**3GPP TSG RAN WG2#121 R2-2301953**

**Athens, Greece, February 27th - 3rd March, 2023**

**Source: ZTE Corporation, Sanechips**

**Title: [AT121][104][NR NTN enh] NTN-NTN cell reselection (ZTE)**

**Agenda item:** **8.7.4.1.2**

**Document for:** **Discussion and Decision**

# Introduction

This document is intended address NTN-NTN cell reselection open issues as per the following email discussion guidelines:

* [AT121][104][NR NTN enh] NTN-NTN cell reselection (ZTE)

Initial scope: continue the discussion on trigger for measurements and cell reselection criteria enhancements based on the selected papers above

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

Please note the following deadlines:

* Deadline for companies' feedback:  **Thursday 2023-03-02 22:00 EET**
* Deadline for rapporteur's summary (in R2-2301953): Friday 2023-03-03 08:00 EET

Companies providing input to this email discussion are requested to leave contact information below.

|  |  |  |
| --- | --- | --- |
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# Discussion

## Trigger for measurements

### Location based trigger

The following agreements have been made at first online of RAN2#121:

|  |
| --- |
| Agreements:   1. In R18, for earth-moving system, satellite with steerable beam is not considered as part of mobility enhancement in NTN. 2. A serving cell reference location and a distance threshold/radius will be broadcast for earth-moving cell. FFS on whether the R17 IEs are reused or not. FFS on whether additional information needs to be broadcast to inform the UE how the reference location moves over time or if this can be derived from other information (e.g. Epoch time and ephemeris). 3. For cell selection/reselection, location-based measurement initiation is supported in earth-moving cell |

For earth-moving cells the key issue is how to update or track the movement of serving cell reference location with the movement of satellite. In [1], it explained that for moving cell with fixed beam the serving cell reference location is relatively static to satellite. If satellite’s trajectory can be derived, then the serving cell reference location can be known too. The assumption of NTN is that UE can derive satellite’s trajectory based on the satellite ephemeris and epochTime which means this information can also be used for estimating the trajectory of serving cell reference location associated to the satellite at epochTime. For example, UE is provided with the reference location at epochTime and satellite ephemeris, then UE can derives the angles between the reference location and satellite’s nadir. Because the beam is fixed, the angle remain unchanged with the movement of satellite. Therefore, as long as the satellite’s position is known, UE shall be able to derive the reference location with respect to the satellite.

**Question 1.1) Do companies agree that for earth-moving cell with fixed beam, the trajectory of serving cell reference location can be derived by UE based on satellite’s ephemeris and ephochTime. If not, please elaborate why it is not feasible in the “Comments” row.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Intel | agree |  |
| Lenovo | No | We have concerns on deriving movement of cell reference location solely relying on ephemeris. Firstly, the trajectory of satellite represented by ephemeris is an ellipse which is not parallel to the earth, meaning that the velocity of satellite does not equal to the velocity of its projection (e.g., cell reference location) on earth. Secondly, the elevation angle between the reference location and the satellite, which is not part of ephemeris, also affects the velocity of the velocity of the cell reference location. As a result, we think there could be error or complex calculation for the UE to derive trajectory of cell reference location only based on ephemeris. |
| OPPO | agree | Under the assumption on earth-moving cell with fixed beam, one way to derive the trajectory of serving cell reference location is based on the sub-satellite point, i.e., the intersection of the line from the Earth center to the satellite with the earth's surface. According to the satellite’s ephemeris and epoch time, the sub-satellite point on ground could be derived, which has been easily implemented for satellite system. |
| LGE | Yes with comment | We think that UE should know the orbit of satellite to derive real-time reference location. If UE cannot derive such ortbit from ephemeris, additional assistance information is needed. |
| vivo | No | The trajectory of satellite movement is an ellipse in the sky while the reference location is a point on the ground and the trajectory of reference location is a circle, so for moving cell with fixed beam the serving cell reference location is not relatively static to satellite. Thus, we don’t think the trajectory of serving cell reference location can be derived based on satellite’s ephemeris and epochTime.  Also, we wonder if UE behaviour on how to derive reference location needs to be specified, if we go with this way. If we leave it to UE implementation, there is bound to be inconsistent UE behaviours on how the referenc location is calculated among UEs. |
| Google | agree |  |
| Apple | Yes with comments | We think that the trajectory of serving cell reference location can be derived based on satellite’s ephemeris and epochTime. But we are not sure about the accuracy. Maybe we should check it with RAN1 and RAN4. |
| MediaTek | Agree |  |
| Samsung | No | Agree with Lenovo and vivo. For earth-moving cell with fixed beam, there is still relative motion between reference location and satellite due to their different trajectories.  If ephemeris is provided by orbital parameters, we understand the UE can derive the ground track of sub-satellite point. But we are not sure the distance between the reference location and sub-satellite point is fixed since the satellite trajectory is epllise and the sub-satellite trajectory is on the groud which are not parallel to each other.  If ephemeris is provided by PVT parameters, we are not sure the UE can derive the trajectory of satellite or the ground track of sub-satellite point.  With these uncertainties we don’t think UE can derive reference location movement soly based on ephemeris and epoch time.  Even without these uncertainties, we still have concern about the computation complexity and the computational power consumption for UE, especially for idle/inactive UE. |
| ITRI | agree |  |
| Nokia | In principle yes | Based on the ephemeris (e.g. PVT data) and the epochTime the UE can calculate how the reference point will be moved in time over the Earth surface. Even if the calculation is simplified (and does not take into account the Earth curvature), the inaccuracy shall not be excessively large to invalidate this functionality. |
| ZTE | Agree | One thing needs to be highlighted here is that when RAN1 discussing the which formats used to indicate satellite ephemeris, it is their understanding that the PVT and satellite orbits provide equivalent information and they can be used to derived from each other. Otherwise the whole mechanism for UE to perform precompensation cannot work. |
| TCL | Agree |  |
| CMCC | agree |  |
| CAICT | No | Same view with lenovo and vivo. the trajectory of satellite is ellipse, so the speed of sub-satellite point is not stable on the ground. It is not accurate to calculate the serving cell reference location based on the satellite’s ephemeris and ephochTime. |
| Transsion | Agreed | R17 RAN2 had introduced IE *ntn-config* that contains ephemeris information, position and velocity, which provided trajectory information of a cell. The reference location shall moved with the trajectory. UE can use the ephemeris to estimate and update reference location independently. |
| Xiaomi | Agree |  |
| CATT | No | Have the same view with Samsung that, for earth-moving cell with fixed beam, there is still relative motion between reference location and satellite due to their different trajectories. And we think, by the ephemeris and epochTime, only the trajectory of sub-satellite point can be derived, but the reference location of serving cell cannot be drived. So a location offset between sub-satellite point and the reference location of the serving cell is needed.  According to the analysis, the rapporteur may want to derive the angles between the reference location of the serving cell and satellite’s nadir by the reference location at epochTime and satellite ephemeris. Then, why not just to provide the location offset between sub-satellite point and the reference location directly? The location offset can be a constant, so, there will no update issue. In our views,the method which provide the location offset is ingenious and elegant. |
| ASUSTeK | agree |  |
| China Telecom | No | If UE could derive the trajectory of serving cell reference location, we think R17 UE could support location-based cell reselection in earth-moving cell. That is what needs to enhance in R18. |
|  |  |  |

If above understanding is confirmed, it still needs discussed whether more information other than epochTime and ephemeris (e.g., validity timer) is needed or not. Companies support validity timer indicates it is to avoid frequent SI update caused due to update of reference location.

Rapporteur observes that current NTN ephemeris information will be provided together with ntn-UlSyncValidityDuration, which specifies the time period that the ephemeris is considered as valid. Since UE needs a valid ephemeris information to estimate the movement of reference location, it is straightforward that current can be used to to update reference location if needed, therefore a new timer seems unnecessary. Company are welcome to provide their comments on whether additional assisting information is needed apart from the ones have already known in SIB19.

**Question 1.2) With the above understanding, do companies consider additional information apart from that can be provided in SIB19 (i.e.,ephemeris, epochTime,** **ntn-UlSyncValidityDuration ) is needed for UE to derive the trajectory of reference location? If so, please elaborate which parameters are needed, how they can be used, and why current SIB19 parameters are inadequate.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Yes/No** | **Comments** | |
| Intel | yes | If PVT ephemeris is broadcast, multiple reference locations and the corresponding time stamps should be provided by NW. if orbital parameters are broadcast, we agree current single reference location is sufficient. | |
| Lenovo | Yes | As we analyzed in Q1.1, ephemeris only is not sufficient and more information is needed. Multiple options can be considered, including indication of cell reference location movement or multiple locations with time stamps. | |
| OPPO | Yes | Under the assumption on earth-moving cell with fixed beam, besides the satellite’s ephemeris and ephochTime, in order to derive the the trajectory of serving cell reference location, UE also needs to know either one of the following additional information:  1) cell reference location at a certain time, e.g., epochTime  2) cell reference location relative to sub-satellite point  In our understanding, the cell reference location relative to sub-satellite point would be more straightforward for the derivation of the trajectory of reference location. | |
| LGE | Yes | We have a same view with Intel. NW should provide the multiple reference locations and their corresponding time information if UE does not know the orbit of satellite. | |
| vivo | Yes | From Intel’s comments, it seems that the method of “UE autonomous derivation of reference location based on ephemeris” is not a stand-alone method, and may not work in some cases (e.g. PVT based ephemeris) where still time-variance reference point is needed. We prefer a unified solution which can cover all cases, and disagree to go with this ephemeris based UE autonomous derivation method.  The parameters in our mind is that we need to have a reference location, a distanceThresh and a new validity timer. The UE gets the reference location, and reaquire it after the associated new validity timer expires. If the UE finds its current distance apart from the reference location is larger than the distanceThresh, it shall perform neighour cell measurements.  For whether reference location and/or distanThresh are new or reuse of existing R17 parameters, see comments for Q1.3 and 1.5 (i.e. as long as not both of them are resuing the R17 parameter).  After seeing companies’ comments/preference, it seems that the solution “multiple reference location + time stamp” supported by a number of companies is a stand-alone solution that can cover all cases and it can avoid complexity of UE autonomous derivation. We are also OK for this solution (at least for the PVT case). | |
| Google | - | Agree with Intel. | |
| Apple | Yes with comment | If NW can provide mulitple reference location and associated timestamp, it would be helpful to increase the accuracy. | |
| MediaTek | Yes | Agree with Intel | |
| Samsung | Yes | There is no guarantee the UE can derive reference location movement only based on ephemeris (either orbitial or PVT parameters) and epoch time. The straightforward way is to directly provide the reference location velocity V(speed and direction) on top the coordinates at a timestamp t0 as the starting time. Then the reference location coordinates at time t are simply derived as (X\_t,Y\_t) = (X\_t0, Y\_t0) + (Vx \* (t-t0), Vy \* (t-t0)). This saves a lot of computation at the UE, and thus is power saving.  The beam motion information is already available at the gNB according to the exemplary NTN implementation in 38.300 (see our paper R2-2301480). | |
| ITRI | Yes | In order to estimate the current location of the reference location of the serving cell, UE need to differentiate earth-moving cells from quasi-earth fixed cells if orbital parameters are broadcast. | |
| Nokia |  | Not sure something more is needed. Even in case of PVT parameters, there is a directionality included there (three dimensional info is there), so maybe multiple reference points are not needed? | |
| ZTE | No | As commented in Q1, PVT is equivalent to orbit information, it is assumed they can be derived from each other. | |
| TCL | Yes | Multiple reference locations with the corresponding time stamps or reference velocity can be provided by NW to improve the accuracy and simply the computation. | |
| CMCC | No | Existing assistance information is sufficient | |
| CAICT | Yes |  |
| Transsion | Yes | For UE power saving purpose, RAN2 can introduce another new reference location and a new distance threshold which can be used to measurement relaxation while UE is within a range that expanded from the new reference location reference location and no larger than the new distance threshold, where the reference location is located in front of the cell moving direction. |
| Xiaomi | Yes | The corresponding time stamp for the reference time should be provided as well. |
| CATT | Yes | Share the same view as OPPO. A relative location, e.g. (Δx1, Δy1) in the following figure, between sub-satellite point and the reference location of the serving cell is needed. See our comment in Question 1.1). |
| ASUSTeK | Yes | The UE could derive real-time reference location based on a received reference location and information such as velocity and time stamp. |
| China Telecom | Yes | Assistant information for UE to derive the reference point change is needed. |
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Another ffs issue is whether R17 IEs (i.e., referenceLocation) can be reused to indicate the serving reference location for erth-moving cell. Based on companies’s comments online, the concern on reusing the referenceLocation for earth-moving cell is that UE may not be able to differentiate between a earth-fixed cell and a earth-moving cell. In response to this concern, one possible way is that UE can rely on the presence of t-service to know if it is a quasi-fixed cell or not. Companies are kindly asked to provide their preference and comments if any.

**Question 1.3) Do companies agree to reuse referenceLocation to indicate the serving cell reference location for moving cell? If not, please add your comments in below table.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Yes/No** | **Comments** | |
| Intel | no | t-service is still optional, we prefer to define a new parameter for reference location in earth-moving cell | |
| Lenovo | FFS | Considering that referenceLocation was introduced for quasi-earth-fixed cell, we can first determine what to be indicated for moving cell and then see whether referenceLocation can be reused. | |
| OPPO | No | In order to differentiate between a earth-fixed cell and a earth-moving cell, we propose to introduce new parameters for earth-moving cell, i.e., cell reference location relative to sub-satellite point. | |
| LGE | No | Earth moving cell may also need t-Service due to feeder link switch. In this case, we prefer to reuse t-Service and define a new parameter for reference location in earth moving cell. | |
| vivo | No | In the current spec., *referenceLocation-r17* is only applicable to quasi-Earth fixed cells, so a new field of reference location for earth-moving cell is preferred. Also t-service cannot solve the distinction issue as indicated by Intel. | |
| Google | No | As discussed in the online session, we may need a new IE providing the reference location information for the earth-moving cell, to make UE aware this is an Earth-moving cell and hence need to derive the trajectory of the reference location. | |
| Apple | FNo | From backword compability issue, introducing new IE is better. | |
| MediaTek | No | New IE seems to avoid confusion. | |
| Samsung | No with comment | The current field description of rel-17 reference location indicates the IE is for NTN quasi-Earth fixed system. If additional parameters specific for earth moving cell is provided and applied together with the Rel-17 refenence location (e.g., a new timestamp or velocity), then the new parameter can implicitly indicate the cell is earth-moving and thus the rel-17 reference location IE can be reused with field description updated. If implicit indication is not feasible, a new IE is needed. | |
| ITRI | No | We share the same view with LG. | |
| Nokia | Better not | A new field would be a cleaner approach, as some companies commented above. | |
| ZTE | Yes or postponed | The intention is to avoid unnecessary redundancy in signalling. As indicated by other companies, the concern is on how to do differentiate and since t-service is optional than it may not be able to work for all cases. However, it is noted this information will be provided together with a distanceThreshold anyway, then only one of the two fields is presented as a by new IE then it shall be able to allow differentiation. In this case it is preferred to reuse the same IE for referenceLocation and introduce new IE for distance Threshold.  But perhaps for now we can postpone the decision and sort it out during stage 3 since it is also not clear if they are any new parameters can be used to serve this purpose. | |
| TCL | No | Agree with majority. A new field is a easy and clean way. | |
| CMCC | Maybe | For earth moving case, the reference location will be changed with satellite movement, therefore the time information related to the real-time reference location is needed. If agree to reuse the R17 IEs, then we could add time information in the IEs and up to NW configuration according to the actual case(e.g.earth moving case). | |
| CAICT | Yes |  |
| Transsion | No | For moving cell, the cell is moving and the remaining serving time is different between UEs, that is the R17 *t-service* can not be reused in moving cell. Regarding reusing R17 reference location, which had been identified as quasi-earth fixed cell, that is, it can not be reuse to identify another type cell. |
| Xiaomi | No | Prefer to introduce a new IE. |
| CATT | No | Introducing a new IE for the reference location of earth moving cells will make the mechinasm clearer. The reference location can be in form of a relative location relative to sub-satellite point.  The *referenceLocation-r17* introduced for earth fixed cell reused the format in TS37.355, shown as follow:  Ellipsoid-Point ::= SEQUENCE {  latitudeSign ENUMERATED {north, south},  degreesLatitude INTEGER (0..8388607), -- 23 bit field  degreesLongitude INTEGER (-8388608..8388607) -- 24 bit field  }  However, considering the range of the coordinate for relative location could be smaller than the current Ellipsoid-Point for referenceLocation, the reference location can be defined with lower accuracy, e.g., INTEGER (0..65535). If relative location relative to sub-satellite point is adopted for earth moving cell, this will be some reduction in signalling overhead. |
| ASUSTeK | No | A new IE could be provided in SIB19. |
| China Telecom | No strong view | UE could distinguish earth-moving and earth-fixed cell on other information. Whether to reuse the reference location IE is just a stage-3 problem. |
|  |  |  |

Furthermore RAN2 has agreed for cell selection/reselection, location-based measurement initiation is supported in earth-moving cell. Rapporteur understands the intention is to reuse the mechanism for quasi-fixed cell where UE initiates measurements when its location to serving cell reference location is larger than the configured distance threshold. In order to guarantee that companies understanding is on the same page, it is proposed to discuss if for earth-moving cell, the location-based cell measurement rules of quasi-fixed mechanism is reused.

**Question 1.4) Do companies agree for earth-moving cell, the location-based cell measurement rules of quasi-fixed mechanism is reused, i.e., for cell reselection in earth-moving cell, UE initiates measurements when its location to serving cell reference location is larger than the configured distance threshold?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Intel | Yes |  |
| Lenovo | Yes |  |
| OPPO | Yes |  |
| LGE | Yes |  |
| vivo | Yes |  |
| Google | Yes |  |
| Apple | Yes |  |
| MediaTek | Yes |  |
| Samsung | Yes |  |
| ITRI | Yes |  |
| Nokia | Yes |  |
| ZTE | Yes |  |
| TCL | Yes |  |
| CMCC | Yes |  |
| CAICT | Yes |  |
| Transsion | Yes |  |
| Xiaomi | Yes |  |
| CATT | Yes |  |
| ASUSTeK | Yes |  |
| China Telecom | Yes |  |
|  |  |  |

With above understanding, a distance threshold is needed to enable location-based measurement initiation for cell reselection in earth-moving cell. Two options have been proposed to indicate the distance thresh on whether it is proposed to reuse the distanceThresh for the same purpose, while there are proposals to have new IEs to have clear differentiation between earth-moving and quasi-fixed cells.Companies are welcome to provide comments on if distance threshold is needed and provide their preference on whether to reuse distanceThresh or new IE for earth-moving cell.

**Question 1.5) Do companies agree a distance threshold is needed for location-based measurement initiation for cell reselection in moving cells? If so, please indicate your preference on how to indicate this information (e.g., reuse distanceThresh or use new IE). Comments are welcome.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Yes/No** | **Reuse distanceThresh or new IE?** | **Comments** |
| Intel | Yes | New IE | Similar to the answer to Q1.3 |
| Lenovo | Yes | FFS | We can first determine what to be indicated for moving cell and then see whether distanceThresh can be reused. |
| OPPO | Yes | New IE | Similar to the answer to Q1.3 |
| LGE | Yes | Reuse | Existing *distanceThresh* can be applied to earth moving cell exactly the same to qausi-earth fixed cell. |
| vivo | Yes | Reuse distanceThresh or new IE | If we can confirm that there is a new reference location introduced, then it is OK to reuse the distanceThresh. We are also OK to introduce a new distanceThresh. Anyway, we cannot have both distanceThresh and reference location reuse those of Rel-17. |
| Google | Yes | Reuse distanceThresh | Distance threshold for an Earth-moving cell does not chage along with the satellite movement. Since this is the same as the quasi-Earth-fixed cell case, we do not see a good reason to introduce a new IE for it. |
| Apple | Yes | See comment | If new reference location is introduced, and new IE is needed for this. |
| MediaTek | Yes | Reuse |  |
| Samsung | Yes | reuse |  |
| ITRI | Yes | FFS | If a new parameter is introduced for UE to differentiate between earth-moving cell and quasi-earth fixed cell, esisting *distanceThreshold* can be reused as a distance threshold for location-based measurement initiation. Otherwise, a new parameter needs to be introduced. |
| Nokia | Yes | Reuse |  |
| ZTE | Yes | Reuse | But again, probably we can wait in stage 3. |
| TCL | Yes | Reuse |  |
| CMCC | Yes | Both are fine |  |
| CAICT | Yes | Reuse |  |
| Transsion | Yes | Reuse | R17 renference location and distance threshold can be reused to initial measurement. |
| Xiaomi | Yes | Reuse |  |
| CATT | Yes | reuse | If Q1.3 agree to introduce new parameters for the reference location of earth-moving cell, the distance threshold can be reused. |
| ASUSTeK | Yes | Reuse |  |
| China Telecom | Yes | reuse |  |
|  |  |  |  |

### Time-based trigger

It is unclear for moving cell, whether time-based measurement initiation is also needed. Based on companies contribution, there are two possible scenarios for time-based measurement initiation:

* Case 1: Stop time due to service link change
* Case 2: Stop time due to feeder-link switch

For case 1: the intention is to introduce a t-service like mechanism as for quasi-fixed system, where the time when satellite is going to stop provides coverage is provided to UE so that it can start measurements for cell reselection before stop time. And this time information is common for all UEs within this coverage and deterministic for quasi-fixed system. However for earth-moving cells, the time the serving cell stops providing service to UE is not the same therefore t-service based measurement may not so meaningful for earth-moving cells.

For case 2, rapporteur understands the feeder-link switch timing is common to all UEs and deterministic, there it is possible to specify a time-based mechanism for this scenaerio.

Companies are encouraged to provide comments on whether time-based initiation measurement is needed for earth-moving cel and what’s the interested scenarios.

**Question 1.6) Companies are kindly asked to indicate their preference on whether to support time-based int measurement initiation for moving cells and the erested scenarios for study as shown below:**

* **Case 1: Stop time due to service link change**
* **Case 2: Stop time due to feeder-link switch**
* **Others, if any**

**Comments are welcome.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Support /Not support** | **case 1 or case 2 or both or..** | **Comments** |
| Intel | Not support |  | We understanding in earth-moving cell, the distance based trigger is actually coverage based trigger. And time based trigger is just another condition that also relies on coverge prediction. |
| Lenovo | Support | At least Case 2 | We think at least for Case 2 it is necessary. Also, if coverage prediction is available, Case 1 can also be considered, depending on whether to introduce the stop time. |
| OPPO | Support | Case 2 and Others | For earth moving cell, case 1 is equivalent to the location-based measurement initiation rule, therefore it is redundant and not necessary to introduce time-based measurement intiation rules for case 1.  For time-based measurement initiation rules, we also think the stop time should be cell-common and deterministic. Beside case 2, i.e., the stop time due to feeder-link switch, another options is that we can introduce a new time threshold according to the time when the moving serving cell comes across some neighbour cells’ coverage. These neighbour cells can be earth-fixed cells, earth moving cells of other orbits, and TN cell, which is up to network deployment. |
| LGE | Support | Case 2 | We agree with Intel for Case 1. However, feeder link switch cannot be predicted by UE. NW should provide the time when the feeder link switch occurs. Accordingly, UE shall follows time-based measurement initiation. |
| vivo | Support | Both | For case 1, the stop time due to the service link switching is a UE specific time and it should be estimated by UE itself, a similar rule for the location-based measurement initiation can be used. For case 2, the stop time that is common to all the UEs in the cell, the stop time due to feeder link switching can be broadcast by the network. |
| Google | FFS | FFS for Case 2 | Case 1 will be identical to the distance-based measurement initiation, and hence is not needed.  Case 2 might be beneficial for the soft feeder-link switch case. But for the hard feeder-link switch case, we wonder whether the UE might be beneficial from triggering measurement upon the stop time. |
| Apple | Support | Case 2 | We only see the benefit in case 2. |
| MediaTek | Not needed |  |  |
| Samsung | support | At least case 2 | We see the t-service can work for feeder link switch. |
| ITRI | Support | Case 2 | Feeder link switch time is cell common and is not predictable by UE. However, some UE served by the earth-moving cell may need to perform cell reselect due to satellite movement even before feeder link switch.  We think location-based trigger is also needed when time-based trigger is configured. |
| Nokia | Partly support | Case 2 | FL switch could be indicated. |
| ZTE | Partially | Case 2 | We can further study feederlink switch use case, but for moving cells perhaps only location based initiation is sufficient. |
| TCL | Support | Case 2 | It is beneficial for case 2 clearly. |
| CAICT | Support | Case 2 | It is beneficial for case 2 clearly. |
| Transsion | Support | Case 2 | For case 1, the cell stop service time is different for UEs.  For case 2, the cell stop service time is common for UEs. |
| Xiaomi | Spport | Case 2 | The feeder link switch time it the same for all UEs and the R17 time based neighbour cell measurement can be reused. |
| CATT | support | Case 2 | For case 1, location-based mechanism is enough. The time-based is used to solve the feeder link switch. |
| ASUSTeK | Not support |  |  |
| China Telecom | Support | Case 2 | Stop time is only useful in case 2. |
|  |  |  |  |

## Cell reselection criteria

Location-based cell reselection and time -based cell reselection have discussed in R17 but not concludes. Location-based cell reselection criteria is proposed to limit the number of candidate cells to be considered for cell reselection while time-based measurement initiation can help UE to reselect to serving cell with longer serving time so that cell reselection frequencies is reduced. Both is helpful for power consumption reduction, which is also one of the cell reselection enhancement purpose. Based on the proposals, companies are kindly asked to provide comments on whether to support location-base cell reselection criteria and /or time-based cell reselection criteria.

**Question 2.1) Companies are kindly asked to indicate their preference on whether to support time-based location-base cell reselection criteria and /or time-based cell reselection criteria for NTN-NTN cell reselection. Comments are welcome.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Support location-based**  **(Yes or No)** | **Support time-based**  **(Yes or No)** | **Comments** |
| Intel | Yes | No | Similar comments as in Q1.6 |
| Lenovo | Yes | Yes | Time-based at least for feeder link switch. |
| OPPO | Yes | No | The start/stop times of neighbour cell are beneficial for deciding when to initiate measurement for cell (re-)selection, but it is not needed to serve as the cell reselection criteria for cell ranking. |
| LGE | Yes | Yes with comment | In earth moving scenario, we understand that remining service time of serving cell is quite different although UE has the same distance between reference location. For example, UE has short remaining service time when satellite moves away from it In contrast, UE has long remaining service time when satellite moves toward UE. It is impossible to distinguish these two cases with location-based criteria. Therefore, time-based cell reselection criteria should be introduced to reduce frequent cell reselection. |
| vivo | No | No | Location-based cell reselection criteria and time-based cell reselection criteria have been extensively discussed in R17, but no relevant agreements have been reached, so from our perspective, we should prioritize the discussion of other issues to complete related features instead of spending time discussing this topic. |
| Google | Yes | No | Is this question applicable to both quasi-Earth-fixed and Earth-moving scenarios? If it is for both scenarios, as now only the reference location is the common parameter that will be signalled in both scenarios, we prefer to support only the location-based scheme. |
| Apple | No | No | Same view as vivo.  In R17, the time-based/location-based cell reselection criteria was extensively discussed but not agreed finally.  In R18 NTN scenario, we donot see any special points which can help the discussion. |
| MediaTek | No | No | Agree with Apple and vivo |
| Samsung | Yes | No | Location-based criteria can be commonly applied to fixed and moving cell, while we don’t see how this commonality for time-based criteria. |
| ITRI | Yes | Yes | Some UE served by the earth-moving cell may need to perform cell reselect due to satellite movement even before feeder link switch.  We think location-based trigger is also needed when time-based trigger is configured. |
| Nokia | No | No | Agree with vivo. |
| ZTE | Yes | Yes | At least location based solution can be supported for NTN-NTN cell (re)selection, which can help limit the number of candidate cells to be considered thus reducing power consumption. The reason it is not finished is due to limit time left in R17. Since we are considering power saving in R18, and it is initial phase we can pick up what have left and continue the discussion. |
| CAICT | Yes | Yes |  |
| Transsion | No | No | This topic had been discussed in R17 and still can not reach consensus. |
| Xiaomi | No | No | We should focus on the neighbour cell measurement as R17. |
| CATT | No | No | Both location-based and time-based will complicate the cell reselection criteria i.e. R criterion, considering the current network deployment, it is not very possible UE could under serval neighbour cells coverage at the same time. The enhancement seem meaningless.   * Location-based:   Especially not for earth-fixed cell. In case of earth-fixed cell, the distance to the reference location of neighbour cells can neither reflect the RSRP nor the remaining serving time. In case of earth moving cell, UE needs to calculate the real time reference location of serval neighbour cells. This will bring large calculate consumption to UE.   * Time-based:   The NW need to provide the remaining serving time of neighbour cells. Which will bring additional signalling overhead to UE. Especially for earth moving cell, the remaining serving time is different for different UEs, only the reference location can be provided, same as location-based mechanism. |
| ASUSTeK | No | No | Agree with Apple |
| China Telecom | Yes | Yes | We notice most companies think time and location information are useful for NTN cell reselection. It is straightforward to add them into reselection criteria. |
|  |  |  |  |

Companies supporting to specify location and/or time-based cell reselection criteria for NTN-NTN cell reselection are invited to provide comments to subsequent questions on the discussion on detailed solutions.

For location based solution, the following options have been identified in R17 for further study.

* **Option 1: Introduce a distance threshold. Cell ranked on R-criterion first and then the distance threshold applies to down scope the candidate cells for reselection.**

- Step 1: UE perform cell ranking based on the R-criterion.

- Step 2: Among the highest ranked N cells:

- For cells provided with reference location: only those whose distance to UE shorter than the distance threshold will be considered by UE as candidate cells.

- For cells not provided with reference location:

Alt.1: Not considered as candidate cell for reselection

Alt.2: Considered as candidate cell for reselection

- Step 3: Among all the candidate cells decided by on the distance threshold in step 2, UE reselect to the highest ranked cell based on R-criterion.

* **Option 2: Introduce a distance threshold. Distance threshold applies to decide the candidate cells and then rank the candidate cells based on R-criterion to decide the target cell for reselection.**

- Step 1:

- For cells provided with reference location: UE evaluate the distance to neighbour cell reference location and only consider cells whose distance to UE are shorter than the threshold to be candidate cells for cell ranking;

- For cells not provided with reference location:

Alt.1: Not considered as candidate cell for reselection

Alt.2: Considered as candidate cell for reselection

- Step 2: UE perform cell ranking on candidate cells decided in step 1 according to R-criterion.

- Step 3: UE reselect to the highest ranked cell.

* **Option 3: Cell ranked on R-criterion first and then the distance criteria applies to decide the target cell for reselection.**

- Step 1: UE perform cell ranking based on the R-criterion.

- Step 2: Among the highest ranked N cells:

- For cells provided with reference location, UE reselect to the cell with the smallest distance to the cell’s reference location.

- For cells not provided with reference location, UE reselect to the highest ranked cell based on R-criterion.

Companies supporting location based solution are invited to provide comments on below

**Question 2.2) Which option do companies prefer to adopt for location based cell reselection in NTN? If option 1/2 is selected, please further indicate which alternative is preferred on the handling of cells not provided reference location.**

* **Option 1: Introduce a distance threshold. Cell ranked on R-criterion first and then the distance threshold applies to down scope the candidate cells for reselection.**
  + **For cells not provided with reference location:**
    - **Alt.1: Not considered as candidate cell for reselection**
    - **Alt.2: Considered as candidate cell for reselection**
* **Option 2: Introduce a distance threshold. Distance threshold applies to decide the candidate cells and then rank the candidate cells based on R-criterion to decide the target cell for reselection.**
  + **For cells not provided with reference location:**
    - **Alt.1: Not considered as candidate cell for reselection**
    - **Alt.2: Considered as candidate cell for reselection**
* **Option 3: Cell ranked on R-criterion first and then the distance criteria applies to decide the target cell for reselection.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Option 1/2/3/other** | **Alternative 1/2 if option 1/2 is selected** | **Comments** |
| Intel | Option 2 | Alt.2 | Distance threshold can be used to rule out some candidate cells to save UE power on measurements. |
| Lenovo | FFS |  | We think it is too early to discuss this, considering that the distance-based ranking depends on the indication of cell reference location. After determining on how to indicate the reference location for a moving cell, we can discuss this. |
| OPPO | Option 3 |  | For both Option 1 and Option 2, we think using an absolute distance threshold to filter candidate cells is problematic because coverage of different NTN cells varies a lot. Using a small distance threshold may undesirably prevent UE from reselecting an NTN cell with large coverage. Besides, since the near-far effect in NTN is not so obvious as TN, a cell with the best RSRP may not be the most suitable cell due to the measurement accuracy issue.  For Option 3, there is no absolute distance threshold, so the issue due to the different NTN coverage does not exist. To some extent, location-based criterion plays the similar role as the legacy beam metrics (i.e., rangeToBestCell and absThreshSS-BlocksConsolidation) in form. Considering RSRP not clearly reflecting the near-far effect in NTN, we should rather consider ranking using the distance information, i.e. cell ranked on R-criterion first and then the distance criteria applies to decide the target cell for reselection. |
| LGE | Option 2 | Alt.2 | Same view with Intel. |
| Google | Option 2 | Alt.2 | Agree with Intel. |
| MediaTek | None | None |  |
| Samsung | Option 3 |  | Agree with OPPO, more importantly Option 3 can be applied to both fixed and moving cells. |
| ITRI | Option 2 | Alt. 2 | Same view with Intel. |
| ZTE | Option 1 | Alt 1 | For option 1 since R-criteria is used then only up to N cells is needed to be compared while option 2 needs to compare with all cells provided with reference location. For option3 we are worried if only distance is used to select the highest rank cell as target, than there might be interference issue. |
| CMCC | Option 2 | Alt.1 | Option 2 could help UE to reduce measurement with the candidate neighboring cells narrowed down. Then alt.1 may be more reasonable due to that alt.2 may lead to invalid measurement. |
| Xiaomi | Option 3 |  |  |
| CATT | None | None |  |
| China Telecom | Option 2 | Alt.1 | Option2 saves measurement energy. For Alt.2, we have doubt that how to decide the threshold is meet without reference location. |
|  |  |  |  |

For time-based solutions it is proposed that UE shall consider neighboring cell’s serving time into account when performing cell reselection. And below options have been proposed:

* Opt-1) Filtering neighbor cell with RST.  
  Step-1. UE calculates RST of neighbor cells.  
  Step-2. UE treats a neighbor cell as barred if RST of neighbor cell is shorter than time threshold.  
  Step-3. UE performs R-value-based ranking evaluation to neighbor cells.  
  Step-4. UE performs cell reselection to the highest ranked cell.
* Opt-2) Filtering neighbor cell with R-value.  
  Step-1. UE performs R-value-based ranking evaluation to neighbor cells.  
  Step-2. UE treats a neighbor cell as barred if R-value of neighbor cell is less than threshold.  
  Step-3. UE performs cell reselection to neighbor cell having the longest RST.
* Opt-3) Introduce RST-based R-value offset, in which neighbor cell having longer RST gets bigger value of R-value offset.  
  Step-1. UE calculates RST of neighbor cells.  
  Step-2. UE performs R-value-based ranking evaluation to neighbor cells.  
  Step-3. UE derives new R-value by adding RST-based R-value offset to R-value derived in Step-2.  
  Step-4. UE performs cell reselection to highest ranked cell.

Companies supporting time based solution are invited to provide comments on below questions

**Question 2.3) Which option do companies prefer to adopt for time based cell reselection in NTN-NTN cell reselection?**

* **Opt-1) Filtering neighbor cell with RST.**
* **Opt-2) Filtering neighbor cell with R-value.**
* **Opt-3) Introduce RST-based R-value offset, in which neighbor cell having longer RST gets bigger value of R-value offset.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1/2/3/other** | **Comments** |
| Intel | none | If reference location and distance threshold are provided for neighbour cells, the distance based neighbour cell selection can also be applied. So we don’t need to introduce another concept of RST. |
| Lenovo | FFS | We think it is too early to discuss this, considering that the time-based ranking depends on the indication or prediction of cell stop serving time. After determining on how to indicate the reference location for a moving cell, we can discuss this. |
| OPPO | none |  |
| LGE | Option1/2/3 | As adressed in Q2.1, we believe that time-based cell reselection should be introduced in Rel-18. All options are acceptable to us. |
| Google | None |  |
| MediaTek | None |  |
| Samsung | none |  |
| ITRI | none | For time-based solutions, cell reselection based one R-value-based ranking would be sufficient. |
| ZTE | Others | To prioritize cells with longer service time among cells have similar radio quality is safer compared to rule out cells with service time less than threshold. In case there is no cell has RST higher then thresholds UE still needs to camp on one of them as long as the reselection criteria is met. |
| CATT | None |  |
| China Telecom | Option1/2/3 | We are open to the time related filtering neighbor method. It can help UE camp to a cell longer. |
|  |  |  |

# Conclusions

<To be generated based on company input>

# References

1. [R2-2301142](file:///C:\\Data\\3GPP\\Extracts\\R2-2301142%20Consideration%20on%20cell%20reselection%20enhancements%20for%20NTN-NTN.docx" \o "C:Data3GPPExtractsR2-2301142 Consideration on cell reselection enhancements for NTN-NTN.docx) Consideration on cell reselection enhancements for NTN-NTN ZTE Corporation, Sanechips discussion Rel-18

1. [R2-2300344](file:///C:\\Data\\3GPP\\Extracts\\R2-2300344%20Discussion%20on%20cell%20reselection%20enhancements%20for%20earth-moving%20cell.docx" \o "C:Data3GPPExtractsR2-2300344 Discussion on cell reselection enhancements for earth-moving cell.docx) Discussion on cell reselection enhancements for earth-moving cell vivo discussion
2. [R2-2300799](file:///C:\Data\3GPP\Extracts\R2-2300799%20Discussion%20on%20NTN-NTN%20cell%20reselection%20enhancements.docx) Discussion on NTN-NTN cell reselection enhancement LG Electronics France discussion Rel-18 NR\_NTN\_enh
3. [R2-2301226](file:///C:\Data\3GPP\Extracts\R2-2301226%20Discussion%20on%20NTN-NTN%20reselection.docx) Discussion on NTN-NTN reselection CMCC discussion Rel-18 NR\_NTN\_enh-Core
4. [R2-2301364](file:///C:\Data\3GPP\Extracts\R2-2301364%20(R18%20NR%20NTN%20WI%20AI%208.7.4.1.2)%20Earth%20moving%20cell.docx) Cell reselection enhancements for Earth moving cell InterDigital discussion Rel-18 NR\_NTN\_enh-Core

# Annex: ASN.1 of SIB19

– *SIB19*

*SIB19* contains satellite assistance information for NTN access.

***SIB19* information element**

-- ASN1START

-- TAG-SIB19-START

SIB19-r17 ::= SEQUENCE {

ntn-Config-r17 NTN-Config-r17 OPTIONAL, -- Need R

t-Service-r17 INTEGER (0..549755813887) OPTIONAL, -- Need R

referenceLocation-r17 ReferenceLocation-r17 OPTIONAL, -- Need R

distanceThresh-r17 INTEGER(0..65525) OPTIONAL, -- Need R

ntn-NeighCellConfigList-r17 NTN-NeighCellConfigList-r17 OPTIONAL, -- Need R

lateNonCriticalExtension OCTET STRING OPTIONAL,

...,

[[

ntn-NeighCellConfigListExt-v1720 NTN-NeighCellConfigList-r17 OPTIONAL -- Need R

]]

}

NTN-NeighCellConfigList-r17 ::= SEQUENCE (SIZE(1..maxCellNTN-r17)) OF NTN-NeighCellConfig-r17

NTN-NeighCellConfig-r17 ::= SEQUENCE {

ntn-Config-r17 NTN-Config-r17 OPTIONAL, -- Need R

carrierFreq-r17 ARFCN-ValueNR OPTIONAL, -- Need R

physCellId-r17 PhysCellId OPTIONAL -- Need R

}

-- TAG-SIB19-STOP

-- ASN1STOP

| ***SIB19* field descriptions** |
| --- |
| ***distanceThresh***  Distance from the serving cell reference location and is used in location-based measurement initiation in RRC\_IDLE and RRC\_INACTIVE, as defined in TS 38.304 [20]. Each step represents 50m. |
| ***ntn-Config***  Provides parameters needed for the UE to access NR via NTN access such as Ephemeris data, common TA parameters, k\_offset, validity duration for UL sync information and epoch. |
| ***ntn-NeighCellConfigList, ntn-NeighCellConfigListExt***  Provides a list of NTN neighbour cells including their *ntn-Config*, carrier frequency and *PhysCellId*. This set includes all elements of *ntn-NeighCellConfigList* and all elements of *ntn-NeighCellConfigListExt*. If *ntn-Config* is absent for an entry in *ntn-NeighCellConfigListExt*, the *ntn-Config* provided in the entry at the same position in *ntn-NeighCellConfigList* applies. |
| ***referenceLocation***  Reference location of the serving cell provided via NTN quasi-Earth fixed system and is used in location-based measurement initiation in RRC\_IDLE and RRC\_INACTIVE, as defined in TS 38.304 [20]. |
| ***t-Service***  Indicates the time information on when a cell provided via NTN quasi-Earth fixed system is going to stop serving the area it is currently covering. The field indicates a time in multiples of 10 ms after 00:00:00 on Gregorian calendar date 1 January, 1900 (midnight between Sunday, December 31, 1899 and Monday, January 1, 1900). The exact stop time is between the time indicated by the value of this field minus 1 and the time indicated by the value of this field. |

#### – *NTN-Config*

The IE *NTN-Config* provides parameters needed for the UE to access NR via NTN access.

*NTN-Config* information element

-- ASN1START

-- TAG-NTN-CONFIG-START

NTN-Config-r17 ::= SEQUENCE {

epochTime-r17 EpochTime-r17 OPTIONAL, -- Need R

ntn-UlSyncValidityDuration-r17 ENUMERATED{ s5, s10, s15, s20, s25, s30, s35,

s40, s45, s50, s55, s60, s120, s180, s240, s900} OPTIONAL, -- Cond SIB19

cellSpecificKoffset-r17 INTEGER(1..1023) OPTIONAL, -- Need R

kmac-r17 INTEGER(1..512) OPTIONAL, -- Need R

ta-Info-r17 TA-Info-r17 OPTIONAL, -- Need R

ntn-PolarizationDL-r17 ENUMERATED {rhcp,lhcp,linear} OPTIONAL, -- Need R

ntn-PolarizationUL-r17 ENUMERATED {rhcp,lhcp,linear} OPTIONAL, -- Need R

ephemerisInfo-r17 EphemerisInfo-r17 OPTIONAL, -- Need R

ta-Report-r17 ENUMERATED {enabled} OPTIONAL, -- Need R

...

}

EpochTime-r17 ::= SEQUENCE {

sfn-r17 INTEGER(0..1023),

subFrameNR-r17 INTEGER(0..9)

}

TA-Info-r17 ::= SEQUENCE {

ta-Common-r17 INTEGER(0..66485757),

ta-CommonDrift-r17 INTEGER(-257303..257303) OPTIONAL, -- Need R

ta-CommonDriftVariant-r17 INTEGER(0..28949) OPTIONAL -- Need R

}

-- TAG-NTN-CONFIG-STOP

-- ASN1STOP

|  |
| --- |
| *NTN-Config* field descriptions |
| ***EphemerisInfo***  This field provides satellite ephemeris either in format of position and velocity state vector or in format of orbital parameters. This field is excluded when determining changes in system information, i.e. changes to ephemerisInfo should neither result in system information change notifications nor in a modification of *valueTag* in *SIB1*. |
| ***epochTime***  Indicate the epoch time for the NTN assistance information. When explicitly provided through SIB, or through dedicated signaling, the *EpochTime* is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signaled together with the assistance information. For serving cell, the field *sfn* indicates the current SFN or the next upcoming SFN after the frame where the message indicating the *epochTime* is received. For neighbour cell, the *sfn* indicates the SFN nearest to the frame where the message indicating the *epochTime* is received. The reference point for epoch time of the serving NTN payload ephemeris and Common TA parameters is the uplink time synchronization reference point. If this field is absent, the epoch time is the end of SI window where this SIB19 is scheduled. This field is mandatory present when provided in dedicated configuration. If this field is absent in *ntn-Config* provided via *NTN-NeighCellConfig* the UE uses epoch time of the serving cell, otherwise the field is based on the timing of the serving cell, i.e. the SFN and sub-frame number indicated in this field refers to the SFN and sub-frame of the serving cell. In case of handover or conditional handover, this field is based on the timing of the target cell, i.e. the SFN and sub-frame number indicated in this field refers to the SFN and sub-frame of the target cell. For the target cell the UE considers epoch time, indicated by the SFN and sub-frame number in this field, to be the frame nearest to the frame in which the message indicating the epoch time is received. This field is excluded when determining changes in system information, i.e. changes to *epochTime* should neither result in system information change notifications nor in a modification of *valueTag* in *SIB1*. |
| ***cellSpecificKoffset***  Scheduling offset used for the timing relationships that are modified for NTN (see TS 38.213 [13]). The unit of the field K\_offset is number of slots for a given subcarrier spacing of 15 kHz. If the field is absent UE assumes value 0. |
| ***kmac***  Scheduling offset provided by network if downlink and uplink frame timing are not aligned at gNB. It is needed for UE action and assumption on downlink configuration indicated by a MAC CE command in PDSCH (see TS 38.213 [13]). If the field is absent UE assumes value 0.  For the reference subcarrier spacing value for the unit of K\_mac in FR1, a value of 15 kHz is used. The unit of K\_mac is number of slots for a given subcarrier spacing. |
| ***ntn-PolarizationDL***  If present, this parameter indicates polarization information for downlink transmission on service link: including Right hand, Left hand circular polarizations (RHCP, LHCP) and Linear polarization. |
| ***ntn-PolarizationUL***  If present, this parameter indicates Polarization information for uplink service link.  If not present and ntn-PolarizationDL is present, UE assumes the same polarization for UL and DL. |
| ***ntn-UlSyncValidityDuration***  A validity duration configured by the network for assistance information (i.e. Serving and/or neighbour satellite ephemeris and Common TA parameters) which indicates the maximum time duration (from *epochTime*) during which the UE can apply assistance information without having acquired new assistance information.  The unit of *ntn-UlSyncValidityDuration* is second. Value *s5* corresponds to 5 s, value *s10* indicate 10 s and so on. This parameter applies to both connected and idle mode UEs. If this field is absent in *ntn-Config* provided via *NTN-NeighCellConfig,* the UE uses validity duration from the serving cell assistance information. This field is excluded when determining changes in system information, i.e. changes of *ntn-UlSyncValidityDuration* should neither result in system information change notifications nor in a modification of *valueTag* in *SIB1*. *ntn-UlSyncValidityDuration* is only updated when at least one of *epochTime*, *ta-Info*, *ephemerisInfo* is updated. |