**3GPP T****SG-RAN WG2 Meeting #119bis-e R2-2210860**

**E-Meeting, Oct 10 – 19, 2022**

**Agenda item:**  **8.7.4**

**Source: Intel Corporation**

**Title: Report of [AT119bis-e][117][NR NTN Enh] cell reselection enhancements (Intel)**

**Document for: Discussion and Decision**

# Introduction

This is the report of the following offline discussion on cell reselection enhancements:

* [AT119bis-e][117][NR NTN Enh] cell reselection enhancements (Intel)

Scope: Discuss NTN-NTN and NTN-TN cell reselection enhancements based on remaining proposals in [R2-2209578](file:///C:\Data\3GPP\Extracts\R2-2209578%20Discussion%20on%20NTN%20cell%20reselection%20enhancements.docx) and [R2-2210353](file:///C:\Data\3GPP\Extracts\R2-2210353%20Further%20view%20on%20Idle-%20and%20Connected-mode%20NTN%20mobility%20in%20Rel-18.docx)

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

* List of proposals for agreement (if any)
* List of proposals that require online discussions
* List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Tuesday 2022-10-18 0600 UTC

Initial deadline (for rapporteur's summary in R2-2210860): Tuesday 2022-10-18 0800 UTC

And according to session chair’s guidance, “Regarding [117] and [118], please note that, besides those in the listed papers, the offlines may also consider alternative proposals from other papers, if they are on the same issues as covered in the selected papers. But additional issues/completely separate proposals should be excluded for now (as otherwise the discussions will explode).”

# Discussion

## 2.1 NTN-NTN cell reselection

During the online discussion in first week, the following agreement was achieved as high level guideline:

Agreements:

1. For NTN-NTN cell reselection with earth moving cell, RAN2 will consider providing parameters of serving cell to UE, for UE to estimate when the serving cell stops providing coverage at the present UE location (FFS whether this will be an optional UE feature) (this does not exclude any time-based or location-based approach) (other solutions can also be considered)

In the following sub-sections, a few detailed designs can be discussed based on relevant proposals.

### 2.1.1 Assistance information of serving cell for UE to estimate when the serving cell stops providing coverage at the present UE location

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| Tdoc | Proposals |
| [R2-2209578](file:///C:\Data\3GPP\Extracts\R2-2209578%20Discussion%20on%20NTN%20cell%20reselection%20enhancements.docx) | Proposal 1: For NTN-NTN cell reselection with earth moving cell, to consider providing parameters of serving cell to UE for UE to estimate the stop time of serving cell. These parameters of the serving cell can be satellite orbital parameters, location coordinates of cell center and the radius of cell coverage. |
| [R2-2210353](file:///C:\Data\3GPP\Extracts\R2-2210353%20Further%20view%20on%20Idle-%20and%20Connected-mode%20NTN%20mobility%20in%20Rel-18.docx) | Proposal 1: UE performs individual estimation, considering satellite’s ephemeris, cell reference location and its own location to enable location-based reselections in Earth-moving scenario. |
| [R2-2210468](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210468-8.7.4-cell-reselection-enhancement.docx) | Proposal 4: If the serving cell is an earth-moving cell, NW provides assistance information for UE to estimate the serving cell movement for location-based cell reselection measurement. |
| [R2-2210737](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210737-Discussion-on-idle-mode-aspects-for-NTN.docx) | Proposal 5 Multiple reference locations and its time information should be broadcasted to provide time-variant reference location of earth moving cell. |
| R2-2210090 | Proposal 1 RAN2 to discuss the following options on location-based measurement initiation for earth moving cell:  - Option 1: A new distance threshold for the distance between UE and the serving satellite, i.e., service link distance.  - Option 2: Rel-17 distance threshold with the cell reference location determination based on the sub-satellite point (derived by satellite ephemeris) and the broadcasted location offset between sub-satellite point and the cell reference location. |

Based on above proposals, in Earth-moving cell UE is able to estimate the movement of cell coverage according to assistance information provided by network. As UE location is also known by UE, then UE can tell when serving cell stops providing coverage at the present UE location.

Regarding the assistance information provided by network,

1. satellite orbital parameters. Ephemeris data (one type is for satellite orbital parameters, the other type is for instantaneous position and velocity of satellite) is already included in SIB19. And for prediction of movement of cell coverage, satellite orbital parameters should be provided.

2. the location of cell center. Similarly, the reference location has been specified for Quasi-Earth-fixed cell, and it can also be provided in Earth-moving cell. Another alternative is to provide “Multiple reference locations and its time information”, instead of updating the value every time along with the cell movement.

3. the radius of cell coverage. Similarly, the distance threshold has been specified for Quasi-Earth-fixed cell, and it can also be provided in Earth-moving cell.

**Question 1: Regarding the assistance information of serving cell for UE to estimate when the serving cell stops providing coverage at the present UE location, whether the following parameters should be provided by network** **in Earth-moving cell:**

1. **satellite orbital parameters, not instantaneous position and velocity of satellite**
2. **location coordinates of cell center, or in other term, cell reference location**
3. **the radius of cell coverage, or in other term, a distance threshold**
4. **a distance threshold between UE and satellite**

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| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | Y but | satellite orbital parameters:  Regarding there was introduced SIB19 to broadcast ephemeris information, position and velocity of satellite, in Rel-17. RAN2 can reuse it for moving cell and there is no need to provide extra satellite orbital parameters.  the location of cell center:  For quasi-earth fixed cell, it will broadcast reference point that indicate the cell center, which should be included for moving cell as well, it can assist UE to estimate how far it’s away from cell center and perform cell reselection evaluation.  the radius of cell coverage:  It can be provided as one part of cell reselection parameters. Based on Rel-17, quasi-earth fixed cell, it had introduce a distance threshold to assist UE to decide whether to perform neighbor cell measurement. In Rel-18, RAN2 can follow the same method for UE measurement enhancement. |
| Samsung | Y 1-3 with comment | For 2 and 3, prefer to use cell reference location and distance threshold, which may or may not be the cell center and the cell radius, respectively, and can be up to NW configuration, similar to the Rel-17 reference location and distance threshold for cell reselection.  For 2, the time stamp for the provided reference location coordinates is also needed. FFS whether ephemeris epoch time can be used or not.  In addition, in the case that the serving cell’s coverage (i.e. satellite beam footprints) is moving relatively static with respect to the satellite’s nadir movement, the UE can estimate the movement of the cell coverage based on serving satellite ephemeris and the reference location with a time stamp. But the UE needs to know the serving cell is an earth moving cell. So in this case, the cell type indication should be provided.  In another case, if the serving cell’s coverage (i.e. satellite beam footprints) is not moving relatively static with respect to the satellite’s nadir movement, the UE cannot estimate the movement of cell coverage only based on the serving satellite ephemeris. In this case, the velocity of the reference location (i.e., moving speed and direction) needs to be provided so that the UE can estimate the trajectory of the reference location. |
| OPPO | Yes (1/2/3 or 1/4, 1 is already supported in legacy) | For earth moving cell, reference location is always time-varying with the movement of satellite, therefore broadcasting cell reference location is not a viable solution.  An obvious approach is to use the distance between UE and the serving satellite, i.e., the service link distance to estimate when the serving cell stops providing coverage at the present UE location. Hence, the parameters 1/4 could be considered to provide by network in earth moving cell.  Alternatively, if we still prefer to reuse the distance between UE and cell reference location at ground to estimate, i.e., based on the parameters 1/2/3. Regarding how to provide the reference location at ground by network, we should consider avoiding the broadcast of time-varying parameter.  p.s. for 1, we think existing SIB19 has already provided serving cell’s satellite ephemeris and we don’t need to mention it again for Rel-18 solutions. |
| Huawei, HiSilicon | Y 1-3 | 1 and 2 are in the current spec already. |
| Lenovo | 1 already supported  Yes to 2/3 with comments | As we commented online, 1 has already been supported, but not enough.  For 2, we need to further consider how to indicate the moving cell reference location more efficiently. For example, reference location with movement information, or multiple reference locations with intervals between.  For 3, the issue is similar to 2, we need to further consider how to indicate the moving cell coverage more efficiently. |
| vivo | Yes for 2 and 3 with comments | UE cannot infer the trajectory of the cell only based on the satellite orbital parameters, as how the cell coverage is projected on the earth surface depends also on how the beams are steered and other related factors. In order to infer the movement trajectory of the earth-moving cell, a rule on how the reference location changes over time (e.g. taking the reference location as a function of time) needs to be known by the UE for calculating the real-time reference location. Combined with cell coverage, UE can calculate when the serving cell stops providing coverage at the present UE location. This, e.g. need of 2-D reference location, is following the same logic as how/why we introduced cell reselection enhancements for the quasi-earth fixed cell case in Rel-17.  For Option 3, perhaps it is hard to say that the threshold is exactly equal to the cell radius, as the UE should start measurement for cell reselection when the serving cell’s coverage is to be lost, instead of having been lost. Also, this threshold is related to the distance between the UE and the reference location, not that apart from the satellite. |
| Apple | Yes for 2 and 3 | To provide the assistance information to describe the earth-moving cell’s coverage, NW can provide the reference location and distance threshold (in legacy way) together with the reference time. |
| Ericsson | Yes 1-3, with comments | Number 1 is already provided. Number 2, the reference location, should be associated with a timestamp. Then, a UE can acquire the current position of the reference location in a similar way as it is done with satellite ephemeris. For number 3, we prefer a distance threshold rather than the cell radius (they are not the same), to follow the same logic as in quasi-earth fixed cells.  We understand that Number 4, absolute distance between the satellite and UE, will not work whenever the there is an offset between satellite trajectory (satellite’s subpoint) and the moving reference location. |
| MediaTek | Yes: 2 and 3. | 1. Both types of ephemeris information in SIB19 can be used for UE to estimate the earth-moving cell coverage moving. No need to limit to “satellite orbital parameter” only.   Note: it may be called **coverage-based solution**. (UE can determine whether it is in coverage based on the estimated stop time (time-based) or periodically checking distance between UE and reference location (location-based). It can be up to UE implementation). |
| Qualcomm | Y to 2 and 3 | Serving satellite ephemeris with validity duration is anyway broadcast so it is up to UE to maintain serving satellite ephemeris.  In 4, we are also not sure if this can be used correctly to estimate cell stop time. |
| Nokia | Yes, at least 1 and 2 | Satellite ephemeris + cell reference location is essential. Then it is up to the UE to perform computations on the basis of 1 and 2, considering its own location. |
| NEC | Yes 1-3, 1/4 can also work | FFS whether we need time stamps or implicit validity duration e.g. using SFN numbering |
| Xiaomi | Yes for 1-3 | For the option 2, the reference location will be changed over time with the moving cell and the frequent update of reference location should be avoided. The reference location could be a relative position which is relative to the satellite’s position. |
| InterDigital | Yes 1-3 | Agree with Samsung, combination of 2/3 could leverage some similarities to the distance-based threshold used in Rel-17, so would be good to have a similar solution. Furthermore, as mentioned by others, some of this information (e.g. ephemeris) is already supported. Further enhancements (e.g. timestamp) should be FFS and considered in combination with Q2 outcome. |
| CATT | yes for 2,3 | For 1, it is more direct for UE to use the position and velocity than orbital parameters, UE can predict the position of satellite by position and velocity in short term. Additionally, the satellite orbital is already provided in SIB19, no enhancement is needed.  Yes for the location coordinates of cell center, in case of earth moving cell, the cell center is keep changing, however it is not enough to just provide a location coordinate, additional time information is needed, FFS in form of time stamp or implicit indicate by the ephemeris information.  For cell coverage, some information is needed to describe the cell edge, radius or a distance threshold can be decided when the mechanism is more clear.  For 4, the distance between UE and satellite can reflect nothing about the remaining serving time of UE. We wonder how it can be used for cell reselection. |
| ZTE | Yes for 1 and 2 | And we understand the current spec supports to provide such information. |
| LGE | Yes with 1-3 | 1. Legacy ephemeris information broadcasted by SIB19 is enough. Further enhancement is not needed.  2. We prefer cell reference location as introduced in the Rel-17 NTN solution. However, for earth moving cell, the cell reference location moves along the earth's surface. It is not enough to provide only one cell reference location to UE. UE should know the exact time when the cell reference location is valid.  3. We prefer distance threshold than cell coverage radius. |
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**Question 2: Regarding how to provide the location coordinates of cell center by network (if it is agreed to be provided as discussed in Q1):**

**Option 1: only location coordinates of current cell center, and network is supposed to update the values every time when it is provided for Earth-moving cell.**

**Option 2:** **multiple reference locations and its time information of Earth-moving cell.**

**Option 3: based on the sub-satellite point derived by satellite ephemeris and the broadcasted location offset between sub-satellite point and the cell reference location**

**Option 4: cell type (fixed or moving), reference location coordinates with a time stamp, and the velocity of reference location**

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| **Company** | **Option 1 or 2 or 3 or 4** | **Additional comments** |
| Transsion Holdings | **Option 2** with comments | Extra reference points can be provided to UE for cell reselection enhancement. Regarding moving cell, UEs are relative static and they may measure for upcoming cell of the same orbital. This extra reference point can be design close to the upcoming cell, for UEs are close to the extra reference point can start performing measurement or the upcoming cell, else, UEs are far from the extra reference point can keep monitoring for serving cell only.  Either reference point or extra reference points, UE can use ephemeris information to estimate/calculate real-time bof them. |
| Samsung | Option 4 | In the case that the serving cell’s coverage (i.e. satellite beam footprints) is moving relatively static with respect to the satellite’s nadir movement, based on the ephemeris, the UE can also derive the trajectory of nadir and the nadir coordinates at the time stamp of reference location. Due to relative static between nadir and reference location, the UE can derive the trajectory of the reference location. So in this case, reference location coordinates with a time stamp should be provided. FFS whether ephemeris epoch time can be used or not.  In another case, if the serving cell’s coverage (i.e. satellite beam footprints) is not moving relatively static with respect to the satellite’s nadir movement, the UE cannot estimate the movement of reference location based on the nadir trajectory. In this case, the coordinates of reference location at a time stamp and the velocity of the reference location (i.e., moving speed and direction) need to be provided, so that the UE can estimate the trajectory of the reference location from the time stamp. By providing the velocity of reference location, NW does not need to frequently update the coordinates and may less frequently update the reference location coordinates with a time stamp and the velocity. |
| OPPO | Option 3 | For the earth moving cell, satellite generates fixed or non-steerable beams whose coverage area slides over the earth surface. Therefore, the reference location is time-varying.  For Option 1, as stated by Rapp, network has to update the values every time.  For Option 2, multiple reference locations and its time information would introduce additional signalling overhead on system information.  Therefore, we suggest to consider Option 3, i.e., to avoid the broadcast of time-varying parameter, the cell reference location can be determinate by a fixed location offset (e.g., in latitude and longitude) away from the sub-satellite point, where the sub-satellite point can be derived from satellite ephemeris, e.g. the intersection of the line from the Earth center to the satellite with the earth's surface.  Ideally, if the satellite generates beam that is perpendicular to the earth’s surface, the cell reference location is exactly the sub-satellite point. In this case, the location offset could be absent. |
| Huawei, HiSilicon | Other | Option 5: cell type, reference location corresponding to the *epochTime* (reuse the existing *epochTime*).  With the existing ephemeris and reference location, the UE can already predict the trajectory of the reference location. But it needs to know cell type, because no prediction is needed in quasi-fixed cells. |
| Lenovo | Option 2/3/4 | We are open to discuss each one to find a solution. For 1 we think it is not useful unless we specify SI change for that, which is not acceptable considering that ephemeris change will neither trigger SI change. |
| vivo | See comments | We prefer that a rule on how the reference location changes over time (e.g. taking the reference location as a function of time) can be provided, and then the UE can calculate real-time reference location based on the rule and the current time. |
| Apple | Option 2/4 | NW can provide the reference (time+ location) info. To reduce the signalling overhead, the reference points that the network may provide will not be particularly dense.  To help UE know the cell coverage in real-time, NW also needs to provide UE with the velocity info of the satellite. |
| Ericsson | Other | Options 1 and 2 are inefficient from a signalling perspective. We have some sympathy towards Option 3. Option 4 includes parameters that are not strictly needed. For instance, cell type can be known implicitly (t-service is not provided in Earth Moving cells), and the velocity of the reference location is the one of the satellite’s subpoint, i.e., can be calculated from the satellite ephemeris.  Thus, UE only needs to know a single location coordinate associated with a timestamp (FSS if epochTime or other).  In addition, Samsung’s and other’s comments seem to be proposing solutions for the two following scenarios:   * Moving beam w.r.t. moving satellite. * Static beam w.r.t. moving satellite.   However, we consider the former is not part of the WID, albeit we believe this should be clarified. |
| MediaTek |  | The location coordinate of cell center can be provided based on Epoch time. So, the network updates the value when ephemeris information/epochtime is updated. |
| Qualcomm | Option 1 with revision | We also think it should be location coordinate at the epoch time. If the cell is broadcasting ephemeris and cell center, both are associated with the epoch time.  How network updates it is up to network, no need to mention it. |
| Nokia | Other | Something similar to Option 1 and 2, but no need to broadcast multiple locations and/or update continuously. We suggest to broadcast a single value with a timestamp and UE shall perform the calculations on this basis. |
| NEC | See comments | With ephemeris and epoch time associated with a cell reference location, the UE should already be able to derive the current cell reference location. However, the UE would need to be indicated explicitly or implicitly that the cell is Earth-moving |
| Xiaomi | Other | Only one reference location is enough, the reference location could be associated with a time, or a function of time, or a relative location which is relative to the satellite’s location. |
| InterDigital | Option 3 or 2 | Slight preference for Option 3. Option 2 may also be okay to avoid constant SIB re-aquisition, however should further discuss details e.g. how many points, spatial distribution etc. to trade off accuracy with signalling overhead. |
| CATT | Option 3 with comment | Option 1 needs frequency update of system information, do the UE need to always read the SIB?  Option 2 brings huge signalling overhead.  For option 3, the location offset between sub-satellite point and each cell reference location of the satellite is unchanged, it is an efficient way to provide the location of reference location. Additionally, considering the antenna angle of the earth moving cells keep unchanged, another candidate option is to provide the angular coordinate of the earth moving cell, with reference to the direction of sub-satellite point.  For option 4, the cell type may be indicated implicitly which can be discussed later. |
| ZTE | Option 1 with revision | Similar understanding as Qualcomm that how network updates it is up to network and there is no need to mention it. |
| LGE | Option 2 | Broadcasting a single cell reference location is not suitable for earth moving cells. Network should update the cell reference location frequently. To obtain up-to-date cell reference location, UE must re-acquire system information frequently, which causes excessive energy drain to UE.  Furthermore, legacy reference location is not related to epochTime and validity duration. It is not consistent that epochTime corresponds to the cell reference location. |
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As for how to provide this assistance information, the following proposal is made.

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| Tdoc | Proposals |
| [R2-2210353](file:///C:\Data\3GPP\Extracts\R2-2210353%20Further%20view%20on%20Idle-%20and%20Connected-mode%20NTN%20mobility%20in%20Rel-18.docx) | Proposal 3: System information is the basic means for providing necessary parameters to assist the NTN UE in intra-NTN cell reselection process. |

Considering the outcome of Q1 and Q2, the proposal is updated to be more specific as below:

Proposal: System information is the basic means for providing necessary parameters to assist UE to estimate when the serving cell stops providing coverage at the present UE location.

**Question 3: whether the following proposal is agreeable:**

**Proposal: System information is the basic means for providing necessary parameters to assist UE to estimate when the serving cell stops providing coverage at the present UE location.**

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| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | Y |  |
| Samsung | Y |  |
| OPPO | Y | We are fine in principle regarding system information is used to provide necessary parameters, but the broadcast of time-varying parameter needs to be avoiding. |
| Huawei, HiSilicon | Y |  |
| Lenovo | Y |  |
| vivo | Yes |  |
| Apple | Y |  |
| Ericsson | Y |  |
| MediaTek | Y | The current ephemeris information, referenceLocation and distanceThresh for quasi earth-fixed cell in SIB19 can be reused. |
| Qualcomm | Y |  |
| Nokia | Y | Fine with the modification. |
| NEC | Y |  |
| Xiaomi | Y |  |
| InterDigital | Y |  |
| CMCC | Y |  |
| CATT | Yes |  |
| ZTE | Y |  |
| LGE | Y |  |
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**Summary:**

According to companies’ input to Q1, ephemeris data is already available in SIB19, so no enhancements need to be considered. And most companies are fine with parameter 2 and 3, but prefer to reuse the terms “reference location” and “distance threshold” like Quasi-Earth-fixed cell. For parameter 4, there are two proponents, but also three companies show the concern on the feasibility.

**Proposal 1: In Earth-moving cell, the reference location and distance threshold of serving cell are provided by network for UE to estimate when the serving cell stops providing coverage at the present UE location.**

Regarding how to provide the reference location of Earth-moving cell, companies have diverging views, and at least 5 options have been mentioned for now. Rapporteur doesn’t see a chance to make consensus on this design, and would suggest to postpone this discussion to next RAN2 meeting.

**Proposal 2: In Earth-moving cell, regarding how to provide the reference location of serving cell****, the following options can be further discussed:**

1. **only location coordinates of current cell center, and network is supposed to update the values every time when it is provided for Earth-moving cell.**
2. **multiple reference locations and its time information of Earth-moving cell.**
3. **based on the sub-satellite point derived by satellite ephemeris and the broadcasted location offset between sub-satellite point and the cell reference location**
4. **cell type (fixed or moving), reference location coordinates with a time stamp, and the velocity of reference location**
5. **cell type, reference location corresponding to the epochTime (reuse the existing epochTime).**

As for Q3, all participant companies agree to the proposal, so this proposal would be suggested as quick agreement for online CB.

**Proposal 3: System information is the basic means for providing necessary parameters to assist UE to estimate when the serving cell stops providing coverage at the present UE location.**

### 2.1.2 Assistance information of neighbour cell for UE to estimate when the neighbour cell starts providing coverage at the present UE location

According to the following proposal, if a UE is able to estimate when the serving cell stops providing coverage at the present UE location, it can also estimate when the neighbour cell starts providing coverage at the present UE location, then it can know which neighbour cells are the next upcoming cells.

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| Tdoc | Proposals |
| [R2-2209578](file:///C:\Data\3GPP\Extracts\R2-2209578%20Discussion%20on%20NTN%20cell%20reselection%20enhancements.docx) | Proposal 3: The parameters explained in Proposal 1 can also be for neighbour cells for UE to estimate which cells are the upcoming cells for cell reselection. I.e., these parameters of the neighbour cell can be satellite orbital parameters, location coordinates of cell center and the radius of cell coverage. |

**Question 4: whether the assistance information below of a neighbour cell can be used for UE to estimate when the neighbour cell starts providing coverage at the present UE location.**

1. **satellite orbital parameters, not instantaneous position and velocity of satellite**
2. **location coordinates of cell center, or in other term, cell reference location**
3. **the radius of cell coverage, or in other term, a distance threshold**

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| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | N |  |
| Samsung | Y with comment | Similar comment as for Q1  For 2 and 3, prefer to use cell reference location and distance threshold, which may or may not be the cell center and the cell radius, respectively, and can be up to NW configuration, similar to the Rel-17 reference location and distance threshold for cell reselection.  For 2, the time stamp for the provided reference location coordinates is also needed. FFS whether ephemeris epoch time can be used or not.  In addition, in the case that the neighbour cell’s coverage (i.e. satellite beam footprints) is moving relatively static with respect to the satellite’s nadir movement, the UE can estimate the movement of the cell coverage based on neighbour cell’s satellite ephemeris and the reference location with a time stamp. But the UE needs to know the neighbour cell is an earth moving cell. So in this case, the cell type indication should be provided.  In another case, if the neighbour cell’s coverage (i.e. satellite beam footprints) is not moving relatively static with respect to the satellite’s nadir movement, the UE cannot estimate the movement of cell coverage only based on the neighbour cell’s satellite ephemeris. In this case, the velocity of the reference location (i.e., moving speed and direction) of the neighbour cell needs to be provided so that the UE can estimate the trajectory of the reference location. |
| OPPO | Y for neighbour cell’s assistance information, FFS for exact information | Providing neighbour cell’s incoming information can be beneficial for UE to decide when to start neighbour cell’s measurement, e.g. only when neighbour cell has come, measurement can be started.  We think at least network can provide some time-based assistance information, e.g. a time threshold according to the time when some moving neighbour cells come across with the serving cell’ coverage. |
| Huawei, HiSilicon | N | It was discussed in R17 whether the assistance information of upcoming cell should be provided, and no conclusion was made. Prefer not to duplicate the discussion. |
| Lenovo | Not sure | We think it may be too early or unnecessary to discuss this for now. Only if we have agreement on idle mobility based on neighbour cell status (e.g., when it stars to serve UE area) shall we discuss what neighbour cell information to be provided. For now we should focus on what and how serving cell information to be provided. |
| vivo | See comments | The benefits of knowing when the neighbour cell starts providing coverage at the present UE location are unclear, and thus it is too early to directly discuss the related assistance information before the need/benefit is first justified. We think we should first focus on the serving cell related enhancements, taking the Rel-17 NTN introduced mechanisms as the baseline. |
| Apple | Y, 2 and 3 | The neighbour cell’s deployment will be changed. with the location of the earth-moving cell change.  Therefore, to help UE only perform the measurement on the adjacent cells, NW can provide the neighbour cells/frequencies together with the reference location info. |
| Ericsson | Postpone | Cell (re)selection procedure should strive for simplicity. Thus, the benefits of using these parameters should be clarified first. |
| MediaTek | No. | Agree with Ericsson. It is becoming a burden for UE in idle mode. Possibility of increased power consumption is high. |
| Qualcomm | Y | The information is helpful to reduce unnecessary search. |
| Nokia | Y | 1 and 2 could be useful, although we believe the calculations for the current serving cell are more important than those for the neighbours. |
| NEC | N | This seems like unnecessary optimisation. |
| Xiaomi | N | Prefer to first study how to trigger cell reselection based on the serving cell information. |
| InterDigital | Y or postpone | If this is considered for earth moving cell, depending on the solution to track reference point movement this may be a lot of extra signalling. We agree in principle this additional information is useful for cell reselection (e.g. to select the neighbour cell with the longest service time), but are also okay to postpone |
| CATT | see the comment | Similar comments for Q1 |
| ZTE | N | Prefer not to duplicate the discussion as we has discussed a lot for earth fixed case in R17 without reaching consensus and it would be more complicated for earth moving case. |
| LGE | Y with comments | RAN2 needs to clarify the usefulness of time- and distance-based cell reselection. After that, RAN2 discusses the assistance information of neighbor cell. Although, we believe that the assistance information of neighbor cell is helpful. |
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**Summary:**

According to companies’ feedback, it would be good to focus on how to utilize serving cell information for idle mode mobility for now, and the discussion on neighbour cells’ assistance information can be postponed to a later stage.

**Proposal 4: The discussion on assistance information of neighbour cell for UE to estimate when the neighbour cell starts providing coverage at the present UE location is postponed.**

### 2.1.3 Whether a UE can relax neighbour cell measurements before the serving cell stops providing coverage at the present UE location

According to the following proposal, in order to save UE power consumption, before the serving cell stops providing coverage at the present UE location, it’s beneficial to relax neighbour cell measurements.

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| Tdoc | Proposals |
| [R2-2209578](file:///C:\Data\3GPP\Extracts\R2-2209578%20Discussion%20on%20NTN%20cell%20reselection%20enhancements.docx) | Proposal 2: If proposal 1 is agreed, to define a new trigger for the measurement relaxation considering the estimated cell stop time. For example, after UE camps in a cell, or for certain time “x”, UE may be allowed to relax neighbour cell measurements until the estimated cell stop time or certain time “y” before the estimated stop time. |

**Question 5: whether a UE is allowed to relax neighbour cell measurements** **before the serving cell stops providing coverage at the present UE location.**

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| --- | --- | --- |
| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | Y | For moving cell scenario, UE can use assistant information and its self location information to decide whether to relax neighbour cell measurements. |
| Samsung | See comment | “Relex neighbor cell measurement” is not clear whether it refers to introduce new measurement rules or existing Rel-17 rules. We think Rel-17 rules can work. |
| OPPO | Left to UE implementation as in Rel-17 | Similar as Rel-17 NR NTN, we only specify that UE shall start neighbour cell’s measurement before T-service, but the exact time for starting the measurement is left to UE implementation. We don’t need to discuss the possible UE implementation, e.g. whether relax measurement or not and when to relax. |
| Huawei, HiSilicon | N | In R17, it was clarified that stop time based measurement triggering aims to guarantee the UE has already measured neighbour cell before the serving cell stops serving, rather than saving UE power.  If we go the other direction in R18, I am not sure how this co-exists with the R17 mechanism.  Besides, we already introduced relaxed monitoring for GSO in R17. |
| Lenovo | Y | OK to have the same mechanism as quasi-fixed, as long as UE can have the exact time when the serving cell stops providing coverage at the present UE location. |
| vivo | No | For quasi-fixed cell, RAN2 agreed that the exact time to start measurement before *t-Service* is up to UE implementation. We think a similar principle can be adopted for earth-moving cell, and this optimization is not needed. |
| Apple | Y |  |
| Ericsson | See comment | The formulation of the question and its relation to the proposal is unclear. We understand that new triggers could be considered to start/relax measurements in earth moving cells. We don’t think these triggers should be time-based. |
| MediaTek | FFS | It is hard to provide stop time for earth-moving cell.  The reference location and distance threshold may be used for relaxing neighbour cell measurement like quasi earth-fixed cell. It can be FFS. |
| Qualcomm | May be | UE should be able to use any existing or new relaxed measurement feature. |
| Nokia | Likely not | As we agreed in Rel-17, the UE should have the measurements completed before the t-Service for the current cell expires, so a similar principle should apply for EMC: UE estimates when the cell will stop providing coverage at current UE location and needs to perform measurements by then. |
| NEC | N | We agree with Huawei |
| Xiaomi | N | Prefer to use the Rel-17 mechanism that the exact time for measure neighbour cell is up to UE implementation. |
| InterDigital | Y | Okay to further discuss |
| CMCC | Y |  |
| CATT | see the comment | Not sure what is the measurement relaxation is refer to, maybe RAN4 should be involved. |
| ZTE | No | We prefer to reuse the R17 mechanism that UE start measurements on neighbour cells before the serving cell stops covering the UE. Allowing UE to relax measurements is actually going to the opposite direction. |
| LGE | N | Agree with Huawei. |
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**Summary:**

This is no majority view on this relaxation of neighbour cell measurements, some companies prefer to leave it to UE implementation, meanwhile some companies are ok for further discussion. Rapporteur understands this enhancement could be discussed later in a paper-driven way, so the discussion could be postponed.

**Proposal 5: The discussion on whether to relax neighbour cell measurements before the serving cell stops providing coverage at the present UE location is postponed.**

### 2.1.4 t-service in Earth-moving cell

In previous questions, the discussion point is whether UE can estimate the “t-service” itself for Earth-moving cell. According to the following proposals, it’s proposed to t-service is still provided in Earth-moving cell, e.g., only “valid for a particular location on Earth”. And the t-service update scheme should also be considered.

|  |  |
| --- | --- |
| Tdoc | Proposals |
| [R2-2210353](file:///C:\Data\3GPP\Extracts\R2-2210353%20Further%20view%20on%20Idle-%20and%20Connected-mode%20NTN%20mobility%20in%20Rel-18.docx) | Proposal 2: To enable time-based reselections in Earth-moving scenario, the IDLE UE is capable of computing its own location to adjust t-Service provided in SIB19. |
| [R2-2210589](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210589.docx) | Proposal 4: Introduce reference location and/or t-service update scheme for cell reselection enhancements for earth moving cell |
| R2-2210090 | Proposal 2 For time-based measurement initiation for earth moving cell, RAN2 consider introducing a new time threshold T1 according to the time when the moving serving cell comes across some neighbour cells’ coverage. FFS on whether T1 is configured per UE or per frequency. |

**Question 6: if RAN2 agrees that UE is able to estimate when the serving cell stops providing coverage at the present UE location, whether t-service still needs to be provided in system information by network in Earth-moving cell.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | N | UE use distance-based or location-based is sufficient. |
| Samsung | N | UE can estimate the movement of cell coverage based on the provided parameters. t-Service for earth moving cell is not needed. |
| OPPO | N | For serving cell-relevant triggering condition, we propose RAN2 to prioritize discussion on location-based trigger which is more straightforward for earth moving cells. Stop time at UE’s present location would be difficult to determine, which can be treated as a low priority. |
| Huawei, HiSilicon | N | It is not feasible to provide t-Service for moving cells, because the exact value is different for UEs located at different places. |
| Lenovo | Maybe | If UE predicts the exact time when the serving cell stops providing coverage at the present UE location, then we do not need t-Service to indicate. However, t-Service may have other use e.g., as the feeder link switch time. |
| vivo | Yes | The UE-autonomously estimated stop time is the time caused by service link switch, but the UE cannot estimate the time of feeder link switch which is only known at the NW side. One cannot assume that feeder link switch never happens in the earth-moving cell case.  Considering the time of feeder link switch is common for all UEs in the cell, handling of the stop time caused by the feeder-link switch in earth moving cell may follow a similar mechanism specified in Rel-17, i.e. a configured *t-Service* with related procedure in TS 38.304. |
| Apple | N | For the earth-moving cell, the t-service configuration is not so effective as in the fix cell, since each UE needs to update and maintain the ToS time according to the satellite’s velocity and location changes.  Therefore, the location-based method is sufficient. |
| Ericsson | See comment | We understand the question is only related to when the serving cell stops covering a certain area. In this case, t-service is not needed. However, feeder link switch optimizations are within the WID scope. As Vivo points out, in this case, t-service should be provided. |
| MediaTek | No. | It is hard to provide stop time for earth-moving cell. It is not needed to provide t-service in earth-moving cell.  Only the coverage information (i.e., ephemeris information, reference location, and distance threshold) should be provided and how to use them is left to UE implementation (i.e., time-based or location-based is depending on UE implementation). |
| Qualcomm | Yes | Agree with vivo, for feeder link switch case, which UE cannot predict based on satellite information, t-service needs to be provided.  For measurement, network can still provide t-service as possible measurement window +/- delta to t-service. |
| Nokia | Y | FFS on the naming, whether it is the same thing or the other. But clearly the UE shall compute its own ‘t-service’ based on what is broadcast in SIB19. |
| NEC | N |  |
| Xiaomi | Y | The t-service can be linked to a reference location, and then the UE could calculate the specific timing based on the reference location, UE location and the coverage information. |
| InterDigital | N | Agree with vivo and Ericsson, feeder-link switch should be discussed separately, but no to general case. |
| CMCC | N | For earth moving cell, t-service is be per UE, and needs to calculate by each UE in the cell individually. Therefore, it is unnecessary to broadcast t-service. |
| CATT | No | It makes the mechanism more complex. |
| ZTE | N | We understand some time information needs to be provided for the case the serving cell stops providing coverage at the present UE location is caused by feeder link switch as this cannot be predicted by UE. |
| LGE | Y | Serving cell should inform the time point when the feeder link switch occurs before the serving cell stop time estimated by the UE is come. The UE cannot estimate service stop time due to the feeder link switch. |
|  |  |  |
|  |  |  |

**Summary:**

Almost all participant companies agree that in Earth-moving cell, a UE is able to estimate its own “t-service” with some assistance information provided by network. But t-service may still be broadcast by network in case of feeder link switch when all UEs in current cell need to switch to another cell.

**Proposal 6: RAN2 to further discuss whether t-service needs to be provided in system information in case of feeder link switch.**

## 2.2 NTN-TN cell reselection

During the online discussion in first week, the following agreement was achieved:

Agreements:

1. To enhance NTN-TN cell reselection, means are defined for a UE to differentiate when camping in an area only covered by NTN network (earth-moving or earth-fixed) vs an area where TN network(s) is/are also available.

### 2.2.1 Cell type (i.e. “TN” vs “NTN”)

Regarding the cell type (i.e. “TN” vs “NTN”), it is proposed that it should be indicated explicitly for a neighbour cell in some proposals below. And there is also one proposal to mention that “a UE can distinguish whether a neighbor cell or frequency belongs to a terrestrial or non-terrestrial network via existing specification”, e.g., “based on the ARFCN of the neighbouring carrier”.

|  |  |
| --- | --- |
| Tdoc | Proposals |
| [R2-2209578](file:///C:\Data\3GPP\Extracts\R2-2209578%20Discussion%20on%20NTN%20cell%20reselection%20enhancements.docx) | Proposal 4.1. If proposal 4 is agreed,” cell type" (i.e. “TN” vs “NTN”) of a neighbour cell is indicated to UE (e.g. explicitly or implicitly). |
| [R2-2210217](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210217.docx) | Proposal 3: Serving cell’s system information include an indication that whether a neighbour cell is an NTN cell or not. |
| [R2-2210438](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210438--R18-NR-NTN-WI-AI-8.7.4--Idle-Inactive-enhancements.docx) | Proposal 7: RAN2 to confirm that a UE can distinguish whether a neighbor cell or frequency belongs to a terrestrial or non-terrestrial network via existing specification. |
| [R2-2210598](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210598.docx) | Proposal 3: We can introduce an indication to identify TN cells in the different neighbor lists. |

After further checking, Rapporteur thinks it’s not feasible to solely rely on ARFCN to distinguish TN cell from NTN cell, as there is an overlap between TN bands and NTN bands.

RAN4 has defined NTN specific band in TS 38.101-5 as below:

Table 5.2.2-1: NTN satellite bands in FR1

|  |  |  |  |
| --- | --- | --- | --- |
| NTN satellite operating band | Uplink (UL) operating band Satellite Access Node receive / UE transmit  FUL,low – FUL,high | Downlink (DL) operating band Satellite Access Node transmit / UE receive  FDL,low – FDL,high | Duplex mode |
| n256 | 1980MHz – 2010 MHz | 2170 MHz – 2200 MHz | FDD |
| n255 | 1626.5 MHz – 1660.5 MHz | 1525 MHz – 1559 MHz | FDD |
| NOTE: NTN satellite bands are numbered in descending order from n256. | | | |

And the NTN frequency range is totally the same as (n255 and n24) or included in TN bands (n256 and n65).

Table 5.2-1: NR operating bands in FR1

|  |  |  |  |
| --- | --- | --- | --- |
| NR operating band | Uplink (UL) *operating band* BS receive / UE transmit  FUL\_low  – FUL\_high | Downlink (DL) *operating band* BS transmit / UE receive  FDL\_low – FDL\_high | Duplex Mode |
| n1 | 1920 MHz – 1980 MHz | 2110 MHz – 2170 MHz | FDD |
| n2 | 1850 MHz – 1910 MHz | 1930 MHz – 1990 MHz | FDD |
| n3 | 1710 MHz – 1785 MHz | 1805 MHz – 1880 MHz | FDD |
| n5 | 824 MHz – 849 MHz | 869 MHz – 894 MHz | FDD |
| n7 | 2500 MHz – 2570 MHz | 2620 MHz – 2690 MHz | FDD |
| n8 | 880 MHz – 915 MHz | 925 MHz – 960 MHz | FDD |
| n12 | 699 MHz – 716 MHz | 729 MHz – 746 MHz | FDD |
| n13 | 777 MHz – 787 MHz | 746 MHz – 756 MHz | FDD |
| n14 | 788 MHz – 798 MHz | 758 MHz – 768 MHz | FDD |
| n18 | 815 MHz – 830 MHz | 860 MHz – 875 MHz | FDD |
| n20 | 832 MHz – 862 MHz | 791 MHz – 821 MHz | FDD |
| n2416 | 1626.5 MHz – 1660.5 MHz | 1525 MHz – 1559 MHz | FDD |
| n25 | 1850 MHz – 1915 MHz | 1930 MHz – 1995 MHz | FDD |
| n26 | 814 MHz – 849 MHz | 859 MHz – 894 MHz | FDD |
| n28 | 703 MHz – 748 MHz | 758 MHz – 803 MHz | FDD |
| n29 | N/A | 717 MHz – 728 MHz | SDL |
| n303 | 2305 MHz – 2315 MHz | 2350 MHz – 2360 MHz | FDD |
| n34 | 2010 MHz – 2025 MHz | 2010 MHz – 2025 MHz | TDD |
| n3810 | 2570 MHz – 2620 MHz | 2570 MHz – 2620 MHz | TDD |
| n39 | 1880 MHz – 1920 MHz | 1880 MHz – 1920 MHz | TDD |
| n40 | 2300 MHz – 2400 MHz | 2300 MHz – 2400 MHz | TDD |
| n41 | 2496 MHz – 2690 MHz | 2496 MHz – 2690 MHz | TDD |
| n46 | 5150 MHz – 5925 MHz | 5150 MHz – 5925 MHz | TDD13 |
| n4711 | 5855 MHz – 5925 MHz | 5855 MHz – 5925 MHz | TDD |
| n48 | 3550 MHz – 3700 MHz | 3550 MHz – 3700 MHz | TDD |
| n50 | 1432 MHz – 1517 MHz | 1432 MHz – 1517 MHz | TDD1 |
| n51 | 1427 MHz – 1432 MHz | 1427 MHz – 1432 MHz | TDD |
| n53 | 2483.5 MHz – 2495 MHz | 2483.5 MHz – 2495 MHz | TDD |
| n65 | 1920 MHz – 2010 MHz | 2110 MHz – 2200 MHz | FDD4 |
| n66 | 1710 MHz – 1780 MHz | 2110 MHz – 2200 MHz | FDD |
| n67 | N/A | 738 MHz – 758 MHz | SDL |
| n70 | 1695 MHz – 1710 MHz | 1995 MHz – 2020 MHz | FDD |
| n71 | 663 MHz – 698 MHz | 617 MHz – 652 MHz | FDD |
| n74 | 1427 MHz – 1470 MHz | 1475 MHz – 1518 MHz | FDD |
| n75 | N/A | 1432 MHz – 1517 MHz | SDL |
| n76 | N/A | 1427 MHz – 1432 MHz | SDL |
| n7712 | 3300 MHz – 4200 MHz | 3300 MHz – 4200 MHz | TDD |
| n78 | 3300 MHz – 3800 MHz | 3300 MHz – 3800 MHz | TDD |
| n7917 | 4400 MHz – 5000 MHz | 4400 MHz – 5000 MHz | TDD |
| n80 | 1710 MHz – 1785 MHz | N/A | SUL |
| n81 | 880 MHz – 915 MHz | N/A | SUL |
| n82 | 832 MHz – 862 MHz | N/A | SUL |
| n83 | 703 MHz – 748 MHz | N/A | SUL |
| n84 | 1920 MHz – 1980 MHz | N/A | SUL |
| n85 | 698 MHz – 716 MHz | 728 MHz – 746 MHz | FDD |
| n86 | 1710 MHz – 1780 MHz | N/A | SUL |
| n89 | 824 MHz – 849 MHz | N/A | SUL |
| n90 | 2496 MHz – 2690 MHz | 2496 MHz – 2690 MHz | TDD5 |
| n91 | 832 MHz – 862 MHz | 1427 MHz – 1432 MHz | FDD9 |
| n92 | 832 MHz – 862 MHz | 1432 MHz – 1517 MHz | FDD9 |
| n93 | 880 MHz – 915 MHz | 1427 MHz – 1432 MHz | FDD9 |
| n94 | 880 MHz – 915 MHz | 1432 MHz – 1517 MHz | FDD9 |
| n958 | 2010 MHz – 2025 MHz | N/A | SUL |
| n9614 | 5925 MHz – 7125 MHz | 5925 MHz – 7125 MHz | TDD13 |
| n9715 | 2300 MHz – 2400 MHz | N/A | SUL |
| n9815 | 1880 MHz – 1920 MHz | N/A | SUL |
| n9916 | 1626.5 MHz – 1660.5 MHz | N/A | SUL |
| n100 | 874.4 MHz – 880 MHz | 919.4 MHz – 925 MHz | FDD |
| n101 | 1900 MHz – 1910 MHz | 1900 MHz – 1910 MHz | TDD |
| n10214 | 5925 MHz – 6425 MHz | 5925 MHz – 6425 MHz | TDD13 |
| n10417,18 | 6425 MHz – 7125 MHz | 6425 MHz – 7125 MHz | TDD |
| NOTE 1: UE that complies with the NR Band n50 minimum requirements in this specification shall also comply with the NR Band n51 minimum requirements.  NOTE 2: UE that complies with the NR Band n75 minimum requirements in this specification shall also comply with the NR Band n76 minimum requirements.  NOTE 3: Uplink transmission is not allowed at this band for UE with external vehicle-mounted antennas.  NOTE 4: A UE that complies with the NR Band n65 minimum requirements in this specification shall also comply with the NR Band n1 minimum requirements.  NOTE 5: Unless otherwise stated, the applicability of requirements for Band n90 is in accordance with that for Band n41; a UE supporting Band n90 shall meet the requirements for Band n41. A UE supporting Band n90 shall also support band n41.  NOTE 6: A UE that supports NR Band n66 shall receive in the entire DL operating band.  NOTE 7: A UE that supports NR Band n66 and CA operation in any CA band shall also comply with the minimum requirements specified for the DL CA configurations CA\_n66B and CA\_n66(2A) in the current version of the specification.  NOTE 8: This band is applicable in China only.  NOTE 9: Variable duplex operation does not enable dynamic variable duplex configuration by the network, and is used such that DL and UL frequency ranges are supported independently in any valid frequency range for the band.  NOTE 10: When this band is used for V2X SL service, the band is exclusively used for NR V2X in particular regions.  NOTE 11: This band is unlicensed band used for V2X service. There is no expected network deployment in this band.  NOTE 12: In the USA this band is restricted to 3450 – 3550 MHz and 3700 – 3980 MHz. In Canada this band is restricted to 3450 – 3650 MHz and 3650 – 3980 MHz.  NOTE 13: This band is restricted to operation with shared spectrum channel access as defined in 37.213.  NOTE 14: This band is applicable only in countries/regions designating this band for shared-spectrum access use subject to country-specific conditions.  NOTE 15: The requirements for this band are applicable only where no other NR or E-UTRA TDD operating band(s) are used within the frequency range of this band in the same geographical area. For scenarios where other NR or E-UTRA TDD operating band(s) are used within the frequency range of this band in the same geographical area, special co-existence requirements may apply that are not covered by the 3GPP specifications.  NOTE 16: DL operation in this band is restricted to 1526 – 1536 MHz and UL operation is restricted to 1627.5 – 1637.5 MHz and 1646.5 – 1656.5 MHz.  NOTE 17: For this band, CORESET#0 values from Table 13-5 or Table 13-6 in [8, TS 38.213] are applied regardless of the minimum channel bandwidth.  NOTE 18: [This band is applicable only to RCC countries in accordance with RCC Recommendation 1/21] | | | |

**Question 7: whether the following proposal is agreeable:**

**Proposal: add an indication of the “cell type” (i.e. “TN” vs “NTN”) of a neighbour cell in system information.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | Y | It can help UE to identify if the neighbor cell is TN or NTN, then UE can based on assistance inform perform cell reselection enhancement respectively. |
| Samsung | Y |  |
| OPPO | Y |  |
| Huawei, HiSilicon | N | We think the UE can use band numbers to differentiate TN and NTN neighbour frequencies.  Even though there is some overlapping in the frequency range of the TN and NTN bands, but we think in real deployment, such overlapping might not happen at the same location? |
| Lenovo | Not sure | Firstly, if we define assistance information as in Q8 below, we wonder if cell type is necessary.  Secondly, does this mean a new and explicit cell type indication? Can *cellBarredNTN* be reused? |
| vivo | No | Some implicit methods can be used: for example, if a cell is associated with some newly defined assistance information (e.g., coverage information of TN cells) for power saving, UE can consider the cell as a TN cell. Something like an explicit “1-bit” indication on the “NTN vs. TN” is not needed. |
| Apple | Y | The explicit indication can make the spec more forward compatible and can avoid the dependence on the RAN4 spec and the NTN specific band number. |
| Ericsson | N | Cell type can be derived implicitly. |
| MediaTek | Not sure the feasibility | The provision of carrier frequency and ephemeris information (i.e., NTN-Config) in SIB19 can identify whether or not a neighbour cell is an NTN cell.  Does P1 mean that network will provide neighbour NTN cell and TN cell on the same carrier frequency in SIB? It should be clarified whether NTN cell and TN cell will be deployed on the same carrier freq. If Yes, the cell type might be needed. |
| Qualcomm | See comments | Then I wonder why companies didn’t agree to clarify the neighbor cell information list in SIB19. If cell ID is present in for neighbor cell in SIB19, is there still confusion?  We have to do it properly, either extend SIB19 with more frequency list and cell list or add satellite identity in neighbor cell list in SIB4. This clarifies whether the cell is NTN cell and which is satellite information. |
| Nokia | N | No need to have explicit indication. Is it expected that all SIBs used since Rel-15 will now have a “TN”-indication added? |
| NEC | N | It would be beneficial to indicate groups of TN/NTN cells according to e.g. their location or used frequencies. Then indicating cell type in neighbour information is not necessary. |
| Xiaomi | N | We are not clear why the cell type is needed for the cell reselection between NTN and TN. The UE perform neighbour cell according to the frequency， only need to indicate whether the frequency is available or not in the given area. |
| InterDigital | N | Agree with Ericsson and Nokia |
| CMCC | N | UE could deduce the NW type implicitly with existing mechanism(e.g. ephemeris). |
| CATT | No | If the neighbour cell is an NTN cell, the ephemeris with PCI and frequency should be broadcasted in SIB19 which can indicate the NTN cell type implicitly.  For TN cell, only the frequency is necessary.  So ephemeris can be used to differentiate whether the cell is a TN cell or NTN cell. |
| ZTE | Y | We understand some NTN indication can be provided per frequency or per cell to help UE identify the network type and perform cell reselection with such information considered. |
| LGE | N | If the NTN and TN cells on same frequency, UE can implicitly distinguish TN cells, e.g., with the presence of SIB19. |
|  |  |  |
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**Summary:**

The proponents think it’s straight forward to add this cell type indication, while a slight majority view is this information can be derived implicitly, e.g., by SIB19, or potential newly defined assistance information (e.g., coverage information of TN cells). Some companies also raise the concern that It should be clarified whether NTN cell and TN cell will be deployed on the same carrier freq.

**Proposal 7: RAN2 to further discuss whether the cell type (i.e. “TN” vs “NTN”) of a neighbour cell can be indicated implicitly by existing system information, e.g., SIB19 or band numbers.**

### 2.2.2 Assistance information for UE to identify an area where TN network is available

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| Tdoc | Proposals |
| [R2-2209578](file:///C:\Data\3GPP\Extracts\R2-2209578%20Discussion%20on%20NTN%20cell%20reselection%20enhancements.docx) | Proposal 4.2. If proposal 4 is agreed, network provides assistance information of NTN-only area (e.g., cell center and cell radius of TN neighbour cells and NTN serving cell, or the boundary line between TN area and NTN area). |
| [R2-2210353](file:///C:\Data\3GPP\Extracts\R2-2210353%20Further%20view%20on%20Idle-%20and%20Connected-mode%20NTN%20mobility%20in%20Rel-18.docx) | Proposal 5: RAN2 is asked to consider the method where System Information provides a location-related indication where the search for TN coverage shall be initiated. |
| R2-2209753 | Proposal 3 In NTN-TN cell reselection for high priority cells, RAN2 shall introduce a new distance threshold for measurement enhancement. |
| [R2-2210045](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210045_NTN_mobility.docx) | Proposal 1: Network provides reference location(s) of TN cells and a distance threshold for measurements of TN frequencies in SIB19 to assist RRC\_IDLE/RRC\_INACTIVE UE in determining whether to perform measurements of TN frequencies for cell reselection. |
| [R2-2210090](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210090-Discussion-on-mobility-enhancements-for-idle-and-inactive-UEs.doc) | Proposal 3 For quasi-earth fixed cells, TN coverage described by a distance range from the cell center and an angle range based on a reference direction can be broadcasted to UEs to assist the TN neighbour cell measurement initiation.  Proposal 4 RAN2 to discuss the following options for the distance/angle range:  - Option 1: Two thresholds, i.e., the minimum threshold and the maximum threshold.  - Option 2: One minimum threshold and one range, i.e. the maximum threshold can be determined based on the minimum threshold and the range. |
| [R2-2210159](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210159-Cell-reselection-enhancements.docx) | Proposal 6: It is proposed to provide reference location of TN neighbor cell, cell coverage radius of TN neighbor cell, relative position to the current NTN cell, etc. to help UE choose suitable TN neighbor cell. |
| [R2-2210217](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210217.docx) | Proposal 1: For RRC\_IDLE and RRC\_INACTIVE UEs, an indication could be included in system information to indicate NTN cell’s coverage overlaps with terrestrial TN cell’s coverage. With this indication, UE may ignore serving cell thresholds and perform TN cell measurements. |
| [R2-2210468](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210468-8.7.4-cell-reselection-enhancement.docx) | Proposal 3: For cell reselection in NTN-NTN and NTN-TN mobility, NW provides TN cell information according to the location within a NTN cell. |
| [R2-2210737](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210737-Discussion-on-idle-mode-aspects-for-NTN.docx) | Proposal 2 Introduce assistance information about an area where TN cell is not deployed and TN frequency identifier to perform reduced measurement on TN frequencies. |
| R2-2210732 | Proposal 7 Introduce a parameter using the polygon shape captured in TS 23.032 to describe the coverage area of a TN neighbour cell. |
| R2-2209408 | Proposal 2: The assistance information provided by NTN cell can include the indication information to indicate the presence of TN cells in pre-divided areas, the area division rules and numbering rules can be preconfigured to UE. |

Regarding the Assistance information for UE to identify an area where TN network is available, the following options are proposed based on the proposals above:

1. The cell center and cell radius of TN neighbour cells, or in other terms, the reference location and a distance threshold of TN neighbour cells
2. the boundary line between TN area and NTN area
3. For quasi-earth fixed cells, TN coverage is described by a distance range from the cell center and an angle range based on a reference direction
4. an indication could be included in system information to indicate NTN cell’s coverage overlaps with terrestrial TN cell’s coverage

**Question 8: Regarding the Assistance information for UE to identify an area where TN network is available, which option(s) is agreeable:**

1. The cell center and cell radius of TN neighbour cells, or in other terms, the reference location and a distance threshold of TN neighbour cells
2. The boundary line between TN area and NTN area
3. For quasi-earth fixed cells, TN coverage is described by a distance range from the cell center and an angle range based on a reference direction
4. An indication could be included in system information to indicate NTN cell’s coverage overlaps with terrestrial TN cell’s coverage
5. NTN cell can be divided to several virtual areas based on certain criteria. The virtual areas and the corresponding TN frequency information are broadcast as assistance information to help UE perform more accurate TN measurements.
6. Introduce a parameter using the polygon shape captured in TS 23.032 to describe the coverage area of a TN neighbour cell.

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| --- | --- | --- |
| **Company** | **option 1/2/3/4** | **Additional comments** |
| Transsion Holdings | Option 1 |  |
| Samsung | See comment | Agree to use reference location and a distance threshold in Option 1, but the reference location can be a location inside or outside the NTN/TN cell. Broadcast cell center and cell radius of TN cells in SI may cause security issue. |
| OPPO | Option 3 | We prefer to use the assistance information based on the cell reference location of NTN cell for quasi-earth fixed cell. i.e., for quasi-earth fixed cells, the detailed coverage information can be one or more coverage areas described by a distance range from the NTN cell center and an angle range based on a reference direction. |
| Huawei, HiSilicon | Option 5 |  |
| Lenovo | Option 1 with comments | For option 1 we share Samsung’s view that the actual TN cell center shall not be indicated, and reference location of TN areas can be used instead.  For Option 2 we wonder the format and signalling overhead of indicating the line.  For Option 3 it does work for quasi-fixed cells, but we think it is better to have a unified solution.  For Option 4 we think the granularity is too coarse to have actual benefits.  For 5 we think it could be complicated if serving NTN cell is earth-moving. |
| vivo | Option 1 | We think option 1 is simpler. More generally, the reference location can even be configured as a location within the TN coverage (i.e. not necessarily within only one TN cell). With how such reference location configured being up to NW implementation, Option 1 can also work in this way. |
| Apple | Option 1 | to help UE only perform the measurement on the adjacent cells, NW can provide the neighbour cells/frequencies together with the reference location info.  NW can provide the deployment of the adjacent neighbor TN cell based on the reference location/distance in the NTN cell. And UE can based on the reference location info estimate whether to enable the neigbhor cell measurement or cell reselection to the TN neighbor cell. |
| Ericsson | Option 6 | In Release 17, the coverage of NTN cells has been described with a reference location and a radius (Option 1), e.g., in discontinuous coverage assistance information. This might be unsuitable for this purpose since indicating the exact position of a gNB might raise security concerns. In addition, the coverage patterns of some Terrestrial networks might be difficult to describe with such parameters. We propose to use the means already captured in the specifications to describe complex areas with precision. |
| MediaTek | Option 1 | The reference location and a distance threshold may be enough.  Alternative: UE may rely on the stored fingerprint of TN network to start detecting the TN network. (like CSG in LTE) |
| Qualcomm | Option 5 | We have concern on signaling overhead of providing such information in SIB. This is not only one reference location. Multiple reference location areas within large cell coverage may need to be provided to UE.  We prefer cell divide its cell coverage, and indicate just few bits in which part of the divided area of the cell coverage, there is TN coverage.  UE can just remember it. |
| Nokia | Option 1 or 4 |  |
| NEC | Option 5, Option 2 is also fine | Given the amount of TN cells and the fact that they will be geographically grouped, this seems a more efficient solution. |
| Xiaomi | Option 1 |  |
| InterDigital | Option 1/4/5 | 1 may be complicated in practice depending on how accurate of a representation of TN coverage is desired. 4 is dependant on deployment (small the cell the better), whereas 5 could be a general solution. 4 could also be combined with 5 (e.g. if virtual area overlaps with TN, indicate) |
| CMCC | Option 1 with comments | In addition to assistance information in option 1, relative position to the current NTN cell or other terms reference point could also be provided. |
| CATT | Option 5 with comment | The indication can be in form of multi bits, which can indicate the presence of TN cells in different areas of the NTN cell. The areas can be pre-divided according to certain rules. |
| ZTE | None | We understand the explicit network type indication per cell or per frequency would be sufficient. |
| LGE | Other | The NTN serving cell should provide the information of area where there is no TN cell, i.e., indirect coverage information of TN. It may sub-optimal solution, however, the operator may reluctant to provide the coverage information by broadcasting manner. Furthermore, if the NTN operator has no TN coverage, it is hard to provide TN coverage information. |
|  |  |  |
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**Summary:**

In total 6 options are proposed by companies, and there is only slight majority preference for option 1, meanwhile come companies suggest using the terms “reference location” and “distance threshold” instead. Since it seems early to conclude, Rapporteur would propose to have further discussion in next RAN2 meeting.

**Proposal 8: Regarding the Assistance information for UE to identify an area where TN network is available, the following options can be further discussed:**

1. **The cell center and cell radius of TN neighbour cells, or in other terms, the reference location and a distance threshold of TN neighbour cells**
2. **The boundary line between TN area and NTN area**
3. **For quasi-earth fixed cells, TN coverage is described by a distance range from the cell center and an angle range based on a reference direction**
4. **An indication could be included in system information to indicate NTN cell’s coverage overlaps with terrestrial TN cell’s coverage**
5. **NTN cell can be divided to several virtual areas based on certain criteria. The virtual areas and the corresponding TN frequency information are broadcast as assistance information to help UE perform more accurate TN measurements.**
6. **Introduce a parameter using the polygon shape captured in TS 23.032 to describe the coverage area of a TN neighbour cell.**

### 2.2.3 UE measurement related behaviour in an area where TN network is not available

|  |  |
| --- | --- |
| Tdoc | Proposals |
| [R2-2209578](file:///C:\Data\3GPP\Extracts\R2-2209578%20Discussion%20on%20NTN%20cell%20reselection%20enhancements.docx) | If proposal 4 is agreed, when a UE is in NTN only area, UE is not required to perform neighbour cell measurements for TN neighbour cells. |
| [R2-2210045](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210045_NTN_mobility.docx) | Proposal 2: If reference location(s) of TN cells and a distance threshold for measurements of TN frequencies are provided in SIB19, and if the distance between UE and any of the reference location(s) of TN cells is longer than the distance threshold, UE is not required to perform measurements of TN frequencies for inter-frequency cell reselection. |
| [R2-2210217](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210217.docx) | Proposal 2: The assistance information could be a distance threshold to a reference location. If UE moves beyond that threshold then it will start performing TN measurement. |
| [R2-2210737](file:///C:\RAN2%20work\RAN2-119bis%202210\tdoc\R2-2210737-Discussion-on-idle-mode-aspects-for-NTN.docx) | Proposal 1 The UE performs measurement on TN frequencies where it can find available TN cells. |

According to the proposals above, UE is not required to perform neighbour cell measurements for TN neighbour cells, when there is no TN network coverage.

**Question 9: whether the following proposal is agreeable:**

**Proposal: UE is not required to perform neighbour cell measurements for TN neighbour cells in an area where there is no TN network coverage.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | Y |  |
| Samsung | Y |  |
| OPPO | Y | It is straightforward if the assistance information on TN coverage could be provided to UE. |
| Huawei, HiSilicon | Y |  |
| Lenovo | Y |  |
| vivo | Yes |  |
| Apple | Y |  |
| Ericsson | Y |  |
| MediaTek | Y |  |
| Qualcomm | Y but | We still prefer to define it as relaxed measurement criteria for TN cell measurement.  There may need to be exit criteria such as time limit. |
| Nokia | Y | That is the purpose of the whole thing. |
| NEC | Y |  |
| Xiaomi | Y |  |
| InterDigital | Y |  |
| CMCC | Y | Beneficial for UE power consumption reduction. |
| CATT | Y |  |
| ZTE | Y |  |
| LGE | Y |  |
|  |  |  |
|  |  |  |

**Summary:**

Since all participant companies agree to this proposal, Rapporteur would list it as quick agreement for online confirmation.

**Proposal 9: UE is not required to perform neighbour cell measurements for TN neighbour cells in an area where there is no TN network coverage.**

### 2.2.4 Detection of NTN coverage

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| --- | --- |
| Tdoc | Proposals |
| [R2-2210353](file:///C:\Data\3GPP\Extracts\R2-2210353%20Further%20view%20on%20Idle-%20and%20Connected-mode%20NTN%20mobility%20in%20Rel-18.docx) | **Proposal 4: RAN2 is asked to consider the method of detecting the transmission energy or SIB presence to determine the NTN coverage.** |

In R2-2210353, one enhancement is proposed that it would be beneficial to start searching for NTN cells only when needed, e.g., UE is about to move out from TN coverage. And the corresponding method could be detecting the transmission energy or SIB presence to determine the NTN coverage.

**Question 10: whether to consider the method of detecting the transmission energy or SIB presence to determine the NTN coverage when a UE currently camps on a TN cell?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y or N** | **Additional comments** |
| Transsion Holdings | N |  |
| Samsung | N | If the neighbor cell type (TN or NTN) is indicated in serving cell SI, UE can know directly whether it’s near NTN coverage. |
| OPPO | N | If Q7 is agreed, no need to discuss this question. |
| Huawei, HiSilicon | N |  |
| Lenovo | N |  |
| vivo | No | The coverage area of TN is much smaller than that of NTN, and thus the neighbour frequency/cell broadcast by the network can almost be detected by UE and the problem of power consumption is not as serious as camping in an NTN cell. So we think the existing mechanism of neighbour cell measurement in TN cell is sufficient. |
| Apple | N | The method requires UE to acquire the neighbour cell’s SIB before camping there, which increases the UE complexity. |
| Ericsson | N | Following Vivo’s reasoning, we don’t see a clear benefit. |
| MediaTek | FFS | Benefits are not clear |
| Qualcomm | No | But to know the cell is TN or NTN, the UE has to read SIB1. |
| Nokia | Y | Proponent. Awareness that there is NTN SIB or at least basic energy detection (lighter than reading SS/PBCH) can be a simple trigger for determining the NTN coverage. |
| NEC | N |  |
| Xiaomi | N |  |
| InterDigital | N |  |
| CMCC | N | We could consider some cases that UE will move out TN coverage and will not have TN coverage for a long time(e.g. ocean/sea voyage, desert crossing, etc.). And with the exiting SI information and other assistance information, UE is able to know whether it will leave TN or NTN coverage. |
| CATT | N | According to the neighbour cell information (e.g. frequency information, priority of cell reselection) broadcasted in SIB3/4, UE can determine whether neighbour cell is NTN cell. |
| ZTE | N |  |
| LGE | N |  |
|  |  |  |
|  |  |  |

**Summary:**

Since there is only one proponent and all other opponent, and as mentioned by companies, the problem of power consumption is not as serious as camping in an NTN cell. Rapporteur would propose not to consider this enhancement.

**Proposal 10: the method of detecting the transmission energy or SIB presence to determine the NTN coverage when a UE currently camps on a TN cell is not pursued.**

# Conclusion

In this offline discussion, some enhancements to cell reselection are discussed. Based on companies’ feedback, the following proposals are made.

Easy agreements:

**(Full consensus) Proposal 3: System information is the basic means for providing necessary parameters to assist UE to estimate when the serving cell stops providing coverage at the present UE location.**

**(Full consensus) Proposal 9: UE is not required to perform neighbour cell measurements for TN neighbour cells in an area where there is no TN network coverage.**

**(19/20) Proposal 10: the method of detecting the transmission energy or SIB presence to determine the NTN coverage when a UE currently camps on a TN cell is not pursued.**

Online confirmation:

**(15/20) Proposal 1: In Earth-moving cell, the reference location and distance threshold of serving cell are provided by network for UE to estimate when the serving cell stops providing coverage at the present UE location.**

Postponed discussion:

**Proposal 2: In Earth-moving cell, regarding how to provide the reference location of serving cell, the following options can be further discussed:**

1. **only location coordinates of current cell center, and network is supposed to update the values every time when it is provided for Earth-moving cell.**
2. **multiple reference locations and its time information of Earth-moving cell.**
3. **based on the sub-satellite point derived by satellite ephemeris and the broadcasted location offset between sub-satellite point and the cell reference location**
4. **cell type (fixed or moving), reference location coordinates with a time stamp, and the velocity of reference location**
5. **cell type, reference location corresponding to the epochTime (reuse the existing epochTime).**

**Proposal 4: The discussion on assistance information of neighbour cell for UE to estimate when the neighbour cell starts providing coverage at the present UE location is postponed.**

**Proposal 5: The discussion on whether to relax neighbour cell measurements before the serving cell stops providing coverage at the present UE location is postponed.**

**Proposal 6: RAN2 to further discuss whether t-service needs to be provided in system information in case of feeder link switch.**

**Proposal 7: RAN2 to further discuss whether the cell type (i.e. “TN” vs “NTN”) of a neighbour cell can be indicated implicitly by existing system information, e.g., SIB19 or band numbers.**

**Proposal 8: Regarding the Assistance information for UE to identify an area where TN network is available, the following options can be further discussed:**

1. **The cell center and cell radius of TN neighbour cells, or in other terms, the reference location and a distance threshold of TN neighbour cells**
2. **The boundary line between TN area and NTN area**
3. **For quasi-earth fixed cells, TN coverage is described by a distance range from the cell center and an angle range based on a reference direction**
4. **An indication could be included in system information to indicate NTN cell’s coverage overlaps with terrestrial TN cell’s coverage**
5. **NTN cell can be divided to several virtual areas based on certain criteria. The virtual areas and the corresponding TN frequency information are broadcast as assistance information to help UE perform more accurate TN measurements.**
6. **Introduce a parameter using the polygon shape captured in TS 23.032 to describe the coverage area of a TN neighbour cell.**