3GPP TSG RAN WG1 #117 R1-240xxxx

Fukuoka, Japan, 20 – 24 May, 2024

**Agenda item: 8.1**

**Source: Moderator (Nokia)**

**Title: Feature lead summary 1 on IoT-NTN discussions**

**WI code: IoT\_NTN\_enh**

**Release: Rel-18**

**Document for: Discussion and Decision**

# Introduction

For Rel18 IoT NTN, 3 remaining issues identified:

1, Clarification of end of GNSS measurement gap/timer is needed

2, Clarification of time adjustment after successful GNSS measurement

3, Dependency between aperiodic measurement gap and autonomous measurements

## Guidelines for the discussion.

The summary is split into three main parts;

* Discussion on drafted TPs for TS 36.213, for exact time of end of GNSS measurement gap/timer, which impact the common understanding between UE and eNB on UE starting to monitor PDCCH.
* Discussion on drafted TPs for TS 36.213, for UE behaviour on time adjustment after successful GNSS measurement
* Discussion on dependency between aperiodic measurement gap and autonomous measurements

As these topics are expected to be discussed on next online session (Wed, 22rd May) it is preferable that the comments are provided already before:

**1st round deadline: Tuesday 21st of May, 18:30 Local time.**

Companies are encouraged to reach out to moderator (Jingyuan.sun@nokia-sbell.com ) if they want to co-source the final CRs (either the full set or individual CRs).

# Discussion

## Topic 1: Draft TPs for TS 36.213 [open]

### Clarification on starting time of (N)PDCCH monitoring

The issue is related to unclear specification on starting time of (N)PDCCH monitoring when UE starts CBRA after GNSS measurement.

At RAN1#113 the following was agreed [1]:

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| **Agreement**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. |

At RAN#114 it was further agreed [2]:

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| AgreementThe 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 proceduresFFS: whether other RA procedure is needed. |

Currently TS 36.213 defines the UE is not required to monitor NPDCCH until the GNSS position is reacquired and a CBRA is performed (likewise for MPDCCH in section 18 of the same specification). While, the exact PDCCH monitoring time is still unclear, as “CBRA is performed” does not point to a specific time, e.g. the start of the RAR window or the time of msg4 reception. Similarly for eMTC.

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| 16.10 GNSS measurement gap related proceduresFor a NB-IoT UE in a NTN FDD serving cell, when the UE receives a GNSS Measurement Command MAC CE in a NPDSCH ending in DL subframe *n*,- if the UE shall not provide HARQ-ACK information for the HARQ process associated with the transport block in the NPDSCH carrying GNSS Measurement Command MAC CE,- the UE shall assume the start of the measurement gap in subframe *n*+13- otherwise,- the UE shall assume the start of the measurement gap in subframe *k*+2, where *k* is the first DL subframe after the end of the transmission of the NPUSCH carrying ACK/NACK response for the HARQ process associated with the transport block in the NPDSCH.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 and a contention based Random Access is performed as specified in TS 36.321 [8]. |

The Random Access procedure in TS 36.321 defines the Random Access Response window, which also accounts for NTN propagation delays. Thus based on the RAN1 agreement for CBRA it is clear when the UE shall monitor the PDCCH for a response to the PRACH as mentioned in [4].

Based on moderator’s view, it is clear that the UE will monitor the PDCCH during relevant parts of the Random Access procedure. However, it is not clear whether 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, i.e. “the UE is not required to transmit or receive” “within the aperiodic GNSS measurement gap duration before the UE reacquires GNSS successfully”.

Based on moderator’s view, the UE should be schedulable, i.e. monitor PDCCH, when the UE starts the Random Access Response window for the CBRA procedure if the RAR window started before the end of the GNSS measurement gap/timer. This will allow the communication to continue as soon as possible after the UE has acquired the new GNSS position fix within the measurement gap/timer. As common understanding between UE and eNB, it should be defined clearly in RAN1 spec on time for UE to start (N)PDCCH monitoring after successfully acquired GNSS, i.e. the GNSS measurement gap / autonomous GNSS measurement timer ends.

One way is that the GNSS measurement gap / autonomous GNSS measurement timer ends and UE begin to monitor (N)PDCCH 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.

The following TPs are proposed in [4]:

**TP#1 for 36.213 Clause 16.10**

***Reason for change:*** *after NB-IoT UE reacquired new GNSS position within the GNSS measurement gap, it is not clear on when NB-IoT UE need to start monitoring NPDCCH when contention based Random Access is performed*

***Summary of change:*** *after NB-IoT UE reacquired new GNSS position within the GNSS measurement gap, when contention based Random Access is performed, NB-IoT UE need to start NPDCCH monitoring for Random Access Response when Random Access Response window starts.*

***Consequences if not approved:*** *after NB-IoT UE reacquires GNSS position, UE and network do not know exact time UE starting the NPDCCH monitoring.*

------------------------------ Start of Text proposal -------------------------------

For a NB-IoT UE in a NTN FDD serving cell, when the UE receives a GNSS Measurement Command MAC CE in a NPDSCH ending in DL subframe *n*,

- if the UE shall not provide HARQ-ACK information for the HARQ process associated with the transport block in the NPDSCH carrying GNSS Measurement Command MAC CE,

- the UE shall assume the start of the measurement gap in subframe *n*+13

- otherwise,

- the UE shall assume the start of the measurement gap in subframe *k*+2, where *k* is the first DL subframe after the end of the transmission of the NPUSCH carrying ACK/NACK response for the HARQ process associated with the transport block in the NPDSCH.

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 and a contention based Random Access is performed when Random Access Response window starts as specified in TS 36.321 [8].

------------------------------ End of Text proposal -------------------------------

**TP#2 for 36.213 Clause 18**

***Reason for change:*** *after eMTC UE reacquired new GNSS position within the GNSS measurement gap, it is not clear on when eMTC UE need to start monitoring PDCCH when contention based Random Access is performed*

***Summary of change:*** *after eMTC UE reacquired new GNSS position within the GNSS measurement gap, when contention based Random Access is performed, eMTC UE need to start PDCCH monitoring for Random Access Response when Random Access Response window starts.*

***Consequences if not approved:*** *after eMTC UE reacquires GNSS position, UE and network do not know exact time UE starting the PDCCH monitoring.*

------------------------------ Start of Text proposal -------------------------------

For a BL/CE UE in a NTN FDD serving cell, when the UE receives a GNSS Measurement Command MAC CE in a PDSCH ending in DL subframe *n*,

- if the UE shall not provide HARQ-ACK information for the HARQ process associated with the transport block in the PDSCH carrying GNSS Measurement Command MAC CE,

- the UE shall assume the start of the measurement gap in subframe *n*+6

- otherwise,

- the UE shall assume the start of the measurement gap in subframe *k*+2, where *k* is the first DL subframe after the end of the HARQ-ACK transmission for the HARQ process associated with the transport block in the PDSCH.

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 and a contention based Random Access is performed when Random Access Response window starts as specified in TS 36.321 [8].

------------------------------ End of Text proposal -------------------------------

Companies are encouraged to provide their view with respect to whether the draft TP is technically correct and should be adopted.

**Initial proposed 1-1:**

**The draft TP#1 for TS 36.213 in is considered technically correct and should be adopted.**

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| **Companies** | **Support/Not Support** | **Comments and Views** |
| Nordic  | Not Support | It is clear when UE shall start monitoring during CBRA |
| Nokia, NSB | Support | To clarify to Nordic, it is not clear as 36.213 only mention “the UE is not required to monitor MPDCCH within the GNSS measurement gap duration” and not mention when during the CBRA UE begin to monitor PDCCH.There is no definition on when UE starts monitoring PDCCH within the GNSSS measurement gap but there is definition that UE should not do UL and DL during the GNSS measurement gap.Based on current spec, eNB will assume UE can not detect PDCCH during the GNS measurement gap and the PDCCH have to be delayed.Thus modification to RAN1 spec is needed, as the TPs. |
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**Initial proposed 1-2:**

**The draft TP#2 for TS 36.213 in is considered technically correct and should be adopted.**

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| **Companies** | **Support/Not Support** | **Comments and Views** |
| Nordic  | Not Support | It is clear when UE shall start monitoring during CBRA |
| Nokia, NSB | Support | To clarify to Nordic, it is not clear as 36.213 only mention “the UE is not required to monitor MPDCCH within the GNSS measurement gap duration” and not mention when during the CBRA UE begin to monitor PDCCH.There is no definition on when UE starts monitoring PDCCH within the GNSSS measurement gap but there is definition that UE should not do UL and DL during the GNSS measurement gap.Based on current spec, eNB will assume UE can not detect PDCCH during the GNS measurement gap and the PDCCH have to be delayed.Thus modification to RAN1 spec is needed, as the TPs. |
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### Clarification on Timing Advance after successful GNSS measurement

In RAN1, there were discussion on timing advance after successful GNSS measurement while with no final consensus.

The issue is summarized as following: After a successful GNSS measurement, UE will have a valid GNSS position and therefore it can determine the UE specific component of the TA (N\_TA,adj\_UE), which is based on the UE location and the satellite ephemeris. However, it is unclear whether the UE shall reset the N\_TA in the N\_TA+N\_TA,offset+N\_TA,adj\_common+N\_TA,adj\_UE definition in TS 36.211 to work along with the new N\_TA,adj\_UE based on new GNSS measurement.

The N\_TA is updated based on the UE receiving Timing Advance Commands (TACs) from the network and this could e.g. occur if

1. The UE position is incorrect due to the UE moving in between performing GNSS measurement
2. The UE position is inaccurate, e.g. due to the UE being indoor/shadowed
3. The UE is using satellite assistance information (ephemeris and common TA) which is inaccurate or outdated

Thus the TACs may address issues concerning the N\_TA,adj\_common and the N\_TA,adj\_UE, but it is not possible to identify which one.

Based on moderator’s view, anyway, UE behavior should be defined clearly on TA to be utilized, to provide UL synchronization and avoid UL interference that may cause performance degradation in IoT NTN system.

If the UE transmits on PUSCH resources after performing a GNSS measurement the N\_TA value may be incorrect and cause uplink interference, especially when with long repetition for IoT NTN UE. The network can respond with TACs, but the range of TAC is limited and it may therefore be difficult for the network to adjust for a large TA error and it would also incur large signaling overhead. This is the issue to be avoided.

Based on moderator’s view, as proposed in [4], one simple correct way is to require the UE always performs the Random Access procedure to obtain a new N\_TA i.e. the UE sets the N\_TA to 0. This is advantageous because the network can set a large TA correction in the Random Access Response message.

The following TPs are proposed in [4] for NB-IoT and eMTC separately.

**TP#3 for 36.213 Clause 16.10**

***Reason for change:*** *after NB-IoT UE reacquired new GNSS position within the GNSS measurement gap, it is not defined how to set NTA when performing CBRA.*

***Summary of change:*** *after NB-IoT UE reacquired new GNSS position within the GNSS measurement gap, UE set NTA to 0 when performing CBRA.*

***Consequences if not approved:*** *after NB-IoT UE reacquired new GNSS position within the GNSS measurement gap, wrong NTA will cause UL interference and request more TAC from eNB.*

------------------------------ Start of Text proposal -------------------------------

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 and a contention based Random Access with NTA =0 is performed as specified in TS 36.321 [8].

------------------------------ End of Text proposal -------------------------------

**TP#4 for 36.213 Clause 18**

***Reason for change:*** *after eMTC UE reacquired new GNSS position within the GNSS measurement gap, it is not defined how to set NTA when performing CBRA.*

***Summary of change:*** *after eMTC UE reacquired new GNSS position within the GNSS measurement gap, UE set NTA to 0 when performing CBRA.*

***Consequences if not approved:*** *after eMTC UE reacquired new GNSS position within the GNSS measurement gap, wrong NTA will cause UL interference and request more TAC from eNB.*

------------------------------ Start of Text proposal -------------------------------

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 and a contention based Random Access with NTA =0 is performed as specified in TS 36.321 [8].

------------------------------ End of Text proposal -------------------------------

Companies are encouraged to provide their view with respect to whether the draft TP is technically correct and should be adopted.

**Initial proposed 2-1:**

**The draft TP#3 for TS 36.213 in is considered technically correct and should be adopted.**

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| **Companies** | **Support/Not Support** | **Comments and Views** |
| Nordic | with modification | For a NB-IoT UE in a NTN FDD serving cell, the UE is not required to monitor NPDCCH from the start of ~~within~~ the GNSS measurement gap duration, until it reacquires GNSS position and a contention based Random Access ~~with N~~~~TA~~ ~~=0~~ is performed as specified in TS 36.321 [8].It is quite clear that UE performs PRACH with N\_TA=0. What is not clear currently is what happens when UE reacquire GNSS during gap, but sends NPRACH only after the gap. Above CR should fix that. |
| Nokia, NSB | support | Thanks Nordic for also agree UE should do CBRA with N\_TA set to 0. But it is still not clear defined in spec, that is why we could like to define it in spec.To clarify to Nordic, in 36.213, it is clear on “UE is not required to monitor MPDCCH within the GNSS measurement gap duration” that already means UE will not monitor PDCCH from the start of the gap. |
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**Initial proposed 2-2:**

**The draft TP#4 for TS 36.213 in is considered technically correct and should be adopted.**

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| **Companies** | **Support/Not Support** | **Comments and Views** |
| Nordic | with modification | same as for NB |
| Nokia, NSB | support | Thanks Nordic for also agree UE should do CBRA with N\_TA set to 0. But it is still not clear defined in spec, that is why we could like to define it in spec.To clarify to Nordic, in 36.213, it is clear on “UE is not required to monitor MPDCCH within the GNSS measurement gap duration” that already means UE will not monitor PDCCH from the start of the gap. |
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## Topic 2: Dependency between aperiodic measurement gap and autonomous measurements [open]

Rel18 IoT NTN is for long connection as Rel17 is only for short connectoin where UE will turn to IDLE mode when GNSS validity duraiton expire and UE will not re-acquire GNSS during the RRC CONNECTED mode.

To support long connection, Rel18 discussed GNSS measurement in RRC CONNECTED mode. The following agreement was reached in RAN1#111 [3] regarding GNSS position fix for IoT NTN:

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| AgreementFor 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
 |

One aspect which needs further clarification is the dependency between the aperiodically triggered GNSS measurement gap and the UE autonomous GNSS measurement, which has been discussed but with no consensus.

There are different understanding from companies on RAN1 #111 agreements although the periodic/triggered GNSS measurement is firstly discussed in RAN1, while later autonomous GNSS measurement as one addition method to try to reduce the signaling overhead from eNB on GNSS measurement triggering, and RAN1 agreed that only when eNB enabled this autonomous GNSS measurement, UE can do it.

Based on moderator’s view, if UE does not support aperiodic triggerred GNSS measurement and independently of whether the UE supports autonomous GNSS measurement or not, when the eNB detects there is contiguous time error even with TAC, the eNB has to release the UE to IDLE mode, which will break the long connection and is not in line with the work item scope of long connections of IoT NTN UE in Rel18. While if the UE only supports autonomous GNSS measurement it can not help when the eNB detects an UL sync issue before the GNSS validuration expires or before extension X expires. That is why the agreement uses “UE can” for aperiodically triggered GNSS measurement, which means UE should support aperiodic triggered GNSS measurement if UE supports Rel18 IoT NTN. While autonomous GNSS measurement is optional for a Rel18 IoT NTN UE as UE “may” do autonomous GNSS measurement.

Additionally, even eNB release UE because of UL unsync issue, as UE still consider GNSS as valid, then when UE reaccess into cell but not re-acquire GNSS as defined in 36.300 “The UE shall have valid GNSS position as well as the ephemeris and common TA before connecting to an NTN cell.”, then still it will cause UL interference and eNB has to release it again. In this case, UE can not perform any effective UL/DL communication while it will always cause UL interference and impact the whole system, by huge of overhead on useless random access and UL interference even can not stopped (because of long time repetitions). While in this case, it does not matter and the eNB can not let UE kept in RRC CONNECTED whether UE support autonomous GNSS measurement or not, resulting long connection broken and impact on entire system.

That is why the agreement uses “UE can” for aperiodically triggered GNSS measurement, which means UE should support aperiodic triggered GNSS measurement if UE supports Rel18 IoT NTN. While autonomous GNSS measurement is optional for a Rel18 IoT NTN UE as UE “may” do autonomous GNSS measurement.

Please companies provide comments/views on the proposed observations and proposed agreement.

**Initial observation 3-1: 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 will break long connection and is not in line with the work item scope of long connections of IoT NTN UE in Rel18.**

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| **Companies** | **Correct/Not correct** | **Comments and Views** |
| Nordic | Disagree | Above statement assumes that UE is not capable to assses/report own GNSS validity time. |
| Nokia, NSB | Correct | To clarify to Nordic, UE can report own GNSS validity duration but the GNSS may be turn to invalid due to UE movement before the GNSS validity duration expire. |
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**Proposed observation 3-2: If Rel18 IoT NTN UE does not support aperiodic triggerred GNSS measurement, even eNB release UE because of UL unsync issue, as UE still consider GNSS as valid, then when UE reaccess into cell but not re-acquire GNSS, which will cause long time UL interference because of UL unsync and much useless signaling overhead for random access that will always fail because of invalid GNSS.**

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| **Companies** | **Correct/Not correct** | **Comments and Views** |
| Nordic  | Disagree | Again this assumes that UE is not capable to assess own validity of GNSS. If this would be the case, R17 would not work, but there are already functional commercial deployments in the field. |
| Nokia, NSB | Correct | To clarify to Nordic, UE can report own GNSS validity duration but the GNSS may be turn to invalid due to UE movement before the GNSS validity duration expire.While in Rel17, eNB should release UE but no definition that UE should always do GNSS measurement before access into the cell. Additionally, For Rel17, it is just for short connection then the issue will be less impact. But for long connection in Rel18, it will cause big issue. |
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**Proposed agreement 3-1:** ***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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| **Companies** | **Support /Not support** | **Comments and Views.** **Please companies not support to provide how to avoid UL interference and useless overhead for random access** |
| Nordic  | Ok, with further clarification | ***If UE supports to re-acquire GNSS over the aperiodic trigger FG 3a/3b, ….***  |
| Nokia, NSB | Support | As UL interference issue and huge overhead observed in **Proposed observation 3-2 based on current spec**, **if UE support re-acquire GNSS, then UE should firstly support aperiodic GNSS measurement and support to do GNSS measurement based on eNB triggering.**  |
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# Summary

To be filled with summary after discussions.

# References

1. RAN1 Chairman’s notes, 3GPP TSG RAN WG1 #113, Incheon, Korea, May 22nd – May 26th, 2023.
2. RAN1 Chairman’s notes, 3GPP TSG RAN WG1 #114, Toulouse, France, 21-25 August, 2023.
3. RAN1 Chairman’s notes, 3GPP TSG RAN WG1 #111, Toulouse, France, November 14th – 18th, 2022.
4. R1-2404741 Maintenance on IoT NTN enhancements Nokia, Nokia Shanghai Bell, Fukuoka, Japan, 20 – 24 May, 2024