3GPP TSG-RAN WG2 Meeting #116-e Tdoc R2- 210xxxx

Electronic Meeting, Nov 1st - 12th, 2021

Agenda Item: 9.2.4

Source: Ericsson

Title: [Offline-029][IoT-NTN] Idle mode mobility and TA handling

Document for: Discussion, Decision

# Introduction

In RAN#86, a SI was approved to determine and evaluate the minimum necessary specification updates to introduce NB-IoT/eMTC support for non-terrestrial networks (NTN), The description for the SI was updated in RAN#90 [1] and it was agreed to use the existing work on NR NTN captured in TR 38.821 [2] as a baseline. In RAN#92-e, a follow up WI was approved to specify NB-IoT/eMTC support for Non-Terrestrial Networks.

In RAN2#115-e two e-mail discussions on TA and idle mode related aspects were documented in [13] and [14].

This document comes from the following:

* [AT116-e][029][IoT-NTN] CP Idle mode Cell and TA related (Ericsson)

 Scope: Ph1 Treat documents under 9.2.4, Related to Idle mode mobility, paging and Handling of Cell deployments and TA. Identify easy agreements, potential agreements (need discussion), potential alternatives, blocking points, Open issues. Pave the way for on-line Discussion.

 Intended outcome: Report

 Deadline: Ph1 Monday W2

This document is an attempt to reach agreements where it is clear that there is significant support and ask questions when there is not as much support or there are only single contribution proposing something.

**Tracking area handling**

**Proposal X**       Discuss whether ... .

**Idle mode mobility**

**Proposal X**         Discuss whether ... .

# Discussion

## Tracking area handling

In RAN2#115-e the following agreements were taken regarding tracking area handling in IoT NTN:

* **The network may broadcast more than one TAC per PLMN in a cell, which is up to network implementation.**
* **The UE determines the Tracking Area based on the broadcast information (the use of other information is not excluded).**
* **When the network stops broadcasting a TAC, the UE needs to know it. FFS how this is done.**
* **UE does not do TAU if one of the currently broadcasted TAC belongs to UE’s registration area.**

Also for reference we list the agreements taken in NR NTN last meeting:

**Agreements (NR NTN):**

1. RAN2 confirms AS indicates to NAS layer all received TACs per PLMN.
2. RAN2 responds to CT1 and SA2 with the confirmation that AS indicates to NAS layer all received TACs per PLMN. In addition it is stated that TACs in NTN are fixed to geographical location on Earth and UE’s location information can be used for TAI selection. Final decision on which criteria to apply (e.g. UE location information or other) is anyway up to CT1 and SA2 judgement

For this meeting the following proposals have been made considering tracking areas for IoT NTN.

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2109633 (Mediatek) | **Proposal 1:** To implement tracking areas fixed on earth with moving cells, the “soft switch” option is used, i.e. each cell can broadcast more than one TAC per PLMN. The TACs that the cell is broadcasting are updated as the cell moves between TAC regions. |
| R2-2109703 (CATT) | **Proposal 7:** System information update notification procedure is used to inform TAC removals.* Enhancement should be considered for stationary eMTC/NB-IoT UEs to avoid frequent signaling reception caused by TAC removals.
 |
| R2-2110113 (ZTE) | **Proposal 3:** System information update notification procedure is used to inform TAC removals in IoT NTN. |
| R2-2110146 (Nokia) | **Proposal 1:** TA soft switch option is only considered for IoT-NTN earth fixed tracking area configuration.**Proposal 2:** RAN2 to consider changes needed to differentiate paging messages of different tracking area when cell is broadcasting multiple tracking area.**Proposal 3:** System Information update notification procedure is not used to inform TAC update on TAC removal. |
| R2-2110480 (Huawei) | **Proposal 1:** The system information modification notification procedure is not used in NB-IoT NTN to signal changes of TAC(s) in the earth moving beam scenario.**Proposal 2:** UE does not need to be explicitly informed when the TAC is no longer broadcast.**Proposal 3:** Same as for NR NTN, AS indicates to NAS layer all received TACs for the selected PLMN.**Proposal 4:** The eNB in IOT NTN sends the broadcast CGI to the CN.**Proposal 5:** The eNB randomly selects one of the broadcast TACs for the selected PLMN to the CN. |
| R2-2111045 (CMCC) | **Proposal 1:** it is proposed to prefer the implicit manner to let the UE be aware of the network stops broadcasting a TAC.**Proposal 2:** The possible approach is as follows:The UE only to receive and decode a SI update information for TAU when it’s position is changing, i.e. a stationary UE can ignore the a SI update information for TAU;CN only paging the UE according to the TAC mapping to the UE’s actual geographical location, not the TAs advertised in the SIB; meanwhile, the UE can determine whether to update the TA to CN via deriving the overlapped TA from at least two TA lists in SIB advertised in different time occasions. |

**Rapporteur comments:**

The first issue that most companies mention is whether system information update notification procedure shall be used to inform TAC removals. The main proposals are that

1. It is used, where the argument is that the failure to notify this may mean that UE misses the paging message [4].
2. It is not used, where it is argued that it is only needed for some UEs in special condition, that it might increase UE power consumption [5] [6].
3. more optimized approaches proposals;
	1. It is used, but enhanced to avoid frequent signaling caused by the TAC removals [2].
	2. Implicit manner; UE only receives and decodes an SI update for TAU when the position is changing and the core network only pages the UE according to its actual geographical location [10].

**Q1 – Whether the system information modification procedure shall be used to inform TAC updates on TAC removal?**

|  |  |  |
| --- | --- | --- |
| Company | Used / not used | Comments |
| OPPO | Used | When the network stops broadcasting a TAC, the UE needs to know it to avoid paging message missing. |
| Xiaomi | Used | When the TAC is removed, the network may use system information modification procedure to inform UE based on the network implementation.  |
| MediaTek | Not Mandatory | It is up to the network whether to indicate the SI has been modified or not. |
|  |  |  |

**Q2 – If Q1 answer is that system information modification procedure shall not be used, does UE not need to be explicitly informed when the TAC is no longer broadcast.**

|  |  |  |
| --- | --- | --- |
| Company | Y / N | Comments |
| MediaTek | Yes | The UE does NOT need to be explicitly informed. If the UE moves out of the Tracking Area, there will be a TAC mismatch during cell reselection and the UE will anyway issue a TAU. |

**Q1-Q2 rapporteur summary:**

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Another proposal in [6] is related to the discussion on what AS indicates to the NAS layer. In NR NTN, it has been agreed that the AS layer will indicate all of the received TACs per PLMN to the NAS layer in order for the NAS layer to determine the TAI, which was the result of an LS exchange with CT1. Rapporteur see no reason why the same agreement cannot be made for IoT NTN, thus we propose:

**Proposal 3**       The AS layer indicates to NAS layer all of the received TACs for the selected PLMN, where it is up to NAS to select one TAC.

**Q3 - Comments on proposal 3:**

|  |  |  |
| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| OPPO | Y | Agree with Rapporteur. It is no reason why the same agreement as NR NTN cannot be made for IoT NTN. |
| Xiaomi | Y |  |
| MediaTek | Yes, but | We can only decide in RAN that AS layer indicates to NAS layer all of the received TACs. The remaining behavior of NAS is in the scope of CT1. |

**Q3 rapporteur summary:**

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Another proposal in [6] discussed is related to a discussion in NR NTN where question is on how the RAN determines what ULI is sent to the core network from the gNB, treated in LS response [11] from SA2 and [12] from RAN3.

In [6] it is mentioned that in LTE the eNB will also need to send the TAC and CGI to the core network, however in the contribution it is mentioned that there is no AS security for NB-IoT, so the eNB will never receive the finer location information. It is further stated that this should not be an issue as emergency calls are not supported for NB-IoT.

The *LS Response to Reply LS on UE location aspects in NTN* [11] from SA2 highlighting the problem can be seen below:

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SA2 reiterates that the geographic area represented by the CGI in a ULI may need to be comparable to a TN cell coverage area in order to support e.g. emergency services, etc. Although, when this is not possible, it can be possible for the 5GCN to obtain a UE location that can be used instead. For an initial access where the UE has just entered an RRC CONNECTED state, SA2 confirms that it is unnecessary for the geographic area represented by the CGI to be comparable to a TN cell coverage area as long this can be supported in a ULI provided subsequently (e.g. in a ULI provided for a subsequent NAS message sent to an AMF).

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Further aspects are explained by RAN3 in *Reply LS on UE location aspects in NTN* [12]:

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RAN3 understands from the RAN2 response that only the serving NTN Uu cell ID (broadcast cell ID of the serving cell) and the broadcast TAC(s) would be available at initial access. As a consequence, RAN3 assumes that at initial access the gNB is typically not able to provide in the ULI a CGI (Earth fixed) with location granularity similar to the ULI provided in TN; and also at initial access, the CGI provided in the ULI may represent a geographical area spanning multiple TACs. Based on the previous reply from SA2 on this topic, RAN3 also assumes that this is acceptable at system level.

Regarding NNSF (and e.g. country selection), RAN3 understands that there may be cases where the NG-RAN is not able to guarantee the selection of the correct CN at initial access without more precise location information, and this would need to be corrected later by the NG-RAN or the CN. Minimizing the number of actions (e.g. by providing some level of additional location information at initial access) seems useful, if at all possible, and RAN3 would like to ask RAN2 to check such feasibility.

After AS security is setup, RAN3 understands from the RAN2 LS that the NG-RAN will be able to obtain the UE’s location information (e.g. GNSS information or otherwise), and thereby construct a CGI provided in the ULI satisfying accuracy requirements comparable to those for TN.

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What is introduced in NR NTN is the possibility of first delivering the coarse location before AS security is established and then the possibility of reporting the finer location as AS security is established. For example the RAN then uses this information to first provide a coarse ULI and then a finer ULI to the core network, which is used for things such as emergency services and in border scenarios.

**Q4: Whether we can confirm that the solutions/principles introduced in NR NTN for determining the needed information that RAN shall provide to the core network shall be reused for IoT NTN?**

|  |  |
| --- | --- |
| Company | Comments |
| OPPO | As for this question, for IoT NTN, we can reuse the solutions/principles introduced in NR NTN. In any case, if finer UE location is reported to NW, AS security has to be established.  |
| Xiaomi | Before we make any agreements on this, we should first identify whether the requirements on the UE location reporting is the same as the NR NTN. Maybe the regular requirements such as the emergency call for IoT NTN is different from NR NTN, and UE don’t need to report its location to the gNB. |
| MediaTek | We do NOT have any agreement on ULI in NR-NTN yet. We only have working assumptions. It is premature to agree on these aspects in IoT-NTN. |

**Q5: If the solutions on providing coarse and finer location to the RAN introduced in NR NTN are not reused for IoT NTN, what solutions should be used for IoT NTN?**

|  |  |
| --- | --- |
| Company | Comments |
| Xiaomi | We should check whether the UE reporting its location is needed or not. |
| MediaTek | The UE reporting for location is not needed in the first release of IoT-NTN. |

**Q6: If the granularity of the location information from the solution for IoT NTN is different compared to NR NTN, is there a need to inform SA2 and RAN3?**

|  |  |
| --- | --- |
| Company | Comments |
| MediaTek | The UE reporting for location is not needed in the first release of IoT-NTN. |

**Q4-Q6 rapporteur summary:**

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In the previous meeting it was agreed that multiple TACs per PLMN may be broadcasted to support multiple TACs per PLMAN. In [1] and [5] the soft TA switch is discussed, where in [5] it is mentioned that the TA soft switch option should only be considered for earth fixed tracking area.

**Q7: Given that multiple TACs per PLMN are already supported – should it be limited to specific use case?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | No | No need to limit to specific use case. |
| Xiaomi | No | It should left to network implementation.  |
| MediaTek | No |  |

In [5] it is further discussed that there is a need to differentiate paging message when a cell is broadcasting multiple tracking areas by using some type of prior indication to the actual paging messages.

**Q8: Are there any need for differentiation of paging messages of different tracking areas when broadcasting multiple tracking areas?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | No | Considering the limited time for Rel-17, enhancement on this to reduce power consumption should not be pursued for this release. |
| Xiaomi | No |  |
| MediaTek | No |  |

**Q7-Q8 rapporteur summary:**

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## Idle mode mobility

In RAN2#115-e the following agreements were taken regarding idle mode mobility in IoT NTN:

* Cell selection / reselection procedures for NB-IoT and LTE-M in TN is the baseline in NB-IoT/LTE-M NTN.
* RAN2 assumes that Satellite assistance information, e.g. for cell selection reselection, for serving cell is provided to UE.
* Wait for the progress in RAN1 before discussion on whether satellite assistance information is broadcast in a separate information block.
* The timing information on when a cell is going to stop serving the area is broadcast at least for the quasi-earth fixed case. FFS details.

Also for reference we list the agreements taken in NR NTN last meeting:

**Agreements (NR NTN):**

1. Broadcast of cell stop time in SIB is only applicable to quasi earth fixed cell (not to moving cell). No further work in this release to address any moving cell specific details on using the cell stop time to assist measurements or cell reselection
2. For quasi-earth fixed cell, the reference location of the cell (serving cell or the neighbor cells) is broadcast in system information
3. For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area.
4. For quasi-earth fixed cell, the broadcast “timing information on when a cell is going to stop serving the area” refers to the time when a cell stops covering the current area.
5. For quasi-earth fixed cell, specify that UE should start measurements on neighbour cells before the broadcast stop time of the serving cell, i.e. the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation.
6. Location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell and/or neighbor cell) taken into account, is supported for quasi-earth fixed cell, if UE has valid location information, which means location acquisition will not be triggered at UE side only for location assisted cell reselection. FFS on the details.

For this meeting the following proposals have been made considering idle mode mobility for IoT NTN.

|  |  |
| --- | --- |
| Tdoc | Proposals |
| R2-2109923 (Mediatek) | **Proposal 1:** Legacy eMTC and NB-IoT cell selection procedures and intra frequency measurements could be reused in IoT-NTN.**Proposal 2:** Legacy eMTC and NB-IoT priorities and frequency specific offsets can be reused to control TN-NTN cell re-selection.**Proposal 3:** Legacy eMTC and NB-IoT cell ranking schemes could be reused to trigger fast cell re-selection of upcoming neighbour cells in IoT-NTN.**Proposal 4:** In NTN coverage holes associated with cell re-selection could be informed to the UEs by using satellite’s long-term (coarse-grained) ephemeris. UEs can use this information for acquiring knowledge about coverage holes (out-of-coverage) and cell re-selection. |
| R2-2110113 (ZTE) | **Proposal 1a:** Location assisted cell reselection is not supported for IoT NTN in R17.**Proposal 1b:** The satellite ephemeris and reference location for neighbour cell(s) are not provided to UE for cell (re)selection in IoT NTN.**Proposal 2:** The timing information about when a neighbor cell is going to start serving the area is broadcast at least for the quasi-earth fixed case in IoT NTN. |
| R2-2110146 (Nokia) | **Proposal 7:** RAN2 to consider modifications to the relaxed monitoring functionality based on UE location changes and ephemeris information instead of serving cell radio condition changes for IoT-NTN. |
| R2-2110480 (Huawei) | **Proposal 6:** Reuse the agreement of time based cell selection in NR: UE should start measurements on neighbour cells before the broadcast stop time of the serving cell, i.e. the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation.**Proposal 12:** The timing information on when a cell is going to stop serving the area for the quasi-earth fixed case is signalled in the same SIB as the ephemeris information. |
| R2-2110551 (Interdigital) | **Proposal 1a:** For quasi-earth fixed cell, specify that UE should start measurements on neighbour cells before the broadcast stop time of the serving cell, i.e. the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation**Proposal 1b:** Introduce an indication of neighbour cell start time for the quasi-earth fixed discontinuous coverage case**Proposal 1c:** If it is agreed to introduce an indication of neighbour cell start time for the quasi-earth fixed discontinuous coverage case, it may optionally also be used by the UE to optimise cell reselection in the continuous coverage case.**Proposal 2a:** For earth moving cell, the reference location of the cell (serving cell or the neighbor cells) is broadcast in system information**Proposal 2b:** If it is agreed for the case of earth moving cell to provide satellite location assistance information to the UE for estimation of the coverage gap timing using location estimation, then this information can be used to estimate the cell change timing in the continuous coverage case. |
| R2-2110770 (NEC) | **Proposal 1:** Same as NR NTN, for IoT NTN, to specify that UE should start measurements on neighbour cells before the broadcast stop time of the serving cell, i.e., the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation**Proposal 2:** Regarding using neighbour cell’s timing information, wait for progress in NR NTN or delay the discussion to future release. |
| R2-2111030 (Xiaomi) | **Proposal 4:** Broadcast of cell stop time in SIB is only applicable to quasi earth fixed cell (not to moving cell) and UE should start to perform intra-frequency or inter-frequency measurements before the cell stop time and the exact time to perform measurements is up to UE implementation**Proposal 5:** When the gNB configure both stop time and NR cell selection/reselection parameters, UE should check both neighbour cell measurement conditions and if one of the conditions is met, the UE shall perform measurement on neighbour cells |

On cell selection and reselection the most widely discussed is related to the agreement in last meeting on network signaling stop time for quasi-fixed earth cell case and the NR NTN agreements on UE starting measurement on neighbouring cells before a broadcasted stop time:

1. For quasi-earth fixed cell, specify that UE should start measurements on neighbour cells before the broadcast stop time of the serving cell, i.e. the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation.

The proposal is to reuse the agreement for IoT NTN but we try to break up the individual parts of the agreement as there have been different views on this.

**Q9 is the following sub-proposal acceptable**: For quasi-fixed earth cell caseUE should start measurements on neighbour cells before the broadcasted stop time of the serving cell, i.e. the time when the serving cell stops covering the current area.

|  |  |  |
| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| OPPO | Y | We can follow on the agreement for NR NTN. |
| Xiaomi | Y |  |
| MediaTek | N | As this is Idle mode behavior, it should be left on to UE implementation. |

Assuming Proposal 1 is acceptable the next question is on how the measurement and evaluation on the neighbouring cell is started. In some [7][6][9][8] it is mentioned that it is up to UE implementation. In other contributions [7][4] it is mentioned that the start of the neighbouring cell measurements can be based on a signaled start time of neighbouring cells.

**Q10:** RAN2 to discuss the following options:

 - 1. UE is only provided thestop time of serving cell and when to start measurements on neighbour cells is up to UE implementation.

 - 2. UE is explicitly provided the start time of the neighbouring cell for the UE to start measuring.

 - 3. Other

|  |  |  |
| --- | --- | --- |
| Company | Support of option (1/2/3) | Comments |
| OPPO | 1 | We can follow on the agreement for NR NTN. |
| Xiaomi | 1 |  |
| MediaTek | 1 |  |

In [9] inter and intra-frequency measurements are explicitly mentioned. It is not entirely clear whether the measurements imply both inter and intra-frequency measurements, we assume that start of both inter and intra-frequency measurements would be up to UE implementation.

**Q11:** If the answer to Q10 is that it is up to UE implementation to start measurements, does this include both inter and intra-frequency measurements when the network signals time to that eNB stops serving the cell.

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comments |
| OPPO | Y |  |
| Xiaomi | Y |  |
| MediaTek | Y |  |

For signaling the time when the cell is going to stop the serving the area there is a proposal that this is signaled in the same SIB as the ephemeris data is signaled in. This is already brought up in Offline-30 IoT NTN CP Other.

**Q9-11 Rapporteur summary:**

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Another set of discussion are related to NR NTN discussion on utilizing location aspects for performing cell reselection. Two companies are discussing that it is not needed [3] [4], mentioning that it is too complicated for IoT NTN and potentially power consuming. Another contribution [7] speaks in favour on the basis that some of the aspects are mentioned for discontinuous coverage. Note that using location-aspects for discontinuous coverage should be discussed in the related e-mail discussion.

**Q12 – Discuss whether location assisted cell reselection is supported for IoT NTN in R17 as in NR NTN. Using location-based aspects for discontinuous coverage is still open.**

|  |  |  |
| --- | --- | --- |
| Company | Supported / not supported | Comments |
| OPPO | Not supported | We think this enhancement can be dropped at this stage for IoT over NTN, since to make this happen, UE may be required to acquire its GNSS locations more frequently, which will increase the power consumption and thus is not so desirable. |
| Xiaomi | Not supported | UE may calculate both signal quality and distance, it will increase the power consumption.  |
| MediaTek | Not Supported | Agree with OPPO and Xiaomi that this will seriously affect UE’s power consumption. |

**Q12 Rapporteur summary:**

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In [5] it is mentioned that relaxed measurement may not function well in discontinuous coverage. It is suggested that RAN2 to considers modifications to the relaxed monitoring functionality based on UE location changes and ephemeris information instead of serving cell radio condition changes.

**Q13 – Comments on the need for relaxed measurements in discontinuous coverage:**

|  |  |  |
| --- | --- | --- |
| Company | Needed / not needed | Comments |
| OPPO | Not needed |  |
| Xiaomi | Not needed | UE track the location changes will increase the UE power consumption. |
| MediaTek | Not needed | We do not need to specify UE behavior when it is out of coverage. |

There are further proposals that are less clear at this point, including further condition in the cell reselection criteria in [9] and information needed for coverage holes in [3] to be used in cell reselection.

**Q14 – Comments on further needed aspects for cell selection reselection**

|  |  |  |
| --- | --- | --- |
| Company | Needed / not needed | Comments |
| OPPO | Not needed |  |
| Xiaomi | Not needed |  |
| MediaTek | Not needed |  |

**Q13-Q14 Rapporteur summary:**

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# Conclusion

This document is to attempt to summarize and find agreements and discussion points for the online session:

**...**

# References

1. R2-2109633, On Soft-switch based Tracking Area Updates in IoT NTN, Mediatek, RAN2#116-e, November 2021
2. R2-2109703, Discussion on the mobility issues of IoT NTN, CATT, RAN2#116-e, November 2021
3. R2-2109923, On soft-switch based Tracking area updates in IoT-NTN, Mediatek, RAN2#116-e, November 2021
4. R2-2110113, Remaining FFSs on CP in IoT NTN, ZTE, RAN2#116-3, November 2021
5. R2-2110146, Further discussion on TA switching and Idle mode procedures for IoT-NTN, Nokia, Nokia Shanghai Bells, RAN2#116-e, November 2021
6. R2-2110480, Control plane for IoT NTN, Huawei, Hisilicon, RAN2#116-e, November 2021
7. R2-2110551, IoT-NTN cell change, Interdigital, RAN2#116-e, November 2021
8. R2-2110770, Analysis on Mobility Aspects for IoT NTN, NEC, RAN2#116-e, November 2021
9. R2-2111030, Discussion on control plane issues for IoT NTN, Xiaomi, RAN2#116-e, November 2021
10. R2-2111045, Discussion on CP Impact for IoT over NTN, CMCC, RAN2#116-e, November 2021
11. S2-2106651, LS Response to Reply LS on UE location aspects in NTN, Qualcomm, SA2#146-e, August 2021
12. R2-2106941, Reply LS on UE location aspects in NTN, Qualcomm, RAN2#115-e, August 2021
13. R2-2109093, Summary of AI 9.2.4.1 “TA and mobility related”, Ericsson, RAN2#115-e, August 2021
14. R2-2109176, Summary of AI 9.2.4.1 “TA and mobility related” ph2, Ericsson, RAN2#115-e, August 2021