is possibility of missing RAR for UE in case of LEO. |

**Rapporteur summary:**

TBA…

Regarding the offset value for the start of mac-ContentionResolutionTimer, the following agreement was made in RAN2#115e meeting.

* Start of mac-ContentionResolutionTimer is delayed by an offset, (assumed equal to UE-eNB RTT). This can be revisited if RAN1 decides something that requires to change this.

It is proposed in [6] that in the MAC specification, delay the start of mac-ContentionResolutionTimer by the UE-eNB RTT, with the UE’s TA equal to T\_TA=(N\_TA+N\_(TA,UE-specific)+N\_(TA,common)+N\_(TA,offset) )×Ts with N\_TA=0.

Corresponding proposals are listed as below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2110479 | Proposal 3: In the MAC specification, delay the start of mac-ContentionResolutionTimer by the UE-eNB RTT. | Huawei, HiSilicon |

Given that RAN1 has reached agreement on estimation of UE-eNB RTT in IoT NTN, rapporteur would like to ask the following question:

**Question 3: Do companies confirm that the start of mac-ContentionResolutionTimer is delayed by UE-eNB RTT in IoT NTN?**

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional comments** |
| MediaTek | Agree |  |
| Xiaomi | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |
| Nokia | Agree |  |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | Agree |  |
| Ericsson | Agree |  |
| ZTE | Agree  |  |
| CMCC | Agree |  |
| Interdigital | Agree |  |
| Apple | Agree |  |
| Rakuten Mobile Inc | Agree |  |

**Rapporteur summary:**

TBA…

In both eMTC and NB-IoT, (N)PRACH resources are configured on a per-CE basis and the UE selects a (N)PRACH resource based on its (N)RSRP evaluation against some threshold. In previous meetings, there are some proposals to enhance the (N)PRACH resource selection, e.g. based on location information, to mitigate the inaccuracy of RSRP measurement in NTN. In [6], it is suggested to reuse legacy mechanism in IoT NTN and do not consider any enhancement.

Corresponding proposals are listed as below.

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| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2110479 | Proposal 5: The legacy mechanism for selection of a (N)PRACH resource based on (N)RSRP threshold(s) is reused in IOT NTN. | Huawei, HiSilicon |

Based on this, rapporteur would like to ask the following question:

**Question 4: Do companies agree that any enhancements on (N)PRACH resource selection in IoT NTN will not be pursued in Rel-17?**

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| --- | --- | --- |
| **Company** | **Agree / Disagree** | **Additional comments** |
| MediaTek | Agree |  |
| Xiaomi | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |
| Nokia | Agree, but | Since the satellite is moving, UE’s RSRP may vary a lot even UE is stationary. This is quite different from legacy IoT system where RSRP is stable during RACH and data transmission period. The legacy CE level and (N)PRACH resource selection based on RSRP threshold may need some enhancements (e.g. consider the change trend of radio conditions to determine the CE level). However, considering the limited time in Rel-17, it’s fine to consider it in future release. |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | Agree |  |
| Ericsson | Agree |  |
| ZTE | Agree |  |
| CMCC | Agree |  |
| Interdigital | Agree |  |
| Apple | Agree |  |
| Rakuten Mobile Inc | Agree But  | We are agreeing to limit scope of Rel17. But not agreeing to have enhancement to selection of CE. Since there are observation of less deviation of RSRP over footprint of NTN cell. In fact, in NR NTN there was discussion about location based Handover due to less variation in RSRP. So, we too feel to have option of location based or some other effective method of CE selection method along with RSRP. |

**Rapporteur summary:**

TBA…

### 2.1.2 (UL) HARQ RTT Timer

Unlike NR, for eMTC and NB-IoT, both HARQ RTT timer and UL HARQ RTT Timer are derived by a formula in TS36.321. In general, the formula can be expressed as below.

HARQ RTT Timer = TPDSCH to UCI + TUCI + Tprocessing + delta PDCCH

UL HARQ RTT Timer = Tprocessing + delta PDCCH

Where,

* TPDSCH to UCI is the time interval from last PDSCH repetion reception to HARQ-feedback transmission;
* TUCI is HARQ-feedback transmission duration;
* Tprocessing is UE processing delay after PUSCH or HARQ-feedback, which is defined as one or a few milliseconds;
* delta PDCCH is not a fixed value but an offset to align with the next NPDCCH occasion, which applies to NB-IoT only.

In RAN2#115e meeting, RAN2 discussed how to adapt (UL) HARQ RTT Timer to IoT NTN, and made the following agreements:

Agreements:

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

In last RAN2 meeting, three options were proposed to extend the (UL) HARQ RTT timer, which would enable the UE to receive a retransmission grant after UE-eNB RTT.

* Option 1: Add an offset, equal to max(UE-eNB RTT - Tprocessing, 0), to the formula calculating the (UL) HARQ RTT timer, where Tprocessing is UE processing delay after PUSCH or HARQ-feedback, which is defined as one or a few milliseconds;
* Option 2: Add an offset, equal to UE-eNB RTT, to the formula calculating the (UL) HARQ RTT timer.
* Option 3: Delay the start of (UL) HARQ RTT timer with an offset of UE-eNB RTT.

In [1], option 1 is proposed for the reason that considering the large RTT impact on (UL) HARQ RTT Timer, UE is actually waiting for both the UE processing delay and the UE-eNB RTT before being ready to receive the earliest PDCCH transmission, and these two time periods are counted in parallel instead of one after another. In both [4], [6], [8] and [10], it is proposed to use option 2. In [8], it is stated that option1 is similar to option2 in that the RTT timer is extended by an offset. However, option1 considers further optimization to exclude the Tprocessing, and it prefers the simple solution (option2) since the UE-eNB RTT is much longer than the UE processing delay for IoT NTN. Besides, in both [6] and [8], option 3 is not preferred since it is not clear how the UE behaves while waiting for the start of (UL) HARQ RTT timer which may bring the complexity to the solution.

Corresponding proposals are listed as below.

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| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2109505 | Proposal 3 In IoT NTN, HARQ RTT Timer and UL HARQ RTT Timer are defined as following:* HARQ RTT Timer = TPDSCH to UCI + TUCI +max(Tprocessing, UE-eNB RTT)+delta PDCCH
* UL HARQ RTT Timer = max(Tprocessing, UE-eNB RTT) + delta PDCCH
 | OPPO |
| R2-2110115 | Proposal 1: To extend the HARQ RTT timer and UL HARQ RTT timer value by UE-gNB RTT (i.e. sum on UE's TA and K\_mac) for IoT NTN. | ZTE Corporation, Sanechips |
| R2-2110479 | Proposal 6: In NB-IoT, an offset equal to UE-eNB RTT is added to the formula calculating the DL HARQ RTT timer. Proposal 7: In NB-IoT, an offset equal to UE-eNB RTT is added to the formula calculating the UL HARQ RTT timer. | Huawei, HiSilicon |
| R2-2110706 | Proposal 2: The timer length of HARQ RTT timer and UL HARQ RTT timer are increased by an offset, where the offset is equal to UE-eNB RTT. | Nokia, Nokia Shanghai Bell |
| R2-2110953 | [Proposal 1 The HARQ RTT Timer length is increased by the UE-eNB RTT.](#_Toc85762117)[Proposal 2 The UL HARQ RTT Timer length is increased by the UE-eNB RTT.](#_Toc85762118) | Ericsson |

In this meeting, only option 1 and option 2 were proposed by companies. Rapporteur would like to ask the following question:

**Question 5: For (UL) HARQ RTT Timer in IoT NTN, which is the preferred option?**

* **Option 1: Add an offset, equal to max(UE-eNB RTT - Tprocessing, 0), to the formula calculating the (UL) HARQ RTT timer**
* **Option 2: Add an offset, equal to UE-eNB RTT, to the formula calculating the (UL) HARQ RTT timer.**

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| --- | --- | --- |
| **Company** | **Option** | **Additional comments** |
| MediaTek | Option 2 |  |
| Xiaomi | Option 2 | The processing delay is very small, no need to optimize for this. |
| OPPO | Option 1 | Similar to the case of the offset for start of ra-ResponseWindow, from UE’s perspective, option 1 is reasonable as it presents the minumum time required for receiving the earliest PDCCH indicating retransmission for the given HARQ process.  |
| Lenovo, Motorola Mobility | Option 2 | We consider processing delay to be neglectable. |
| Nokia | Option 2 | Follow the NR NTN solution for simplicity. |
| Huawei, HiSilicon | Option 2 |  |
| Qualcomm | Option 2 | Simple |
| Ericsson | Option 1 | We are also fine with option 2 |
| ZTE | Option 2 |  |
| CMCC | Option 2 |  |
| Interdigital | Option 2 |  |
| Apple | Option 2 |  |
| Rakuten Mobile Inc | Option 2 | The Value of **Tprocessing** is very small compared to UE-eNB RTT ,so there will not be a big difference in both options. |

**Rapporteur summary:**

TBA…

### 2.1.2 TA reporting

TA report during RACH has been discussed in NR NTN WI. The motivation of introducing UE-calculated TA report during RACH is to let gNB know the absolute TA value of the UE, so that gNB could utilize UE’s absolute TA to schedule UL transmission for the UE, which could reduce unnecessary latency. So far, RAN2 has reached the following agreement on TA report in NR NTN.

Agreement in RAN2#114e:

1. If enabled by the network, the UE reports information about UE specific TA pre-compensation at the random access procedure (MSGA/MSG3 or MSG5) using a MAC CE. Actual content is FFS and also depends on further RAN1 input (we can revise this whole agreement if RAN1 come to a different conclusion in terms of what needs to be conveyed to the NW)

Agreement in RAN2#105e:

1. UE specific TA reporting during RACH procedure is enabled/disabled by SI (FFS for RACH in connected mode)
2. The content of UE specific TA pre-compensation reported in RA procedure using MAC CE is UE specific TA (this can be revisited after receiving RAN1 response).
3. Reporting on the information about UE specific TA in connected mode is supported, FFS via RRC signalling or MAC CE
4. Event-triggers for reporting on the information about UE specific TA in connected mode is supported. FFS on the details. Confirmation by RAN1 is also needed
5. Information about UE specific TA pre-compensation is not reported in RA procedures triggered due to “Request for Other SI”
6. The event-triggers for reporting information about UE specific TA are based on TA values (confirmation from RAN1 is needed)
7. A TA offset threshold can be used for event-triggered reporting, at least the offset threshold can be between current information about UE specific TA and the last successfully reported information about UE specific TA
8. The event-triggers for reporting information about UE specific TA based on time threshold is not supported in NTN.
9. No new indication in RRC reconfiguration with sync is needed to configure the UE to report information about UE specific TA in handover procedure (besides the SIB indication carried in HO command on whether TA report is enabled/disabled in the target cell).
10. Under the work assumption "the UE location information cannot be reported in connected mode", the content of UE specific TA reported in connected mode is UE specific TA pre-compensation(for the details of the TA value, confirmation from RAN1 is needed).
11. If the reported content of information about UE specific TA is UE location information in connected mode, RRC signalling is used to report.
12. Under the work assumption "the UE location information can be reported in connected mode", for TA reporting purposes in connected mode, the network can configure the UE to send either the UE specific TA pre-compensation (for the details of the TA value, confirmation from RAN1 is needed) or the UE location information

Working Assumption:

1. If the reported content of information about UE specific TA is TA pre-compensation value in connected mode, MAC CE is used to report

TA reporting was not discussed during the SI for IoT NTN. In RAN2#115e meeting, TA reporting in IoT NTN was discussed and the following agreement was made.

|  |
| --- |
| Agreement:* RAN2 assumes that TA information (FFS what) reporting by the UE on network enabling will be needed in IoT NTN. Expect RAN1 need to progress on this, and can maybe reuse NR NTN progress. FFS in which message this is provided.
 |

Proposals in [2], [4], [5] and [6] related to TA reporting during RACH procedure in IoT NTN are listed below.

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| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2109701 | Proposal 1: RAN2 confirms to reuse the following NR NTN agreements for IoT NTN:* If enabled by the network, the UE reports information about UE specific TA pre-compensation at the random access procedure (MSGA/MSG3 or MSG5) using a MAC CE;
* UE specific TA reporting during RACH procedure is enabled/disabled by SI;
* The content of UE specific TA pre-compensation reported in RA procedure using MAC CE is UE specific TA.
 | CATT |
| R2-2110115 | Proposal 2b: An indication in SIB1 or SIB2 is used to control the UE specific TA reporting in RA procedure and in connected mode. Proposal 2c: If UE specific TA MAC CE is included in Msg3, it can be always placed in the fixed position in Msg3. With this way, no additional subheader for UE specific TA MAC CE in RA procedure is needed.Proposal 2d: Once the indication of UE specific TA reporting is included in SIB, the UE in the cell should always report the UE specific TA information in the RA procedure. | ZTE Corporation, Sanechips |
| R2-2110268 | Proposal 2: It is proposed to follow NR NTN regarding the content of TA information reporting by the UE and in which message this is provided. | CMCC |
| R2-2110479 | Proposal 8: In NB-IoT, during initial access not using EDT, TA reporting is done in MSG5. Proposal 9: In NB-IoT, during initial access using EDT, TA reporting is done in MSG3.  | Huawei, HiSilicon |

Rapporteur thinks it would be good to first discuss stage-2 issues before touching stage-3 details. Therefore, rapporteur would like to ask the following questions.

**Question 6: Do companies agree to support TA reporting using MAC CE during RACH procedure in IoT NTN?**

* **Option 1: Yes, only support TA reporting in Msg5**
* **Option 2: Yes, support TA reporting in Msg3/Msg5**
* **Option 3: No**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Additional comments** |
| MediaTek | Option 2 |  |
| Xiaomi | Option 2 | Same as NR |
| OPPO | Option 2 |  |
| Lenovo, Motorola Mobility | Option 2 |  |
| Nokia | Option 2 with modification | Suggest rewording as: support UE-specific TA reporting using MAC CE in Msg3/Msg5.Per agreement from NR NTN, UE may report coarse location in Msg5 via RRC for cell id mapping in earth moving cell as request by RAN3. We think the agreement is also appliable for IoT NTN.It is NW implementation to decide using this coarse location (together with satellite ephemeris data) for TA estimation or not. If yes, the coarse location (e.g. for both TA reporting purpose and cell id mapping purpose) is not reported via MAC CE but RRC in Msg5 Agreements via email - via offline 102:1. If SA3 has no concern reporting coarse location during initial access, the coarse location information is reported in Msg5, i.e., via RRCSetupComplete/RRCResumeComplete message.
 |
| Huawei, HiSilicon | option 2 | can we change ‘RA procedure’ to ‘initial access’ as MSG5 is not part of the RA procedure |
| Qualcomm | Option 2 | If not possible in Msg3, then it can be reported in Msg5. |
| Ericsson | Option 2  |  |
| ZTE | Option 2 | For EDT, reporting in MAC CE along with Msg3For Non-EDT, reporting in MAC CE along with Msg5. |
| CMCC | Option 2 |  |
| Interdigital | Option 2 |  |
| Apple | Option 2 | This also seems consistent with NR NTN (as of now) |
| Rakuten Mobile Inc | Option 2 |  |

**Rapporteur summary:**

TBA…

**Question 7: If the answer to Question 6 is option 1 or option 2, do companies agree that for IoT NTN, UE specific TA reporting during RACH procedure in RRC IDLE/INACTIVE is enabled/disabled by SI, similar with NR NTN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional comments** |
| MediaTek | Agree |  |
| Xiaomi | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |
| Nokia | Agree with comment | Since the WI is for IoT NTN connected to EPC, RRC INACTIVE mode should be removed ?  |
| Huawei, HiSilicon | agree with comments | can we change ‘RA procedure’ to ‘initial access’ as MSG5 is not part of the RA procedureRRC\_INACTIVE can be removed as not supported in EPS |
| Qualcomm | Agree |  |
| Ericsson | Agree with Nokia/Huawei |  |
| ZTE | Agree | We prefer that UE specific TA reporting can be controlled by network. For UE in Idle/inactive, to use SIB is straightforward.On one hand, as in general IoT services are delay insensitive, if UE specific TA reporting is disabled by SIB, eNB can use maximum RTT as UE-eNB RTT. This can be beneficial for UE power saving and simplify the scheduling of eNB.On the other hand, eNB can also enable the UE specific TA reporting by SIB. Then eNB can determine the UE-eNB RTT according to UE’s report. This can be beneficial for decreasing the scheduling delay and reducing UL-DL collisions. |
| CMCC | Agree |  |
| Interdigital | Agree | Although we wonder in what case it would be disabled? |
| Apple | Agree |  |
| Rakuten Mobile Inc | Agree | We are agree with Nokia & Huawei comment to remove RRC Inactive as EPS does support. |

**Rapporteur summary:**

TBA…

**Question 8: If the answer to Question 7 is yes, then is UE specific TA reporting during RRC\_Connected mode RACH also controlled by enabling/disabling indication in SI?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comments** |
| MediaTek | Wait for NR-NTN agreements | We think it is better to wait for progress in NR-NTN. |
| Xiaomi | No | Wait for NR conclusion.  |
| OPPO | No | Wait for NR conclusion |
| Lenovo, Motorola Mobility | Postpone | We can wait for NR NTN agreements. |
| Nokia | Wait for NR NTN conclusion |  |
| Huawei. HiSilicon  | No | TA reporting during RACH in connected mode has not been discussed. Although we assume it will be possible, we think it should be based on trigger (e.g. PDCCH order, TA update..) not an SIB indication  |
| Qualcomm | No |  |
| Ericsson | Wait for NR NTN conclusion |  |
| ZTE | Yes | As commented in Q7, we can see the benefits and flexibility of allowing eNB to enable/disable UE specific TA reporting. We think enable/disable indication in SIB would be enough.We are unclear what we need to wait from RAN1? given we have majority view on Q6 and Q9. Q7 seems a pure RAN2 issue. |
| CMCC | Keep align with NR-NTN |  |
| Interdigital | ? | It would be more natural to use dedicated signalling, however we are not sure there is any case that this would be enabled for initial access then disabled for RRC\_Connected. |
| Apple | Wait for NR NTN |  |
| Rakuten Mobile Inc | Wait for NR NTN | It’s better to follow NR NTN, however we feel it should be trigger-based mechanism rather indicating in SI. |

**Rapporteur summary:**

TBA…

Proposals in [2], [4], [6], [7] and [8] regarding TA reporting in RRC connected mode in IoT NTN are listed below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2109701 | Proposal 2: TA information reporting should be supported in connected mode for IoT NTN.Proposal 3: If UE location information can be reported in RRC connected mode, the content of TA information can be UE specific TA information (The details of UE specific TA information can be revised with RAN1) or UE location information.Proposal 4: If UE location information cannot be reported in RRC connected mode, the content of TA information should be UE specific TA information (The details of UE specific TA information can be revised with RAN1).Proposal 5: RAN2 discusses the following methods to report the TA information:* Option 1: TA information requested by network;
* Option 2: Periodical reporting of TA information;
* Option 3: Event-triggered method based on TA value, e.g. a TA change threshold between current TA and the last successfully reported TA is configured to control TA information report.
 | CATT |
| R2-2110115 | Proposal 2a: MAC CE can be also used for UE specific TA reporting in connected mode.Proposal 2b: An indication in SIB1 or SIB2 is used to control the UE specific TA reporting in RA procedure and in connected mode. Proposal 2e: The subheader for UE specific TA MAC CE is used in connected mode. Proposal 2f: The discussion on details about event-triggers for reporting on the information about UE specific TA in connected mode can be postponed till further NR NTN and RAN1 conclusion are made. | ZTE Corporation, Sanechips |
| R2-2110479 | Proposal 10: In NB-IoT, in connected mode, TA reporting is done using a MAC CE. | Huawei, HiSilicon |
| R2-2110550 | Proposal 1: At least for NB-IoT, detailed location information cannot be reported in RRC\_CONNECTED.Proposal 2: FFS for eMTC whether to report detailed location information in RRC\_CONNECTEDProposal 3: For NB-IoT, a new MAC CE is used for reporting of UE specific TA and is used for both reporting during RACH procedure and reporting in RRC\_CONNECTED.Proposal 4: For eMTC, a new MAC CE is used for reporting of UE specific TA during RACH procedure. FFS how to report in RRC\_CONNECTED. | Interdigital, Inc. |
| R2-2110706 | Proposal 4: Reporting UE location for determining UE-specific Timing Advance in half duplex deployments is one method, which can be used by eNB scheduler to avoid UL-DL collisions. Proposal 5: As UE location reporting is already agreed and utilized in RAN2 and RAN3 for multiple purpose in NTN, UE location reporting should be specified for IoT NTN in Rel 17.Proposal 6: RRC signalling is used to report UE location. | Nokia, Nokia Shanghai Bell |

Based on the above proposals, rapporteur would like to ask the following questions regarding TA reporting in RRC connected mode.

**Question 9: Do companies agree to support TA reporting in RRC connected mode in IoT NTN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional comments** |
| MediaTek | Agree |  |
| Xiaomi | Agree |  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |
| Nokia | Agree |  |
| Huawei, HiSilicon | agree  |  |
| Qualcomm | Agree |  |
| Ericsson | Agree |  |
| ZTE | Agree |  |
| CMCC | Agree |  |
| Interdigital | Agree |  |
| Apple | Agree |  |
| Rakuten Mobile Inc | Agree |  |

**Rapporteur summary:**

TBA…

**Question 10: if the answer to Question 9 is yes, which information should be supported and which message should be used for TA reporting in RRC connected mode in IoT NTN?**

* **Option 1: only support UE-specific TA report, using MAC CE**
* **Option 2: only support UE location report, using RRC signalling**
* **Option 3: support both UE-specific TA report using MAC CE and UE location report using RRC signalling**
* **Option 4: others**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Additional comments** |
| MediaTek | Option 1 | Only Option 1 seems sufficient. |
| Xiaomi | Option 1 | No LCS issue was discussed for IOT, there is no agreement made on this. Thus we assume that location report was not available, we should only consider TA report at this stage. |
| OPPO | Option 1 | We think UE-specific TA reporting is sufficient. We also have concern on security for UE location report, especially for NB-IoT with control plane CIoT EPS/5GS optimisation, AS security is not used. |
| Lenovo, Motorola Mobility | Option 1 | No need to introduce additional signalling. |
| Nokia | Option 3 | For Option1, we think some issues need to be addressed, e.g. 1)The UE specific TA reporting (option1) may be out-of-date and invalid as assistance for network due to channel repetitions in IoT NTN.2) Due to satellite movement, the frequency of UE specific TA reporting(option1) will be much larger, e.g. 6-11 times in some cases, than for location reporting (option2), which will cost much more air interface resource, especially with channel(s) repetitions.For Option2, we think it can minimize signalling overhead, because network and UE can both predict TA based on UE location and satellite ephemeris data. UE only needs to report if it has moved. For the NB-IoT with control plane CIoT EPS optimisation where AS security is not used. RAN2 agreed UE may report coarse location in Msg5 via RRC for cell id mapping in earth moving cell as request by RAN3. We think the Msg5 (with coarse location) is appliable for CIoT EPS optimisation as well.Agreements via email - via offline 102:1. If SA3 has no concern reporting coarse location during initial access, the coarse location information is reported in Msg5, i.e., via RRCSetupComplete/RRCResumeComplete message.

Considering the UE location is agreed for other purpose in RAN3 and RAN2 (e.g. cell id mapping) thus NW can use it for TA estimation. We prefer Option2.However, as agreed in NR NTN, the network can configure the UE to send either the UE specific TA pre-compensation using MAC CE or the UE location information using RRC. We accept the compromise to go with Option3 to align NR and IoT NTN solution. |
| Huawei, HiSilicon | option 3 with comment | In our understanding reporting the UE location can reduce the signalling oerheadin NB-IOT there is no AS security, so it will only be possible to report the coarse location (same as initial access).In NB-IoT there is no measurement (configuration/ reporting) procedures so the benefit of RRC signalling compared to MAC signalling is not obvious. so we propose to reword the proposals for both options 2 and 3* **Option 2: only support UE location report, ~~using~~ FFS RRC signalling or MAC CE**
* **Option 3: support both UE-specific TA report using MAC CE and UE location report ~~using~~ FFS RRC signalling or MAC CE**

For eMTC, we need to decide whether to follow NR or NB-IoT |
| Qualcomm | Option 3 | Network should be able to configure UE to report both or one of them. |
| Ericsson | Option 3 with comment | MAC CEs reporting only during RA procedures, and we need to postpone until NR NTN decides if TA value reporting in connected mode will use MAC CE or RRC.  |
| ZTE | Option 1 | UE-specific TA report is enough for eNB to determine UE-eNB RTT.We think currently only UE location report in Msg5 is agreed in RAN3 and RAN2. There will be further specification impacts if it wants to support UE location report in connected mode.Even location information report might be supported for connected mode, for eNB, without clear justification for the necessity and benefit, to support multiple ways to calculate UE-eNB RTT is an unnecessarily complexity. |
| CMCC | Option 1 or Option 3 | If the security issue can be solved or SA2 confirms that there is no major security issue, it is also possible to report the location information. |
| Interdigital | Option 1 | For NB-IoT we think RRC signalling is not an option.  |
| Apple | Option 1 or Option 4 | We should also consider UE specific RA reporting using RRC for eMTC. We cannot agree on UE location since it is not fully resolved, and pending SA3 reply. |
| Rakuten Mobile Inc | Option 3 | We think UE-specific TA reporting is sufficient, but if security issue resolved in SA3 then no problem in reporting UE coarse location in Msg5. |

**Rapporteur summary:**

TBA…

**Question 11: Regarding trigger condition of TA reporting in connected mode, which option(s) do companies think is needed for IoT NTN?**

* **Option 1: event-triggered TA reporting**
* **Option 2: NW requested TA reporting**
* **Option 3: Periodical TA reporting.**
* **Option 4: Semi-persistent TA reporting**
* **Option 5: None**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Additional comments** |
| MediaTek | Option 1 |  |
| Xiaomi | Option 1 & 2 | We can wait for NR NTN agreement |
| OPPO | At least option 1FFS for option2/3/4 | Prefer to wait for NR NTN agreements. |
| Lenovo, Motorola Mobility | Option 1 |  |
| Nokia | Option 1 | Option 1 is efficient and sufficient for Rel-17. Option1 is the only one which can reflect UE and/or satellite movement in a timely manner, all other options would delay such information (or need to be configured to report very frequent) |
| Huawei, HiSilicon | Option 1 | Option 1 is our preference. we could also accept option 2 or 3. |
| Qualcomm | Option 1 only |  |
| Ericsson | Option 1 | Better wait NR NTN agreements.  |
| ZTE | Option 1 | Less Uu interface signalling overhead. |
| CMCC | Option 1 at least for now | Wait for the NR NTN agreements. |
| Interdigital | Option 1 | Event triggered reporting minimises signalling overhead from unnecessary reporting.  |
| Apple | Option 1 |  |
| Rakuten Mobile Inc | Option 1 | We think event triggered is best solution from signalling perspective, |

**Rapporteur summary:**

TBA…

## UL synchronization

In the RAN1-106bis meeting, RAN1 discussed validity timer for UL synchronization in IoT NTN. According to RAN1 discussion, a validity timer for ephemeris data is introduced which indicates the maximum time during which the UE can apply the satellite ephemeris for UL synchronization without having acquired new satellite ephemeris. However, RAN1 has no conclusion to specify the validity timer maintenance and UE behaviour related to expiry of UL synchronization validity timer. RAN2 is asked to decide the expected behaviour.

|  |
| --- |
| Agreement:RAN1 has discussed the following aspects and leaves it up to RAN2 to specify UE behaviour related to expiry of UL synchronization validity timer and determine which of the following aspects are to be specified: * Mechanisms for UE to declare loss of UL synchronization including mechanisms for UL synchronization recovery procedure when UL synchronization is lost if UL synchronization validity timer expires in RRC\_CONNECTED
	+ It is up to RAN2 to specify this new behaviour for connected UE within RLF set of procedures or a new procedure for re-acquiring satellite ephemeris
	+ Mechanism for UL synchronization includes re-acquiring the satellite ephemeris and common TA parameters if indicated on SIB
	+ A new clause of RLF for loss of UL synchronization if validity timer for UL synchronization expires assuming a new re-interpretation of RLF set of procedures is specified for recovery of UL synchronization with re-acquisition of satellite ephemeris and common TA parameters if indicated
	+ Potential additional RACH after re-acquisition of satellite ephemeris and common TA parameters if indicated for the UL synchronization recovery procedure in case of potential residual TA error.
* If validity timer for UL synchronization expires and no UL synchronization recovery mechanisms specified as above, UE behaviour shall declare RLF and go into idle mode autonomously to re-acquire ephemeris SIB. UE will then need to re-access the cell via Random Access procedure.
* UE signalling to indicate the validity timer for UL synchronization is about to expire
 |

Since the expiry of the UL synchronization validity timer means that ephemeris data are not valid, it means UL sync for UE is missed and UE should stop UL transmission before achieving new one. In [6], it is proposed that there should be a common understanding on validity timer status between UE and network, the main reason is that if eNB don’t know whether UE’s validity timer is expired, eNB may schedule the UE even UL sync is missed. More specifically, it is suggested that UE informs network after UE reads a new satellite ephemeris data, or if the validity timer is about to expire. While in [4], it is proposed not to introduce UE signaling to indicate the validity timer for UL synchronization is about to expire, since it's very doubtful whether the UE can find a suitable enough timing to send such indication.

Corresponding proposals are listed as below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2110115 | Proposal 5: UE signaling to indicate the validity timer for UL synchronization is about to expire is not introduced. | ZTE Corporation, Sanechips |
| R2-2110706 | Proposal 7: There should be a common understanding on validity timer status between UE and network, which should be specified in IoT NTN.Proposal 8: A TAT-like validity timer could be used as a baseline, where the UE should inform network when it reads new ephemeris data, so that both the UE and the network reset the validity timer and keep a common understanding on UL synchronization status.Proposal 9: To reduce overhead, UE reporting for validity timer status update should be reduced. The detail solution can be further discussed. | Nokia, Nokia Shanghai Bell |

**Question 12: Do companies agree to introduce UE reporting of validity timer status or not?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional comments** |
| MediaTek | Disagree | This is not needed. |
| Xiaomi | Disagree | We do not think there will be misalignment between UE and network on validity timer. According to RAN1 agreement, the validity timer for UL synchronization is started/restarted with configured timer validity duration at the epoch time of the assistance information (i.e. serving satellite ephemeris data).No matter when UE acquires the SIB, the epoch time will not change unless ephemeris/common TA is updated. In that case, all UE will update their SI triggered by SI information change notification. Thus, all UE hold the same epoch time all the times, then the validity timer running status will be the same.  |
| OPPO | Disagree | We understand the intention of introducing this UE reporting is to reach a common understanding about the validity timer status between NW and UE, so that NW would not schedule the UE when it knows the validity timer has expires, which may reduce PDCCH/PDSCH miss-detection. However, we don’t think this is an essential issue. Moreover, even though UE reports its validity timer status to NW, NW still does not know the exact status of UE’s validity timer due to the large propagation delay between UE and NW which is un-known to NW. |
| Lenovo, Motorola Mobility | Disagree | We see no necessity to introduce. |
| Nokia | Agree | The ephemeris information is very important for UE time and frequency synchronization for UL transmission. When the validity timer is expired, the UE should stop UL transmission. To avoid eNB scheduling the UE even UL sync is missed, UE and NW should have the common understanding on validity timer status. According to RAN1 input, we understand the validity timer is introduced in order to avoid constant re-reading of SIBs. The expectation is that UE does not need to read all the ephemeris information while the validity timer has not expired (e.g. UE could be able to project the satellite movement for a time duration in the order of 10-30 seconds). We understand it is RAN1 common understanding that SIB (containing ephemeris data) does not trigger a SI modification procedure. When introducing the validity timer RAN1 implicitly indicated that it is for UE implementation to guarantee re-read SIB within validity timer to make sure its ephemeris is valid. That means no matter how many times ephemeris is updated within a validity timer, UE should not care, assuming its data is still valid. On the other hand, if SI information change notification is used every time the ephemeris is provided/updated, the UE will effectively have to read the information all the time (and stop the UL/DL data transmission for NB-IoT) which would not be according to the purpose of the validity timer.To enable the NW to know the status of when UE decodes the SIB (carrying the ephemeris data) successfully and when the UE will (re)start the validity timer, the UE should report its the validity timer status to NW, or alternatively provide information to the network that the validity timer is about to expire. Of course, the details can be further discussed. |
| Huawei, HiSilicon | Disagree | If we were to support something, I would assume this would be the validity duration at the time of initial access. After this, there is no need for further reporting.None that RAN1 has not discussed reporting of the ephemeris validity timer , only reporting of the GNSS fix validity time |
| Qualcomm | Disagree | Additional UE signaling is not preferred. |
| Ericsson | Disagree | There is nothing the NW can do to help the UE acquire the SIBs when a reasonable broadcast frequency of ephemeris/common TA is used. [Nokia]: Even NW broadcast ephemeris/common TA in a reasonable frequency, UE cannot guarantee it can always maintain the validity timer (i.e. no timer expiry happens at all). For example, UE is in UL transmission repetitions which cannot read the ephemeris due to half duplex. In this case, if the NW don’t know the validity timer is expired or not, NW may continue receiving the UE’s repetition even UE already stop UL transmissions because of UL sync lost (validity timer expired). Furthermore, NW may continue scheduling this UE though it is UL out of sync. |
| ZTE | Disagree | We have similar view as OPPO. |
| CMCC | See comments | Wait for RAN1 progress regarding the validity timer about other issue.  |
| Interdigital | Disagree | UE can recover loss of sync using RRC re-establishment. |
| Nokia |  | In order to conclude whether “introduce UE reporting of validity timer status or not“, to make progress, we propose RAN2 to discuss below aspect first: \* *Whether UE and NW should have a common understanding of UE’s validity timer status.*If yes, then we can continue discussing how NW and UE maintain the common understanding. Thanks. |
| Apple | Disagree | Seems unnecessary. |
| Rakuten Mobile Inc | See Comments | Let observe scenario where UE has option to report validity status, but when UE’s UL sync is missed, then we don’t think UE will able to successfully report to eNB. Also as Nokia rightly said (in 2nd Comment) first there should be discussion on “Whether UE and NW should have a common understanding of UE’s validity timer status.” |

**Rapporteur summary:**

TBA…

Upon expiry of the UL synchronization validity timer, UE may need to acquire SIB to update the ephemeris and recover UL synchronization. Currently, the eMTC/NB-IoT UE is not required to acquire any SIB in RRC\_CONNECTED, therefore, acquisition of SIB may also incur interruption.

The following solutions are proposed by companies to facilitate a UE in connected mode to acquire SIB and recover UL synchronization after expiration of UL synchronization validity timer:

* Option 1: UE triggers RLF based on a new RLF timer (e.g., t317) for synchronization recovery. [3]
* Option 2: UE re-acquires the SIB and triggers RACH procedure to recover from UL out of synchronization.[4] [8]
* Option 3: UE explicitly notifies the network about the expiry of validity timer and the network will release the UE to RRC\_IDLE state.[9]

In [3], it is proposed to introduce a new RLF timer (e.g., t317) which is similar to existing timer t310. UE behaviour upon detecting synchronization failure would be to trigger t317. If UE is able to acquire ephemeris before t317 expiry, then t317 can be stopped. Upon expiry of t317, RLF is triggered. It is pointed out that the advantage of this new RLF timer is that if UE is fast enough to acquire the ephemeris and update time/frequency compensation, it does not have to go through RRC re-establishment procedure.

In [4], it thinks to trigger RLF and RRC reestablishment procedure brings with large interruption. As the UL out of synchronization caused by the expiration of validity timer is very similar as the legacy UL out of synchronization caused by the expiration of TA timer, e.g., both can lead to the infeasible UL transmission, it thinks option 1 may be a bit more straightforward. In [8], it is also stated that when the validity timer expires, it is only the UL synchronization that is unavailable, but the DL synchronization is kept. The UE should stay in RRC\_CONNECTED mode.

In [9], option 3 is suggested, given that the UE never re-acquire the SIB contents after moving to RRC\_CONNECTED for the duration of time it is in RRC\_CONNECTED, for a number of reasons, e.g.HD FDD scheduling operations.

Corresponding proposals are listed as below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2109966 | Proposal 1 A new RLF timer (e.g., t317) is triggered when the synchronization validity timer is expired.Proposal 2 The new RLF timer (e.g., t317) is stopped if the UE acquires ephemeris and starts synchronization validity timer.Proposal 3 RLF is triggered upon expiry of the new RLF timer (e.g., t317).Proposal 4 Wait for RAN1 progress on GNSS validity before making decision on UE behaviour upon expiry of GNSS validity. | Qualcomm Incorporated |
| R2-2110115 | Proposal 6: For IoT NTN, after validity timer expires, the UE re-acquires the SIB and triggers RACH procedure to recover from UL out of synchronization.  | ZTE Corporation, Sanechips |
| R2-2110706 | Proposal 10: To save power and resource consumption, once the validity timer has expired, UE should remain in RRC Connected mode. The UE can therefore read the new ephemeris data for UL synchronisation and report it to the network (e.g. via CFRA as indicated by PDCCH order). | Nokia, Nokia Shanghai Bell |
| R2-2110919 | Proposal 1: RAN2 to specify the UE behaviour for RLF when UL synchronization is lost, due to expiry of the UL validity timer. | MediaTek Inc. |

Given that various options are proposed by companies, rapporteur would like to check which enhancement direction companies are interested in.

**Question 13: Regarding how to recover UL synchronization loss when UL synchronization validity timer expires in RRC\_CONNECTED, which is the preferred option?**

* **Option 1: UE triggers RLF based on a new RLF timer (e.g., t317) for synchronization recovery.**
* **Option 2: UE re-acquires the SIB and triggers RACH procedure to recover from UL out of synchronization.**
* **Option 3: UE explicitly notifies the network about the expiry of validity timer and the network will release the UE to RRC\_IDLE state.**
* **Option 4: other**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Additional comments** |
| MediaTek | Option 1 or Option 3 |  |
| Xiaomi | FFS | We suggest to postpone the discussion to next meeting for people to better understand the issue and conceive a better solution with less RAN2 spec impact. In general option 1 is a bad idea, which tries to reuse RLF procedure, but actually very little can be reused, most of the behaviours are new. Regarding option 2 and 3, further analysis is required to consider not only validity timer expire but also GNSS position fix outdated issues. When we look at the whole picture, we can then decide whether a common solution is feasible or different approaches are required for different purpose. At this stage, we think companies need more time to digest the issues brought up by RAN1. |
| OPPO | Option 2 | UL out of synchronization caused by the expiration of validity timer is very similar as the legacy UL out of synchronization caused by the expiration of TAT, we think option 2 is simple and straightforward. |
| Lenovo, Motorola Mobility | Option 2 | Less spec impacts. |
| Nokia | Option 2 | When the validity timer expires, it is only the UL synchronization that is unavailable, but the DL synchronization is kept. This is similar to legacy UL out of synchronization caused by the expiration of timeAlignmentTimer. We prefer the simple solution as legacy procedure for TAT timer. UE should be kept in RRC\_Connected instead of released to RRC\_Idle. Also, UE should avoid RLF procedure thus go RRC idle for RRC re-establishment. |
| Huawei, HiSilicon | Option 4 | Same as proposed in R2-2110919, UE triggers RLF when UL synchronization validity timer expires. This is the simpler solution and we only need to define a new trigger. This may not be the most efficient, but it is not supposed to happen for short transmissions so this is not critical. Optimisations can be discussed in R18Option 1: We think the wording of option 1 is misleading. In [3]. RLF is triggered only if the UE cannot manage to reacquire the NTN SIB in a given time. We think that option 1 is not sufficient on its own and that the UE will need to trigger a RACH procedure and send a new TA report, to inform the NW , i.e. combined with option 3Option 2: We think that option 2 is not sufficient on its own and that we will need a guard timer as in option 1 to declare RLF if UE cannot reacquire the NTN SIB in a given timerOption 1 & 2 are optimisations and will require a lot of discussion on how to trigger RACH and what to report. we do not think this is essential in R17Option 3 does not prevent the timer to expire so does not the solve the problem |
| Qualcomm | Option 1 | Ultimately UE may need to trigger RLF if it cannot recover in the specified time by RLF timer.To Huawei: Option 1 is sufficient because once UE triggers RLF, it is existing procedure to trigger reestablishment, we do not have to do any change. |
| Ericsson | FFS | Related to this is if UE loses the accuracy of the UE location: WID: “Simultaneous GNSS and NTN NB-IoT/eMTC operation is not assumed.” If UE implementation cannot accurately know the UE location, similar actions may be required as when the UL synch is lost. **Option 1:** In this case the UE will release all configurations for UL (e.g., PUCCH, flush HARQ buffers) and DL (e.g., flush all DL HARQ buffers including the broadcast process if UE is trying to acquire SIBs…). eNB must reconfigure these after reacquiring UL synch even though the UE could go on using the resources as soon as synch is acquired. **Option 2:** Obviously, UE must reacquire SIBs and if within a certain time since loss of synch, the UE can continue use all configured resources. What does it mean UE triggers RACH? Shall the UE behave as after a PDCCH ordered resynch, as after a TAT expiry or after RLF? **Option 3:** How can the UE notify network when it is not in synch? Will the UE not suspend all UL transmission when detecting out of UL synch? What can the network do to a UE that will soon go out of sync, if the UE reports before it loses synch? |
| ZTE | Option 2 | For Option 3, per our understanding, it's very doubtful whether the UE can find a suitable enough timing to send such indication about the expiry of validity timer. Considering the mobility of UE and the prediction error, the expiration of validity timer may not be able to strictly align with the actual time when UL synchronization is lost. Then it may be possible that UE is already out of sync when it decides to send such indication. This will cause that the gNB cannot receive the indication and therefore cannot release UE. For Option 2, we have similar view as Nokia that the UL out of synchronization caused by the expiration of validity timer is very similar as the legacy UL out of synchronization caused by the expiration of TA timer, both can lead to the infeasible UL transmission. Therefore, we think Option 2 may be a bit more straightforward. With Option 2, UE can be considered to remain in the connected state, but just encounters a transmission interruption. Compared with the other two options, the whole recovery from out-of-sync in Option 2 would need less interaction between UE and gNB and cause less service interruption. |
| CMCC | Neutral |  |
| Interdigital | Option 2 |  |
| Apple | Option 2 | Seems most straightforward. |
| Rakuten Mobile Inc | Option 1 or Option 2 | We think Option 2 is way simpler to implement. Option 1 also legacy Re-Establishment procedure but with new timer t317. But we strongly oppose Option 3 since UE will not be in position to report validity status to eNB due to UL synch missed. |

**Rapporteur summary:**

TBA…

## 2.3 RLC

Both AM and UM modes use the *t-Reordering* timer to control the RLC waiting interval for out-of-order MAC data before considering the missing data as lost and handing any received data off to the PDCP layer. The *t-Reordering* timer can be configured with fixed values between 0 and 1600ms. Large propagation delay might have impacts on *t-Reordering* timer. In the SI phase, it is agreed that the value range of the RLC t-Reordering timer will be extended to support IoT NTN.

In RAN2#115e meeting, the following agreement has been made regarding RLC t-Reordering.

|  |
| --- |
| **Agreement:*** RAN2 confirm the SI agreement that the value range of the RLC t-Reordering timer will be extended to support IoT NTN.
 |

Regarding the exact value of RLC t-Reordering for IoT NTN, it is suggested in [4] that the RLC t-Reordering timer value is extended with ENUMERATED (ms3200, ms6400). In [10], it is proposed to reuse the NR NTN solution in IoT NTN.

Corresponding proposals are listed as below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2110115 | Proposal 3: The RLC t-Reordering timer value is extended with ENUMERATED (ms3200, ms6400) for IoT NTN. | ZTE Corporation, Sanechips |
| R2-2110706 | Proposal 3: The value range of RLC t-Reordering timer shall be extended. The values which should be added to value range should consider number of HARQ retransmissions and NTN RTD covering possible satellite orbit distances. | Nokia, Nokia Shanghai Bell |
| R2-2110953 | [Proposal 5 The RLC timer t-Reordering is extended with higher values. IoT NTN can reuse the NR NTN solution.](#_Toc85762121)  | Ericsson |

**Question 14: Regarding how to extend RLC t-Reordering in IoT NTN, which is the preferred option?**

* **Option 1: the value of RLC t-Reordering timer is extended with ENUMERATED (ms3200, ms6400)**
* **Option 2: other**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option**  | **Additional comments** |
| MediaTek | Option 2 | Wait for NR-NTN and reuse NR-NTN’s solutions. |
| Xiaomi | Option 2 | We agree with mediaTek that we can wait for NR agreement. Regarding the issue of option 1, the current value set for t-Reordering has a very big gap between 200ms and 1600ms. We think additional values need to be introduced between 200ms and 1600ms, similar to NR NTN: “The value range of t-Reassembly shall be extended. The following set of values are possibly added for t-Reassembly timer: {ms210, ms220, ms340, ms350, ms550, ms1100, ms1650, ms2200}”For values beyond 1600ms, a smaller step should be considered, and the upper bound should be larger than 2200ms, given the high repetition of PUSCH(maximum 2048). Some suggested values are {3000, 4000, 5000, 6000} |
| OPPO | Option 2 | Agree with MediaTek |
| Lenovo, Motorola Mobility | Postpone | We can wait for NR NTN agreements. |
| Nokia | Option2 | The exact value extension can be further discussed. E.g. what’s the number of HARQ retx and channel repetitions are expected by RAN2. |
| Huawei, HiSilicon | Option 2 | Can wait for NR NTN and see if it is reusable for IOT NTN |
| Qualcomm | Option 2 | Ok to wait. |
| Ericsson | Option 2 | Postpone until NR NTN have agreed on this.  |
| ZTE | Option 1 | Option 1 is a simple way to extend the value range.And since EC (e.g. large repetition) is supported in IoT NTN, the maximal value of RLC t-reordering timer needs to be larger than that of NR. It is not suitable to reuse the NR values. |
| CMCC | Option 2 | Wait for NR-NTN agreements. |
| Interdigital | Option 2 | Fine to wait for NR, but should also check whether any agreement for NR makes sense for IoT and not blindly follow. |
| Apple | Option 2 | Can wait |
| Rakuten Mobile Inc | Option 2 | It’s better to wait for NR NTN agreements. |

**Rapporteur summary:**

TBA…

In [7], another RLC issue due to long propagation delays in IoT NTN is raised. That is, for very long propagation delays as is the case with GEO satellites, the RLC RTT will be extremely long which would suggest unacceptable UE memory requirement or very low throughput rates supported when using RLC AM (i.e. because the L2 buffer size is directly proportional to RTT). Based on this, it is propose RAN2 to discuss how to support RLC AM in Rel-17, e.g. RLC RTT value to be used in L2 buffer requirement calculations, whether need to specify data rate limitation, how to minimise protocol stalling due to unreliable feedback.

Corresponding proposals are listed as below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2110550 | Proposal 5: RLC UM provides a best effort solution in Rel-17.Proposal 6: RAN2 to discuss how to support RLC AM in Rel-17.* RLC RTT value to be used in L2 buffer requirement calculations.
* Whether data rate limitation needs to be specified.
* How to minimise protocol stalling due to unreliable feedback.
 | Interdigital, Inc. |

Rapporteur would like to collect companies’ views on this issue:

**Question 15: Do companies agree to discuss how to support RLC AM in Rel-17 (e.g. RLC RTT value to be used in L2 buffer requirement calculations, whether need to specify data rate limitation, and how to minimise protocol stalling due to unreliable feedback, etc.)?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Additional comments** |
| MediaTek | Disagree | The L2 buffer requirement does not go up as HARQ will not be disabled in IoT-NTN. Hence, the amount of data to be buffered during the RLC RTT time is quite limited. |
| Xiaomi | Disagree | For intermittent delay-tolerant small packet transmissions, we do not think buffer would be an issue. |
| OPPO | Disagree | Agree with MediaTek |
| Lenovo, Motorola Mobility | Disagree | Agree with MediaTek. |
| Nokia | Agree | Fine to discuss the impact. |
| Huawei, HiSilicon  | Disagree  | At least in NB-IoT, the buffer size is independent of the RTT. it is correct that the larger RTT may decrease the data rate but this is not an issue |
| Qualcomm | Maybe | We are open to discuss any L2 buffer impact. |
| Ericsson | Disagree | RLC buffer sizes shall not be affected.  |
| ZTE | Disagree | Agree with MediaTek |
| CMCC | Disagree | RLC UM is enough for R17. |
| Interdigital | Agree | For NB-IoT the L2 buffer requirement is based on traffic model anyway so maybe no impact. The point of this proposal is to highlight that (for eMTC) the peak throughput cannot be achieved with the current L2 buffer requirement and current RLC/MAC, and we should consider whether to add a note or limitation in 36.306 e.g. regarding the supported traffic/data rate in R17, then address improvements to performance in R18 to support higher throughput closer to the peak rate for TN. This also depends on what the QoS requirement is so we can’t just ignore the issue. |
| Apple | Disagree |  |
| Rakuten Mobile Inc | Agree with comment | We think there is no issue to bring this topic to discussion even though there may be not be agreement in R17. But HARQ disablement may be entertained in R18 so at that time this topic will be crucial. So, no harm in capturing few suggestion /comments. |

**Rapporteur summary:**

TBA…

## 2.4 PDCP

The transmitting PDCP entity shall discard the PDCP SDU when the *discardTimer* expires for a PDCP SDU or when a status report confirms the successful delivery. The *discardTimer* can be configured up to 1500ms for eMTC and up to 81920ms for NB-IoT, or can be switched off by choosing infinity. The *discardTimer* mainly reflects the QoS requirements of the packets belonging to a service.

In RAN2#115e meeting, RAN2 made the following agreements regarding PDCP *discardTimer*:

|  |
| --- |
| **Agreements:*** Do not extend the PDCP discardTimer for NB-IoT over NTN.
* FFS whether to extend the PDCP discardTimer for eMTC over NTN.
 |

In [4], [5], and [10], it is proposed to extend PDCP discardTimer for eMTC over NTN. in [4], it is further suggested to extend the timer value with ENUMERATED (ms3000, ms6000), while in [10], it is suggested to extend the timer with a single value 2000ms.

Corresponding proposals are listed as below.

|  |  |  |
| --- | --- | --- |
| Tdoc No | Proposals | Source |
| R2-2110115 | Proposal 4: The PDCP discardTimer for eMTC is extended with ENUMERATED (ms3000, ms6000), and the PDCP discardTimer for NB-IoT is not extended. | ZTE Corporation, Sanechips |
| R2-2110268 | Proposal 3: It is proposed to extend the PDCP discardTimer for eMTC over NTN. | CMCC |
| R2-2110953 | [Proposal 6 Extend the PDCP discardTimer with the single value 2000ms.](#_Toc85762122) | Ericsson |

**Question 16: Do companies agree that the PDCP discardTimer should be extended to support eMTC over NTN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree / Disagree** | **Additional comments** |
| MediaTek | Agree | Extension in Discard Timer seems required in eMTC. |
| Xiaomi | Agree | NR has agreed to extend discard timer to 2000ms. For eMTC, the discard timer should at least be larger than t-Reordering.  |
| OPPO | Agree |  |
| Lenovo, Motorola Mobility | Agree |  |
| Nokia | Agree | Following NR NTN agreement to extend the timer is fine.  |
| Huawei, HiSilicon | Disagree | Wonder why it is needed as SA2 has excluded any change to dedicated bearer  |
| Qualcomm | Agree |  |
| Ericsson | Agree |  |
| ZTE | Agree | The PDCP discard timer should extended to avoid unnecessary expiration of PDCP discard timer in large RTT case. |
| CMCC | Agree |  |
| Interdigital  | Agree |  |
| Apple | Disagree | This timer is related to QoS and not RLC RTT. So we should not be extending it just because we can. |
| Rakuten Mobile Inc | Agree |  |

**Rapporteur summary:**

TBA…

**Question 17: If the answer to Q16 is yes, which option do companies prefer regarding the extended value of PDCP t-Reordering for eMTC over NTN?**

* **Option 1: The PDCP discardTimer value is extended with ENUMERATED (ms3000, ms6000)**
* **Option 2: The PDCP discardTimer value is extended with ENUMERATED (ms2000)**
* **Option 3: other**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Additional comments** |
| MediaTek | Option 3 | PDCP Discard Timer should be larger than RLC Reordering Timer. |
| Xiaomi | other | For eMTC, the discard timer should at least be larger than t-Reordering. |
| OPPO | Option 3 | PDCP Discard Timer should be larger than RLC Reordering Timer. |
| Lenovo, Motorola Mobility | Option 3 | Depending on agreements for RLC t-Reordering timer. |
| Nokia | Option 3 | For eMTC over NTN, the details of the discardTimer value depends on QCI QoS requirement defined by SA2. Not sure if new QCI is needed for eMTC over NTN. |
| Huawei, HiSilicon | Option 3 | Not needed |
| Qualcomm | Option 3 | May need extension. We can discuss the range or wait conclusion for RLC t-reordering timer. |
| Ericsson | Option 2 | Proponent.Depending on the QoS requirements, discardTimer can have value infinity in legacy which is longer than all available values for RLC t-Reordering.  |
| ZTE | Option 3 | We think PDCP Discard Timer should be extended with the similar granularity as that for the RLC t-reordering. We are open to discuss the more suitable extension, e.g., based on the extension of RLC t-Reordering timer. |
| CMCC | Option 3 | Considering that the disgardTimer should be greater than the RLC t-Reordering timer, therefore we need to discuss the extension value of RLC t-Reordering timer firstly. |
| Interdigital | Option 3 |  |
| Rakuten Mobile Inc | Option 3 | There is requirement of PDCP Discard Timer should be larger than RLC Reordering Timer |

**Rapporteur summary:**

TBA…

# 3. Summary and Proposals

This section summarizes the discussion and reports the following proposals:

*Proposals for easy agreements:*

*Proposals for further online discussion:*

# 4. References

1. R2-2109505 Discussion on UP impact for IoT over NTN OPPO discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN
2. R2-2109701 Discussion on TA information reporting for IoT NTN CATT discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN
3. R2-2109966 UL synchronization validity timer in RRC\_CONNECTED Qualcomm Incorporated discussion Rel-17 FS\_LTE\_NBIOT\_eMTC\_NTN
4. R2-2110115 Remaining FFSs on UP in IoT NTN ZTE Corporation, Sanechips discussion FS\_LTE\_NBIOT\_eMTC\_NTN
5. R2-2110268 Discussion on UP aspects for IoT-NTN CMCC discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN
6. R2-2110479 User plane for IOT NTN Huawei, HiSilicon discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN
7. R2-2110550 IoT-NTN UP impacts Interdigital, Inc. discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN
8. R2-2110706 On User Plane aspects for IoT NTN Nokia, Nokia Shanghai Bell discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN
9. R2-2110919 Validity Timer Expiry and Synchronization Loss in IoT-NTN MediaTek Inc. discussion
10. R2-2110953 User plane aspects of NB-IoT and LTE-M in NTNs Ericsson discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN

# Contact information

|  |  |
| --- | --- |
| Company | Delegate contact |
| COMPANY\_NAME | NAME (email@address.com) |
| MediaTek | Abhishek.Roy@mediatek.com |
| OPPO | Haitao Li (lihaitao@oppo.com) |
| Huawei, HiSilicon | Odile Rollinger (odile.rollinger@huawei.com) |
| ZTE | Ting Lu (lu.ting@zte.com.cn) |
| InterDigital | Brian Martin (brian.martin@interdigital.com) |
| Rakuten Mobile Inc | Pankaj Shete (pankaj.shete@rakuten.com) |
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