**3GPP TSG-RAN WG2 Meeting #113bis-electronic R2-21xxxxx**

**Online, April 12th – April 20th, 2021**

**Agenda item: 9.2.3**

**Source: MediaTek Inc.**

**Title: Summary for Control Plane Procedures in IoT-NTN**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution is aimed at providing a summary of contributions regarding the mobility and tracking area aspects in IoT-NTN. The following 22 contributions with “Idle Mode Mobility (Cell Selection/Re-selection and Tracking Area Update), Connected Mode Mobility and System Information Broadcast (SIB)” are summarized:

1. [R2-2102744](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102744.zip), Discussion on control plane for IoT over NTN, OPPO
2. [R2-2102829](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102829.zip), On Cell-Reselection in NR-NTN, MediaTek Inc.
3. [R2-2102957](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102957.zip), Discussion on the mobility of IoT over NTN, CATT
4. [R2-2102961](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102961.zip), Essential adaptations for discontinuous coverage in IoT-NTN, Gatehouse Satcom A/S
5. [R2-2103051](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103051.zip), Connected mode and idle mode mobility Qualcomm
6. [R2-2103136](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103136.zip), Discussion on RRC Idle mobility for IoT NTN Xiaomi
7. [R2-2103183](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103183.zip), Discussion on connected mode mobility in NB-IoT and eMTC NTN Xiaomi
8. [R2-2103190](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103190.zip), On the mobility aspects of IoT-NTN Nokia, Nokia Shanghai Bells
9. [R2-2103243](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103243.zip), Discussion on the issue of mobility for IoT over NTN Spreadtrum
10. [R2-2103342](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103342.zip), Control plane aspects of IoT over NTN ZTE Corporation, Sanechips
11. [R2-2103411](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103411.zip), Potential issues in IoT NTN with discontinuous coverage Lenovo, Motorola Mobility
12. [R2-2103412](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103412.zip), Further considerations on RLF-based mobility for NB-IoT in NTN Lenovo, Motorola Mobility
13. [R2-2103510](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103510.zip), Discussion on Mobility for NTN NB-IoT Huawei, HiSilicon
14. [R2-2103511](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103511.zip), Discussion on discontinuous coverage for NTN NB-IoT Huawei,
15. [R2-2103727](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103727.zip), RLF-based NB-IoT mobility in NTN CMCC
16. [R2-2104298](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2104298.zip), Discussion on TA Update for IoT-NTN CMCC
17. [R2-2104017](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2104017.zip), Mobility for NB-IoT and LTE-M in NTN Ericsson
18. [R2-2102745](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102745.zip), Discussion on system information enhancement for IoT over NTN OPPO
19. [R2-2102830](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102830.zip), On Providing Ephemeris Information in IoT-NTN MediaTek Inc.
20. [R2-2103052](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103052.zip), Enhancement to SIB acquisition Qualcomm
21. [R2-2103233](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103233.zip), On system information enhancement and IoT features applicability for NTN Nokia, Nokia Shanghai Bell
22. [R2-2103357](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103357.zip), SIB and IoT features applicability for IoT over NTN ZTE Corporation, Sanechips

**Note-1**: RAN Plenary (RP) recommendations are to keep scope small and guidance in RP-210915 shall be taken into account when assessing the proposals, i.e. focus on essential enhancements. Non-essential enhancements should be considered only if impact is small.

* [AT113bis-e][0xx][IoT NTN] Mobility and Tracking Area (Mediatek)

      Scope: Take into account the contributions in AI 9.2.3. Collect comments. Determine which additional enhancements to be considered for IoT NTN (if any). Note that the RP recommendations to keep scope small and guidance in RP-210915 shall be taken into account when assessing the proposals, i.e. focus on essential enhancements. Non-essential enhancements should be considered only if impact is small.

      Intended outcome: Report

**Initial Deadline for comments: Thursday April 15, UTC: 1 PM.**

Rapporteur’s Summary Upload: Thursday April 15, UTC: 11 PM.

Final Deadline for comments on Rapporteur Summary: Friday April 16, UTC: 1 PM.

**Note-2**: As TN-NTN mobility is out-of-scope of this Study Item, proposals corresponding to TN-NTN mobility are not discussed in this summary.

# 2 Contact Information

|  |  |  |
| --- | --- | --- |
| Company | Name | Email |
| MediaTek Inc. | Abhishek Roy | Abhishek.Roy@mediatek.com |
| Huawei, HiSilicon | Tangxun | tangxun@huawei.com |
| OPPO | Haitao Li | lihaitao@oppo.com |
| Xiaomi | Xiaolong Li | lixiaolong1@xiaomi.com |
| ZTE | Ting Lu | lu.ting@zte.com.cn |
| LG | Oanyong Lee | aidoy.lee@lge.com |
| GateHouse | Robert van der Pool | rvp@gatehouse.com |
| Novamint | Thierry Bérisot | tberisot@novamint.com |
| Sateliot | Ramon Ferrús | ramon.ferrus@sateliot.space |
| Qualcomm | Bharat Shrestha | bshrestha@qti.qualcomm.com |
| Lenovo | Min Xu | xumin13@lenovo.com |
| Nokia | Srinivasan Selvaganapathy | Srinivasan.selvaganapathy@nokia.com |
| CATT | Sidong Li | lisidong@catt.cn |
| Ericsson | Emre A. Yavuz | emre dot yavuz at ericsson dot com |
| Eutelsat | Rene Faurie | rfaurie-LS at sfr dot fr |
| Sequans | Olivier Marco | omarco at sequans.com |
| Apple | Sarma Vangala | svangala@apple.com |
| Hughes/EchoStar | Munira Jaffar | munirajaffar@hughes.com |

# 3 Idle Mode Mobility in IoT-NTN

In RAN2#113-e meeting, NB-IoT/eMTC support for NTN was discussed over email discussion, and the following agreements were made regarding the Idle Mode mobility (Cell Selection/Re-selection and Tracking Area Update):

Table 1: RAN2#113-e Agreements on Idle Mode in IoT-NTN

* **Proposal 3: RAN2 will capture the options for signalling of Tracking Areas in the TR and wait for progress in NR-NTN for possible updates, if applicable to IoT NTN.**
* **Proposal 4(a): Paging capacity is evaluated using the same methodology captured in TR 38.821 as the baseline.**
* **Proposal 4(b): RAN2 will evaluate the paging capacity and the impact on the size of the Tracking Area considering the target IoT NTN device density captured in TR 36.763.**
* **Proposal 5: RAN2 will use cell selection/re-selection mechanism of NB-IoT/eMTC as a baseline. Enhancements introduced for cell selection/re-selection mechanism in NR NTN will be considered if applicable to IoT-NTN.**
* **Proposal 6: Cell selection/re-selection mechanism in IoT-NTN can be enhanced by using satellite assistance (e.g. ephemeris) information (similar to NR-NTN). RAN2 will wait for RAN1’s progress about the details of satellite ephemeris information.**

In the remaining part of this section, we summarize the contributions separately for Cell Selection Re-selection and Tracking Area Update.

3.1 Cell Selection and Re-selection in IoT-NTN

In RAN2#113-e, cell selection/re-selection enhancements in NR NTN was discussed and the following agreements have been made.

Table 2: RAN2#113-e Agreements on Cell Selection/Re-selection in NR-NTN

Agreements:

1. RAN2 thinks that a UE needs to know whether the network is a TN or NTN no later than SIB1 reception
2. The information on when a cell is going to stop serving the area and/or the timing information (e.g. timer or absolute time) about new upcoming cell is supported at least in Earth-fixed NTN scenario. FFS if both types of information are needed. FFS if this is known from system information and/or the ephemeris.

(10/21) contributions have provided proposals on idle mode mobility for IoT-NTN. Among these 10 contributions, 2 contributions (R2-2102829, R2-2102957) have suggested using existing cell selection/re-selection mechanism of NB-IoT/eMTC as a baseline, which was already agreed in RAN2 113-e (Proposal 5). While R2-2102744 has suggested location based cell selection/re-selection, R2-2102829 have pointed out that such optimizations are not needed, as the legacy measurement based methods could be used for cell reselection. Location-based cell reselection requires UE to process its location at every DRX cycle, thereby incurring additional power consumption, which needs to be avoided in IoT/eMTC devices. Moreover, as suggested by RAN plenary, in Rel-17 the focus is only on essential enhancements. R2-2102957, on the other hand, has suggested the use of legacy (measurement-based) cell selection/re-selection for earth-fixed beams.

R2-2103190 has suggested enhancements for reduction of additional energy consumption for eDRX operation and relaxed RRM measurements. Similarly, R2-2103591 considers a scheme where the UE is alternating between eDRX and PSM based on the presence or outage of coverage. However, these solutions can be considered as optimizations over basic essential (minimum working) solution. Given the guidance from RAN Plenary to focus on essential enhancements, it is imperative to agree on basic working solution and consider further enhancements in future releases. Hence, based on this discussion, the rapporteur asked the following question:

**Question 1: Do the companies agree that existing measurement based procedures can be used for a baseline working solution for Cell Selection/Re-selection in IoT-NTN and further enhancements (e.g. eDRX enhancements and measurement relaxation) can be considered in future releases?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| Huawei, HiSilicon | Yes but | Existing cell (re-)selection mechanism can be reused in IoT NTN but this will be at the cost of the battery life, e.g. in case of moving cells or discontinuous coverage. Also, paging does not work in discontinuous coverage scenario, so only PSM can be used. Further enhancement could be done if time allows. |
| OPPO | No | We think camping on a non-best cell may cause even more UE power. Since existing RSRP-based procedures have difficulty to reflect the cell edge and center, in our view location needs to be used together in evaluating the target cell. |
| Xiaomi | Yes but | We think existing measurement based procedures can be used as a baseline, but the enhancements from NR-NTN also can be considered, such as timing information about serving cell. |
| ZTE | No | Even there is kind of guideline about focusing on basic essential solution, as long as LEO NTNs with moving cells scenario would be considered, we still think unnecessary UE power consuming in Cell Selection/Re-selection for IoT UE with long eDRX cycle/PSM and under quick moving cells cannot be neglected (even the UE might still be a stationary one). Such issue might be seldom in legacy IoT network and doesn’t exist in NR NTN (as eDRX cycle is not supported there). Therefore, to address this issue is kind of essential work other than just optimization.  Specifically, as mentioned in [R2-2103342], the main reason for the issue is that the potential serving cell for the UE in subsequent eDRX cycle might be totally different from the neighbor cells that are measured by the UE in an eDRX cycle. Therefore, the neighbor cell measurement in an eDRX cycle may not give any help for the UE to select to the next satellite in the subsequent eDRX cycle and such neighbor cell measurement is useless. The straightforward way for addressing this issue is to try to avoid useless or unnecessary neighbour cell measurement in this case when eDRX cycle is configured. |
| LG | Yes | As Xiaomi commented, we think that existing measurement based UE mobility procedures and enhancements from NR-NTN (e.g. ephemeris based cell selection and reselection) can be also considered. |
| GateHouse | No | Agree with ZTE that existing procedures may be used as a  baseline, but the case of discontinuous coverage and LEO  moving beams should be addressed in Rel 17.  As indicated in [R2-2102961](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102961.zip). Discontinuous reception will be a  main issue during deployment of dense LEO constellations, it will  be an issue related to satellite errors/failures in LEO/MEO and  finally some operators plan to deploy low density constellations. |
| Novamint | No | Existing procedures may be used as a baseline however, let’s not forget that we are aiming to have a first workable version in Release 17 which can meet market adoption which means to be able to be very cost effective and to be competitive as well with non-3GPP proprietary solutions considering the use cases targeted such as Asset tracking, asset monitoring…  In this context, such first version needs to be able to support small constellations of cubsat (in the case of LEO) with progressive deployment while being already offering the service as soon as the first satellite is in orbit which means discontinuous coverage. Similar for GEO, service link discontinuity is seen as very important for cost perspective.  Therefore, we agree with ZTE and GateHouse that dedicated and specific IoT-NTN enhancements for Cell Selection/Re-selection (such as support of service link discontinuity) are essential work and not just optimization.  PS: We realised that [R2-2102961](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102961.zip) from GateHouse was not listed in the introduction though it is related to this topic so we added it up (with revision marks). It should be added to the references at the end of the document |
| Sateliot | No | As pointed out by ZTE, Novamint and GateHouse, cell selection/re-selection enhancements needed to be able to cope with the nature of service discontinuity / discontinuous coverage / intermittent coverage holes cannot be left to subsequent releases but form part of a minimum workable solution under Rel-17. |
| Qualcomm | No | eDRX and relaxed monitoring are existing important features. These should be considered with minor adaptation for NTN specially in GEO scenario. |
| Lenovo | No | We should not preclude all further enhancements so early for a Study Item. In addition to the existing measurement based procedures, at least enhancements (or similar principles) discussed in NR NTN (e.g. ephemeris assisted cell reselection) could be used in IoT NTN as well. And we also agree with ZTE, GateHouse and Sateliot that we need to consider further enhancement for discontinuous coverage or coverage hole e.g. to avoid unnecessary cell search or measurement, as power consumption is always essential to IoT devices. |
| Nokia | Depends on scenarios to be supported for Rel-17 | Cell selection mechanism can be used as such. Reuse of idle mode measurements on serving cell ,trigger of measurements for cell reselection and serving cell relaxed measurements may need some minimum changes to improve the battery life time. These features are required for UE in DRX/eDRX configurations. If discontinuous coverage is key scenario for immediate deployment, some minimum enhancements for this scenario should be considered which may be limited to UE behaviour specification in 36.304. |
| CATT | See comments | Suggest RAN2 to consider following two option:  Option 1: Don’t consider eDRX mechanism in R17 IoT over NTN  Option 2: Consider eDRX mechanism in R17 IoT over NTN  For option 1, existing measurement based procedures can be used for a baseline working solution for Cell Selection/Re-selection in IoT-NTN. Option 1 is more power consuming, and no enhancement.  For option 2, same as ZTE comments, in earth moving cell, serving cell is always changed with the LEO moved. And the serving duration of a NTN cell may be just a few seconds it is much less than the eDRX cycle. Therefore, when a NB-IoT/eMTC UE wakes up to detect the paging info during the eDRX period, UE may always miss the dwell cell it stayed in when it went to sleep. Existing measurement based procedures seems not workable in earth moving cell. Option 2 need more time to discuss.  Whether option 1 or 2 is depended if time allows. |
| Ericsson | Yes, but | RAN2 has agreed that cell selection/re-selection mechanism of NB-IoT/eMTC is used as baseline and enhancements introduced for cell selection/re-selection mechanism in NR NTN will be considered if applicable. Existing measurement-based procedures can be used as baseline, but it would be good to study potential enhancements to address the concerns on UE power consumption due to discontinuous coverage, the need for frequent system information acquisition etc. |
| Eutelsat | Yes but… | Discontinuous coverage needs to be addressed for NGSO deployments, which implies that a measurements-based cell reselection may need to be complemented or assisted.  E.g. device waking-up from PSM deep-sleep and device operating periods should be conditional to the coverage of a spot beam for the considered service (conceivably derived from ephemeris / orbits timing information and in conformity with the IoT application requirements). Measurements could be triggered only if/when the device remains within the satellite service area. When to perform measurements could be further conditioned by a minimum elevation of the serving satellite for limiting power consumption. |
| Sequans | No | We should not preclude further enhancements at this stage if they are required to handle efficiently new NTN scenarios |
| Convida | No | Although, we agree that existing measurement based procedures can be used for a baseline, additional enhancements appear to be necessary |
| Apple | No | Existing measurement based procedures should be considered as baseline. Further enhancements at least at this stage should be considered. |
| Hughes/EchoStar | Yes but | Existing cell (re-)selection mechanism can be reused in IoT NTN but this will be at the cost of the battery life, e.g. in case of moving cells or discontinuous coverage |

LEO NTNs with moving beams might not have continuous cell coverage, i.e. there could be intermittent coverage holes between consecutive cells (beams). Hence, UEs might face out-of-coverage problems during the cell movements. (5/21) contributions have provided proposals regarding such discontinuous coverage and its possible solutions. R2-2103342 and R2-2103136 has mentioned that it is beneficial for IoT UE in RRC idle and inactive mode to stop searching a cell in a coverage hole. Subsequently R2-2103342 has also suggested options to determine such discontinuous coverage, including satellite and/or network assistance (e.g. ephemeris information). Studying on reducing UE’s power consumption during discontinuous coverage is also proposed in R2-2103411 and R2-2103511. Support for satellite assistance, including ephemeris information is also mentioned in R2-2102829 and R2-2104017. Hence, based on these contributions the rapporteur would like to ask the following question:

**Question 2: Do companies agree that satellite assistance information could be provided to the UE, so that UE can use this information for acquiring knowledge about coverage holes (out-of-coverage or discontinuous coverage) to improve cell re-selection in IoT-NTN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| Huawei, HiSilicon | Yes | Assistance information could include cell center location and radius, then UE could estimate the cell coverage and determine if it is in coverage or out of the cell. |
| OPPO | Yes | Same view as Huawei. UE may derive the coverage holes from those available cell’s coverage information. |
| Xiaomi | Yes | The satellite assistance information on coverage holes can be provided to UE, then UE should keep in dormancy in the coverage holes to reduce power consumption. |
| ZTE | Yes, but | We agree the issue of coverage hole in IoT NTN may be more serious than that in legacy IoT network and therefore agree that addressing this issue is also essential.  However, we don’t think satellite assistance information provision is the only suitable way for IoT UE. Some other ways for assisting cell selection/reselection for idle mode UE can also be considered, e.g., with more consideration on trade-off between signaling overhead and UE power saving/simplicity. For example, the direct information about when a cell is going to stop serving the area and/or the timing information about new upcoming cell can be provided. This may be benefit to UE as UE no need to do much calculation. Anyway, down-selection on the solutions can be left to WID stage. |
| LG | Yes | The satellite assistance information such as upcoming satellite scheduling information can be used to avoid coverage holes (e.g. because of feeder-link switch) or cell reselection to a cell which will disappear soon. |
| GateHouse | Yes | Solution proposals should be investigated. Since the ephemeris  data (TLE or GNSS+velocity) is considered essential for PUSCH  transmissions it may be convenient to utilize this information. |
| Novamint | Yes | Agree with answers from Huawei, Oppo, Xiaomi, LG and Gatehouse. |
| Sateliot | Yes | Providing UEs with such information needed for UEs to acquire knowledge about coverage holes (out-of-coverage or discontinuous coverage) will not only improve cell re-selection in IoT-NTN but also may be key to many other features (e.g. cell search, managing PSM / eDRX modes, system information acquisition, etc.) |
| Qualcomm | Yes | However, how to signal such coverage information needs to be studied. We may need to wait RAN1 and NR NTN progress on ephemeris format and accuracy. |
| Lenovo | Yes | We think such assistance information can be helpful for cell search, measurement and reselection. For the content of assistant information we are open to use ephemeris, serving time or other new indications to achieve accurate coverage hole prediction for a UE (details can be further studied). This could be partly depend on NR NTN progress e.g. on ephemeris format and indication of serving or stop serving time. |
| Nokia | Yes | We should first agree on support for discontinuous coverage scenario. Above assistance information would be beneficial for UE to decide on cell-selection/idle mode measurements based on location. |
| CATT | Yes | Assistance information can refer to NR NTN, e.g. location-based or time based info. We can discuss the specific info in WID. |
| Ericsson | Yes | The format and the content of such assistance information need to be studied. RAN2 has already agreed that cell selection/re-selection mechanism can be enhanced by using satellite assistance (e.g. ephemeris) information (similar to NR-NTN) and that it will wait for RAN1’s progress regarding the details of satellite ephemeris information. We can further discuss whether the information, e.g., about coverage holes, can be provided implicitly or explicitly. |
| Eutelsat | Yes | See answer to Question 1. The exact nature of the assistance information (ephemeris, or information pre-processed by the network) may deserve further study, also depending on NR NTN findings. |
| Sequans | Not sure | Benefit of NTN is supposed to be enhanced coverage, so not sure why coverage holes would be a problem to handle. |
| Convida | Yes | Agree with most of the views above that this is necessary. The details are FFS. |
| Apple | Yes | There is definitely a trade-off advantage in terms of power savings in providing ephemeris to some categories UE. However, how big these benefits are for different IoT device categories needs to be further studied. |
| Hughes/EchoStar | Yes | Same view as Huawei |

3.2 Tracking Area Update in IoT-NTN

In RAN2#113-e, Tracking Area Update in NR NTN was discussed and the following agreements have been made:

Table 3: RAN2#113-e Agreements on Tracking Area in NR-NTN

Agreements:

1. In NTN, the UE determines the TA based on the broadcast information (the use of other information is not excluded). In any case RAN2 will not go in a different direction than other groups
2. In NTN, the network may broadcast more than one TACs per PLMN in a cell, which is to up to network implementation.

It was already agreed in RAN2#113-e that RAN2 will capture the options for signalling of Tracking Areas in the TR and wait for progress in NR-NTN for possible updates, if applicable to IoT-NTN. R2-2102744 and R2-2103190 have proposed to use NR-NTN agreements, mentioned in Table 3, as baseline for IoT-NTN.

**Question 3: Do companies agree that Tracking Area in IoT-NTN can use the NR-NTN agreements, where the network may broadcast more than one TACs per PLMN in a cell?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| Huawei, HiSilicon | Yes | Ok to follow NR, as the issue is the same in both IoT NTN and NR NTN. |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| ZTE | Yes | “Soft switch" option that one cell can broadcast more than one TAC per PLMN to avoid the frequent TAU for UE has been captured in 36.763. |
| LG | Yes | We are fine to follow the conclusions from NR-NTN. |
| GateHouse | Yes, but | Ok to follow NR for fixed cells, but in the moving beam scenario  further investigation and definitions are required.  In our view, a more flexible TA scheme is warranted.  We suggest calling the proposed (NR-TA) TA format 0 and study  other formats. Potentially, allow defined TA formats be picked by  network operators. |
| Novamint | Yes, but | As stated by Gatehouse, for the moving beam scenario, further investigation is needed |
| Sateliot | Yes |  |
| Qualcomm | Yes | Same solution as defined for NR NTN would work. For eMCT/NB-IoT, we need to further check if considering hard TAC update may be simple and sufficient. |
| Lenovo | Yes | For TAC IoT NTN faces the same issues as in NR NTN. We can revisit the final agreement to be made in NR NTN and see if it can be reused or further enhancement is needed. |
| Nokia | Yes | OK to support more than one TAC per PLMN in cell. The mechanism of changing the TAC list within system information by avoiding system information re-acquisition is essential for IoT-NTN. |
| CATT | Yes | IoT NTN can follow the conclusions of NR-NTN. |
| Ericsson | Yes |  |
| Eutelsat | Yes | Noting that most IoT devices are not "always on" - for battery life considerations - in contrast to devices supporting conversational services, hence TAC change likelihood may be much less frequent for an IoT NTN device than for a NR NTN device. |
| Sequans | Yes |  |
| Convida | Yes |  |
| Apple | Yes |  |
| Hughes/EchoStar | Yes | OK to follow NR |

# 4 Connected Mode Mobility in IoT-NTN

In RAN2#113-e meeting, the following agreements were made regarding the Connected Mode mobility in IoT-NTN.

Table 4: RAN2#113-e Agreements on Cell Selection/Re-selection in NR-NTN

(1) Proposal 1: For eMTC in NTN CHO can be used for both moving cell and fixed cell scenarios, and the CHO procedure and execution condition defined in Rel-16 is the baseline. The existing measurement framework for CHO (e.g. measurement configuration, execution) is the baseline. The existing eMTC measurement criteria and event can be used in NTN. Support for new measurement would need justification, but is not precluded, e.g. for enh coverage. Time or timer based and Location based CHO triggering event, in combination with the existing R16 CHO measurement based event, can be introduced for both moving cell and fixed cell scenarios. Support for new triggering events is not precluded. (note that LTE CHO isn’t supported for 5GC, and same assumptions as LTE applies).

(2) Proposal 2: Rel-17 RLF enhancements in NB-IoT can be considered in NB-IOT NTN, if applicable. Further enhancements on RLF-based mobility can be considered, e.g. by using satellite assistance (ephemeris) information.

(9/21) contributions have provided proposals on Connected Mode mobility for IoT-NTN. Among these contributions, three contributions R2-2102744, R2-2103183 and R2-2103342 have mentioned that satellite assistance (e.g. ephemeris broadcast) can help the UE to configure cell measurements and triggers in Connected Mode mobility. Two contributions R2-2103051 and R2-2103183 have discussed configuration of location and time based triggering event. As such proposals of triggering events are under discussions in NR-NTN as well, it will be wise to wait and use NR-NTN agreements for these configurations. Hence, rapporteur would like to ask the following question:

**Question 4: Do companies agree that for configuration of location and time based triggering events, related to CHO in eMTC-based NTN, RAN2 should follow the proceedings in NR-NTN and use the agreements made in NR-NTN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| Huawei, HiSilicon | Partially Yes | We should also determine at first if existing handover mechanism can be reused, and then evaluate if we can follow the proceedings in NR NTN after there is concrete agreement made in NR NTN. |
| OPPO | Yes |  |
| Xiaomi | Yes | RAN2 can wait and reuse NR-NTN agreements about the configuration of location and time based CHO triggering event. But RAN2 should discuss whether these NR-NTN agreements are suitable for the eMTC NTN. And some specific configuration for eMTC NTN should not be precluded. |
| ZTE | Yes | In order to avoid redundant discussion, we agree to wait for NR-NTN agreements on configuration of location and time based triggering events and then use them if applicable.  Another important issue is, if the measurement gap configuration does not consider the propagation delay difference, the UE may be unable to perform measurements on the configured reference signals.  Moreover, how to reduce the negative impacts of coverage hole on the service continuity of the connected mode UE is also essential work that needs to be considered, e.g., for both eMTC and NB-IoT. See our comments for Q5. |
| LG | Yes | For all the UE mobility issues in connected mode, NR-NTN can be the baseline. |
| Novamint | Yes |  |
| Qualcomm | Yes | The solution defined for NR can be used whenever possible. |
| Lenovo | Yes | The connected mobility enhancements in NR NTN can be beneficial for eMTC. We can revisit the final agreement to be made in NR NTN and see if it can be reused or further enhancement is needed. |
| Nokia | No | As connected mode mobility is not essential feature for IoT-NTN we think extending eMTC to support CHO and also with additional triggers for CHO is not needed for the first release. |
| CATT | See comments | NR NTN didn’t have any agreement of introducing new events. How to use location-based and time-based info is under discussion. IoT NTN should wait for NR NTN agreement. |
| Ericsson | Yes | RAN2 has already agreed that CHO can be used for both moving cell and fixed cell scenarios, and the CHO procedure and execution conditions defined in Rel-16 is the baseline. This includes existing measurement framework and time or timer-based and location-based CHO triggering event, in combination with the existing Rel-16 CHO measurement-based event. |
| Sequans | Partially Yes | In general NR NTN agreements can be used as a baseline, but we cannot blindly say we would follow them for eMTC without even knowing/analysing those agreements in the context of eMTC. |
| Convida | Yes | We agree that the solutions agreed for NR should be used as a baseline. Further enhancements should not be precluded. |
| Apple | Yes | NR NTN procedures and agreements in general should be the baseline for IoT-NTN |
| Hughes/EchoStar | Partially yes | For all the UE mobility issues in connected mode, NR-NTN can be the baseline but connected mode mobility is not essential for IoT-NTN for the first release. |

Enhancements on RLF triggers are mentioned in R2-2103243 and R2-2103411. Similarly, conditional RRC reestablishment is proposed in R2-2103412 ad R2-2103727. However, these solutions can be considered as optimizations over basic essential (minimum working) RLF-based solution for NB-IoT mobility. Given the guidance from RAN Plenary to focus on essential enhancements, it is imperative to agree on basic working solution and consider further enhancements in future releases.

**Question 5: Do the companies agree that existing RLF-based mobility procedures can be used for a basic working solution of Connected Mode mobility in NB-IoT based NTN in Rel-17 and further enhancements (RLF triggers and conditional RRC reestablishment) can be considered in future releases?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| Huawei, HiSilicon | Yes | Existing RLF-based mobility procedures can be reused in IoT NTN. Further optimization can be considered if time allows. |
| OPPO | Yes |  |
| Xiaomi | Partially Yes | Existing RLF-based mobility procedures can be used for a basic solution and further enhancements can be considered.  But conditional RRC reestablishment is not essential for NB-IoT terminals without low latency requirements. |
| ZTE | No | In IoT application, A UE will typically be kept in connected for 10 seconds. However, in LEO NTNs with moving cells case, it’s possible that “*a UE served by an NTN LEO cell of diameter 50 km may remained connected for a maximum of 6.61 seconds*”. Then more RLF may be seen in this case.  Moreover, due to existence of coverage hole, whether the UE can timely reestablish to a new cell is also an issue. After RRC reestablishment procedure is triggered, as T310 is some kind of short, if a suitable cell couldn’t be detected during T310, e.g., due to coverage hole, lots of the failure of RRC reestablishment may happen.  In order to address the above issues, one possible way is that in discontinuous coverage, eNB can proactively release/suspend the UE before the RLF occurs. |
| LG | Yes, but | We think RLF-based mobility can work, but it takes too much delay because of very long propagation delay. So we may need some enhancements for this. |
| GateHouse | No | Agree with ZTE |
| Novamint | No | Agree with ZTE too |
| Qualcomm | No | Some minor enhancement can be considered for RLF detection. |
| Lenovo | No | We agree with ZTE that for discontinuous coverage case, proactive release/suspend for UE is useful to avoid unnecessary procedures including RLF and reestablishment.  Additionally, if the assistant information for coverage holes is agreed (as in Q2), conditional RRC reestablishment can also be considered e.g. at the time when coverage restores.  Even for continuous coverage, we also think that conditional RRC reestablishment can help NB-IoT devices served by moving LEO to omit unnecessary signalling e.g. for power saving. |
| Nokia | Yes | Basic NB-IoT functionality related to connected mode mobility is enough for first release. |
| CATT | No | Legacy RLF could work, but in case of earth moving cell scenario, fast moving of the satellite may cause more RLF than NB-IoT in TN. Whether and how to adapt the situation need further discussion. |
| Ericsson | Yes |  |
| Eutelsat | Yes | A short data burst may well fit in a single or a couple of subframe(s)/block(s) and should be completed within cell flyover in most cases for earth moving beams. Further optimization (e.g. conditional triggers) can be considered if time allows and/or in future releases. |
| Sequans | Yes |  |
| Convida | Yes | We think that existing RLF-based mobility procedures can be used as a starting point. Additional enhancements should be considered to address some of the issues that ZTE points out. |
| Apple | Yes | Existing RLF procedures can be used as baseline but as ZTE mentions, enhancements are needed. |
| Hughes/EchoStar | Yes | Existing RLF procedures can be used as baseline |

If companies consider any of the RLF enhancement proposals to be essential for the first release, please provide justifications on why these should be considered as essential in Section 6. Hence, based on this discussion, the rapporteur asked the following question.

# 5 System Information Broadcast in IoT-NTN

As mentioned before in Section 2, satellite assistance (e.g. ephemeris) needs to be provided to the UE to improve idle mode mobility during coverage holes (or discontinuous coverage). Ephemeris information is also needed for estimating the round-trip time, needed for timer adjustments and Timing Advancements. While the exact format of ephemeris is in the scope of RAN1, RAN2 needs to decide the signalling for providing this ephemeris to the UE.

(5/21) contributions have provided proposals on System Information Broadcast (SIB) in NR-NTN. Proposals in R2-2102745, R2-2102830, R2-2103052, and R2-2103357 have suggested SIB for providing different assistance information to the UEs. R2-2103052 has also suggested the usage of area-specific SIB to reduce the frequency of SIB-acquisition.

**Question 6: Do companies agree that an NTN-specific SIB needs to be defined for providing satellite ephemeris information to all UEs in IoT-NTN?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| Huawei, HiSilicon | No | Similar to TN/NTN indication, we think UE should derive ephemeris data no later than SIB1 to avoid further power consumption, as UE may need this ephemeris information to calculate and adjust the timing advance from time to time. |
| OPPO | Yes | Ephemeris is needed for UE for many purposes, e.g. TA pre-compensation during RACH. |
| Xiaomi |  | We suggest to wait for the conclusion from NR-NTN. |
| ZTE | Yes | If Satellite ephemeris information is introduced to deal with discontinuous coverage issue, TA pre-compensation, UE mobility issue etc., it’s better to be provided with a NTN-specific SIB.  The scheduling periodicity of this NTN-specific SIB can be separately set according to the satellite mobility. |
| LG | Not yet | In NR-NTN, whether to introduce NTN-specific SIB is FFS. So we should wait for the conclusion from NR-NTN. |
| GateHouse | Yes | Agree with ZTE.  Also, in addition to the information required to perform immediate  synchronisation, another SIB may contain information relevant  for long term scheduling of PSM and idle DRX as suggested in  [R2-2102961.](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2102961.zip) |
| Novamint | Yes | Agree with OPPO, ZTE, GateHouse |
| Sateliot | Yes | It should also be defined if there is a single type of satellite ephemeris information to be broadcast or distinction should be made at least between:  -Short-term satellite ephemeris information, used e.g. for uplink synchronisation / TA pre-compensation  -Long-term satellite ephemeris information, used e.g. for coverage hole estimation. |
| Qualcomm | Yes | We also think it is better to define an NTN specific SIB to carry satellite and link specific information |
| Lenovo | Yes but | We prefer to introduce a new SIB for ephemeris but we better wait for NR NTN decision on this FFS. |
| Nokia | Yes | Separate SIB for NTN specific information with fixed scheduling can be considered. For ephemeris related information NR-NTN format can be used as basis. |
| CATT | Yes but | IoT NTN should follow the NR NTN conclusion. |
| Ericsson | Too early to conclude | RAN2 needs to wait for progress in RAN1 regarding the details of satellite ephemeris information. Depending on the details and other criteria such as the need for such information during cell (re)selection etc., RAN2 should study whether NTN-specific SIB is introduced. |
| Eutelsat | Yes | May be aligned to NR NTN solution if the specified ephemeris information addresses the IoT NTN needs. |
| Sequans |  | Likely yes but we prefer to wait for RAN1 details as well as NR NTN decisions. |
| Convida | See comment | In NR NTN, introduction of NTN-specific SIB is FFS. We should wait for the conclusion from NR-NTN to use as a baseline. |
| Apple | No | We prefer to wait for RAN1 to conclude on this. However, we agree with Huawei that the presence of ephemeris on the UE is better and would save a lot of broadcast bandwidth. |
| Hughes/EchoStar | Yes | Follow NR-NTN decision |

**Question 7: Do companies agree that it is useful to introduce SI Area Concept, as in NR, to reduce the frequency of SIB-acquisition in IoT-NTN?**

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| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| Huawei, HiSilicon | No | This is an optimisation and would require a full redesign of the SIB. However, without any optimisation, there will be impact on the battery life, especially for stationary UEs in the moving cells scenarios.  We think it will be useful to study other options to reduce system information acquisition |
| OPPO | No | This is not essential for IoT-NTN to work. |
| Xiaomi | No | Based on the introduction section, R17 will focus on essential enhancements. The SI Area Concept is an optimisation and can be discussed in the future release. |
| ZTE | Yes | If IoT NTN moving cell is supported, we think SI Area Concept is needed and beneficial to avoid frequent SI acquisition. Furthermore, the cell beam may also be necessary to balance between frequent TAU and UE density. |
| LG | No | It is not essential for IoT-NTN. |
| GateHouse | Yes |  |
| Novamint | Yes | Agree with ZTE |
| Sateliot | Yes |  |
| Qualcomm | Yes | Agree with ZTE. Frequent SI acquisition should be avoided upon frequent cell change due to moving cells. |
| Lenovo | FFS | If ephemeris is broadcasted as a new SIB, this could be considered e.g. in a satellite constellation manner. |
| Nokia | Yes | Some form of common system information across set of NTN cells would be beneficial to reduce the system information re-acquistion for every cell change. Cell-change scenario cannot be avoided even for stationary device in NTN system. Hence some improvement on this aspect can be considered. The details of which system information to be considered for this common system information can be discussed further. |
| CATT | No | This is a kind of optimization, not essential for IoT NTN Rel-17. If necessary, we could further consider it in the future release. |
| Ericsson | No | However, it would be good to study whether/how to reduce the need for system information acquisition, considering the frequency of service/feeder link switch, to mitigate the impact on UE power consumption. |
| Eutelsat | FFS | Optimizations wrt power savings are worthwhile to investigate if time allows / in next release. |
| Sequans | FFS | We are not sure what is implied by "SI Area Concept" but agree to consider improvements to limit frequent SI acquisition. |
| Convida |  | Agree that this concept should be further studied to identify the potential benefits. Frequent SI acquisition should be minimized. |
| Apple | Yes | Agree with ZTE. |
| Hughes/EchoStar | FFS |  |

Further optimization and enhancements on SIB acquisition, group wake-up signal, preconfigured UL, PUR optimization, relaxed monitoring and multiple CEL support, SIB enhancements, as suggested in R2-2103233, R2-2103357 can be considered as not essential and discussed in future releases. If companies consider any of these proposals to be essential for the first release, please provide justifications on why these should be considered as essential in Section 6.

# 6 Others

**Question 7: Companies are encouraged to provide any other issues along with justification on why this should be considered as essential in the first release here.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / No** | **Comments (if any)** |
| GateHouse | Yes | 1) Cell selection and re-selection procedures for the  discontinuous coverage and the moving beams scenario.  2) Study TA schemes - at least allowing for other TA  formats in future releases. |
| Novamint | Yes | Support for discontinuous coverage/service link discontinuity and moving beams scenario should be consider as essential in the first release for both LEO and GEO in order to allow cost effective and competitive solutions and market adoption |
| Sateliot | Yes | Agree with GateHouse and Novamint comments.  In addition, enhancements to enable the proper use of PSM & eDRX & SI update/acquisition features under the presence of coverage holes are necessary to have a power-efficient, competitive solution. |
| Lenovo | Yes | Agree with above three companies that discontinuous coverage case is essential to be included and considered in this release. This case is realistic for satellite service providers, and contributions have revealed that it has negative impact on CONNECTED and IDLE procedures if we follow existing mechanisms. A most direct impact is unnecessary power consumption of IoT devices especially both NW and UE may predict and avoid. |
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# 7 Conclusion

<To be updated after receiving responses from the companies>

# 8 References

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2. R2-2102829 On Cell-Reselection in NR-NTN, MediaTek Inc.
3. R2-2102957 Discussion on the mobility of IoT over NTN, CATT
4. R2-2103051 Connected mode and idle mode mobility, Qualcomm
5. R2-2103136 Discussion on RRC Idle mobility for IoT NTN, Xiaomi
6. R2-2103183 Discussion on connected mode mobility in NB-IoT and eMTC NTN, Xiaomi
7. R2-2103190 On the mobility aspects of IoT-NTN, Nokia, Nokia Shanghai Bells
8. R2-2103243 Discussion on the issue of mobility for IoT over NTN, Spreadtrum
9. R2-2103342 Control plane aspects of IoT over NTN, ZTE Corporation, Sanechips
10. R2-2103411 Potential issues in IoT NTN with discontinuous coverage, Lenovo, Motorola Mobility
11. R2-2103412 Further considerations on RLF-based mobility for NB-IoT in NTN, Lenovo, Motorola Mobility
12. R2-2103510 Discussion on Mobility for NTN NB-IoT, Huawei, HiSilicon
13. R2-2103511 Discussion on discontinuous coverage for NTN NB-IoT, Huawei,
14. R2-2103727 RLF-based NB-IoT mobility in NTN, CMCC
15. R2-2104298 Discussion on TA Update for IoT-NTN, CMCC
16. R2-2104017 Mobility for NB-IoT and LTE-M in NTN, Ericsson
17. R2-2102745 Discussion on system information enhancement for IoT over NTN, OPPO
18. R2-2102830 On Providing Ephemeris Information in IoT-NTN, MediaTek Inc.
19. R2-2103052 Enhancement to SIB acquisition, Qualcomm
20. R2-2103233 On system information enhancement and IoT features applicability for NTN Nokia, Nokia Shanghai Bell
21. R2-2103357 SIB and IoT features applicability for IoT over NTN ZTE Corporation, Sanechips