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?**

|  |  |  |  |
| --- | --- | --- | --- |
| **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 scenario  b) 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. |
| CMCC | a and b | both earth fixed and earth moving | Only relying on RSRP/RSRQ measurement results may not perform cell (re)selection well due to the unobvious near-far effect. |
| Huawei, HiSilicon | a and b | All scenarios | Direct timing information can be broadcasted in Quasi-Earth-fixed scenario. But in Earth-moving scenario, for each UE the timing information is different, so it has to be calculated by each UE, which needs network to provide other assistance information, e.g. cell center location and cell radius. |
| CATT | a) | b) | In our understanding, only the time when the serving cell is stop to leave is enough. E.g., assuming the serving cell will stop to provide services to the UE at time T, the UE can start measurement at the time T- Tdeltaoffset.  This information is applicable for measurement initiation for cell re-selection either due to service/feeder link switches in case of earth fixed beam or due to feeder link switch in case of earth moving cell. |
| NEC | a) but only of serving cell  b) maybe e.g., in hard feeder link switch case | All scenarios  (Quasi-Earth-fixed and Earth moving) | For moving satellite LEO, regardless Quasi-Earth-fixed or Earth moving cells, the satellite likely will move away and then cannot be fed by original GW/gNB but fed by another GW/gNB, consequently, it happens that a cell stops, and another cell starts serving the same area.  Timing of serving/camping cell leaving is needed to prepare UE to do cell reselection away.  Timing of neighbour cell (for replacement) coming up may be useful in case of hard feeder link switch case, since the coming up cell will replace the leaving cell, and there is potential small gap, UE is better to know and reselect to the right cell in one go.  Timing of other neighbouring cells leaving or coming up may not be so necessary since UE will detect it by itself sooner or later, but we are open to discuss if there is gain. |
| Ericsson | A and B | Earth fixed is priority | In 304 there is measurement rule that allows UE to refrain from performing measurements if condition (Srxlev > SIntraSearchP and Squal > SIntraSearchQ) is true. This rule allows UE to save power but it also means that UE would start to measure only after serving cell is already disappeared which will introduce large delay to reselection. Thus, the rule should be modified to take into account the time when serving cell is going to go such that UE starts measuring before it happens.  Information on neighbor cells is useful to UE to know which cells are worth trying to detect and when. |
| LG | c) Both a) and b) | c) Both, but earth-fixed with priority | Basically we think the timing information is more suitable to earth fixed beam scenario, but we do not need to make such restriction that the timing information cannot be used for earth-moving beam. |
| Convida | c) Both a) and b) | Both, see comments | Although timing information is important to assist in cell (re)selection, it should be noted that there are several methods for UEs to arrive at this information. For example, the timing information can be implied by the UE location and Satellite ephemeris without an explicit timer/time broadcast. |
| Intel | a) and b) | All scenarios but see related comment | We share the views already explain that both information is helpful depending on the NTN deployment (e.g. a) might be more beneficial for Earth-fixed scenario and b) for Earth-moving scenario). However, this may not need to be limited from specification point of view as network could provide the appropriated one based on its applicable scenario. |
| ITRI | a | Quasi-earth-fixed | In quasi-earth-fixed scenario UE may not perceive obvious RSRP/RSRQ difference until the serving cell stopped serving the area. Knowing the timing on when the serving cell is going to stop serving the area is useful for UE to trigger neighbour cell search and measurements for cell reselection.  In earth-moving scenario, UE could determine when to start performing neighbour cell search and measurements for cell reselection based on RSRP/RSRQ measurement. |
| Xiaomi | a and b | a | For the timing information on when a cell is going to stop serving the area, we think the time information on serving cell is enough.  For the scenarios, we think we should study earth fixed scenario with priority. |
| Qualcomm | a | b | If each cell broadcasts “a”, it should be enough. Wouldn’t it be likely a ~ b? |
| Lenovo | c) | All scenarios | We think at least a) is useful for performing neighboring cell measurement or ranking, b) could be further optimization if the service period is short. These info can be used for all scenarios (fixed, quasi-fixed and moving) |
| Apple | a and b both depending on the scenario | All scenarios | Though both are needed, we feel we can derive this information using ephemeris. Explicit broadcast of this information would be wasteful for generic scenarios, complicated for earth moving scenarios and comes with a lot more added complexity for mixed NTN (GEO+LEO, GEO+HAPS and LEO+HAPS) scenarios. |
| Sequans | a and b | b | Both info could be useful. It applies mainly for earth fixed, but also earth moving in case of feeder link change. |
| ZTE | a | Both earth fixed and moving scenarios | We understand the timing information on when a cell is going to stop serving the area can be useful for UE to decide when to start measurements on neighbour cells as well as reselect to a cell with longer valid time. |
| ITL | a | Earth fixed | We think that there is no merit use for the timing information about new upcoming cell. Based on the legacy measurement procedure, new upcoming cell could be detected. Thus, the timing information about when a cell is going to stop serving the area is enough.  In scenario earth moving scenario, there are different timing information should be applied for each UEs in coverage. In this aspect, it is unclear for using cell selection/re-selection. |

### 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. |
| CMCC | a | Using remaining serving timing info can better assist in determining when to measure neighbour cells considering the unobvious near-far effect in NTN system. |
| Huawei, HiSilicon | A,b,c,d | The remaining serving time can be calculated by UE, and UE can select a target cell with the longest remaining serving time to reduce frequency of cell reselection. |
| CATT | a) | The timing can be used for initiating the measurement, whether cell reselection should be performed and which cell can be chosen can be based on the measurement. |
| NEC | 1. or c) | Stop serving timing information regarding serving/camping cell: Depending on if the timing information is exact the cell swich-off time or with a bit advance, it could be the time to do cell reselection or the time to perform measurement for cell reselection/ handover. |
| Ericsson | A, b, c | For a)  In 304 there is measurement rule that allows UE to refrain from performing measurements if condition (Srxlev > SIntraSearchP and Squal > SintraSearchQ) is true. This rule allows UE to save power but it also means that UE would start to measure only after serving cell is already disappeared which will introduce large delay to reselection. Thus, the rule should be modified to take into account the time when serving cell is going to go such that UE starts measuring before it happens.  Information on neighbor cells is useful to UE to know which cells are worth trying to detect and when.  For b) when UE does cell ranking, it could exclude cells that are going to stop serving so UE would not reselect such cell  For c) one can define UE states that are like mobility states such that depending how much time there is left to be served in cell where UE is camping, UE starts reselection |
| LG | Option a) | Currently UE performs measurements on the neighbour cells based on measurement rule which is based on serving cell quality. We can add timing information condition to the measurement rule. Based on the measurement results, UE can perform cell reselection evaluation. |
| Convida | d) | All of the above. These are not mutually exclusive options and can be considered with option a) as a first step to decide when to perform neighbour measurements to then determine cell reselection. Per [18], mobility states and measurement rules/relaxation as currently defined in TS 38.304 need to be enhanced for NTN scenarios with timing information as one possible criterion. |
| Intel | a and c | Depending on whether the UE is or not camping already in this cell, the information provided may be helpful to decide on whether to perform or not measurements and/or cell reselection |
| ITRI | c | If UE knowing when the serving cell is going to stop serve the area, UE could initiate neighbour cell search and measurements for cell reselection accordingly. In the case of cell reselection when feeder link switch, UE may stay with the same cell/gNB based on cell reselection priority if configured. |
| Xiaomi | a | If the timing information on when a cell is going to stop serving the area is only include serving cell, we think the timing information should be used to trigger UE to perform neighour cell measurement. |
| Qualcomm | a or c | “a” for relaxed monitoring and “c” to trigger cell reselection procedure. But “b” is not necessary.  Deciding target cell requires UE to know target cell timing. Say there are 10 candidate cells in ranking based cell reselection, UE cannot have timing information of all. So “b” is not practical solution. |
| Lenovo | a | At least the timing info can be used for a), for b) and c) we can leave it to legacy mechanisms. |
| Apple | a and c but prefer d | Though this information can be used for deciding when to perform measurements, legacy options should be sufficient if this information is available at the UE in the form of entire ephemeris database. |
| Sequans | a and b | We think this could impact the measurements and candidate selection (no direct indication on when the UE should perform the reselection) |
| ZTE | a and b | For a), a TIntraSearch and a TnonIntraSearch can be configured to UE. UE will start to perform intra-frequency measurements when the remaining valid time of the current cell Tremaining <= TIntraSearch before the Srxlev <= SIntraSearchP or SSqual <= SIntraSearchQ is fullfiled. Similarly, UE will start to perform measurments on inter-frequency with an equal or lower reselection priority when Tremaining <= TnonIntraSearch before the Srxlev <= SnonIntraSearchP or SSqual <= SnonIntraSearchQ is fullfiled.  For b), a threshold of the remaining valid time together with adjustments on the R-value or reselection priority can be configured to UE, neighbor cells with remaining valid time longer than the threshold will get a bonus by improving the reselection priority or R-value with the adjustment factor configured.  To find a cell with high RSRP and longest valid time, a rangeToBestCellNTN can be configured. UE rank the neighbor cells based on the R-criterion while the cells whose R value is within range to best cell of the R value of the highest ranked cell will be considered as candidate cells. Among all these candidate cells, UE will reselect to the cell with longest valid time. |
| ITL | a and b | Option (a) can be used to measure for neighboring cells when the serving cell is going to stop serving the area. Option (b) can be used to cell ranking during cell re-selection procedure. |

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. |
| Huawei, HiSilicon | A,b | When the neighbour cell is available, UE can perform measurement and further determine if cell reselection is needed. |
| NEC | b | In hard feeder link switch, this is useful for UE to find the target cell quickly and directly, note that radio-based reselection criteria still have to be met |
| Ericsson | a)b) | It can be used for the cell ranking to exclude cells from the list that are about to disappear |
| LG | Option a) | Similarly with our answer to question 2, we can provide start timing point to trigger measurement on the cell. If the cell is the only one in the frequency, then the UE will start measurement on the frequency. If the cell is not the only neighbour cell in the frequency to the UE, then the UE will continue the measurement on the frequency. |
| Convida | a) and b) | Assuming that the satellite ephemeris and UE location is known, both options a) and b) can be considered, including when to relax measurements. Per Q2 and [18], mobility states and measurement rules/relaxation as currently defined in TS 38.304 need to be enhanced for NTN scenarios with timing information as one possible criterion. |
| Intel | a and b | Similar comment to previous question applies |
| ITRI | a | Network may configure UE to perform IDLE mode measurements. The timing information about when a cell starts to be available for measurement could prevent UE from searching unavailable cells to reduce UE power consumption. |
| Xiaomi | a and b | If neighour cell is available, the UE can perform neighbour cell measurement and decide whether selects it. |
| Qualcomm | Not needed | See response in Q2. |
| Lenovo | a | At least the timing info can be used for a), for b) we can leave it to legacy mechanisms. |
| Apple | a and b but prefer c | This information can be gathered from ephemeris instead of wasting bandwidth. Refer back to comments for Q1. |
| Sequans | a and b | Similar as previous question |

### 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]
   1. 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. |
| CMCC | a with comments | System information could be used for both Earth Fixed and Earth moving scenarios. |
| Huawei, HiSilicon | A, c | Direct timing information can be broadcasted in Quasi-Earth-fixed scenario. But in Earth-moving scenario, for each UE the timing information is different, so it has to be calculated by each UE, which needs network to provide other assistance information, e.g. cell center location and cell radius. |
| CATT | a) with comments | If only the time information about when a serving cell is going to leave is needed, SIB is enough. Specific RRC signalling is unnecessary since the time information contained in specific RRC signalling and SIB should be same as the SIB, it is unnecessary to provide it through dedicated signalling from the perspective of signalling overhead.  System information is also applied to feeder link switch for earth moving scenario. |
| NEC | a) also, for earth moving scenario  b) can be discuss later | System information is better, since it is common information |
| Ericsson | A and b | These are not exclusive |
| LG | Option a), b) | Broadcast manner is simple approach. However, some UEs locating at opposite side inside a cell coverage may need different timing information of a cell. Thus, we can also consider providing the timing information via RRCRelease message. |
| Convida | a) b) and c) | SI and/or pre-configuration as part of satellite ephemeris are potential options. Again, “timing information” is ambiguous at this point and need not be an explicit time/timer. Furthermore, with respect to options a) & b) TS 38.304 defines the following for cell reselection: “Absolute priorities of different NR frequencies or inter-RAT frequencies may be provided to the UE in the system information, in the RRCRelease message, or by inheriting from another RAT at inter-RAT cell (re)selection” These options for priorities could be re-used for NTN and timing information. |
| Intel | a and b | Share the same view as Nokia |
| ITRI | a | System information is sufficient to provide the timing information for cell reselection to all IDLE/INACTIVE UE served by the cell. |
| Xiaomi | a and b | Following the legacy mechanisms. |
| Qualcomm | a and b | Ok to consider RRC release message. |
| Lenovo | a and b | Both can be considered |
| Apple | c | Not sure how timing information of a previous connection release might be relevant for current situations. This information is available through ephemeris and doesn’t need any explicit signaling which can lead to legacy implementations without any major changes. |
| Sequans | a and b | Both could be considered |
| ZTE | a | The cell expire time can be broadcast to UE for earth fixed scenario. |
| ITL | a and b | For the Idle/Inactive mode, both a and b can be considered. |

## 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. |
| CMCC | Yes | The RSRP/RSRQ difference between the cell edge and cell center is small, with UE location info could be beneficial for cell (re)selection procedure and the power consumption could be resolved by periodically updating the location of the UE instead of continuous tracking, etc. |
| Huawei, HiSilicon | Yes | We see some overlap between timing based and location based cell reselection, at least one of them can be adopted. |
| CATT | Yes | The UE location used as the cell selection/reselection measurement initiation condition should also be supported in Rel-17. |
| NEC | No | For idle mode mobility, RSRP/RSRQ based should be enough |
| Ericsson | Yes | In 304 there is measurement rule that allows UE to refrain from performing measurements if condition (Srxlev > SintraSearchP and Squal > SintraSearchQ) is true. This rule allows UE to save power. We commented already about the situation where cell may disaapear but when UE moves, the RSRP may does not decline like it does in TN and the radio coverage of a cell may be huge. UE may not reselect early enough even if UE has moved away of the planned coverage of a cell. This is not ok especially at country boarders.  Another thing is to take this into account in reselection such that UE does not reselect to a cell that is too far. |
| LG | Yes | For earth moving beam case, we think location-based cell reselection may be more effective because the cell coverage dynamically changes. We think similar approach with location-based CHO triggering condition (i.e. distance between UE and cell reference point) can be considered. |
| Convida | Yes | Also, see [18] section 2.4, UE may choose to evaluate the type of NTN platform and coverage area/time, associated satellite ephemeris data, to determine when to perform measurements and aid in cell reselection. |
| Intel | Yes | UE location can help with cell reselection especially measurement when it is close to another cell, which may provide savings on UE’s power consumption. |
| ITRI | No | UE could rely on timing information and RSRP/RSRQ measurement for cell reselection. UE location seems to be not really useful. |
| Xiaomi | Yes | In order to UE power saving, we think the UE location only can be used to determine target cell. |
| Qualcomm | Yes | Just to clarify, using GNSS does not mean UE would have to fix GNSS very frequently or every time it evaluates cell reselection.  Compared to satellite speed, UE speed is negligible so it should be sufficient to use last determined location information. It can be discussed how many paging DRX cycle can be considered valid to use last determined location information. But we agree the use of GNSS should definitely be limited in IDLE mode, way longer than in connected mode. |
| Lenovo | Yes | Location can be helpful considering fuzzy RSRP difference in NTN cells. |
| Apple | No | Not only is there a need for this but there are better more simpler mechanisms to achieve this goal. First would be to provide ephemeris to UE. |
| Sequans | No | We are not sure the gain is worth it. This may limit the need for measurements but would also require GNSS measurements. This might be considered as a later stage. |
| ZTE | Yes | The distance to satellite or distance to cell center can be taken into consideration when UE performs cell reselection so that cells with shorter distance to UE can be prioritized a little bit or cells being too far from UE can be excluded in cell reselection. |
| ITL | No | We think that timing information and legacy measurement are enough for cell re-selection. |

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. |
| CMCC | a and b | Both a and b are applicable. |
| Huawei, HiSilicon | b | In connected mobility enhancement, we already agreed to use cell reference location, and which can be the cell center in our view. |
| CATT | b) |  |
| Ericsson | B, D | Could be useful also consider both serving and neighbor cell centers to define better the boarder. |
| LG | Option b) | We think distance between UE and satellite is not feasible. Distance between UE and cell center is enough. |
| Convida | a) or b) | Either method may be sufficient. Due to lack of near/far effect, RSRP should not be the only criteria and should be used in concert with the additional “location” criteria. |
| Intel | See comment | We prefer having a common/aligned definition of the term “location” information across different mechanisms that rely in this. Note that RAN2#113bis agreement on this for CHO was “T*he location in location-based CHO execution triggering for NTN describes the distance between the UE and the reference location of the cell (serving cell or the target cell). FFS what the reference location of the cell is (e.g cell center or other) and how this is provided to the UE*” therefore we suggest discussing this topic for a single mechanism and reuse the same definition. |
| ITRI | c | We don’t consider location assisted cell reselection is necessary. |
| Xiaomi | b |  |
| Qualcomm | b only if serving cell is considered. | We do not agree to add overhead by broadcasting beam center or reference location coordinates of N neighbor cells, i.e., do not accept “b” if neighbor cell is considered. |
| Lenovo | c | Agree with Intel. |
| Apple | c | Agree with intel. Having a common term for both reselections and CHO is better. However, location information might not be necessary at all as others have suggested with ephemeris available at the UE. Only a way to map the cell ID to the satellite. |
| Sequans | c | If introduced, would need to be b) to handle the case of cells from the same satellite. |
| ZTE | b | For simplicity the same definition as agreed for CHO triggering can 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)?**

|  |  |  |
| --- | --- | --- |
| **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. |
| CMCC | b | To better help select a new appropriate neighboring cells with UE location information. |
| Huawei, HiSilicon | c | Location can be used to calculate remaining serving time of each cell, i.e. serving cell and neighbour cells. Based on UE location, cell coverage information and ephemeris information, UE can derive all timing information, i.e. when to stop serving, when the neighbour cell is available and the remaining serving time. |
| CATT | a) | At least the UE location information can be used for initiating the measurement on neighbour cells. |
| Ericsson | A and B I, ii | Both measurements and used in ranking decision/cell reselection decision. Scaling is complicated. |
| LG | Option a) | We did not decide whether to introduce location-based cell reselection yet.. So the details should be discussed later. |
| Convida | A) | a) UE location + satellite ephemeris |
| Intel | a |  |
| ITRI | c | If timing information of when a cell stopped/starts serving an area is provided, location assisted cell reselection is not necessary. |
| Xiaomi | c | UE location should be combined with the existing NR S-criterion and R-criterion to reduce the number of times of acquiring the UE location when UE performs cell reselection.  The neighbour cell measurement can be triggered by S-criterion and timing information, and UE location and R-criterion can be used to determine target cell.  And cell reference distance should be provided to UE. |
| Qualcomm | a | Again see our response in Q6. To repeat, UE should not be required to acquire SIB of N neighbor cells just to know beam information of neighbor cells or it should not incur SIB overhead to broadcast beam information of N neighbor cells. So simply “b” is not practical. |
| Lenovo | a) | For b) we can leave it to legacy mechanisms. |
| Apple | a maybe but prefer c | None. |
| Sequans | c | If introduced, could be used for a) and/or b). |
| ZTE | b |  |

## 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?**

|  |  |  |
| --- | --- | --- |
| **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. |
| CMCC | No | Implicit indication is sufficient based on system information. |
| Huawei, HiSilicon | No | Ephemeris information can be used to indicate a NTN cell. |
| CATT | See comment | Regarding to the network type indication, there are many implicit methods, e.g., NTN-specific PLMN, NTN-specific SIB. Whether **NTN-specific PLMN is feasible depends on CT1, whether NTN-specific SIB is feasible depends on what information should be contained in the NTN-specific SIB**. It had better postpone the discussion until we have clear understanding on these issues. |
| NEC | Maybe | This indication may be useful when both NTN, TN are serving the same area, and UE could prioritize a particular type of network |
| Ericsson |  | In that meeting we also agreed to wait until there is progress in ephemeris. |
| LG | Yes | Explicit network type indication is the simplest way. |
| Convida | No | An explicit indicator is redundant information, especially with several implicit indications. For example, since the presence of an NTN SIB to be scheduled (for e.g., satellite ephemeris) if it is present, it can be concluded that the gNB is served by an NTN. See [17] for more details. |
| Intel | Stage-3 | This could be better discussed via stage-3 running CR i.e. whether UE can get this information implicitly (e.g. when broadcasting some NTN related configuration) or not. |
| ITRI | Yes | It is beneficial for UE to determine NTN/TN efficiently by introducing explicit indication. We also prefer UE could determine NTN or TN according to SI scheduling information if NTN specific SIB is introduced. |
| Xiaomi | No | The implicit indication is enough. |
| Qualcomm | Wait for RAN4 | TN and NTN may not be deployed in the same band.  We should wait until this part is clear. |
| Lenovo | No | Implicit indication (e.g. via ephemeris contents) is enough. |
| Apple | Yes | Cell selection could be biased in cases of TN vs. NTN. For reselection scenarios though we might be ok without this indication as long as TN and NTN are not deployed on the same bands. |
| Sequans |  | This depends on what will be already signaled (such as ephemeris) |
| ITL |  | It is too early to decide explicit vs. implicit. |

**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?**

|  |  |  |
| --- | --- | --- |
| **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. |
| CMCC | No | Pls. see our comments to Q8. |
| Huawei, HiSilicon | No | Ephemeris information can be used to indicate satellite type. |
| CATT | See comment | Same comment as Question 8. |
| NEC | Maybe | See answer to Question 8 |
| Ericsson |  | We already have the agreement. This is stage 3 detail and it may not be useful to discuss. |
| LG | No | We can introduce beam-specific information (timing information of earth-fixed beam, and location information of earth-moving beam). So we can use the beam-specific information as an implicit indication. |
| Convida | No | Similar to Q8, this can be inferred from, e.g., system information. See [17]. |
| Intel | See comments | Some level of information of the kind satellite in use may be helpful. The categorization defined on NTN running CR to TS 38.300 could be taken as baseline. This differentiates between the following types of service links: earth fixed, quasi-earth-fixed and earth moving. |
| ITRI | No | We don’t think it is necessary for cell reselection. |
| Xiaomi | No | The Ephemeris data can be used. |
| Qualcomm | May be | We can still wait until we are clear what are parameters specific to NTN cell that need to be broadcast in SIB1. |
| Lenovo | See comments | For GEO/LEO/HAP, implicit indication (e.g. via ephemeris contents) is enough. For earth-fixed/moving, explicit indication can be considered. |
| Apple | No | This can be derived from ephemeris. |
| Sequans |  | Same comment as previous question. |

## 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.

|  |  |
| --- | --- |
| **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. |
| Apple | We prefer RAN2 to discuss satellites esp. LEO configurations in terms of how high speed train situations are treated in current specification. The respective RSRP/RSRQ thresholds can be adjusted similar to how high speed train scenarios on earth are adjusted. This will allow for discussing earth moving beams as well and not move have to prioritize earth fixed beams only for cell reselection scenarios.  Also, entire ephemeris available at the UE can achieve a lot of savings in terms of broadcast bandwidth while still allowing RAN2 to use existing methodologies without too many specification changes. |
|  |  |
|  |  |
|  |  |
|  |  |

# 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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