3GPP TSG-RAN WG2 Meeting #113-e R2-2102014

Electronic, Jan 25th – Feb 5th, 2021

Agenda Item: 8.10.3.1

Source: CMCC

Title: Summary of email discussion [AT113-e][104][NTN] TAC update (CMCC)

Document for: Discussion and Decision

# 1 Introduction

This document is for the following offline discussion, particularly for topics in 8.10.3.1:

* [AT113-e][104][NTN] TAC update (CMCC)

Scope: Discuss TAC update procedure, based on R2-2101607, R2-2100259, R2-2100742, R2-2100820, R2-2101406

Initial intended outcome: Summary of the offline discussion with e.g.:

§ List of proposals for agreement (if any)

§ List of proposals that require online discussions

Initial deadline (for companies' feedback): Monday 2021-02-01 11:00 UTC

Initial deadline (for rapporteur's summary in R2-2102014): Monday 2021-02-01 17:00 UTC

Proposals marked "for agreement" in R2-2102014 not challenged until Tuesday 2020-02-02 11:00 UTC will be declared as agreed by the session chair. For the rest the discussion will continue online.

To address this issue of frequent TAU procedure triggered by the satellite motion, the “fixed tracking area” concept is proposed and has been captured in TR 38.821 (section 7.3.1.3) [1], in which the tracking area code (TAC) is fixed on ground while the cells is sweeping on the ground. And it means that while the cells sweep on the ground, the tracking area code (i.e. TAC) broadcasted is changed when the cell arrives to the area of next planned earth fixed tracking area. Two approaches were discussed during the study item on how to effectively update the TACs that the cells/satellites are broadcasting they move across TAs, one is hard TAC update, another is soft TAC update, which is summarized in TR 38.821 [1] and previous email discussion [2] before RAN2#112 meeting:

**Hard TAI update** means that each cell can broadcast only on tracking area code. When this is combined with Earth fixed tracking area, it will create fluctuation at the border areas of these Earth fixed tracking areas, as depicted in Figure 1.



Figure 1 Tracking area update for Earth moving beams with hard TAI update

**Soft TAI update** requires the network to broadcast more than one TAI for a cell and PLMN. The cell adds the new TAC in its system information in addition to the old and removes the old a bit later. If there is a chain of TAs, the TA list adds one TA more and removes one old while the cell sweeps the ground. This also reduces the amount of TAUs for UEs that happen to be located at the border area, as depicted in Figure 2.



Figure 2 Tracking area update for Earth moving beams with soft TAI update

In [1][2][3][4][5][6][7], the pros and cons of the two approached are illustrated. In a summary, Soft TAI update solution can mitigate the increasing TAI update signaling with the problem of paging overhead, while the hard TAI update option has the problem of signaling overhead and boundary fluctuation, as shown in figure3. From another perspective, we could say that this issue mainly requires a compromise between paging load and signaling overhead actually.



Figure 3: TAC fluctuation at the border area

To progress the topic, this document provides questions with respect to the two approaches and companies are requested to provide their views on those.

# 2 Discussion

As mentioned in [1][2][3][4][5], although there is the concern about the increasing paging load resulting from a cell broadcasting multiple TAIs. However, the satellite/cell will remove the old TAC once the satellite/cell cover the most geography area corresponding to the new TAC after it adds the new TAC in its system information in addition to the old one. And considering the short duration for the transition stage of the satellite passing over the boundary area, the increasing paging signaling only occurs in a short period. On the other hand, as VDF mentioned, how the MNOs and Satellite service providers jointly arrive at a suitable and practical Tracking Areas to suit their networks’ needs is up to deployment and implementation, not a standards issue.

**Question 1: Do companies assumes that in soft TAI update approach, the multiple TACs only broadcasted just during the transition stage of the satellite passing over the boundary area, or up to deployment and implementation? This means the paging load caused by multiple TACs broadcasted in one cell is limited and is under controlled.**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| Panasonic | No | There is always a satellite/cell passing through the boundary of TAs at any time, and hence there is always a satellite/cell broadcasting multiple TACs and having increased paging overheads. Therefore, the impact is always there that impacts different satellite/cell at different time. |
| Huawei, HiSilicon | Yes | It depends on NW implementation to decide the size of one TAC, and for one satellite multiple TACs are only broadcasted during the transition stage. |
| OPPO | No | Agree with Panasonic. For a certain satellite, multiple TACs’ broadcasting applies to each satellite/cell passing through the TA boundary. |
| MediaTek | Yes | While this is left to implementation, we assume that multiple TACs are only broadcasted just during the transition stage of the satellite passing over the boundary area. This will limit the paging load caused by multiple TACs. |
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**Regarding hard TAI update,** sinceonly one TAC per PLMN ID is broadcasted in SI, when gNB switches its TAC during satellite’s cell sweep on the ground, a stationary UE may need to perform TAU because of the different TAs at different timings, which results in signalling-intensive situation and increases the UE’s power consumption.

**Question 2: Do companies agree that hard TAI update will result in frequent TAU signalling overhead and increases the UE’s power consumption?**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| Panasonic | Maybe | With some enhancements, such frequent TAU signaling overhead can be avoided even in the hard TAI update approach. For instance, the network can configure multiple TAs to the UE that is closed to the boundary of multiple TAs. Then this UE will not trigger TAI update even if the broadcasted TAC changes. For another instance, if we can prevent the satellite from performing paging (i.e., SI update procedure) due to the TAC update, such frequent TAU signaling overhead can be prevented as well. |
| Huawei, HiSilicon | Yes | For the UE on the TAC list edge, frequent TAU is inevitable. |
| OPPO | Yes | TAC update from network will lead to TAU signaling from lots of UEs. |
| MediaTek | Yes | If the UE is required to check Tracking Area changes, then there will be increase in TAU signalling load and UE’s power consumption. |
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In section 1, the pros and cons of the two approaches illustrated in [1][2][3][4][5][6][7] was summarized. Based on the comparison, companies are invited to answer this Question:

**Question 3: Do companies have a preference on supporting either hard or soft TAI update, or both?**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| Panasonic | Both | We think both hard and soft TAI update approaches should be supported. More specifically. Hard TAI update is just the special case (i.e., subset) of the soft TAI update. |
| Huawei, HiSilicon | Yes | We prefer soft TAC update. |
| OPPO |  | We prefer soft TAC update. |
| MediaTek | Yes | Soft update is preferred |
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Additionally, in NTN, to avoid having TAU performed frequently by the UE triggered by the satellite motion, as indicated in TR 38.821, the tracking area may be designed to be fixed on ground. As mentioned in [1][3][6], a relative issue is how does the UE determine the TA it is currently located, which can be categorized into two groups:

1. **current TA is determined based on the broadcasted radio coverage,**
2. **current TA is determined based on UE’s geographical location and satellite’s ephemeris’ information.**

**Question 4: which option is companies’ preference, option 1 or option 2?**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| Panasonic | Option 1 | As mentioned in our paper R2-2100820, option 1 should be the baseline and option 2 can be considered later if time allows. |
| Huawei, HiSilicon | Partially option 1 | UE can determine the TA based on UE location and the broadcasted radio coverage.  For option 2, we don’t know how satellite ephemeris maps to geographical area. |
| OPPO | Option 1 | Option 1 is the existing approach, in our understanding. |
| MediaTek | Option 1 | This is aligned with TN behavior. |
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As mentioned in [3][6], in the soft TAI update scheme, it is beneficial to allow gNB to not trigger the SI update when the list of broadcast TACs changed, since it is not necessary for the UE staying in the same cell to know whether a new TAC is added or an existing TAC is deleted from the TAC list due to the satellite movement. UE will have to check the TAC list only when it just enters into a new cell. Moreover, if the option 2 in question 4 is adopted, it is straightforward that there is no necessity of SI update due to satellite motion.

**Question 5: do companies agree that such kind of TAC change in SI caused by satellite motion will not trigger paging for system information change?**

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| Panasonic | Yes | This is to avoid consuming UE’s power in acquiring SI due to the TAC change caused by the satellite motion, which might in turn consume more UE’s power in performing the TAU procedure. |
| Huawei, HiSilicon | Yes | Paging for system information change is not needed, as for one specific UE the key SI information is unchanged. |
| OPPO | Yes |  |
| MediaTek | Yes |  |
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In [5], the paper have pointed out that soft TAC update procedure has some NAS impact. For example, AS reports multiple TACs per PLMN to NAS for cell selection and NAS has to determine whether to trigger registration update based on reported multiple TACs per PLMN (unlike today where only one reported TAC per PLMN is used). The RAN can determine and report one TAC for a UE in the NG ULI as for TN.

Question 6: Do compaines agree that the soft TAC update has NAS impact and LS to CT1 and SA2 asking for any concern on soft TAC update mechanism is needed.

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| **Company** | **Yes/No** | **Comment / alternative proposal** |
| Panasonic | Yes | There could be NAS impact but it is not difficult to resolve. For instance, it can be further specified that once the registered TAC is still within the list of TACs reported from RRC, UE will not trigger the registration update. |
| Huawei, HiSilicon | No | UE can determine which TA it belongs to, as mentioned in Q4. Then as legacy only one TA is reported to NAS. In this way no LS is needed. |
| OPPO | Yes | We are ok to send LS to CT1/SA2. |
| MediaTek | Yes | During registration procedure the NAS should select one of the several broadcasted TACs for the UE. While this is left to implementation, it would make sense for the network to choose the TAC that the satellite is moving into. This is because a UE that has reselected to the new cell and performing the registration procedure is located at the leading edge of the cell. We are open to send an LS to SA2 for this. |
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# **3 Conclusion**

TBD

# 4 References

1. R2-2001627 Impact of CG/SPS with periodicities non dividing HF length Sequans Communications3GPP TR 38.821 Solutions for NR to support non-terrestrial networks (NTN), version 16.0.0
2. R2-209820, [POST111e][910][NTN] Impacts of earth fixed and moving beams (Ericsson)
3. R2-2101607 Considerations on Soft TAI Update CMCC discussion Rel-17
4. R2-2100259 Improving Tracking Area Updates in NR-NTN MediaTek Inc. discussion
5. R2-2100742 TAC update procedure Qualcomm Incorporated discussion Rel-17
6. R2-2100820 Fixed Tracking Area and the Tracking Area Code in NTN PANASONIC R&D Center Germany discussion R2-2009120
7. R2-2101406 TAI update for earth moving cell NEC Telecom MODUS Ltd. discussion

# **6 Proposals in summary contribution**