**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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| **Company** | **Name** | **Email** |
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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** |
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**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** |
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**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** |
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**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** |
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**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** |
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**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** |
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**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** |
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**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** |
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**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