**3GPP TSG RAN WG1 Meeting #116 R1-2401542**

**Athens, Greece, February 26th – March 1st, 2024**

**Agenda Item: 8.9**

**Source: Moderator (MediaTek)**

**Title: Feature lead summary #1** **of AI 8.9 on improved GNSS operations**

**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] Issue #1: UL transmission after original validity duration expires

**Agreement (RAN1 106e):**

For TA update in RRC\_CONNECTED state, combination of both open (i.e. UE autonomous TA estimation, and common TA estimation) and closed (i.e., received TA commands) control loops shall be supported for IoT-NTN

**Agreement (RAN1 109e):**

Closed loop time and frequency correction, with potential enhancements, for IoT-NTN is considered to reduce the need for UE to update GNSS position fix in long connection time

**Agreement (RAN1 112):**

At least for the case when frequency error is within frequency error requirements, study the mechanisms and conditions to allow UL transmission after original GNSS validity duration expires without GNSS re-acquisition for some duration.

* FFS: with legacy closed loop time correction or enhanced closed loop time correction
* This mechanism is enabled/configured by eNB
* FFS: whether such mechanism will be specified depends on the outcome of this study

**Agreement (RAN1 113):**

From RAN1 perspective, at least for the case when frequency error and timing error are within frequency and timing error requirements with legacy closed loop time correction, UL transmission can be allowed in a duration X after original GNSS validity duration expires without GNSS re-acquisition.

RAN1 will decide further details of the above.

**Agreement (RAN1 114):**

From RAN1 perspective, down select one for the duration X:

· Alt-3: when timeAlignmentTimer is not infinity, X is equal to remaining timeAlignmentTimer;

when timeAlignmentTimer is infinity, X is equal to Y;

o FFS: whether X can be used to extend the original GNSS validity duration

o Y is a configured value.

Note 1: The feature can be enabled/disabled by network

Note 2 (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 114bis):**

When timeAlignmentTimer is infinity, the duration X is equal to Y. Network can configure Y via a 3-bit field at least with component values [sf500, sf750, sf1280, sf1920, sf2560, sf5120, sf10240].

FFS: whether there is a new value.

**Agreement (RAN1 114bis):**

The feature of *“UL transmission after original validity duration expires with duration X”* can be enabled/disabled by network via RRC signalling.

**Agreement (RAN1 115):**

From RAN1 perspective, the start time of duration X is at the point where original GNSS validity duration expires

* when timeAlignmentTimer is infinity, the end of X is at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to Y every time when a MAC CE (to be defined by RAN2) is received
  + Note 1: It is up to RAN2 to decide whether the MAC CE is the legacy TAC or a new TAC or a new MAC CE.
* Note 2: It is up to RAN2 to implement the above behaviour based on new timer, existing timer, or by extending GNSS validity.
* Send an LS to RAN2

**RAN2-121bis**

1. UE can stay in RRC\_CONNECTED state when current GNSS position becomes out-of-date if the UE enters a GNSS measurement gap. FFS whether the new GNSS measurement shall be started before, upon or after the current GNSS validity duration expiry

**RAN2-123**

If there is neither network aperiodically trigger nor network configuration of UE autonomously GNSS measurement, UE moves to RRC\_IDLE after GNSS becomes invalid. It’s FFS how to decide GNSS valid or invalid considering duration X and Y.

**RAN2-124**

* The duration X is not used to extend the original GNSS validity duration but at least to perform uplink transmission
* The start time of duration X is at the point where original GNSS validity duration expires (The wording can be rephrased based on how to capture it).
* UE may use the outdated GNSS position within the duration X at least for mobility. The network can limit the number of times X is extended and/or the value of X (can check if we need some different behaviour to handle the CHO in Earth Moving Cell case)
* For the case when timeAlignmentTimer is infinity, a (legacy/new) MAC CE is introduced/used to reset ULTransmissionExtentionTimer with length equal to Y.

## Company contributing views

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| ZTE | Proposal 1: From RAN1 perspective, the GNSS position fix obtained before duration X is triggered, can be utilized for calculating for uplink transmission within duration X. |
| OPPO | Proposal : Align the functionality between the TAT timer infinity and not infinity case to allow the network to flexibly extend the UL transmission. |
| Nokia, NSB | Observation 2: The eNB may transmit a Timing Advance Command prior to the GNSS validity duration expiry without intending to extend the GNSS validity duration expiry by the corresponding restart of the timeAlignmentTimer.  Proposal 4: The MAC CE that resets ULTransmissionExtentionTimer shall not be the legacy MAC CE TAC, for case with TAT as both finite or infinite.  Observation 3: If the uplink transmission is allowed in a duration X after expiry of the original GNSS validity duration, the UE cannot perform uplink pre-compensation based on UE location unless the duration X also extends the GNSS validity duration.  Observation 4: The eNB can provide Timing Advance Commands to the UE during the duration X, if the UE is not allowed to perform uplink pre-compensation based on the old UE location. The eNB can trigger a new aperiodic GNSS measurement gap if needed.  Observation 5: The eNB, or alternatively specification, must decide if the UE’s old GNSS location can be used for uplink transmit pre-compensation during the extension X.  Proposal 5: RAN1 to discuss whether option 1 (reuse GNSS) or 2 (rely on TAC) for TA adjustment during extended duration is used or can be configured by the eNB.  Observation 6: If the UE transmits using segments during the duration X, the UE will not monitor for Timing Advance Commands, to adjust the timing advance per segment, during the segmented transmission.  Proposal 6: If the UE is not allowed to use the old UE location during duration X, RAN1 needs to define whether 1) eNB cannot schedule segmented transmissions or 2) eNB provides a TAC per segment prior to starting the repetition period. |
| Apple | Proposal 1: UL transmission extension is triggered by eNB with new MAC CE for timeAlignmentTimer value of infinity and not infinity.  Proposal 2: When timeAlignmentTimer is not infinity, the end of X is at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to the remaining value of TimeAlignmentTimer every time when a MAC CE is received.  Proposal 3: No special handling is needed to determine the timing advance within duration X. |
| Ericsson | Observation 4: When timeAlignmentTimer is finite, the end of the duration X is at the point where the remaining timeAlignmentTimer expires.  Observation 5: The legacy TAC can be used to extend the timeAlignmentTimer and therefore the duration X.  Proposal 3: For “GNSS operation”, it is up to RAN2 to decide whether the legacy TAC or a new TAC or a new MAC CE can be used for extending the duration X when the timeAlignmentTimer is finite. |
| Qualcomm | Observation 1: According to current specifications, any time a UE transmits a NPRACH, it uses a value of .  Observation 2: If a considerable amount of time has passed since the last GNSS position fix the accuracy of becomes progressively worse over time.  Observation 3: Although the eNB can progressively correct (by issuing TA commands) the timing error due to a stale UE location, this correction is not applied when transmitting NPRACH (which currently uses . This may cause the timing error to go beyond the NPRACH correction capability.  Proposal 2: If the UE is configured with GNSS validity extension (duration X), the UE applies the accumulated for (N)PRACH transmission. |

In RAN1 #114 meeting, RAN1 agreed for the duration X where UL transmission can be allowed after original GNSS validity duration expires without GNSS re-acquisition. When timeAlignmentTimer is not infinity, X is equal to remaining timeAlignmentTimer; when timeAlignmentTimer is infinity, X is equal to Y and Y is a configured value.

In RAN1 #114bis, it is agreed that Network can configure Y via a 3-bit field at least with component values [sf500, sf750, sf1280, sf1920, sf2560, sf5120, sf10240].

During RAN1#115, ant LS was sent to RAN2 in R1-2312696 to inform RAN2 to take the RAN1#115 agreement copied below into account.

RAN1#115 Agreement

From RAN1 perspective, the start time of duration X is at the point where original GNSS validity duration expires

* when timeAlignmentTimer is infinity, the end of X is at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to Y every time when a MAC CE (to be defined by RAN2) is received
  + Note 1: It is up to RAN2 to decide whether the MAC CE is the legacy TAC or a new TAC or a new MAC CE.
* Note 2: It is up to RAN2 to implement the above behaviour based on new timer, existing timer, or by extending GNSS validity.
* Send an LS to RAN2

Contributing companies discussed about duration X/ Y and related issues/enhancements.

1. **Length/configuration of duration X/Y**

The issue of Length/configuration of duration X/Y has been discussed several meetings and made great progress in RAN1 #115 and RAN1 #114, as depicted in Table 1 and Table 2.

Table 1: Length/configuration of duration X/Y when TAT is **infinite**

|  |  |  |  |
| --- | --- | --- | --- |
| Start of X | End of X | Procedure | Next step |
| at the point where original GNSS validity duration expires | at the point where new timer ULTransmissionExtentionTimer expires | ULTransmissionExtentionTimer is reset with length equal to Y every time when a MAC CE is received | up to RAN2 to decide whether the MAC CE is the legacy TAC or a new TAC or a new MAC CE and up to RAN2 to implement the behaviour based on new timer, existing timer, or by extending GNSS validity |

Table 2: Length/configuration of duration X/Y when TAT is **not infinite**

|  |  |  |  |
| --- | --- | --- | --- |
| Start of X | End of X | Procedure | Next step |
| at the point where original GNSS validity duration expires | **Option 1:** at the point where new timer ULTransmissionExtentionTimer expires  **Option 2:** at the point where timeAlignmentTimer expires | X is equal to remaining timeAlignmentTimer  **Option 1:** UL transmission extension is only set once and it cannot be further extended.  **Option 2:** UL transmission extension is extended by legacy MAC TAC with length equal to (remaining) timeAlignmentTimer every time when a legacy MAC TAC is received.  **Option 3:** UL transmission extension is extended by a new MAC TAC/MAC CE with length equal to (remaining) timeAlignmentTimer every time when a new MAC TAC/MAC CE is received. |  |

OPPO, Nokia, NSB, Apple, Ericsson proposed duration X can be extended when TAT is not infinite.

* OPPO, (Ericsson) proposed by legacy MAC TAC.
* Nokia, NSB, Apple proposed by new MAC TAC/MAC CE.
* Ericsson proposed it is up to RAN2 to decide.
* OPPO mentioned there are different interpretations on the RAN1 agreement on the UL transmission extension when TAT timer is not set to infinity. The first interpretation is that for UL transmission extension in X duration, when the UE receives a TAC, the TAT timer is to be reset and the X duration is accordingly extended. While the other interpretation is that the UL transmission extension is only set once and it cannot be further extended. OPPO proposed to align the functionality between the TAT timer infinity and not infinity case to allow the network to flexibly extend the UL transmission.
* Nokia, NSB observed the eNB may transmit a Timing Advance Command prior to the GNSS validity duration expiry without intending to extend the GNSS validity duration expiry by the corresponding restart of the timeAlignmentTimer. Nokia, NSB further proposed MAC CE that resets ULTransmissionExtentionTimer shall not be the legacy MAC CE TAC, for case with TAT as both finite or infinite.
* Apple mentioned the comparison of two configurations, i.e., TAT value is infinite or finite, is showing in below table 1 of R1-2400994. Apple further proposed that UL transmission extension is triggered by eNB with new MAC CE for timeAlignmentTimer value of infinity and not infinity and When timeAlignmentTimer is not infinity, the end of X is at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to the remaining value of TimeAlignmentTimer every time when a MAC CE is received.

|  |  |  |
| --- | --- | --- |
| UL transmission extension | timeAlignmentTimer is not infinity | timeAlignmentTimer is infinity |
| Duration X | Value of timeAlignmentTimer | Configured value of Y |
| Duration extension triggering/Reset | TAC? | New MAC CE, or TAC? |
| End of duration X | timeAlignmentTimer expires and no triggering signaling is received ? | ULTransmissionExtentionTimer expires and no triggering signaling is received |
| Multiple-time extension | Yes | Yes |

Table 1 of R1-2400994: UL transmission extension: TAT configured with infinity and not infinity

* Ericsson observed that when timeAlignmentTimer is finite, the end of the duration X is at the point where the remaining timeAlignmentTimer expires and the legacy TAC can be used to extend the timeAlignmentTimer and therefore the duration X. Ericsson proposed, for consistency, for“GNSS operation”, it is up to RAN2 to decide whether the legacy TAC or a new TAC or a new MAC CE can be used for extending the duration X when the timeAlignmentTimer is finite.

1. **calculation within duration X**

ZTE, Apple, proposed theGNSS position obtained before duration X is triggered, can be utilized for calculating for uplink transmission within duration X.

* ZTE mentioned the closed loop mechanism including the accumulated TA value by TAC within duration X is based on the previous pre-compensated TA according to the GNSS position obtained before duration X, and the satellite mobility is generally much higher than UE mobility. If a fixed UE specific TA is applied within the duration X, the closed loop TA adjustment need to mitigate the TA variation caused by both satellite mobility and UE mobility. Massive closed loop TA commands may be needed to keep UL synchronization. While if the old GNSS position fix is applied to estimate the UE specific TA with degraded accuracy, the satellite mobility can be handled to some degree, and closed loop TA adjustment will mainly mitigate the TA variation caused by UE mobility. The required signaling overhead of closed loop TA command will be significantly reduced.
* Nokia, NSB mentioned If the uplink transmission is allowed in a duration X after expiry of the original GNSS validity duration, the UE cannot perform uplink pre-compensation based on UE location unless the duration X also extends the GNSS validity duration and the eNB can provide Timing Advance Commands to the UE during the duration X, if the UE is not allowed to perform uplink pre-compensation based on the old UE location where the eNB can trigger a new aperiodic GNSS measurement gap if needed. The eNB, or alternatively specification, must decide if the UE’s old GNSS location can be used for uplink transmit pre-compensation during the extension X. Nokia, NSB proposed RAN1 to discuss whether option 1 (reuse GNSS) or 2 (rely on TAC) for TA adjustment during extended duration is used or can be configured by the eNB. Besides, Nokia, NSB mentioned if the UE transmits using segments during the duration X, the UE will not monitor for Timing Advance Commands, to adjust the timing advance per segment, during the segmented transmission and proposed If the UE is not allowed to use the old UE location during duration X, RAN1 needs to define whether 1) eNB cannot schedule segmented transmissions or 2) provides a TAC per segment prior to starting the repetition period. To the moderator understanding, RAN2 has agreed CR R2-2313779 in stage 2 TS36.300 on the issue related to validity of GNSS: “The UE computes the frequency Doppler shift of the service link, and pre-compensates for it in the uplink transmissions, by considering UE position and the ephemeris. If the UE does not have valid ephemeris and Common TA, it shall not transmit until they are regained. If the GNSS position becomes out-dated, it shall not transmit unless configured with uplink transmissions extension that is active”
* Apple mentioned during duration X where UL transmission is allowed, no special handling is needed to determine the timing advance within duration X.

1. **calculation for (N)PRACH within duration X**

Qualcomm proposed to not reset for (N)PRACH transmission within duration X.

* Qualcomm observed according to current specifications, any time a UE transmits a NPRACH, it uses a value of , if a considerable amount of time has passed since the last GNSS position fix the accuracy of becomes progressively worse over time, although the eNB can progressively correct (by issuing TA commands) the timing error due to a stale UE location, this correction is not applied when transmitting NPRACH (which currently uses . This may cause the timing error to go beyond the NPRACH correction capability. Qualcomm proposed if the UE is configured with GNSS validity extension (duration X), the UE applies the accumulated for (N)PRACH transmission.

Moderator View: For the length/configuration of duration X/Y, RAN1 can first align understanding on the end/length of duration X when TAT is not infinity, while RAN2 can further discuss consistent procedures on MAC related issues together with case when TAT is infinity. RAN2 can further discuss GNSS valid or invalid considering duration X and Y, as RAN2 has agreed CR R2-2313779 in stage 2 TS36.300 on the issue related to validity of GNSS: “The UE computes the frequency Doppler shift of the service link, and pre-compensates for it in the uplink transmissions, by considering UE position and the ephemeris. If the UE does not have valid ephemeris and Common TA, it shall not transmit until they are regained. If the GNSS position becomes out-dated, it shall not transmit unless configured with uplink transmissions extension that is active”. If needed, RAN1 just needs to discuss how to calculate within duration X, which has already been captured in TS 36.211. For calculation for (N)PRACH within duration X, RAN1 can align understanding first.

## First Round Discussion

**Initial Proposal 1-1:**

**From RAN1 perspective, *when timeAlignmentTimer is not infinity, down select:***

* + ***Alt-1:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to remining timeAlignmentTimer every time when a MAC CE (to be defined by RAN2) is received***
  + ***Alt-2:*** ***the end of X should be at the point where timeAlignmentTimer expires and timeAlignmentTimer is reset every time when a legacy MAC TAC is received***
  + ***Alt-3:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer with fixed length equal to remining timeAlignmentTimer is not reset when a MAC CE (to be defined by RAN2) is received***

**Note 1: It is up to RAN2 to decide whether the MAC CE is the legacy TAC or a new TAC or a new MAC CE.**

Note 2: It is up to RAN2 to implement the above behaviour based on new timer, existing timer, or by extending GNSS validity.

**Initial Conclusion 1-2:**

**From RAN1 perspective, *the GNSS position obtained before duration X is triggered, can be utilized for calculating for uplink transmission within duration X.***

***Note:*** ***no change to existing RAN1 spec***

**Initial Proposal 1-3:**

**From RAN1 perspective, *down select:***

* ***Alt-A:*** **There is no consensus in RAN1 on  *calculation*-related enhancements *for (N)PRACH transmission within duration X* in Rel-18 IoT NTN.**
* ***Alt-B:*** ***The accumulated before (N)PRACH needs to be applied for (N)PRACH transmission within duration X.***

Companies are encouraged to provide comments within the following table:

|  |  |  |
| --- | --- | --- |
| Companies | Alt | Comments |
| Ericsson |  | 1-1: We can support Alt-1 and Alt-2 (with a suggested revision).  Alt-1: We can support this as it as it will help unify the design for both cases.  Alt -2: We can support this but please replace “legacy MAC TAC” with “MAC CE (to be defined by RAN2)”. Otherwise, please add another alternative in case you do not want to revise Alt-2.  Alt-3: Disagree.  1-2: OK. Maybe add the word “latest” before GNSS position.  1-3: We are not convinced on the need of resetting N\_TA for (N)PRACH during UL extension duration. If the UE’s position is so inaccurate that it cannot perform (N)PRACH, then it should refresh its GNSS position at the end of X and then perform (N)PRACH. Also, the spec impact is noticeable as legacy (N)PRACH uses N\_TA=0. |
| QC |  | For 1-1, we think it should be up to RAN2 to decide between alt-1 and alt-2.  1-2: OK  1-3: As mentioned before, it would be unfortunate if the UE would need to reacquire GNSS just because the NPRACH cannot be corrected with closed loop commands. Therefore, we would prefer alt-B |
| Nordic |  | 1-1 New MAC-CE has not been agreed yet for the “infty” case  1-2 OK, but do not spend time offline on this  1-3 We are OK to support Alt-B |
| CATT |  | 1-1 Alt2  1-2 OK  1-3 Alt-B |
| Nokia, NSB |  | 1-1: We support alt-1 as unified solution between case with finite and infinite TAT. While we support new MAC CE to indicate but not legacy TAC, considering the requirement to only adjust time by the legacy TAC but not extend UL.  1-2: Not support. The original RAN1 view on the extension is eNB to use TAC to update the timing but try to avoid unnecessary GNSS measurement. When GNSS expire, it is expired. An outdated GNSS will cause unexpected result of that is not under control of eNB. When GNSS expire, eNB TAC may be the only way to adjust the TA while UE can not update the **.** If there is time error, eNB can trigger a new GNSS measurement.  A fixed at the GNSS expire time can be used instead of recalculate. Or eNB can control whether outdated GNSS can be used for calculation of but not always up to UE decision/implementation.  1-3: We have similar understanding as Ericsson. As GNSS is already outdated, the extension is to continue UL transmission based on TAC from eNB but not for a always extension. If there is requirement for a new random access, there need a new GNSS. While after new GNSS measurement, all issue solved. |
| Huawei, Hisilicon |  | 1-1 the previous RAN1 agreement implies alt 2 at least for TAT is not infinite. For the case of TAT is infinite, we already sent LS to RAN2 in last meeting and can wait for their response.  1-2 support  1-3 share similar view as Ericsson. |
| Samsung |  | * 1. Either Alt1 or Alt2. We prefer to conclude the RAN1 discussion on this topic (and on the whole issue#1) in this meeting.   2. OK   3. Alt-A |
| ZTE |  | For 1-1: we would prefer alt-3 or alt-1, where network is able to maintain the TA without extending duration X.  For 1-2: Agree. Otherwise, massive TAC will be needed to mitigate the fast timing drift caused by satellite mobility.  For 1-3: we agree with Ericcson that when GNSS error is too large and NPRACH cannot be performed, the UE should update the GNSS instead of continuously relying on closed loop adjustment from eNB. |
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## Second Round Discussion

Initial Proposal 1-1 was not discussed in offline due to lack of time. This can be discussed online.

**Initial Proposal 1-1:**

**From RAN1 perspective, *when timeAlignmentTimer is not infinity, down select:***

* + ***Alt-1:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to remining timeAlignmentTimer every time when a MAC CE (to be defined by RAN2) is received***
  + ***Alt-2:*** ***the end of X should be at the point where timeAlignmentTimer expires and timeAlignmentTimer is reset every time when a legacy MAC TAC is received***
  + ***Alt-3:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer with fixed length equal to remining timeAlignmentTimer is not reset when a MAC CE (to be defined by RAN2) is received***

**Note 1: It is up to RAN2 to decide whether the MAC CE is the legacy TAC or a new TAC or a new MAC CE.**

Note 2: It is up to RAN2 to implement the above behaviour based on new timer, existing timer, or by extending GNSS validity.

Conclusion 1-2 was discussed offline, with no consensus. This issue was discussed several meetings, and not further discussed in RAN1#116.

**Initial Conclusion 1-2:**

**From RAN1 perspective, *the GNSS position obtained before duration X is triggered, can be utilized for calculating for uplink transmission within duration X.***

***Note:*** ***no change to existing RAN1 spec***

Conclusion 1-3a was agreeable during offline. It will be discussed online

**Conclusion 1-3a:**

**There is no consensus in RAN1 on further enhancements with *not resetting (i.e. apply accumulated before (N)PRACH transmission) for (N)RACH transmission within duration X*.**

|  |  |  |
| --- | --- | --- |
| Companies | Alt | Comments |
| Ericsson |  | 1-1: We can support Alt-1 and Alt-2 (with a suggested revision).  Alt-1: We can support this as it as it will help unify the design for both cases.  Alt -2: We can support this but please replace “legacy MAC TAC” with “MAC CE (to be defined by RAN2)”. Otherwise, please add another alternative in case you do not want to revise Alt-2.  Alt-3: Disagree. |
| QC |  | For 1-1, we think it should be up to RAN2 to decide between alt-1 and alt-2. |
| Nordic |  | 1-1 New MAC-CE has not been agreed yet for the “infty” case |
| CATT |  | 1-1 Alt2 |
| Nokia, NSB |  | 1-1: We support alt-1 as unified solution between case with finite and infinite TAT. While we support new MAC CE to indicate but not legacy TAC, considering the requirement to only adjust time by the legacy TAC but not extend UL. |
| Huawei, Hisilicon |  | 1-1 the previous RAN1 agreement implies alt 2 at least for TAT is not infinite. For the case of TAT is infinite, we already sent LS to RAN2 in last meeting and can wait for their response. |
| Samsung |  | 1-1 Either Alt1 or Alt2. We prefer to conclude the RAN1 discussion on this topic (and on the whole issue#1) in this meeting. |
| ZTE |  | For 1-1: we would prefer alt-3 or alt-1, where network is able to maintain the TA without extending duration X. |
| Nordic |  | Alt2 is preference |
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|  |  |  |

# [Active] Issue #2: 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.

## Company contributing views

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| ZTE | Proposal 2: eNB trigger to make GNSS measurement does not impact the autonomous GNSS reacquisition after the GNSS measurement gap. |
| 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 3: 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.  Proposal 8: The UE has to support receiving the aperiodic trigger for a GNSS measurement gap if the UE supports the autonomous GNSS measurement. |
| Huawei, HiSilicon | Proposal 2: UE may re-acquire GNSS autonomously (when configured by the network) in the GNSS measurement timer, if UE does not receive eNB trigger to make GNSS measurement within duration T, where T is latest reported remaining GNSS validity duration plus UL transmission extension duration X (if any). |

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.

1. ***Relationship of GNSS measurement gap and timer***

The issue is to clarify the relationship of GNSS measurement gap and timer. If UE has a long connection time, and there is a GNSS measurement trigger, after the GNSS measurement is done, the previous GNSS measurement trigger will not impact following GNSS measurement timer as depicted in following figure 2-1, where the GNSS measurement timer can still be activated.

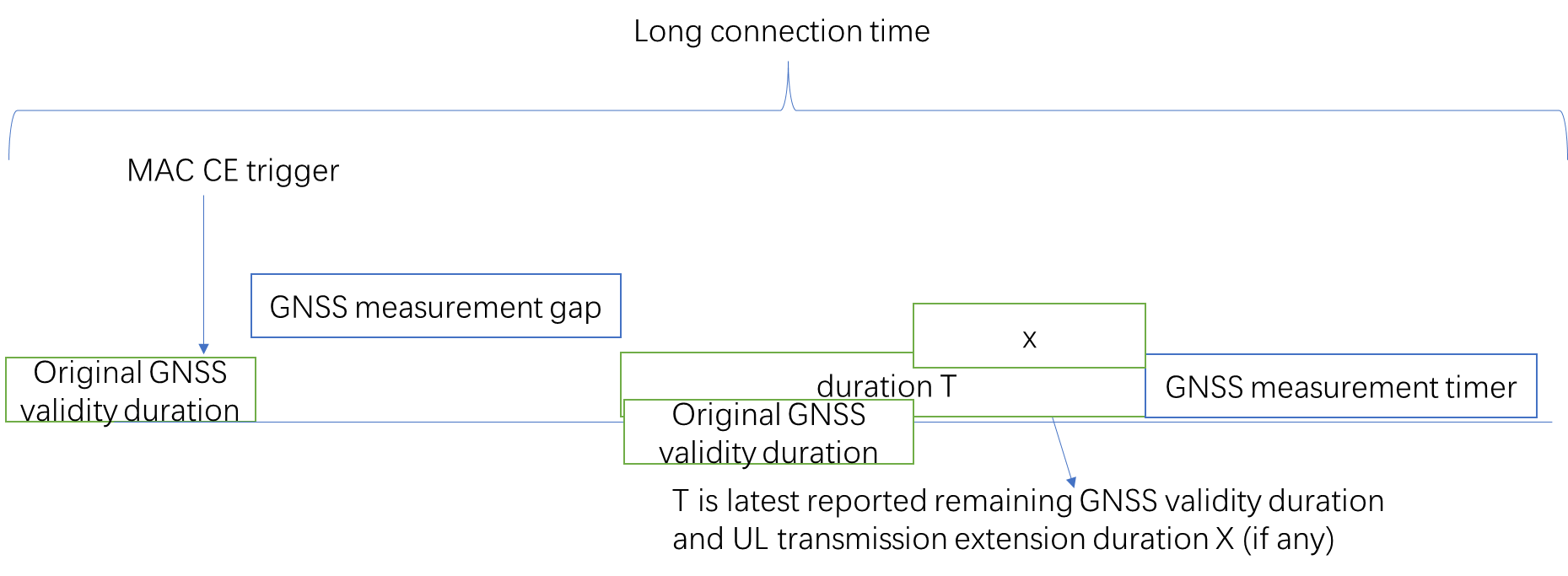


Fig.2-1 the start time of GNSS measurement gap

ZTE, Huawei, HiSilicon proposed eNB trigger to make GNSS measurement does not impact the autonomous GNSS reacquisition after the GNSS measurement gap.

* Nokia, NSB proposed the UE has to support receiving the aperiodic trigger for a GNSS measurement gap if the UE supports the autonomous GNSS measurement. To the moderator understanding, 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.
* Huawei, HiSilicon mentioned the restriction to perform autonomous GNSS measurement only takes effect during a period after UE receives a triggering MAC CE. Such period can be the updated validity duration after the measurement in gap plus potential UL extension duration X if enabled, as shown in figure 1 of R1-2401380.

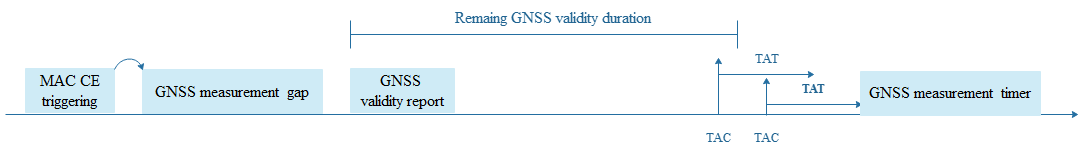


Figure 1 of R1-2401380**.** Autonomous GNSS measurement timer start after last triggered GNSS measurement

1. ***Others***

* 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. 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”.

Moderator View: On the relationship of timer and gap, eNB trigger with MAC CE to make GNSS measurement in GNSS measurement gap should not impact the autonomous GNSS reacquisition after the GNSS measurement gap. Besides, to the moderator understanding, 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.

## First Round Discussion

***Initial Conclusion 2:***

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

Companies are encouraged to provide comments within the following table:

|  |  |
| --- | --- |
| Companies | Comments |
| Ericsson | OK |
| Qualcomm | It is unclear what is the specification impact of this conclusion. Does it imply that a UE needs to support triggered GNSS gap as a prerequisite of autonomous gap? If so, we are not OK. |
| Nordic | maybe conclusion should be conditioned on “if eNB GNSS gap trigger is configured to a UE.” |
| CATT | If the autonomous measurement has been configured before, it could be applicable. |
| Nokia, NSB | We are not OK for this conclusion. This is to clarify the agreement in RAN1 #111 meeting for autonomous GNSS measurement. Then we should make the agreement entirely clear.  For RAN1 understanding at RAN1 #111 meeting, firstly UE should support network triggered GNSS measurement as network know whether UE’s UL sync is still good based on the measured GNSS and UE should behavior new GNSS measurement based on network triggering. While autonomous GNSS measurement is for saving overhead but it is not RAN1 discussion that UE only do autonomous GNSS measurement as it is not acceptable from UL synchronization performance. RAN1 also has not discussed the independent way for aperiodic triggering and autonomous measurement.  We propose to update the conclusion as following if all can accept:   * **If UE support GNSS re-acquisition, to guarantee UL synchronization with detection from eNb, when eNB trigger GNSS measurement, UE should do aperiodic GNSS measurement. Only when eNB has not triggered aperiodic GNSS measurement, to save overhead of GNSS measurement triggering, there can be autonomous measurement, i.e. the autonomous GNSS measurement depends on whether eNB triggering aperiodic GNSS measurement.** * **the UE may re-acquire GNSS autonomously (when configured by the network) in the GNSS measurement timer, if UE does not receive eNB trigger to make GNSS measurement within duration T, where T is latest reported remaining GNSS validity duration plus UL transmission extension duration X (if any).”** |
| Huawei, HiSilicon | Support the conclusion.  We think the conclusion is independent of the UE feature discussion. |
| Samsung | OK |
| ZTE | Support the conclusion as a clarification without spec impact. |
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# [Active] Issue #3: Success/Failure of GNSS measurement

**RAN2-116bis**

UE need to have a valid GNSS fix before going to connected. RAN2 assumes that the UE may need to re-acquire the GNSS fix right before establishing the connection (regardless if previously valid or not), if needed to avoid interruption during the connection.

When the GNSS fix becomes outdated in RRC\_CONNECTED mode, the UE goes to IDLE mode.

**Agreement (RAN1 112):**

The following alternatives can be considered to inform eNB the success of GNSS measurement at UE side after GNSS measurement in RRC connected.

* Alt-1: The UE will report the new GNSS validity duration
* Alt-2: The reception of any UL transmission from the UE at eNB after the GNSS measurement

**Agreement (RAN1 114)**

From RAN1 perspective, after autonomous GNSS measurement timer expires if UE failed to re-acquire GNSS position fix within the autonomous GNSS measurement timer UE goes to IDLE mode.

**Agreement (RAN1 114)**

From RAN1 perspective, for the aperiodic GNSS measurement gap triggered by eNB with MAC CE, down select one of the alternatives for the failure of GNSS measurement:

* Alt-1: UE goes to IDLE mode after the end of GNSS measurement gap if UE failed to re-acquire GNSS position fix within GNSS measurement gap.

**Agreement (RAN1 114)**

In RRC connected, every time after successful GNSS measurement, UE reports the new remaining GNSS validity duration.

FFS: Whether UE should report the new remaining GNSS validity duration within a duration D.

**RAN2-121bis**

UE can stay in RRC\_CONNECTED state when current GNSS position becomes out-of-date if the UE enters a GNSS measurement gap. FFS whether the new GNSS measurement shall be started before, upon or after the current GNSS validity duration expiry

**RAN2-122**

The UE triggers GNSS measurement reporting every time upon completing the GNSS fix operation.

## 3.1 Company contributing views

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| Nokia, NSB | Observation 7: The value of N\_TA is not clear after a UE has completed the GNSS measurement successfully.  Proposal 7: RAN1 to discuss whether the UE after a successful GNSS measurement gap/autonomous GNSS timer either performs the Random Access procedure or reuses the previous N\_TA, when the new UE position is similar to the previous UE position. |
| Ericsson | Observation 6: 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 7: Reusing the old value after GNSS reacquisition is not optimal as the UE will update the old according to its new position estimate.  Observation 8: Resetting after GNSS reacquisition is not optimal as it incorrectly assumes that the previous value configured by the network was meant to account for only the UE position error.  Observation 9: After a successful GNSS reacquisition, neither resetting nor reusing the old will result in the correct TA value for uplink transmission.  Observation 10: The UE can calculate the timing error due to inaccurate UE position by comparing the values of based on its previous GNSS position and its new GNSS position after GNSS reacquisition, i.e., .  Proposal 4: For “GNSS operation,” the UE should set after a successful GNSS reacquisition where is the timing error due to inaccurate UE position and can be calculated by comparing based on the previous GNSS position and based on new GNSS position after GNSS reacquisition. |
| Qualcomm | Proposal 3: After the UE successfully reacquires GNSS, RAN1 to downselect between the following two options:   * The UE sets * The UE considers its TA timer to have expired (and shall perform RACH procedure) |
| Nordic Semiconductor ASA | Proposal 1: The accumulated timing advance term should be reset, i.e., to set after a new GNSS position fix is obtained in RRC Connected mode. |

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 after GNSS measurement for PUSCH transmission without consensus.

**calculation after GNSS measurement in RRC connected state**

Nokia, NSB, Qualcomm, Nordic proposed to set (by (N)PRACH) after successful GNSS measurement in RRC Connected mode.

Nokia, NSB proposed to reuse the previous N\_TA, when the new UE position is similar to the previous UE position.

Ericsson, proposed to set after a successful GNSS reacquisition where is the timing error due to inaccurate UE position and can be calculated by comparing based on the previous GNSS position and based on new GNSS position after GNSS reacquisition

Qualcomm proposed UE considers its TA timer to have expired (and shall perform RACH procedure).

* Nokia, NSB mentioned the value of N\_TA is not clear after a UE has completed the GNSS measurement successfully and proposed RAN1 to discuss whether the UE after a successful GNSS measurement gap/autonomous GNSS timer either performs the Random Access procedure or reuses the previous N\_TA, when the new UE position is similar to the previous UE position.
* 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 value after GNSS reacquisition is not optimal as the UE will update the old according to its new position estimate. Resetting after GNSS reacquisition is not optimal as it incorrectly assumes that the previous value configured by the network was meant to account for only the UE position error. After a successful GNSS reacquisition, neither resetting nor reusing the old will result in the correct TA value for uplink transmission. The UE can calculate the timing error due to inaccurate UE position by comparing the values of based on its previous GNSS position and its new GNSS position after GNSS reacquisition, i.e., . Ericsson proposed for “GNSS operation,” the UE should set after a successful GNSS reacquisition where is the timing error due to inaccurate UE position and can be calculated by comparing based on the previous GNSS position and based on new GNSS position after GNSS reacquisition.
* Qualcomm proposed that after the UE successfully reacquires GNSS, the UE sets or the UE considers its TA timer to have expired (and shall perform RACH procedure)
* Nordic proposed the accumulated timing advance term should be reset, i.e., to set after a new GNSS position fix is obtained in RRC Connected mode.

Moderator View: For resets after GNSS measurement, in the moderator understanding, the mobility of satellite is more obvious than UE, since there is no need to resets for SIB31 updates, UE should not reset for GNSS measurement.

## 3.2 First Round Discussion

***Initial* Conclusion *3:***

**From RAN1 perspective, *down select:***

* ***Alt-A:*** ***There is no consensus in RAN1 on calculation-related enhancements after GNSS measurement in RRC connected state in Rel-18 IoT NTN.***
* ***Alt-B:*** ***The for the first UL transmission after successful GNSS measurement in RRC Connected mode.***

Companies are encouraged to provide comments within the following table:

|  |  |  |
| --- | --- | --- |
| Companies | Alt | Comments |
| Ericsson | Alt-C | Please include Alt-C as well (Alt-A is not really an alternative):  ***ALT-C: The where for the first UL transmission after successful GNSS measurement in RRC Connected mode.***  Note that Alt-A (resets ) incorrectly assumes that the previous value configured by the network was meant to account for only the UE position error. However, it may contain timing corrections due to satellite position errors as well. Therefore, after GNSS fix, we should only remove the timing errors due to inaccurate UE position from N\_TA which can be calculated by the UE using the old and the new position: . |
| Qualcomm | Alt-B | We could consider Alt-C as well or new Alt-D (the UE considers is TAT expired and shall perform RACH). |
| Nordic |  | @FL: even though satellite moves faster than UE, 2us TA error is deadly for NPUSCH  We do not have strong preference on solution, but issue should be solved.  Simple solution is better. |
| CATT | Alt-B | After GNSS re-acquisition, the can be reset to 0. The UL synchronization will be re-established. |
| Nokia, NSB |  | Actually, it is not only how to decide NTA but also whether new random access is needed after UE successfully required new GNSS. If location difference of UE based on old GNSS and new GNSS is not large, then even it is possible to avoid the PRACH transmission and reusing NTA. While if the location difference of UE based on old GNSS and new GNSS is large, then always random access is needed for UL synchronization with NTA=0.  E.g. Alt-D: The UE performs RACH with NTA = 0 if 'old position - new position > thr", otherwise UE sets new NTA = old NTA for the first UL transmission after successful GNSS measurement in RRC Connected mode. |
| Huawei, Hisilicon |  | In NR NTN, after UE updates GNSS, UE is still using the old N\_TA. Similar design can be used in IoT NTN at least if the new GNSS is acquired before the original validity duration expires. Otherwise, PRACH can be used assuming N\_TA=0. |
| Samsung |  | Reusing the old N\_TA is not perfect but could work. Alternatively, UE starts RACH procedure with N\_TA=0. We prefer to agree on one solution. |
| ZTE |  | We think no need of calculation-related enhancements. If the TA error is too large, the UE can just perform PRACH to correct the timing error, where will be applied. |
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## 3.3 Second Round Discussion

The second round proposal based on companies contribution is made below:

***Initial* Conclusion *3a:***

**From RAN1 perspective, there is no consensus on  *further enhancements for for the first UL transmission after successful GNSS measurement in RRC connected state.***

* ***Set***
* ***Set where***
* ***The UE considers TAT has expired and shall perform RACH***
* ***The UE performs RACH with if “old position - new position > thr", otherwise UE sets***

Companies are encouraged to provide comments within the following table:

|  |  |  |
| --- | --- | --- |
| Companies | Alt | Comments |
| Nordic |  | If UE knows that old TA is a complete non-sense after position fix, it should have a choice to ignore eNB’s UL grant and send NPRACH instead. If no spec change is desired, at least a conclusion like this should be done. |
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# 4 [Active] Issue #4: TPs

Several TPs are proposed by contributing companies.

## 4.1 [Active] TPs for the accumulated for (N)PRACH transmission with duration X

#### 4.1.1 Motivation

In R1-2401421, Qualcomm observed according to current specifications, any time a UE transmits a NPRACH, it uses a value of , if a considerable amount of time has passed since the last GNSS position fix the accuracy of becomes progressively worse over time, although the eNB can progressively correct (by issuing TA commands) the timing error due to a stale UE location, this correction is not applied when transmitting NPRACH (which currently uses . This may cause the timing error to go beyond the NPRACH correction capability. Qualcomm proposed if the UE is configured with GNSS validity extension (duration X), the UE applies the accumulated for (N)PRACH transmission.

Moderator View: The TPs are associated with Issue 1 of proposal 1-3, RAN1 can first discuss on whether the TPs are needed.

#### 4.1.2 Proposed draft TPs

**Reason for change:**

To mitigate issue for the timing error to go beyond the NPRACH correction capability.

**Summary of change:**

UE to also use the closed loop accumulated TA for NPRACH when the UE is configured with GNSS validity extension.

**Consequence if not approved:**

The timing error due to a stale UE location may go beyond the NPRACH correction capability.

|  |
| --- |
| **============================== <TP2.1 36.211> ==================================**  5.7.1 Time and frequency structure  **<Unchanged parts are omitted>**  The start of the random access preamble formats 0-3 shall be aligned with the start of the corresponding uplink subframe at the UE assuming  except if *GNSSExtensionByClosedLoop* is configured, in which case the accumulated is used. The random access preamble format 4 shall start  before the end of the UpPTS at the UE, where the UpPTS is referenced to the UE's uplink frame timing assuming.  **<Unchanged parts are omitted>**  **================================= </TP2.1> ======================================**  **============================== <TP2.2 36.213> ==================================**  4.2.3 Transmission timing adjustments  Upon reception of a timing advance command or a timing adjustment indication for a TAG containing the primary cell or PSCell, the UE shall adjust uplink transmission timing for PUCCH/PUSCH/SRS, and PRACH if higher layer parameter *GNSSExtensionByClosedLoop,* of the primary cell or PSCell based on the received timing advance command or a timing adjustment indication.  **<Unchanged parts are omitted>**  In case of random access response, and if higher layer parameter *GNSSExtensionByClosedLoop* is not configured*,* an 11-bit timing advance command [8], *TA*, for a TAG indicates *NTA* values by index values of *TA* = 0, 1, 2, ..., 256 if the UE is configured with a SCG, and *TA* = 0, 1, 2, ..., 1282 otherwise, where an amount of the time alignment for the TAG is given by *NTA* = *TA* ×16. *NTA* is defined in [3].  In case of random access response, and if higher layer parameter *GNSSExtensionByClosedLoop* is configured*,* an 11-bit timing advance command [8], *TA*, indicates adjustment of the current *NTA* value, *NTA\_old* , to the new *NTA* value, *NTA,new* by index values of *TA* = 0, 1, 2, ..., 1536, where an amount of the time alignment is given by *NTA,new* = *NTA,old +TA* ×16.  In other cases, a 6-bit timing advance command [8] or the Timing advance adjustment field in DCI format 6-0A/B if present [4], *TA*, for a TAG indicates adjustment of the current *NTA* value, *NTA,old*, to the new *NTA* value, *NTA,new*, by index values of *TA* = 0, 1, 2,..., 63, where *NTA,new* = *NTA,old* + (*TA* −31)×16. Here, adjustment of *NTA* value by a positive or a negative amount indicates advancing or delaying the uplink transmission timing for the TAG by a given amount respectively.  **<Unchanged parts are omitted>**  16.1.2 Timing synchronization  Upon reception of a timing advance command, the UE shall adjust uplink transmission timing for NPUSCH, and SR if configured with higher layer parameter *sr-WithoutHARQ-ACK-Config*, and NPRACH if configured with higher layer parameter *GNSSExtensionByClosedLoop,* based on the received timing advance command.  The timing advance command indicates the change of the uplink timing relative to the current uplink timing as multiples of 16. The start timing of the random access preamble is specified in [3].  In case of random access response, and if higher layer parameter *GNSSExtensionByClosedLoop* is not configured*,* an 11-bit timing advance command [8], *TA*, indicates *NTA* values by index values of *TA* = 0, 1, 2, ..., 1536, where an amount of the time alignment is given by *NTA* = *TA* ×16. *NTA* is defined in [3].  In case of random access response, and if higher layer parameter *GNSSExtensionByClosedLoop* is configured*,* an 11-bit timing advance command [8], *TA*, indicates adjustment of the current *NTA* value, *NTA\_old* , to the new *NTA* value, *NTA,new* by index values of *TA* = 0, 1, 2, ..., 1536, where an amount of the time alignment is given by *NTA,new* = *NTA,old +TA* ×16.  In other cases, a 6-bit timing advance command [8] or the Timing advance adjustment field in DCI format N0 if present [4], *TA*, indicates adjustment of the current *NTA* value, *NTA,old*, to the new *NTA* value, *NTA,new*, by index values of *TA* = 0, 1, 2,..., 63, where *NTA,new* = *NTA,old* + (*TA* −31)×16. Here, adjustment of *NTA* value by a positive or a negative amount indicates advancing or delaying the uplink transmission timing by a given amount respectively.  **================================= </TP2.2> ======================================** |

#### .1.3 First Round Discussion

***Initial Proposal 4.1:***

***Companies are encouraged to comment on whether TPs in section 4.1.2 of R1-240XXXX are needed.***

Companies are encouraged to provide comments within the following table:

|  |  |  |
| --- | --- | --- |
| Companies | Yes/No | Comments |
| Ericsson |  | It depends on the conclusion of Issue 1. |
| Nokia, NSB |  | Same view as Ericsson, RAN1 should firstly discuss issue 1 before any TP. |
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## 4.2 [Active] TP for setting after successful GNSS measurement in RRC Connected mode

#### 4.2.1 Motivation

In R1-2401462, 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 since the UE position is accurate again after GNSS reacquisition. However, based on current specification a UE shall monitor (N)PDCCH right after GNSS measurement gap, and it 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. Nordic proposed that the accumulated timing advance term should be reset, i.e., to set after a new GNSS position fix is obtained in RRC Connected mode.

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

#### 4.2.2 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 since the UE position is accurate again after GNSS reacquisition

**Summary of change:**

Reset the accumulated timing advance term, i.e., to set 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  (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 (defined in [3]) based on one-way propagation delay which can be obtained as:  where , , and are given by the higher layer parameters *nta-Common*, *nta-CommonDrift*, and *nta-CommonDriftVariation* respectively, and is the epoch time given by the higher layer parameter *epochTime*. provides a distance at time 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 . 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  (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 (defined in [3]) based on one-way propagation delay which can be obtained as:  where , , and are given by the higher layer parameters *nta-Common*, *nta-CommonDrift*, and *nta-CommonDriftVariation* respectively, and is the epoch time given by the higher layer parameter *epochTime*. provides a distance at time 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 . After the UE successfully reacquires GNSS, the UE sets *NTA* =0.  **================================= </TP1> ======================================** |

#### 4.2.3 First Round Discussion

***Initial Proposal 4.2:***

***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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| Companies | Yes/No | Comments |
| Ericsson |  | It depends on the conclusion on Issue 3. |
| Nokia, NSB |  | Same view as Ericsson, RAN1 should firstly discuss issue 3 before any TP. |
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# 5 Proposals for online/offline discussions

## 5.1 Proposals for Tuesday offline discussion

Issue #1: UL transmission after original validity duration expires

Initial Proposal 1-1 was not discussed in offline due to lack of time. This can be discussed online.

**Initial Proposal 1-1:**

**From RAN1 perspective, *when timeAlignmentTimer is not infinity, down select:***

* + ***Alt-1:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to remining timeAlignmentTimer every time when a MAC CE (to be defined by RAN2) is received***
  + ***Alt-2:*** ***the end of X should be at the point where timeAlignmentTimer expires and timeAlignmentTimer is reset every time when a legacy MAC TAC is received***
  + ***Alt-3:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer with fixed length equal to remining timeAlignmentTimer is not reset when a MAC CE (to be defined by RAN2) is received***

**Note 1: It is up to RAN2 to decide whether the MAC CE is the legacy TAC or a new TAC or a new MAC CE.**

Note 2: It is up to RAN2 to implement the above behaviour based on new timer, existing timer, or by extending GNSS validity.

No consensus on conclusion 1-2. This issue was discussed several meetings, and not further discussed in RAN1#116.

**Initial Conclusion 1-2:**

**From RAN1 perspective, *the GNSS position obtained before duration X is triggered, can be utilized for calculating for uplink transmission within duration X.***

***Note:*** ***no change to existing RAN1 spec***

Conclusion 1-3a was agreeable during offline.

**Conclusion 1-3a:**

**There is no consensus in RAN1 on further enhancements with *not resetting (i.e. apply accumulated before (N)PRACH transmission) for (N)RACH transmission within duration X*.**

Issue #2: GNSS measurement gap/timer

No consensus on conclusion 2. It will not be discussed again in RAN1#116.

***Initial Conclusion 2:***

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

Issue #3: Success/Failure of GNSS measurement

Not discussed in offline. Can be discussed online

***Initial* Conclusion *3a:***

**From RAN1 perspective, there is no consensus on  *further enhancements for for the first UL transmission after successful GNSS measurement in RRC connected state.***

* ***Set***
* ***Set where***
* ***The UE considers TAT has expired and shall perform RACH***
* ***The UE performs RACH with if “old position - new position > thr", otherwise UE sets***

## 5.2 Proposals for Wednesday online discussion

Proposals for GNSS measurement in RRC Connected mode

***Initial Conclusion 2a:***

***UE re-acquires GNSS (when configured by the network) in the GNSS measurement gap, 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)***

Proposals for UL transmission after original validity duration expires

**Initial Conclusion 1-2a:**

**From RAN1 perspective, *the GNSS position obtained before duration X is triggered is outdated during X, but it can be utilized for calculating for uplink transmission within duration X.***

***Note:*** ***no change to existing RAN1 spec***

**Conclusion 1-3a:**

**There is no consensus in RAN1 on further enhancements with *not resetting (i.e. apply accumulated before (N)PRACH transmission) for (N)RACH transmission within duration X*.**

**Initial Proposal 1-1:**

**From RAN1 perspective, *when timeAlignmentTimer is not infinity, down select:***

* + ***Alt-1:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer is reset with length equal to remining timeAlignmentTimer every time when a MAC CE (to be defined by RAN2) is received***
  + ***Alt-2:*** ***the end of X should be at the point where timeAlignmentTimer expires and timeAlignmentTimer is reset every time when a legacy MAC TAC is received***
  + ***Alt-3:*** ***the end of X should be at the point where new timer ULTransmissionExtentionTimer expires and ULTransmissionExtentionTimer with fixed length equal to remining timeAlignmentTimer is not reset when a MAC CE (to be defined by RAN2) is received***

**Note 1: It is up to RAN2 to decide whether the MAC CE is the legacy TAC or a new TAC or a new MAC CE.**

Note 2: It is up to RAN2 to implement the above behaviour based on new timer, existing timer, or by extending GNSS validity.

Issue #3: Proposal for the first UL transmission after successful GNSS measurement in RRC connected state

***Initial* Conclusion *3a:***

**From RAN1 perspective, there is no consensus on  *further enhancements for*** ***for the first UL transmission after successful GNSS measurement in RRC connected state.***

* ***Set***
* ***Set where***
* ***The UE considers TAT has expired and shall perform RACH***
* ***The UE performs RACH with if “old position - new position > thr", otherwise UE sets***

# 6 Conclusion

# 7 References

1. RP-223519, Moderator (MediaTek), Revised WID on IoT NTN enhancements, 12-16 December, 2022
2. R1-2400352, Remaining issue on IoT-NTN, ZTE
3. R1-2400586, Discussion on maintenance on IoT NTN enhancements, OPPO
4. R1-2400878, Maintenance on IoT NTN enhancements, Nokia, Nokia Shanghai Bell
5. R1-2400994, Remaining issues on IoT NTN enhancements, Apple
6. R1-2401193, Maintenance on IoT NTN enhancements, Ericsson Inc.
7. R1-2401380, Maintenance of Rel-18 IoT NTN, Huawei, HiSilicon
8. R1-2401421, Maintenance on IOT NTN enhancements, Qualcomm Incorporated
9. R1-2401462, Maintenance on IoT NTN enhancements, Nordic Semiconductor ASA