3GPP TSG-RAN WG2 Meeting #114-e R2-21xxxxx

Online, 19 – 27th of May 2021

**Agenda item: 8.10.3.2**

**Source: ZTE corporation, Sanechips**

**Title: Report from [Post113bis-e] [101] [NTN] cell reselection (ZTE)**

**WID/SID: NR\_NTN\_solutions-Core - Release 17**

**Document for: Discussion and Decision**

# 1 Brief scope of the paper

This document aims at collecting companies’ views regarding the Rel-17 NTN cell re-selection:

* [Post113bis-e] [101] [NTN] cell reselection (ZTE)

Scope: Discuss cell selection/reselection for NR NTN, also based on contributions for AI 8.10.3.2 at RAN2#113bis-e

Intended outcome: email discussion summary

Deadline: Long (May 10th)

The following sections elaborate on the topics listed in the scope above and the rapporteur would like to highlight:

* Only topics raised by at least two companies are covered in this email discussion considering the limited time before next meeting.
* Proposals on ephemeris format and provisioning are not covered in this email as there is not enough progress in RAN1 which would be helpful to RAN2 discussion.

# 2 Discussion

## 2.1 Timing info assisted cell reselection

The following agreements have been made in RAN2#113e with several FFS left:

*The information on when a cell is going to stop serving the area and/or the timing information (e.g. timer or absolute time) about new upcoming cell is supported at least in Earth-fixed NTN scenario. FFS if both types of information are needed. FFS if this is known from system information and/or the ephemeris.*

In various TDocs submitted to RAN2#113bis-e [1][2][4][6][7] [10] [11] [14] [16], understanding on the need and the usage of the information on when a cell is going to stop serving the area and/or the timing information has been shared to address the FFS left above.

### Need of the timing information

Firstly, companies are asked to express their views on what kind of timing information is needed to assist cell reselection in NTN:

1. The timing information on when a cell is going to stop serving the area (including serving cell and neighbor cells)
2. The timing information about new upcoming cell (i.e. the time when a new upcoming cell starts to be available)
3. Both a) and b)

Also the following options have been proposed on the applicable scenarios of the timing info to assist cell reselection:

a) Earth fixed scenario only

b) Both earth fixed and moving scenarios

Companies are encouraged to choose the preferable timing information, the applicable scenarios for the chosen one and justify their selection.

**Question 1: What kind of timing information is needed to assist cell reselection in NTN, a), b) or c)? And what is the applicable scenario for the chosen timing info, earth fixed only or both earth fixed and earth moving?**

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| --- | --- | --- | --- |
| **Company** | **Option** | **Applicable scenarios** | **Comments** |
| Samsung | a only | Quasi-Earth-fixed beam only (=Earth-fixed in the description above) | The timing information on when the serving cell will stop serving the area is not useful at all for Earth-fixed (GNSS) and Earth-moving non-GNSS satellites. As long as the information about neighbor cells (current and incoming) is broadcast, there is no need to waste precious SIB info to define “availability times” of upcoming neighbors. We observe that there are two types of neighbors: neighbors of the currently serving cell and upcoming cells (the cell that would have the same coverage as the currently serving cell and neighbors of such upcoming cell).  |
| Thales | d) No enhancement needed | All scenarios | Existing cell (re)selection mechanisms based on RSRP/RSRQ measurements as well as suitable configuration of cell re selection offset/priorities and cell (re)selection measurement triggering (e.g. s-IntraSearchP parameter) would be sufficient.However, a) or b) could be further investigated later for optimisation |
| MediaTek | b) | Earth Moving   | The timing information about new upcoming cell will be helpful to address the discontinuous coverage (e.g. coverage holes). This information will be useful to avoid unnecessary cell search by the UE when there is no cell expected.  |
| Vodafone | a and b | Earth Stationery and Earth Moving  | This is useful new feature as the UE is notified of Cell’s service being stopped or a new cell is being activated, however for a regular cell selection and re-selection the traditional RSRP /RSRQ measurements can be used  |
| OPPO | a and b | All scenarios | The timing information about leaving cell is useful for UE to perform neighbor cell measurement, and timing information about upcoming cell is useful for the UE to find the target cell sooner. |
| Nokia | a and b, depending on the scenario | a) for Earth-fixed scenariob) for Earth-moving scenario | a) is the most straightforward option, ephemeris may contain such information on how long this area will be served by particular cell. This can work fine in Earth-fixed scenario.Using this information for other scenarios would be more complicated so for Earth-moving case, especially in sparse deployment, option b could be more useful. |

### Usage of the timing information

On the usage of the timing information when a cell is going to stop serving the area at UE side, the following options have been proposed:

1. Decide when to perform measurement on neighbor cells [1] [4] [6] [11] [16]
2. Decide the target cell for reselection [6] [16]
3. Decide when to perform cell reselection [10] [11]
4. Other

Companies are encouraged to choose one or more from the options above and justify their selection.

**Question 2: If companies understand that the timing info when a cell is going to stop serving the area is need (i.e. answer a/c to question 1), among all the options listed above, what is the preference on the usage of such info at UE side during cell reselection?**

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| --- | --- | --- |
| **Company** | **Option** | **Comments**(Companies answering d) are invited to provide more details in this column) |
| Samsung | Enhanced “a” | The gNB can broadcast a time threshold before which there is no need for the UE to search for neighbors for quasi-Earth-fixed cells if the UE is in the Inner Area of the cell (e.g., distance to the center is short OR RSRP is high) and after which the UEs can look for neighbors and perform cell reselection.  |
| Thales | d) other | Use existing cell (re) selection mechanism. Consider enhancement for optimisation in a later stage. See response to question 1 |
| MediaTek | d) | Legacy measurement based methods are enough to identify the cell edge (for neighbour cell measurements and re-selection).  |
| Vodafone  | d | If a cell is going to stop serving, the UE needs to know in advance that the cell will no longer be available. This should be transmitted in one of the SIBs to the UE before the UE decides on the cell selection or re-selection. |
| OPPO | a | Without this information, it will take some time for UE to trigger neighbor cell measurement. |
| Nokia | c | If the timing information is defined as the point in time when the cell, where UE is currently camped at, will stop serving this area (option a) then in our understanding the UE shall reselect to another cell (also considering the radio measurements) when the related timer expires or the absolute UTC time occurs. |

On the usage of the timing information about new upcoming cell (i.e. the time when a new upcoming cell starts to be available), the following options have been proposed:

a) Decide when to perform measurement on neighbor cells [6]

b) Decide the target cell for reselection [6] [14]

c) Other

Companies are encouraged to choose one or more from the options above and justify their selection.

**Question 3: If companies understand that the timing information about new upcoming cell (i.e. the time when a new upcoming cell starts to be available is need (i.e. answer b/c to question 1), among all the options listed above, what is the preference on the usage of such info at UE side during cell reselection?**

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| **Company** | **Option** | **Comments**(Companies answering c) are invited to provide more details in this column) |
| Samsung | c- Other. Not b. | We should perhaps discuss this along with SMTC configuration and measurement gap configuration. |
| Thales | c) Other | Use existing cell (re) selection mechanism. Consider enhancement for optimisation in a later stage. See response to question 1 |
| MediaTek | a) and b) | This information will assist the UEs to decide when and which cells to search for when there is a possibility discontinuous coverage (coverage holes). |
| Vodafone | combination of the above  | As in the question above, the UE needs to know in advance that a particular cell is going to be available and this must be transmitted to the UE via one of the Sibs before the UE makes a decision on cell selection or re-selection  |
| OPPO | b |  |
| Nokia | b | In case of option b in Q1, the UE may reselect to that cell, if radio-based reselection criteria are also met. |

### Provisioning the timing information

The following options have been proposed on how to provide the timing information to UE:

1. System information [7]
	* 1. Only for earth fixed scenario [6] [16]
2. RRCRelease message [6]

c) Other

**Question 4: How the timing information is provided to UE?**

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| --- | --- | --- |
| **Company** | **Option** | **Comments**(Companies answering c) are invited to provide more details in this column) |
| Samsung | a and c | Yes- “a” is useful for quasi-Earth-fixed beams only.The UE can use “time since last cell reselection” along with RSRP (and possibly distance/propagation delay) for quasi-Earth-fixed beams and Earth-moving beams when the UE is outside the “Inner Area” of the serving cell. |
| Thales | c) Other | Use existing cell (re) selection mechanism. Consider enhancement for optimisation in a later stage. See response to question 1 |
| MediaTek | a) | As this is Idle mode and the information is needed to all the UEs, SIB should be used for both Earth Fixed and Earth moving beams. |
| Vodafone  | for a network wide (a) but (b) could also work  | Option (a) in a SIB, but it depends on how frequently the SIB is broadcasted and how frequently the cells come Alive or go off.  |
| OPPO | a | a) is enough for idle mode UEs. |
| Nokia | a and b | It is OK to follow the existing principles where the reselection information can be provided in both System Information and RRC Release message. |

## 2.2 Ephemeris/Location assisted cell reselection

The following agreements have been made in RAN2#111e with several FFS left for ephemeris based cell reselection:

*Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN (FFS what the term satellite/HAPS ephemeris actually means). FFS when this ephemeris based cell selection / reselection can be used. FFS whether UE location (and/or other information) based cell selection and reselection should be introduced for NTN.*

In various TDocs submitted to RAN2#113bis-e [1] [4] [6] [11] [16], UE location assisted cell reselection have been proposed. Companies are invited to share their preference on whether to support location assisted cell reselection in NTN.

**Question 5: Do companies support to introduce location assisted cell reselection in NTN?**

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| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | Earth-fixed beams: distance between UE and serving cell center (or, equivalently RSRP or UE-serving cell one-way propagation delay) exceeds a threshold (indicating that the UE is away from the serving cell) and the neighbor RSRP exceeds a threshold (indicating that the neighbor cell can provide adequate signal strength), the UE performs cell reselection.Quasi-Earth-fixed beams and Earth-moving beams: time since last cell reselection exceeds a threshold (indicating that the UE is away from the serving cell) and the neighbor RSRP exceeds a threshold (indicating that the neighbor cell can provide adequate signal strength), the UE performs cell reselection. |
| Thales | No | Use existing cell (re) selection mechanism. Consider enhancement for optimisation in a later stage. See response to question 1 |
| MediaTek | No | It will have serious energy consumption problem in Idle UE. Considering UE checking location information in every DRX cycle, it will make additional energy consumption in every second, which will seriously degrade UE’s battery consumption. Furthermore it is not clear what issue is being resolved by introducing this new mechanism. As outlined in our Tdoc [2], legacy measurement based reselection are sufficient to address idle mode mobility. |
| Vodafone | No  | For a regular cell selection and re-selection this would be unnecessary a |
| OPPO | Yes | Location-based scheme is useful to overcome the RSRP-based approach where RSRP value cannot accurately reflect the cell center and cell edge. |
| Nokia | No | It is enough to use the timing information + legacy radio measurements. |

Similar to the discussion happened for location based CHO, we need to understand what the term “location” actually implies and what kind of quantity needs to be considered during cell reselection. It can be at least one of the following:

1. Distance between the UE and the satellite [11] [16]
2. Distance between the UE and the cell centre (of either the serving cell or the neighbor cell) [1] [11] [14] [16]
3. other

Companies are encouraged to choose one or more from the options above and justify their selection.

**Question 6: If companies support to introduce location assisted cell reselection in NTN (i.e. answer “Yes” to Question 5), what kind of quantity needs to be considered, a), b) or c)?**

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| **Company** | **Option** | **Comments**(Companies answering c) are invited to provide more details in this column) |
| Samsung | b | The combination of RSRP (especially of the neighbor cell) and distance between the UE and the cell center would be very helpful. The distance by itself (i.e., as a standalone trigger) should not be used, because the neighbor cell may not be able to provide adequate signal strength to the UE, resulting in failed cell reselection toward cell and delaying cell reselection to a suitable neighbor cell. |
| Thales | c) Other | Use existing cell (re) selection mechanism. Consider enhancement for optimisation in a later stage. See response to question 1 |
| MediaTek | c) Nothing | As mentioned in our answer to Question 5), it will make severe adverse impacts in UE’s battery consumption. |
| Vodafone ` | c  | Location assistance is not necessary  |
| OPPO | b |  |
| Nokia | None | We do not think this is needed. But if supported, for simplicity the same definition as agreed for CHO triggering shall be used.  |

Further details on how to use the location information to assist cell reselection have also been shared by the proponents and we have the following options to consider:

a) UE use the location information to decide when to perform measurement on neighbor cells [4] [11]

b) UE use the location information to decide the target for cell reselection

* + 1. Among the N best cells ranked based on R-criterion, UE re-select to the cell with shortest distance [1] [11]
		2. Only cells with distance shorter than a threshold will be considered as candidates for re-selection. [11]
		3. Cells with shorter distance are biased in cell ranking based on R criterion. [11] [14]

c)other

Companies are encouraged to choose one or more from the options above and justify their selection.

**Question 7: On usage of the location information to assist cell reselection, which option(s) are preferred, a), b) or c)?**

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| --- | --- | --- |
| **Company** | **Option** | **Comments**(Companies answering c) are invited to provide more details in this column) |
| Samsung | a and c. Not b. | Instead of distance to a neighbor cell, we prefer a more direct quantity- neighbor RSRP. Similar to the combination trigger that RAN2 has discussed for CHO, we prefer the use of a combination trigger for cell reselection. RAN2 should discuss what combination triggers would be most useful for cell selection/reselection. Examples of useful combination triggers include (i) serving cell propagation delay (or UE-cell center distance) larger than a threshold AND neighbor cell RSRP larger than a threshold (suitable for all beams), (ii) time since last cell reselection greater than a threshold AND neighbor cell RSRP larger than a threshold (suitable for quasi-Earth-fixed beams and Earth-moving beams). At least these two combination triggers are quite helpful in our view. Furthermore, multiple triggers can be simultaneously evaluated by the UE and the UE can perform cell reselection when any of the trigger conditions is satisfied. |
| Thales | c) Other | Use existing cell (re) selection mechanism. Consider enhancement for optimisation in a later stage. See response to question 1 |
| MediaTek | c) Nothing | As mentioned in our answer to Question 5), it will make severe adverse impacts in UE’s battery consumption. |
| Vodafone  | c  | Location assistance is not necessary  |
| OPPO | b |  |
| Nokia | Option a if any, but nothing preferable | Option a would allow not to change the cell reselection principles, but will be just used as a trigger for measuring certain cells. |

## 2.3 Network type and/or scenario indication for neighbor cells

The following agreement has been made on the network type indication at RAN2#113e:

*RAN2 thinks that a UE needs to know whether the network is a TN or NTN no later than SIB1 reception*

In various TDocs submitted to RAN2#113bis-e [1] [5] [10], there has been interest in an explicit indication for network type (e.g. TN vs NTN) and /or network scenario (e.g. earth moving vs earth fixed, GEO/ LEO /HAPS).

Since this email discussion focus on cell reselection in NTN, companies are invited to show their preference on whether there is need to indicate network type and/or scenarios explicitly for neighbor cells to assist cell reselection.

**Question 8: Is there a need to introduce explicit network type (e.g. NTN vs TN) indication for neighbor cells to assist cell reselection?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | We recommend the explicit network type to be defined and broadcast for the serving cell as well as neighbor cells. In our view, a comprehensive “network type” that distinguishes among a TN, GEO, MEO Quasi-Earth Fixed Beams, MEO Earth-moving Beams, LEO Quasi-Earth Fixed Beams, and LEO Earth-moving beams should be defined in RAN and broadcast in a SIB and conveyed to the AMF by the gNB on the N2 interface. Our understanding based on one of the LSs from SA2 is that SA2 has already defined GEO, MEO, and LEO as RAT Type (which should perhaps be NTN Type and not RAT Type!).While we prefer an explicit NTN Type indication to simplify the UE operations, we are willing to compromise if an efficient method to convey the NTN Type implicitly is suggested.We suggest that RAN2 discuss if the NTN Type should also convey the NTN platform type (e.g., GEO vs. MEO vs. LEO) and the beam type (e.g., quasi-Earth-fixed vs. Earth-moving) for non-GNSS satellites. Several companies had expressed a view to broadcast the beam type. We can combine beam type with the NTN type (including TN/NTN separation) to efficiently convey the NTN Type along with the beam type. We are also willing to compromise if a separate beam type is defined.We are also open to a compromise if the physical layer indicating the NTN type explicitly or implicitly if RAN1 is open to such solution. |
| Thales | No | We believe that this information is valuable for NTN-TN mobility.However the type of network (NTN or TN) may be implicitly derived from existing SIB parameters (e.g. PLMN Id, ephemeris data or not). |
| MediaTek | Too early to decide | As per our earlier discussions, an implicit indication is preferable. Towards end of the WI when we look into the signalling aspects, we can decide if an explicit signalling indication is needed. |
| Vodafone  | Yes | From operational perspective it is essential for the Home network knows where the UE is either in a Terrestrial Network or out in the Non-terrestrial Network  |
| OPPO | Yes | This is beneficial for UE’s power saving, i.e. no need to decode ephemeris to know whether it is TN or NTN. |
| Nokia | No | The question could be a bit more precise: does it refer to indicating the type in each cell’s SI (such as SIB1?) or does it relate to other SIBs, providing the information about neighbours for reselection? Overall, we assume NTN will likely use separate PLMN, different carriers, etc. so there will be sufficient number of distinguishable factors which can be used to determine what kind of cell that is (i.e. TN or NTN, GEO, LEO, etc.). In addition, it is highly expected there will be a separate NTN SIB, which would also allow to differentiate TN and NTN cells. |

**Question 9: Is there a need to introduce explicit network scenario (e.g. earth moving vs earth fixed, GEO/ LEO /HAPS) indication for neighbor cells to assist cell reselection?**

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| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | For both cell selection and reselection, the conveying of the NTN Type would help the UE prioritize selection of a specific type of the network (TN vs NTN as well as preference of one type of NTN platform to another NTN platform type).  |
| Thales | No | The mobility procedures (e.g. triggers, measurement strategy) may be adapted according to the type of beams: (quasi) Earth fixed, Earth moving,However no need to signal the UE which will execute the procedures. |
| MediaTek | No | We do not see a need for such an indication at the moment. |
| Vodafone  | Yes  | From operational perspective it is essential for the Home network knows where the UE is.Not sure what is meant by introducing the Scenario, however the adjacent/neighbouring cell-type is essential to be transmitted in one of the SIBs to the UE |
| OPPO | Yes | There is no other way for UE to know earth moving v.s. earth fixed. Explicit indication would be useful for UE to select the target cell. |
| Nokia | No | The question could be asked a bit more precisely, stating where such indication is considered to be available (e.g. SIB1)? But overall we do not think there is such need. |
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## 2.4 Other issues

If companies understand there are also other issues need to be discussed but have not covered by the above questions, please list them below. Note that the issues listed in this chapter might not necessarily result in proposals to be discussed as part of the report of this email discussion.

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| --- | --- |
| **Company** | **Issues or comments** |
| Samsung | We suggest that RAN2 discuss the following topics.1. Efficient neighbor search. There are huge opportunities for the UE to save power by not searching for neighbors at all when the UE is in the Inner Area (IA) of a cell. The UE should look for neighbors only when it is outside the IA for Earth-fixed and Earth-moving beams. For quasi-Earth-fixed beams, timer can be used as part of a combined criterion for neighbor search. It is possible to define the IA of a cell using quantities such as RSRP, the UE’s relative location in the cell, and time (e.g., time since last cell reselection and remaining serving time of the current cell for quasi-Earth-fixed beams). 2. Satellite-movement based offset for cell selection/reselection. Some companies had suggested the use of the knowledge of the satellite movement to prioritize/de-prioritize selection of a given neighbor cell. We suggest that RAN2 consider adding a satellite movement-based offset so that an outgoing cell is not preferred and an incoming cell is preferred. Indeed, for an Earth-moving beam case, if the satellite is moving from East to West, even the highest-speed UE cannot move into a cell that is West of the currently serving cell. The neighbor cell rank can be calculated by considering the satellite movement-based offset.3. s-IntraSearchP. A UE may not search for a neighbor when the serving cell RSRP meets the s-IntraSearchP criterion. This can pose a challenge in quasi-Earth-fixed cells where many UEs around the cell center and in the middle of the cell would have strong RSRPs and hence such UEs may not search for incoming neighbor cells. Hence, we suggest that RAN2 consider disabling s-IntraSearchP for an NTN, especially for quasi-Earth-fixed beams.4. SIB-based cell change. The serving cell can send a SIB-based cell change order to an incoming cell in case of quasi-Earth-fixed beams. |
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# 3 Conclusions

Based on the views expressed in the previous sections, we propose the following:

*To be added*

# 4 List of referenced documents

[1] R2-2102741 Discussion on idle/inactive mode procedures in NTN OPPO discussion Rel-17 NR\_NTN\_solutions-Core

[2] R2-2102825 On Cell-Reselection in NR-NTN MediaTek Inc. discussion R2-2100260

[3] R2-2102826 On Soft-switch based Tracking Area Updates in NR-NTN MediaTek Inc. discussion

[4] R2-2102953 Leftover issues on IDLE and inactive mode CATT discussion

[5] R2-2103077 Cell Reselection, System Information, and Paging Enhancements for an NTN Samsung Research America discussion

[6] R2-2103135 Cell selection and reselection enhancements for NTN Xiaomi discussion

[7] R2-2103245 Issues on cell selection and reselection in NTN Spreadtrum Communications discussion Rel-17 NR\_NTN\_solutions-Core

[8] R2-2103408 Ephemeris provision and network type indication for NTN Lenovo, Motorola Mobility discussion Rel-17

[9] R2-2103461 PLMN separation for NTN & TN ASUSTeK discussion Rel-17 NR\_NTN\_solutions-Core R2-2101755

[10] R2-2103597 Idle mode enhancement in NTN Sony Europe B.V. discussion Rel-17 NR\_NTN\_solutions-Core

[11] R2-2103631 WF for cell reselection in NTN Huawei, HiSilicon, BT Plc, CAICT, China Telecom discussion Rel-17 NR\_NTN\_solutions-Core

[12] R2-2103837 Cell Selection And Cell Reselection Solutions for Non Terrestrial Networks Apple, British Telecom discussion NR\_NTN\_solutions-Core

[13] R2-2103838 Considerations on ephemeris database and parameter distribution to UEs in Non Terrestrial Networks Apple discussion NR\_NTN\_solutions-Core

[14] R2-2103965 Cell reselection in NTN InterDigital discussion Rel-17 NR\_NTN\_solutions-Core

[15] R2-2103966 Ephemeris in NTN InterDigital discussion Rel-17 NR\_NTN\_solutions-Core

[16] R2-2104066 Further consideration on cell selection and reselection in NTN ZTE corporation, Sanechips discussion Rel-17 NR\_NTN\_solutions-Core

[17] R2-2104147 NTN indication and idle mode enhancements Convida Wireless discussion

[18] R2-2104149 NTN Cell (re)selection and idle mode enhancements Convida Wireless discussion

[19] R2-2104210 Understanding on the newly introduced Access Technology identifier for NTN ZTE corporation, Sanechips discussion Rel-17 NR\_NTN\_solutions-Core

# Contact information

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