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 **Error! Reference source not found.** and it was agreed to use the existing work on NR NTN captured in TR 38.821 **Error! Reference source not found.** 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.

# 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. |

### 2.1.1 TAC removal handling

**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?**

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| --- | --- | --- |
| 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. |
| Qualcomm | Not used | This frequent signaling overhead should be avoided. How you manage modification period if cell is also supporting UEs using eDRX? |
| Lenovo, Motorola Mobility | NW implementation | This can be NW implementation and no need to specify anything. |
| ZTE | Used | 1) is the simplest way to avoid any potential issues. |
| CMCC | Used but | UE only receives and decodes an SI update for TAU when the position is changing |
| Ericsson | Not used |  |
| Interdigital | Not used | While the NW may choose to use SI update, an alternative could be to provide some timing information regarding TAC validity  |
| NEC | Not used | In our understanding, almost all UEs in a given TA will do cell reselection before that TA removed out from the broadcasted list. Mismatch will be temporary. |
| Huawei, HiSilicon | Not used | The most typical use case of IOT NTN are stationary UEs and UEs with long eDRX. For these UEs, there is no benefit but only negative impact in having a notification In NB-IoT, the smallest MP is 40.96 s. If we use system information modification procedure, it will always be ON so there is no benefit at all and it will use a lot of system resource. Requesting the UE to acquire the MIB every MP boundary will have the same effect w/o the negative impact. |
| Nokia | Not used |  The UE need to know the TAC removal only if the UE enters into the moving cell from the cell belonging to old tracking area (leaving tracking area) and also crosses border along with the moving cell to new tracking area. In this case if SI update is not done this UE will not know its entry into new tracking area. It is also applicable when the UE in old tracking area also moves at the same time of cell movement. Sending system information notification to address this case will impact stationary UE of the cells. Hence this update should not be used. A mobile UE which knows the multiple TA broadcasting can check based on its implementation at specific points to know the change.  |
| Vodafone | Not used, but | But UE should re-read TAC information if it moves a ‘significant’ distance. |
| Apple | Up to network | Can be left to network implementation |
|  |  |  |

**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. |
| Qualcomm | Y | TAC validity time can be provided to UE.  |
| Ericsson | Y  | Validity timer for the TAC can be provided for the UE to determine when it needs to perform a registration update, tracking area update etc. (We realize the question is not any easy one with 3 negations...) |
| Interdigital | Y | See above |
| NEC |  | The UE does NOT need to be explicitly informed. |
| Huawei, HiSilicon | N | The UE does NOT need to be explicitly informed.The UE will sooner rather than later be out of the coverage of the cell, acquire new system information and perform TAU. This is enough.  |
| Nokia | N | The TA change can be updated to UE as part of its next service request via NAS signalling. |
| Vodafone |  | The UE only needs to perform a TA Update if the UE moves into an area where it will no longer be paged. The UE can determine this by e.g. re-reading the SIBs when it wakes from PSM/eDRX or when (with discontinuous coverage) the satellite rises above the horizon; or by (implementation specific means) after moving X miles. |
| Apple | N | Depending on the deployment scenario, it may be OK if TA change notification is delayed. |
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**Q1-Q2 rapporteur summary:**

For Q1, a large amount of companies are in favour of not using system information modification procedure to inform TAC updates. The arguments arguing for it to be used to avoid paging message missing and that it is simplest way to avoid potential issues with missed paging messages. The arguments for it not be used is that it will cause frequent signalling, and that given the use case of stationary UEs with long eDRX it will very detrimental to both network and UE performance. Several companies state that it can be up to network whether it is used or not to inform the UEs of TAC removal. Given this, we propose that:

**Proposal 1**       System modification procedure is not used to inform UEs of TAC removal.

For Q2, the question was slightly confusing due to the double negation. The question was on whether UE would at all need to be informed when the TAC is no longer broadcast. Some companies state that the UE does not need to be explicitly informed when the TAC is no longer broadcast, stating that there will be a TAC mismatch and that UE anyways performs TAU. Given that the reply here depends on the outcome of Proposal 1 and that it has been agreed that the UE needs to know when the network stops broadcasting a TAC, we propose that RAN2 discusses whether there is a still a need to let UE know that a TAC is no longer broadcast.

**Proposal 2**       RAN2 to discuss whether there is a need for UE to explicitly be made aware when network stops broadcasting a TAC or whether a TAC validity time can be provided to the UE.

### 2.1.2 AS to NAS indication of TACs

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**       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:**

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| --- | --- | --- |
| 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. |
| Qualcomm | Y | Follow same what will be adopted in NR NTN. |
| Lenovo, Motorola Mobility | Y |  |
| ZTE | Y | We also think we can have the same agreement. |
| CMCC | Y | Align with NTN |
| Ericsson | Y | Agree with Mediatek |
| Interdigital  | Y |  |
| NEC | Y | We do not see any reason not to follow NR NTN |
| Huawei, HiSilicon | Y |  |
| Nokia | Y | Whenever UE AS layer detect change in TA it can inform all the detected TA to NAS.  |
| Vodafone | Y | Do the same as NR NTN |
| Apple | Y | Stick to NR NTN agreement |
|  |  |  |

**Q3 rapporteur summary:**

All companies agree with the proposal, but one stated that we can only state AS behaviour. The rapporteur proposes:

**Proposal 3**       The AS layer indicates to NAS layer all of the received TACs for the selected PLMN.

### 2.1.3 RAN information to core network

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?**

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| --- | --- |
| 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. |
| Qualcomm | Yes, there is no point to repeat same discussion in IoT session. |
| Lenovo, Motorola Mobility | We think this should be triggered and discussed in IoT NTN session. And if the solutions/principles introduced in NR NTN is applicable, agreements will be made easier. |
| ZTE | Yes. We understand similar requirements exist in IoT NTN (e.g., such information is needed to ensure the selection of the correct CN at initial access etc.), so we suggest to try to reuse corresponding NR NTN solutions/principles. But we know reporting the finer location after AS security is established would be infeasible to IoT UE using CP solution. Then either way is to allow only coarse location reporting for IoT UE using CP (may need to check with RAN3 whether it’s enough?), or it may be considered to report finer location reporting via NAS (may need to check with CT1/SA2?)? |
| CMCC | Agree with QC, the NTN conclusion (which is on the way) can be used. |
| Ericsson | We can let NR NTN first do the work and see if the solution is workable for IoT NTN.  |
| Interdigital | Considering that AS security is never established in NB-IoT we cannot confirm the same solutions will apply. |
| NEC | We still need to follow the principle that finer location is only report to eNB when AS security is in place. Hence we tend to agree that finer location may not be available in eNB in NB-IoT case. |

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| Huawei, HiSilicon | NB-IOT: we cannot confirm that the solutions/principles introduced in NR NTN are reused in full as there is no AS security and thus there will be no finer location. On the other hand, there is no emergency services (example cited by SA2 for the need of a finer location) |
| Nokia | NR-NTN agreements can be reused |
| Vodafone | We should aim to reuse the (existing and future) NR-NTN agreements. Huawei raise a valid point on how to handle things if there is no AS security. |
| Apple | We have to wait for NR NTN to progress more on this topic. And then decide if the NR NTN solution is feasible for IOT NTN given some differences such as lack of AS security in NB-IoT. |
|  |  |

**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?**

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| --- | --- |
| 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. |
| Qualcomm | No other solution is not needed. We can use solution defined for NR NTN for both cases when location can be reported and if any when location is not reported. |
| Lenovo, Motorola Mobility | We should check whether UE location reporting is needed in IoT NTN first. |
| CMCC | Check whether the UE reporting its location is needed or not. |
| Ericsson | We can wait for NR NTN to see the complete solution introduced for Q4 and then see if location is needed or not, but we also need to consider the feasibility first here.  |
| Interdigital | Coarse location reporting maybe OK, however how to report this needs to be discussed as there is no measurement reporting in RRC connected for NB-IoT. |
| NEC | In NB-IoT case, maybe we need to live with coarse location information. further discussion is needed |

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| Huawei, HiSilicon | NB-IoT: coarse location (pending SA3 reply on NR NTN LS) should be enough. If the CN needs a finer location, it can use LCS |
| Nokia | Agree with Huawei |
| Vodafone | Agree with Huawei. We need the S1 interface to comply with the existing specs on Cell ID/ULI reporting as this information is used in lots of places with the CN and O&M/billing systems, however, the geographic size of the cell may be large. |
| Apple | We don‘t think any new solution is needed. |
|  |  |

**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?**

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| --- | --- |
| Company | Comments |
| MediaTek | The UE reporting for location is not needed in the first release of IoT-NTN. |
| Qualcomm | No. Even with 5km accuracy of location report, the NTN can work well. |
| Lenovo, Motorola Mobility | We should check whether UE location reporting is needed in IoT NTN first. |
| Ericsson | As the use case is different compared to NR NTN, we should probably inform SA2 and RAN3 at one point that there are similar problems but where the solution might be different.  |
| NEC | Yes |
| Huawei, HiSilicon | FFS . can wait to progress first |
| Nokia | We need to conclude on the location reporting solution for IoT-NTN. We can wait for the progress. |
| Vodafone | No. The NTN provider and VPLMN operator will have an understanding of the granularity of the location information. Location reporting (with arbitrary granularity) will however be essential. |
| Apple | We cannot answer this question now, need to decide first if UE location reporting is essential for IoT NTN |
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**Q4-Q6 rapporteur summary:**

In Q4 it is clear that topic is still not mature, given that there is only a single contribution addressing the topic and that the details are still be worked out in NR NTN. The points raised were that NR NTN should be reused, that IoT NTN requirements (such as no emergency services) need to be considered on top of solutions in NR NTN, that we may not be able to apply NR NTN solutions given that AS security cannot be relied upon. Another company mentioned that it is still premature given that NR NTN have not made the agreements yet on the exact details of ULI.

In Q5 a lot of companies raised the point that coarse location may be sufficient for IoT NTN, while some mention that no location reporting would be needed for IoT NTN, at least for the first release. One company raised the issue that how to report location in NB-IoT needs to be discussed as there is no measurement reporting in connected mode.

In Q6 the opinions were different, some companies answered that it might be needed, while some state that it is not needed, while most companies state that it is FFS pending what is the outcome of the earlier mentioned issues. We thus propose to not inform SA2 or RAN3 at this stage.

Given that the topic is not considered mature we do not think a conclusion can be made for this meeting on Q4-Q6. The discussion likely needs to be postponed, but we propose the following proposal for discussion:

**Proposal 4**       For determining the needed UE information that RAN shall provide to the core, the NR NTN solutions are used where applicable, depending on IoT requirements (no need for emergency services) and IoT-specific issues (no AS security).

### 2.1.4 Other TA handling

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?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | No | No need to limit to specific use case. |
| Xiaomi | No | It should left to network implementation.  |
| MediaTek | No |  |
| Qualcomm | No | In HARD TAC update also, the UE needs to be aware of the update. |
| Lenovo, Motorola Mobility | No | No need. |
| ZTE | No | The network may broadcast more than one TACs per PLMN in a cell, which is up to network implementation. |
| CMCC | No | No need |
| Ericsson | No |  |
| Interdigital | No |  |
| NEC | No | First, we understand [5] want to only support soft TAC but not hard TAC with earth moving cell scenario, which seems different from the Q7. Our opinion is to leave to network implementation. |
| Huawei, HiSilicon | No | In NB-IoT, all PLMNs have the same TAC, there is no reason to change this. So the agreement for NB-IoT should be read as ‘multiple TACs per cell’ is supported” |
| Nokia | No | In our comment when multiple TAC is used for IoT-NTN for TA change scenario, soft switch only supported to avoid unnecessary tracking area updates from stationary UE. TA hard switch will impact signalling and power consumption of IoT-NTN UE significantly. |
| Apple | No | Up to network implementation |
|  |  |  |

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 |  |
| Qualcomm | Yes | If this can be done with simple change, it seems beneficial to UE. The paging associated to TAC1 will not wake up UEs belonging to TAC2 or TAC3.This can be further discussed. |
| Lenovo, Motorola Mobility | No |  |
| ZTE | No | Unclear what’s the benefit (e.g., if it’s assumed each TAC would not be so big). And what kind of prior indication is under consideration, UE-specific or cell-specific? Physical layer signal or high layer indication? Anyway, it seems much work would be needed. That’s undesired. |
| CMCC | No |  |
| Ericsson | No | Would seem to require a lot of work and the solution is unclear at this point.  |
| Interdigital | No | Maybe for R18. |
| NEC | No | We also feel there is no enough time to conclude on this |
| Huawei, HSilicon | No |  |
| Nokia | Yes | For mobile UE TA wide paging will be used. In cell containing two tracking areas, the TA wide paging will increase the paging load from NW. This is unavoidable. But this increased paging load also increase false wake-up at UE. So some mechanisms to differentiate the paging for tracking area is needed. |
| Vodafone | Not sure | **The bigger need may be that paging from different PLMNs (in different countries) can be differentiated.**  |
| Apple | No | Needs further study to determine is this is really needed. Can be left for a later release. |
|  |  |  |

**Q7-Q8 rapporteur summary:**

In Q7 most companies agree that there is no need to limit multiple TACs to a specific use case. It is mentioned that what the contribution actually suggested to state was that hard TAC switch should not be used for earth moving scenario. However, it seems as if most companies think that the decision whether to use hard TAC or soft TAC is up to network implementation, thus we propose to discuss the following proposal:

**Proposal 5**       The use of hard TAC or soft TAC is up to network implementation in earth-fixed and earth-moving cells.

In Q8, most companies are in line with that there is not a need for differentiation of paging messages of different tracking areas when broadcasting multiple tracking areas, the arguments being that the benefits are unclear and that there would be a lot of work needed and that it can be considered in release 18. The arguments for states that if it can be done with a simple change it could be beneficial, that the paging load will increase and that the paging from different PLMNs can be differentiated. Given the above discussion we propose the following as a discussion point:

**Proposal 6**       Differentiation of paging messages when broadcasting multiple tracking areas in rel-17 is not pursued for rel-17.

## 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.

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| --- | --- |
| 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 |

### 2.2.1 Neighbouring measurement starting time

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. |
| Qualcomm | Yes | We understand it optional. |
| Lenovo, Motorola Mobility | Y | We can reuse NR NTN solution. |
| ZTE | Y |  |
| CMCC | Y |  |
| Ericsson  | Yes | Let us follow the agreements for NR NTN |
| Interdigital | Y | At least for continuous coverage case, no point to measure neighbour cells if there is a coverage gap approaching.. |
| NEC | Y |  |
| Huawei, HiSilicon | Y |  |
| Nokia | Yes | OK |
| Apple | Y |  |
|  |  |  |

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 |  |
| Qualcomm | 1 |  |
| Lenovo, Motorola Mobility | 1 | We can reuse NR NTN solution. |
| ZTE | 2 | It can help UE avoid unnecessary measurement on neighboring cells and save power. Power saving is not critical in NR NTN. That’s the difference. |
| CMCC | 1 | reuse NR NTN solution |
| Ericsson  | 1 |  |
| Interdigital | 1 | Normally we specify when UE is allowed not to measure, if stop time is provided in SIB then UE may anyway measure ahead of that time even if we add no requirements.  |
| NEC | 1 |  |
| Huawei, HiSilicon | 1 |  |
| Nokia  | 1 | Stop time of serving cell is sufficient. UE can detect neighbour cells based on current cell reselection mechanism. |
| Apple | 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 |  |
| Qualcomm | Y | Yes based legacy procedure. |
| Lenovo, Motorola Mobility | Y |  |
| CMCC | Y |  |
| Ericsson  | Y |  |
| Interdigital | Y |  |
| NEC | Y | UE shall measure all inter and intra frequencies. In legacy, UE may not measure frequency with lower or equal priority if serving cell quality is very good, but since the serving cell will disappear, so UE shall measure all, i.e. not only frequencies with higher priority. |
| Huawei, HiSilicon | Y |  |
| Apple | 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:**

For Q9 most companies agree that UE should start measurements on neighbour cells before the broadcasted stop time of the serving cell for IoT NTN. One company stated that it is not need as it is up to UE implementation. For Q10, most companies agree that the UE is provided the stop time and it is up to UE implementation when to perform the measurement, while one company mentioned that UE can be explicitly provided with the start time when to start measuring. For the question on whether both inter and intra-frequency measurements are included when it is up to UE when to perform measurements.

Given the level of support, we propose the following agreement:

**Proposal 7**       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 (inter and intra-frequency) is up to UE implementation.

### 2.2.1 Location-based cell reselection

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. |
| Qualcomm | Support | Same as in NR NTN, it should be up to UE. |
| Lenovo, Motorola Mobility | Not supported | Not for this release considering UE power consumption. |
| ZTE | Not supported | Location assisted cell reselection requires UE to obtain the ephemeris information of the neighbor cell and predict the distance between UE and the neighbor cells when cell reselection happens, which would be more frequent than that for UE in discontinuous coverage. Then it will cause more UE power consumption. |
| Ericsson | Not supported | We can live without this for rel-17.  |
| Interdigital | optional | If we introduce some enhancements for discontinuous coverage there is no reason to exclude using that for continuous coverage. |
| NEC | Not supported  | Share the same view as OPPO |
| Huawei, HiSilicon | Not supported |  |
| Nokia | No | This is not essential requirement for IoT-NTN. Moreover it is upto UE to make use of location information in addition to network provide criterias. Need not be specified. |
| Apple | No | OK to drop this enhancement for now. |
|  |  |  |

**Q12 Rapporteur summary:**

For Q12 most companies think that location-assisted cell reselection shall not be supported for IoT NTN, the arguments being concerns regarding power consumption, need for obtaining ephemeris of neighbouring cells and that it is not essential for IoT NTN in release 17. The arguments for is that it can be supported for NR NTN since we are anyways introducing enhancements for discontinuous coverage.

Given the overwhelming arguments to not support location assisted cell reselection as in NR NTN, we propose:

**Proposal 8**       Location-assisted cell reselection as agreed in NR NTN is not supported for IoT NTN in rel 17.

### 2.2.1 Other idle mode mobility

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. |
| Qualcomm | Not needed |  |
| Lenovo, Motorola Mobility | See comments | The question is not clear to us. In our understanding [5] proposes to modify relaxed measurements for discontinuous coverage (e.g. based on UE location), and we think this is not needed. But for the question itself, we think relaxed measurements could be useful in discontinuous coverage. |
| ZTE | Not needed |  |
| CMCC | Not needed |  |
| Ericsson  | Not needed |  |
| Interdigital | FFS | Relaxed monitoring is intended to save power, if the UE has to use location tracking to determine the criteria it defeats the purpose. We could consider enhancements in R18, in R17 relaxed monitoring doesn’t always have to be enabled in the cell. . |
| NEC | Not needed | For moving satellite scenario mentioned in [5], we do not think enhancement on relaxed measurement will anyway work well due to frequent cell change |
| Huawei. HiSilicon | Not needed | When the UE is in coverage hole, it can stop all idle mode functions, i.e. no measurements |
| Nokia | Needed |  In our contribution we have indicated that relaxed monitoring as defined in current spec may not be effective for stationary UE in moving cell scenario as there will be serving cell change even for stationary UE. Some other means will be needed for effective relaxed monitoring mechanism for IoT-NTN. |
| Apple | Not needed | UE behavior in out-of-coverage does not need to be specified. |
|  |  |  |

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 |  |
| Qualcomm | Needed | Coverage hole information or information on how UE detects it is time to search TN frequency would be needed.How to bar legacy UEs from reading NTN SIB1? |
| Lenovo, Motorola Mobility | Not needed |  |
| ZTE | Not needed |  |
| CMCC | Not needed |  |
| Ericsson | Not needed | Not needed at this point, or more details are needed at this late stage.  |
| Huawei, HiSilicon | Not Needed |  |
| Nokia | Not Needed |  |
| Apple | Not needed |  |
|  |  |  |

**Q13-Q14 Rapporteur summary:**

For Q13 most companies seem to agree that there is no need for relaxed measurements in discontinuous coverage with the arguments being that there is no need to specify behaviour when the UE is out of coverage and that when the UE is in a coverage hole it can stop all idle mode functions and use no measurements. The proponent company mentioned that relaxed monitoring may not work well in current spec with moving cell and stationary UEs and that some other means will be needed for effective relaxed monitoring mechanism for IoT-NTN. It is quite clear that an overwhelming major are not interested in relaxed monitoring for discontinuous coverage as, this was the question, but for the sake of progress the rapporteur thinks that the following proposal can be discussed:

**Proposal 9**       Relaxed monitoring enhancements are not specified for IoT NTN in rel-17.

For Q14, most companies state that nothing else is needed, while one company mentions coverage hole information or information on how UE detects it is time to search for TN frequencies. Bar legacy UEs from reading NTN SIB1 is also mentioned, but this discussed in the other control plane e-mail discussion [Offline-030][IoT-NTN] CP other. For this question we propose that further improvements are discussed next meeting.

# Conclusion

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

Proposals for agreement:

**Proposal 3**       The AS layer indicates to NAS layer all of the received TACs for the selected PLMN.

**Proposal 7**       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 (inter and intra-frequency) is up to UE implementation.

**Proposal 8**       Location-assisted cell reselection as agreed in NR NTN is not supported for IoT NTN in rel 17.

Proposals for online discussion:

**Proposal 1**       System modification procedure is not used to inform UEs of TAC removal.

**Proposal 2**       RAN2 to discuss whether there is a need for UE to explicitly be made aware when network stops broadcasting a TAC or whether a TAC validity time can be provided to the UE.

**Proposal 5**       The use of hard TAC or soft TAC is up to network implementation in earth-fixed and earth-moving cells.

**Proposal 6**       Differentiation of paging messages when broadcasting multiple tracking areas in rel-17 is not pursued for rel-17.

**Proposal 9**       Relaxed monitoring enhancements are not specified for IoT NTN in rel-17.

Proposals that can be discussed but most likely postponed:

**Proposal 4**       For determining the needed UE information that RAN shall provide to the core, the NR NTN solutions are used where applicable, depending on IoT requirements (no need for emergency services) and IoT-specific issues (no AS security).

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