**3GPP TSG-RAN2 Meeting #113bis-e R2-210xxxx**

**Online, April 12 – 20, 2021**

**Agenda Item: 9.2.1**

**Source: Huawei**

**Title: [Offline-027] IOT NTN essential parts (Huawei)**

**Document for: Discussion and decision**

# Introduction

This document is the summary of the offline email discussion “[AT113bis-e][027][IoT NTN] Essential Parts (Huawei)”, as indicated below:

* [AT113bis-e][027][IoT NTN] Essential Parts (Huawei)

Scope: Take into account the contributions on Essential parts in AI 9.2.1. Collect comments. Identify/confirm enhancements that are considered essential for IoT NTN. Can also collect opinions, on which aspects of those enhancements need further study in the SI. Note it is not expected to achieve full consensus on all points, e.g. for some points it might only be possible to capture observations such as: “there is significant/some/low/no interest to enhance X, to address problem Y”. Exclusion proposals are not the primary focus but can be captured if there is a clear benefit to exclude. Note that this listing is not intended to be an exhaustive scope (the old agreement still generally applies that R2 assumes all functions upto R16 can be supported, unless problems are found).

Intended outcome: Report

Final Deadline for comments: Friday April 16 (so the report can be in time for on-line session Monday). Intermediate deadlines by Rapporteur if needed.

Note that discussion of which scenario is supported/ prioritised is not included in this email discussion.

# Discussion

For each enhancement discussed below, please clarify if further study is required on the specific enhancement in addition to what is currently captured in TR 36.723.

## User plane

### Random Access procedure

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 1: Delaying the start of ra-ResponseWindow and mac-ContentionResolutionTimer with an offset can be considered as essential for Rel-17 and this topic has been concluded in TR-36.373  Proposal 3: RAN2 prioritises the following functionality for IoT-NTN in Rel-17   * RACH window offsets |
| R2-2103177 [5] | Proposal 2: TA pre-compensation is considered as essential minimum functionality.  Proposal 3: Enhancement of MAC/RLC/PDCP timers (e.g. RAR window, contention resolution timer, DRX HARQ RTT timer, SR prohibit timer, t-Reordering, discardTimer) to address long RTT should be considered as essential minimum functionality. |
| R2-2103509 [7] | Proposal 1: Random access procedure: The same enhancements to ra-ResponseWindow and ra-ContentionResolutionTimer as NR NTN are reused. Need for enhancements to ra-ResponseWindowSize depends on RAN1. |

1. Do companies think that enhancements to ra-ResponseWindow and mac-ContentionResolutionTimer are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| Xiaomi | **yes** | Otherwise, UE may not be able to receive RAR and msg4. |
| Huawei, HiSilicon | **yes** | The solution is already captured in the TR. No additional study needed. |
| MediaTek | **yes** | It is essential, else the UE will be unable to receive RAR and msg4. |
| Qualcomm | **Yes** | Similar enhancement as in NR NTN is needed for the start of RA response window and MAC contention resolution timer.  But there is no need to extend these timers. |
| OPPO | **Yes** | The start offset for ra-ResponseWindow and mac-ContentionResolutionTimer should be adjusted considering large propagation delay in NTN. |
| Lenovo | **Yes** | Essential for UE reception of RAR and msg4. |
| CATT | **Yes** | ra-ResponseWindow and ra-ContentionResolutionTimer can follow the NR NTN. |
| Ericsson | **Yes** | RAN2 has agreed that an offset is used to “delay (adjust) the start of *ra-ResponseWindow* and *mac-ContentionResolutionTimer*“ and it is assumed that if the start of the RA response window is accurately compensated and no extension of repetition is required, there is no need to extend the *ra-ResponseWindowSize*. Stage 3 details can be discussed during the WI phase. |
| Gatehouse | **Yes** | Agree with others.  We are thinking that the timers – in general - should be adaptable to the specific constellation class (LEO, MEO, GEO), which should be signalled in MIB/SIB. I.e. no need for GEO-coherent timing delays in LEO NTN. |

### HARQ operation and DRX

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 3: Extension of HARQ-RTT-Timer and UL-HARQ-RTT-Timer can be considered as essential for Rel-17 and this topic has been concluded in TR-36.373.  Proposal 3: RAN2 prioritises the following functionality for IoT-NTN in Rel-17   * HARQ RTT timer extension   Proposal 4: RAN2 to deprioritise the following functionality for Rel-17  • Enhancements related to disabling HARQ |
| R2-2103177 [5] | Proposal 3: Enhancement of MAC/RLC/PDCP timers (e.g. RAR window, contention resolution timer, DRX HARQ RTT timer, SR prohibit timer, t-Reordering, discardTimer) to address long RTT should be considered as essential minimum functionality.  Proposal 4: Disabling HARQ is not considered as essential minimum functionality. |
| R2-2103189 [6] | Proposal 2: Only basic HARQ functionality supported in Rel-17. The data rate target in TR need to be removed or re-visited since no HARQ enhancements to be supported. |
| R2-2103509 [7] | Proposal 2: HARQ operation: Disabling of HARQ feedback is not supported in IOT NTN for the considered scenarios. |
| R2-2104016 [8] | Observation 2 The main motivation for introducing enhancements for HARQ operation in NR NTN is to address throughput stalling due to the large HARQ RTT.  Proposal 2 The necessity of HARQ enhancements for IoT NTN should be studied considering the reduction in link throughput. |

1. : Do companies think that enhancements to HARQ-RTT-Timer and UL-HARQ-RTT-Timer are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| Xiaomi | **yes** | DRX function is essential for power saving for IOT. If HARQ RTT timer is not enhancement, UE cannot receiving DL/UL retransmission scheduling when DRX is configured. |
| Huawei, HiSilicon | **yes** | The solution is already captured in the TR. No additional study needed. |
| MediaTek | **yes** | The timers needs to be enhanced for correct scheduling, transmission and reception. |
| Qualcomm | **Yes** | The timer values need to be extended similar to NR NTN. |
| OPPO | **Yes** | These timers need to be extended to accommodate NTN’s large transmission delay. |
| Lenovo | **Yes** | Same as in NR NTN. |
| CATT | **Yes** | DRX function is essential for power saving for IOT. However Disabling of HARQ feedback is not essential. |
| Ericsson | **Yes** | RAN2 has agreed to reuse NR-NTN agreements as baseline for the starting of HARQ-RTT-Timer and UL-HARQ-RTT-Timer in eMTC/NB-IoT NTN.  For NR-NTN RAN2 has agreed that for UE with pre-compensation capability (at least for the HARQ-feedback enabled case. FFS for HARQ-feedback disabled, if supported), drx-HARQ-RTT-TimerDL is offset by UE-specific RTT (UE-gNB delay) in LEO/GEO. It is FFS if offset is applied to: 1) the start of the timers or 2) the timer value range (i.e. existing values within value range increased by offset)  Stage 3 details can be discussed during the WI phase. |
| Gatehouse | **Yes** | Agree with others, also see Q1 |

1. : Do companies think that enhancements to disable HARQ are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **no** | The reason for introducing disabling HARQ is to avoid the peak data rate reduction due to HARQ stalling issue caused by the large RTT. However, for intermittent delay-tolerant small packet transmissions, data rate will not be an issue. |
| Huawei, HiSilicon | **no** | Not needed for the use case of intermittent delay-tolerant small packet transmissions |
| MediaTek | **no** | Agree with xiaomi and Huawei that HARQ disabling to avoid the peak data rate reduction (arising from HARQ stalling caused by the large RTT) will not arise for intermittent delay-tolerant small packet transmissions. |
| Qualcomm | **Yes** | This should be considered at least for GEO case not to severely degrade the throughput.  As large number of repetitions can be scheduled, network should be able to schedule new transmission without waiting such large RTT. |
| OPPO | **No** | Agree with Xiaomi and Huawei. |
| Lenovo | **No** | We think the characteristics of IoT services (e.g. small data size, delay-tolerant) will not cause much issues as that in NR NTN. |
| CATT | **No** | Share the same understanding as Xiaomi. |
| Ericsson | **Maybe** | It would be good to wait until RAN1 concludes the study on the benefits and drawbacks of disabling HARQ feedback especially in the context of peak data rate in full and half duplex modes, device complexity, latency and power saving.  Note that as discussed and concluded earlier in RAN2, for dynamic grant, one possibility for "enabling"/"disabling" HARQ uplink retransmission at UE transmitter is that no additional mechanism needs to be introduced, i.e. gNB can send a grant with NDI “not toggled/toggled” without waiting for decoding the result of previous PUSCH transmission. |
| Gatehouse | **No, but** | This is not essential for us, but we are not opposed to including it. |

### Scheduling request

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 2: Extension of the sr-ProhibitTimer can be considered essential for Rel-17 and this topic has been concluded in TR-36.373.  Proposal 3: RAN2 prioritises the following functionality for IoT-NTN in Rel-17   * SR prohibit timer extension |
| R2-2103177 [5] | Proposal 3: Enhancement of MAC/RLC/PDCP timers (e.g. RAR window, contention resolution timer, DRX HARQ RTT timer, SR prohibit timer, t-Reordering, discardTimer) to address long RTT should be considered as essential minimum functionality. |
| R2-2103509 [7] | Proposal 3: Scheduling request: sr-ProhibitTimer is modified for including larger values. |

1. : Do companies think that enhancements to sr-ProhibitTimer are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **yes** | Otherwise, UE cannot be prohibited from sending SR before waiting for UL scheduling. |
| Huawei, HiSilicon | **yes** | The solution is already captured in the TR. No additional study needed. |
| MediaTek | **yes** | It is essential, otherwise UE might transmit spurious SR before UL scheduling. |
| Qualcomm | **Yes** | This timer needs to be extended. |
| OPPO | **Yes** | We have agreed to extend sr-ProhibitTimer to support NTN in RAN2#113e meeting. |
| Lenovo | **Yes** | Same as in NR NTN. |
| CATT | **Yes** | Enhancement to sr-ProhibitTimer is essential and may follow the NR NTN. |
| Ericsson | **Yes** | RAN2 has agreed that *sr-ProhibitTimer* is modified for larger values to support IoT NTN. It was also agreed that alignment to NR NTN can be considered. In this meeting RAN2 has agreed for NR NTN that the timer length of *sr-ProhibitTimer* is extended. Stage 3 details can be discussed during the WI phase. |
| Gatehouse | **Yes** | Agree |

### UL scheduling, EDT and PUR

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 9: Enhancements related to UL scheduling can be deprioritised for Rel-17.  Proposal 4: RAN2 to deprioritise the following functionality for Rel-17   * UL scheduling enhancements |
| R2-2103177 [5] | Proposal 6: Latency reduction/UL scheduling enhancement is not considered as essential minimum functionality.  Proposal 10: EDT/PUR is not considered as essential minimum functionality. |
| R2-2103189 [6] | Proposal 3: Latency time evaluation considering the additional delay due to NTN adaptation should be concluded within RAN2/RAN1.  Proposal 4: RAN2/RAN1 to agree on whether relaxation on latency for Exception Reporting (i.e. Alarm reporting, Critical event reporting from IoT device) beyond 10 seconds is acceptable or not to further decide on essential features.  Proposal 5: If the latency requirements cannot be relaxed for Rel-17, features relevant for small data transmission (i.e. EDT, Fast RRC connection release) should be considered as essential features for the study. |
| R2-2104016 [8] | Observation 3 Whether any enhancements are needed or justified for latency depends on the evaluation results provided based on the assumptions which are under discussion in [Post113-e][055][IoT NTN] Performance Evaluation.  Proposal 3 RAN2 to conclude performance evaluations before considering whether latency is an essential functionality in IoT NTN and discuss the need for enhancements. |

1. : Do companies think that enhancements to UL scheduling are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| Xiaomi | **no** | It was already agreed in RAN2 #112e meeting that: Unlike NR-NTN, as latency is not a critical performance requirement in NB-IoT devices, UL scheduling enhancement for delay reduction is not necessary for NB-IoT over NTN. Besides, we do not think 10 seconds latency cannot be met by existing feature e.g. repetition. And considering that the number of IOT NTN devices for R17 might not be very large, latency caused by congestion would not be high. |
| Huawei, HiSilicon | **no** | the use case is delay-tolerant . |
| MediaTek | **no** | It has been already agreed in RAN2 #112e meeting that: Unlike NR-NTN, latency is not a critical performance requirement in NB-IoT devices and hence UL scheduling enhancement for latency reduction is not needed. |
| Qualcomm | **No** | As configured grant and EDT can be supported. |
| OPPO | **No** | We have already made the following agreement in RAN2#112e meeting:  Unlike NR-NTN, as latency is not a critical performance requirement in NB-IoT devices, UL scheduling enhancement for delay reduction is not necessary for NB-IoT over NTN. |
| Lenovo | **No** | We think the characteristics of IoT services (e.g. small data size, delay-tolerant) will not cause much issues as that in NR NTN. |
| CATT | **No** | UL scheduling enhancement for delay reduction is not necessary for IoT over NTN. |
| Ericsson | **Maybe** | When compared to NR-NTN, it is clear that latency is not a critical performance requirement for IoT NTN. UL scheduling enhancements can be considered as non-essential from that perspective. However there may be a need to improve latency in general terms, e.g., time required to complete a transmission in the UL successfully. This depends on the outcome of the discussion in [Post113-e][055][IoT NTN] Performance Evaluation. |
| Gatehouse | **No** | Agree with others |

1. : Do companies think that EDT and PUR are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| Xiaomi | **no** | EDT/PUR was introduced mainly for reducing latency and signalling, it is not critical for IOT intermittent delay-tolerant small packet transmissions, and should be deprioritized. |
| Huawei, HiSilicon | **no but** | EDT/PUR were introduced for power saving for exactly the use case of intermittent delay-tolerant small packet transmissions. We do not see any reason to exclude.  EDT is based on the RACH procedure and the enhancements to -ResponseWindow and mac-ContentionResolutionTimer apply, no additional work is needed.  PUR is based on EDT minus msg1/msg2, thus the enhancement to mac-ContentionResolutionTimer should also be applied to pur-ResponseTimer. |
| MediaTek | **no** | EDT/PUR optimizations are not critical and can be cosidered in future releases. |
| Qualcomm | **Yes/No** | EDT and PUR are completely different.  EDT: Yes, it is the most essential RACH-based feature and there is no further RAN2 impact foreseen to support it in NTN.  PUR: It is not clear if PUR can be supported in LEO scenario. However, it can be considered for GEO scenario but RAN1 may need to look into it. |
| OPPO | **No but** | Agree with Huawei. |
| Lenovo | **Yes** | Using EDT/PUR in IoT NTN is not just for reducing latency, but also for reducing signalling and thus power consumption. And for PUR as a Rel-16 feature, the *pur-ResponseTimer* needs similar enhancement as that for UP timers in NR NTN. |
| CATT | **No** | EDT/PUR is not critical for IOT over NTN and are not essential. |
| Ericsson | **Maybe** | Please see the reply for Q5 above. |
| Gatehouse | **No** | Not essential, but EDT is low hanging fruit as Qualcomm noted – we are not opposed to it. The same applies to PUR if it is just a matter of a timer. |

### RLC and PDCP

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 9: Extending the RLC and PDCP sequence number space can be deprioritised for Rel-17.  Proposal 4: RAN2 to deprioritise the following functionality for Rel-17   * RLC and PDCP SN extension * RLC reordering timer and PDCP discard timer extension |
| R2-2103177 [5] | Proposal 3: Enhancement of MAC/RLC/PDCP timers (e.g. RAR window, contention resolution timer, DRX HARQ RTT timer, SR prohibit timer, t-Reordering, discardTimer) to address long RTT should be considered as essential minimum functionality. |
| R2-2103509 [7] | Proposal 4: RLC reordering: The value range of the RLC t-Reordering timer is extended.  Proposal 5: PDCP: Enhancement to PDCP discard timer is not needed for NB-IoT NTN |

1. : Do companies think that enhancements to RLC SN and PDCP SN are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **no** | It was already agreed in RAN2 #112e that: There is no need to extend RLC and PDCP SN length for eMTC/NB-IoT NTN, similar to NR-NTN. |
| Huawei, HiSilicon | **no** | already agreed. |
| MediaTek | **no** | It has been agreed in RAN2 #112e that: There is no need to extend RLC and PDCP SN length for eMTC/NB-IoT NTN, similar to NR-NTN |
| Qualcomm | **No** | Same as in NR. |
| OPPO | **No** | We have already made the following agreement in RAN2#112e meeting:  There is no need to extend RLC and PDCP SN length for eMTC/NB-IoT NTN, similar to NR-NTN. |
| Lenovo | **No** | Same as in NR NTN. |
| CATT | **No** | Share the same understanding as Xiaomi. |
| Ericsson | **No** | RAN2 has agreed that there is no need to extend RLC and PDCP SN length. |
| Gatehouse | **No** | Agree with others |

1. : Do companies think that enhancements to RLC t-Reordering timer are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **yes** | In RAN2 #113e, it was agreed that Extend the value range of t-Reordering to support IoT NTN. If t-Reordering is not enhanced, t-Reordering would expire too early, left no time for HARQ retransmissions. |
| Huawei, HiSilicon | **yes** | The solution is already captured in the TR. No additional study needed. |
| MediaTek | **no** | Although it is agreed in RAN2#113e, it does not seem to be essential as continiuous data is not expected. |
| Qualcomm | **Yes** |  |
| OPPO | **Yes** | We have already made the following agreement in RAN2#113e meeting:  Extend the value range of *t-Reordering* to support IoT NTN. |
| Lenovo | **Yes** | Same as in NR NTN. |
| CATT | **Yes** | RLC t-Reordering timer can follow the NR NTN which is under discussion. |
| Ericsson | **Yes** | RAN2 has agreed that the value range of *t-Reordering* is extended for IoT NTN. Stage 3 details can be discussed during the WI phase. |
| Gatehouse | **Yes** |  |

1. : Do companies think that enhancements to PDCP discard timer are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **Yes** | For NR NTN, it is agreed during online session that the value range of t-Reassembly is {ms210, ms220, ms340, ms350, ms550, ms1100, ms1650, ms2200}, and that the network can configure the values of PDCP discardTimer and PDCP t-Reordering timer greater than the RLC t-Reassembly timer.  Similarly for IOT NTN, PDCP discard timer should be greater than t reordering timer. The current maximum PDCP discardTimer is 1500ms. Therefore, PDCP discard timer needs to be extended. Otherwise, PDCP SDU will be discard without sufficient RLC retransmission. Although infinity value can be configured for PDCP discardTimer, it does not allow outdated PDU being discard, which may impact the application layer. |
| Huawei, HiSilicon | **No** | For NB-IoT, there is no QoS requirement and no risk of buffer overflow for the considered use case.  For eMTC, it is possible to configure infinity value. We do not think that an extension is required for the considered use case. |
| MediaTek | **No** | The current maximum value of Discard Timer in IoT is sufficient. Further more, large amount of continiuous data is not expected. |
| Qualcomm | **Yes** | This will only have minimum impact of signalling new values. |
| OPPO | **No** | We see no need to extend PDCP Discard timer unless any new QoS requirement is defined |
| Lenovo | **No** | This is a bit different to NR NTN as for IoT NTN the QoS requirement is different. |
| CATT | **FFS** | PDCP discard timer depends on the QoS requirement and we can follow the NR NTN. We are not sure an enhancement to PDCP discard timer is essential so far but it still can be studied. |
| Ericsson | **No** | In this meeting RAN2 has agreed that network can configure the values of PDCP *discardTimer* and PDCP *t-Reordering* timer greater than the RLC *t-Reassembly* timer in NR NTN. It is also agreed that the range of the PDCP *discardTimer* and the PDCP *t-reordering* timer are extended. For IoT NTN, futher discussion is required regarding whether there is a need to extend the PDCP discard timer and if so how. |
| Gatehouse | **No, but** | This is not seen as a very large effort so no need to exclude. |

### Coverage enhancements

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102743 [1] | Proposal 1 Coverage enhancements should be studied and specified for IoT over NTN in Rel-17. |
| R2-2102828 [2] | Observation 13: IoT-NTN work related to eMTC should focus on CE mode A operation, and changes related to CE mode B can be deprioritised for Rel-17.  Proposal 4: RAN2 to deprioritise the following functionality for Rel-17   * CE mode B operation |
| R2-2103189 [6] | Proposal 10: Deployment scenarios for Rel-17 should be prioritised to further analyse the coverage enhancement relaxation. Further discussions required in RAN1 to conclude on the relaxation in coverage enhancements. |

1. Do companies think that coverage enhancements and CE-Mode B are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **FFS** | RAN1 to decide |
| Huawei, HiSilicon | **FFS** | Need for coverage enhancements is up to RAN1.  Not supporting CE mode B will reduce the amount of work needed in RAN2 for R17. |
| MediaTek | **no** | CE-Mode B is an optional feature and does not need to be considered in the first release. CE-Mode A should be sufficient. |
| Qualcomm | **Yes/No** | This should be left to RAN1 to decide. |
| OPPO | **Yes** | Link budget may become even more challenging due to the larger path loss in NTN, but it is up to RAN1 to decide. |
| Lenovo | **FFS** | RAN1’s work. |
| CATT | **FFS** | It still can be studied. |
| Ericsson | **Maybe** | It would be better to wait until RAN1 concludes whether there is any need to enhance coverage further within the context of NTN. |
| Gatehouse | **FFS** | Agree with Ericsson. |

## Control Plane

### Tracking area management

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 6: Tracking area management can be considered as essential functionality for Rel-17 and related options have been captured in TR-36.763.  Proposal 3: RAN2 prioritises the following functionality for IoT-NTN in Rel-17   * Tracking area management |
| R2-2103509 [7] | Proposal 6: Tracking area: Same enhancements as agreed in NR NTN can be reused in IOT NTN. |

1. Do companies think that enhancements to tracking area management are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **yes** | From deployment point of view, earth moving cell is less complex than earth fixed cell. In the early deployment, to save cost, it might be beneficial to deploy earth moving cell. However, for earth moving cell, TAC update is required to meet the requirement of fixed tracking areas on earth. Therefore, we agree to introduce the same enhancements as agreed in NR NTN without further enhancements. |
| Huawei, HiSilicon | **yes** | It is already agreed in the TR to reuse NR agreements. No additional study needed. |
| MediaTek | **yes** | Tracking area enhancements are needed for implementations. Both soft and hard-switch TAU needs to be included, as already captured in TR 26.373 and agreed in RAN2#113-e. |
| Qualcomm | **Yes** | For eMTC/NB-IoT, only HARD TAC update mechanism may be sufficient. |
| OPPO | **Yes** | The same TAC update procedures as in NR NTN can be adopted in IoT NTN. |
| Lenovo | **Yes** | Same as in NR NTN. |
| CATT | **Yes** | For earth fixed cell scenarios, it seems the legacy tracking area management means could be fully reused.  For earth fixed cell scenario, how to manage the tracking area is under dicussion in NR NTN. We believe the same enhancement as agreed in NR NTN could be reused in IoT NTN. |
| Ericsson | **Yes** | It has been agreed that RAN2 should wait until agreements regarding TAU are made in the NR-NTN WI, and use those for IoT NTN, if applicable. In this meeting, it is agreed for NR-NTN that when network stops broadcasting a TAC, the UE needs to know. We think further discussion is required. |
| Gatehouse | **Yes, but** | In addition to the agreements in NR NTN, which are still under discussion, the impact that discontinous coverage and moving cells have on TA management should be investigated. |

### Idle mode mobility

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 4: Reusing the Idle mode mobility baseline for NB-IoT and eMTC can be considered as essential functionality for Rel-17 as captured in TR-36.763. If time permits, additional enhancements from NR-NTN can also be considered.  Proposal 3: RAN2 prioritises the following functionality for IoT-NTN in Rel-17   * Reusing Idle mode and Connected mode mobility baseline |
| R2-2103509 [7] | Proposal 7: Cell selection/reselection: The existing mechanisms can be reused. For scenarios with regular long coverage outages, enhancements to synchronise paging and UE wake up time with in-coverage are necessary. |
| R2-2104016 [8] | Proposal 5 Existing mobility mechanisms are considered essential functionality for LTE-M and NB-IoT in IoT NTN.  Proposal 6 Minor adjustments to existing mobility mechanisms, such as a new parameter, parameter values, timers, timing etc. are considered essential enhancements to adapt functionality to NTN.  Proposal 7 No new mobility mechanisms or major enhancements to existing mechanisms are introduced in Rel-17 for IoT NTN |

Please note that power saving optimisations are discussed in 2.2.5.

1. Do companies think that existing idle mode mobility mechanisms are essential and that no further enhancements (other than power consumption related) are needed?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **yes** | At initial deployment of IOT NTN, UE may suffer from long coverage outage due to significantly small number of serving satellites in NSGO case. It would be undesirable for UE to keep searching for cells and drain out battery. Enhancement on this to save UE power consumption should be considered as essential. |
| Huawei, HiSilicon | **yes** | Existing mechanisms will work although maybe not optimal. |
| MediaTek | **yes** | Existing Idle Mode mobility mechanisms are essential and that no further enhancements are needed. Optimizations can be considered in future releases. |
| Qualcomm | **No** | Existing mechanism can be baseline, but some minor enhancement is necessary. Cell Barring mechanism between TN and NTN, Priority between TN vs NTN and providing coverage information to UE should be considered additionally for cell reselection. |
| OPPO | **Yes** | Existing idle mode mobility mechanisms will work. Enhancement can be considered in later release. |
| Lenovo | **No** | We should not preclude all further enhancements so early for a Study Item. In addition to the existing measurement based procedures, at least enhancements (or similar principles) discussed in NR NTN (e.g. ephemeris assisted cell reselection) could be used in IoT NTN as well. |
| CATT | **Yes, but** | The idle mode mobility mechanisms for NB-IoT and eMTC can be considered as essential functionality for Rel-17.  Due to the scenarios of IoT NTN are quite different with the scenarios of legacy NB-IoT/eMTC, minor adjustments should be allowed to adapt the functionality from NR NTN. No major enhancements are expected. |
| Ericsson | **Yes** | We think existing idle mode mobility mechanisms are essential functionality in IoT NTN as stated in [8]. Minor adjustments to existing mobility mechanisms, such as a new parameter, parameter values, timers, timing etc. should also be considered as essential enhancements to adapt functionality to NTN. However, it is acceptable at this stage that no new mobility mechanisms or major enhancements to existing mechanisms are introduced in Rel-17.  Note that RAN2 has agreed that enhancements introduced for cell selection/re-selection mechanism in NR NTN will be considered if applicable and cell selection/re-selection mechanism in IoT-NTN can be enhanced by using satellite assistance (e.g. ephemeris) information. |
| Gatehouse | **Yes, but** | Conditioned on the power consumption related features in 2.2.6 will mitigate excess battery drain for cell slection and reselection in the discontinous coverage case. |

### Connected mode mobility

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 5: Reusing the connected mode mobility baseline for NB-IoT and eMTC can be considered as essential functionality for Rel-17.  Observation 10: Enhancements to improve mobility performance in connected mode can be deprioritised for Rel-17.  Proposal 3: RAN2 prioritises the following functionality for IoT-NTN in Rel-17   * Reusing Idle mode and Connected mode mobility baseline   Proposal 4: RAN2 to deprioritise the following functionality for Rel-17   * Enhancements to Connected mode mobility performance |
| R2-2103177 [5] | Proposal 7: Time or timer based and Location based CHO, location based measurement event, and cell selection/reselection enhancement reusing NR NTN conclusion can be considered as essential minimum functionality for R17 IOT NTN.  Proposal 8: RLF enhancement is not considered as essential minimum functionality for R17 IOT NTN. |
| R2-2103189 [6] | Proposal 11: For NB-IOT over NTN, RLF enhancements are not considered for Rel-17. |
| R2-2103509 [7] | Proposal 8: Connected mode mobility: The existing mechanisms can be reused. Further enhancements are not needed for the considered use cases. |
| R2-2104016 [8] | Proposal 5 Existing mobility mechanisms are considered essential functionality for LTE-M and NB-IoT in IoT NTN.  Proposal 6 Minor adjustments to existing mobility mechanisms, such as a new parameter, parameter values, timers, timing etc. are considered essential enhancements to adapt functionality to NTN.  Proposal 7 No new mobility mechanisms or major enhancements to existing mechanisms are introduced in Rel-17 for IoT NTN |

Please note that power saving optimisations are discussed in 2.2.5.

1. Do companies think that existing connected mode mobility mechanisms are essential and no further enhancements (other than power consumption related) are needed?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **yes for eMTC, no for NB-IOT** | Due to movement of satellite, HO may happen frequently for eMTC. Due to the near far effect, current RSRP/RSRQ based HO may not be enough. To improve HO performance, Time or timer based and Location based CHO, location based measurement event reusing NR NTN conclusion can be considered as essential minimum functionality for R17 eMTC NTN.  However, for NB-IOT, RLF enhancement is not considered as essential minimum functionality for R17 IOT NTN. |
| Huawei, HiSilicon | **yes** | Connected mode mobility will be a rare event considering the use case of short lived connections. Existing mechanisms will work although maybe not optimal. |
| MediaTek | **yes** | Enhancements in Connected mode mobility need not be considered as essential minimum functionality for R17 IOT NTN. The traffic expected is sporadic. |
| Qualcomm | **Yes/No** | Answer to Q13:  Yes for NB-IoT.  No for eMTC. As per agreement, at least CHO can be considered for eMTC. During WI phase, simply measurement enhancement done for NR NTN can be considered when applicable. |
| OPPO | **Yes** | Existing connected mode mobility mechanisms will work. Enhancement can be considered in later release. |
| Lenovo | **No** | The connected mobility enhancements in NR NTN including CHO can be beneficial for eMTC. For NB-IoT we think RLF-based mobility may cause unnecessary RLF and reestablishment especially when served by LEO, and conditional reestablishment is needed. |
| CATT | **See comments** | For earth moving cell scenario, HO may happen frequently for eMTC UEs. The connected mode mobility mechanisms introduced for NR NTN could be considered for IoT NTN.  For NB-IoT, due to the movement of the satellite, the possibility of RLF for the connected UEs is bigger than legacy NB-IoT case. Whether and how to enhance it in Rel-17 need further discussion. |
| Ericsson | **Yes** | Connected mode mobility is not supported for NB-IoT. Similar to the idle mode mobility case, we think existing mobility mechanisms are considered essential functionality in IoT NTN as stated in [8]. Minor adjustments to existing mobility mechanisms, such as a new parameter, parameter values, timers, timing etc. should also be considered as essential enhancements to adapt functionality to NTN. However, it is acceptable at this stage that no new mobility mechanisms or major enhancements to existing mechanisms are introduced in Rel-17.  Note that RAN2 has already agreed that CHO can be used for both moving cell and fixed cell scenarios, and the CHO procedure and execution condition defined in Rel-16 is the baseline. Stage 3 details can be discussed during the WI phase. |
| Gatehouse | **No, for NB-IoT** | No they are not essential and yes no further enhancments are needed.  In the LEO case, it will take time before constallations become so dense that handover’s from satellite to satellite may happen. Better to focus on idle mode mobility for Rel 17. |

### Paging

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 12: Paging capacity and connection density evaluations can be considered as low priority for Rel-17.  Proposal 4: RAN2 to deprioritise the following functionality for Rel-17   * Performance evaluation work |
| R2-2102961 [4] | Observation #1: Discontinuous coverage is inherent in NTN NB-IoT and shall be handled to avoid service degradation and extraneous UE power consumption.  Observation #7: A UE for which scheduled paging occasions coincide with coverage gaps will be unreachable by the network.  Observation #8: The network may plan paging occasions for UEs to coincide with satellite coverage of tracking areas (TA)s.  Proposal #4: The network and UEs should agree upon the timing of paging occasions such that they coincide with satellite coverage. |
| R2-2103177 [5] | Proposal 9: Capacity related issue (e.g. paging capacity) is not considered as essential minimum functionality. |
| R2-2103509 [7] | Proposal 7: Cell selection/reselection: The existing mechanisms can be reused. For scenarios with regular long coverage outages, enhancements to synchronise paging and UE wake up time with in-coverage are necessary. |

Please note that power saving optimisations are discussed in 2.2.5.

1. Do companies think that existing paging mechanisms are essential and no further enhancements are needed?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **no** | Paging enhancement is not necessary. For capacity, in early deployment, it is not an issue. For paging occasion, network can handle it by implementation. For outage, normal i-drx can be applied without further enhancement. |
| Huawei, HiSilicon | **no** | For the use case of intermittent delay-tolerant small packet transmissions, paging is not needed and PSM can be used instead.  If use cases with mobile terminated calls are supported in discontinuous coverage scenarios, enhancements are needed to synchronise paging and satellite coverage. |
| MediaTek | **yes** | No further enhancements to paging are not needed at this point. |
| Qualcomm | **Yes** | Paging optimization would be out of RAN2 scope. |
| OPPO | **Yes** | Any paging enhancement can be considered in later release. |
| Lenovo | **Yes** | Enhancement for paging can be considered later if issue identified. |
| CATT |  | Legacy paging mechanism could be fully reused, no enhancement is required. |
| Ericsson | **Yes** | RAN2 has agreed that paging capacity is evaluated using the same methodology captured in TR 38.821 as the baseline and paging capacity and the impact on the size of the Tracking Area considering the target IoT NTN device density captured in TR 36.763 will be evaluated.  If performance evaluations such as random access and paging capacity, and connection density, are considered non-essential, we wonder how short comings, in case it is observed, are expected to be addressed during the WI phase. |
| Gatehouse | **See comment** | No, the existing paging mechanism **is not sufficient, further enhancements are needed**.  We believe paging (mobile terminated transmission) is an essential feature.  Enhancements are required for paging in the discontinous coverage scenario as we outlined in [R2-2102961](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102961.zip) along with a minimum viable solution. |

### Ephemeris

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102828 [2] | Observation 7: Provisioning of ephemeris information to the UE can be considered as essential functionality for Rel-17.  Observation 10: Enhancements to improve mobility performance in connected mode can be deprioritised for Rel-17.  Proposal 3: RAN2 prioritises the following functionality for IoT-NTN in Rel-17   * Ephemeris provisioning |
| R2-2103509 [7] | Proposal 9: System information: Enhancements are necessary to provide NTN specific information to the UE. Agreement from NR NTN can be reused as a baseline for IOT NTN. |

1. Do companies think that provisioning of ephemeris is essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **yes** | without it, UE cannot perform TA pre-compensation |
| Huawei, HiSilicon | **yes** | Further sudy is needed. pending on RAN1 progress. |
| MediaTek | **yes** | Without ephemeris or some form of satellite assistance the TA compensation and timer adjustments will not work. |
| Qualcomm | **Yes** | We should wait NR NTN and RAN1 progress for format, accuracy, and update of ephemeris. |
| OPPO | **Yes** | Ephemeris is needed for TA pre-compensation and timer adjustment. |
| Lenovo | **Yes** | Same as in NR NTN. |
| CATT | **Yes** | Provisioning of ephemeris to UE is essential for IoT NTN, the means for NR NTN could be reused. |
| Ericsson | **Yes** |  |
| Gatehouse | **Yes** | Further study is needed to determine the format, but for UL communication ephemeris information is essential. We have also proposed to utilize a “long-term” ephemeris for scheduling purposes for paging (PSM, iDRX) in the discontinous coverage case. |

### Power saving optimisations

The following proposals are made in documents [1] - [8]:

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2102743 [1] | Proposal 2 Power consumption enhancements should be studied and specified for IoT over NTN in Rel-17. |
| R2-2102956 [3] | Observation 1: If LEO with earth moving cell is prioritized, we should further consider the solutions for idle/connected mode mobility, to adapt the frequent change of the cell coverage caused by the movement of the LEO satellites.  Proposal 5: we should not simply down-prioritize the Mobility aspects functionalities, some adaptions may be needed for idle mode and connected mode mobility in case of earth moving cell is deployed. |
| R2-2102961 [4] | Observation #1: Discontinuous coverage is inherent in NTN NB-IoT and shall be handled to avoid service degradation and extraneous UE power consumption.  Observation #2: To mitigate discontinuous coverage, the UE and network must be aware of gaps in coverage.  Proposal #1: Transmit an almanac for scheduling purposes and a short-term ephemeris for synchronization purposes. This can be an optional feature for operators to support discontinuous coverage (SIBx).  Proposal #2: The short-term ephemeris should be broadcast as minimum at a rate allowing UEs on the edge to receive and decode the short-term ephemeris within the UEs access window. Since the window size will depend on the constellation, it should be a constellation dependent parameter.  Observation #3: The almanac could be broadcast at a lower rate, but also at least once per access window.  Observation #4: It is possible to reduce UE energy consumption for searching significantly by using almanac based predictions.  Observation #5: The number of cell search trials can be 100s compared to typically 1 in terrestrial NB-IoT depending on the coverage scenario, which results in relatively large energy consumption.  Proposal #3: The cell search process should be optimized for energy consumption in NTN.  Observation #6: A UE waking up to receive paging while in a coverage gap will unnecessarily consume energy.  Proposal #5: 3GPP to further study how to adapt iDRX and PSM for discontinuous coverage and cell-reselection.  Proposal #6: Re-use the current PSM scheme adjusting only the timers with the wait-time until the next satellite covers the UE. |
| R2-2103177 [5] | Proposal 5: power consumption optimization for reducing power consumption of acquiring GNSS location is not considered as essential minimum functionality. |
| R2-2103189 [6] | Proposal 6: Connected mode enhancements related to power consumption is not considered as essential for Rel-17.  Proposal 7: Key features for power consumption reduction for IoT-NTN are eDRX/PSM and serving cell relaxed measurements. Adaptation of these features for NTN should be considered as essential.  Proposal 8: Battery lifetime requirements should to be revisited if the eDRX operations is considered without any modification for NTN aspects such as GNSS operation and cell-change during eDRX wake-up occasion. |
| R2-2103509 [7] | Proposal 7: Cell selection/reselection: The existing mechanisms can be reused. For scenarios with regular long coverage outages, enhancements to synchronise paging and UE wake up time with in-coverage are necessary.  Proposal 8: Connected mode mobility: The existing mechanisms can be reused. Further enhancements are not needed for the considered use cases.  Proposal 10: For LEO cell moving scenario, enhancements are needed to avoid the UE having to reacquire system information in every new cell |
| R2-2104016 [8] | Observation 4 Whether any enhancements are needed for UE power consumption depends on the evaluation results from studies in RAN1.  Proposal 4 RAN2 to wait until RAN1 studies on UE power consumption in IoT NTN conclude before considering whether UE power consumption is an essential functionality in IoT NTN and discuss the need for enhancements. |

1. Do companies think that enhancements (and which ones) for power saving in Idle mode are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **yes** | Power saving is important for IOT. However, the first priority should be adopt power saving enhancement as agreed in NR NTN. |
| Huawei, HiSilicon | **yes** | One of the key requirement of IOT is the battery life. Unless we agree to reduce battery life requirements, enhancements are needed at least for the use case of:  - Stationary UEs in moving cell scenarios (relaxed monitoring, SIB reading)  - Discontinuous coverage (avoid unecessary scans in covergae holes) |
| MediaTek | **no** | Ephemeris information can be used to stop cell searching in discontiunous coverage. Further enhancements to power savings can be discussed in future releases. |
| Qualcomm | **Yes** | Following can be considered.  1. SI update/acquisition mechanism,  2. eDRX,  3. PSM,  4. Relaxed monitoring in GEO scenario,  5. Wake-up signal (WUS) in GEO scenario |
| OPPO | **Yes** | Power consumption is a very important feature for IoT devices. We think this requirement still applies in IoT over NTN. |
| Lenovo | **Yes** | Power saving is important for IoT devices. Particularly in IoT NTN unnecessary power consumption caused by discontinuous coverage should be studied. |
| CATT | **Yes** | As mentioned in [3][4][6][7], it’s necessary to consider how to resolve the cell-change during eDRX wake-up occasion in earth moving cell scenario.  For continuous coverage, the current PSM scheme could be reused with some adjustment to search for the new cell according to the ephemeris data when wake-up.  For discontinuous coverage deployment, PSM scheme could be re-designed/simplified, sleep down or power off when the serving satellite is gone, wake up/power on and do cell search when the new satellite comes. |
| Ericson | **Yes** | Power saving enhancements may be required depending on the impact on UE power consumption in IoT NTN. Note that in RAN1#104-e, the following agreement were made: “Study potential impact of GNSS Position fix on UE power consumption using battery life methodology in Rel-13 TR 45.820 (Section 5.4)”. RAN1 also agreed to study the potential impact of NTN SIB carrying the satellite ephemeris on UE power consumption. |
| Gatehouse | **Yes** | Agree with huawei.  We can add that specifically, “NTN enhancements for idle mode mobility with support for discontinous coverage “ is seen as a minimum enhancement for IoT NTN. This would entail cell selection and reselection, cell search, PSM/iDRX |

1. Do companies think that enhancements (and which ones) for power saving in connected mode are essential?

|  |  |  |
| --- | --- | --- |
| **Company** | **essential (yes/no)** | **Detailed comments** |
| xiaomi | **no** | For intermittent data transmission, UE will in idle mode for most of the time, power saving enhancement for connected mode should be de-prioritized. |
| Huawei, HiSilicon | **no** | For the considered use case, connection will be short lived. |
| MediaTek | **no** | Connected mode power savings is not essential for intermittent data transmission. |
| Qualcomm | **Yes** | This should not be understood as we will not try to see existing features if they can be supported without major change.  1. Multiple TBs scheduling,  2. PDCCH-based HARQ feedback,  3. Release Assistance Indication |
| OPPO | **No** | Same view as Xiaomi, Huawei and MediaTek. |
| Lenovo | **Yes** | Although the duration in CONNECTED is expected to be short in IoT NTN, there may still be unnecessary power consumption caused by discontinuous coverage. E.g. proactive release/suspend for UE is useful to avoid unnecessary procedures including RLF and RRC reestablishment when UE approaches a coverage hole, and conditional RRC reestablishment can also be considered at the time when coverage restores. |
| CATT | **No** | Share the view with Xiaomi. |
| Ericsson | **No** |  |
| Gatehouse | **No, but** | The focus should be idle mode mobility, but enhancements like those Lenovo are mentioning are clearly relevant. |

## Other

1. Whether essential functionalities have been missed in the discussion?

|  |  |
| --- | --- |
| **Company** | **Detailed comments** |
| Lenovo | Discontinuous coverage case is essential to be included and considered in this release. This case is realistic for satellite service providers, and contributions have revealed that it has negative impacts on CONNECTED and IDLE procedures if we follow existing mechanisms. A most direct impact is unnecessary power consumption of IoT devices which can be predicted and avoided by enhancement at NW or UE. |
| Ericsson | Not only paging capacity evaluation but also connection density evaluation should also be discussed. Random access capacity is yet another important aspect for performance, but it is not mentioned here since RAN2 has agreed the following:  “RAN2 assumes that PRACH capacity in eMTC/NB-IoT over NTN will be evaluated to check whether it can support the large cell size of GEO/LEO. However, RAN2 believes this is more of a RAN1 topic and thus recommends companies to submit their contributions in RAN1.  The question is whether RAN2 would consider random access capacity evaluation in case the assumption above does not hold, i.e., no evaluation is performed in RAN1, for example due to limited time, unless it is explicitly agreed in RAN1 that there is no need to do so. |
|  |  |
|  |  |

# Conclusion

# References

1. [R2-2102743](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102743.zip) Discussion on scope of IoT over NTN OPPO

1. [R2-2102828](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102828.zip) Identifying Essential Topics in IoT-NTN MediaTek Inc.

1. [R2-2102956](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102956.zip) Determination of essential parts for IoT NTN CATT

1. [R2-2102961](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102961.zip) Essential adaptations for discontinuous coverage in IoT-NTN Gatehouse Satcom A/S, Sateliot

1. [R2-2103177](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103177.zip) Essential functionality for IOT NTN Xiaomi

1. [R2-2103189](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103189.zip) Analysis on essential parts for IoT-NTN functionality for Rel-17 Nokia, Nokia Shanghai Bell

1. [R2-2103509](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103509.zip) Discussion on essential functionalities for IOT NTN Huawei, HiSilicon

1. [R2-2104016](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2104016.zip) Discussion on essential functionality in IoT NTN - scenarios and scope Ericsson

# Participants

|  |  |  |
| --- | --- | --- |
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