**3GPP TSG-RAN WG2 Meeting #121R2-2301951**

**Athens, Greece, Feb 27th – 3rd March 2023**

**Agenda Item: 8.6.2.2**

**Source: CATT**

**Title: Report of [AT121][101][IoT NTN enh] GNSS operation (CATT)**

**Document for: Discussion and Decision**

# Introduction

This document is the report of the following offline discussion:

**[AT121][101][IoT NTN enh] GNSS operation (CATT)**

Initial scope: Discuss proposals in 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

Deadline for companies' feedback:  Wednesday 2023-03-01 06:00 EET

Deadline for rapporteur's summary (in R2-2301951): Wednesday 2023-03-01 12:00 EET

Status: ongoing

# Contact Information

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# Discussion

## 3.1 GNSS measurement trigger and GNSS position fix time duration for measurement report

For GNSS position fix time duration for measurement, the following agreements have been achieved:

In RAN1#109 meeting,

**Agreement**

UE reports additional GNSS assistance information and further study the detailed GNSS assistance information, including e.g. GNSS position fix measurement time

* Note: Since RAN1 agreed that GNSS validity duration is reported by UE in Rel-17, it is already included in GNSS assistance information.

In RAN1#110 meeting,

**Agreement**

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

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

In RAN1#110bis meeting,

**Agreement**

Support eNB to at least aperiodically trigger UE to make GNSS measurement.

**Agreement**

If eNB aperiodically triggers UE to make GNSS measurement, a MAC CE is used.

In RAN1#111 meeting,

**Agreement**

For GNSS measurement in RRC connected, if eNB aperiodically triggers connected UE to make GNSS measurement, UE can re-acquire GNSS position fix with a gap

* FFS details of gap configuration

The UE may re-acquire GNSS autonomously (when configured by the network) if UE does not receive eNB trigger to make GNSS measurement

* FFS based on configured timing

**Agreement**

UE reports GNSS position fix time duration for measurement at least during the initial access stage

* which message carries this information is up to RAN2

Several issues have been discussed in companies’ contributions.

### Message to carry GNSS position fix time duration for measurement

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| --- | --- | --- |
| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2300175 | **Proposal 1 GNSS position fix time duration for measurement is reported in Msg5, e.g. RRCConnectionResumeComplete, RRCConnectionSetupComplete and RRCreestablishmentComplete messages.** | OPPO |
| [2] R2-2300204 | **Proposal 7: For GNSS position fix time duration for measurement during the initial access stage, the following Msg5 message can be used: RRCConnectionResumeComplete, RRCConnectionSetupComplete, RRCConnectionResumeComplete-NB, RRCConnectionSetupComplete-NB.** | CATT |
| [3] R2-2300263 | **Proposal 1: UE reports GNSS position fix time duration in Msg5 during the initial access stage.** | MediaTek Inc. |
| [4] R2-2300580 | **Proposal 2a: The GNSS assistance information MAC CE can be transmitted at least with Msg5.**  **Proposal 2b: RAN2 to discuss whether The GNSS assistance information MAC CE can be transmitted with Msg3** | Interdigital, Inc. |
| [5] R2-2300739 | **Proposal 1: UE reports the GNSS position fix duration together with R17 gnss-validityduration to NW in the following RRC messages:**  **• RRCConnectionSetupComplete**  **• RRCConnectionReestablishmentComplete**  **• RRCConnectionResumeComplete**  **• RRCConnectionReconfigurationComplete for HO case.** | Apple |
| [9] R2-2301053 | **Proposal 7a: It’s suggested to introduce GNSS position fix time duration in the following Msg5 messages: RRCConnectionSetupComplete, RRCConnectionResumeComplete, RRCreestablishmentComplete, RRCConnectionReconfigurationComplete, RRCConnectionSetupComplete-NB, RRCConnectionResumeComplete-NB, RRCreestablishmentComplete-NB.**  **Proposal 7b: It’s no need for UE to report all GNSS position fix time duration for different GNSS start modes via UE capability report procedure.** | ZTE Corporation, Sanechips |
| [11] R2-2301252 | **Observation 1: How the UE reports GNSS assistance information is up to RAN2.**  **Proposal 1: GNSS assistance information (e.g. GNSS position fix time duration for measurement, GNSS validity duration) is reported at least in Msg5.** | CMCC |
| [12] R2-2301493 | **Proposal 1: UE Information Request/Response procedure can be used to send GNSS position fix time duration and UE does not need to signal availability of this information. Other details are FFS.** | Samsung Electronics Benelux BV |
| [13] R2-2301660 | **Proposal 1: During the initial access stage, UE can report GNSS position fix time duration for measurement in Msg5.** | Nokia, Nokia Shanghai Bell |

There are 8 companies ([1], [2], [3], [4], [5], [9], [11], [13]) propose to use Msg5 to carry the GNSS position fix time duration for measurement during the initial access, with one company also open on Msg3[4]. And one company [12] proposes to use UE Information Request/Response procedure to send GNSS position fix time duration.

The option of Msg5 to carry the GNSS position fix time duration for measurement during the initial access, one company [2] thinks *RRCreestablishmentComplete* should not be included, because RRC connection reestablishment procedure does not belong to initial access procedure. And two companies [5] [9] think *RRCConnectionReconfigurationComplete* should also be included, considering HO scenario.

So the moderator suggests RAN2 discussing the following proposal:

**Proposal 1: For GNSS position fix time duration for measurement during the initial access, at least the following Msg5 message can be used: *RRCConnectionResumeComplete, RRCConnectionSetupComplete, RRCConnectionResumeComplete-NB, RRCConnectionSetupComplete-NB***

* **FFS for *RRCreestablishmentComplete and RRCConnectionReconfigurationComplete.***
* **FFs for Msg3**

**Q1: Companies are invited to indicate whether you support proposal 1 above?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| Google | Yes |  |
| InterDigital | Yes |  |
| Lenovo | Yes |  |
| Qualcomm | Yes |  |
| Nokia | Yes | Support the proposal 1 and OK to further discuss the use of additional “RRC complete” messages. |
| ZTE | Yes | Just minor wording suggestion:  **Proposal 1: For UE to report GNSS position fix time duration for measurement during the initial access, at least the following Msg5 message can be used: *RRCConnectionResumeComplete, RRCConnectionSetupComplete, RRCConnectionResumeComplete-NB, RRCConnectionSetupComplete-NB***   * **FFS for *RRCreestablishmentComplete and RRCConnectionReconfigurationComplete.*** * **FFS for Msg3** |

**Conclusion for Q1: TBD**

### Trigger of GNSS measurement

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| Tdoc No. | Relevant Proposals | Source |
| [3] R2-2300263 | **Proposal 4: A new DL MAC CE is used by the network to trigger UE to make GNSS measurement in connected mode.** | MediaTek Inc. |
| [5] R2-2300739 | **Observation 1: When to trigger GNSS measurement is up to network implementation.**  **Proposal 4: New MAC CE as the GNSS measurement command is introduced.** | Apple |
| [10] R2-2301209 | **Observation 1: UE re-acquiring GNSS position fix with a new gap is agreed by RAN1.**  **Proposal 1: Use the same MAC CE to simultaneously trigger the GNSS position fix and configure the measurement gap.** | Huawei, Turkcell, HiSilicon |
| [11] R2-2301252 | **Proposal 4: A new MAC CE should be introduced for eNB to dynamically trigger UE to make GNSS measurement.** | CMCC |
| [12] R2-2301493 | **Proposal 2: Introduce ability to instruct UE to perform GNSS measurements in an RRCRelease message.** | Samsung Electronics Benelux BV |
| [14] R2-2301880 | **Proposal 3 Introduce a new IE gnss-fixDuration for reporting “GNSS position fix time duration for measurement”. This report is triggered to be reported in the same places where gnss-validityDuration is triggered today.**  **Observation 2 Using MAC CE to trigger UEs to acquire GNSS position fix carries a major security risk.**  **Observation 3 Using RRC for reporting the GNSS validity duration and GNSS position fix time duration will trigger SR/BSR when reports are ready while a MAC CE will not trigger SR/BSR. Further RRC is more secure and can reuse the existing gnss-validityDuration IE for the report.**  **Proposal 5 Introduce a new field gnss-positionFixReq in the UEInformationRequest and UEInformationRequest-NB for triggering the UE to acquire a GNSS position fix.**  **Proposal 6 Introduce gnss-validityDuration and gnss-fixDuration in UEInformationResponse and UEInformationResponse-NB.** | Ericsson |

Four companies ([3], [5], [10], [11],) think new MAC CE can be used to trigger UE GNSS measurement, one company [12] thinks RRCRelease message can be used to instruct UE to perform GNSS measurement, one companies([14]) thinks there may be security risk using MAC CE to trigger UEs to acquire GNSS position fix, and RRC message (UEInformationRequest) solution is suggested.

The moderator thinks that, the target of GNSS operation enhancement is letting UE perform GNSS measurement and maintain RRC connected state at the same time. So for the RRCRelease option, more discussion on scenario may be needed. And the MAC CE option has been agreed in RAN1, for the security risk, maybe some check with SA3 is needed. For the detail of MAC CE can be further discussed. So moderator suggests the following proposal:

**Proposal 2: Woking assumption: at least for eNB aperiodically triggering UE to make GNSS measurement, new MAC CE is used.**

**Q2: Companies are invited to indicate whether you support proposal 2 above?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| Google | No | We do think using MAC CE may bring security issue. Besides, we may need to consider how to acknowledgement the reception of such a MAC CE. As the handling of the acknowledgment may lead to the RRC state change, we think it is better to handle the acknowledgement in RRC. We may also enhance the legacy measurement gap configuration a bit to make it also suitable for the GNSS measurement purpose, to minimize the standardization efforts. |
| InterDigital | FFS | We need to take the discussion on security before making this decision. |
| Lenovo | FFS | We share the concern on security using MAC CE. |
| Qualcomm | Yes | There are several MAC CEs and DCIs from network, long DRX command can change UEs DRX cycle, TA command can change UE’s closed loop TA.  This is about UE fixing and coming back to network. If UE’s GNSS is still valid when such fake command is received, then UE can come back to network by simply reporting new GNSS validity duration to network.  It does not mean UE is being sent to IDLE mode, so we do not see what is security issue. |
| Nokia | Yes |  |
| ZTE | Yes | In our assumption, such MAC CE can be a simple one to just indicate to the UE the allowance of GNSS reacquisition during connected mode. Moreover, Such trigger also can be used by the eNB when eNB see the need to temporarily trigger the UE to re-acquire the GNSS position fix.  Regardless of in which cases the trigger is received, generally UE needs to wait till the expiration of GNSS validity duration timer and then performs GNSS reacquisition.  We see no security issue (agree with Qualcomm). And the legacy acknowledgement scheme is enough. |

**Conclusion for Q2: TBD**

**Q3: if answer to Q2 is yes, companies are further invited to indicate whether you support to send LS to SA3 to check if there is security issue to use MAC CE for eNB aperiodically triggering UE to make GNSS measurement?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| InterDigital | FFS | We’re not sure it is a serious risk, there are other MAC CEs which trigger procedures (e.g. Rel-18 LTM uses MAC CE To trigger PCell change). As no permanent ID is expected to be contained in the MAC CE then the risk appears relatively small. On the other hand we have no objection to ask SA3, and would also be fine with RRC Trigger only if there is a concern. |
| Qualcomm | No | No, this is not MAC CE command to move UE to IDLE mode. |
| Nokia | FFS | We share the same concern as interdigital. There are many other DL MAC CE (e.g. DRX MAC CE or TA Command) which may also cause the incorrect/unexpected UE behaviour. We are not sure why the security concern is only for the MAC CE to trigger GNSS measurement. |
| ZTE | No | Seems no such need. |

**Conclusion for Q3: TBD**

### Content of GNSS measurement triggering MAC CE

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| Tdoc No. | Relevant Proposals | Source |
| [3] R2-2300263 | **Proposal 5: The contents of the DL MAC CE can include the time the GNSS measurement can take.** | MediaTek Inc. |
| [8] R2-2301895 | **Proposal 8 For GNSS measurement triggered by eNB or UE itself, the measurement gap length can be configured by eNB.**  **Proposal 9 For GNSS measurement triggered by eNB or UE itself, the measurement gap length is configured via RRC message.**  **Proposal 10 For GNSS measurement triggered by eNB or UE itself, wait for RAN1 conclusion on when to start the GNSS measurement, and whether the start time should be configurable.** | Xiaomi |
| [9] R2-2301053 | **Proposal 2: GNSS position fix time duration can be used as implicit measurement gap and it’s no need for NW to explicitly configure measurement gap in the trigger MAC CE.** | ZTE Corporation, Sanechips |
| [10] R2-2301209 | **Observation 1: UE re-acquiring GNSS position fix with a new gap is agreed by RAN1.**  **Proposal 1: Use the same MAC CE to simultaneously trigger the GNSS position fix and configure the measurement gap.** | Huawei, Turkcell, HiSilicon |
| [13] R2-2301660 | **Proposal 5: Support eNB to configure multiple GNSS measurement configurations in SIB, hence eNB may activate the gap configuration via MAC CE. UE may also report which configuration it applies.** | Nokia, Nokia Shanghai Bell |

Two companies ([3], [10]) think the GNSS measurement triggering MAC CE can include the time/gap of GNSS measurement, one company [8] thinks the measurement gap is configured via RRC signalling, one company [9] thinks no explicit measurement gap is needed as the GNSS position fix time duration can be reused. One company [13] thinks GNSS measurement triggering MAC CE can include one of the multiple gap configuration configured via SIB.

Even the UE has reported the GNSS position fix time duration for measurement to network, it is better the network can configure a measurement gap based on the UE reported GNSS position fix time duration, which can be seen as confirmation to the UE report, and is useful to guarantee the network and UE has the same understanding on the actual measurement gap. If new MAC CE is used for for eNB aperiodically triggering UE to make GNSS measurement, as discussed in Question 2, it may be simpler to use the same MAC CE to simultaneously trigger the GNSS measurement and configure the measurement gap, relative to triggering GNSS measurement by MAC CE, and measurement gap configuration by RRC message. But we can leave the actual format of the MAC CE open, for example, if the MAC CE indicates the actual measurement gap, or the MAC CE indicates one of the multiple gap configurations broadcast via SIB.

**Proposal 3: The GNSS measurement triggering MAC CE should include gap configuration for GNSS measurement.**

* **FFS for the detail format of the MAC CE.**

**Q4: Companies are invited to indicate whether you support proposal 3 above?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| Google | - | We can further discuss the details of the MAC CE only if Proposal 2 is agreed. |
| InterDigital | No | Gap can be configured by RRC even if we have a MAC CE trigger. |
| Lenovo | No | Gap configuration is better to be RRC. |
| Qualcomm | Yes | Gap length according to what UE reported in Msg5 is ok. |
| Nokia | No | We think the GNSS position fix time duration is semi-static and therefore the corresponding measurement gap duration can be configured via RRC. It will be an unnecessary signalling overhead to transmit the semi-static value in each MAC CE triggering the GNSS measurement. |
| ZTE | No | Firstly we want to clarify that, GNSS position fix time duration is the length of total time required by the UE to acquire/re-acquire GNSS position fix and is determined by the GNSS start mode. Based on the suggestion in Q1, UE and eNB can maintain the same GNSS position fix time duration. Moreover, according to our observation on the discussion in RAN1 and RAN2 till now, most companies think GNSS position fix time duration can be stable (it may be also possible that UE reports a relaxed value during initial random access). Therefore, we see no any need for the eNB to explicitly configure “another” gap. If the configured gap is shorter than the GNSS position fix time duration, it cannot work; if the configured gap is longer than the GNSS position fix time duration, it would cause unnecessary additional service interruption and UE power consumption.  Secondly, if gap and maybe start time of GNSS measurement need to be provided in the MAC CE trigger, does it mean the performing of GNSS reacquisition must rely on reception of this MAC CE trigger? And does it also means every time when closing to the expiration of GNSS validity duration timer, the eNB should send this MAC CE trigger? Since the main logical process for the UE is to perform GNSS reacquisition upon expiration of GNSS validity duration timer, we see no any benefit of such MAC CE trigger which needs to be sent repeatedly and we only see unnecessary signalling overhead.  Last, there is legacy acknowledgement for Msg5 report and so no need of other confirmation to the UE report. And with the GNSS position fix time duration and GNSS validity duration reported from UE in Msg5, we also think the consistent understanding between UE and eNB can be guaranteed. |

**Conclusion for Q4: TBD**

### Report of GNSS position fix time duration in connected

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| Tdoc No. | Relevant Proposals | Source |
| [3] R2-2300263 | **Proposal 2: UE reporting GNSS position fix time duration in connected mode is not supported.** | MediaTek Inc. |
| [4] R2-2300580 | **Proposal 1b: The GNSS assistance information MAC CE can be used in RRC\_CONNECTED and during random access.**  **Proposal 1c: The GNSS assistance information MAC CE is used regardless of the trigger (gNB aperiodic or UE autonomous)**  **Proposal 4: GNSS assistance information MAC CE is reported when the UE detects that the GNSS validity duration changes by a configured threshold.** | Interdigital, Inc. |
| [8] R2-2301895 | **Proposal 7 Send LS to RAN1 to ask if UE needs to update GNSS position fix time duration during connected mode.** | Xiaomi |
| [9] R2-2301053 | **Proposal 1: Working assumption: GNSS position fix time duration can keep unchanged when UE is in connected mode.**  **Proposal 7c: It’s no need for eNB to request UE to report GNSS position fix time duration in connected mode.**  **Proposal 7d: It’s no need for UE to report GNSS position fix time duration in connected mode.** | ZTE Corporation, Sanechips |
| [11] R2-2301252 | **Proposal 3: Whether/how to report GNSS position fix time duration for measurement in connected mode can wait for RAN1’s progress.** | CMCC |
| [13] R2-2301660 | **Proposal 2: Send LS to RAN1 to confirm whether the GNSS position fix time duration for measurement may be changed during the long data connection.** | Nokia, Nokia Shanghai Bell |

Two companies ([3], [9]) think there is no necessity to support UE reporting GNSS position fix time duration in connected mode. One company [4] may think the connected UE can report GNSS position fix time duration (include in GNSS assistance information MAC CE) to eNB. Three companies ([8], [11], [13]) think more information from RAN1 is needed.

The moderator thinks that, RAN1 has had some discussion on the issue of whether the GNSS position fix time duration for measurement may be changed during the long data connection, but has achieved no agreement. RAN2 can wait the output of RAN1, or we can send LS to RAN1 to push the progress on this issue.

**Proposal 4: Send LS to RAN1 to check whether the GNSS position fix time duration for measurement may be changed during the long data connection**

**Q5: Companies are invited to indicate whether you support proposal 4 above?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | No |  |
| Google | No | We believe the GNSS position fix duration is unlikely to change, but are okay to wait for further RAN1 progress. |
| InterDigital | No | We can wait a bit longer. |
| Lenovo | No | We can wait for RAN1, no need to ask |
| Qualcomm | No |  |
| Nokia | Yes | To make progress, we prefer to ask RAN1 and highlight the issue then RAN2 awaits the RAN1 feedback. |
| ZTE | No | Based on our observation on the discussion in RAN1 and RAN2 till now, most companies think GNSS position fix time duration can be stable. It may be also possible that UE reports a relaxed value during initial random access, which would make it even less likely that the change of GNSS position fix time duration occurs. |

**Conclusion for Q5: TBD**

### Rel-18 UE behaviour if no connected GNSS measurement is triggered

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| Tdoc No. | Relevant Proposals | Source |
| [2] R2-2300204 | **Proposal 3: By default, Rel-18 IoT NTN UE (supporting the improved GNSS operations) will leave RRC\_CONNECTED state when current GNSS position becoming out-of-date, unless configured by network to perform GNSS measurement (e.g. eNB aperiodically triggers UE to perform GNSS measurement or UE re-acquires GNSS autonomously based on network configuration).** | CATT |
| [14] R2-2301880 | **Proposal 7 An NTN UE that supports release 18, can be configured to not go to IDLE when GNSS position becomes outdated.** | Ericsson |

The moderator thinks that, it cannot be assumed that all the Rel-18 IoT NTN UE will always stay long connection state, and a Rel-18 IoT UE can camped under or served by a legacy cell, so it is necessary to make it clear the UE behaviour when the Rel-18 IoT NTN UE is not triggered to perform GNSS measurement, and the exiting GNSS position becoming out-of-date, considering the compatibility. And for UE triggering connected GNSS measurement, more RAN1 input is needed. So moderator suggests:

**Proposal 5: By default, Rel-18 IoT NTN UE (supporting the improved GNSS operations) will leave RRC\_CONNECTED state when current GNSS position becoming out-of-date, unless configured by network to perform GNSS measurement (e.g. eNB aperiodically triggers UE to perform GNSS measurement or UE re-acquires GNSS autonomously based on network configuration).**

**Q6: Companies are invited to indicate whether you support proposal 5 above?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| Google | Yes, but… | We only agree the first-half part of Proposal 5, and think the network is expected to provide the UE with the gap before the GNSS validity duration expires. In case the GNSS validity duration expires before the arrival of a GNSS measurement gap, the UE shall follow the R-17 behaviour and leave RRC\_CONNECTED. |
| InterDigital | Yes | In other words, if R18 feature is not configured then UE follows Rel-17 behaviour. |
| Lenovo |  | We wonder how to handle the case when UE is performing GNSS measurement configured by network but the current GNSS position becoming out-of-date. |
| Qualcomm | Yes |  |
| Nokia |  | Support that the Rel-18 IoT NTN UE leaves RRC Connected when the GNSS position is out-of-date. The UE behaviour, when a GNSS measurement is happening at/after the expiry of the GNSS validity duration needs further discussion. |
| ZTE | Yes | Based on our assumption for the MAC CE trigger, we also think if UE hasn’t received any trigger after it enters connected mode, UE and eNB would follow same understanding that this UE will not perform GNSS reacquisition during connected mode. So we are high level fine with the proposal 5.  But we think the current text say some details which haven’t been agreed. So our suggestion is :  **Proposal 5: By default, Rel-18 IoT NTN UE (supporting the improved GNSS operations) will leave RRC\_CONNECTED state when current GNSS position becoming out-of-date, unless it has been indicated by network to perform GNSS measurement.** |

**Conclusion for Q6: TBD**

### UE/Network capability indication of supporting GNSS operation enhancement

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| Tdoc No. | Relevant Proposals | Source |
| [2] R2-2300204 | **Observation 1: UE should confirm whether the network supports improved GNSS operations or not, before the UE reports GNSS position fix time duration for measurement to the network during the initial access, to avoid potential resource waste.**  **Observation 2: Network needs to know whether the UE supports improved GNSS operations or not, to avoid invalid configuration to UE.**  **Proposal 1: RAN2 to discuss whether indication is needed to indicate whether the network/UE supporting the improved GNSS operations.**  **Proposal 2: RAN2 to discuss how to deliver the indication of whether the UE/network supporting the improved GNSS operations is needed.** | CATT |
| [4] R2-2300580 | **Proposal 3: RAN2 to discuss whether the GNSS assistance information MAC CE is configured:**  **1. in SIB**  **2. dynamically based on Msg3 grant size in RAR (if both Msg3 and Msg5 are supported)**  **3. based on an indication in Msg4 (if only Msg5 is supported)** | Interdigital, Inc. |

Generally, for a new feature, some capability negotiation is needed, to avoid unnecessary resource waste or invalid configuration. Otherwise, for example, the UE may report GNSS position fix time duration for measurement to network during the initial access stage, even the network does not support GNSS operation enhancement; the network may trigger a connected UE to perform GNSS measurement, even the UE does not support GNSS operation enhancement. However, it should also some evaluation whether the Rel-18 IoT NTN UE/Network always support the GNSS operation enhancement, considering the little complexity or cost increase. So the moderator thinks it is valuable for RAN2 to discuss whether UE/Network capability indication of supporting GNSS operation enhancement is needed or not.

**Proposal 6: RAN2 to discuss whether UE/Network capability indication of supporting GNSS operation enhancement is needed.**

**Q7: Companies are invited to indicate whether you support proposal 6 above?**

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| **Company** | **Yes or No** | **Comments** |
| MediaTek | FFS | Capability could be introduced later once the method is finalized. |
| Google | Yes |  |
| InterDigital | Yes | UE capability is needed. Normally we do not specify NW capability, NW can configure/not configure. |
| Lenovo | Yes |  |
| Qualcomm | Yes | But it can also be discussed later. |
| Nokia | No, but | We don’t think a network capability indication need to be defined.  Whether UE capability is needed can be further discussed. In our understanding, to support long data connections, Rel-18 IoT NTN shall support GNSS operation enhancement by default and that a capability is not needed. |
| ZTE | FFS for UE but no for NW | The MAC CE trigger already can be used as the implicit indication of NW capability. UE capability seems also needed but can be discussed later. |

**Conclusion for Q7: TBD**

**Q8: if the answer of Q7 is yes, Companies are further invited to indicate whether you support UE capability indication or network capability indication?**

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| --- | --- | --- | --- |
| **Company** | **Yes or No for UE capability indication** | **Yes or No for network capability indication** | **Comments** |
| MediaTek | FFS | FFS |  |
| Google | Yes | Yes |  |
| InterDigital | Yes | No | As above, NW configures or does not configure, no need to indicate capability |
| Lenovo | FFS | FFS |  |
| Qualcomm | Yes | No | Agree with InterDigital |
| Nokia | FFS | No |  |

**Conclusion for Q8: TBD**

### Other issue of GNSS measurement trigger and GNSS position fix time duration for measurement report

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| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2300175 | **Proposal 3 UE should go back to IDLE mode if it cannot acquire its GNSS location for eNB-triggered and/or UE-autonomous GNSS measurement.** | OPPO |
| [2] R2-2300204 | **Proposal 4: RAN2 to discuss whether UE reports to network the assistance information about UE preference on long connection.**  **Proposal 8: The UE should try another one or several attempts of GNSS measurement in duration, e.g., configured by network.** | CATT |
| [5] R2-2300739 | **Proposal 6: When GNSS measurement is completed, UE sends the response message (i.e. GNSS valid duration MAC CE) to NW.**  **Proposal 7: When NW receives the GNSS valid duration MAC CE, NW can assume the triggered GNSS measurement is completed.** | Apple |
| [7] R2-2300979 | **Observation 1: For a long GNSS position fix gap with a length of seconds or tens of seconds, a UE in RRC\_CONNECTED may not be able to maintain or resume the RRC connection during or after the gap.**  **Observation 2: When a GNSS position fix gap is configured, a T310 value not long enough will lead UE to RLF, and a T301 value not long enough will lead UE to RRC\_IDLE.**  **Observation 3: When a GNSS position fix gap is configured, ephemeris data and common TA at UE may become invalid during the gap and UE has to re-acquire ephemeris data and common TA after the gap.**  **Observation 4: When a GNSS position fix gap is configured, unnecessary neighbour cell measurement in RRC\_CONNECTED could be triggered after the gap starts.**  **Proposal 1: RAN2 to consider signalling enhancements, e.g., RLF handling, ephemeris update and neighbour cell measurement, to support GNSS position fix in RRC\_CONNECTED with a long gap configured.** | Lenovo |
| [9] R2-2301053 | **Proposal 5: UE is supported to autonomously reacquire GNSS during inactive state of C-DRX.**  **Proposal 6: UE may need to report kind of indication to inform eNB about a “temporarily” GNSS reacquisition which is performed during an inactive state of C-DRX.** | ZTE Corporation, Sanechips |
| [13] R2-2301660 | **Proposal 9: RAN2 to discuss handling a GNSS measurement during a long period of downlink/uplink repetitions.**  **Proposal 10: RAN2 to postpone the discussion on whether the UE can reacquire the GNSS position fix outside the Connected DRX Active Time.** | Nokia, Nokia Shanghai Bell |

Two companies ([1], [2]) have discussed the UE behaviour if the UE cannot re-acquire the GNSS position, but have different view, going to IDLE or trying another several attempts. Two companies ([5], [7]) have discussed the UE behaviour when the UE finish the GNSS measurement. Three companies ([2], [9], and [13]) have discussed the case of UE triggered GNSS measurement. For these issues, moderator thinks more information from RAN1 is needed, or RAN1 is discussing some of these issues. For example, RAN1 has been discussing the issue of whether UL re-synchronization is always needed before UL transmission, after the GNSS measurement. And RAN1 has also been discussing the UE triggered GNSS measurement. So moderator suggests postponing the discussion on these issues.

**Proposal 7: Postpone the discussion on the following issues:**

* **UE behaviour when the UE completes GNSS measurement**
* **UE behaviour when the UE can’t re-acquire GNSS position according to the configuration**
* **UE triggered GNSS measurement**

**Q9: Companies are invited to indicate whether you support proposal 7 above?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| Google | Yes | We can wait for further RAN1 progress on these aspects. |
| InterDigital | FFS | We are OK to wait a bit longer for RAN1, but since at least 3 companies support UE triggered GNSS measurement it would be better to capture these points as FFS rather than postponed. |
| Lenovo | Yes and | For UE triggered GNSS measurement we can wait for RAN1. |
| Qualcomm | Ok |  |
| Nokia | Yes | We are fine to wait more progress from RAN1. |
| ZTE | No | Since it has benefit of avoiding or reducing the possible service transmission interruption, we think it can be prioritized to discuss whether and how to support UE to autonomously reacquire GNSS during inactive state of C-DRX.  Moreover, since C-DRX is also defined in MAC spec, we think RAN2 would be the suitable place to discuss this feature.  For other two issues, they can be discussed along with the discussion on GNSS reacquisition procedure. |

**Conclusion for Q9: TBD**

## GNSS validity duration report

For GNSS validity duration report by the connected UE, the following agreements have been achieved:

In RAN1#110 meeting:

**Agreement**

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

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

In RAN1#111 meeting:

**Agreement**

In connected mode, UE may report GNSS validation duration with MAC CE.

Several issues have been discussed in companies’ contributions.

### Trigger of GNSS validity duration report

|  |  |  |
| --- | --- | --- |
| Tdoc No. | Relevant Proposals | Source |
| [1] R2-2300175 | **Proposal 2 Reporting GNSS validity duration can be triggered after GNSS measurement is done.** | OPPO |
| [2] R2-2300204 | **Proposal 5：GNSS validation duration MAC CE should be triggered after each successful GNSS measurement.** | CATT |
| [3] R2-2300263 | **Proposal 8: A new UL MAC CE is used to report remaining GNSS validity duration after GNSS measurement in connected mode.**  **Proposal 9: UE can choose not to report the remaining GNSS validity duration if the new value is identical to the previously reported value and does not cause any misinterpretation.** | MediaTek Inc. |
| [4] R2-2300580 | **Proposal 4: GNSS assistance information MAC CE is reported when the UE detects that the GNSS validity duration changes by a configured threshold.** | Interdigital, Inc. |
| [5] R2-2300739 | **Proposal 3: UE informs the GNSS validity duration via new MAC CE in the following two cases:**  **• Case 1: When performing the GNSS fix operation**  **• Case 2: When the UE mobility state is changed or when the GNSS validity duration is changed greatly (e.g. duration change > configured threshold).** | Apple |
| [6] R2-2300892 | **Proposal 6 After GNSS fix, if the GNSS validity duration changes compared to previous, the UE triggers new remaining GNSS validity duration report.** | Qualcomm |
| [8] R2-2301895 | **Proposal 1 If GNSS position fix is re-acquired, GNSS validity duration MAC CE is triggered.** | Xiaomi |
| [9] R2-2301053 | **Proposal 8c: It’s no need for eNB to request UE to report updated GNSS validity duration in connected mode.** | ZTE Corporation, Sanechips |
| [13] R2-2301660 | **Proposal 4: When UE is in RRC Connected mode, the UE should report GNSS validity duration to eNB if the variation between current GNSS validity duration and the previously reported value is larger than a threshold.** | Nokia, Nokia Shanghai Bell |
| [14] R2-2301880 | [[**Proposal 3 Introduce a new IE gnss-fixDuration for reporting “GNSS position fix time duration for measurement”. This report is triggered to be reported in the same places where gnss-validityDuration is triggered today.**](#_Toc127518441)](#_Toc127518441) | Ericsson |

For the trigger of GNSS validity duration report, [1], [2] , [8] (maybe [5])think the UE should report GNSS validation duration after each successful GNSS measurement, [3] thinks the UE can choose not to report the remaining GNSS validity duration if the new value is identical to the previously reported value, [4], [6] , [13] and [14] (maybe [5]) think the UE can report GNSS validation duration if the GNSS validity duration has changed, for example, the variation between current GNSS validity duration and the previously reported value is larger than a threshold. One company [9] thinks there is no need for connected UE to report GNSS validity duration. The moderator suggests RAN2 discussing the several option on this issue.

**Proposal 8: RAN2 to discuss the following options for connected UE GNSS validity duration report：**

* **Option 1: UE reports GNSS validity duration after each time of GNSS measurement**
* **Option 2: UE reports GNSS validity duration only the GNSS validity duration has changed, e.g. larger than a configured threshold**
* **Option 3: UE will not report GNSS validity duration**
* **Option 4: Waiting for RAN1 progress**

**Q10: Companies are invited to indicate which option in proposal 8 you prefer?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| MediaTek | Option 2 |  |
| Google | Option 2 | However, we think option 1 and option 2 can be enabled together, and hence would like to suggest replacing the word “only” with “when” in option 2. |
| InterDigital | Option 2 |  |
| Lenovo | Option 2 |  |
| Qualcomm | Option1+Option2 | For Option 2, there would still be some indication is needed to let network know it is back from the GNSS fix and new GNSS validity duration can be started. Option 1 would be simple solution. |
| Nokia | Option 2 | It is beneficial to only report the GNSS validity duration when the value has changed. However, it is also important for the UE and eNB to have a synchronized understanding of the outcome of the GNSS measurement. Therefore, we suggest the UE shall still provide an indication of a successfully completed GNSS measurement even if the GNSS validity duration has not changed. |
| ZTE | Option 2 | We think Option 2 is mainly for GNSS validity duration report during connected mode. Furthermore, we assume UE also needs to report the whole GNSS validity duration during initial random access. |

**Conclusion for Q10: TBD**

### Report of GNSS validity duration

|  |  |  |
| --- | --- | --- |
| Tdoc No. | Relevant Proposals | Source |
| [4] R2-2300580 | **Proposal 1a: Introduce a single new GNSS assistance information MAC CE, which contains at least GNSS position fix time and validity duration.** | Interdigital, Inc. |
| [9] R2-2301053 | **Proposal 8a: It’s suggested to introduce a whole GNSS validity duration in the following Msg5 messages: RRCConnectionSetupComplete, RRCConnectionResumeComplete, RRCreestablishmentComplete, RRCConnectionReconfigurationComplete, RRCConnectionSetupComplete-NB, RRCConnectionResumeComplete-NB, RRCreestablishmentComplete-NB.**  **Proposal 8b: RAN2 also confirms to introduce a new UL MAC CE for UE to report the updated** **GNSS validity duration in connected mode.** | ZTE Corporation, Sanechips |
| [11] R2-2301252 | **Proposal 2: A new MAC CE should be introduced to report GNSS validity duration.** | CMCC |
| [14] R2-2301880 | [[**Proposal 3 Introduce a new IE gnss-fixDuration for reporting “GNSS position fix time duration for measurement”. This report is triggered to be reported in the same places where gnss-validityDuration is triggered today.**](#_Toc127518441)](#_Toc127518441) | Ericsson |

Almost all the companies propose to introduce a new MAC CE for GNSS validity duration, which is aligned with the RAN1 agreement. One company suggests introducing single new GNSS assistance information MAC CE, which contains at least GNSS position fix time and validity duration. The moderator thinks maybe a separate MAC CE is better, because GNSS position fix time and validity duration many not always be reported together, but we can leave this issue open, including the name of the new defined MAC CE mentioned by one company [14]. GNSS validity duration via Msg5 has been supported in Rel-17, now this issue is focusing on GNSS validity duration report by connected UE.

**Proposal 9: new MAC CE should be defined for connected UE reporting GNSS validity duration.**

**Q11: Companies are invited to indicate whether you support proposal 9 above??**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| Google | No | With similar reasons mentioned in Q2, we prefer to use the RRC message for the connected UE to report the GNSS validity duration. |
| InterDigital | - | The above doesn’t add anything to what RAN1 already agreed |
| Lenovo | FFS | Same concern for security |
| Qualcomm | Yes |  |
| Nokia | No | We wonder why MAC CE is needed to report GNSS validity duration. We prefer to use RRC messages which is aligned with the design in Rel-17.  The value granularity for GNSS validity duration is seconds or minutes (as listed in proposal 10). We think it is not that time-critical to justify MAC CE instead of RRC for the reporting. If we go with MAC CE, there are many additional aspects which need to be addressed (e.g., MAC CE priority, how to handle the case of lack of UL resource for MAC CE transmission, transmission reliability in HARQ Mode-B etc). We would like to keep it simple to use RRC based solution. |
| ZTE | Msg5 and MAC CE | In R17 IoT NTN, the GNSS remaining time has been introduced and UE needs to report this information to the network in Msg5.  In our assumption, for R18 UE, after the first time UE reacquires the GNSS, UE will restart the counting of validate duration with the length of the whole GNSS validity duration. However, the eNB has no idea of this whole GNSS validity duration and then eNB and UE cannot be aligned anymore. In order to address this issue, we think anyway UE needs to report the whole GNSS validity duration during initial random access.  Furthermore, we have sympathy with the view that GNSS validity duration may change when there is a big change of UE velocity, so we can agree to support update of GNSS validity duration during connected mode. And an UL MAC CE can be used for this purpose. |

**Conclusion for Q11: TBD**

### The value of GNSS validation duration

|  |  |  |
| --- | --- | --- |
| Tdoc No. | Relevant Proposals | Source |
| [2] R2-2300204 | **Proposal 6: The value range {10s, 20s, 30s, 40s, 50s, 60s, 5 min, 10 min, 15 min, 20 min, 25 min, 30 min, 60 min, 90 min, 120 min, infinity} introduced for R17, can be reused for GNSS validation duration MAC CE unless modified by RAN1.** | CATT |
| [3] R2-2300263 | **Proposal 10: The content of the GNSS validity duration in MAC CE reuse the enumeration in Rel-17.** | MediaTek Inc. |
| [6] R2-2300892 | **Proposal 1 Introduce GNSS-ValidityDurationAdd-r18 such that more granular value of remaining GNSS validity duration can be reported, i.e., GNSS-ValidityDuration-r17 (unit S or min) + GNSS-ValidityDurationAdd-r18 (unit-less).** | Qualcomm |

The actual value of remaining GNSS validity duration has been discussed in Rel-17 widely, two companies ([2], [3]) suggest reusing the value of remaining GNSS validity duration has been discussed in Rel-17, for Rel-18 connected UE reporting GNSS validity duration, one company [6] suggests more granular value for Rel-18 remaining GNSS validity duration report. So the moderator suggests at least the value of remaining GNSS validity duration defined in Rel-17 can be reused, and we can leave the issue of more granular value open, and can revise this if required by RAN1.

**Proposal 10: The value range {10s, 20s, 30s, 40s, 50s, 60s, 5 min, 10 min, 15 min, 20 min, 25 min, 30 min, 60 min, 90 min, 120 min, infinity} introduced in R17 is reused for connected UE GNSS validation duration report, unless modified by RAN1.**

* **FFS if more granular value is needed**

**Q12: Companies are invited to indicate whether you support proposal 10 above?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| MediaTek | Yes |  |
| Google | Yes |  |
| InterDigital | Yes |  |
| Lenovo | Yes |  |
| Qualcomm | See comments | To take the benefit of ongoing GNSS enhancement, more granular value can be considered.  “**unless modified by RAN1”** is not needed in the proposal. |
| Nokia | Yes |  |
| ZTE | Yes |  |

**Conclusion for Q12: TBD**

## 3.3 Other

|  |  |  |
| --- | --- | --- |
| Tdoc No. | Relevant Proposals | Source |
| [3] R2-2300263 | **Proposal 7: Network can config UE to delay a certain time after the end of the validity duration.** | MediaTek Inc. |
| [4] R2-2300580 | **Proposal 5: Introduce a prohibit timer to prevent excessive acquisition and reporting of GNSS information.** | Interdigital, Inc. |
| [5] R2-2300739 | **Proposal 5: Upon receiving the GNSS measurement MAC CE, UE may skip the measurement if UE’s GNSS info is still valid for a long time.** | Apple |
| [6] R2-2300892 | **Proposal 2 When GNSS measurement is triggered, the UE considers the timeAlignmentTimer expired and starts a new timer T3xx (T318-like timer).**  **Proposal 3 When GNSS is fixed, the UE stops timer T3xx and triggers PRACH to synchronize with the network. FFS in msg3, new validation time MAC CE can be sent.**  **Proposal 4 While the timer T3xx is running, the UE does not monitor PDCCH. Discuss whether to send LS to RAN4 now or later.**  **Proposal 5 After expiry of T3xx, the UE triggers RRC-Reestablishment procedure.** | Qualcomm |
| [8] R2-2301895 | **Proposal 2 When GNSS validity duration MAC CE is triggered, if there is no UL resources available, SR should be triggered. The SR resource can be separately configured for GNSS validity duration MAC CE.**  **Proposal 3 GNSS validity duration MAC CE has lower priority than Timing Advance report MAC CE but higher priority than BSR.**  **Proposal 4 When GNSS validity duration is included in the RRCConnectionReconfigurationComplete message, all triggered GNSS validity duration MAC CE should be canceled.**  **Proposal 5 After GNSS validity duration MAC CE is included in the MAC PDU for transmission, all triggered GNSS validity duration MAC CE should be canceled.**  **Proposal 6 When MAC resets, all triggered GNSS validity duration MAC CE should be canceled.** | Xiaomi |
| [9] R2-2301053 | **Proposal 3: Expiration of GNSS validity duration can be used as implicit start time of GNSS measurement. It’s no need for NW to explicitly configure the start time of GNSS measurement or the parameters for calculating start time of GNSS measurement in the trigger MAC CE.**  **Proposal 4: For R18 IoT NTN, if the out-of-sync evaluation period is longer than the GNSS position fix time duration, UE could reacquire GNSS position fix within GNSS position fix time duration. Otherwise, UE can firstly trigger RLF and re-acquires GNSS position fix during RLF procedure.** | ZTE Corporation, Sanechips |
| [10] R2-2301209 | **Proposal 2: The configuration of the timer for autonomous GNSS re-acquiring can be used as an implicit enabler for the autonomous GNSS re-acquiring.**  **Proposal 3: RAN2 to further study how to solve the issue caused due to the unavailability of measurement and communication with NW during the UE performing GNSS measurement.** | Huawei, Turkcell, HiSilicon |
| [12] R2-2301493 | **Proposal 3: RAN2 to consider LPP for IoT NTN to deliver GNSS assistance data.** | Samsung Electronics Benelux BV |
| [13] R2-2301660 | **Proposal 3: During handover procedure, UE should report either the GNSS position fix time duration for measurement or whether GNSS re-acquisition is to be performed.**  **Observation 7: UE and eNB must have a common understanding of when the UE is performing the autonomous GNSS measurement.**  **Proposal 6: Postpone the discussion in RAN2 on the configuration for autonomously GNSS measurement.**  **Proposal 7: RAN2 to discuss whether GNSS reacquisition is always needed before each RRC establishment for UE requiring long data transmission duration.**  **Proposal 8: RAN2 to discuss how to handle interruptions of the RLF procedure by GNSS measurements.** | Nokia, Nokia Shanghai Bell |
| [14] R2-2301880 | **Proposal 4 Wait for further RAN1 progress before deciding the value range for “GNSS position fix time duration for measurement” in gnss-fixDuration.** | Ericsson |

These contributions and proposals have given very valuable discussion on some aspects of GNSS operation enhancement, but maybe it is better we discuss these proposals after the discussion of the proposals listed in section 3.1 and 3.2, considering the limited online time, and some proposals may need more progress of other issue.

**Proposal 11: Postpone the discussion of the proposals listed in this section.**

**Q13: Companies are invited to indicate whether you have concern on proposal 11 above?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| Google | No | We can discuss these proposals in the next meetings. |
| InterDigital | No | If time allows we can discuss but agree it’s unlikely. |
| Lenovo | No | No need to restrict for nnow. |
| Qualcomm | No |  |
| Nokia | No |  |
| ZTE | - | We think we need to discuss whether expiration of GNSS validity duration should be the start time of GNSS reacquisition. This is part of the previous main discussion. |

**Conclusion for Q13: TBD**

# 3. Conclusion

Based on the discussion above, following proposals are given:

**TBD**

# 4. References

1. R2-2300175 Discussion on GNSS operation in connected mode OPPO discussion Rel-18 IoT\_NTN\_enh-Core
2. R2-2300204 Discussion on GNSS operation in connected mode CATT discussion Rel-18 IoT\_NTN\_enh-Core
3. R2-2300263 Enhancements on GNSS operation MediaTek Inc. discussion
4. R2-2300580 GNSS acquisition and reporting for IoT NTN Interdigital, Inc. discussion Rel-18 IoT\_NTN\_enh-Core
5. R2-2300739 Improved GNSS Operation Apple discussion Rel-18 IoT\_NTN\_enh-Core
6. R2-2300892 GNSS fix in RRC\_CONNECTED Qualcomm Incorporated discussion Rel-18 IoT\_NTN\_enh-Core
7. R2-2300979 Considerations on long GNSS operation in CONNECTED state Lenovo discussion Rel-18
8. R2-2301895 Discussion on GNSS operation enhancement Xiaomi discussion Rel-18
9. R2-2301053 Further discussion on GNSS enhancements ZTE Corporation, Sanechips discussion IoT\_NTN\_enh-Core
10. R2-2301209 Discussion on the enhancement of GNSS operation Huawei, Turkcell, HiSilicon discussion Rel-18 IoT\_NTN\_enh-Core
11. R2-2301252 Discussion on the GNSS enhancement for IoT-NTN CMCC discussion Rel-18 IoT\_NTN\_enh
12. R2-2301493 On improved GNSS operation for IoT NTN Samsung Electronics Benelux BV discussion Rel-18 IoT\_NTN\_enh
13. R2-2301660 On GNSS operation enhancements for IoT NTN Nokia, Nokia Shanghai Bell discussion Rel-18 IoT\_NTN\_enh-Core
14. R2-2301880 R18 IoT NTN performance enhancement Ericsson discussion Rel-18 IoT\_NTN\_enh