**3GPP TSG-RAN WG2 Meeting #112-eTdoc R2-2010765**

**Source: Ericsson (Email discussion rapporteur)**

**Title:** **[AT112-e][104][NTN] Misc CP issues (Ericsson)**

**Agenda Item: 8.10.3.1**

**Document for: Discussion**

# 1 Introduction

NTN Rel-17 WI was started in RAN2#111. In RAN2#112 the below agreements were reach for AI “Earth fixed moving beams” in the first online session:

#### 8.10.3.1 Earth fixed moving beams related issues

Including the outcome of Post111-e][910[NTN] Impacts of earth fixed and moving beams

[R2-2009820](file:///C:\Data\3GPP\Extracts\R2-2009820_RAN2Email910_EarthFixedMovingBeams_Report.docx) [POST111e][910][NTN] Impacts of earth fixed and moving beams (Ericsson) Ericsson report

Agreements:

1. RAN2 to consider the case where gNB is co-located at the GW with higher priority.
2. RAN2 will continue working with the assumption that during service link switch two satellites have two different PCIs. Check if an LS to RAN1 asking for feasibility of having same PCI as well can be agreed

This email discussion was also agreed in RAN2#111 and the scope of the discussion is stated as below

* [AT112-e][104][NTN] Misc CP issues (Ericsson)

Scope: Discuss (a revision of) p7, p8, p9, p11 from [R2-2009820](file:///C:\Data\3GPP\Extracts\R2-2009820_RAN2Email910_EarthFixedMovingBeams_Report.docx) and discuss an LS to RAN1 asking for feasibility of having two satellites with same PCI during service link switch

Intended outcome: summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals that require online discussions

and draft LS to RAN1

Initial deadline (for companies' feedback): Monday 2020-11-09 17:00 UTC

Initial deadline (for rapporteur's summary in R2-2010765 and draft LS in R2-2010766): Monday 2020-11-09 23:00 UTC

Proposals marked "for agreement" in R2-2010765 not challenged until Tuesday 2020-11-10 12:00 UTC will be declared as agreed by the session chair. For the rest the discussion will continue online.

R2-2010765 Summary of offline 104 - Misc CP issues Ericsson discussion Rel-17 NR\_NTN\_solutions-Core

R2-2010766 Draft LS to RAN1 on same PCI during service link switch Ericsson LS out Rel-17 NR\_NTN\_solutions-Core To:RAN1

The proposals p7-p9, p11 that are under the scope of this discussion are listed as follows:

Proposal 7 RAN2 to prioritize discussing CHO in context of Scenarios 1-3.

Proposal 8 RAN2 to discuss the below solutions or their variants further(yellow most straightforward additions added)

* Solution 11: Informing of the upcoming feeder link switch (the UE about PCI leaving and another PCI appearing due to feeder link switch)
  + stored at UE or via system information or paging indicator
* Solution 12: UE does cell ranking and reselection based on
* information of Solution 7 stored at UE or via system information or paging indicator
* UE absolute location
* UE location relative to serving satellite
* Round trip time (RTT) for the satellite
* Remaining dwell time(time left to be served) in a cell that is leaving or appearing

Proposal 9 RAN2 to agree to support the following solutions (details FFS)

* information of Solution 7(Informing of the upcoming feeder link switch (the UE about PCI leaving and another PCI appearing due to feeder link switch))
* Remaining dwell time(time left to be served) in a cell that is leaving or appearing(which is same as signal left to be available):
* Samsung and ZTE would like to continue discussing this offline

Proposal 11 RAN2 to prioritize discussing soft TAI update

# 2 Connected mode mobility for Scenarios 1-3

In this Section we discuss Proposal 7:

Proposal 7 RAN2 to prioritize discussing CHO in context of Scenarios 1-3.

Connected mode mobility in NTN may be categorized into the following scenarios:

* Scenario 1: Feeder link switch for earth fixed beam, with/without service link switch due to satellite switch
* Scenario 2: Feeder link switch for earth moving beam, with/without service link switch due to satellite switch
* Scenario 3: Service link switch for earth fixed beam due to satellite switch
* Scenario 4: Connected mode mobility for earth moving beam when the beam no longer serves the UE
* Scenario 5: Connected mode mobility for both earth moving and earth fixed beam due to UE movement

For Scenarios 1-3, the UE may be informed in the HO command of the upcoming feeder link switch (the UE about PCI leaving and another PCI appearing due to feeder link switch). Further, UE location and satellite ephemeris may be used as a trigger for the CHO. During previous email discussion also signalling overhead and latency related to CHO were broad up.

*Q2.1 Companies to describe preferred content of the CHO command including a possible trigger specific to Scenarios 1-3. Overhead and latency related aspects, concerns or solutions may also be elaborated.*

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| Company | **Answer** |
| Nokia | The CHO command should contain the legacy (as defined in R16) information/configuration for accessing the upcoming target cell. Satellite ephemeris (likely too large to be inserted into dedicated signalling) should be assumed to be known, as the UE has acquired that before moving to CONNECTED. NTN-specific CHO condition (if defined) is obviously also included. |
| MediaTek | We think the legacy R-16 information with the A4 event for handover should be sufficient for CHO with potentially smaller “time to trigger” durations. |
| Samsung | 1. Triggers. Existing triggers of R16 are inadequate for an NTN. Companies have suggested different triggers including time/timer and elevation angle, and location (e.g., distance from the center of cell or distance from the platform). We think that the reliability of some new NTN triggers may not be known before deployments or field testing have been carried out. Hence, to provide flexibility and mitigate risks with NTN deployments, we suggest defining flexible combination triggers. Here are a couple of possibilities: (1) Define a set of trigger conditions (TCs) with combination triggers and indicate one or more TCs in an RRC signaling message or (2) define a set of individual triggers (ITs) and specify combinations of ITs in an RRC signaling message.  2. Incoming Cell/Neighbor. We suggest to define a satellite movement-based neighbor list and a satellite-movement based offset in measurement event trigger conditions in case of Earth-moving beams and quasi-Earth-fixed beams. These suggestions reflect the fact that a UE cannot move into an outgoing NTN cell, because the satellite moves faster than a UE. For example, if a satellite is moving from right-to-left, a UE cannot enter a cell that to the left of its currently serving cell. This will save the processing power at the UE, reduce the possibility of handover to an incorrect cell, and make handover more reliable.  3. CHO and Traditional Handover. CHO can certainly reduce the overall handover delay. However, CHO can significantly reduce the amount of radio resources available for user traffic because of the need to reserve resources at multiple cells for a large number of users experiencing handover. Hence, we suggest that RAN2 consider enhancements to CHO and traditional handover.  4. Intra-handover User Traffic Transfer. In the traditional handover user traffic is not transferred between (i) the RRC Reconfiguration message carrying the handover command and (ii) the RRC Reconfiguration Complete message. To reduce user traffic interruption while handover signaling exchange is ongoing, RAN2 can consider supporting intra-handover/intra-RA user traffic. Configured and/or dynamic scheduling can be considered.  5. Historical Measurements. We suggest a simple addition of historical measurements in a Measurement Report to facilitate predictive handover decision-making at the gNB. For example, the UE can be configured to report N measurements that are M ms apart. This will help the gNB predict how the measurements may be Z ms in future. |
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# 3 Idle mode mobility for Scenarios 1-3

In this Section we discuss Proposals 8 and 9:

Proposal 8 RAN2 to discuss the below solutions or their variants further(yellow most straightforward additions added)

* Solution 11: Informing of the upcoming feeder link switch (the UE about PCI leaving and another PCI appearing due to feeder link switch)
  + stored at UE or via system information or paging indicator
* Solution 12: UE does cell ranking and reselection based on
* information of Solution 7 stored at UE or via system information or paging indicator
* UE absolute location
* UE location relative to serving satellite
* Round trip time (RTT) for the satellite
* Remaining dwell time(time left to be served) in a cell that is leaving or appearing

Proposal 9 RAN2 to agree to support the following solutions (details FFS)

* information of Solution 7(Informing of the upcoming feeder link switch (the UE about PCI leaving and another PCI appearing due to feeder link switch))
* Remaining dwell time(time left to be served) in a cell that is leaving or appearing(which is same as signal left to be available):

For Scenarios 1-3, the Idle mode UE may be informed in the SI of the upcoming feeder link switch (the UE about PCI leaving and another PCI appearing due to feeder link switch). This information could also include “time left to be served” of the cell that is about to disappear. Indeed, in last round of email discussion, supporting having network to broadcast this type of information had majority support. In this round, an agreement on these is attempted.

**Proposal 1 RAN2 to agree to support broadcasting the following information in order to assist feeder link/servince link switch (details FFS)**

* **Information about cell/PCI ceasing to serving the area as well as time left to be served(dwell time/signal left to be available)**
* **Information about another cell/PCI starting to serve the area as well as possible timing information**

*Q3.1 Companies to state whether they agree to Proposal 1(reworded from Proposal 9)*

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| Company | **Answer** |
| Nokia | A bit convoluted way of wording it, but does it mean the UE in IDLE still relies on the legacy reselection principles (S and R criteria), but additionally may read from the broadcast signalling a timing information which cell shall be available in this area in particular time period? If that is the right understanding, then fine. |
| MediaTek | We believe that UE can use existing R-16 based cell re-selection principles as baseline. Satellite’s long-term (coarse-grained) ephemeris can be used on top of R-16 based principles to indicate information about potential neighbor cell (PCI) to serve the area as well as possible timing information. |
| Samsung | A. Cell Reselection Triggers.  A1. Existing triggers of R16 are inadequate for an NTN. Companies have suggested different triggers including time/timer and location (e.g., distance from the center of cell or distance from the platform). We think that the reliability of some new NTN triggers may not be known before deployments or field testing have been carried out. Hence, to provide flexibility and mitigate risks with NTN deployments, we suggest defining flexible combination triggers. Example approaches: (i) define a set of full trigger conditions and indicate one or more TCs in a SIB or (ii) define a set of individual triggers and broadcast TCs as combinations of individual triggers.  A2. For quasi-Earth-fixed beams, we can order UEs to do cell reselection to an incoming neighbor cell via a SIB.  B. Neighbor Cell Search.  B1. A white list of neighbor cells for a focused cell search to save UE processing time and avoid cell reselection to an incorrect cell.  B2. Exploit the knowledge of satellite/platform movement. Add an “encouragement” offset for “key” candidate cell(s) (e.g., an incoming neighbor cell with an identical overlap with the outgoing serving cell in case of a quasi-fixed-Earth beams) and a “neutral” offset for other candidate cells (e.g., other neighbors as non-key candidate cells).  B3. The UE should only search for the white list for cell reselection to save processing power and to reduce processing time to quickly detect a better candidate cell.  B4. For quasi-Earth-fixed beams, UEs can save measurement and processing time by not observing neighbors for a time period after cell reselection to save power. For quasi-Earth-fixed beams, we need to disable the SintraSearch criterion to enable the UE to detect an incoming neighbor cell in large parts of the serving cell. |
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# 4 Tracking area

In this Section we discuss Proposal 11:

*Proposal 11 RAN2 to prioritize discussing soft TAI update*

Related to this proposal the following papers were submitted to RAN2#112-e(may not be the full list):

[R2-2008838](file:///C:\Data\3GPP\Extracts\R2-2008838%20Discussion%20on%20Tracking%20Area%20for%20Earth%20Moving%20Cells.docx) Discussion on tracking area for earth moving cells CATT discussion Rel-17 NR\_NTN\_solutions-Core

[R2-2009805](file:///C:\Data\3GPP\Extracts\R2-2009805_Tracking%20area%20management%20for%20earth%20moving%20cells.docx) Tracking area management for earth moving cells ZTE corporation, Sanechips discussion Rel-17 NR\_NTN\_solutions-Core

[R2-2009823](file:///C:\Data\3GPP\Extracts\R2-2009823%20NTN%20Fixed%20Moving%20Beams.docx) Aspects for Earth fixed and Earth moving beams for NTN Ericsson discussion NR\_NTN\_solutions-Core

[R2-2009980](file:///C:\Data\3GPP\Extracts\R2-2009980_TAI%20update%20for%20earth%20moving%20cell.docx) TAI update for earth moving cell NEC Telecom MODUS Ltd. discussion

[R2-2008898](file:///C:\Data\3GPP\Extracts\R2-2008898_TAU_NR-NTN_v2.0.docx) Improving Tracking Area Updates in NR-NTN MediaTek Inc. discussion

[R2-2009120](file:///C:\Data\3GPP\Extracts\R2-2009120%20Fixed%20Tracking%20Area%20and%20the%20Tracking%20Area%20Code%20in%20NTN.docx) Fixed Tracking Area and the Tracking Area Code in NTN PANASONIC R&D Center Germany discussion [R2-2006821](file:///C:\Data\3GPP\archive\RAN2\RAN2%23111\Tdocs\R2-2006821.zip)

[R2-2010377](file:///C:\Data\3GPP\Extracts\R2-2010377%20Considerations%20on%20Soft%20TAI%20Update.docx) Considerations on Soft TAI Update CMCC discussion Rel-17 NR\_NTN\_solutions-Core

Proposal 2: it is proposed that the UE can derive the TAC according to the geographical location, and such kind of TAC change causing by satellite moving will not trigger paging for system information change.

The main aspect in those is in relation to whether tracking area would be completely replaced by fixed geographical areas and tracking area update is simply based on UEs GNSS positioning. This, and whether also Cell ID should correspond to geographically fixed area has been discussed also in SA2 and RAN3 and the following LS have been sent between those WGs with RAN2 CC:ed.

[R2-2008730](file:///C:\Data\3GPP\Extracts\R2-2008730_R3-205795.docx) Reply LS on SA WG2 assumptions from conclusion of study on architecture aspects for using satellite access in 5G (R3-205795;; contact: Qualcomm) RAN3 LS in Rel-17 NR\_NTN\_solutions-Core To:SA2, RAN2, CT1

* Noted

[R2-2010696](file:///C:\Data\3GPP\Extracts\R2-2010696_S2-2008307.docx) Reply LS on SA WG2 assumptions from conclusion of study on architecture aspects for using satellite access in 5G (S2-2008307; contact: Intel) SA2 LS in Rel-17 5GSAT\_ARCH To:RAN3 Cc:RAN2, SA3-LI, SA5

* Noted

Furthermore, RAN3 has continued to discuss this topic and is preparing LS to both SA2 and RAN3 to inform about related RAN3 agreements.

As the discussion is currently ongoing in other WGs that are planning to inform RAN2, it is better to wait more detailed RAN2 discussion and base the discussion on the said input. However, a placeholder is provided here in order to companies express their views although it seems better to wait with the actual discussion and conclusions.

*Q4.1 Views on Earth fixed tracking area or Cell ID?*

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| Company | **Answer** |
| Nokia | Not sure if the question is correctly stated? Earth-fixed TAs have been already decided, right? Then regarding the Cell ID, we agree the discussion could be postponed a bit, considering what is currently happening in RAN3. |
| MediaTek | We believe that Earth-fixed TAs have already been decided. On top of that we prefer Soft switch between TAIs over using GNSS positioning. UE’s location information to derive the tracking area in idle mode should not be used, as it will have adverse effects on UE’s power consumption. |
| Samsung | To realize Earth-fixed TAs, we suggest a UE-based approach where a time-based mapping between (i) the TAI broadcast by an NTN cell and (ii) a fixed-Earth geographic area (let’s call it a “Virtual Tracking Area” or VTA) is used by the UE to decide whether to do a registration update. We can re-use R15 mechanisms of one TAI/cell and RA=TAI List = list of VTAs or fixed-Earth geographic areas. The VTA-TAI mapping is known to the UE and the AMF. The AMF registers the UE in one or more VTAs. Each VTA is associated with a given Earth-fixed geographic area and corresponds to (i) one set of TAIs at one instant and (ii) another set of TAIs at another instant.  We understand that several companies like the approach of broadcasting multiple TAIs per cell to realize Earth-fixed TAs. However, we have serious concerns about this approach. When multiple TAIs are broadcast per NTN cell, the reliability of SIB detection is affected adversely due to the updates needed to reflect a change in the TAI List. Such change can occur any time (even in the middle of a 160 ms SIB transmission) due to the change in the geographic area illuminated by a beam. |
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# 5 Service link switch for Earth fixed beams

In this Section an LS to RAN1 asking for feasibility of having two satellites with same PCI during service link switch is discussed.

During the study item RAN2 did not consider Earth fixed beam scenario as it was excluded from the study item plan and the TR 38.821 captures as follows:

## 7.4 Earth fixed cells vs Earth moving cells

Compared to LEO based Earth moving cells scenario where cells are moving on the ground, LEO based Earth fixed cells scenario refer to NTN that provide cells fixed with respect to a certain location on the Earth during a certain time duration. This can be achieved with NTN platforms generating steerable beams which footprint is fixed on the ground.

The same solutions identified for Earth moving cell scenario can also be applied for Earth fixed cell scenario, however whether specific solutions are necessary (or preferred) for each scenario can be further evaluated in the normative phase (See [74]).

One of the main aspects related to the Earth fixed beams is the service link switch depicted in Figure 4. Due to the movement of the non-GEO satellites in relation to the surface of the earth, at some point in time one satellite leaves and is not able to serve a certain geographical area.



Figure 4 Service link switch for Earth fixed beams

It is possible to consider that the PCI via satellite 1 and satellite 2 can be the same or different, and that these SSBs may be on same or different sync raster points. If the SSBs are on different sync raster point, the mobility during the service link switch is L3 mobility from RAN2 perspective regardless whether the PCI is same or different. If these SSBs are on the same sync raster point and PCI are different, the switch is again L3 mobility. RAN2 has concluded that at least these scenarios should be supported and RAN2 is working further for the RAN2 solutions.

However, if these SSBs have same PCI and are on the same sync raster point, the switch can be L1 switch if this option proves viable. However, this would require that the gNB would either repeat the SSB beams(1 to L\_max) of the SSB burst via satellite 1 and satellite 2, or use only part of SSB beams(1 to K) via satellite 1 and part(K+1 to L\_max) via satellite 2. Whether this is feasible in practice would require RAN1 expertice as the delay difference between the feeder+service link for satellite 1 and 2 may cause difficulties for the UE to receive all the 1-L\_max SSB beams in their corresponding nominal locations with respect to time and delay.

A draft LS asking the feasibility is provided in the same draft folder.

Q5*.1 Companies to comment on the draft LS as well as express whether they support sending the LS or not.*

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| **Company** | **Support** | **Answer** |
| Nokia | No support | We believe Intel made a very good comment during the online session on 3/11 which accurately summarizes the problem. We do not think sending an LS is justified, especially if RAN2 agreed to “continue working with the assumption that during service link switch two satellites have two different PCIs”. So why do we need to add yet another case to the RAN2 pile? What would happen if RAN1 decides this is doable? Will RAN2 then work on this scenario as well (in addition to trying to address numerous other, challenging topics), despite most of the companies prioritize different scenario? Another aspect is related to general practice of sending the LS – they usually contain the solutions commonly acknowledged by RAN2, which RAN2 is interested to pursue. We believe the minority which does see the scenario with the same PCI beneficial, shall bring the topic directly in RAN1 and initiate potential LS to RAN2 (assuming RAN1 finds this scenario beneficial and viable). |
| MediaTek | No support | Given this is the first release of NR-NTN, we think there is no need to send an LS to RAN1 and open up the possibility to add extra cases on RAN2. We agree with Nokia that RAN2 should continue working with the assumption that during service link switch two satellites have two different PCIs. |
| Samsung | No support | Using different PCIs on a given frequency is practical. |
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# 6 Summary of proposals

TBA