**3GPP TSG RAN WG2 #119bis electronic  *R2-210xxxx***

**Online, October 10th – 19th, 2022**

**Agenda item: 8.6.3**

**Source: ZTE (rapporteur)**

**Title: Report of [AT119bis-e][118][IoT NTN Enh] Mobility enhancements**

**Document for: Discussion and Decision**

# Introduction

This document is the report of the following offline discussion:

* *[AT119bis-e][118][IoT NTN Enh] Mobility enhancements (ZTE)*

*Scope: Discuss mobility enhancements, based on remaining proposals in* [*R2-2209836*](file:///C:\Data\3GPP\Extracts\R2-2209836%20Further%20discussion%20on%20mobility%20enhancements.docx)*,* [*R2-2209443*](file:///C:\Data\3GPP\Extracts\R2-2209443_Mobility%20Enhancements%20in%20IoT-NTN.docx) *and* [*R2-2209411*](file:///C:\Data\3GPP\Extracts\R2-2209411.docx)

*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): Tuesday 2022-10-18 1000 UTC*

*Initial deadline (for rapporteur's summary in R2-2210861): Tuesday 2022-10-18 1200 UTC*

*Status: Ongoing*

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# Discussion

In RAN2 #119e meeting, RAN2 have had some initial discussion on mobility enhancements for R18 IoT NTN, and the following agreements are reached:

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| *Agreements [RAN2#119e]:*   1. *IoT NTN can use the mechanism for neighbour cell measurements in connected mode (specified in Rel-17 for NB-IoT). FFS if any enhancements are needed (e.g. triggers) for both NB-IoT and eMTC.* 2. *RAN2 to continue working on a new time-based trigger for triggering intra and inter frequency measurements in connected mode, e.g. the serving cell is going to stop covering the current area, for both earth-moving and earth-fixed cell (FFS on distance-based trigger)* 3. *CHO enhancements for eMTC NTN (i.e. time/timer based solution) are introduced based on the R17 NR NTN solution. FFS on location-based solution* 4. *Measurement results reporting is not supported in Rel-18 NB-IoT NTN.* |

In the on-going RAN2#119bis-e meeting, RAN2 had some online discussion based on the following contributions:

[1] R2-2209836 Further discussion on mobility enhancements ZTE Corporation, Sanechips discussion Rel-18

[2] R2-2209443 On Mobility Enhancements in IoT-NTN MediaTek Inc. discussion Rel-18

[3] R2-2209411 Discussion on IoT NTN Mobility Enhancements CATT discussion Rel-18

The following new agreement is achieved:

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| *Agreements [RAN2#119bis-e]:*   1. *For eMTC over NTN, for both earth-moving and earth-fixed cell scenarios, we introduce location based CHO triggering events.* |

According to session Chair’s guideline, in this offline, we will further discuss the remaining proposals in the above three contributions. All the related proposals are copied below for reference. Please note the ones that have reached the revised agreement or been postponed are marked with [gray](https://dict.cn/gray).

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| Contributions | The related proposals |
| R2-2209836[1] | **Proposal 1: The configuration framework for connected mode neighbor cell measurement in SIB3-NB can be reused for R18 NB-IoT over NTN and can be further extended, e.g., to incorporate more possible triggering conditions. [Postponed]**  **Proposal 2: It’s suggested not to introduce new triggering condition for connected mode neighbor cell measurement for eMTC over NTN.**  **Proposal 3: In NB-IoT over NTN, the triggering condition for connected mode neighbor cell measurement can be based on distance between the UE and the satellite.**  **Proposal 4: For NB-IoT over LEO, connected mode neighbor cell measurement when the target cell is in enhanced coverage still needs to be considered. [Postponed]**  **Proposal 5: For supporting connected mode neighbor cell measurement in NB-IoT over LEO, RAN2 needs to inform RAN4 that requirement of Measurement Occasion (MOdetect\_inter\_NB1-NC and MOmeasure\_inter\_NB1-NC) with 2000 ms length is needed. [Postponed]**  **Proposal 6: For NB-IoT over LEO, UE could perform connected mode measurements on neighbor cell by using resources on which the UE is not scheduled for data transmission or reception. This is already supported by RAN4 specification. [Postponed]**  **Proposal 7: For NB-IoT over LEO, UE can report an indication to inform eNB that UE is going to start the connected mode neighbor cell measurements.**  **Proposal 8: For eMTC over NTN, except moving cells scenario for LEO, it’s suggested to introduce location based CHO triggering events. [Have reached a revised agreement]** |
| R2-2209443[2] | **Proposal 1: UE shall start intra/inter frequency measurement in connected mode before the t-Service if present.**  **Proposal 2: The exact time to start measurements in connected mode before t-Service can be left to UE implementation.**  **Proposal 3: The condition of stopping UE measurement before t-Service is not specified.**  **Proposal 4: For earth-moving cell, the serving cell footprint information is broadcast for determining the time of loss of coverage of current cell in NB-IoT.**  **Proposal 5: NB-IoT UE starts intra/inter frequency measurements in RRC connected mode before the calculated time of losing coverage.**  **Proposal 6: NB-IoT UE can calculate the time of losing coverage before entering RRC connected mode and skip to next cell if the remaining time of current cell’s coverage is too short to start a connection.**  **Proposal 7: For eMTC, network assigns UE a time of probably losing coverage after the location report. UE starts intra/inter frequency measurements before this time.**  **Proposal 8: The exact time to start measurements in connected mode before the assigned time of losing coverage can be left for UE implementation.**  **Proposal 9: UE calculates the time of UE entering the neighbor satellite’s coverage.**  **Proposal 10: UE starts intra/inter frequency measurements in RRC connected mode after the calculated time of entering the neighbor satellite’s coverage**  **Proposal 11: RAN2 will re-use the location-based solutions introduced in Rel-17 NR NTN as the baseline for mobility enhancements in eMTC-based NTN. Any further enhancements in FFS. [Have been covered by the new agreement]** |
| R2-2209411[3] | **Proposal 1: For IoT-NTN, the connected UE should trigger the neighbor cell measurement before the end of the serving time of serving cell or the starting serving time of the neighbor cell for the UE which is late arrival.**  **Proposal 2: For IoT-NTN, distance-based trigger for triggering intra and inter frequency measurements in connected mode is not supported.**  **Proposal 3：Location-based CHO solution should not be supported by eMTC UE in NTN. [Have been covered by the new agreement]** |

## Whether to enhance connected mode measurement for eMTC NTN

In [1, R2-2209836], company give the **Proposal 2** and explain that the mechanism of R17 NB-IoT connected mode measurement and also some under-discussion new triggers (e.g., to trigger intra and inter frequency measurements in connected mode when the serving cell is going to stop covering the current area) are not suitable for eMTC NTN which is generally characterized with middle or high mobility. The online discussion for **Proposal 2** in [1] are copied below:

**Proposal 2: It’s suggested not to introduce new triggering condition for connected mode neighbor cell measurement for eMTC over NTN.**

* NEC supports this
* Ericsson does not support this. This is not about connected mode measurements for HO but assistance information for the network
* Apple/QC/MTK/Lenovo/Intel support p2
* Oppo also don’t support p2, as we would be left with RSRP only. We need to consider enhancements for eMTC. CATT agrees we need time-based solution at least.
* Samsung also does not agree with p2.
* Huawei agrees with p2.
* CMCC agrees with Huawei and think we can say we align to NR NTN.
* ZTE clarifies that the proposals is for connected mode neighbor cell measurement (for which no enhancements is considered as needed)
* IDC thinks that both NB-IoT and eMTC only have RSRP threshold to trigger measurements currently. IDC thinks the original WI objective was meant for NB-IoT but it’s not clear this is not useful for eMTC
* Ericsson think there is no differentiation in the WID for this.

According to the discussion, some companies still think the enhancements to connected mode measurement would also be needed for eMTC NTN. They may worry that the existing RSRP-based criteria may not trigger neighbour cell measurements as expected.

For reference, in [2, R2-2209443], companies give the following 2 proposals on measurement enhancements for eMTC NTN:

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| R2-2209443[2] | **Proposal 7: For eMTC, network assigns UE a time of probably losing coverage after the location report. UE starts intra/inter frequency measurements before this time.**  **Proposal 8: The exact time to start measurements in connected mode before the assigned time of losing coverage can be left for UE implementation.** |

Moreover, in [13, [R2-2210089](file:///C:\Data\3GPP\Extracts\R2-2210089-%20Discussion%20on%20mobility%20enhancement%20for%20IoT%20NTN.doc)], [16, [R2-2210196](file:///C:\Data\3GPP\Extracts\R2-2210196%20(R18%20IoT-NTN%20WI%20AI%208.6.3)%20-%20mobility%20enhancements.docx)] and [22, [R2-2210735](file:///C:\Data\3GPP\Extracts\R2-2210735%20-%20Discussion%20on%20connected%20mode%20measurements.docx)], companies also give some proposals for enhancements on connected mode measurement for eMTC NTN

**Q1: Companies are invited to indicate whether you support to introduce enhancements for connected mode measurement for R18 eMTC NTN? If yes, companies are invited to elaborate the main issues that needs to be addressed.**

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| **Company** | **Yes or No** | **Comments** |
| ZTE | No | As mentioned in [13], for eMTC UE in connected mode, s-Measure can be used to control UE to perform neighbor cell measurements. In general, when the serving cell RSRP is better than a threshold, UE is not required to perform neighbor cell measurements. We have sympathy with that, due to the issue that the signal quality change may be very small between the cell center and the cell edge, the neighbor cell measurements may be not easy to be triggered in eMTC NTN.  However, different from NB-IoT, for eMTC, the purpose of connected mode measurement is mainly for connected mode mobility, e.g., handover. So UE generally needs an “always on” measurement in order to find out better neighbor cells timely and trigger handover. But we think the current under-discussion new triggers, e.g., to trigger measurement when the current cell is about to stop serving or when determining UE close to the cell edge based on distance between UE and satellite, would cause too late measurement, may even worse than RSRP-based trigger. Therefore, we think eMTC NTN can still rely on the existing connected mode measurement scheme (some threshold/configuration may need to be adapted to NTN network). |
| MediaTek | Yes | We believe that RSRP change is expected low between Nadir and cell edge, hence the RSRP-based trigger may not be useful.  For earth-fixed case, t-service is broadcast to indicated when serving cell will stop provide coverage. In Rel-17, UE in idle mode can trigger neighbor cell measurement before t-service to check if there is any neighbor cell to reselect. In Rel-18, UE in connected mode can also trigger neighbor cell measurement before t-service. For NB-IoT UE, the measurement result can be used to reduce the time taken of RRC connection reestablish.  For eMTC UE, the connected mobility is normally achieved by handover. However, in NTN, at least in early stage, satellite coverage may not be sufficient, and TN and NTN may not getting through, handover may not be reliable and RLF will occur. Hence RLF enhancement also has meaning for that. |
| Xiaomi | No | Before the R17, the neighour cell measurement before RLF is not allowed for NB-IoT UE, so the new trigger is introduced for UE performing the neibhour cell measurement before the RLF in R17, and we consider to introduce the enhancements for connected mode measurement for NB-IoT NTN UE. However, for eMTC UE, it always can perform the neighbor cell measurement in RRC connected, and the time base and location based CHO also will be introduced, thus the connected mobility works well with the agreed mechanism, there is no need to introduce the new trigger for RRC Connected neighbour cell measurement. |
| OPPO | Yes | To address the unclear near-far issue in NTN, RSRP-based s-measure criteria should be enhanced by introducing location based criteria.  In addition, since time-based measurement trigger for RRC\_IDLE has been introduced for in R17, this time-based measurement trigger can be re-used for RRC\_CONNECTED for eMTC NTN in R18. |
| Lenovo | Maybe | Not quite sure whether the question is about measurement itself or measurement report triggering. For measurement itself, we think current mechanism is sufficient. For measurement report triggering, we are open to discuss whether NR NTN enhancements (i.e. location-based triggering, Event D1) can be reused. |
| Spreadtrum | No | For NB-IOT UE, a new trigger for neighbor cell measurement is introduced to reduce the time taken of RRC reestablishment, due to that it is not allowed to perform conventional neighbor cell measurement in RRC connected mode. However, the eMTC UE is allowed to perform regular measurement for the purpose of mobility. That is to say, the current mechanism for eMTC is enough to meet the requirement of performing measurement in RRC connected mode. Therefore, we cannot see a need to introduce enhancement for connected mode measurement for eMTC. |
| NEC | No | Based on objective of this WID as quoted below, it is our understanding that triggering neighbor cell measurement before RLF is intended for NB-IoT to accelerate RRC-re-establishment. Discussion on trigger neighbor cell measurement before HO seems out of scope.  - Support of neighbour cell measurements and corresponding measurement triggering before RLF, using Rel‑17 (TN) NB-IoT, eMTC as a baseline. [RAN2]  - Re-use the solutions introduced in Rel-17 NR NTN for mobility enhancements for eMTC, with minimum necessary changes to adapt them to eMTC [RAN2]  Moreover, we did not enhance measurement initiation (S-Measure) for NR NTN.    Finally, with time-based CHO trigger, we assume UE implementation will measure neighbors before the configured time point to prepare the CHO execution. Anything else do we need to specify? |
| Huawei, HiSilicon | No | We think for eMTC, the Connected mode mobility can be enhanced by time-based CHO and/or location-based CHO already. |
| InterDigital | FFS | We agree that the measurements before RLF objective is directed at NB-IoT. However, if we consider time based trigger for CHO it might be useful. In NR the time based and location based trigger need to be configured along with RSRP threshold therefore measurement needs to be triggered based on RSRP. However if we allow configuring time based trigger without RSRP threshold (see p6 in [16])\_then it would be beneficial to trigger measurements based on a time trigger in order to support this. We should discuss the time based trigger for CHO in more detail before deciding this. |
| Qualcomm | No, but see comments | Agree with NEC.  For measurement object configuration, existing mechanism is sufficient. UE makes regular measurement as specified by RAN4 spec as needed without any further enhancement. Just look at the NR solution.  However, what we need a new enhancement is to have a condition to trigger the measurement report. |
| Ericsson | Yes | In Rel-17, RAN2 introduced a mechanism to **assist** an NB-IoT UE to trigger cell search when it is likely to declare RLF. It is expected that such assistance can facilitate performing the cell search faster and thus reduce the time it takes to re-establish an RRC connection especially when inter-frequency cells are considered.  An important aspect that was considered is the criteria defined so that neighbor cell measurements are triggered only when RLF is to be declared due to “mobility” This was to avoid any impact on the battery life performance of UEs that are “stationary”. Network provides such criteria, based on a combination of serving cell quality threshold and variance, to a UE regarding when to start measurements to accelerate cell search once RLF is declared.  Legacy relaxed monitoring criteria is used as a baseline to address the variance part of the criteria. Relaxed neighbor cell monitoring state in connected mode is similar to relaxed monitoring state in idle and the objective is to estimate whether the UE is stationary or has low mobility. Note that **it is up to the UE to perform such measurements** even when criteria are fulfilled and measurement results, if performed, are not required to be reported  In Rel-18, the following objectives are captured under “Mobility Enhancements” in the WID on IoT NTN enhancements:  - Support of neighbor cell measurements and corresponding measurement triggering before RLF, using Rel‑17 (TN) NB-IoT, eMTC as a baseline. [RAN2]  - Re-use the solutions introduced in Rel-17 NR NTN for mobility enhancements for eMTC, with minimum necessary changes to adapt them to eMTC [RAN2]  It is clear from the first objective that the assistance mechanism introduced in Rel-17 is to be adopted for both NB-IoT and LTE-M in Rel-18 IoT NTN. This aspect was discussed in the previous meeting and concluded. The intention with this objective is to reduce the time it takes to re-establish an RRC connection after RLF is declared. This is more relevant to NB-IoT as HO is not supported, but it is not about the handover mechanism, and it also applies to LTE-M.  Any enhancements regarding the plain vanilla HO mechanism or the CHO mechanism should be discussed separately considering the second objective above.  Another aspect to note is the comments from some companies on measurements and measurement reporting. It seems some companies have mixed those up. The mechanism introduced for NB-IoT in Rel-17 is about providing assistance information for a UE to trigger measurements (optional) to perform cell search faster and there is no reporting. This is not the case for HO where reporting is required so that the network can decide when to trigger the HO. This is of course slightly different for CHO, where execution of the HO command depends on some conditions.  Yet another important aspect to note is that the following statement provided by some companies is not correct: “Neighbor cell measurement before RLF is not allowed for NB-IoT UE,”. This is possible and it is up to the UE. No reporting is required though.  In legacy, a network can configure an LTE-M UE to perform measurements and trigger certain reporting based on signal strength criteria for serving and neighbor cells with the intention to execute the handover procedure, but this first objective is about RLF and RRC connection-reestablishment. We understand that an NB-IOT UE would experience RLF more likely compared to an LTE-M UE due to lack of support for HO, but this should not be a reason for not introducing any enhancements.  Another aspect to consider here is the time and distance based criteria to be introduced to trigger the measurements. This is not possible in legacy and should be introduced both for NB-IoT and LTE-M as stated in the WID. |
| Intel | No | Agree with Huawei, for eMTC, the Connected mode mobility can be enhanced by time-based CHO and/or location-based CHO already. |

**Conclusion for Q1: TBD**

**Q2: If answer to Q1 is Yes, companies are further invited to indicate what measurement enhancements can be introduced for eMTC NTN in your thinking (we don’t’ intend to discuss the details, you can just mention the high level aspects).**

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| **Company** | **Comments** |
| MediaTek | Same as NB-IoT, measurement trigger before t-service time and distance based measurement trigger. |
| OPPO | Both location based trigger and time based trigger can be considered. |
| Lenovo | For measurement report triggering, we are open to discuss whether NR NTN enhancements (i.e. location-based triggering, Event D1) can be reused. |
| InterDigital | See Q1 |
| Ericsson | Same as NB-IoT for the fist objective under “Mobility enhancements” in the IoT NTN WID. Please see the reply to Q1for details. |
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**Conclusion for Q2: TBD**

## Detailed enhancements for connected mode measurement

In this section, the details of measurement triggers would be further discussed.

Unless indicated specially, technical discussion in this section can be considered applicable to both NB-IoT NTN and eMTC NTN. But if the conclusion of Q1 would be that measurement enhancements are not needed for eMTC NTN, the final technical proposals in this section will explicitly apply only to NB-IoT NTN.

### General aspects

One of the objectives of R18 IoT NTN is “*to support of neighbor cell measurements and corresponding measurement triggering before RLF, using Rel‑17 (TN) NB-IoT, eMTC as a baseline”.* Moreover, in RAN2 #119e meeting, RAN2 has high level agreement that IoT NTN can use the mechanism for neighbor cell measurements in connected mode (specified in Rel-17 for NB-IoT). However, according to the comments during previous discussion, companies may still have different views on to what extent can this R17 NB-IoT measurement mechanism be used for R18 IoT NTN.

Per rapporteur’s knowledge, two main specification work have been done for R17 NB-IoT connected mode measurement. One part is the measurement configuration and measurement procedure based on the configured criteria in RAN2. The other part is the performance requirement defined by RAN4.

We can only consider the RAN2 specification part. For reference, the RAN2 related specification are copied as below:

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| -- ASN1START  SystemInformationBlockType3-NB-r13 ::= SEQUENCE {  cellReselectionInfoCommon-r13 SEQUENCE {  //the unrelated part is skipped//  ]],  [[ connMeasConfig-r17 ConnMeasConfig-NB-r17 OPTIONAL, -- Need OR  t-Service-r17 TimeOffsetUTC-r17 OPTIONAL -- Need OR  ]]  }  //the unrelated part is skipped//  ConnMeasConfig-NB-r17 ::= SEQUENCE {  s-MeasureIntra-r17 NRSRP-Range-NB-r14,  s-MeasureInter-r17 NRSRP-Range-NB-r14 OPTIONAL, -- Need OP  neighCellMeasCriteria-r17 SEQUENCE {  s-MeasureDeltaP-r17 ENUMERATED {dB6, dB9, dB12, dB15},  t-MeasureDeltaP-r17 ENUMERATED {s15, s30, s45, s60}  } OPTIONAL -- Need OR  }  -- ASN1STOP 5.5 Measurements…………………………………………..5.5.8 Measurements in NB-IoT Upon transition to RRC\_CONNECTED mode, the UE shall:   1. if *neighCellMeasCriteria* is present in *SystemInformationBlockType3-NB:*   2> set NRSRPRef to the latest result of the serving cell measurement as used for cell selection/reselection evaluation;  2> if therelaxed monitoring criterion defined in TS 36.304 [4] was not fulfilled:   1. start T326 with the value *t-MeasureDeltaP*;   While in RRC\_CONNECTED mode, after performing a measurement, the UE shall:   1. in the following use the NRSRP measurement for the measured carrier and *nrs-PowerOffsetNonAnchor* corresponding to the measured carrier; 2. if *neighCellMeasCriteria* is present in *SystemInformationBlockType3-NB*:   2> if (NRSRPRef – (NRSRP– *nrs-PowerOffsetNonAnchor*)) > *s-MeasureDeltaP*:   1. set NRSRPRef = (NRSRP – *nrs-PowerOffsetNonAnchor*); 2. start or restart T326 with the value *t-MeasureDeltaP*; 3. if *neighCellMeasCriteria* is not present in *SystemInformationBlockType3-NB*; or 4. if T326 is running:   2> if (NRSRP – *nrs-PowerOffsetNonAnchor*) < *s-MeasureIntra*, perform intra-frequency measurements as defined in TS 36.133 [16];  2> if (NRSRP – *nrs-PowerOffsetNonAnchor*) < *s-MeasureInter*, perform inter-frequency measurements as defined in TS 36.133 [16]. |

During the discussion, companies seems to have common understanding that, in NTN network, since the signal quality change may be very small when the UE moves between the cell center and the cell edge, the RSRP-based triggering conditions for connected mode neighbor cell measurement may no longer be suitable to use.

Based on that, some companies think the whole mechanism still can be kept for R18 IoT NTN and whether the criteria is configured can be left to NW implementation (maybe seldom configured). Meanwhile, it seems some other companies may think RSRP-related measurement configuration and procedure would be excluded for R18 IoT NTN and only new triggers are needed. In order to make things clear, rapporteur invite companies to further elaborate their thoughts.

**Q3: Companies are invited to indicate their understanding on what aspects of R17 NB-IoT connected mode measurement can be kept/applied for R18 IoT NTN.**

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| **Company** | **Comments** |
| ZTE | We suggest to apply the whole mechanism of R17 NB-IoT connected mode measurement in RAN2 for R18 IoT NTN, e.g., measurement configuration and measurement procedure. It may only need to add some simple description in stage-2 spec and in UE capability part to indicate this feature can be used by R18 IoT NTN.  Certainly, the performance requirement in RAN4 also needs to be applied.  We don’t think it’s good idea to explicitly excluded measurement configuration and measurement procedure of R17 NB-IoT from R18 IoT NTN. |
| MediaTek | Agree with ZTE to keep the R17 NB-IoT mechanism. |
| Xiaomi | Agree to apply the mechanism of R17 NB-IoT connected mode measurement for R18 IoT NTN. And we also consider the new trigger condition could work with the legacy mechanism, for example, the *neighCellMeasCriteria* can be worked with the new trigger condition. |
| OPPO | Agree with Xiaomi. |
| Lenovo | Agree with Xiaomi |
| Spreadtrum | We think the whole mechanism of R17 NB-IoT connected mode measurement can be generally applied to R18 IoT NTN. Maybe, some additional principle is needed on how the new trigger works with the legacy one or works independently. |
| NEC | In our understanding, it is the framework or principle of Rel17 NB-IoT connected mode measurement before RLF can be reused. All details can be rediscussed, including whether we should combine Rel17 trigger with new trigger or rel-17 trigger will not be used at all.  On the other hand, in practice all these RSRP based configurations may not be used at all in NTN scenario. But one possible way forward is leave to NW whether to configure Rel17 RSRP based trigger or not.  Our discussion should focus on details of other triggers. |
| Huawei, HiSilicon | At least R17 mechanism can be applied to R18. Whether combination of triggers is allowed needs further discussion. |
| InterDigital | Triggering measurements before RLF can apply to NTN, we need to discuss triggers and timers. |
| Qualcomm | Agree with Huawei. |
| Intel | Ok to keep the R17 NB-IoT mechanism, it’s up to network to decide whether to configure s-measure. |

**Conclusion for Q3: TBD**

### Time-based new trigger

#### Based on the time when current cell stops serving

The related proposals are copied below:

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| Contributions | The related proposals |
| R2-2209443[2] | **Proposal 1: UE shall start intra/inter frequency measurement in connected mode before the t-Service if present.**  **Proposal 2: The exact time to start measurements in connected mode before t-Service can be left to UE implementation.**  **Proposal 3: The condition of stopping UE measurement before t-Service is not specified.**  **Proposal 4: For earth-moving cell, the serving cell footprint information is broadcast for determining the time of loss of coverage of current cell in NB-IoT.**  **Proposal 5: NB-IoT UE starts intra/inter frequency measurements in RRC connected mode before the calculated time of losing coverage.** |
| R2-2209411[3] | **Proposal 1: For IoT-NTN, the connected UE should trigger the neighbor cell measurement before the end of the serving time of serving cell or the starting serving time of the neighbor cell for the UE which is late arrival.** |

The online discussion for proposal 1 in [2] are copied below:

Proposal 1: UE shall start intra/inter frequency measurement in connected mode before the t-Service if present.

* IDC thinks is related to p10,
* Oppo supports p1 and p2
* Ericsson agrees with IDC and in any case thinks this should be “may” not “shall”
* ZTE thinks think P1 is mainly for continuous coverage case, and P10 is for discontinuous coverage case)
* QC thinks this is meant to introduce new triggers for eMTC
* Continue in offline 118

**Q4: Companies are invited to indicate which proposals can be agreeable. And you can further give suggestions on the proposals in your preference. If you say none, you can indicate reason and may also give other proposals related to time-based trigger.**

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| **Company** | **Agreeable proposals** | **Comments** |
| ZTE | P1, P2 and P3 in [2] | Some wording suggestions:  **Proposal 1: UE may start intra/inter frequency measurement in connected mode before the *t-Service*, if present.**  P2, P3 may be generally ok, but we understand when to start/stop the measurement may also rely on requirements defined in RAN4. So either way we don’t agree P2, P3 now, or we can change P3, P3 like this:  **Proposal 2: The exact time to start measurements in connected mode before t-Service can be left to UE implementation and follow the requirements defined in RAN4.**  **Proposal 3: RAN2 would not specify I condition of stopping UE measurement before t-Service.**  For earth-moving cell case, we don’t support P4 and P5. We think instead of calculating the time of losing coverage of current cell, it may be easier for UE to calculate the distance between it and satellite and such calculation may require less information. In other word, for earth-moving cell case, we can mainly rely on the new distance-based trigger. |
| MediaTek | P1, P2, P3, P4, P5 in [2] | The idea of distance-based trigger is to compare the distance between UE and satellite, but it may need to check the distance multiple times hence need multiple times GNSS positioning. But estimate of when the distance will below a threshold based on the current location and moving speed requires less GNSS positioning. It may not be as accurate as the directly comparing distance-based trigger, but it can save power consumption. This method can also be categorized as a variant of distance-base trigger.  The actual text could be edited as”sugg’sted by Ericsson and mentioned by ZTE. |
| Xiaomi | P1, P2, P3, P4, P5 in [2] | For the earth moving cell, we think the P4 and P5 can be considered, since the UE can calculate its specific time based one UE location, footprint information and the broadcasted timing information. |
| OPPO | P1, P2, P3, P4, P5 in [2] |  |
| Lenovo | P2, P4, P5 in [2]  Comments to P1 and P3 | For P1 and P3, we think it shall be for continuous coverage only:  **Proposal 1: UE shall start intra/inter frequency measurement in connected mode for continuous coverage before the t-Service if present.**  **Proposal 3: The condition of stopping UE measurement before t-Service for continuous coverage is not specified.**  That is, if in discontinuous coverage, UE does not need to perform any measurement in connected mode if there is no coverage in future. |
| Spreadtrum | P3, P4 in [2] | We think a time trigger condition should be defined for UE to determine the exact time to start measurement, which is similar to the legacy principle of starting measurement based on the exact threshold. |
| NEC | P1 and P2 in [2] with comment  First part of P1 in [3] | We support time-based trigger, i.e., P1 and P2 or first part of P1 in [3] but “shall” in P1 and P2 can be changed into “may”. UE implementation should do best effort, and it may not be mandatory if UE will not report anything. |
| Huawei, HiSilicon | P1~P5 in [2] | On the serving cell footprint information, we actually think it should be broadcast even in R17. Because RAN2 has also agreed that when out of coverage, the UE is not required to perform any cell search and may deactivate its AS functions to optimize the power consumption, but UE cannot determine when the serving cell coverage will disappear in moving cell scenarios. |
| InterDigital | Combine P1 in Q4 with P10 in Q5. | We need to combine the triggers in Q4 and Q5. The UE starts measurements before t-Service if t-ServiceStart for the neighbour cell has passed. This covers the continuous and discontinuous coverage case, and it would be simpler to specify like this. |
| Qualcomm | For NB-IoT, P1,2,4,5 | For eMTC, P1 and P2 are not needed. UE will anyway perform measurement before t-service. |
| Intel | P1 in [3] | We also suggest to clarify, even if the current RSRP is higher than S-measure, UE still need to start neighbour cell measurements before the end time of serving cell’s coverage. |

**Conclusion for Q4: TBD**

#### Based on the time when neighbour cell starts serving

The related proposals are copied below:

|  |  |
| --- | --- |
| R2-2209443[2] | **Proposal 9: UE calculates the time of UE entering the neighbor satellite’s coverage.**  **Proposal 10: UE starts intra/inter frequency measurements in RRC connected mode after the calculated time of entering the neighbor satellite’s coverage** |
| R2-2209411[3] | **Proposal 1: For IoT-NTN, the connected UE should trigger the neighbor cell measurement before the end of the serving time of serving cell or the starting serving time of the neighbor cell for the UE which is late arrival.** |

**Q5: Companies are invited to indicate which proposals can be agreeable. And you can further give suggestions on the proposals in your preference. If you say none, you can indicate reason and may also give other proposals related to time-based trigger.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agreeable proposals** | **Comments** |
| ZTE | None | According to the description in [2][3], we understand P9 and P10 in [2] and P1 in [3] are mainly used for discontinuous coverage case. We think they are irrelevant to the current connected mode measurement in mobility enhancement topic. For connected mode measurement, UE is still in connected mode and needs to perform neighbor cell measurement before losing coverage of current cell. But for discontinuous coverage case, after out of coverage of current cell, UE enters into a state similar as PSM. If UE can predict the start time of next coming cell, UE may not need to perform regular measurement, but can just try to camp that cell.  Anyway, it may be more suitable to discuss P9 and P10 in [2] and P1 in [3] in discontinuous coverage topic. |
| MediaTek | P9,10 in [2] | It is still possible that UE in connected mode under NTN can be covered by another satellite. The discontinuous coverage feature is trying to solve the case when the coverage is discontinuous, but it does not exclude the case of continuous coverage.  Hence if UE starts neighbor cell measurement when new neighbor cell is available, it definitely can help to the upcoming RLF.  If the coverage is discontinuous, then condition of trigger neighbor cell measurement in connected mode for new satellite will not be fulfilled, there is also no harm here.  This is not an enhancement of discontinuous coverage, quite opposite, it is a case of continuous coverage. Thus, it’s not suitable to move to discontinuous coverage topic. |
| Xiaomi | P9,10 in [2]  P1 in [3] | The UE power consumption will be reduced with considering the upcoming timing information of the neighour cell when UE performs the neighbour cell measurement since the unnecessary neighbour cell measurement can be avoided. |
| OPPO | P9,10 in [2] | We think the starting time of neighbor cell can be considered in both continuous coverage and discontinuous coverage scenario. UE should not perform measurement on a neighbor cell before its starting time. |
| Lenovo | P9 in [2]  Comments to P10 in [2] | For P10, we think it shall be for continuous coverage only:  **Proposal 10: UE starts intra/inter frequency measurements in RRC connected mode for continuous coverage after the calculated time of entering the neighbor satellite’s coverage**  That is, if in discontinuous coverage, UE does not need to perform any measurement in connected mode if there is no coverage in future. |
| Spreadtrum | P9 in [2] | If the time point of UE entering the neighbor satellite’s coverage is earlier than that of the time-threshold of triggering measurement, UE starts intra/inter frequency measurements when the trigger condition meets. Otherwise, UE starts intra/inter frequency measurements at the time point of UE entering the neighbor satellite’s coverage. Anyway, the UE needs to calculate the time of UE entering the neighbor satellite’s coverage. |
| NEC | None | It can be discussed as assistance information for discontinuous coverage scenario , but not here |
| Huawei, HiSilicon | None | Triggering measurements based on neighbor cell coverage introduces more UE complexity than based on serving cell’s RSRP or remaining serving time, as the UE needs to monitor (multiple) neighbor cell coverage information. Besides, we agree with ZTE that neighbor cell coverage information is only provided in the scenario of discontinuous coverage, which is a separate discussion. |
| InterDigital | Combine P1 in Q4 with P10 in Q5. | We need to combine the triggers in Q4 and Q5. The UE starts measurements before t-Service if t-ServiceStart for the neighbour cell has passed. This covers the continuous and discontinuous coverage case, and it would be simpler to specify like this. |
| Qualcomm | None | We also think it is unlikely that UE will have such detail information of the neighbor cell. Lets hope at least ephemeris of the neighbor cell is provided for the measurement. |
| Intel | P1 in [3] | it’s reasonable to say “which is late arrival” to avoid unnecessary early start. |

**Conclusion for Q5: TBD**

### Distance-based new trigger

The proposals related to distance-based new trigger are copied below:

|  |  |
| --- | --- |
| R2-2209836[1] | **Proposal 3: In NB-IoT over NTN, the triggering condition for connected mode neighbor cell measurement can be based on distance between the UE and the satellite.** |
| R2-2209411[3] | **Proposal 2: For IoT-NTN, distance-based trigger for triggering intra and inter frequency measurements in connected mode is not supported.** |
| R2-2210089[13] | **Proposal 1: Location based measurement triggering in RRC\_CONNECTED is supported for IoT NTN.**  **Proposal 2: For quasi-earth fixed cell, distance between UE and serving cell reference location is used to trigger measurement in RRC\_CONNECTED for IoT NTN.**  **Proposal 3: For earth moving cell, distance between UE and serving satellite is used to trigger measurement in RRC\_CONNECTED for IoT NTN.** |

It can be seen companies show diverse views in above proposals. In [3], company mentions that, since time-based and RSRP-based trigger for neighbor cell measurement can work well for earth-fixed NTN cell and also can work for earth-moving NTN cell, the distance-based trigger mechanism is not necessary. Moreover, distance-based mechanism needs the UE to perform GNSS measurement to evaluate whether the distance-based mechanism is fulfilled, which will increase the UE power consumption.

**Q6: Companies are invited to indicate whether you support to introduce distance-based new trigger for connected mode measurement for R18 IoT NTN and elaborate your reasons. If you say Yes, you can also give more thoughts about the distance-based new trigger.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| ZTE | Yes | We are fine with P3 in [1] and no comments.  We think time-based trigger may not work well for earth-moving cell case and therefore, distance-based trigger is still needed.  The details can be discussed in next meeting. Generally, we expect a simple solution and hope to avoid introducing reference location or something like that for NB-IoT NTN. |
| MediaTek | Yes | Agree with ZTE that time-based trigger may not work well for earth-moving cell case. |
| Xiaomi | Yes | We think the network can provide the reference location and threshold for UE to determine neighbour cell measurement. |
| OPPO | Yes | For **quasi-earth fixed cells**, distance between UE and serving cell reference location is used to trigger measurement in RRC\_CONNECTED for IoT NTN.  For **earth moving cells**, distance between UE and serving satellite is used to trigger measurement in RRC\_CONNECTED for IoT NTN. |
| Lenovo | Yes | We are OK to reuse NR NTN distance-based trigger for connected mode measurement report triggering. |
| spreadtrum | No | We think time-based trigger is enough to achieve the purpose of reducing time taken of RRC reestablishment. In addition, the mechanism of distance-based trigger will have negative impact on UE power consumption due to positioning operation. |
| NEC | Yes | Location-based trigger is useful for earth moving scenario. For earth moving cell, both time-based and  location-based trigger probably require UE-side estimation, and location-based trigger might be more straight forward. |
| Huawei, HiSilicon | Yes | In Rel-17, RAN2 discussed location-based reselection in IoT NTN, but it was not adopted because some companies think updating GNSS position frequently will waste UE power and some other considered the location-based enhancement not essential.  But we think the case for RRC\_CONNCTED is different from RRC\_IDLE. When UE is in RRC\_CONNECTED, it anyway needs to have a valid GNSS for timing/frequency synchronisation with serving cell. Besides, Rel-18 is considering improved GNSS operation to enable UE to update the GNSS in RRC\_CONNECTED, so we think it is not a problem for UEs in RRC\_CONNECTED to maintain a valid GNSS, and location-based measurement triggering is feasible. |
| InterDigital | Yes | Better support for earth moving case, and since we introduce GNSS enhancements this should be possible. |
| Qualcomm | Yes for NB-IoT.  Yes for CHO. |  |
| Intel | Yes | And we also think for Earth-moving cell, time based and location based solution are actually the same thing, as UE estimates the stop time of serving cell’s coverage based on the distance between UE and reference location. |

**Conclusion for Q6: TBD**

## Other aspects

In [1], for connected mode measurement, company give the following proposal to say, if UE needs to perform a long time measurement (e.g., UE in enhanced coverage), it’s better for UE to inform eNB that UE is going to start the connected mode neighbour cell measurements.

|  |  |
| --- | --- |
| R2-2209836[1] | **Proposal 7: For NB-IoT over LEO, UE can report an indication to inform eNB that UE is going to start the connected mode neighbor cell measurements.** |

**Q7: Companies are invited to indicate whether you can agree the P7 in [1] and elaborate your reasons.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| ZTE | Yes | As mentioned in [1], for UE in enhanced coverage, as UE can only make use of “vacant” resources (e.g., resources on which the UE is not scheduled for data transmission or reception) to perform measurement and the measurement time may be long, eNB needs to restrict the scheduling in order to leave enough “vacant” resources for UE. In order to facilitate eNB to schedule “vacant” resources only when it’s needed, we suggest UE to inform eNB that it going to start the connected mode neighbour cell measurements (e.g., that may means the criteria has been fulfilled). |
| MediaTek | No | This mechanism was discussed in Rel-17 and was not agreed. In Rel-18, we don’t see any special need to introduce this mechanism. |
| Xiaomi | No | Agree with MediaTek, |
| OPPO | No | Agree with MediaTek. This is not a NTN-specific issue. |
| Lenovo | No | For now we see no need of indication. |
| Spreadtrum | No | Also agree with MediaTek. |
| NEC | No | we understand the motivation of the proposal is to enable gNB to provide scheduling “gap”, then UE could use it for neighbour measurements. However, there would be then no gain anymore comparing measurement after RLF declaration. So we think making use of “vacant” resource is enough. No indication is needed |
| Huawei, HiSilicon | No | Such enhancement can be postponed. |
| InterDigital | No | As long as UE performs measurements according to RAN4 requirement we don’t see why an indication is needed. |
| Qualcomm | No |  |
| Intel | No |  |

**Conclusion for Q7: TBD**

|  |  |
| --- | --- |
| R2-2209443[2] | **Proposal 6: NB-IoT UE can calculate the time of losing coverage before entering RRC connected mode and skip to next cell if the remaining time of current cell’s coverage is too short to start a connection.** |

In [2], company mention that UE can calculate the time of losing coverage before entering RRC connected mode right after acquiring assistance information. If the remaining time of current cell’s coverage is too short to start a RRC connection, UE may choose to wait for the next cell.

**Q8: Companies are invited to indicate whether you can agree the P6 in [2] and elaborate your reasons.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| ZTE | Yes | We think the intention of P6 in [2] is make sense.  Even it may be more suitable to be discussed in discontinuous coverage topic, we think it may be also workable in continuous coverage case. For example, in earth-fixed cell, if UE knows the stop time of current cell and UE also can predict the needed time of service transmission, UE can choose not to trigger the access to this cell if it evaluates the service cannot be finished before the cell stop time. |
| MediaTek | Yes | UE can predict the remaining service time of current serving cell at least by t-Service. If the remaining service time is less than time taken by connection establishment, UE can choose to skip this cell to the next cell in the continuous coverage scenario to save power consumption. The threshold of judgement could leave for UE implementation. |
| Xiaomi | No | It will lead to strict requirement on how to set the t-service. In the Rel-17, the t-Service is only used for RRC ilde UE to perform neibhour cell measurement. |
| OPPO | No | It can be up to UE implementation. For UE’s prediction of the time used for starting a connection, we are not sure how to specify that. |
| Lenovo | Maybe | But how to determine the threshold? UE implementation requires accurate information of cell coverage, especially for earth-moving cells. |
| Spreadtrum | Yes | We think the decision on whether to start connection towards one certain cell is up to UE implementation. |
| NEC | Yes | Considering that NB-IoT service are delay tolerant, It make sense for UE to delay the access after cell reselect to next cell if current cell is going to stop the service. It is an easy way to avoid unnecessary RRC re-establishment or handover.to |
| Huawei, HiSilicon | No | Agree with others that it can be left to UE implementation. |
| InterDigital | No | UE could do this by implementation and we don’t see any specification impact. |
| Qualcomm | Yes but | It needs to be clarified what is “skip to next” cell?  Is this the second best suitable cell before entering RRC connected? |
| Intel | No | Up to UE implementation |

**Conclusion for Q8: TBD**

# Conclusion

*[Easy Agreements]*

*[To be discussed]*

# References

[1] R2-2209836 Further discussion on mobility enhancements ZTE Corporation, Sanechips discussion Rel-18

[2] R2-2209443 On Mobility Enhancements in IoT-NTN MediaTek Inc. discussion Rel-18

[3] R2-2209411 Discussion on IoT NTN Mobility Enhancements CATT discussion Rel-18

[4] [R2-2209580](file:///C:\Data\3GPP\Extracts\R2-2209580%20Discussion%20on%20neighbour%20cell%20measurements%20in%20IoT%20NTN.docx) Discussion on neighbour cell measurements in IoT NTN Intel Corporation discussion Rel-18

[5] [R2-2209718](file:///C:\Data\3GPP\Extracts\R2-2209718%20IoT%20mobility.doc) Connected mode mobility enhancements Qualcomm Incorporated discussion Rel-18

[6] [R2-2209719](file:///C:\Data\3GPP\Extracts\R2-2209719%20RLF%20detection.doc) RLF detection in earth fixed cell Qualcomm Incorporated discussion Rel-18

[7] [R2-2209751](file:///C:\Data\3GPP\Extracts\R2-2209751%20Discussion%20on%20mobility%20enhancement%20for%20IoT%20NTN.docx) Discussion on mobility enhancement for IoT NTN Transsion Holdings discussion Rel-18

[8] [R2-2209794](file:///C:\Data\3GPP\Extracts\R2-2209794_RLF%20in%20IoT%20NTN.doc) Neighbour cell measurements before RLF Apple discussion Rel-18 IoT\_NTN\_enh

[9] [R2-2209967](file:///C:\Data\3GPP\Extracts\R2-2209967%20NTN-specific%20CONNECTED%20neighbour%20cell%20measurement%20for%20NB-IoT.docx) NTN-specific CONNECTED neighbour cell measurement for NB-IoT Lenovo discussion Rel-18

[10] [R2-2209968](file:///C:\Data\3GPP\Extracts\R2-2209968%20On%20IDLE%20mobility%20for%20IoT%20NTN.docx) On IDLE mobility for IoT NTN Lenovo discussion Rel-18

[11] [R2-2209978](file:///C:\Data\3GPP\Extracts\R2-2209978.doc) Discussion on triggering neighbour cell measurement before RLF Spreadtrum Communications

[12] [R2-2210074](file:///C:\Data\3GPP\Extracts\R2-2210074-Mobility-Enhancements-IoT-NTN.docx) On the applicability of mobility enhancements features for IoT-NTN Nokia, Nokia Shanghai Bell

[13] [R2-2210089](file:///C:\Data\3GPP\Extracts\R2-2210089-%20Discussion%20on%20mobility%20enhancement%20for%20IoT%20NTN.doc) Discussion on mobility enhancement for IoT NTN OPPO discussion Rel-18

[14] [R2-2210122](file:///C:\Data\3GPP\Extracts\R2-2210122%20Enhancements%20on%20the%20neighbour%20cell%20measurement.doc) Enhancements on the neighbour cell measurement Xiaomi discussion

[15] [R2-2210154](file:///C:\Data\3GPP\Extracts\R2-2210154%20Discussion%20on%20the%20mobility%20enhancement%20for%20IoT-NTN.docx) Discussion on the mobility enhancement for IoT-NTN CMCC discussion Rel-18

[16] [R2-2210196](file:///C:\Data\3GPP\Extracts\R2-2210196%20(R18%20IoT-NTN%20WI%20AI%208.6.3)%20-%20mobility%20enhancements.docx) IoT-NTN mobility enhancements Interdigital, Inc. discussion Rel-18

[17] [R2-2210321](file:///C:\Data\3GPP\Extracts\R2-2210321.docx) Mobility Enhancement for IoT NTN Samsung R&D Institute UK discussion

[18] [R2-2210372](file:///C:\Data\3GPP\Extracts\R2-2210372.docx) Use of Elevation Angle Threshold for IoT NTN Neighbour Cell Measurements SHARP

[19] [R2-2210407](file:///C:\Data\3GPP\Extracts\R2-2210407%20Discussion%20on%20mobility%20enhancements.DOC) Discussion on mobility enhancements Huawei, HiSilicon discussion Rel-18

[20] [R2-2210597](file:///C:\Data\3GPP\Extracts\R2-2210597.docx) Discussion on Mobility Enhancements of IoT NTN TURKCELL discussion Rel-18

[21] [R2-2210733](file:///C:\Data\3GPP\Extracts\R2-2210733%20-%20Discussion%20on%20Conditional%20Handover%20in%20IoT%20NTN.docx) Discussion on Conditional Handover in IoT NTN Ericsson discussion Rel-18

[22] [R2-2210735](file:///C:\Data\3GPP\Extracts\R2-2210735%20-%20Discussion%20on%20connected%20mode%20measurements.docx) Discussion on connected mode measurements Ericsson discussion Rel-18