**3GPP T****SG-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**: **eMTC based NTN will use the following connected mode mobility agreements made in NR-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 (e.g. measurement configuration, execution and reporting) is the baseline, and all the existing measurement criteria and event can be used in NTN.**
3. **Time or timer based and 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.**
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.**

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.**

# 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 contributions are 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 rea 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 different options for the signalling TAs in the TR and wait for progress in NR-NTN, with possible agreements during the WI (if approved).** **RAN2 will also evaluate paging capacity in IoT- NTN to check whether it can support large tracking area in GEO**.

# 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. |
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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. |
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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). |
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**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. |
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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?**

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| **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. |
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**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?**

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| **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). |
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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?**

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

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| **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. |
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# 6 Conclusion < will be updated after Email discussion >

**Proposal 1**: **eMTC based NTN will use the following connected mode mobility agreements made in NR-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 (e.g. measurement configuration, execution and reporting) is the baseline, and all the existing measurement criteria and event can be used in NTN.**
3. **Time or timer based and 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.**
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.**

**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.**

**Proposal 3: RAN2 will capture the different options for the signalling TAs in the TR and wait for progress in NR-NTN, with possible agreements during the WI (if approved).** **RAN2 will also evaluate paging capacity in IoT- NTN to check whether it can support large tracking area in GEO**.

Remaining Proposals will be made based on rapporteur’s summary from the email discussions.

# 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.