**3GPP TSG-RAN WG2 Meeting #113-electronic R2-2102248**

**Online, January 25th – February 5th, 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 control plane aspects in IoT-NTN. The following 16 contributions with “Connected Mode Mobility, Tracking Area Update and Cell Selection/Re-selection” are summarized:

1. [R2-2100166](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100166.zip), Discussion on connected mode mobility for IoT over NTN, OPPO
2. [R2-2100167](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100167.zip), Discussion on idle mode procedure for IoT over NTN, OPPO
3. [R2-2100257](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100257.zip), IoT NTN Observations and Proposals, Lockheed Martin.
4. [R2-2100263](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100263.zip), Improving Tracking Area Updates in IoT NTN, MediaTek Inc, Eutelsat
5. [R2-2100264](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100264.zip), On Cell Re-selection in IoT-NTN, MediaTek Inc, Eutelsat
6. [R2-2100266](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100266.zip), Connected Mode Mobility in IoT-NTN, MediaTek Inc, Eutelsat
7. [R2-2100338](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100338.zip), Consideration on the control plane of IoT over NTN, ZTE Corp, Sanechips
8. [R2-2100541](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100541.zip), Discussion on the service link discontinuity and affected procedures for NB-IoT NTN, Gatehouse, Sateliot
9. [R2-2100738](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100738.zip), Connected mode and idle mode mobility, Qualcomm Inc.
10. [R2-2100807](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100807.zip), Discussion on connected mode mobility in NB-IoT and eMTC NTN, Xiomi
11. [R2-2100808](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100808.zip), Cell selection and reselection for IoT NTN, Xiomi
12. [R2-2101054](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101054.zip), Discussion on Mobility and TA for NTN NB-IoT, Huawei, HiSilicon
13. [R2-2101131](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101131.zip), Discontinuous coverage for IoT NTN, Lenovo, Motorola Mobility
14. [R2-2101132](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101132.zip), RLF-based mobility for NB-IoT in NTN, Lenovo, Motorola Mobility
15. [R2-2101248](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101248.zip), Discussion on the service link discontinuity and affected procedures for NB-IoT NTN, Gatehouse, Sateliot, Thales
16. [R2-2101555](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101555.zip), Idle and connected mode mobility for IoT NTN, Ericsson
17. [R2-21005](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101555.zip)10, Mobility aspects for IoT-NTN, Nokia, Nokia Shanghai Bell.

In Section 2 and Section 3, summary of connected mode mobility and Tracking Area Update are provided and proposals for possible agreements in online sessions are made. Subsequently, In Section 4 the questions for email discussions are provided for companies to respond.

# 2 Connected Mode Mobility in IoT-NTN

In RAN2#112-e meeting, NB-IoT/eMTC support for NTN was discussed over email discussion, and the following agreements were made regarding the Connected Mode mobility:

* **[035] 16: RAN2 agrees to use Rel-16 RLF-based NB-IoT mobility as a baseline for mobility in NB-IoT over NTN.**
* **[035] 17: RAN2 will wait until agreements regarding handover, including Conditional Handover, solutions are made in the NR-NTN WI, discuss if it would be beneficial for eMTC over NTN, if adopted.**
* **[035] 18: RAN2 should wait for RAN1’s input on supporting multiple beams per cell for eMTC/NB-IoT over NTN.**

As the handover process in NB-IoT and eMTC based NTN is quite different in the remaining part of this section, we summarize the contributions separately for eMTC-based NTN and NB-IoT based NTN.

2.1 Connected Mode Mobility for eMTC based NTN

In RAN2#112-e, handover trigger enhancements in NR NTN was discussed and the following agreements have been made.

Agreements via email - offline 105:

1. Time or timer based CHO triggering event, in combination with the existing R16 CHO measurement based event, should be introduced for both moving cell and fixed cell scenario. FFS on how to configure the time or timer based CHO triggering event. Also FFS how to consider the feeder/service link switch timing.
2. DAPS HO for NTN is de-prioritized in this release.
3. Location based CHO triggering event, in combination with the existing R16 CHO measurement based event, should be introduced for both moving cell and fixed cell scenario. FFS on how to configure the location based CHO triggering event. FFS if location based CHO triggering event only (not in combination with other events) can also be considered.
4. The Location-based measurement event, in combination with the existing measurement event in NR, should be supported in NTN for both moving cell and fixed cell scenarios. FFS on how to configure the location based measurement event.

The intention of introduce location based measurement event and location based CHO triggering event is to improve handover robustness due to unclear difference in RSRP between cell edge and cell center in NR NTN. The contributions in R2-2100166 [1], R2-2100266 [6], R2-2100338 [7], R2-2100807 [10] and R2-2100510 [17] support these agreements and also proposed to use these agreements for enhancing connected mode mobility in eMTC. However, the contribution in R2-2101555 [16] suggested not to include Conditional Handover (CHO) in IoT-NTN to minimize additional network and UE complexity.

**Rapporteur’s Summary**:

(6/16) contributions have provided proposals on connected mode mobility for eMTC-based NTN. Among these 5 contributions, 5 contributions are in favor of using the NR-NTN agreements, made in RAN 2#112-e on CHO and measurement triggers.

Hence based on the existing agreements made in RAN2#112-3 in NR-NTN WI and IoT-NTN SI, the rapporteur proposes the following proposal (for discussion/agreement in online session):

**Proposal 1**: **For eMTC in NTN:**

1. **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.**
2. **The existing measurement framework for CHO (e.g. measurement configuration, execution and reporting) is the baseline, and all the existing measurement criteria and event can be used in NTN. Support for new measurement is not precluded.**
3. **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.**
4. **FFS on (a) how to configure the time and location based CHO triggering event and (b) how to estimate the feeder/service link switch timing.**

Rapporteur’s Summary:

One of the companies provided some editorial comments to modify the proposal and one company raised concern regarding power consumption issues for location based CHO events. Based on this, the rapporteur modified the proposal as follows:

**Proposal 1: For eMTC in NTN**

(i) **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.**

**(ii) The existing measurement framework for CHO (e.g. measurement configuration, execution and reporting) is the baseline, and all the existing measurement criteria and event can be used in NTN. Support for new measurement is not precluded.**

(iii) **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.**

2.2 Connected Mode Mobility for NB-IoT based NTN

During RAN2#112-e it was agreed to use Rel-16 RLF-based NB-IoT mobility as a baseline for mobility in NB-IoT over NTN. Enhancements on RLF-based mobility is already under discussions in Rel-17. R2-2100738 [9] and R2-2100510 [17] mention to use this Rel-17 RLF enhancement can be used as baseline to enhance RLF-based mobility in NTN. High speed of LEO satellites might result in fast radio link degradation between UE and the serving cell, thus triggering RLF faster than expected. Similar to handover based mobility management, R2-2100338 [7] and R2-2100807[10] mention enhancement of RLF by using satellite assistance information, broadcast by network. In a line similar to CHO, triggering of conditional RRC re-establishment before RLF is also suggested in R2-2101132 [14]. As traditional NB-IoT and eMTC transmission repetition increases link robustness, but generally requires a stable UE-eNB link (in terms of delay variation), the contribution in R2-2100257 [3] urges to discuss supporting simultaneous connected mode mobility and repetition for IoT-NTN.

**Rapporteur’s Summary**:

(6/16) contributions have provided proposals on connected mode mobility for NB-IoT based NTN. Among these 6 contributions, 4 contributions are in favor of using RLF enhancements for RLF-based mobility in NB-IoT NTN. While two companies suggested to use Rel-17 RLF enhancement can be used as baseline, the other two suggested using of satellite assistance, broadcast by the network, for further enhancement of RLF-based mobility.

Hence based on the existing agreements made in RAN2#112-3 in NR-NTN WI and IoT-NTN SI, the rapporteur proposes the following proposal (for discussion/agreement in online session):

**Proposal 2: RAN2 will use Rel-17 RLF enhancement as baseline to enhance RLF-based mobility in NB-IoT based NTN. Further enhancements on RLF-based mobility can be considered, e.g. by using satellite assistance (ephemeris) information.**

Rapporteur’s Summary:

One company has raised concerns about what types of mechanisms will be introduced in R-17 NB-IoT. Hence, the rapporteur updates the proposal as:

**Proposal 2: RAN2 will study if Rel-17 based enhancements on RLF-based mobility in NB-IoT will be beneficial for NB-IoT NTN. Further enhancements on RLF-based mobility can be considered, e.g. by using satellite assistance (ephemeris) information.**

# 3 Tracking Area Update in IoT-NTN

Idle mode mobility in IoT-NTN is broadly divided into two major parts: (1) Tracking Area Update (TAU) and (2) Cell Selection/Re-selection. As shown in the Table below, earth-fixed Tracking Area concept of NR-NTN was agreed for eMTC/NB-IoT NTN in RAN2#112-e.

**[035] 14: RAN2 will use earth-fixed Tracking Area concept of NR-NTN in eMTC/NB-IoT NTN.**

**[035] 15: RAN2 should wait until agreements regarding TAU are made in the NR-NTN WI, and use those for eMTC/NB-IoT over NTN, if applicable.**

Regarding the solutions for Tracking Area Update (TAU), R2-2100263 [4] suggests to use “soft-switch” method, with network maintaining a list of Tracking Area Codes (TAC). On the other hand, R2-2100338 [7] has proposed to use satellite-fixed tracking area. Finally, as NR NTN has not concluded yet on any solution, R2-2101054 [12] proposes to capture all the options in the IoT-NTN TR and wait for further progress in NR-NTN.

**Rapporteur’s Summary**:

(3/16) contributions have provided proposals on Tracking Area Update in IoT-NTN. Among these 3 contributions, one contribution is in favor of using multiple TACs (soft-switch), one is in favor of satellite-fixed TA and the last one suggests capturing all the solutions and wait for further progress in NR-NTN. As paging capacity of the network is closely related to tracking area sizes, the paging capacity needs to be evaluated to confirm that it can support large TA in GEO-NTN. As there is no clear preference, for the sake of progress of the SI, the rapporteur suggests the following proposal (for discussion/agreement in online session):

**Proposal 3: RAN2 will capture the options for signalling of TAs in the TR and wait for progress in NR-NTN for possible updates, if applicable to IoT NTN.**

**Proposal 4:** **RAN2 will evaluate paging capacity for IoT UEs in NTN to check how large a tracking area can be considering the target IoT NTN device density captured in TR 36.763**.

Rapporteur’s Summary:

One company has raised concerns about the texts of the proposal and suggested to divide the proposal into two proposals. Hence, the rapporteur updates the proposal as:

**Proposal 3: RAN2 will capture the options for signalling of TAs in the TR and wait for progress in NR-NTN for possible updates, if applicable to IoT NTN.**

**Proposal 4:** **RAN2 will evaluate paging capacity for IoT UEs in NTN to check how large a tracking area can be considering the target IoT NTN device density captured in TR 36.763.**

# 4 Cell Selection/Reselection in IoT-NTN

In this section, we intend to discuss the remaining control plane contributions in the form of an email discussion. The following agreements were agreed on eMTC/NB-IoT NTN in RAN2#112-e.

* **[035] 11: RAN2 will discuss on providing satellite ephemeris data and other information using System Information (SI) message for eMTC/NB-IoT NTN.**
* **[035] 12: RAN2 will use cell selection/reselection for NR-NTN as the baseline and discuss further about the detailed solutions in eMTC/NB-IoT NTN.**

While it was agreed in RAN2#112-e that RAN2 will use cell selection/reselection for NR-NTN as the baseline and discuss further about the detailed solutions in eMTC/NB-IoT NTN, R2-2101054 [12] has called for an revision of the agreement by mentioning that cell selection/re-selection of NB-IoT are considered as a baseline and the enhancements introduced for NR NTN considered when applicable for IoT-NTN. Based on this the rapporteur would like to ask the following question:

**Question 1: Do companies agree that the existing agreement, made in RAN2 #112-e needs to be revised as “cell selection/re-selection of NB-IoT are considered as a baseline and the enhancements introduced for NR NTN considered when applicable for IoT-NTN**”**?**

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| **Company** | **Agree / Disagree** | **Additional comments** |
| Huawei, HiSilicon | Agree | There are several differences between the cell selection/reselection mechanisms in NR-NTN and NB-IoT, e.g. priority based reselection is not supported in NB-IoT. So the baseline should still be the corresponding procedure in IoT NTN, and the enhancements discussed in NR-NTN can be further evaluated if they can be applied in IoT NTN. |
| ZTE | Agree | Agree with Huawei.Moreover, besides evaluating the enhancements discussed in NR-NTN, the enhancements that are only needed by/applicable to IoT NTN (especially for NB-IoT over NTN) but not needed by NR-NTN should not be excluded. |
| Lenovo | Agree | The revised version is more reasonable as cell (re)selection for NB-IoT and NR are different. Meanwhile enhancement for cell (re)selection in NR NTN is still under discussion and the applicability to NB-IoT in NTN needs to be further evaluated. |
| Xiaomi | Agree | Since NB-IoT don’t support cell reselection frequency priority, the selection/reselection mechanism for NR-NTN couldn’t be reused simply for NB-IoT NTN. So we think the revised agreement is reasonable. |
| Nokia | Agree  | Cell selection and reselection requirements of IoT should be considered as baseline. Revision of agreement is preferred. |
| Qualcomm | Agree  | We can also correct the intention of previous agreement and make new agreement.[035] 12: RAN2 will use cell selection/reselection enhancement introduced for NR-NTN as the baseline and discuss further about the detailed solutions in eMTC/NB-IoT NTN.🡪existing cell selection/reselection procedures are applicable to eMTC/NB-IoT in NTN. |
| OPPO | Agree | Agree with Huawei. |
| Gatehouse, Sateliot | Agree | Agree that cell selection/re-selection of NB-IoT TN is considered as the baseline for cell selection/re-selection of NB-IoT for NTN.Agree that enhancements introduced by NR NTN should be considered when applicable to NB.IoT NTN.Further to the above, additional enhancements may be needed, at least to efficiently support a NB-IoT NTN system under discontinuous service link coverage. |
| CMCC | Agree | As we all know, cell reselection for NB-IoT is different from NR NTN, because it does not support frequency priority. Therefore the revision is more reasonable. |
| Novamint | Agree | Cell selection/res-election requirements of NB-IoT should be considered as baseline Nevertheless, some improvements may be needed |
| Apple | Agree | We can consider cell selection/reselection in NBIoT as baseline with enhancements introduced in NR NTN applied to NBIoT NTN wherever applicable.  |
| LG | Agree | We agree that the LTE NB-IoT cell selection/reselection should be the baseline, and adopt NR-NTN idle mode rules if applicable to IoT-NTN. Maybe some ephemeris information-based cell selection/reselection could be also used in IoT-NTN. |

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| CATT | Agree | Agree with Huawei. |
| Ericsson | Agree |  |

Rapporteur’s Summary:

All the companies agree that the existing agreement, made in RAN2 #112-e needs to be revised as “cell selection/re-selection of NB-IoT are considered as a baseline and the enhancements introduced for NR NTN considered when applicable for IoT-NTN”. Hence the rapporteur suggest the following proposal:

**Proposal 5:** **RAN2 will use** **cell selection/re-selection of NB-IoT as a baseline. Enhancements introduced for cell selection/re-selection in NR NTN will be considered when applicable for IoT-NTN.**

R2-2100167 [2], R2-2100264 [5], R2-2101054 [12] mention enhancements to the cell selection/re-selection procedure, by using satellite assistance information.

**Question 2: Do companies agree that cell selection/re-selection procedure in IoT-NTN should be enhanced by using satellite assistance information?**

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| **Company** | **Agree / Disagree** | **Additional comments** |
| Huawei, HiSilicon | Agree | The ephemeris data can be further studied to assist cell selection/reselection. But RAN1 has not concluded the format of ephemeris data, and in RAN2 we can wait until further progress is made in NR NTN. |
| ZTE | Agree with comments | We think using satellite assistance information may be just one of the possible solutions. Therefore, it may be better to ask “Do companies agree that using satellite assistance information can be considered for cell selection/re-selection procedure enhancement in IoT-NTN?” We understand satellite assistance information may be helpful for the UE to trigger cell re-selection more appropriately, so we are fine to further study. |
| Lenovo | Agree | Satellite assistance information including ephemeris can be helpful in cell (re)selection. Other alternatives are not precluded. |
| Xiaomi | Agree | Based on agreements from NR-NTN, ephemeris data can be used for cell selection/re-selection, so we think at least the ephemeris data can be used for IoT-NTN cell selection/reselection. |
| Nokia | Agree but | System information content related to satellite information needs to be concluded which is needed for other purpose such as timing alignment. Once concluded, whether additional information for cell selection assistance is needed can be considered. For this consideration RAN2 also need to conclude on whether NTN-NT mobility in idle mode is also applicable for the study or not. |
| Qualcomm | Agree | This would be the intention of the previous agreement made in RAN2#112e.RAN2 will use cell selection/reselection enhancement introduced for NR-NTN as the baseline and discuss further about the detailed solutions in eMTC/NB-IoT NTN. |
| OPPO | Agree | We think ephemeris should be used combined with UE location information to help UE perform cell selection/reselection. |
| Gatehouse, Sateliot | Agree | Satellite assistance information, including satellite ephemeris, is needed to enhance the NB-IoT cell (re)selection as well as other idle mode mechanisms such as eDRX/PSM. |
| CMCC | Agree | Satellite assistance information(e.g. satellite ephemeris) is benefit for cell (re)selection procedure. |
| Novamint | Agree | Satellite assistance information and idle mode mechanisms such as eDRX/PSM should be considered to enhance NB-IoT cell selection/reselection |
| Apple | Agree |  |
| LG | Agree | In NR-NTN, ephemeris information-based cell selection/reselection, e.g. when LEO each satellite start/stop serving certain area. If can reduce the signalling load of UE, so we could adopt such mechanism to IoT-NTN in which especially UE power saving is extremely important. |

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| CATT | Agree | How to use the ephemeris data for cell (re)selection need to be further studied, we can wait for further progress made in NR NTN. |
| Ericsson | Agree in principle | In principle such information can be one of the aspects that can be considered to assist cell selection/reselection, if studied and found to be beneficial. However, RAN1 has not concluded on the format of ephemeris data and therefore RAN2 can wait until the discussion progresses. Other mechanism, separately or in combination with ephemeris data should not be precluded. |

Rapporteur’s Summary:

All the 14 companies agreed (or agreed in principle) that satellite ephemeris could be considered to assist cell selection/re-selection in IoT-NTN. Two companies suggested that RAN2 can wait until discussions are progressed as RAN1 has not yet concluded on format of ephemeris. One company has also mentioned that using satellite ephemeris could be one of the possible solution. Yet, another company has commented that this will be similar to the agreement made in NR-NTN. Hence, based on the comments the rapporteur proposed the following:

**Proposal 6:** **Cell selection/re-selection procedure 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.**

The contributions in R2-2100264 [5], R2-2100541 [8], R2-2101131 [13] and R2-2101248 [15] mention the effect of coverage holes or discontinuous coverage in cell selection/re-selection in IoT-NTN. R2-2100264 [5] also suggests the usage of satellite assistance (e.g. ephemeris) to inform the UE about discontinuity.

**Question 3(a): Do companies agree that RAN2 should study the effect of discontinuous coverage of IoT-NTN over cell re-selection?**

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| **Company** | **Agree / Disagree** | **Additional comments** |
| Huawei, HiSilicon | Agree, but postpone | There is no corresponding agreement made in RAN1 to further study the cube satellite scenario. We can focus the basic adaptation of IoT NTN with the assumption of continuous coverage for the time being. If RAN1 decide to adopt cube satellite, we can further analyse the RAN2 impact. |
| ESA | Agree | Our understanding is that “Set-4” (i.e., cubesats) is going to be added from the current RAN-1 discussion. In particular, for IoT/M2M scenarios, the case of discontinuous coverage is an important market opportunity, since a full coverage and continuous satellite constellation might be very expensive and not really needed for market, where data-rates and delays are the driving factors. |
| ZTE | Postpone | Generally agree with Huawei and we can wait to see RAN1 formal agreements. |
| Lenovo | Agree | Discontinuous coverage could be a scenario for IoT NTN and can be considered as a special case of LEO. Regarding RAN1’s discussion it is expected to study its effect and potential issues. Moreover even for the satellites other than cube satellites, discontinuous coverage could happen in time and/or region e.g. due to severe interference caused by transit (when a satellite is on a line between the Sun and the Earth). |
| Xiaomi | Agree with comment | RAN2 can study it if RAN1 makes agreements on discontinuous coverage scenario. |
| Nokia | Postpone | The basic scenario for discontinuous coverage in RAN1. Also availability of TN coverage in those areas needs to be considered during the study of these scenarios |
| Qualcomm | Agree | Not only for cube satellite scenario, we want to take this also as a scenario of out of coverage in the study item. |
| OPPO | Postpone | Agree with Huawei, we should wait for RAN1 agreement. |
| Gatehouse, Sateliot | Agree | In our view, discontinuous coverage is not an effect to be addressed only for cube satellite scenarios, but applicable to any LEO constellation not designed to provide full, continuous coverage.Even in the case of a LEO constellation intended to achieve continuous coverage in the long term, discontinuous coverage could be the normal operation condition at initial stages, because of a gradual build-up of the constellation.Moreover, as ESA points out, in the IoT market, a continuous, full coverage, satellite constellation might not even be a cost-effective solution for the market, especially for delay tolerant IoT services. In particular, there is a wide range of IoT applications which only need to have satellite access opportunities of short durations (e.g., tens or a few hundreds of seconds) a few times a day (i.e., revisiting times in the order of hours). |
| CMCC | Agree, but | Discontinuous coverage may lead to data transmission interruption. However, it may be better to wait for RAN1 progress before further discussion. |
| Novamint | Agree  | Agree with ESA comment. This is needed for Market Adoption |
| Apple | Postpone | Postpone until RAN1 discussions are complete.  |
| LG | Agree | We agree to study the discontinuous coverage. In NR-NTN, some discontinuous coverage cases during feeder-link switch are proposed by some companies. We can take the discussion into account. |

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| Eutelsat | Agree | Discontinuous coverage is a scenario that has to be considered for IoT NTN for the case of LEO satellites, even more during initial phases of fleet deployment. Discontinuous coverage issues should be studied jointly with RAN1. |
| THALES | Agree | We agree that discontinuous coverage should be studied, as LEO constellations might not be dense enough to provide continuous coverage. |
| CATT | Postpone | Pending to the RAN1 progress. |
| Ericsson | Agree | We think this is not necessarily related to the cube satellite scenario but can also be considered as a scenario for out of coverage. |

Rapporteur’s Summary:

9 out of the 17 companies agreed that RAN2 should study the effect of discontinuous coverage of IoT-NTN over cell re-selection. 3 companies agreed with the need for study, but suggested to postpone it until RAN1 makes some progress on it. 5 companies mentioned to postpone it until further progress is made by RAN1.

**Question 3(b): If the answer to Question 3(a) is “Agree” then do companies agree that satellite assistance (e.g. ephemeris) could be used as a possible solution to inform the UE about possible coverage discontinuity?**

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| **Company** | **Agree / Disagree** | **Additional comments** |
| Huawei, HiSilicon | postpone | At first the ephemeris format needs to be determined by RAN1, i.e. to clarify what it is, then we can consider how to use it to inform the UE about possible coverage discontinuity. |
| ESA | Agree |  |
| ZTE | Postpone | Generally agree with Huawei. |
| Lenovo | Agree | Satellite assistance information including ephemeris can be helpful. Other alternatives are not precluded. |
| Xiaomi |  | We can discuss it after RAN1 making agreements on discontinuous coverage scenario. |
| Nokia  | Postpone | Can be discussed after agreement on scenario. |
| Qualcomm | May be | Further study is needed to how to address the issue. Some assistance information on availability of the future coverage in the area would be very helpful. |
| OPPO | Postpone | Agree with Huawei. |
| Gatehouse, Sateliot | Agree | Ephemeris is likely an important element in the solution. It needs to be studied which modifications are needed to support discontinuous coverage. |
| CMCC |  | Please see our comments to Q3(a). |
| Novamint | Agree | It makes sense to consider Satellite assistance information/Ephemeris as a primary solution to support coverage discontinuity |
| Apple | Postpone | Agree with Huawei |
| LG | Agree | If feeder-link switch is going to be performed soon, the network may inform it to UEs so that the UEs could avoid the unnecessary such as re-establishment procedure or RLF declaration. |

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| Eutelsat | Agree |  |
| THALES | Agree | Like GateHouse, Sateliot we believe ephemeris to be an important element in the solution. |
| CATT | Postpone | Maybe the satellite ephemeris info could be used as the assistance info in this case. We should wait for the RAN1 agreements first, and then to discuss the potential solutions if the scenario is confirmed. |
| Ericsson | Possibly | But further study is needed to check the details and whether other mechanisms are available as separate or complementary solutions. |

Rapporteur’s Summary:

9 out of the 17 companies agreed that satellite assistance (e.g. ephemeris) could be used as a possible solution to inform the UE about possible coverage discontinuity. The remaining companies mentioned to postpone it until further progress is made by RAN1.

As there is no clear majority, in response to the rapporteur suggests to discuss the following proposal during online session:

**Proposal 7: RAN2 will study the effect of discontinuous coverage of IoT-NTN over cell re-selection after RAN1 has made some progress on this aspect.**

R2-2100264 [5], R2-2100338 [7], R2-2100738 [9] and R2-2100808 [11] mention the use of legacy eMTC priorities and/or NB-IoT *Qoffset* to control cell re-selection between TN-NTN cells, LEO-GEO cells and earth-fixed and earth-moving cells. On the other hand, the contribution in R2-2100510 [17] prefer to exclude Idle mode mobility scenario between TN and NTN.

**Question 4(a): Do companies agree that legacy eMTC priorities could be used to prioritize cell re-selection between LEO-GEO cells and earth fixed-earth moving cells?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree / Disagree** | **Additional comments** |
| Huawei, HiSilicon | Disagree | We are not sure if this scenario really exist, i.e. a mixed deployment with both LEO and GEO satellites, and both earth fixed-earth moving cells. In our opinion, the satellite type in a NTN network should be the same, e.g. LEO satellite with moving beams. |
| ZTE | Partially agree with TN-NTN scenario | We tend to agree with Huawei that mixed deployment for pure NTN network may be not so common and can be deprioritized. Moreover, earth fixed-earth moving cells is still under discussion in NR-NTN, we need to wait for more progress.But we think TN-NTN mixed deployment would be general as one of the purposes of introducing NTN is to compensate coverage in some remote areas and to fulfil anywhere connectivity. Therefore, idle mode mobility scenario between TN and NTN cannot be excluded.For eMTC over NTN, priority based cell reselection mechanism can be re-used in this scenario, e.g., to guarantee TN cell is with higher priority and more easily to be selected when it exists. For NB-IoT over NTN, a simple method based on cell Qoffset may be feasible, e.g., to decrease the order of a NTN cell in the ranking list by using an offset. |
| Lenovo | Postpone | We need to wait for the progress for fixed/moving cell in NR NTN and possibly further discussion on scenarios in IoT NTN, to see if mixed deployment in NTN is a common or a rare case. Besides at least for TN-NTN scenario we think legacy eMTC priorities could be used. |
| Xiaomi | Agree | We think legacy eMTC cell reselection priorities could be used as baseline for eMTC-NTN. |
| Nokia | Disagree | Deployment scenario for single network having both LEO and GEO based NTN cells needs to be checked first. Even in that case additional enhancements for these scenarios not needed for idle mode mobility.  |
| Qualcomm | Partly agree | LEO and GEO are different RATs as per NR NTN solution. Therefore they can be prioritized using existing mechanisms. But for moving vs fixed cell, what only matters to UE is how long a cell will be seen visible. |
| OPPO | Agree | For eMTC, the legacy priorities could be used to control cell reselection between different cell type.  |
| CMCC |  | Whether the mixed deployment is a common case may be studied firstly. |
| Novamint | Disagree | This scenario of LEO-GEO is far away to be a current realistic scenario from market perspective. It has in particular many impacts on the device side and is not justified by the main massive IoT use cases considered. |
| Apple | Partially Agree | As ZTE mentioned, we think for the TN-NTN cases eMTC priorities can be used as baseline.  |
| LG | Disagree | We wonder if UE mobility between LEO and GEO is common scenario in IoT-NTN.  |

|  |  |  |
| --- | --- | --- |
| CATT | Disagree | Share the view with Huawei and Nokia, the deployment scenario should be clarified first. |
| Ericsson | Maybe | In principle we do not see a reason why such mechanism should not be used but first we should discuss whether those scenarios should be studied. |

Rapporteur’s Summary:

Out of 13 companies only 2 companies agreed and 3 companies partially agreed legacy eMTC priorities could be used to prioritize cell re-selection between LEO-GEO cells and earth fixed-earth moving cells. 2 of the companies who agreed partially preferred using it for cell reselection between TN-NTN. The companies who disagreed want to confirm the deployment scenarios before making any progress.

**Question 4(b): Do companies agree that Qoffset based method could be used for NB-IoT to prioritize cell re-selection between LEO-GEO cells and earth fixed-earth moving cells?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree / Disagree** | **Additional comments** |
| Huawei, HiSilicon | Disagree | See comments above for Q4a |
| ZTE | Partially agree with TN-NTN scenario | See comments above for Q4(a). |
| Lenovo | Postpone | Too early to decide. See comments above for Q4(a). |
| Xiaomi |  | We think other solutions also can be considered, for instance,The network can indicate UE to reselect to the target network type (e.g. LEO/GEO/earth fixed/earth moving) with priority. |
| Nokia | Disagree | As per comments to Question 4a. |
| Qualcomm | Disagree | The Qoffset based method could work for LEO vs GEO cell but we should not preclude other solutions at this stage. |
| OPPO | Agree | The cell specific Qoffset can be used to control cell reselection between different cell type. |
| CMCC | Postpone | This issue is too early to discuss. |
| Novamint | Disagree | Same as 4Q(a) |
| Apple | Postpone | Though we believe that the Qoffset can be helpful for TN-NTN scenarios we can postpone this topic until the more preliminary procedures are decided. |
| LG | Disagree | It is too early to narrow down the solutions. |

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| --- | --- | --- |
| CATT | Disagree | As per comments to Question 4a. |
| Ericsson | Maybe | We should first discuss whether those scenarios should be studied. |

Rapporteur’s Summary:

Out of 13 companies only one company agreed and one company partially agreed for using Qoffset based method for NB-IoT to prioritize cell re-selection between LEO-GEO cells and earth fixed-earth moving cells. As most of the companies either disagreed or preferred to postpone the discussion and TN-NTN mobility is not in the scope of IoT-NTN SI, the rapporteur suggests the following proposal:

**Proposal 8: RAN2 will postpone the use prioritizing cell re-selection between LEO-GEO cells and earth fixed vs. earth moving cells in IoT-NTN.**

The effects of eDRX on cell reselection is discussed in R2-2100338 [7], R2-2100541 [8], R2-2100738 [9], R2-2100808 [11] and R2-2101248 [15]. While R2-2100338 [7] suggests to trigger cell selection procedure immediately at the beginning of PTW in an eDRX cycle, R2-2100808 [11] mentions usage of satellite assistance information, R2-2100541 [8] and R2-2101248 [15] propose study of eDRX and its effects with discontinuous coverage. On the other hand, R2-2100738 [9] suggests to wait for progress in RAN1 and RAN4 regarding this issue.

**Question 5(a): Do companies agree that RAN2 should evaluate eDRX with additional considerations of possible discontinuous coverage?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree / Disagree** | **Additional comments** |
| Huawei, HiSilicon | Partially agree | We agree to discuss the effect of eDRX but we should postpone the aspects related to discontinuous coverage as per Q3a. |
| ESA | Agree | In line with Q3a. |
| ZTE | Partially agree | According to our comments to Q3(a) and Q3(b), before getting more progress from RAN1, we will mainly focus on the eDRX impacts on cell re-selection in the continuous coverage scenario. |
| Lenovo | Neutral | The evaluation can be considered after confirmation of studying discontinuous coverage scenario. |
| Xiaomi | Agree |  |
| Nokia | Agree for first part | Compared to TN mobility for eDRX scenarios, the power consumption for eDRX scenario even for stationary UE considering satellite mobility will be higher. So additional consideration needed for eDRX scenario. |
| Qualcomm | Agree | The possible issue due to amount of time UE will be in long eDRX sleep and amount of time UE will be in coverage outage can be evaluated together. |
| OPPO | Partially agree | Agree with Huawei. |
| Gatehouse, Sateliot | Agree | Devices need to be able to re-synchronize to the network and regain coverage, also in scenarios considering eDRX and discontinuous coverage. Satellite constellations servicing intended discontinuous coverage, likely have devices connected with focus on low power usage, and thus eDRX/PSM. |
| CMCC |  | It could be discussed until a clear progress on discontinuous coverage has made. |
| Novamint | Agree | It is paramount to address this aspect for the reasons mentioned by Gatehouse/ Sateliot.  |
| Apple | Partially Agree | Agree for eDRX scenarios. But for discontinuous coverage we prefer to postpone the discussion until RAN1 confirmation is received.  |
| LG | Postpone | Such solution can be discussed after discussion on discontinuous coverage scenario. |

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| --- | --- | --- |
| Eutelsat | Agree | Both eDRX and PSM may need to be enhanced in discontinuous coverage scenarios. |
| THALES | Agree | Agree with Sateliot / GateHouse |
| CATT | Partially agree | Share the view with Huawei. |
| Ericsson | Agree |  |

Rapporteur’s Summary

Out of 17 companies, 8 companies agreed that RAN2 should evaluate eDRX with additional considerations of possible discontinuous coverage. 6 companies partially agreed to study eDRX only. One company is neutral and one company suggested to postpone it.

**Question 5(b): If the answer to Question 5(a) is “Agree”, suggest possible improvements for cell re-selection during eDRX cycle?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree / Disagree** | **Additional comments** |
| ZTE |  | For IoT UE configured with (long) eDRX cycle, the neighbour cells in an eDRX cycle may stop serving this area in the further eDRX cycle. Therefore:* More stringent condition for triggering the neighbor cell measurement for UE configured with eDRX cycle would be needed, e.g., with intention to try to avoid invalid or unnecessary neighbour cell measurement. And/or,
* It can be considered that UE configured with eDRX cycle can perform the cell selection procedure immediately at the beginning of PTW in an eDRX cycle.
 |
| Xiaomi |  | The assistance information of target cells can be provide to UE in advance for UE performing cell selection/reselection when UE wakes from eDRX cycle. For example, the frequency and PCI of target cell can be provide to UE. |
| Nokia |  | Enhancements to minimise the overall power consumption on UE waking up in eDRX occasion in new cell needs to be considered. This includes cell reselection enhancements and system information acquisition enhancements. |
| Qualcomm | -- | It is not clear what it meant by “during eDRX cycle”. If you are asking about PTW then it is same as what UE does in IDLE mode. UE always wakes up little early to get ready for PTW. |
| Gatehouse, Sateliot |  | The device’s eDRX cycle will need to be synchronized with satellite coverage, for example by using constellation ephemeris information. |
| Novamint |  | We should consider to synchronise the eDRX cycle with the coverage using Satellite assistance/ephemeris information |
| Eutelsat |  | Solutions should be studied during the FS |
|  |  |  |
| THALES |  | We should use the ephemeris to determine the time interval where the UEs can sleep. |
| Ericsson |  | We should first discuss and identify what the potential problems are and/or what sort of improvements would be good to have considering the benefits. |

Rapporteur’s Summary

9 companies expressed opinions and provided solutions for improvements in cell selection/re-selection during eDRX cycle. The solutions range from using more stringent conditions to usage of satellite assistance (e.g. ephemeris, with possible synchronization with eDRX cycle).

As the solutions are widely varied, rapporteur suggests the following:

**Proposal 9: RAN2 will evaluate the effects of eDRX on cell selection/re-selection in IoT-NTN. The exact solution approach is FFS.**

# 6 Conclusion

Based on the responses received from all the companies, the rapporteur has categorized the proposals into three different categories: **(A) Proposals with Complete / Majority consensus**, i.e. the proposals supported by all the majority participating companies **(B) Proposals with no clear majority**. Rapporteur’s proposals, categorized into these three different categories are mentioned below:

**(A) Proposals with Complete / Majority Support**

**Proposal 1: For eMTC in NTN**

1. **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.**
2. **The existing measurement framework for CHO (e.g. measurement configuration, execution and reporting) is the baseline, and all the existing measurement criteria and event can be used in NTN. Support for new measurement is not precluded.**
3. **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.**

**Proposal 2: RAN2 will study if Rel-17 based enhancements on RLF-based mobility in NB-IoT will be beneficial for NB-IoT NTN. Further enhancements on RLF-based mobility can be considered, e.g. by using satellite assistance (ephemeris) information.**

**Proposal 3: RAN2 will capture the options for signalling of TAs in the TR and wait for progress in NR-NTN for possible updates, if applicable to IoT NTN.**

**Proposal 4:** **RAN2 will evaluate paging capacity for IoT UEs in NTN to check how large a tracking area can be considering the target IoT NTN device density captured in TR 36.763.**

**Proposal 5:** **RAN2 will use** **cell selection/re-selection of NB-IoT as a baseline. Enhancements introduced for cell selection/re-selection in NR NTN will be considered when applicable for IoT-NTN.**

**Proposal 6:** **Cell selection/re-selection procedure 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.**

**(B) Proposals with no clear majority**

**Proposal 7: RAN2 will study the effect of discontinuous coverage of IoT-NTN over cell re-selection after RAN1 has made some progress on this aspect.**

**Proposal 8: RAN2 will postpone the use prioritizing cell re-selection between LEO-GEO cells and earth fixed vs. earth moving cells in IoT-NTN.**

**Proposal 9: RAN2 will evaluate the effects of eDRX on cell selection/re-selection in IoT-NTN. The exact solution approach is FFS.**

# 7 References

[1] R2-2100166, Discussion on connected mode mobility for IoT over NTN, OPPO.

[2] R2-2100167, Discussion on idle mode procedure for IoT over NTN, OPPO.

[3] R2-2100257, IoT NTN Observations and Proposals, Lockheed Martin.

[4] R2-2100263, Improving Tracking Area Updates in IoT NTN, MediaTek Inc, Eutelsat.

[5] R2-2100264, On Cell Re-selection in IoT-NTN, MediaTek Inc, Eutelsat.

[6] R2-2100266, Connected Mode Mobility in IoT-NTN, MediaTek Inc, Eutelsat.

[7] R2-2100338, Consideration on the control plane of IoT over NTN, ZTE Corp, Sanechips.

[8] R2-2100541, Discussion on the service link discontinuity and affected procedures for NB-IoT NTN, Gatehouse, Sateliot.

[9] R2-2100738, Connected mode and idle mode mobility, Qualcomm Inc.

[10] R2-2100807, Discussion on connected mode mobility in NB-IoT and eMTC NTN, Xiomi.

[11] R2-2100808, Cell selection and reselection for IoT NTN, Xiomi.

[12] R2-2101054, Discussion on Mobility and TA for NTN NB-IoT, Huawei, HiSilicon.

[13] R2-2101131, Discontinuous coverage for IoT NTN, Lenovo, Motorola Mobility.

[14] R2-2101132, RLF-based mobility for NB-IoT in NTN, Lenovo, Motorola Mobility.

[15] R2-2101248, Discussion on the service link discontinuity and affected procedures for NB-IoT NTN, Gatehouse, Sateliot, Thales.

[16] R2-2101555, Idle and connected mode mobility for IoT NTN, Ericsson.