**3GPP TSG RAN WG2 #119bis-e *draft R2-2210840***

**Online, 10 - 19 Oct, 2022**

**Source:** CATT

**Title:** Report of [AT119bis-e][101][R18 IoT-NTN] GNSS operation (CATT)

**Agenda Item:** 8.6.2.2

**Document for:** Discussion and decision

# Introduction

This document serves as a report of the following offline discussion:

* [AT119bis-e][101][R18 IoT-NTN] GNSS operation (CATT)

Initial scope: Discuss the proposals in the submitted contributions in AI 8.6.2.2

Initial intended outcome: Summary of the offline discussion with e.g.:

* ·         List of proposals for agreement (if any)
* ·         List of proposals that require online discussions
* ·         List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Thursday 2022-10-13 1200 UTC

Initial deadline (for rapporteur's summary in R2-2210840): Thursday 2022-10-13 1400 UTC

1. Contact Information

To make it easier to find the contact delegate for potential follow-up questions, delegates are encouraged to provide their contact information in the following table:

|  |  |  |
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# Discussion

## GNSS assistance information report

In RAN1# 110-e meeting, the following agreements have been achieved:

**Agreement**

GNSS assistance information that UE reports to eNB at least consists of:

* GNSS position fix time duration for measurement
* GNSS validity duration

**Agreement**

When eNB triggers UE to make GNSS measurements, UE re-acquires GNSS position fix

* FFS details of signalling
* FFS how UE reports GNSS assistance information after eNB trigger and the detailed content
* Note: further discuss whether a UE is expected to handle all eNB triggers

For GNSS measurement, RAN1 has agreed to report the GNSS position fix time duration for measurement and GNSS validity duration as assistance information, and has left the detail signalling design as open issue, which should be discussed by RAN2. Several companies have shown views on this issue.

### GNSS position fix time duration for measurement report

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| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2209409 | Observation 1: Msg5 is not suitable for GNSS assistance information report for the UE in RRC\_CONNECTED.  Proposal 8: For the case of eNB triggering UE to make GNSS measurements, UE report the GNSS position fix time duration for measurement when the NW indicate the UE to report it. FFS for the detail of the message. | CATT |
| [2] R2-2209835 | Proposal 3: GNSS position fix time duration and GNSS validity duration need to be introduced in the following Msg5 messages: RRCConnectionSetupComplete, RRCConnectionResumeComplete, RRCreestablishmentComplete, RRCConnectionReconfigurationComplete, RRCConnectionSetupComplete-NB, RRCConnectionResumeComplete-NB, RRCreestablishmentComplete-NB. | ZTE Corporation, Sanechips |
| [4] R2-2210097 | Proposal 2 GNSS position fix measurement time is reported in Msg5, e.g. RRCConnectionResumeComplete, RRCConnectionSetupComplete and RRCreestablishmentComplete messages. | OPPO |
| [5] R2-2210153 | Observation 1: How the UE reports GNSS assistance information is up to RAN2.  Proposal 1: RAN2 take GNSS assistance information reported in Msg5 as baseline. The details of GNSS assistance information wait for RAN1’s progress.  Proposal 2: Whether to introduce additional signaling for GNSS assistance information reporting can be further discussed if RAN1 agreed UE re-acquires GNSS position fix with a new gap. | CMCC |
| [7] R2-2210440 | Observation 1: Unlike GNSS location information, GNSS assistance information (i.e., position fix time duration and validity duration) does not require AS security since it provides no indication of the UE’s actual position.  Observation 2: Semi-static signaling (e.g. RRC) may not be suitable to report GNSS assistance information since position fix time duration and validity duration can vary dynamically based on UE characteristics (e.g. surroundings, UE speed).  Proposal 1: Introduce a new GNSS assistance information MAC CE, which contains at least GNSS position fix time and validity duration.  Proposal 2: GNSS assistance information is at least reported upon NW request. FFS other reporting trigger conditions.  Proposal 3: GNSS assistance information is reported when the UE detects that the GNSS validity duration changes by a configured threshold. | InterDigital |
| [8] R2-2210644 | Observation 1: The eNB can configure the UE’s GNSS measurement based on the GNSS assistance information reported by the UE.  Proposal 1: RAN2 to discuss when the UE reports GNSS assistance information including at RACH procedure, after completing a GNSS measurement in RRC Connected mode, and during handover procedure. | Nokia, Nokia Shanghai Bell |

According to the proposals list above, many companies proposed serval candidate solutions on the topic of GNSS position fix time duration for measurement. However these views are divergence due to the following factors:

* The variability characteristics of GNSS fix time, e.g. whether the GNSS position fix time duration maybe different for the same UE when getting GNSS at different time;
* The scenario when UE need to report the GNSS position fix time duration;
* The signalling used for report GNSS position fix time duration.

Hence, Rapporteur thinks the following issues need to be discussed firstly:

* **Issue 1: whether the GNSS position fix time duration for measurement keeps unchanged during the long connection mode for the same UE**

It is stated in [1] [7]that, the value of GNSS position fix time duration for measurement could vary depending on UE surroundings dynamically because of the change of the GNSS channel quality. And the report of the value of GNSS position fix time duration should be dynamical. However, it is stated in [2] that, the GNSS position fix time duration for measurement is generally determined by the GNSS mode, and for the whole duration of the connection, the GNSS mode is unchanged. Thus, GNSS position fix time duration can also keep unchanged. Therefore, it’s enough for UE to report GNSS position fix time duration only once via Msg5.

About this issue, RAN1 may already have some discussion when they discussed the report of GNSS position fix time duration for measurement, but more clear information is needed. So one option is RAN2 to check with RAN1, e.g. LS can be sent to RAN1 on this issue.

So Rapporteur would like to ask the following two questions:

**Question 1: For the issue, whether the GNSS position fix time duration for measurement keeps unchanged during the long connection mode for the same UE, which the following options is your preferred one?**

* **Option 1: The GNSS position fix time duration for measurement keeps unchanged during the long connection mode**
* **Option 2: The GNSS position fix time duration for measurement may change during the long connection mode**
* **Option3: UP to RAN1**

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| **Company** | **Option** | **Additional comments** |
| Lenovo | Option 3 | This is hardly in RAN2 scope and we prefer to ask RAN1 to further clarify this issue. |
| Samsung | Option 3 | How can option 1 be an option at all? GNSS measurements are highly uncertain.  Our understanding is that if a GNSS position fix time duration is ever to be reported it would be after a GNSS measurement has been performed. The eNB could not use the GNSS position fix time of one occasion and use it to make assumptions about the next GNSS position fix time. This is one of the main weaknesses of having GNSS measurements being performed in RRC connected mode. |
| MediaTek | Option 3 | This is not in RAN2 scope and should be on RAN1. IoT-NTN WID has clearly mentioned this in RAN1’s scope. |
| Intel | Option 3 | The FFS in RAN1 agreements means it needs to resolved by RAN1. If this FFS should be discussed in RAN2, RAN1 could have sent an LS to RAN2. |
| CATT | Option 2/Option 3 | We think the GNSS position fix time duration for measurement can be impacted by the GNSS channel quality, so it may change time to time. But we are also ok to check with RAN1. |
| Xiaomi | Option 3 | wait for RAN1 agreement on this |
| Nordic | Option 2/Option 3 | UE does not really know the time it takes to make a GNSS position fix in advance except at some granular level. It is fine to ask RAN1 view as well. |
| Nokia | Option 2 | The GNSS position fix time duration may change if the UE is in significantly different conditions (i.e. shadowed). Hence we don’t think Option1 is valid. |
| Qualcomm | Option 3 |  |
| NEC | Option3 | There is obviously different understanding in RAN2 and it is out of RAN2 expertise |
| InterDigital | Option 3 | Agree with Nokia that position fix may vary based on UE surroundings. However, we can wait for RAN1 to confirm. |
| Sequans | Option 3 |  |
| ZTE | Option 1/Option 3 | 1. Per our knowledge till now, GNSS position fix time duration for measurement is mainly determined by the GNSS mode, such as hot start, warm start. We assume that, after the UE successfully acquires GNSS position fix before accessing the NW, GNSS mode can keep unchanged for the whole duration of the connection, e.g., always in hot start mode or warm start mode, and so we think GNSS position fix time duration can also keep unchanged for the whole duration of the connection. 2. Now we're talking about what assistance information needs to be reported by UE. If as mentioned by some companies, GNSS position fix time duration may change very dynamically/frequently, we cannot understand why it can be listed as an assistance information. So in our assumption, as it is UE’s implementation to determine GNSS position fix time duration, UE can estimate and report an enough value for GNSS position fix time duration in order to guarantee enough time for re-acquire GNSS position fix in most cases. 3. In our understanding on how the eNB make use of this assistance information of GNSS position fix time duration, the eNB needs to exactly know the start time of GNSS re-acquisition and also length of time duration it takes for the UE to re-acquire GNSS position fix in connected mode (e.g., the GNSS position fix time duration for measurement). And then the eNB can stop scheduling for the UE within this time period when UE goes to reacquire GNSS (there is also proposal from other company that such assistance information of GNSS position fix time duration can help NW to configure a suitable gap for GNSS measurement, we think it may be possible but unnecessary). Therefore, if such GNSS position fix time duration may change very dynamically, UE report of this information would be useless, no matter such report occurs before a GNSS measurement will be performed or after a GNSS measurement has been performed. In other word, if the UE can report a relatively stable value for GNSS position fix time duration, it is enough to report this value only once during the RRC connection establishment. |
| OPPO | Option 3 | This is still under RAN1 discuss. We should wait for RAN1’s conclusion. |

**Rapporteur summary:**

**TBA…**

**Question 2: For the selection of Question 1, do you agree to send LS to confirm or check the view with RAN1?**

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| **Company** | **Yes/No** | **Additional comments** |
| Lenovo | Yes |  |
| Samsung | No | I think we can wait a bit with these details. |
| MediaTek | No | RAN1 is discussing this and we should let them to come up with their agreements. |
| Intel | No |  |
| CATT | Yes | For the progress of RAN2, we think it is useful to make this issue clear as early as possible. So LS can be sent to RAN1 to show RAN2 concern on this issue. Otherwise, it is difficult to make further progress on this issue in RAN2. |
| Xiaomi | No | We can just wait for RAN1 agreement |
| Nordic | Yes | Agree with CATT |
| Nokia | Yes | RAN2 can confirm with RAN1 on the understanding which is helpful for the following signalling design. |
| Qualcomm | No |  |
| NEC | No strong opinion | We need this information to continue RAN2 discussion, at the same time, RAN1 is discussing this aspect, we also can wait. |
| InterDigital | No | RAN1 is already aware and discussing |
| Sequans | No |  |
| ZTE | No strong opinion | Either waiting or sending a LS is fine.  If we decide to send a LS, we’d better explicitly ask how often this information of GNSS position fix time duration changes, and if it changes quickly, what is the intention to list it as GNSS assistance information. |
| OPPO | No |  |

**Rapporteur summary:**

**TBA…**

* **Issue 2: the scenario to report the GNSS position fix time duration for measurement**

It is stated in [1] that, the GNSS position fix time duration could be different at different time, it is better to be reported not too early than the time UE perform the GNSS measurement, and GNSS position fix time duration could be reported only when long connection mode is needed, so UE could report the GNSS position fix time duration for measurement when the NW indicate the UE to report it. [7] also stated GNSS assistance information is at least reported upon NW request.

In [8], company suggests thinking different scenarios for GNSS assistance information, for example, at RACH procedure (the starting point is that at RACH procedure the UE could provide the GNSS assistance information in Msg5), after completing a GNSS measurement in RRC Connected mode, and during handover procedure. [2][4] and [5] propose to report it in MSG5, which could be covered by “at RACH procedure”.

So Rapporteur suggests RAN2 discussing the scenarios of UE reporting GNSS position fix time duration for measurement

**Question 3: Do companies agree to take at least the following scenarios into consideration, for UE reporting GNSS position fix time duration for measurement?**

* **Upon network request**
* **During RACH procedure**
* **After completing a GNSS measurement**
* **During handover procedure**

**If any other scenario, please provide in the comments.**

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| **Company** | **Yes/No** | **Additional comments** |
| Lenovo |  | For now we only see the need of reporting upon network request. For other scenarios (RACH, GNSS complete and HO), we see no essential requirement of reporting and network can request UE to report if necessary. |
| Samsung | Upon network request | If a network needs the information, which it could determine via the already introduced *GNSS-ValidityDuration*, we think simply UEInformationRequest / UEInformationResponse can be used. This is commonplace for so-called assistance information such as the already introduced coarse GNSS location. |
| MediaTek | Upon network request | If the network needs and requests this, UE can report it. |
| Intel | Upon network request | It’s already agreed in RAN1. |
| CATT | Yes | We think we can make our discussion based on the listed scenarios. |
| Xiaomi | Upon network request | For others, wait for RAN1 progress on position fix time |
| Nordic | Yes | Prefer “upon network request”. |
| Nokia | Yes | We don’t think there is any agreement in RAN1 on the scenarios when UE should report the assistance information.  As mentioned in Q1, the GNSS position fix time duration may change during the connection. The fix time is determined by UE instead of network. Hence it is not possible for network to always request UE report the value at proper time.  In our view, all the scenarios listed are reasonable for further discussion. It can be further discussed whether UE should only report the value to NW if the value has changed. |
| Qualcomm | Upon network request | Lets wait RAN1 progress for others. |
| NEC |  | We do not really understand why discuss scenarios. If here we are discussing when to report GNSS position fix time duration for measurement. This should as part of the solutions, and it depends on whether this assistance information vary during the whole connection. |
| InterDigital | Yes | Can additionally consider conditional reporting (e.g. if position fix time duration changes more than a configured threshold). This would be a good compromise considering the different understandings of whether position fix time is semi-static or dynamic over the duration of connection. That scenario would accommodate both cases. |
| Sequans |  | That could be postponed after it is decided if fix time can change during the connection. |
| ZTE | During RACH procedure | Firstly, for this information, we don't see the necessity and feasibility of the eNB request because the eNB has no way to know whether and when this GNSS position fix time duration may change. A UE-side threshold may be a little feasible but it may be also difficult to configure such threshold.  Secondly, according to RAN1 progress, we only see the need of a NW trigger for triggering UE to make GNSS measurements, we see no any intention to let NW trigger UE to report GNSS assistance information.  Finally, as mentioned in Q1, if such GNSS position fix time duration may change very dynamically, we don’t see the necessity of reporting such information and we also cannot figure out when is the suitable timing for the reporting. Or if the UE can report a relatively stable value for GNSS position fix time duration, it is enough to report this value only once during the RRC connection establishment. |
| OPPO |  | It would depend on the result of issue1. If the GNSS position fix time duration for measurement keeps unchanged during a long RRC connection, reporting it during initial access is sufficient, and no need for any further report. |

**Rapporteur summary:**

**TBA…**

* **Issue 3: signalling used for report GNSS position fix time duration**

It is stated in [1] Msg5 is not suitable for GNSS assistance information report for the UE in RRC\_CONNECTED. And in [7], it is stated that Semi-static signaling (e.g. RRC) may not be suitable to report GNSS assistance information since position fix time duration and validity duration can vary dynamically based on UE characteristics suggest to introducing new GNSS assistance information MAC CE.

In [2], company thinks the GNSS position fix time duration for measurement is generally determined by the GNSS mode, and for the whole duration of the connection, the GNSS mode is unchanged. Thus, GNSS position fix time duration can also keep unchanged. Therefore, it’s enough for UE to report GNSS position fix time duration only once via Msg5. In [4], company thinks the GNSS measurement time can be reported in the same message with GNSS validity duration, i.e. Msg5. And in [5], the company think that, Msg5 can be used for GNSS assistance information report, if RAN1 agreed that UE re-acquires GNSS position fix during RLF procedure (option 1). Otherwise, if RAN1 agreed that UE re-acquires GNSS position fix with a new gap (option 2), the UE can also report the GNSS assistance information via other signaling, e.g. UE Assistance Information, and the new message may also be considered.

Rapporteur thinks that this issue is much related with the discussion result of issue 1 and issue 2. So Rapporteur suggests to postponing the discussion on this issue.

**Question 4: Do companies agree to postpone the discussion on the signalling used for report GNSS position fix time duration?**

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| **Company** | **Yes/No** | **Additional comments** |
| Lenovo | Yes |  |
| Samsung | Yes |  |
| MediaTek | Yes |  |
| Intel | Yes |  |
| CATT | Yes | More information is needed for the signalling discussion. |
| Xiaomi | Yes |  |
| Nordic | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| NEC | Yes |  |
| InterDigital | Yes |  |
| Sequans | Yes |  |
| ZTE | Fine to postpone since this seems the majority view |  |
| OPPO | Yes |  |

**Rapporteur summary:**

**TBA…**

### GNSS validity duration

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| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2209409 | Observation 1: Msg5 is not suitable for GNSS assistance information report for the UE in RRC\_CONNECTED.  Proposal 9: UE report the remaining GNSS validity duration when the UE recovery the connection with the NW after re-acquire the GNSS position without NW indication. FFS for the detail of the message. | CATT |
| [2] R2-2209835 | Observation 2: After re-acquisition of the GNSS in connected mode, UE will restart the counting of validate duration for GNSS position fix and the eNB should also know the (complete) GNSS validate duration in order to keep a consistent understanding with UE on the validate duration.  Proposal 3: GNSS position fix time duration and GNSS validity duration need to be introduced in the following Msg5 messages: RRCConnectionSetupComplete, RRCConnectionResumeComplete, RRCreestablishmentComplete, RRCConnectionReconfigurationComplete, RRCConnectionSetupComplete-NB, RRCConnectionResumeComplete-NB, RRCreestablishmentComplete-NB.  Proposal 4: UE don’t need to report GNSS position fix time duration and GNSS validity duration after each time UE finishes re-acquisition of GNSS position fix during connected mode. | ZTE Corporation, Sanechips |
| [5] R2-2210153 | Observation 1: How the UE reports GNSS assistance information is up to RAN2.  Proposal 1: RAN2 take GNSS assistance information reported in Msg5 as baseline. The details of GNSS assistance information wait for RAN1’s progress.  Proposal 2: Whether to introduce additional signaling for GNSS assistance information reporting can be further discussed if RAN1 agreed UE re-acquires GNSS position fix with a new gap. | CMCC |
| [6] R2-2210406 | Proposal 2: Support the aperiodic triggering by network. | Huawei, HiSilicon |
| [7] R2-2210440 | Proposal 1: Introduce a new GNSS assistance information MAC CE, which contains at least GNSS position fix time and validity duration.  Proposal 2: GNSS assistance information is at least reported upon NW request. FFS other reporting trigger conditions.  Proposal 3: GNSS assistance information is reported when the UE detects that the GNSS validity duration changes by a configured threshold. | InterDigital |
| [8] R2-2210644 | Observation 1: The eNB can configure the UE’s GNSS measurement based on the GNSS assistance information reported by the UE.  Proposal 1: RAN2 to discuss when the UE reports GNSS assistance information including at RACH procedure, after completing a GNSS measurement in RRC Connected mode, and during handover procedure. | Nokia, Nokia Shanghai Bell |

In [1], company thinks the UE should report its GNSS validity duration after each GNSS measurement during the RRC\_CONNECTED state. In [6], company thinks the validity duration depends on UE speed which may change and not predictable for a very long time. So aperiodic triggering by network can be supported to allow flexible and efficient configuration. And in [7], company thinks the GNSS validity duration can change larger than a configured threshold.

But in [2] company thinks the GNSS validity duration can be kept same during the whole connection, so UE can report the GNSS validate duration information via Msg5, and UE don’t need to report GNSS validity duration after each time UE finishes re-acquisition of GNSS position fix during the connected mode.

In [5], company thinks that, Msg5 can be used for GNSS assistance information report, if RAN1 agreed that UE re-acquires GNSS position fix during RLF procedure (option 1). Otherwise, if RAN1 agreed that UE re-acquires GNSS position fix with a new gap (option 2), the UE can also report the GNSS assistance information via other signaling, e.g. UE Assistance Information, and the new message may also be considered.

Even GNSS validity duration via Msg5 has been supported in Rel-17, considering the UE may also need to report its GNSS validity duration after each GNSS measurement during the RRC\_CONNECTED state, GNSS validity duration via Msg5 maybe not sufficient.

So, Rapporteur suggests discussing the following two questions:

**Question 5: Do companies think other signalling apart from Msg5 is needed for GNSS validity duration report?**

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| **Company** | **Yes/No** | **Additional comments** |
| Lenovo | Postpone | We think this issue is similar to Issue 3 and could be postponed for now.  If RAN1 choose option 1 (UE re-acquires GNSS position fix during RLF procedure), Msg5 can be sufficient.  If RAN1 choose option 2 (UE re-acquires GNSS position fix with a new gap) or both Option 1 and Option 2, other signalling apart from Msg5 is needed. |
| Samsung | No | No, we do not think it is needed. In fact, we think that the measurements should be performed in RRC idle mode as the general notion of performing a measurement in RRC connected mode for an unspecified time will clash with a lot of RRC connected mode procedures, such as RLF, acquiring uplink sync validity etc. If a UE is released to RRC idle mode to perform a GNSS measurement, then when it re-connects it will report the GNSS validity duration in Msg5. |
| MediaTek | No | We should wait for RAN1, but as of now, msg 5 seems sufficient. |
| Intel | No | Wait for RAN1 |
| CATT | Yes | GNSS validity duration via Msg5 has been supported in Rel-17, which is about the GNSS validity duration of the GNSS measurement performed in RRC\_IDEL/RRC\_INACTIVE state.  But we think the issue discussed here is more about the GNSS validity duration of the GNSS measurement re-performed after UE entering RRC\_CONNECTED, which may be different from the value reported in Msg5. So the UE needs to report the updated value of GNSS validity duration. However, Msg5 may not be suitable any more. Therefore, other signalling is needed.  Certainly, Msg5 based solution is OK for Option 1, e.g. UE re-acquiring GNSS position fix during RLF procedure. |
| Xiaomi | No | Wait for RAN1 |
| Nordic | No | Currently Msg5 seems adequate. |
| Nokia | Yes | Agree with Lenovo this issue is similar to Issue3. In our view validity duration after each GNSS measurement may change. During the long connection, other signalling apart from Msg5 is needed. |
| Qualcomm | Postpone | We need to confirm if duration can change. |
| NEC | Probably yes | Unless as other companies point out that UE always re-acquires GNSS position fix during RLF procedure, and the total GNSS validity duration does not change after GNSS fix |
| InterDigital | Yes | Agree with Nokia. The validity duration is particularly dependant on UE circumstances (e.g. speed), so may need to be updated during connection, in which case other signalling (e.g. MAC CE) is needed. Also okay to wait for more progress in RAN1. |
| Sequans | Postpone | We can wait for more progress in RAN1. |
| ZTE | Yes for Msg5  No for other signaling | We want to clarify that in R17, only the GNSS remaining time, not the whole GNSS validity duration, has been reported to NW via Msg5. The eNB can deduce the start time of (the first) GNSS re-acquisition based on the GNSS remaining time and may take some implementation optimization, e.g., to release the UE before the GNSS fix become invalid to avoid the resource from being hung for a long time.  As we have analysed in our contribution, if UE is allowed to re-acquire GNSS fix (maybe for several times) during a long connection duration, only the GNSS remaining time would not be enough. That is, after re-acquisition of the GNSS in connected mode, UE will restart the counting of validate duration for GNSS position fix (for the whole GNSS validity duration). But as eNB only has the previous GNSS remaining time information, eNB and UE cannot be aligned about validity duration of GNSS anymore. For addressing this issue, the straightforward way is to let UE also report the whole GNSS validity duration to the NW.  In a summary, for R18 GNSS enhancement, we think to report the whole GNSS validity duration in Msg5 would be a basic solution.  There may be further thinking that the whole GNSS validity duration may also change dynamically (depends on UE speed?), and therefore it should be reported after each time UE re-acquire GNSS fix in connected mode. In our assumption, GNSS validity duration may be mainly related to UE capability and we are not clear why it can be impacted by UE speed. Then we’d better to wait for more RAN1 clarification. Even this is a case, we can add a scheme for only delta report on top of Msg5 report. |
| OPPO | Postpone | It would depend on whether GNSS validity duration keeps unchanged during a long RRC connection, which is still under RAN1 discussion. We prefer to wait for RAN1’s conclusion. |

**Rapporteur summary:**

**TBA…**

## GNSS measurement gap configuration

In RAN1#109e, RAN1 has studied the case for IoT devices performing GNSS measurement during connected mode, and identified below two options.

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| **Agreement**  At least the following options can be considered on GNSS measurement in connected for potential enhancements for improved GNSS operations:   * Option 1: UE re-acquires GNSS position fix during RLF procedure * Option 2: UE re-acquires GNSS position fix with a new gap   Note: this does not imply that a Rel-18 IoT NTN UE is mandated to support one or both of the options. |

For the Option 2 above, a new measurement gap is needed for UE performing GNSS position fix re-acquisition. How to configure the measurement gap needs to be discussed.

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| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2209409 | Proposal 3：The GNSS measurement should not be started before the GNSS position becoming out-of-date.  Proposal 4：For the end time of the GNSS measurement, RAN2 can wait the discussion of RAN1.  Proposal 5：NW should configure a gap via explicit RRC signalling for GNSS measurement. | CATT |
| [2] R2-2209835 | Observation 1: The eNB needs to exactly know the length of time duration it takes for the UE to re-acquire GNSS position fix in connected mode (e.g., the GNSS position fix time duration for measurement) so that the eNB can stop scheduling for the UE within this time period when UE goes to reacquire GNSS. | ZTE Corporation, Sanechips |
| [6] R2-2210406 | Proposal 1: RAN2 discusses how to enable UE in RRC\_CONNECTED to perform GNSS fix during a gap.  Proposal 3: Use the MAC CE to configure the measurement gap for GNSS position fix. | Huawei, HiSilicon |

In [1], company thinks that, the GNSS measurement should not be started before the GNSS position becoming out-of-date, and the end of the GNSS measurement depends on more RAN1 inputs, e.g. whether the UL re-synchronization is always needed after the GNSS measurement. Anyway, a GNSS measurement gap is always needed, and should be configured by network via explicit signalling.

In [2], company thinks that, eNB needs to exactly know the start time of GNSS re-acquisition and also length of time duration it takes for the UE to re-acquire GNSS position fix in connected mode. And the start time of GNSS re-acquisition can be deduced by the GNSS remaining time but time duration cannot be known based on current specification. So, UE report of GNSS position fix time duration would be needed.

In [6], company thinks that, the RRC reconfiguration is not supported for CP CIoT of NB-IoT, and for MAC CE signaling, the current specification on DL MAC CE signaling activation can be reused for the start of the next GNSS measurement. So the MAC CE is better so that IoT NTN can use the unified solutions. Considering the CP CioT of NB-IoT, Rapporteur wonders the necessity of keeping long connection.

RAN1 has no clear agreement on which option to be selected, but companies have already some discussion on gap configuration. So Rapporteur would like to ask the following question:

**Question 6: For option 2 (UE re-acquires GNSS position fix with a new gap), which following option is your preferred one to configure the GNSS measurement gap?**

* **Option 1: explicitly signalling**
  + **Option 1-1:RRC signalling**
  + **Option 1-2: MAC CE**
* **Option 2: implicit way, e.g. deduced by the GNSS remaining time and GNSS position fix time duration**
* **Option 3: others**

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| **Company** | **Option** | **Additional comments** |
| Lenovo | Option 1 | Based on the need of position fix from network, at least explicit signalling is needed. |
| Samsung | Option 3 | We think that RAN2 should really consider whether GNSS measurement gaps are suitable. In fact, RAN1 has not yet stated that GNSS measurement gaps are to be introduced, but rather stated the two options for performing GNSS measurements. Furthermore we are not sure RAN1 has considered the implications of the UE going away for potentially seconds in RRC connected mode. |
| MediaTek | Postpone | This is dependent on RAN1’s potential agreements and RAN2 should wait for such agreements. |
| Intel | Postpone | RAN1 conclusion (not available yet) should be the starting point for further RAN2 discussion. |
| CATT | Option 1 or Option 3 | We think based on the precondition of “For option 2 (UE re-acquires GNSS position fix with a new gap)”, we think Option 1 is needed.  It is indeed not clear whether measurement gap will be introduced based on RAN1 agreements, as Samsung stated, so we are also ok to Option 3 or postpone the discussion of this issue. |
| Xiaomi | postpone | Wait for RAN1 progress |
| Nordic | postpone | Wait for RAN1 progress but for this specific question options bias towards Option 3. |
| Nokia | Option 1 | With the assumption that UE re-acquires GNSS position fix with a new gap , NW and UE should have a common understanding on the gap so explicitly signalling is preferred considering the GNSS fix time duration is dynamically changed. |
| Qualcomm | Postpone |  |
| NEC |  | We need to wait for RAN1 agreement on which option will be selected first. |
| InterDigital | Option 1/Postpone | Agree NW and UE should have common understanding which is best achieved via explicit signalling, however as mentioned by others we may need to wait for RAN1. |
| Sequans | Postpone | Wait for RAN1 |
| ZTE | Option 2 | If we can guarantee that the UE report of GNSS assistance information is reliable, we think it’s enough to use the implicit way, e.g. NW can deduce when the UE will start the re-acquisition of GNSS fix and how long the re-acquisition will last, based on knowledge of the GNSS remaining time/GNSS validity duration and GNSS position fix time duration. And then the eNB can stop scheduling for the UE within this time period when UE goes to re-acquire GNSS.  If implicit way is feasible, we see no reason to introduce explicit way (e.g., to explicitly configure a GNSS measurement gap), provided that it must cause more signalling overhead and UE power consumption.  Furthermore, as GNSS re-acquisition during connected mode would anyway cause service transmission interruption, we are strongly against kind of complicated scheme, e.g, GNSS measurement gap could cover the length of several GNSS position fix time durations reported by UE. |
| OPPO | postpone | RAN1 has not reached agreement to support gap based GNSS measurement so far, we think it is too earlier to discuss this. |

**Rapporteur summary:**

**TBA…**

## UE behaviour if the UE can’t re-acquire GNSS position fix during the GNSS measurement gap duration

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| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2209409 | Proposal 6: The UE should be allowed to perform several times of GNSS measurement attempts based on suitable network configuration.  Proposal 7: The UE behaviour related to GNSS measurement:   * If the UE will re-acquire UL synchronization after GNSS measurement   + the UE informs the finish of GNSS measurement to network by RACH procedure   + the UE and the network should let the UE leave the RRC\_CONNECTED if the UE cannot re-acquire the GNSS position before or at the end of the measurement gap. * If the UE will not re-acquire UL synchronization after GNSS measurement   + the UE may need not inform the finish of GNSS measurement to network   + the UE and the network should let the UE leave the RRC\_CONNECTED if the UE cannot re-acquire the GNSS position after N times of measurement gap | CATT |
| [4] R2-2210097 | Proposal 1 UE should go back to IDLE mode if it cannot acquire its GNSS location during connected mode (e.g. before timer expiry or within the gap duration). | OPPO |

In [1], it is stated that, the UE behaviour if the UE cannot acquire the GNSS position fix during the GNSS measurement gap duration depends on whether the UE will re-acquire UL synchronization after GNSS measurement, for which more RAN1 input is needed.

It [4], company thinks UE is expected to complete the GNSS measurement during the timer running or the gap duration, and in case UE cannot acquire its GNSS location, UE should return back to IDLE mode as the fallback solution.

Rapporteur thinks that, the UE behaviour if the UE cannot acquire the GNSS position fix during the GNSS measurement gap duration depends on the concept of GNSS measurement gap, which may need more information from RAN1, e.g. whether the UE will re-acquire UL synchronization after GNSS measurement.

So Rapporteur would like to ask the following question:

**Question 7: Do you agree that RAN2 to postpone the discussion of UE behaviour if the UE cannot acquire the GNSS position fix during the GNSS measurement gap duration?**

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| **Company** | **Option** | **Additional comments** |
| Lenovo | Yes (postpone) | Discussed in RAN2#119. |
| Samsung | Yes |  |
| MediaTek | Yes (Postpne) |  |
| Intel | Yes (postpone) |  |
| CATT | Yes |  |
| Xiaomi | Yes |  |
| Nordic | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| NEC | Yes |  |
| InterDigital | Yes |  |
| Sequans | Yes |  |
| ZTE | Fine to postpone since this seems the majority view | For clarification, we think the issue (issue#1) of UE behaviour if the UE can’t re-acquire GNSS in GNSS measurement gap or GNSS position fix duration is different from the issue (issue#2) of whether the UE will re-acquire UL synchronization after GNSS measurement.  Issue #1 is about exceptional case handling. We think the way mentioned in [4] may be straightforward. The discussion on issue#2 may need more RAN1 inputs. |
| OPPO | Yes |  |

**Rapporteur summary:**

**TBA…**

## Others

There are some other proposals, mentioned by only one or two companies’ contribution, or more information is needed before the discussion. Rapporteur thinks these proposals can be discussed separately if time is allowed, or can be postponed.

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| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2209409 | Proposal 1：By default, Rel-18 IoT NTN UE will follow the Rel-17 IoT NTN UE procedure to leave RRC\_CONNECTED upon indication of out-of-date GNSS position, unless the eNB has triggered the UE to make GNSS measurements during RRC connected state. For the option of UE triggering the UE to make GNS measurements, more RAN1 inputs (if they will) are needed.  Proposal 2：RAN2 discuss the following options for negotiation of long connection mode:   * Option 1: Negotiation of long connection mode is needed before each time the GNSS position becoming out-of-date * Option 2: Keep the UE at connection mode after one time negotiation of long connection mode   Proposal 6: The UE should be allowed to perform several times of GNSS measurement attempts based on suitable network configuration.  Proposal 7: The UE behaviour related to GNSS measurement:   * If the UE will re-acquire UL synchronization after GNSS measurement   + the UE informs the finish of GNSS measurement to network by RACH procedure   + the UE and the network should let the UE leave the RRC\_CONNECTED if the UE cannot re-acquire the GNSS position before or at the end of the measurement gap. * If the UE will not re-acquire UL synchronization after GNSS measurement   + the UE may need not inform the finish of GNSS measurement to network   + the UE and the network should let the UE leave the RRC\_CONNECTED if the UE cannot re-acquire the GNSS position after N times of measurement gap | CATT |
| [2] R2-2209835 | Proposal 1: For R18 IoT NTN, if the out-of-sync evaluation period is longer than the GNSS position fix time duration, UE could re-acquire GNSS position fix within GNSS position fix time duration.  Proposal 2: For R18 IoT NTN, eNB could trigger UE to re-acquire GNSS position fix within GNSS position fix time duration via RRC message. | ZTE Corporation, Sanechips |
| [3] R2-2209966 | Observation 1: UE position can be roughly determined by multiple timing advance values to its serving cell in different time points, without re-acquiring the GNSS.  Observation 2: UE position can be roughly determined by UE propagation delays or differential propagation delays to multiple satellites, without re-acquiring the GNSS.  Proposal 1: RAN2 to consider enhancements to timing advance or propagation delay calculation for position fix purposes, to reduce the need to update GNSS position fix in long connection time. | Lenovo |
| [7] R2-2210440 | Observation 3: Excessive acquisition and reporting of GNSS information can lead to unnecessary power consumption and lower throughput.  Proposal 4: Introduce a new prohibit timer to prevent excessive acquisition and reporting of GNSS information. | InterDigital |
| [8] R2-2210644 | Proposal 2: RAN2 to study alternatives to RRC configuration of GNSS measurements for UE relying on the CP solution.  Proposal 3: RAN2 to discuss whether GNSS reacquisition is always needed for short RRC Idle periods during a long data transmission duration. | Nokia, Nokia Shanghai Bell |
| [9] R2-2210703 | Observation 1: The varying nature of GNSS measurements could make it difficult for the network to setup measurement gaps or timers for the UE to perform GNSS measurements.  Observation 2: With a GNSS measurement taking several seconds, a LEO NTN cell might still not be present.  Observation 3: The UE is not expected to measure serving or neighbouring cells during GNSS measurements.  Observation 4: Uplink synchronization might also expire during GNSS measurement being performed.  Proposal 1: RAN2 to discuss whether GNSS measurements in connected mode is feasible or a sensible solution for IoT NTN.  Proposal 2: RAN2 to consider solution to perform GNSS measurement in RRC idle or in inactive mode for longer connection times. | Samsung |

And Rapporteur would like to ask the following question:

**Question 8: Do companies have strong concern to postpone the discussion of the proposals listed above?**

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| **Company** | **Comments** |
| Samsung | Yes. We really think that RAN2 should have a discussion regarding some of the issues being proposed on performing GNSS measurements in RRC connected mode as this will have very large impact on RRC connected mode procedures. In fact only in this list of proposals we have several reasons why it will take a lot of work to introduce this:  **Problems with UL synchronization during performing GNSS measurments**  [1] *Proposal 7: The UE behaviour related to GNSS measurement:*   * *If the UE will re-acquire UL synchronization after GNSS measurement*   + *the UE informs the finish of GNSS measurement to network by RACH procedure*   + *the UE and the network should let the UE leave the RRC\_CONNECTED if the UE cannot re-acquire the GNSS position before or at the end of the measurement gap.*   **Problems with RLF operation**  [2] *The missing samples in RLM during GNSS position fix time duration may trigger out-of-sync indication from PHY to RRC, and even finally trigger a RLF, especially for cell edge UE.*  **Unable to re-configure an NB-IoT (CP-solution) UE (to include RRC measurement gaps)**  [8] *Proposal 2: RAN2 to study alternatives to RRC configuration of GNSS measurements for UE relying on the CP solution.* |
| MediaTek | These issues should be postponed until further enhancements and agreements are made in RAN1 |
| Intel | Agree with MTK |
| Qualcomm | No. |
| Sequans | No |
| ZTE | We agree we should firstly focus on the basic issues as discussed in previous questions.  Only one thing we want to indicate that (may be same important as the previous questions), it seems RAN1 has agreed that eNB needs to trigger UE to make GNSS measurements. From RAN2 perspective, we understand it means, NW needs to indicate UE whether GNSS measurements/ re-acquisition during connected mode is allowed. So we need to discuss whether and how to introduce such NW indication. |

**Rapporteur summary:**

**TBA…**

# Conclusion

**TBA…**

# Reference

1. R2-2209409 Discussion on the issues of GNSS operation in connected mode CATT discussion Rel-17 IoT\_NTN\_enh
2. R2-2209835 Further discussion on GNSS enhancements ZTE Corporation, Sanechips discussion Rel-17 IoT\_NTN\_enh
3. R2-2209966 Considerations on reducing UE GNSS operations in long connection time Lenovo discussion Rel-17 IoT\_NTN\_enh
4. R2-2210097 Discussion on GNSS operation in connected mode OPPO discussion Rel-17 IoT\_NTN\_enh
5. R2-2210153 Discussion on the GNSS enhancement for IoT-NTN CMCC discussion Rel-17 IoT\_NTN\_enh
6. R2-2210406 Discussion on GNSS operation Huawei, HiSilicon discussion Rel-17 IoT\_NTN\_enh
7. R2-2210440 GNSS acquisition and reporting for IoT NTN InterDigital discussion Rel-17 IoT\_NTN\_enh
8. R2-2210644 Regarding GNSS operation enhancements for IoT NTN Nokia, Nokia Shanghai Bell discussion Rel-17 IoT\_NTN\_enh
9. R2-2210703 On improved GNSS operation for IoT NTN Samsung R&D Institute UK discussion Rel-17 IoT\_NTN\_enh