**3GPP TSG RAN WG1 Meeting #116bis R1-2403421**

**Changsha, Hunan Province, China, April 15th – 19th, 2024**

**Agenda Item: 8.4**

**Source: Moderator (MediaTek)**

**Title: Feature lead summary #1** **Maintenance of Rel-18 IoT NTN**

**Document for: Discussion**

# 0 Introduction

## 0.1 Background

In RAN#98e, the revised WID on IoT NTN enhancements has been endorsed for Release 18 [1].

The work item aims to specify further enhancements for E-UTRA (LTE-RAN) based NTN (non-terrestrial networks) according to the following assumptions:

- GEO and NGSO (LEO and MEO).

- Earth fixed Tracking area. Earth fixed & Earth moving cells for NGSO

- FDD mode

- UEs with GNSS capabilities

The detailed objectives are to specify enhanced NB-IoT NTN and eMTC NTN radio interfaces and E-UTRAN/NG-RAN as follows:

4.1.1 IoT-NTN Performance Enhancements in Rel-18 to address remaining issues from Rel-17

This work considers Rel-17 IoT-NTN as baseline as well as Rel-17 NR-NTN outcome and the further IoT-NTN performance enhancements objectives are listed below:

- Disabling of HARQ feedback to mitigate impact of HARQ stalling on UE data rates [RAN1,RAN2]

- Study and specify needed improved GNSS operations for a new position fix for UE pre-compensation during long connection times and for reduced power consumption. Simultaneous GNSS and NTN NB-IoT/eMTC operation is not assumed. [RAN1, RAN2]

* *NOTE: The need for RAN4 Core requirements for this objective will be identified after the conclusion on the need for improvements.*

In this meeting, company views on remaining issues of improved GNSS operations for IoT NTN are summarized and proposals on identified issues are made.

## 0.2 Contact Information

Please help to fill in the contact information for the FL summary. (If any change, please revise.)

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# [ACTIVE-GNSS] Issue #1: GNSS measurement gap/timer

**Agreement (RAN1 111)**

For GNSS measurement in RRC connected, if eNB aperiodically triggers connected UE to make GNSS measurement, UE can re-acquire GNSS position fix with a gap

* FFS details of gap configuration

The UE may re-acquire GNSS autonomously (when configured by the network) if UE does not receive eNB trigger to make GNSS measurement

* FFS based on configured timing

**Agreement (RAN1 112)**

On the length of GNSS measurement gap, which is aperiodically triggered by eNB, the gap duration should be equal to or larger than the latest UE reported GNSS position fix time duration.

FFS: whether the gap duration is configured by eNB, or the gap duration is equal to the latest reported GNSS position fix time duration.

**Agreement (RAN1 112)**

On when the GNSS measurement gap starts, which is aperiodically triggered by eNB with MAC CE, RAN1 can down select one of the following alternatives:

* Alt 1: the start time should be at n+ X, where n is the end of MAC CE receiving subframe/slot
* FFS: details of X, e.g. predefined value or configured value
* Alt 2: the start time should be based on the current GNSS validity duration with delay or without delay

**Agreement (RAN1 112bis)**

For the GNSS measurement gap aperiodically triggered with MAC CE, the duration for the GNSS measurement gap can be configured by eNB.

* The gap duration is equal to the latest reported GNSS position fix time duration for measurement when the duration for GNSS measurement gap is not included in the configuration by eNB.

**Agreement (RAN1 112bis)**

On when the aperiodic GNSS measurement gap starts, which is aperiodically triggered by eNB with MAC CE, the start time should be at n+ X, where n is the end of MAC CE receiving subframe/slot

* FFS: details of X, e.g. predefined value or configured value, considering HARQ feedback for the MAC CE, etc

**Agreement (RAN1 113)**

The UE is not required to transmit or receive any channel / signal within the aperiodic GNSS measurement gap duration before the UE reacquires GNSS successfully.

FFS: UE’s behavior within the duration after UE reacquires GNSS successfully to the end of the gap if the UE reacquires GNSS successfully before the end of the gap.

**Agreement (RAN1 113)**

For the aperiodic GNSS measurement gap triggered by eNB with MAC CE, down select one of the alternatives for the start time of the gap:

* Alt 1: should be at n+ X, where n is the end of MAC CE receiving subframe/slot and X>= 12ms for NB-IoT, X>= 3ms for eMTC
* Note: X is one value regardless of HARQ feedback enabled or disabled for the MAC CE
* FFS: details, e.g. X is predefined value or configured value
* Alt 2: should be at n+ X1, where n is the end of MAC CE receiving subframe/slot when HARQ feedback for the MAC CE is disabled and X1>= 12ms for NB-IoT, X1>= 3ms for eMTC, or should be at p+ X2, where p is the end of HARQ feedback transmission subframe/slot when HARQ feedback for the MAC CE is enabled
* FFS: details, e.g. X1 and X2 are predefined value or configured value, including whether X1 and X2 can be the same
* Alt3: should be at p+ X, where p is the end of HARQ feedback transmission subframe/slot, where HARQ feedback for the MAC CE is always enabled
* FFS: details, e.g. X is predefined value or configured value

**Agreement (RAN1 114)**

For the aperiodic GNSS measurement gap triggered by eNB with MAC CE, the start time of the gap should be at

* n+ X1, where n is the end of MAC CE receiving subframe/slot when HARQ feedback for the MAC CE is disabled and X1>= 12ms for NB-IoT, X1>= 3ms for eMTC,
* or should be at p+ X2, where p is the end of HARQ feedback transmission subframe/slot when HARQ feedback for the MAC CE is enabled
	+ X1 is predefined values, where X1=12ms for NB-IoT, and FFS X1 for eMTC
	+ FFS: X2 is predefined value or configured value.

**Agreement (RAN1 114)**

Network can configure the length for GNSS measurement gap via a 4-bit field with component values [1,2,3,4,5,6,7,13,19,25,31] second.

* FFS: other component values
* Note: RAN2 can further discuss whether separate configurations are needed for GNSS measurement gap and GNSS measurement timer, and whether the configuration is by RRC or MAC CE

**Agreement (RAN1 114)**

For the aperiodic GNSS measurement gap triggered by eNB with MAC CE, the start time of the gap should be at n+ X1, where n is the end of MAC CE receiving subframe/slot when HARQ feedback for the MAC CE is disabled.

* X1=12ms for NB-IoT
* X1=6ms for eMTC

**Agreement (RAN1 114)**

The UE is not required to monitor N/MPDCCH within the aperiodic GNSS measurement gap, except after a CBRA (PRACH) is sent.

* CBRA (PRACH) can be sent at least to request UL resource to report the remaining GNSS validity duration.

Note1: The CBRA (PRACH) can only be sent within the duration after UE reacquires GNSS successfully to the end of the gap.

Note2: Whether CBRA (PRACH) is sent is up to UE implementation.

Note3: no change to existing CBRA procedures

FFS: whether other RA procedure is needed.

**Agreement (RAN1 114bis)**

For the aperiodic GNSS measurement gap triggered by eNB with MAC CE, the start time of the gap should be at p+ X2, where p is the end of HARQ feedback transmission subframe/slot when HARQ feedback for the MAC CE is enabled and X2 is a predefined value, down select

* Alt- A: X2 = 1ms
* Alt- B: X2 = 2ms
* Alt- C: X2 = 3ms
* Alt- E: X2 = 1ms for NB-IoT, X2 = 4ms for eMTC

**Agreement (RAN1 114bis)**

For the aperiodic GNSS measurement gap triggered by eNB with MAC CE, the start time of the gap should be at p+ X2, where p is the end of HARQ feedback transmission subframe/slot when HARQ feedback for the MAC CE is enabled and X2 is predefined value, where X2 = 2ms.

**Agreement (RAN1 111)**

For GNSS measurement in RRC connected, if eNB aperiodically triggers connected UE to make GNSS measurement, UE can re-acquire GNSS position fix with a gap

* FFS details of gap configuration

The UE may re-acquire GNSS autonomously (when configured by the network) if UE does not receive eNB trigger to make GNSS measurement

* FFS based on configured timing

**Agreement (RAN1 113)**

For NB-IoT and eMTC, at least for the case where the network configuration does not include a periodicity (if supported), for autonomous GNSS re-acquisition, the UE may re-acquire GNSS autonomously during GNSS measurement timer, the start time of the autonomous GNSS measurement timer is based on the original GNSS validity duration.

* FFS: additional delay and details of delay (if any), e.g. delay can be zero or can be equal to/larger than the duration X where UL transmission can be allowed after original GNSS validity duration expires without GNSS re-acquisition.
* Note1: Autonomous GNSS re-acquisition mechanism is enabled or disabled by network.
* Note2: The length of GNSS measurement timer can be configured by network and the length of GNSS measurement timer is equal to the latest reported GNSS position fix time duration for measurement when the length of GNSS measurement timer is not configured
* Note3: The autonomous GNSS re-acquisition can be periodic in certain conditions without further spec impact

**Agreement (RAN1 114)**

For autonomous GNSS timer, the start time of the autonomous GNSS measurement timer is where the original GNSS validity duration expires, and the duration X (if any) expires.

Note (as already agreed): The duration X is where UL transmission can be allowed after original GNSS validity duration expires without GNSS re-acquisition.

**Agreement (RAN1 114)**

Network can configure the length for GNSS measurement timer via a 4-bit field with component values [1,2,3,4,5,6,7,13,19,25,31] second.

* FFS: other component values
* Note: RAN2 can further discuss whether separate configurations are needed for GNSS measurement gap and GNSS measurement timer

**Conclusion (RAN1 116)**

UE may re-acquire GNSS (when configured by the network) in the GNSS measurement timer, if eNB does not trigger UE to make GNSS measurement within duration T, where T is latest reported remaining GNSS validity duration plus UL transmission extension duration X (if any).

## Company contributing views

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| Contribution | Observation/Proposals |
| Nokia, NSB | Observation 1: Based on the Random Access procedure accounting for NTN propagation delay it is clear when the UE shall monitor the PDCCH for a response to the PRACH.Proposal 1: The GNSS measurement gap / autonomous GNSS measurement timer ends when the UE starts the Random Access Response Window for a CBRA procedure if the RAR window started before the end of the original gap/timer.Observation 6: If Rel18 IoT NTN UE does not support aperiodic triggerred GNSS measurement, when the eNB detects there is contiguous time error even with TAC, the eNB has to release the UE to IDLE mode, which is not in line with the scope of long connections of IoT NTN UE in Rel18.Proposal 4: If UE supports to re-acquire GNSS, the UE should monitor for the eNB’s GNSS measurement trigger during the original GNSS validity duration + duration X (if any) when configured by eNB.The UE may re-acquire GNSS autonomously (when configured by the network) in the GNSS measurement timer, if* the original GNSS validity duration expires,
* the duration X (if any) expires, and
* UE has not received any GNSS measurement trigger during the original GNSS validity duration + duration X (if any).
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RAN1 has agreed on the procedures of the GNSS measurement gap/timer and the UE behavior during the GNSS measurement gap. In this meeting, contributing companies further discuss on Relationship of GNSS measurement gap and timer and related issues.

* Nokia, NSB mentioned based on the Random Access procedure accounting for NTN propagation delay it is clear when the UE shall monitor the PDCCH for a response to the PRACH and proposed the GNSS measurement gap / autonomous GNSS measurement timer ends after the UE starts the Random Access Response Window for a CBRA procedure if the RAR window started before the end of the original gap/timer.
* Nokia, NSB observed that if Rel18 IoT NTN UE does not support aperiodic triggered GNSS measurement, when the eNB detects there is contiguous time error even with TAC, the eNB has to release the UE to IDLE mode, which is not in line with the scope of long connections of IoT NTN UE in Rel18 and proposed that If UE supports to re-acquire GNSS, the UE should monitor for the eNB’s GNSS measurement trigger during the original GNSS validity duration + duration X (if any) when configured by eNB, the UE may re-acquire GNSS autonomously (when configured by the network) in the GNSS measurement timer, if the original GNSS validity duration expires and UE has not received any GNSS measurement trigger during the original GNSS validity duration, or if the duration X (if any) expires and UE has not received any GNSS measurement trigger during the original GNSS validity duration + duration X (if any).

Moderator View: For the AS related operations within the gap, to the moderator understanding, RAN2 has agreed RACH related procedure with GNSS measurement gap in RAN2 123bis “*The following update in NOTE in Stage 2 running CR is agreed: NOTE: The AS operations (e.g. RLM related timers, dataInactivityTimer, CHO execution, neighbour cell measurement,* ***RACH****, SR, and BSR) are suspended when UE is performing GNSS measurement during GNSS measurement gap and resumed when the GNSS measurement is finished*”.

Based on above agreement, it is clear that the network can expect the UE to start monitoring the PDCCH and perform AS operations after starting the CBRA procedure if the GNSS measurement gap/timer has not ended. On the relationship of timer and gap, RAN2 #124 agreed CR R2-2313783 (TS 36.306) that two different UE capabilities NOT one capability are reported for GNSS measurement gap and autonomous GNSS measurement respectively, *ntn-Triggered-GNSS-Fix-r18* and *ntn-Autonomous-GNSS-Fix-r18*, which can be seen as aperiodic measurement gap and autonomous measurements can be dependent.

## First Round Discussion

***Initial Conclusion 1:***

***From RAN1 perspective, separate UE capabilities are reported for GNSS measurement gap and autonomous GNSS measurement.***

Companies are encouraged to provide comments within the following table:

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| Companies | Comments |
| QC | We agree, but this is a UE feature discussion. |
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# [ACTIVE GNSS] Issue #2: $N\_{TA} $ calculation after GNSS measurement in RRC connected state

## 2.1 Company contributing views

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| Contribution | Observation/Proposals |
| Nokia, NSB | Observation 2: The value of N\_TA is not clear after a UE has completed the GNSS measurement successfully.Observation 3: Performing the Random Access procedure after every GNSS measurement has high signalling overhead and latency.Observation 4: Reusing the N\_TA, based on the previous GNSS position, can enable the UE to skip the Random Access procedure.Observation 5: For cases with different distance between old and new UE GNSS position, the reasonability of the accumulated TA is different and also UL sync status is different, requiring different UE behavior.Proposal 2: After a successful GNSS measurement /autonomous GNSS measurement, if the difference between the new and old UE positions is small, UE can be allowed to reuse the previous N\_TA and skip the random access procedure, otherwise UE should firstly perform the Random Access procedure for UL synchonization. |
| Ericsson | Observation 1:The network will typically use NTA to compensate for errors due to estimation of UE and satellite’s position/common TA: a) UE position error due to movement between GNSS updates, and b) Satellite position error due to estimating the serving satellite’s position and common TA using stale ephemeris/common TA parameters. Observation 2: Reusing the old $N\_{TA}$ value after GNSS reacquisition is not optimal as the UE will update the old $N\_{TA,adj}^{UE}$ according to its new position estimate. Observation 3: Resetting $N\_{TA}=0$ after GNSS reacquisition is not optimal as it incorrectly assumes that the previous $N\_{TA}$ value configured by the network was meant to account for only the UE position error.Observation 4: After a successful GNSS reacquisition, neither resetting $N\_{TA}=0$ nor reusing the old $N\_{TA}$ will result in the correct TA value for uplink transmission.Observation 5: The UE can calculate the timing error due to inaccurate UE position by comparing the values of $N\_{TA,adj}^{UE}$ based on its previous GNSS position and its new GNSS position after GNSS reacquisition, i.e., $T\_{error\\_UE\\_position}=N\_{TA,adj}^{UE}-N\_{TA,adj[OLD]}^{UE}$.Proposal 1: Select Alt-B: set $N\_{TA}=N\_{TA\\_old}-T\_{error\\_UE\\_position}$ *where* $T\_{error\\_UE\\_position}=N\_{TA,adj }^{UE}-N\_{TA,adj[OLD]}^{UE}$ is the timing error due to inaccurate UE position and can be calculated by comparing $N\_{TA,adj [OLD]}^{UE}$ based on the previous GNSS position and $N\_{TA,adj}^{UE}$ based on new GNSS position after GNSS reacquisition. |
| Nordic Semiconductor ASA | Proposal 1: After a new GNSS position fix is obtained in RRC Connected mode, conclude that UE considers its TA timer to have expired and may skip scheduled transmission until UE transmits (N)PRACH, if $N\_{TA}>0$.Proposal 2: As an alternative solution, the accumulated timing advance term is reset, i.e., to set $N\_{TA}=0,$ after a new GNSS position fix is obtained in RRC Connected mode and UE is expected to monitor DL control channel right after the measurement gap ends. |
| Huawei, HiSilicon |  |

In RAN1 #114, it has been agreed that In RRC connected, every time after successful GNSS measurement, UE reports the new remaining GNSS validity duration. In RAN1 #115, RAN1 discussed whether there is a need to reset $N\_{TA}=0$ after GNSS measurement for PUSCH transmission without consensus.

At RAN1#116 discussion, the following FL recommendation was made

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| ***FL recommendation:*** ***Companies in RAN1 are encouraged to discuss further enhancements for*** $N\_{TA} $***for the first UL transmission after successful GNSS measurement in RRC connected state in RAN1#116bis.**** ***Set*** $ N\_{TA}=0$
* ***Set*** $N\_{TA}=N\_{TA\\_old}-T\_{error\\_UE\\_position}$ ***where*** $T\_{error\\_UE\\_position}=N\_{TA,adj [OLD]}^{UE}-N\_{TA,adj}^{UE}$
* ***The UE may consider TAT has expired and shall perform RACH***
* ***The UE performs RACH with*** $N\_{TA}=0 $ ***if “old position - new position > thr", otherwise UE sets*** $N\_{TA}=N\_{TA\\_old}$
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* Nokia, NSB mentioned the value of NTA is not clear after a UE has completed the GNSS measurement successfully, performing the Random Access procedure after every GNSS measurement has high signalling overhead and latency and reusing the NTA, based on the previous GNSS position, can enable the UE to skip the Random Access procedure. Besides, Nokia mentioned for cases with different distance between old and new UE GNSS position, the reasonability of the accumulated TA is different and also UL sync status is different, requiring different UE behavior and proposed after a successful GNSS measurement /autonomous GNSS measurement, if the difference between the new and old UE positions is small, UE can be allowed to reuse the previous NTA and skip the random access procedure, otherwise UE should firstly perform the Random Access procedure for UL synchronization.
* Ericsson observed the network will typically use NTA to compensate for errors due to estimation of UE and satellite’s position/common TA: a) UE position error due to movement between GNSS updates, and b) Satellite position error due to estimating the serving satellite’s position and common TA using stale ephemeris/common TA parameters, Reusing the old $N\_{TA}$ value after GNSS reacquisition is not optimal as the UE will update the old $N\_{TA,adj}^{UE}$ according to its new position estimate, Resetting $N\_{TA}=0$ after GNSS reacquisition is not optimal as it incorrectly assumes that the previous $N\_{TA}$ value configured by the network was meant to account for only the UE position error, After a successful GNSS reacquisition, neither resetting $N\_{TA}=0$ nor reusing the old $N\_{TA}$ will result in the correct TA value for uplink transmission and The UE can calculate the timing error due to inaccurate UE position by comparing the values of $N\_{TA,adj}^{UE}$ based on its previous GNSS position and its new GNSS position after GNSS reacquisition, i.e., $T\_{error\\_UE\\_position}=N\_{TA,adj}^{UE}-N\_{TA,adj[OLD]}^{UE}$. Ericsson proposed to select Alt-B: set $N\_{TA}=N\_{TA\\_old}-T\_{error\\_UE\\_position}$ *where* $T\_{error\\_UE\\_position}=N\_{TA,adj }^{UE}-N\_{TA,adj[OLD]}^{UE}$ is the timing error due to inaccurate UE position and can be calculated by comparing $N\_{TA,adj [OLD]}^{UE}$ based on the previous GNSS position and $N\_{TA,adj}^{UE}$ based on new GNSS position after GNSS reacquisition. To the moderator understanding, in R2-2313780, it has been specified that “start or restart timer T318, if timer T317 expires during GNSS measurement, or if timer T317 expires before GNSS measurement and timer T318 is stopped upon GNSS measurement;” where SIB31 may be updated before the first UL transmission after GNSS measurement in RRC connected state.
* Nordic mentioned after a new GNSS position fix is obtained in RRC Connected mode, conclude that UE considers its TA timer to have expired and may skip scheduled transmission until UE transmits (N)PRACH, if $N\_{TA}>0$ and as an alternative solution, the accumulated timing advance term is reset, i.e., to set $N\_{TA}=0,$ after a new GNSS position fix is obtained in RRC Connected mode and UE is expected to monitor DL control channel right after the measurement gap ends.

Moderator View: For resets $N\_{TA}=0$ after GNSS measurement, in the moderator understanding, the mobility of satellite is more obvious than UE, since there is no need to resets $N\_{TA}=0$ for SIB31 updates, UE should not reset $N\_{TA}=0$ for GNSS measurement.

## 2.2 First Round Discussion

***Initial* Proposal *2:***

***Down select alternatives for*** $N\_{TA} $ ***calculation-related enhancements after GNSS measurement in RRC connected state in Rel-18 IoT NTN.***

* ***Alt A: Set*** $ N\_{TA}=0$
* ***Alt B: Set*** $N\_{TA}=N\_{TA\\_old}-T\_{error\\_UE\\_position}$ ***where*** $T\_{error\\_UE\\_position}=N\_{TA,adj [OLD]}^{UE}-N\_{TA,adj}^{UE}$
* ***Alt C: The UE may consider TAT has expired and shall perform RACH***
* ***Alt D: The UE performs RACH with*** $N\_{TA}=0 $ ***if “old position - new position > thr", otherwise UE sets*** $N\_{TA}=N\_{TA\\_old}$
* ***Alt E: No further enhancements***

Companies are encouraged to provide comments on alternatives within the following table, and also indicate first choice and second choice:

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| --- | --- | --- | --- | --- | --- | --- |
| Companies | Alt A | Alt B | Alt C | Alt D | Alt E | Comments |
| QC |  |  |  |  |  | This was discussed in the previous meeting without conclusion. We would be OK with any alternative except for alt D. |
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# 3 [ACTIVE GNSS] Issue #3: TPs

Several TPs are proposed by contributing companies.

## 3.1 [Active] TPs for monitoring PDCCH after NB-IoT UE reacquires a new GNSS position successfully within the GNSS measurement gap

#### 3.1.1 Motivation

In R1-2402993, Nokia, NSB observed after NB-IoT UE reacquired new GNSS position within the GNSS measurement gap, if the distance between the new GNSS position and the old GNSS position is small enough, there is no need for a new CBRA before monitoring PDCCH for new UL or DL related scheduling, where current NTA value before GNSS measurement gap is used.

Moderator View: In RAN1 #114, RAN1 made agreement to make UE and network have same understanding on when the DCI can be transmitted: “The UE is not required to monitor N/MPDCCH within the aperiodic GNSS measurement gap, except after a CBRA (PRACH) is sent.” If UE starts to monitor N/MPDCCH before sending CBRA, then the network may consider the UE has not finished GNSS measurement, it is not beneficial to the system efficiency. RAN1 can align understanding on whether the TPs are necessary.

#### 3.1.2 Proposed draft TPs

**Reason for change:**

After NB-IoT UE reacquired new GNSS position within the GNSS measurement gap, if the distance between the new GNSS position and the old GNSS position is small enough, there is no need for a new CBRA before monitoring PDCCH for new UL or DL related scheduling, where current NTA value before GNSS measurement gap is used.

**Summary of change:**

Separate conditions for NB-IoT UE to perform synchronization and monitoring PDCCH after NB-IoT UE reacquires a new GNSS position successfully within the GNSS measurement gap.

**Consequence if not approved:**

CBRA always needed even NB-IoT UE has not moved with large distance, and latency for CBRA always needed so that IoT operation is delayed by unnecessary CBRA and power is wasted.

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| **======================== <** **TP#1 for 36.213 Clause 16.10>==============================**16.10 GNSS measurement gap related procedures**<Unchanged parts are omitted>**For a NB-IoT UE in a NTN FDD serving cell, the UE is not required to monitor NPDCCH within the GNSS measurement gap duration, until * it reacquires GNSS position if the distance between the old GNSS position and new GNSS position is not larger than position changing threshold, where current *NTA* value before GNSS measurement gap is used and no need for contention based Random Access, or
* it reacquires GNSS position and RAR window starts in a contention based Random Access, which is performed as specified in TS 36.321 [8], where *NTA* is reset as 0, if the distance between the old GNSS position and new GNSS position is larger than position changing threshold.

**<Unchanged parts are omitted>****========================= <** **TP#1 for 36.213 Clause 16.10>=============================****======================== <** **TP#2 for 36.213 Clause 18>==============================**18 GNSS measurement gap related procedures for BL/CE UE**<Unchanged parts are omitted>**For a BL/CE UE in a NTN FDD serving cell, the UE is not required to monitor MPDCCH within the GNSS measurement gap duration, until * it reacquires GNSS position if the distance between the old GNSS position and new GNSS position is not larger than position changing threshold, where current *NTA* value before GNSS measurement gap is used and no need for contention based Random Access, or
* it reacquires GNSS position and RAR window starts in a contention based Random Access, which is performed as specified in TS 36.321 [8], where *NTA* is reset as 0, if the distance between the old GNSS position and new GNSS position is larger than position changing threshold.

**<Unchanged parts are omitted>****========================= <** **TP#2 for 36.213 Clause 18>=============================** |

#### 3.1.3 First Round Discussion

***Initial Proposal 3.1:***

***Companies are encouraged to comment on whether TPs in section 3.1.2 of R1-240XXXX are needed.***

Companies are encouraged to provide comments within the following table:

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| Companies | Yes/No | Comments |
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## 3.2 [Active] TP for setting $N\_{TA}=0$ after successful GNSS measurement in RRC Connected mode

#### 3.2.1 Motivation

In R1-2403282, Nordic proposed a TP mentioned that after the UE obtains a new GNSS position fix in RRC Connected, it is important to reset the accumulated timing advance term, i.e., to set $N\_{TA}=0,$ since the UE position is accurate again after GNSS reacquisition.

Moderator View: The TPs are associated with Issue 3, RAN1 can first discuss on whether the TPs are needed.

#### 3.2.2 Proposed draft TP

**Reason for change:**

After the UE obtains a new GNSS position fix in RRC Connected, it is important to reset the accumulated timing advance term, i.e., to set $N\_{TA}=0,$ since the UE position is accurate again after GNSS reacquisition

**Summary of change:**

Reset the accumulated timing advance term, i.e., to set $N\_{TA}=0,$ after GNSS reacquisition**.**

**Consequence if not approved:**

The UE may receive DL allocation or UL grant before it initiates CBRA to provide new GNSS validity duration. PUCCH or NPUSCH format 2 (for HARQ-ACK transmission) or (N)PUSCH transmitted with incorrect TA would cause interference in eNB reception.

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| **================================= </TP1> ======================================****============================== <TP1 36.213> ==================================**4.2.3 Transmission timing adjustments**<Unchanged parts are omitted>**For a BL/CE UE in a NTN serving cell, using serving satellite higher-layer ephemeris parameters, if configured, the BL/CE UE determines $N\_{TA,adj}^{UE}$ (defined in [3]) using the serving satellite position and its own position to pre-compensate the two-way transmission delay on the service link. To pre-compensate the two-way transmission delay between the uplink time synchronization reference point and the serving satellite, the BL/CE UE determines $N\_{TA,adj}^{common} $(defined in [3]) based on one-way propagation delay $Delay\_{common}\left(t\right)$ which can be obtained as:$$Delay\_{common}\left(t\right)=\frac{1}{2}\left[N\_{TA}^{common}+N\_{TA}^{commonDrift}×\left(t-t\_{epoch}\right)+N\_{TA}^{commonDriftVariation}×\left(t-t\_{epoch}\right)^{2} \right]$$where $N\_{TA}^{common}$, $N\_{TA}^{commonDrift}$, and $N\_{TA}^{commonDriftVariation}$ are given by the higher layer parameters *nta-Common*, *nta-CommonDrift*, and *nta-CommonDriftVariation* respectively, and $t\_{epoch}$ is the epoch time given by the higher layer parameter *epochTime*. $Delay\_{common}(t)$ provides a distance at time $t$ between the serving satellite and the uplink time synchronization reference point divided by the speed of light. The uplink time synchronization reference point is the point where DL and UL are frame aligned with an offset given by $N\_{TA,offset}$. After the BL/CE UE successfully reacquires GNSS, the UE sets *NTA* =0.**<Unchanged parts are omitted>**16.1.2 Timing synchronization**<Unchanged parts are omitted>**For a UE in a NTN serving cell, using serving satellite higher-layer ephemeris parameters, if configured, the UE determines $N\_{TA,adj}^{UE}$ (defined in [3]) using the serving satellite position and its own position to pre-compensate the two-way transmission delay on the service link. To pre-compensate the two-way transmission delay between the uplink time synchronization reference point and the serving satellite, the UE determines $N\_{TA,adj}^{common} $(defined in [3]) based on one-way propagation delay $Delay\_{common}\left(t\right)$ which can be obtained as:$$Delay\_{common}\left(t\right)=\frac{1}{2}\left[N\_{TA}^{common}+N\_{TA}^{commonDrift}×\left(t-t\_{epoch}\right)+N\_{TA}^{commonDriftVariation}×\left(t-t\_{epoch}\right)^{2} \right]$$where $N\_{TA}^{common}$, $N\_{TA}^{commonDrift}$, and $N\_{TA}^{commonDriftVariation}$ are given by the higher layer parameters *nta-Common*, *nta-CommonDrift*, and *nta-CommonDriftVariation* respectively, and $t\_{epoch}$ is the epoch time given by the higher layer parameter *epochTime*. $Delay\_{common}(t)$ provides a distance at time $t$ between the serving satellite and the uplink time synchronization reference point divided by the speed of light. The uplink time synchronization reference point is the point where DL and UL are frame aligned with an offset given by $N\_{TA,offset}$. After the UE successfully reacquires GNSS, the UE sets *NTA* =0.**================================= </TP1> ======================================** |

#### 3.2.3 First Round Discussion

***Initial Proposal 3.2:***

***Companies are encouraged to comment on whether TPs in section 4.2.2 of R1-240XXXX are needed.***

Companies are encouraged to provide comments within the following table:

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## 3.3 [Active] TP for procedures after successful GNSS measurement in RRC Connected mode

#### 3.2.1 Motivation

In R1-2403339, Huawei, HiSilicon proposed a TP mentioned that when UE applies UL transmission a long time after the last GNSS measurement, e.g. the UL transmission in the duration X after original GNSS validity duration expires, big portion of the accumulated TA adjustment $N\_{TA}$ is contributed to the inaccurate GNSS information assumed by UE. After GNSS measurement autonomously performed by UE or triggered by eNB, the TA error caused by inaccurate GNSS is corrected by new self-compensation of $N\_{TA,adj}^{UE}$ based on the fresh GNSS information. However, according to current specification in TS36.213, the accumulated TA adjustment which includes the TA compensation for the TA error caused by outdated GNSS information is not reset until a NPRACH is transmitted. The “double” TA correction may introduce even larger TA error for the UL data transmission after GNSS measurement, especially when the GNSS measurement is applied after the original GNSS validity duration expires. To solve this issue, for a successful GNSS measurement ends later than the original validate duration expires, the first UL transmission should be a NPRACH. If a GNSS information is updated before the original GNSS validity duration expires, the TA error due to position error is considered tolerable and the ongoing TA accumulation can continue as legacy behaviour, similar as NR NTN.

Moderator View: The TPs are associated with Issue 3, RAN1 can first discuss on whether the TPs are needed.

#### 3.2.2 Proposed draft TP

**Reason for change:**

After a successful GNSS measurement, TA error for the UL data transmission after GNSS measurement will be introduced, especially when the GNSS measurement is applied after the original GNSS validity duration expires.

**Summary of change:**

For a successful GNSS measurement ends later than the original validate duration expires, the first UL transmission should be a NPRACH.

**Consequence if not approved:**

Larger TA error will be introduced if the first UL transmission after a successful GNSS measurement is data transmission.

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| **================================= </TP1> ======================================****============================== <TP1 36.331> ==================================**5.5.9 GNSS measurement triggering and reportingFor BL UEs or UEs in CE or NB-IoT UEs that are connected to NTN, GNSS measurement can be triggered aperiodically by the GNSS Measurement Command MAC CE (see TS 36.321 [6]), or triggered by the UE autonomously if enabled by the network, or triggered by the UE using available idle periods.<Unchanged parts are omitted>1> upon starting GNSS measurement:2> stop timer T318, if running;1. upon indication that GNSS becomes valid:

2> if before GNSS validity duration expiry3> instruct lower layers to report the remaining GNSS measurement validity duration (see TS 36.321 [6]).2> else 3> initiate the random access procedure before reporting the remaining GNSS measurement validity duration (see TS 36.321 [6]).2> start or restart timer T318, if timer T317 expires during GNSS measurement, or if timer T317 expires before GNSS measurement and timer T318 is stopped upon GNSS measurement;1> upon indication that GNSS measurement has failed:2> if GNSS position is out-of-date; and2> if *ul-TransmissionExtensionEnabled* is not configured or T390 has expired:3> perform the actions upon leaving RRC\_CONNECTED as specified in 5.3.12, with release cause 'other'.<Unchanged parts are omitted>**================================= </TP1> ======================================** |

#### 3.2.3 First Round Discussion

***Initial Proposal 3.2:***

***Companies are encouraged to comment on whether TPs in section 4.2.2 of R1-240XXXX are needed.***

Companies are encouraged to provide comments within the following table:

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# [ACTIVE-HARQ] ISSUE 4 Capture NPDCCH monitoring behavior

Regarding the NPDCCH monitoring behavior for HARQ disabling, when single TB is scheduled by a single DCI for a UE with a HARQ process which is configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI, the UE does not wait for an RTT plus 3 ms for PDCCH monitoring.

However, as comments by [OPPO], how to perform PDCCH monitoring in this case is not clear. [OPPO] further propose that the new UE behaviour for PDCCH monitoring in this case should follow the same UE behaviour when a DL HARQ process is configured with disabled HARQ feedback, i.e., the UE is not required to monitor NPDCCH in a period of 12 ms from the end of reception of the NPDSCH, and the corresponding TP(CR) as follow:

TP 1-1a

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| **Reason for change:** | Clarify UE behaviour for PDCCH monitoring when single TB is scheduled by a single DCI for a UE with a HARQ process which is RRC configured with disabled and DCI override to enabled. |
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| **Summary of change:** | Add UE monitoring behaviour that UE is not required to monitor NPDCCH in a period of 12 ms from the end of reception of the NPDSCH when single TB is scheduled by a single DCI for a UE with a HARQ process which is configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI. |
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| **Consequences if not approved:** | The UE behaviour is missing when single TB is scheduled by a single DCI for a UE with a HARQ process which is RRC configured with disabled and DCI override to enabled. |

TS36.21316.6 Narrowband physical downlink control channel related procedures**<Unchanged parts are omitted>**If a NB-IoT UE receives a NPDSCH transmission ending in subframe *n,* and if the UE is not required to transmit a corresponding NPUSCH format 2 or if the NPUSCH transmission carries ACK/NACK response, as determined in clause 16.4.2, for the same HARQ process ID associated with a transport block scheduled in a NPDCCH scheduling a single transport block, and the UE is configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information for the same HARQ process ID and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB*, the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+1* to subframe *n+12*.**<Unchanged parts are omitted>** |

From the moderator’s understanding, for DCI based overridden mechanism, for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI, the NBIoT UE does not wait for an RTT+3ms before monitoring NPDCCH for the same HARQ process. That is to say, in the above case, UE will/may continue to monitor NPDCCH for the same HARQ process right after the uplink transmission (e.g. NPUSCH format 2 for HARQ-ACK), and UE doesn’t have the ‘Waiting GAP’ NPDCCH monitoring restriction 🡪 NPDCCH monitoring restriction after uplink transmission:

* ……, if the UE has a NPUSCH transmission ending in subframe *n,* UE **may** startto receive an NPDCCH with DCI format N0/N1 for the same HARQ process ID as the NPUSCH transmission **from subframe n+1 (till any subframe specified as “NO NPDCCH monitoring” in TS36.213)**.

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| Agreement (RAN1#114bis)Confirm the following working assumptions from RAN1#113:For single TB scheduled by DCI, * Working assumption 2 For Option 1 + Option 3 DCI based overridden mechanism, for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI, the NBIoT UE does not wait for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH for the same HARQ process (or monitoring any NPDCCH for the case of single HARQ process configuration).
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| TS36.213 v18.2.0 16.6else if the UE is not using higher layer parameter *edt-Parameters* or if the UE is using higher layer parameter *edt-Parameters* and  - if the NB-IoT UE has a NPUSCH transmission ending in subframe *n*, - the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3] for FDD; and - the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+1* to subframe *n+3* or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+*1* to subframe *n*+*K*mac+3 except if the UE is configured with higher layer parameter *uplinkHARQ-mode* set to ‘*HARQModeB*’, or if the NPUSCH transmission carries ACK/NACK response as determined in clause 16.4.2 and the UE is configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB*.  |

Regarding the NPDCCH monitoring restriction after the reception of NPDSCH (e.g., for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI), there may be 2 understanding as follows (take single HARQ process as an example),

**Understanding 1:** (legacy behavior, by FL) No NPDCCH monitoring between NPDSCH and NPUSCH

* [TS36.213 clause 16.6] […], the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+ k* to subframe *n+m-1.*
* The NPDCCH monitoring restriction motivation is to avoid the potential collision of uplink/downlink scheduling (see detail in R1-163658 and R1-1709718)

**Understanding 2:** (follow HARQ feedback disabling case, by OPPO) No NPDCCH monitoring only in 12ms window after NPDSCH.

* [Agreement for RAN1-110bis] For a DL HARQ process with disabled HARQ feedback in NB-IoT, UE is not required to monitor NPDCCH in a period of Y=12(ms) from the end of reception of the NPDSCH.
* [Agreement for RAN2-123bis] For a HARQ process configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI, UE behaviour on DRX follows the case when HARQ feedback is disabled.
* There is no obvious benefit to wait for the transmission of HARQ-ACK for NPDCCH monitoring since the HARQ-ACK for this case is used for link adaptation.
* The understanding can further solve the HARQ stalling issue and improve the throughput.
* The understanding may be more aligned with RAN2 agreement for **DRX** below**.**

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| TS36.213 v18.2.0 16.6If a NB-IoT UE detects NPDCCH with DCI Format N1 ending in subframe *n*, and if the corresponding NPDSCH transmission starts from *n+k,* and - for FDD, if the corresponding NPUSCH format 2 transmission starts from subframe *n+m* or in a NTN serving cell, from an uplink subframe which, after accounting for uplink transmission timing, overlaps with downlink subframe *n+m*, the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+ k* to subframe *n+m-1*. - for TDD, if the corresponding NPUSCH format 2 transmission ends in subframe *n+m* the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+ k* to subframe *n+m-1*. |

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| RAN2-123bis Chairman Note[R2-2309527](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2309527%20-%20Discussion%20on%20HARQ%20enhancement%20for%20IoT%20NTN.doc) Discussion on HARQ enhancement for IoT NTN OPPO discussion Rel-18 IoT\_NTN\_enh-Core< DRX for single TB scheduling >Proposal 1 For NB-IoT UEs configured with two HARQ processes and at least one of them is configured with HARQ feedback disabled, RAN2 does not change the operation on drx-InactivityTimer for single-TB scheduling case.* QC supports this. MTK agrees
* ZTE agrees with the principle
* Agreed

Proposal 2 For a HARQ process configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI, UE behaviour on DRX follows the case when HARQ feedback is disabled. * QC agrees that DCI enabling/disabling should not impact DRX and then supports the proposal. MTK also supports
* Agreed

 Agreement (RAN1#110bis-e)For a DL HARQ process with disabled HARQ feedback in NB-IoT, UE is not required to monitor NPDCCH in a period of Y=12(ms) from the end of reception of the NPDSCH. |



Figure 1 NPDCCH monitoring restriction.

Question 1: do you agree with any understanding above for the NPDCCH monitoring after the NPDSCH reception for the case (e.g., HARQ feedback disabled by RRC and reversed to enabled by DCI)

* If agree with Understanding 1, do you agree to conclude the understanding without any specification change.
	+ e.g., Conclusion 1-1： For single TB scheduled by DCI, for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI, the NBIoT UE doesn’t monitor NPDCCH for the same HARQ process from the start of the NPDSCH corresponding to the HARQ process till the start of the corresponding HARQ-ACK transmission(i.e., from subframe n+ k to subframe n+m-1 in TS36.213 clause 16.6) (or monitor any NPDCCH for the case of single HARQ process configuration) as legacy behavior.
* If agree with Understanding 2, do you agree the following proposal and corresponding TP/CR proposed by OPPO (e.g., TP 1-1a) above.
	+ e.g., Proposal 1-2： For single TB scheduled by DCI, for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI, the NBIoT UE doesn’t monitor NPDCCH for the same HARQ process only in the first 12ms window in the period between the end of NPDSCH corresponding to the HARQ process and the start of the corresponding HARQ-ACK transmission (or monitor any NPDCCH for the case of single HARQ process configuration).

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | About the Feature Leads understanding on “*UE will/may continue to monitor NPDCCH for the same HARQ process right after the uplink transmission (e.g. NPUSCH format 2 for HARQ-ACK)*”. It is not “right after” because not only the legacy rule in clause 16.6 applies, but also “Half-duplex FDD operation” in clause 4.1 of TS 36.211 and the “half-duplex guard subframe” in clause 10.2.2.3 of TS 36.211 apply.1st HARQ process has “HARQ feedback” disabled and the 2nd HARQ process has “HARQ feedback” enabled.

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| Subframe# | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 |
| NPDCCH | 0 |  | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NPDSCH |  |  |  |  |  | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| NPUSCH Format 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | No monitoring NPDCCH |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | No monitoring NPDCCH due to clause 16.6 in TS 36.213 |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note: The arrow pointing downwards “↓” refers to the earliest subframe from which the subsequent NPDCCH can be received.Having said that, legacy specification procedures apply, and we can probably conclude the following:Conclusion: “When single TB is scheduled by a single DCI for a UE with a HARQ process which is configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI, the UE does not wait for an RTT plus 3 ms for PDCCH monitoring,” it is RAN1 understanding that the subsequent NPDCCH monitoring follows legacy procedures:* “No-monitoring rule” when there is an NPUSCH Format 2 transmission in clause 16.6 of TS 36.213.
* “Half-duplex FDD” operation in clause 4.1 of TS 36.211
* “Half-duplex guard subframe” in clause 10.2.2.3 of TS 36.211.
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| Qualcomm | We do not think we need to conclude anything on this issue. For the case where the UE sends HARQ-ACK, the legacy monitoring restrictions of NPDCCH between NPDSCH and NPUSCH format 2. |

# 6 Proposals for online/offline discussions

# 7 Conclusion

# 6 References

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7. R1-2402312, Draft CR on HARQ enhancement for IoT NTN, OPPO