**3GPP TSG-RAN WG2 Meeting #121bis-e R2-2304244**

**Online, 17th – 26th April, 2023**

**Agenda item: 7.6.2.2**

**Source: MediaTek Inc.**

**Title: [AT121bis-e][104][IoT NTN Enh] GNSS operation enhancements (Mediatek)**

**Document for: Discussion and Decision**

# 1 Introduction

This document is aimed at discussing on the open issues, related to GNSS operation enhancement of IoT-NTN and identify potential agreements for possible convergence.

* [AT121bis-e][104][IoT NTN Enh] GNSS operation enhancements (Mediatek)

Initial scope: Discuss the proposals in the submitted contributions in AI 7.6.2.2

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)

**Deadline for companies' feedback**: Wednesday 2023-04-19 18:00 UTC

Deadline for rapporteur's summary (in R2-2304244): Wednesday 2023-04-19 20:00 UTC

# 2 Contact

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| --- | --- |
| Company | Delegate Contact |
| MediaTek | Abhishek Roy (Abhishek.Roy@mediatek.com) |
| OPPO | Haitao Li (lihaitao@oppo.com) |
| Intel | Tangxun (xun.tang@intel.com) |
| Nokia | Ping Yuan (Ping.1.Yuan@nokia-sbell.com) |
| Samsung | Jonas Sedin (j.sedin@samsung.com) |
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# 3 Discussion

In R-18 IoT-NTN Work Item Description (WID), further enhancement to GNSS operation has been proposed, as mentioned in table below:

Table 1: GNSS operation enhancement in R-18 IoT-NTN WID

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| 4.1.1 IoT-NTN Performance Enhancements in Rel-18 to address remaining issues from Rel-17This 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:- 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.*
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Based on these WID objectives, several companies have provided contributions in RAN2-121bis-e. These contributions are categorized into different categories for possible discussion and agreements:

## 3.1 GNSS position fix time duration

* **RRCReestablishmentComplete and RRCConnectionReconfigurationComplete messages.**

In last RAN2 meeting, an open issue was left as:

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| For UE to report GNSS position fix time duration for measurement during the initial access, at least the following Msg5 message can be used:  RRCConnectionSetupComplete, RRCConnectionSetupComplete-NB,  RRCConnectionResumeComplete, RRCConnectionResumeComplete-NB, FFS for RRCreestablishmentComplete and RRCConnectionReconfigurationComplete. FS for Msg3 |

Contributions in [1], [2], [3], [4], [9], [10], [11], [12], [15], [16] have mentioned about whether to report GNSS position fix time duration in RRCReestablishmentComplete(-NB) and RRCConnectionReconfigurationComplete messages. The 8 companies think it needs to be reported and 4 companies think it is not needed. Based on these contributions the rapporteur would like to ask the following question:

**Question 1: Do companies agree that UE should report the GNSS position fix duration in RRCReestablishmentComplete(-NB) and RRCConnectionReconfigurationComplete messages?**

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Disagree | UE has reported the GNSS position fix duration during initial access and that will be stored as UE’s context in network side and that is sufficient for network to know for connected mode UE.  |
| Intel | Disagree | Agree with Oppo’s view |
| Nokia | Agree | In Rel-17, GNSS validity duration was agreed to be reported in RRCReestablishmentComplete(-NB) and RRCConnectionReconfigurationComplete messages. We don’t see motivation to differentiate the behaviour for GNSS position fix duration hence introduce more complexity. Furthermore, we think the GNSS position fix time duration maybe dynamically changed during the long connection if the UE starts moving or the (GNSS) propagation conditions changed a lot (e.g, shadowed). It is not reasonable to add a dynamic changed parameter as part of UE context (for inter-node information exchange). |
| Samsung | Disagree | We think it can be reported via UEInformationRequest/Response as it is not crucial.  |
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**Rapporteur Summary**

* **Msg3**

In last RAN2 meeting, an open issue was left as:

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| For UE to report GNSS position fix time duration for measurement during the initial access, at least the following Msg5 message can be used:  RRCConnectionSetupComplete, RRCConnectionSetupComplete-NB,  RRCConnectionResumeComplete, RRCConnectionResumeComplete-NB, FFS for RRCreestablishmentComplete and RRCConnectionReconfigurationComplete. FS for Msg3 |

Contributions in [1], [4], [14] tender to no need to for UE to provide GNSS position fix time duration in Msg3.

Contribution [16] thinks it may be beneficial in some cases to already transmit the GNSS assistance information in Msg3, in case there is sufficient UL grant available.

Based on these contributions the rapporteur would like to ask the following question:

**Question 2: Do companies agree that it is no need for UE to provide GNSS position fix time duration in Msg3?**

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| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Agree | It is not urgent to provide it in Msg3 as normally NW will use it after Msg5. Plus, Msg3 has a size limitation. |
| Intel | Agree |  |
| Nokia | Agree |  |
| Samsung | Agree | There is no motivation to have it in Msg3. And no need to overload msg3 and make scheduling more difficult.  |
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**Rapporteur Summary**

* **Report of GNSS position fix time duration in connected mode**

This issue was discussed in the last RAN2 meeting and was postponed. Contribution [3] and [8] think GNSS fix time duration report is not needed during RRC connection. Contribution [10] thinks we can wait for RAN1’s progress. Contributions [12],[14] think UE reports GNSS fix time duration UEInformationRequest /UEInformationResponse which imply it can be reported in RRC connected. Since this issue is still open in RAN1, rapporteur suggest we wait for the progress in RAN1.

**Question 3: Do companies agree that we wait for the progress in RAN1 about UE report GNSS position fix time duration in RRC connected?**

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Agree with comments | We can wait for RAN1, but this is only about whether GNSS position fix time will change in RRC connected and whether reporting GNSS position fix time is triggered by its change. This should be decoupled with Q1 as the two RRC messages in Q1 are also related to RRC connected mode. |
| Intel | Agree |  |
| Nokia | Agree |  |
| Samsung | Disagree | We do not think that we need to leave this to RAN1.  |
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**Rapporteur Summary**

## 3.2 Leaving RRC Connected State

In last RAN2 meeting an open issue was left as:

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| 2.FFS whether the UE can stay in RRC\_CONNECTED state when current GNSS position becoming out-of-date if the UE has initiated a new measurement |

Contributions in [3], [5],[7], [10], [14] thinks UE can stay in RRC connected mode, Contribution [11] think we should wait for RAN1 conclusion on the mechanisms to allow UL transmission after original GNSS validity duration expires without GNSS re-acquisition.

Based on the majority view, rapporteur would like to ask the following question:

**Question 4: Do companies agree that UE can stay in RRC\_CONNECTED state when current GNSS position becoming out-of-date if the UE has initiated a new measurement?**

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| **Company** | **Agree/Disagree** | **Comments** |
| OPPO |  | Maybe we should first discuss whether to stop the current GNSS valid timer if the UE has initiated a new measurement since anyway UE will have a new GNSS valid timer to start after GNSS measurement. Then we don’t need to consider the case of current GNSS validity timer’s expiry during GNSS measurement. |
| Intel | Agree | It’s unnecessary to let UE go to Idle if the GNSS coordinates can be acquired soon. |
| Nokia | Agree the revised the proposal. | We think the new GNSS measurement performed by UE should be started no later than the validity duration expiry or upon the expiry of the validity duration. Otherwise, it is not clear whether UE is allowed to perform UL transmission during the period in between the timer expiry and the start of measurement gap for GNSS measurement. So, we proposed as below:* *UE can stay in RRCCONNECTED state when current GNSS position becoming out-of-date if a new GNSS measurement* ***is performing*** *by the UE or* ***is to be performed*** *by the UE upon the validity duration expiry.*

On the new mechanism to allow UL transmission after original GNSS validity duration expires **without GNSS re-acquisition**, it is a different issue. We can wait for RAN1 progress. |
| Samsung | Agree | To OPPO: The GNSS validity duration is not really defined as a timer. And we think that it will be more complicated to define a stop and then a start. We have spec text on how this can be solved in R2-2304017. We are not sure with the clarification by Nokia. We think that if the GNSS validity is out-of-date and UE has not started a measurement, then it should go to idle mode as legacy. It needs to be started before the GNSS validity is out-of-date and the text seem to imply that it is about to be started. Agree with the clarification by Nokia, but we think that the agreement should be:**Proposal 4: UE can stay in RRC\_CONNECTED state when current GNSS position is out-of-date if the UE has initiated a new measurement before the GNSS becomes outdated according to GNSS validity duration.**  |
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**Rapporteur Summary**

**3.3 GNSS validity duration report**

* **Remaining validity duration or whole validity duration**

In last RAN2 meeting an open issue was left as:

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| 4.UE reports GNSS validity duration after GNSS measurement. FFS whether the UE reports every time or only if the validity duration changes. FFS if the duration is the remaining validity duration or the whole duration |

Contributions in [1], [2], [3], [5], [7],[9],[10],[11],[14],[15], [16] think the duration should be remaining validity duration while the contributions in [4],[8],[13] think the duration can be the whole duration.

Based on the majority view, rapporteur would like to ask the following question:

**Question 5: Do companies agree that the GNSS validity duration UE reported after GNSS measurement is the remaining validity duration?**

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Agree | Only remaining valid duration is useful for network to schedule the right timing of GNSS measurement gap. |
| Intel | **Agree** |  |
| Nokia | Agree | Following Rel-17 principle is fine. |
| Samsung | Agree | Same as Rel-17.  |
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**Rapporteur Summary**

* **GNSS validity report (MAC CE or RRC signalling)**

RAN1 has agreed that the GNSS validity report is via UL MAC CE.

Contributions in [2], [3], [5], [8],[9],[10],[15], [16] think GNSS validity duration is reported by UE via MAC CE.

Contribution in [12] think GNSS validity should be reported via UEInformationResponse and UEInformationResponse-NB.

Based on the majority view, rapporteur would like to ask the following question:

**Question 6: Do companies agree that the GNSS validity duration should be reported via MAC CE?**

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Agree |  |
| Intel | Agree |  |
| Nokia |  | We can accept majority view (via MAC CE). |
| Samsung | Disagree | We do not think that these procedures should be in MAC at all. The reasons are: * The GNSS out-of-date handling is specified in RRC in Rel-17
* The GNSS position fix time we have agreed to report in RRC messages
* If we have UE-triggered GNSS measurements, these are likely triggered in RRC based on RRC configuration

Furthermore, in question Q4, we are discussing how to deal with the GNSS measurement related to current RRC procedures. In Q11 we are discussing connection between RLF and GNSS measurements and in Q12 we are discussing problems related to another RRC procedure. Do we really want to specify indications in-between MAC and RRC in these cases just because RAN1 made an uninformed decision?Our proposal is: **Proposal 6: GNSS measurements are triggered in RRC using an RRC command and GNSS validity duration reported via RRC.**  |
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**Rapporteur Summary**

* **Report GNSS validity duration (every time vs. only if the validity duration changes)**

In last RAN2 meeting an open issue was left as:

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| 4.UE reports GNSS validity duration after GNSS measurement. FFS whether the UE reports every time or only if the validity duration changes. FFS if the duration is the remaining validity duration or the whole duration |

Contributions in [1], [2], [9],[14], [15],[16] think the UE always report the GNSS validity duration after GNSS measurement. Contributions in [3], [8], [10], [11] think the UE should report only if the validity duration changes.

Based on the majority, rapporteur would like to ask the following question:

**Question 7: Do companies agree that the UE always report the GNSS validity duration after GNSS measurement?**

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| --- | --- | --- |
| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Agree |  |
| Intel | Disagree | Optimization is needed to save UE power if the GNSS validity duration doesn’t change all the time. |
| Nokia | Disagree | If the GNSS validity duration is not changed at all, repeat the same reporting is a waste of UE’s power consumption. |
| Samsung | Agree | We do not see any need of having optimizations here. Power saving is a bad argument – the power consumption due to performing a GNSS measurement will be several magnitudes larger compared to sending the report. This just makes the procedures more complicated for very weak reasons.  |
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**Rapporteur Summary**

* **One or more attempts of GNSS measurement**

Contributions in [5], [7],[9] think when UE failed to obtain GNSS fix during the GNSS measurement gap, UE moves to idle. Contributions in [2], [3], if UE failed on getting GNSS fix, and there is another configuration that allows UE can do GNSS measurement again, UE can try another attempts of GNSS measurement.

Based on the contributions, rapporteur would like to ask the following question:

**Question 8: Do companies agree to allow multiple attempts of GNSS measurement when it is possible?**

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| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Disagree | If GNSS measurement during gap fails, then we don’t see any better chance to succeed using UE autonomous measurement supposing that GNSS coverage remains the same. In our understanding, UE autonomous GNSS measurement is only useful when UE has not received/tried the gap-based measurement requested by the network and GNSS validity timer expires. |
| Intel | Disagree | We prefer “UE moves to idle” in this case. |
| Nokia | Disagree | Similar view as OPPO. |
| Samsung | Disagree | Will be very complicated for the network to handle UEs if they can stay in connected and come back after several GNSS measurement attempts.  |
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**Rapporteur Summary**

## 3.4 GNSS Measurement trigger

* **eNB aperiodcally trigger via MAC CE or RRC signalling**

RAN1 has agreement that the eNB aperiodcally trigger is via MAC CE. But in the last RAN2 meeting, companies have security concern on MAC CE, as it is not protected by AS security. if an attacker sends this triggering MAC CE – the UE would stop communicating and disappear from the network’s point of view.

Contributions in [2], [3], [9], [10] think eNB aperiodcally trigger is via MAC CE. Contributions in [12],[14] think it is via RRC signalling. Contribution in [8] thinks it can be RRC signalling, or DCI based.

Since RAN1 has made agreement on MAC CE, and RAN2 has divergence on this issue, rapporteur would like to ask the following question:

**Question 9: Do companies agree to send LS to RAN1 for RAN2’s security concern?**

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| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Disagree | We don’t see any security issue here, similar as other MAC CEs. Also RAN1 is not in the position to discuss/resolve security issues. |
| Intel | Disagree | If there is security concern, we could consult SA3 and CC RAN1. |
| Nokia | Disagree |  |
| Samsung | Disagree | No need for this. There are several other cases where using MAC CE causes a UE to go off for a long time as explained by some companies in the last meeting. We think that MAC CE is highly unsuitable for many other reasons.  |
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**Rapporteur Summary**

* **UE autonomously trigger GNSS measurement in C-DRX inactive time**

Contribution in [4],[7] support UE autonomously reacquire GNSS during inactive state of C-DRX. Contribution in [11] thinks the discussion should be postponed for RAN1’s progress.

Since this topic was discussed in RAN1, rapporteur would like to ask the following question:

**Question 10: Do companies agree to postpone the discussion of UE autonomously reacquire GNSS during inactive state of C-DRX in RAN2?**

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| **Company** | **Agree/Disagree** | **Comments** |
| OPPO | Agree  |  |
| Intel | Agree |  |
| Nokia | Agree | From our point of view, RAN2 should prioritize the discussion on the basic functions of GNSS operation for long data connections (e.g. aperiodical triggered GNSS MG and autonomous GNSS MG). Based on that, RAN2 can further discuss whether the UE can reacquire the GNSS position fix outside the Connected DRX Active Time. |
| Samsung | Agree |  |
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**Rapporteur Summary**

## 3.5 Other

* **Conflict between RLF and GNSS measurement**

During the long duration of GNSS measurement, the supervision of DL channel is still running, it will probably lead to a radio link failure as the UE has to suspend the DL receiving during the GNSS measurement. To address this issue, contributions in [1] and [5] thinks the UE suspends RLM and RLF monitoring when new GNSS measurement is triggered. Contribution in [4] if the out-of-sync evaluation period is shorter or equal than the GNSS position fix time duration, UE can firstly trigger RLF and reacquires GNSS position fix during RLF procedure. Contribution in [6] provides options: (1) suspend RLM; (2) configure a longer T310 to cover GNSS measurement gap; (3) suspend RRC reestablishment until the end of the gap.

Based on the contributions, rapporteur would like to ask the following question:

**Question 11: Which option do companies prefer to address the issue of possible RLF during the measurement gap?**

**Option 1: suspend the RLM**

**Option 2: if the out-of-sync evaluation period is shorter or equal than the GNSS position fix time duration, UE can firstly trigger RLF and reacquires GNSS position fix during RLF procedure.**

**Option 3: Network ensure the configuration of RLF detection can cover GNSS measurement gap.**

**Option 4: Keep the RLM but suspend the RRC reestablishment until the end of the gap.**

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| **Company** | **Option** | **Comments** |
| OPPO | Option 1 | Suspending RLM is the simplest way as UE’s cellular module is suspended as well during GNSS measurement.For option 2, triggering RLF is not a good choice as gap-based GNSS measurement is intended to keep UE in connected mode without triggering RLF.For option 3, a longer T310 may delay RLF declaration and RRC re-establishment for the case when UE is not performing GNSS measurement. For option 4, UE is in fact not suffering RLF and it is just using gap to perform GNSS measurement and triggering RRC reestablishment will defeat the benefit of introducing gap-based GNSS measurement, which is supposed to keep UE in connected as much as possible. |
| Intel | Option 1 |  |
| Nokia | Option1 with comments | We tend to agree the principle that the RLM should be temporarily stopped during the gap while resume the monitoring after the gap. However, to minimize the impact to the spec (e.g., to avoid much impact on the UE behaviour in RAN4 spec), in case of there is a collision between T310 and GNSS MG, the simplest way seems to be UE extending the network configured T310 with the additional GNSS MG length to avoid any fake RLF declaration.  |
| Samsung | Option 1 |  |
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**Rapporteur Summary**

* **Conflict between reading SIB31 in connected and GNSS measurement**

It is possible that T317 expired during the GNSS measurement gap. Contribution in [6] think in this case, UE should read SIB31 and postpone the GNSS measurement. Contribution in [15] think UE should perform the GNSS measurement and read SIB31 after the GNSS measurement.

Based on the contributions, rapporteur would like to ask the following question:

**Question 12: Which option do companies prefer to resolve the conflict between reading SIB31 in connected and GNSS measurement?**

**Option 1: Read SIB31 and postpone the GNSS measurement**

**Option 2: Postpone reading SIB31 until GNSS measurement**

**Option 3: Network configuration**

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| **Company** | **Option** | **Comments** |
| OPPO | Option 2 | Since GNSS measurement has been started, it is better not to interrupt/stop it. Plus, option 2 should be:**Option 2: Postpone reading SIB31 until GNSS measurement is done** |
| Intel | Option 2 |  |
| Nokia | FFS | If the UE can read the SIB31 before the start of MG, we wonder why the SIB31 reading or the GNSS measurement should be postponed.  |
| Samsung | Option 3 | We think that we should not complicate the T317/T318 procedures (for both network and the UE). If T318 has expired the UE goes to RLF as in Rel-17. The possible values of T317 and T318 should be able to solve this.  |
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**Rapporteur Summary**

# 4 Conclusion

**<To be Uploaded later>**

# 5 References

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| 1 | [R2-2302543](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302543.zip) | Discussion on GNSS operation for IoT NTN | OPPO |
| 2 | [R2-2302558](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302558.zip) | Discussion on GNSS operation in connected mode | CATT |
| 3 | [R2-2302673](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302673.zip) | GNSS operation enhancements | MediaTek Inc. |
| 4 | [R2-2302820](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302820.zip) | Procedure of GNSS reacquisition | ZTE Corporation, Sanechips |
| 5 | [R2-2303044](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303044.zip) | GNSS fix in RRC\_CONNECTED | Qualcomm Incorporated |
| 6 | [R2-2303250](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303250.zip) | On GNSS position fix in RRC\_CONNECTED for IoT NTN | Lenovo |
| 7 | [R2-2303297](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303297.zip) | Discussion on the GNSS Validity Reporting in Connected State | Google Inc. |
| 8 | [R2-2303330](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303330.zip) | GNSS fix in connected mode | NEC |
| 9 | [R2-2303404](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303404.zip) | Improved GNSS Operation | Apple |
| 10 | [R2-2303518](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303518.zip) | Discussion on GNSS enhancement for IoT-NTN | CMCC |
| 11 | [R2-2303645](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303645.zip) | Discussion on enhancements on GNSS operation for IoT NTN | Nokia, Nokia Shanghai Bell |
| 12 | [R2-2303836](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303836.zip) | R18 IoT NTN GNSS operation enhancements | Ericsson |
| 13 | [R2-2303965](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303965.zip) | Discussion on GNSS operation enhancements | Huawei, HiSilicon |
| 14 | [R2-2304017](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304017.zip) | On improved GNSS operation for IoT NTN | Samsung R&D Institute UK |
| 15 | [R2-2304029](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304029.zip) | Discussion on GNSS operation enhancement | Xiaomi |
| 16 | [R2-2304183](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304183.zip) | GNSS acquisition and reporting for IoT NTN | InterDigital, Europe, Ltd. |