**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.*

|  |  |
| --- | --- |
| 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. |
| BT | NTN has completely different characteristics than TN so it is not possible to relay in legacy procedures only.  Since the UE position is known, CHO command may include a timer to trigger the UE CHO report assuming the satellite network knows the next satellites that will cover the area.  We agree with Samsung that reliability of some new NTN triggers may not be known before deployments or field testing have been carried out. We would like to add legacy triggers to this affirmation.  Apart, we can use the experience from current satellite system providing voice and data service to sharpen up our conclusions. |
| Lenovo | Triggering conditions include the independent UE location, timer (e.g. based on ephemeris or coverage) and measurement conditions (e.g. A3/A5). In addition, the combination of the above conditions should be supported as well to ensure the robustness. And, we think it is better to wait for the email discussion on RRC aspect as triggering conditions are to be discussed for CHO, which may be applied for Scenario 1-3 as well. |
| OPPO | We think apart from the legacy CHO execution condition, NTN-specific execution condition should be added in the CHO configuration. FFS NTN-specific condition is distance-based or timer-based. |
| Xiaomi | For scenario 1 and scenario 2, during the feeder link switch, the serving satellite for UE does not changed, so we are not clear how the CHO trigger described in the above to resolve the issues that many connected UEs need to be handed over with the duration of feeder link switch. For example, if the HO command including the PCI appearing, all the UE in the serving satellite may perform handover at the same time when the PCI of serving satellite is changed. So we think that CHO command including timer of trigger UE hand over can resolve the issue that many UEs need to be handed over. In details, the timer can be configured to UE in a broadcast manner to reduce signalling overhead and UE could scale the timer based on service requirement or randomly.  For scenario 3, if the two cells are fully overlapped, how the UE location and satellite ephemeris to use when UE performs hand over since the distances between UE and two different cells are the same. So, for scenario 3, we prefer CHO command including upcoming service link switch (PCI leaving and another PCI appearing) can be considered. |
| Apple | It is too early to discuss the execution conditions and triggers for CHO without discussing what parameter should be used. Beyond the legacy CHO triggers new NTN specific conditions will need to be added. How and what these are will need to still be discussed. As was mentioned even in the post 111-e offline, there is impact to UE power due to location based CHOs as the UE needs to constantly check its location against the CHO trigger. There are reliability impacts due to timer based CHOs and impacts on how ephemeris related conditions can be created for the UEs. We don’t have to yet rule out elevation angle completely since it is useful for HAPS based mechanisms. Given so many unanswered questions defining triggers should probably reduced priority over defining the CHO conditions.  Beyond CHO, we also prefer a solution suggested by Samsung on providing satellite movement based neighbor cell information and offsets to the measurements trigger conditions due to this constant mobility. |
| Spreadtrum | We think that it is not good to couple feeder link switch together with service link switch. They should be discussed separately.  For feeder link switch, i.e. scenario 1 and 2, timer based condition can be used because the time of the feeder link switch hasbeen pre-decided.  For the same reason, timer based can be used in scenario 3, i.e. service link switch for earth fixed beam due to satellite switch.  BTW, for scenario 4 and 5, both signal quality and UE location in the layout of the NTN cells should be taken into to consideration. So a combined metric is needed. We propose to use the RSRPs weighted with UE location in the layout of the NTN cells. For example, RSRP\*(R-D)/R, in which R is the radius of the cell and D is the distance between UE and the center of the cell. |
| Qualcomm | The rel-16 CHO should be baseline whether the UE executes CHO command for a candidate cell due to service link switch or feeder link switch. As we discussed, condition to trigger CHO can be timer-based or location-based.  If network can predict the gateway switch time, it can simply enable the timer-based triggering condition with new timer value. |
| APT | 1. Target common timing advance value (e.g., feeder link RTT for the target satellite) 2. Target satellite ephemeris 3. Target cell center and cell radius for earth-fixed cell 4. Target distance (threshold) between the target satellite and the UE for earth-moving cell |
| CATT | We agree that the legacy CHO mechanism should be the baseline, but for the CHO trigger condition, no evidence is proved that legacy A4 event can’t work, so we prefer to minimize the spec impact in the first release. |
| Huawei, HiSilicon | At first we need to understand whether the legacy R16 CHO triggers can still work, a LS could be sent to RAN1 to confirm if near-far effect is still valid in case of NTN. If as mentioned by TR 38.821, it is ambiguous in the NTN cell edge we can further discuss which new trigger can be adopted. |
| Thales | A satellite and feeder link switch over correspond to a switch of both feeder and service links.   * A satellite switch over is the procedure that transfers the established connections with UEs served in a given geographical area by a given NTN Gateway between 2 satellites. * A feeder link switch over is the procedure that transfers the established connections with UEs served in a given geographical area between 2 NTN gateways (and possibly satellites) attached to same or different PLMNs   Here under are illustrated Satellite and Feeder link switch over.    Satellite and/or NTN-GW switch are events predictable by the network. So the network should inform the UE of upcoming feeder link or service link switch: inform the UE about PCI leaving and another PCI appearing due to feeder link/service link switch. |
| Ericsson | CHO command should include Rel-16 content as baseline. Then, there is separate discussion for Scenarios 4-5 where location and timer are strong candidates. Here Scenarios 1-3 are discussed and the effect that a cell/PCI stops serving an area and another cell/PCI starts serving an area needs to be taken into account. Depending how the time/timer is defined, this may take care of this use case. However, it should be carefully considered that the time/timer works such that it takes “time left to be served” into account.  Then, we agree with Samsung that it should be flexible how the different tiggers are combined though it should be done in most straightforward and simple way without any not necessarily needed definitions.  Further we agree that traditional HO command should be enhanced as well to inform UE about changes in the network.  Finally, what exactly is in the HO/CHO command in relation to satellite movement depends how ephemeris data is defined and what is assumed that UE knows from other than HO signalling. Thus we agree with Nokia’s thinking here. |
| LG | Network can expect when the feeder link switch or service link switch will be performed. Therefore, based on the scheduled upcoming link switch, next CHO candidate cell lists can be provided. Then the UE performs CHO evaluation to the cells sequentially. Similarly, upcoming feeder link switch can be indicated in advance if the NTN service will be unavailable temporarily. |
| Vodafone | For the Intra NTN handover, the possible practical scenarios are well illustrated by Thales, also agree with BT that we need to include a conventional handover: there is nothing wrong with conventional handover and it takes less network resources.  On this particular topic, the cell PCI change is not a good idea and from operational perspective the PCI must not change. This needs to be resolved! |
| ITRI | We think that CHO content should at least include NTN-specific execution condition.  NTN-specific CHO evaluation trigger condition could be optionally included in CHO content with considering the measurement object may appear after the receiving of CHO configuration |
| Intel | We think that we can use existing HO CHO with new NTN execution condition for NTN specific triggering. |
| Sony | Rel-16 CHO should be the baseline. We agree with others that mobility in scenarios 1-3 is predictable and so a timer-based solution can work and details e.g. how the timer and dwell time is defined can be discussed further. For scenario 4and 5, both location and timer based approach in addition to the upcoming cell list with the trigger condition can work. |
| ETRI | We agree that the CHO command in Rel-16 is used as a baseline. For NTN, satellite ephemeris information of incoming cell can be additionally configured. |
| ZTE | As discussed in another offline, we understand that both location and time based CHO execution condition can be configured in combination with the Rel-16 CHO execution conditions.  Time based CHO execution condition in combination with the Rel-16 CHO execution condition would be useful for scenario 1-3, in which the time or time range for feeder link switch or service link switch due to satellite switch is predictable and can be configured to UE. CHO will be executed at the configured time or time range when the Rel-16 condition based on measurements (e.g. A3/A5/A3+A5) is also satisfied. |

Summary

Majority of the companies state Rel-16 CHO should be considered as baseline and that NTN specific enhancements are needed. Two companies out of 22 do not prefer to introduce new triggers. One company prefers to send LS to RAN1 to check whether RSRP values of the cells are really similar. Most companies prefer location and timer trigger although it it not clear whether this was Scenarion 1-3 specific reply. Few companies mention that UE cannot predict the change of feeder/service link. Further, several companies prefer combination for different triggers. Note that replies other than CHO specific are not considered in the summary.

**Proposal 1 Rel-16 CHO is considered as baseline and a combination of NTN specific triggers is adopted. These may be at least location and timer based and it should be able to reflect the feeder/service link switch timing.**

# 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)*

|  |  |
| --- | --- |
| 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. |
| BT | For moving beams, is the remaining time in the cell equal for all the UEs under the beam? If the answer is no, then we don’t see the need to broadcast it.  For static beams, if the PCI remains the same, it is not need to broadcast the PCI change. Apart, with a fix PCI in ground, it is possible to reduce the UE measurements as for the UE, it is like the cell doesn’t change. |
| Lenovo | The second bullet alone is sufficient as cell/PCI ceasing to serving the area will trigger neighboring cell measurement. |
| OPPO | We don’t understand how these kinds of information can help idle mode mobility and what they are used for. Are they used for triggering measurement or used for ranking? For dwell time, we have the same question as BT. |
| Xiaomi | We are not clear how the proposal to resolve the issue that “too many” idle mode UEs need to reselect to another cell, may be more details needed. For scenarios 1 and 2, there is only one satellite for UE during the feeder link switch, we think the existing cell selection/reselection procedure can be used.  For scenario 3, if the time information is broadcasted to assist UE cell resection, it implies that all UEs begin performing cell reselection when the two cells are fully overlapped that the time information is the same for all the UEs, thus does not resolve the issue that too many UEs need to reselect to another cell. So, for scenario 3, we think upcoming PCI can be broadcasted to assist UE performing the cell reselection. |
| Apple | We also think that the question needs to be re-worded. We can have two sets of neighbor cells – NTN and TN. Currently it seems we are only talking about NTN neighbors only. We prefer a solution which can cover both NTN and TN neighbors. For NTN only neighbors, we too agree with BT and Oppo that dwell time might not be the most accurate metric since it changes constantly per UE in Earth-moving beams scenarios. RAN3 is also considering geographically fixed cell IDs and may be it is good to wait for that discussion to complete before we arrive at a conclusion here.  For TN neighbors, the list can be extremely prohibitive esp. in GEO cases and in some LEO cases too.  It will therefore be good to reconsider this question in a different way and break it down per TN and NTN. |
| Spreadtrum | Agree. For scenario 1-3, UE cannot know when will the feeder link switch or service link switch based on current available mechanisms in the spec or location and ephemeris. So we have to introduce new methods. |
| Qualcomm | When UE selects a cell, it should be able to know cell expiry time and future serving cell. If network cannot predict the future time for gateway switch, it should use existing tool (e.g., barring or paging). We suggest  Proposal 1: In order to assist feeder link or service link switch, cell expiry time and next cell/PCI are broadcast by a cell. |
| APT | Agree to Proposal 1. However, the dwell time may need a cell center (a referent point on the ground) and that might need to be broadcasted to UE for calculating the UE-specific dwell time. |
| CATT | For the first bullet in P1:  For the remaining time in serving cell, we share the similar view BT, this time is per UE, no need to broadcast this time duration. But the time when source cell will be dropped is common to all UEs, so the time when source cell will be dropped should be provided by SI or paging message to guarantee that all UEs in source cell will do cell reselection to the target cell before source cell dropped, otherwise, paging is out of control for some time.  As for info about cell/PCI ceasing to serving the area, this info is already known by UE via serving cell SIB1 reading, no need to be broadcast in an extra way.  For the second bullet in P1:  We think the next cell info is necessary to be known by UE. Apart from PCI and timing info, we think the following info is also beneficial:  -Frequency info of next cell; |
| Huawei, HiSilicon | The wording of P1 is not so clear, further discussion in still needed. According to legacy cell reselection procedure, there are two steps, i.e. measurement and reselection determination. If assistant information is broadcasted, how to use it in UE? Is it used to start neighbor cell measurement or for reselection determination. |
| Thales | Agree with proposal 1 |
| Ericsson | Agree with Proposal 1 |
| LG | Such indication of upcoming feeder link/service link switch will be beneficial to UEs to avoid unnecessary cell reselection, if a cell is measured with good RSRP but will temporarily unavailable soon. So we are fine with proposal 1. |
| Vodafone | as explained in the previous Answer, changing PCI from operation perspective, is not a good idea and it confused the Network and the UE. For a sporadic feeder link switch the PCI must remain constant |
| ITRI | For IDLE UE, we think Rel-16 measurement rules for cell reselection also works for NTN. Ephemeris information could be utilized by UE e.g., in priority handling for cell reselection. Then the mapping between ephemeris and PCI, e.g., the mapping of the succeeding satellite and the upcoming serving cell PCI, need to be broadcast. |
| Intel | We agree the proposal in general but think that may be the second bullet is enough. |
| Sony | We think Rel-16 should be the baseline in addition to the ephemeris information. Any other information should be studied further. |
| ETRI | We have the same concerns with BT. The PCI and remaining time can be helpful to reselection procedure, but further discussion is needed. |
| ZTE | For the first bullet (i.e. information about cell/PCI ceasing to serve the area), we do not see the need to broadcast any additional information as the existing “cellbarred” can be set and UE will reselect to another cell naturally.  For the second bullet (i.e. information about cell/PCI will start to serve UE after the feeder lin switch), we understand that the existing neighbour cell list broadcast in system information can be used .  In general, the proposals seem to be some kind of timer based priority adjustment mechanism, and the serving cell shall be considered as lowest priority one the timer in bullet one expired, and the neighbour cell will be considered as higher priority once the timer in bullet two expired.  We understand that this can be achieved by NW implementation (e.g. timer is maintained on NW side and NW update the system information on time to adjust the reselection priority or black cell list/white cell list.) |

Summary

Majority of companies prefer to have Rel-16 cell reselection principles as baseline. Further, almost all companies agree that information about when a cell is going to stop serving the area and information about new upcoming cell is needed. However, there is discussion on how this should be worded and whether this is said to be part of the ephemeris data or not.

Note that RAN2 has agreed to work on NTN mobility before discussing NTN-TN mobility.

**Proposal 2 Rel-16 cell reselection principles are considered as baseline and that information about when a cell is going to stop serving the area and information about new upcoming cell is needed. In which for and how this is exactly implemented in the cell reselection principles is FFS.**

# 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.

R3-207062=> R2-2011041        arrived today:

RAN3 thanks SA2 for their reply LS in R3-206842/S2-2008307.

RAN3 would like to inform SA2 and RAN2 that RAN3 agreed that a Cell ID as used in the User Location Information on the NG/N2 interface corresponds to a fixed geographical area, and the Tracking Area is coupled with geographical area.

Although it is up to RAN2 to decide how cell IDs and TAIs are broadcast in SIB1 for NTN, RAN3 would like to share the approaches so far considered in RAN3:

a) On Uu, SIB content corresponds to momentary coverage area of a satellite beam related to the geographically fixed areas of TAs/Cells - irrespective of whether the beam is fixed or moving.

b) The cell ID used on Uu SIB content (and probably on Xn) are decoupled from cell ID used on NG(N2). The respective mapping is performed in RAN. This requires gNB to acquire the UE’s location information.

To progress further, RAN3 would also like to ask RAN2 to provide any feedback on the above approaches including, e.g. SIB aspects, and how the RAN could acquire information on the UE’s location if this is needed e.g. for above approach, and for registration, etc.

Note: NTN WID includes “identification of potential issues associated to the use of the existing Location Services (LCS) application protocols to locate UE in the context of NTN and specify adaptations if any [RAN2/3]”. This could be used to determine the UE location with sufficient level of accuracy if needed, as requested in R3-206842.

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

|  |  |
| --- | --- |
| 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. |
| Lenovo | Wait for other WGs decision. |
| OPPO | We prefer to wait for input from other working groups. |
| Xiaomi | We think that UE acquires the TAC which is broadcasted by network should be supported in Rel-17, and UE accrues the TAC based on the UE location can be considered in the future release. |
| Apple | We should wait for other WG before concluding on this. |
| Spreadtrum | Agree with Nokia |
| Qualcomm | We are OK to wait RAN3 LS. |
| CATT | Firstly, Earth-fixed TA has been already confirmed in WI. And we think there is no need to broadcast more than one TA in the SI, the TA fluctuation issue can also be solved by proper configured TAI list by AMF implementation. The legacy mechanism can work without any enhancement.  Regarding to the discussion for CGI, more input is needed from other group before discussion. |
| Huawei, HiSilicon | Earth fixed Tracking Area is reasonable and applicable in all cases, but we don’t understand how to implement earth fixed Cell ID in case of earth moving beam. If we support earth fixed Cell ID, does it mean we exclude moving beam scenario? |
| Thales | Proposal 1: **agree**.  Note that ” R2-2009256 Earth fixed, moving cells in NTN – Thales” is also related to this issue.  Proposal 2: **request for clarification**. What does “UE can derive the TAC according to the geographical location” exactly means |
| Ericsson | R3-207062=> R2-2011041        arrived today, content pasted above the question.  Our short response is that we should avoid approaches which would impact the 5GC (e.g. with Registration Area Update containing a geo location only and 5GC doing the mapping). However, to provide response from RAN2, more discussion is needed and it is likely that RAN2 cannot reply from this meeting. |
| LG | It seems there is no critical issue in RAN2 yet. |
| Vodafone | Tracking are changes should be avoided if possible and **Cell ID should not change** |
| ITRI | Per RAN2 agreements we consider earth-fixed TA is the consensus. For the mapping of TA and cell ID, we would suggest to wait for input from other working groups. |
| Intel | RAN2 already has agreement on earth fixed tracking. |
| Sony | We are ok to wait for the discussion on RAN3 LS first. |
| ETRI | The RAN3 LS should be discussed first. |
| ZTE | 1. We understand that earth fixed TA has been assumed for this WI. 2. Regarding how to enforce earth fixed TA, the following approaches have been evaluated and agreed to be further studied since SI:   Approach 1: For the case when UE location information is unavailable, the tracking area code (i.e. TAC) broadcast is changed when the cell arrives to the area of next planned earth fixed tracking area location while the cells sweep on the ground.  Approach 2: For the case when UE location information is available, the earth is divided into a lot of geographical areas and each geographical area is mapped to a certain TAC and the mapping between TAC and location information is kept on both UE side and network side. UE derives the TAC based on its location information and initiates TAU procedure if it detects entering a tracking area that is not in the list of tracking areas that the UE previously registered to.  Hard switch and soft switch are candidate options on the details of broadcasting the TAC for Approach 1.  Adopting Approach 1 and approach 2 should be discussed and decided before agreeing on the details of any approach.   1. Considering that UE with GNSS capability is assumed in this WI, approach 2 is applicable to all the UEs with limited impact on the existing procedure. Furthermore, since no TAC is needed in system information for approach 2, network does not need to derive the TAC and update system information when cell sweeps, reducing the signaling overhead in updating the TAC. Thus, approach 2 is preferred from our perspective. |

Summary

RAN3 LS should be discussed before progressing on this issue.

**Proposal 3 Discuss RAN3 LS online**

# 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.*

|  |  |  |
| --- | --- | --- |
| **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. |
| BT | Support | From a network management point of view, it is desirable to keep the same PCI in the same location as it is done in TN. Apart, it is beneficial for the UE to perform L1 HO instead L3.  In R2-2009820, many companies express that its intention to send a LS to RAN1. Then, we consider it is important to respect such discussion and send the LS to RAN1. |
| Lenovo | Support | We can send LS for further information. |
| OPPO | Support | Based on the discussion, we believe the question to RAN1 should be:  Is it feasible to support the same SSBset (cell/PCI) simultaneously on the same sync raster via two different satellites? |
| Xiaomi | No support | If two different satellites have the same PCI, the switch can be the L1 switch. So we think RAN1 can directly discuss this case without LS from RAN2. |
| Apple | Support | We agree with BT here. The architecture becomes simpler for service link switch if the same PCI can be used in the same location. |
| Spreadtrum | Not support | We do not think the solution introducing this LS is not viable. |
| Qualcomm | Not support | RAN2 has already made the working assumption that two satellites will have two different PCIs during switch. This may be sufficient to progress. Probably there is no need to send LS to RAN1 and increase workload across working groups. |
| APT | Support | We support sending an LS to check the feasibility. However, we are not sure about the main benefit to support the same PCI via satellite 1 and satellite 2. |
| CATT | Not support | Agree with above, from RAN2 perspective, two satellites will have two different PCIs during switch. If RAN1 wants to support more scenarios, RAN1 should trigger the discussion first. |
| Huawei, HiSilicon | support | Besides this question, we also would like to ask RAN1 if near-far effect is still valid in NTN cell. |
| Thales | Not support | As per our analysis given in “R2-2009256 Earth fixed, moving cells in NTN”, in earth fixed cell scenario, in case of satellite switch, a fixed cell area will be covered by the beam of the next satellite. In a short instance, a certain area is covered by 2 beams served by both satellites. The first cell will be replaced by the second cell.  The option of same PCI on same sync raster location via satellite 1 and satellite 2 is not a viable option. The delays and frequency shift/Doppler on both service links/feeder links from satellite 1 and 2 are different. Clearly, this option will be seen by the UE as two different cells with equal PCI and frequency: This is a PCI collision.  So for Earth fixed cell, cells need to regularly change PCI (a different PCI for each serving satellite) to ensure simultaneous coverage from different satellites.  At our point of view, the LS is not necessary. |
| Ericsson | either | We would be ok also to not to send the LS in case it is clear to provide solutions on the different PCI(L3 mobility) case. |
| LG | Not support | Even if RAN1 replies that same PCI from different satellites is possible, we wonder if it impacts RAN2 discussion. It would be such as intra-cell handover from UE’s point of view. |
| Vodafone | Support | From operational aspect of the network **we must have constant PCI** as stated by BT |
| ITRI | Support | We see the benefit of L1 switch when service link switch and are fine to send LS to RAN1.  It is fine to clarify whether it is feasible from RAN1 aspect that SSB bursts of the same PCI are transmitted from different satellites on the same sync raster. |
| Intel | No support | In general, we don’t think we should have different cell ID on different satellite. |
| Sony | Support | We think it’s fine to send LS. If RAN1 identify that the same PCI is viable, then L1 switch should be discussed mainly in RAN1. PCI allocation should be up to implementation, but it is good to evaluate if the same PCI is a feasible solution or not and this requires RAN1’s expertise. |
| ETRI | Support | We are ok to send the LS to confirm the RAN1 perspective. |
| ZTE | Support | We think the following case seems interesting to explore and then check with RAN1: Use only part of SSB beams(1 to K) via satellite 1 and part(K+1 to L\_max) via satellite 2. |

Summary

10 companies not supporting the LS and 11 companies supporting the LS thus it seems online discussion is needed whether the LS is sent or not.

**Proposal 4 Discuss online whether to sent the LS or not**

# 6 Summary of proposals

**Proposal 1 Rel-16 CHO is considered as baseline and a combination of NTN specific triggers is adopted. These may be at least location and timer based and it should be able to reflect the feeder/service link switch timing.**

**Proposal 2 Rel-16 cell reselection principles are considered as baseline and that information about when a cell is going to stop serving the area and information about new upcoming cell is needed. In which for and how this is exactly implemented in the cell reselection principles is FFS.**

**Proposal 3 Discuss RAN3 LS online**

**Proposal 4 Discuss online whether to sent the LS to RAN1 or not**