**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 21 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. [R2-2103051](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103051.zip), Connected mode and idle mode mobility Qualcomm
5. [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
6. [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
7. [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
8. [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
9. [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
10. [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
11. [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
12. [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
13. [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,
14. [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
15. [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
16. [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
17. [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
18. [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.
19. [R2-2103052](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103052.zip), Enhancement to SIB acquisition Qualcomm
20. [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
21. [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

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# 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?**

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| --- | --- | --- |
| **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. |
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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?**

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| **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. |
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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?**

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| **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 |  |
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# 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?**

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| **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 |  |
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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?**

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| **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 |  |
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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?**

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| **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. |
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**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. |
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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.**

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| **Company** | **Yes / No** | **Comments (if any)** |
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# 7 Conclusion

 <To be updated after receiving responses from the companies>

# 8 References

1. R2-2102744, Discussion on control plane for IoT over NTN, OPPO
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