3GPP TSG RAN WG1 Meeting #110-bis-e R1-2212058

e-Meeting, October 10th – 19th, 2022

Agenda Item: 8.14

Source: Moderator (MediaTek)

Title: Maintenance on NB-IoT/eMTC to support NTN: time and frequency

synchronization

Document for: Discussion and Decision

# Introduction

At the RAN#92 meeting, a new Work Item was approved for IoT Non Terrestrial Network (NTN) [1]. In this meeting, company views on UL synchronization for IoT NTN are summarized and observations/proposals on identified issues are made. Observations and proposals in Company’s TDoc contributions are listed in the Appendix.

Identified remaining IoT NTN-specific topics are discussed in Sections 2, 3, and 4.

A summary of [110bis-e-R17-IoT-NTN-01] Email discussion to determine maintenance issues to be handled in RAN1#110bis-e is provided below

* Issues 1-1, 1-6, 1-7, 1-8 are editorial revisions
* Issues 1-2, 1-3, 1-9 are not for discussion in RAN1#110bis-e
* Issues 1-4, 1-5 are for discussion in RAN1#110bis-e

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| **Issue#** | **Issue** | **Company inputs (if any)**[Companies will provide their views here] |
| 1-1 | Clarify source of quantity $N\_{segment}^{precompensation}$ in higher layer configuration for eMTC and NB-IoT UE when the UE performs segmented pre-compensation.In RAN1#107-e, there was agreement.**Agreement**Support network re-configuration of UL transmission segment by dedicated RRC SignallingIn TS 36.213, “higher layer” is typically used for RRC parameters provided with common RRC signalling in SIB or dedicated RRC signalling. Moderator understanding is that the text in TS 36.213 Section 4.2.3 and 16.1.2 should be revised as “where the quantity $N\_{segment}^{precompensation}$ is provided by ~~system information~~ by higher layer, as specified in 3GPP TS 36.331” | 8 Companies (Lenovo, OPPO, ZTE, QUALCOMM, Nokia/NSB,SONY, Sequams, MediaTek) agreed with the moderator editorial text revision. **Moderator recommendation**: The text in TS 36.213 Section 4.2.3 and 16.1.2 should be revised as “where the quantity $N\_{segment}^{precompensation}$ is provided by ~~system information~~ higher layer, as specified in 3GPP TS 36.331”  |
| 1-2 | Clarify UE behavior of dropping samples for NPRACH of NB-IoT UE when the UE performs segmented pre-compensation.The text proposal aims to clarify the UE behaviour for adjustment of the uplink transmission timing for NPRACH. This UE behaviour was discussed in RAN1 with following agreement in RAN1 107e. **Agreement**For NB-IoT, UE pre-compensation per segment of NPRACH is applied from one segment to the next segment by using one or more of the following methods if supported by UE implementationUE may drop / Insert samplesUE may blank subframe / repetition unit where UE drops a subframe / repetition unitThe total transmission time is not changedFFS Details of method(s) to drop / insert samples / blank subframe / repetition unit FFS Specification impactTo the moderator understanding there was no RAN1 agreement for the text proposal below for UE behaviour for timing adjustment for NPRACH and the current specification is sufficient. When the UE's uplink NPRACH transmissions in preamble sequence repetition *n* for one segment and preamble sequence repetition *n*+1 for the next segment are overlapped due to the timing adjustment, the UE shall complete transmission of preamble sequence repetition *n* and not transmit the overlapped part of preamble sequence repetition *n*+1.To the moderator understanding there was no RAN1 agreement for this text proposal for UE behaviour for timing adjustment for NPRACH and the current specification is sufficient.  | 4 companies (ZTE, Qualcomm, Sequams, MediaTek) agreed with moderator assessment. Nokia, SSB commented that the issue needs to be discussed or Rel-17 cannot work. On Lenovo comment, moderator intention was to indicate that the current agreement was sufficient and there was no basis for the proposed CR, not that agreement was missing. **Moderator’s view**: as mentioned by Sequans on “not transmit the overlapped part”, it is up to UE implementation. This issue was discussed in previous meetings already and there was no consensus that further specification in RAN1 specs was needed.**Moderator recommendation**: Following the majority view, it is recommended not to discuss this issue in this meeting. |
| 1-3 | Clarify that segmented uplink transmission gap is only applied when the timing advance of the next segment is longer than the previous, transmitted segment. To the moderator understanding there is no RAN1 agreement for the proposed text revision and the current specification is sufficient. “a transmission gap of $N\_{gap}^{precompensation}$ time units shall be counted for the PUSCH resource mapping but not used for transmission of the PUSCH of the next segment, if the timing advance of the next segment is longer than the timing advance of the transmitted segment,”. | 3 companies(**ZTE, QUALCOMM, MediaTek**) agreed with the moderator assessment. **Nokia, NSB** and **SONY** want to discuss the issue of segmented uplink transmission gap is only applied when the timing advance of the next segment is longer than the previous, transmitted segment. **Moderator’s view**: this issue was already discussed in previous meeting without consensus to capture UE behaviour in RAN1 specifications. It can be left to the UE implementation.**Moderator recommendation:** Following the majority view, it is recommended not to discuss this issue in this meeting. |
| 1-4 | NTN SIB AccummulationEricsson proposed the following:Network to optionally indicate if NTN SIB accumulation across SI windows is allowed or not.For eMTC NTN with explicit epoch time indication, without introducing additional signalling, support NTN SIB accumulation at least for the following SI periodicities: {8, 16, 32, 64,128} framesFor NB-IoT NTN with explicit epoch time indication, without introducing additional signalling, support NTN SIB accumulation at least for the following SI periodicities: {64,128} frames.For explicit epoch time indication, introducing additional signalling can help extend the SIB accumulation to even larger SI periodicities and/or optimize the UE behavior regarding SIB accumulationFor IoT NTN, adopt the same definition for validity of assistance information as for NR NTN.Nokia proposed in R1-2209244 Only explicit signaling of Epoch time for assistance information shall be specified for IoT NTN and RAN1 send LS to RAN2 to update SIB31 description in RRC specification to make the epochTime a mandatory field.As was discussed and captured in FL summary in RAN1#110 and summarised above, RAN2 has specified signalling for implicit Epoch time. This implies that SIB accumulation is not supported in Rel-17 since updating to serving cell ephemeris information does not affect the system information value. When epoch time is not explicitly indicated, the UE uses the starting time of the DL subframe corresponding to the end of the SI window during which the SI message carrying SIB31 is transmitted. SIB accumulation across SI windows is new functionality. There was no consensus in RAN1 that it is essential to specify SIB accumulation. It is not essential to specify SIB accumulation across SI windows. | 2 companies (Qualcomm, MediaTek) agree with moderator assessment, 2 companies (ZTE. Sequams) are open to discuss the issue, 1 company want to remove implicit signaling from IoT NTN (this means no SIB accumulation for implicit signalling), 2 companies want to discuss SIB accumulation. **Moderator’s view**: This issue has been discussed in 2 previous meetings, and is not seen as essential. Implicit signalling is optional in the network and RAN2 has specified solution in Rel-17 for implicit signalling. Hence, network can choose not to configure it. SI Window parameters can be configured to make implicit signalling workable. This topic was extensively discussed in RAN1#110 without consensus. However, it was discussed in online session that this issue could be revisited in RAN1#110-bis. **Moderator recommendation:** Discuss this issue over email in RAN1#110bis-e |
| 1-5 | Processing time for downlink receptionQualcomm raised a new issue for processing time for downlink reception. In terrestrial networks, eMTC/NB-IoT UEs typically require a certain amount of “minimum processing time” to process a downlink reception, before transmitting an associated uplink that may be triggered by the downlink reception. Examples include:(N)PDSCH triggering HARQ-ACK(N)PDCCH triggering (N)PUSCH(N)PDCCH triggering PDCCH-ordered (N)PRACHThe moderator understanding is that Qualcomm analysis is correct. The network is required to set Koffset larger than TTA,NTN max to ensure these conditions for processing time for downlink reception for | 5 companies (OPPO, Qualcomm, SONY, Sequans, MediaTek) support moderator proposal. 2 companies (Lenovo, ZTE) do not support.**Moderator’s view**: It is correct that Koffset is configured by the network. However, the moderator understanding is that this issue has potential impact on the processing time for implementation. More understanding is needed on whether restrictions are necessary. **Moderator’s recommendation**: Discuss this issue over email in RAN1#110bis-e |

# UL Segmented Transmission

In RAN1#109-e, the following agreements were made on single UE capability and specification in TS 36.211.

**Agreement**

The single UE capability that governs UE behavior w.r.t gaps between segments for PUSCH, PUCCH and NPUSCH, when the UE performs segmented pre-compensation, is as follows:

When a single capability is signalled: UE drops one or more of the following durations of uplink transmission between segments (indicated by the capability):

1 slot (applicable to eMTC)

1 subframe (applicable to eMTC)

1 slot (applicable to NB-IoT)

2 slots (applicable to NB-IoT)

1 symbol (applicable to both eMTC and NB-IoT)

UE follows legacy behaviour at slot boundaries due to TA adjustment

When capability is NOT signalled: UE follows legacy behaviour at slot boundaries due to TA adjustment

## Company views

OPPO proposed draft CR R1-2208831 to TS 36.213 Section 4.2.3 and 16.1.2 on UL segmented transmission [2].

Reason for change: In RAN1 meeting #107e, the following agreement on UE pre-compensation in segment was made and was not reflected in the specification.

Agreement

For UL Segmented transmission during RRC\_CONNECTED:

• If a segment duration is configured, the UE is expected to adjust the value for pre-compensation for a segment. .

Summary of change: Reflect the missing agreement on UE pre-compensation in segment.

Consequences if not approved: Incomplete specification.

Nokia proposed draft CR#2 R1-2209243 to TS 36.213 Section 4.2.3 and 16.1.2 on clarify source of quantity $N\_{segment}^{precompensation}$ in higher layer configuration for eMTC and NB-IoT UE when the UE performs segmented pre-compensation [4].

Reason for change: Clarify source of quantity $N\_{segment}^{precompensation}$ in higher layer configuration for eMTC and NB-IoT UE when the UE performs segmented pre-compensation.

Summary of change: For NB-IoT, the quantity $N\_{segment}^{precompensation}$ is configured from system information for PRACH and from RRC configuration for PUCCH/PUSCH. For eMTC, the quantity $N\_{segment}^{precompensation}$ is configured system information for NPRACH and from RRC configuration for NPUSCH .

Consequences if not approved: Release 17 eMTC/NB-IoT UEs cannot communicate via NGSO NTNs

**Moderator view**: On OPPO draft CR (R1-2208831) and Nokia draft CR#2 (R1-2209243) for TS 36.213 Section 4.2.3 and 16.1.2:

These CRs propose revision based on RAN1#107-e agreement.

**Agreement**

Support network re-configuration of UL transmission segment by dedicated RRC Signalling

The revised text for Section 4.3 and 16.1.2 in TS 36.213 is copied below

* OPPO revised text: “where the quantity $N\_{segment}^{precompensation}$ is provided by system information or higher layers, as specified in 3GPP TS 36.331”
* Nokia revised text: “where the quantity $N\_{segment}^{precompensation}$ is provided by system information or RRC configuration, as specified in 3GPP TS 36.331”

In TS 36.213, “higher layer” is typically used for RRC parameters provided with common RRC signalling in SIB or dedicated RRC signalling. Moderator understanding is that the text in TS 36.213 Section 4.2.3 and 16.1.2 should be revised as “where the quantity $N\_{segment}^{precompensation}$ is provided by ~~system information~~ by higher layer, as specified in 3GPP TS 36.331”

## FL recommendation

***FL recommendation 2.1-a****: Draft CR to TS 36.213 in Sections 4.2.3 Transmission timing adjustments for eMTC and Section 16.1.2 Timing synchronization for NB-IoT on UE pre-compensation in segment based on OPPO draft CR R1-2208831 and Nokia draft CR#2 R1-2209243.*

Reason for change: In RAN1 meeting #107e, the following agreement on UE pre-compensation in segment was made and was not reflected in the specification.

**Agreement**

Support network re-configuration of UL transmission segment by dedicated RRC Signalling.

Summary of change: Reflect the missing agreement on UE pre-compensation in segment.

Consequences if not approved: Incomplete specification.

TP to Section 4.2.3 and 16.1.2: “where the quantity $N\_{segment}^{precompensation}$ is provided by ~~system information~~ higher layer, as specified in 3GPP TS 36.331”

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| Companies | Comments |
| Lenovo | To align the legacy text, it is better to update as “higher layers” |
| Moderator | Minor editorial revisions for reference for CRs were made |
| Ericsson | Support. Lenovo’s edit is ok. |
| ZTE | Support |
| Nokia, NSB | OK. Also aligned with our drafted CR. |
| SONY | Support. Lenovo’s edit is OK. |
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# NTN SIB accumulation

This issue of NTN SIB accumulation was discussed in RAN1#110.

The SIB accumulation was discussed in 1st offline session. RAN2 made the following agreements:

Update to serving cell ephemeris information does not affect the system information value tag and does not trigger System information modification procedure. How to trigger re-read of this information is FFS. FFS if the UE shall reacquire the new SIB when SI update is triggered.

Updates to serving cell ephemeris information are not bound to the BCCH modification period.

Implicit signalling of epochTime in SIB31 in broadcast signalling is supported.

Then RAN2 specified implicit Epoch time in TS 36.331 as in endorsed CR in R2-2206693

***epochTime***

*Epoch time of the satellite ephemeris data and common TA parameters, see TS 36.213 [23]. The reference point for epoch time of the serving satellite ephemeris and Common TA parameters is the uplink time synchronization reference point.*

*epochTime is the starting time of a DL subframe indicated by startSFN and startSubframe.*

*If the field is absent, the UE uses the starting time of the DL subframe corresponding to the end of the SI window during which the SI message carrying SIB31 is transmitted.*

*E-UTRAN always includes epochTime when SystemInformationBlockType31 is provided through dedicated signalling.*

*Update to serving cell ephemeris information does not affect the system information value tag and does not trigger System information modification procedure. How to trigger re-read of this information is FFS. FFS if the UE shall reacquire the new SIB when SI update is triggered.*

*Updates to serving cell ephemeris information are not bound to the BCCH modification period.*

Both eMTC and NB-IoT allow SIB repetitions within an SI window. The SI window configuration details for eMTC and NB-IoT are provided in Table 1. Additionally, the legacy eMTC/NB-IoT UEs can accumulate SIBs across multiple SI windows if needed for decoding (except for the SIBs that change frequently such as SIB16).

Table 1 SI window configuration parameters for eMTC and NB-IoT.

|  |  |  |  |
| --- | --- | --- | --- |
|  | SI window length | Repetition pattern within SI window | SI periodicity |
| eMTC | {1, 2, 5, 10, 15, 20, 40, 60, 80, 120, 160, 200} ms | Every radio frame or every {2nd, 4th, 8th} radio frame | {8, 16, 32, 64, 128, 256, 512} radio frames |
| NB-IoT | {160, 320, 480, 640, 960, 1280, 1600} ms | Every {2nd, 4th, 8th, 16th} radio frame | {64, 128, 256, 512, 1024, 2048, 4096} radio frames |

## Company views

Ericsson provided some analysis to show that in eMTC/NB-IoT NTN, there are numerous configurations of the SI window periodicity and the validity timer duration for which the NTN SIB may remain unchanged over many SI windows and can therefore be accumulated. Without NTN SIB accumulation across SI windows, the network may need to configure longer SI windows to support a larger number of repetitions, resulting in a high signalling overhead. If the network optionally signals in SIB1 assistance information such as whether SIB accumulation is prohibited or not, and/or the number of SI windows that can be accumulated, or the H-SFN number for the explicit epoch time to extend its range, or the explicit time (e.g., subframe, SFN, H-SFN) until the NTN SIB remains unchanged, it can help optimize the UE behavior as the UE will know when to stop attempting to decode the SIB. Moreover, it can also extend the epoch timer range which in turn can make SIB accumulation feasible even for larger SI periodicities.

Ericsson proposed the following:

* Network to optionally indicate if NTN SIB accumulation across SI windows is allowed or not.
* For eMTC NTN with explicit epoch time indication, without introducing additional signalling, support NTN SIB accumulation at least for the following SI periodicities: {8, 16, 32, 64,128} frames
* For NB-IoT NTN with explicit epoch time indication, without introducing additional signalling, support NTN SIB accumulation at least for the following SI periodicities: {64,128} frames.
* For explicit epoch time indication, introducing additional signalling can help extend the SIB accumulation to even larger SI periodicities and/or optimize the UE behavior regarding SIB accumulation
* For IoT NTN, adopt the same definition for validity of assistance information as for NR NTN.

Nokia proposed in R1-2209244 Only explicit signaling of Epoch time for assistance information shall be specified for IoT NTN and RAN1 send LS to RAN2 to update SIB31 description in RRC specification to make the epochTime a mandatory field.

**Moderator view**: As was discussed and captured in FL summary in RAN1#110 and summarised above, RAN2 has specified signalling for implicit Epoch time. This implies that SIB accumulation is not supported in Rel-17 since updating to serving cell ephemeris information does not affect the system information value. When epoch time is not explicitly indicated, the UE uses the starting time of the DL subframe corresponding to the end of the SI window during which the SI message carrying SIB31 is transmitted. SIB accumulation across SI windows is new functionality. There was no consensus in RAN1 that it is essential to specify SIB accumulation. It is not essential to specifiy SIB accumulation across SI windows.

## FL Recommendation

***FL recommendation****: RAN2 specification for signalling for implicit Epoch time is sufficient. Additional signalling to extend the SIB accumulation Extension for explicit signalling is out of scope of maintenance phase. SIB Accummulation is de-prioritised in Rel-17.*

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| Companies | Comments |
| Lenovo | Support FL recommendation. |
| Ericsson | We strongly disagree with the moderators’ observation that “SIB accumulation across SI windows is new functionality” as legacy terrestrial eMTC and NB-IoT have had this functionality for many releases. This functionality enables the network to use a resource-efficient lean SI transmission with shorter SI windows and fewer repetitions since the UEs can decode the SIB by accumulating it across multiple SI windows. Therefore, it should also be supported for NTN in Rel-17.With explicit epoch time, existing signalling for SI configuration parameters can be used to support this feature (see [R1-2209650](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_110b-e/Docs/R1-2209650.zip) for detailed analysis). This is because the UE will already know its SI periodicity. Assuming the shortest validity timer of 5 seconds, it is obvious that SIB accumulation is feasible for certain SI periodicities. A way forward would be to agree to enable SIB accumulation at least for these periodicities. * For eMTC NTN with explicit epoch time indication, without introducing additional signalling, support NTN SIB accumulation at least for the following SI periodicities: {8, 16, 32, 64} frames

Table 2 Number of eMTC NTN SIBs that can be accumulated before the validity timer expires.

|  |  |
| --- | --- |
| **Validity timer (sec)** | **eMTC SI window periodicity (sec)** |
| 0.08 | 0.16 | 0.32 | 0.64 | 1.28 | 2.56 | 5.12 |
| **Number of eMTC SI windows within a validity timer duration** |
| **5** | 62 | 31 | 15 | 7 | 3 | 1 | - |
| **10** | 125 | 62 | 31 | 15 | 7 | 3 | 1 |
| **15** | 187 | 93 | 46 | 23 | 11 | 5 | 2 |
| **30** | 375 | 187 | 93 | 46 | 23 | 11 | 5 |
| **60** | 750 | 375 | 187 | 93 | 46 | 23 | 11 |
| **120** | 1500 | 750 | 375 | 187 | 93 | 46 | 23 |
| **180** | 2250 | 1125 | 562 | 281 | 140 | 70 | 35 |
| **240** | 3000 | 1500 | 750 | 375 | 187 | 93 | 46 |
| **900** | 11250 | 5625 | 2812 | 1406 | 703 | 351 | 175 |

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| ZTE | We are open to discuss SIB accumulation to improve coverage, but also fine with FL recommendation. If SIB accumulation is applied, the network may directly broadcast the number of SI windows among which the SIB is repeated, which is the most simple way. |
| Nokia, NSB | **We do not agree this or SIB accumulation is de-prioritized in Rel17 but SIB accumulation as legacy featured should be supported**. In SI, there is already one assumption as “It is assumed that all cellular IoT features specified up to Rel-16 are supported for IoT NTN.” as in 36.763.SIB accumulation is important feature to guarantee coverage which should always be needed.As we mentioned in first round, RAN2 has not exclude SIB accumulation but not discuss in detail considring IoT special requirement.**As there is already explicity signaling always can work, we propose only define explicit signaing for epoch time but not define implicit signaling in Rel17 IoT NTN.** |
| SONY | We strongly disagree with the moderators’ observation that “SIB accumulation across SI windows is new functionality” as legacy terrestrial eMTC and NB-IoT have had this functionality for many releases. [same view as Ericsson]Whether or not RAN2 have specified that SIB accumulation is not supported for implicit epoch time, we still have the case of explicit epoch time. We would assume that if an eNB was concerned with SIB coverage due to an inability to accumulate SIB for implicit epoch time signalling, it would signal the epoch time explicitly. We really need to get this issue sorted out at this meeting. SIB accumulation has been supported for many releases. The IoT-NTN SI assumed that all cellular features specified up to Rel-16 are supported for IoT-NTN, hence SIB accumulation needs to be supported in Rel-17 IoT-NTN. There was no consensus to remove the SIB accumulation feature in Rel-17 IoT-NTN. |
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# Processing time for downlink reception

## Company views

Qualcomm raised a new issue for processing time for downlink reception. In terrestrial networks, eMTC/NB-IoT UEs typically require a certain amount of “minimum processing time” to process a downlink reception, before transmitting an associated uplink that may be triggered by the downlink reception. Examples include:

* (N)PDSCH triggering HARQ-ACK
* (N)PDCCH triggering (N)PUSCH
* (N)PDCCH triggering PDCCH-ordered (N)PRACH

As example of NPDSCH triggering HARQ-ACK in NB-IoT is provided below. The standards text (from TS 36.213) for transmitting HARQ-ACK is as follows:

*16.4.2 UE procedure for reporting ACK/NACK*

*The UE shall upon detection of a NPDSCH transmission ending in NB-IoT subframe n intended for the UE and for which an ACK/NACK shall be provided, start, after the end of*

*-* $n+k\_{0}^{'}+K\_{offset}-1$ *DL subframe for FDD,*

*-* $k\_{0}^{'}-1$ *NB-IoT UL subframes following the end of n+12 subframe for TDD,*

*transmission of the NPUSCH carrying ACK/NACK response…*

In FDD (relevant to NTN), for terrestrial networks, $K\_{offset}=0$, and hence, the “processing time” that a UE has, to generate the HARQ ACK, is given by:

* $k\_{0}^{'}-1-[T\_{TA,terrestrial}]$(Terms normalized to same time units, e.g., a time unit of slots/subframes)

For legacy terrestrial, however, this $T\_{TA}$ is typically very small. Hence, the “minimum” processing time that a UE needs (in terrestrial) is given by:

* $T\_{proc,terrestrial}^{min}=k\_{0}^{',min}-1-[T\_{TA,terrestrial}^{max}]$ (Terms normalized to same time units, e.g., a time unit of slots/subframes)

**In terrestrial networks, the minimum processing time that a UE needs to process an NPDSCH before it can transmit a corresponding HARQ-ACK is given by** $k\_{0}^{',min}-1-[T\_{TA,terrestrial}^{max}]$**.**

For NTN, there is a very large TA, which is reflected by the following two additional terms (w.r.t terrestrial) in the expression for TA in TS 36.211:

* $T\_{TA,NTN}=\left(N\_{TA}+N\_{TA,offset}+N\_{TA,adj}^{common}+N\_{TA,adj}^{UE}\right)T\_{s}=T\_{TA,terrestrial}+\left(N\_{TA,adj}^{common}+N\_{TA,adj}^{UE}\right)T\_{s}$.

Further, due to the (non-zero) $K\_{offset}$ term in NTN, the “processing time” that the UE has in NTN, to generate the HARQ ACK is given by:

* $k\_{0}^{'}-1+K\_{offset}-[T\_{TA,NTN}]$ (Terms normalized to same time units, e.g., a time unit of slots/subframes)

Hence, if $K\_{offset}<$ $[(N\_{TA,adj}^{common}+N\_{TA,adj}^{UE})T\_{s}]$ for a UE, the “processing time” to generate the HARQ ACK is smaller than terrestrial for a given value of $k\_{0}^{'}$. Such a scenario may occur, e.g., for certain UEs at the cell-edge, in a cell where the $K\_{offset}$ is not configured overly conservatively

We want to avoid such a situation, since certain legacy UEs cannot meet a “tighter than terrestrial” processing time (in this running example, from NPDSCH to HARQ-ACK)

**Under certain circumstances—e.g., for the same value of** $k\_{0}^{'}$**, if** $K\_{offset}<$$[(N\_{TA,adj}^{common}+N\_{TA,adj}^{UE})T\_{s}]$**—a NB-IoT UE over NTN may have to process a NPDSCH in less than the minimum processing time afforded to it in terrestrial networks**

**This may prevent a legacy NB-IoT UE from operating seamlessly in an NTN network**

To this end, we propose the following limitation in the specifications (for this running example of NPDSCH triggering HARQ-ACK), such that a NB-IoT UE is not required to meet a tighter processing timeline than terrestrial in NTN.

Qualcomm make the following proposal for NPDSCH triggering HARQ-ACK:

**For NB-IoT over NTN, for a NPDSCH triggering a HARQ-ACK, the following condition must be satisfied, for the UE to be required to process the NPDSCH:**

$\left(k\_{0}^{'}-1+K\_{offset}-[T\_{TA,NTN}]\right)\geq T\_{proc,terrestrial}^{min} \left\{ =k\_{0}^{',min}-1-[T\_{TA,terrestrial}^{max}]\right\}$**,**

**where** $k\_{0}^{', min}, T\_{TA,terrestrial}^{max}$ **and** $T\_{TA,NTN} $**are defined in TS 36.211, and [.] denotes a quantization to appropriate slot/subframe/RU units.**

While the example above has been for NPDSCH triggering HARQ-ACK, the same principle applies to other downlink-triggering-uplink processing times.

Qualcomm further propose for the NPDCCH triggering a NPUSCH:

**For NB-IoT over NTN, for a NPDCCH triggering a NPUSCH, the following condition must be satisfied, for the UE to be required to transmit the NPUSCH:**

$\left(k\_{0}-1+K\_{offset}-[T\_{TA,NTN}]\right)\geq T\_{proc,terrestrial}^{min} \left\{ =k\_{0}^{min}-1-[T\_{TA,terrestrial}^{max}]\right\}$**,**

**where** $k\_{0}^{min}, T\_{TA,terrestrial}^{max}$ **and** $T\_{TA,NTN} $**are defined in the specifications, and [.] denotes a quantization to appropriate slot/subframe/RU units.**

Qualcomm further propose for a NPDCCH triggering a “PDCCH order” based NPRACH:

**For NB-IoT over NTN, for a NPDCCH triggering a “PDCCH order” based NPRACH, the following condition must be satisfied, for the UE to be required to transmit the NPRACH:**

$\left(k\_{2}-1+K\_{offset}-[T\_{TA,NTN}]\right)\geq T\_{proc,terrestrial}^{min} \left\{ =k\_{2}^{min}-1-[T\_{TA,terrestrial}^{max}]\right\}$**,**

**where** $k\_{2}^{min}, T\_{TA,terrestrial}^{max}$ **and** $T\_{TA,NTN} $**are defined in the specifications, and [.] denotes a quantization to appropriate slot/subframe/RU units.**

While the above proposals are made for NB-IoT, similar amendments to the specifications are necessary to maintain adequate processing time for eMTC UEs over NTN.

**Specify similar conditions for processing times for “downlink triggering uplink” settings for eMTC over NTN, as described in Proposals 1 through 3 for NB-IoT over NTN in this contribution.**

**Moderator view**: Qualcomm analysis is correct. The network is required to set Koffset larger than TTA,NTN max to ensure these conditions for processing time for downlink reception for

## FL Recommendation

***FL recommendation 4.1a:*** *Support the following for “minimum processing time” to process a downlink reception, before transmitting an associated uplink that may be triggered by the downlink reception for NPDSCH/PDSCH triggering HARQ-ACK in NB-IoT/eMTC*

*For NB-IoT over NTN, for a NPDSCH triggering a HARQ-ACK, the following condition must be satisfied, for the UE to be required to process the NPDSCH:*

$\left(k\_{0}^{'}-1+K\_{offset}-[T\_{TA,NTN}]\right)\geq T\_{proc,terrestrial}^{min} \left\{ =k\_{0}^{',min}-1-[T\_{TA,terrestrial}^{max}]\right\}$*,*

*where* $k\_{0}^{', min}, T\_{TA,terrestrial}^{max}$ *and* $T\_{TA,NTN} $*are defined in TS 36.211, and [.] denotes a quantization to appropriate slot/subframe/RU units.*

***FL recommendation 4.1b:*** *Support the following for “minimum processing time” to process a downlink reception, before transmitting an associated uplink that may be triggered by the downlink reception for NPDCCH/PDCCH triggering NPUSCH/PUSH for NB-IoT/eMTC:*

*For NB-IoT over NTN, for a NPDCCH triggering a NPUSCH, the following condition must be satisfied, for the UE to be required to transmit the NPUSCH:*

$\left(k\_{0}-1+K\_{offset}-[T\_{TA,NTN}]\right)\geq T\_{proc,terrestrial}^{min} \left\{ =k\_{0}^{min}-1-[T\_{TA,terrestrial}^{max}]\right\}$*,*

*where* $k\_{0}^{min}, T\_{TA,terrestrial}^{max}$ *and* $T\_{TA,NTN} $*are defined in the specifications, and [.] denotes a quantization to appropriate slot/subframe/RU units.*

***FL recommendation 4.1c:*** *Support the following for “minimum processing time” to process a downlink reception, before transmitting an associated uplink that may be triggered by the downlink reception for NPDCCH/PDCCH triggering NPDCCH/PDCCH-ordered NPRACH/PRACH for NB-IoT/eMTC:*

*For NB-IoT over NTN, for a NPDCCH triggering a “PDCCH order” based NPRACH, the following condition must be satisfied, for the UE to be required to transmit the NPRACH:*

$\left(k\_{2}-1+K\_{offset}-[T\_{TA,NTN}]\right)\geq T\_{proc,terrestrial}^{min} \left\{ =k\_{2}^{min}-1-[T\_{TA,terrestrial}^{max}]\right\}$*,*

*where* $k\_{2}^{min}, T\_{TA,terrestrial}^{max}$ *and* $T\_{TA,NTN} $*are defined in the specifications, and [.] denotes a quantization to appropriate slot/subframe/RU units.*

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| Companies | Comments |
| Lenovo | I am wondering if the proposals are agreed, which spec do you expect to capture the agreement. How to define the following parameters? How to inform to UE if needed?$T\_{TA,terrestrial}^{max}$ *and* $T\_{TA,NTN} $*are defined in the specifications*Consider the eMTC/NBIoT is not delay sensitive system, it can be implemented by eNB.(e.g., configure proper Koffset). |
| Ericsson | Agree with FL recommendation that UE’s processing time be respected. However, it is not clear if a spec change is necessary. Why would the network configure a smaller-than-required Koffset? |
| ZTE | We fully agree with Ericsson. The Koffset was introduced to handle the impact of large TA. The value of Koffset can be properly determined by eNB and no need to specify the restriction. |
| Noika, NSB | We have similar view as Ericsson and ZTE. ENB can select proper Koffset to remove the impact of large TA, thus it is network implemetnaion and no need to update specification for this issue. |
| SONY | Agree with other companies that the network can configure an appropriate Koffset. The eNB should respect the UE’s processing times.[In 4.1b, it would be nice if we could replace “PUSH” with “PUSCH”] |
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# Conclusions

TBA

# References

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3. R1-22089242, Draft CR on correction of IoT NTN with dropping in pre-compensation per segment in 36.213, Nokia, Nokia Shanghai Bell, RAN1#110-bis-e, October 2022
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7. R1-2209650, On SIB accumulation and Timing relationship enhancements in IoT NTN, Ericsson, RAN1#110-bis-e, October 2022
8. R1-2210020, Maintenance for IoT NTN, Lenovo, RAN1#110-bis-e, October 2022

# Appendix

In the Table below, company proposals for time and frequency synchronization are listed

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| Contribution | Observation/Proposals |
| Nokia (R1-2209244) | Observation 1: Implicit indication of the Epoch time of assistance information in NTN SIB does not work, because the assistance information may not necessarily be updated every SI window.Observation 2: eMTC UE may only apply sample dropping/insertion for segmented transmission of PRACH.Observation 3: The transmission for segmented uplink transmission is only needed when the timing advance of the next segment is longer than the previous segment.Observation 4: If the transmission gap is applied, when the timing advance of the next segment is shorter than the previous, the decoding performance will decrease.Proposal 1: Only explicit signaling of Epoch time for assistance information shall be specified for IoT NTN.Proposal 2: RAN1 send LS to RAN2 to update SIB31 description in RRC specification to make the epochTime a mandatory field.Proposal 3: RAN1 should add RRC signaling to configure segment size for UL precompensation in 36.213.Proposal 4: RAN1 to discuss NB-IoT UE segmented transmission of NPRACH, where network is not aware of the UE capability for dropping during segmented transmission.Proposal 5: RAN1 to clarify that segmented uplink transmission gap is only applied when the timing advance of the next segment is longer than the timing advance of the previous, transmitted segment. |
| Ericsson (R1-2209650) | Observation 1 : In eMTC/NB-IoT NTN, there are numerous configurations of the SI window periodicity and the validity timer duration for which the NTN SIB may remain unchanged over many SI windows and can therefore be accumulated.Observation 2: NTN SIB may need to be updated much more frequently for LEO than for GEO.Observation 3: Without NTN SIB accumulation across SI windows, the network may need to configure longer SI windows to support a larger number of repetitions, resulting in a high signalling overhead.Observation 4: For explicit epoch time indication, without introducing additional signalling, the epoch time indication range essentially limits the NTN SIB accumulation to shorter SI periodicities of up to 128 frames.Observation 5: Depending on the SI periodicity, the UE may determine whether to accumulate the NTN SIB.Observation 6 : For explicit epoch time indication, introducing additional signalling can help extend the SIB accumulation to even larger SI periodicities and/or optimize the UE behavior regarding SIB accumulation.Proposal 1 : Network to optionally indicate if NTN SIB accumulation across SI windows is allowed or not.Proposal 2 : For eMTC NTN with explicit epoch time indication, without introducing additional signalling, support NTN SIB accumulation at least for the following SI periodicities: {8, 16, 32, 64,128} frames.Proposal 3: For NB-IoT NTN with explicit epoch time indication, without introducing additional signalling, support NTN SIB accumulation at least for the following SI periodicities: {64,128} frames.Proposal 4: For IoT NTN, adopt the same definition for validity of assistance information as for NR NTN. |
| Lenovo (R1-2210020) | ***Proposal 1:*** *Adopt TP#1 to TS36.213 to clarify the UE dropping rule for NPRACH segmented transmission when transmission collision.****Observation 1:*** *No CR is needed for specifying the UE dropping rule for all uplink segmented transmission for eMTC.* |
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