3GPP TSG-RAN WG2 Meeting #115 Electronic R2-21xxxxx

Elbonia, 16 – 27 August 2021

**Agenda item: 8.10.3.2**

**Source: ZTE corporation, Sanechips**

**Title: Report of [AT115-e][108][NTN] idle mode aspects (ZTE)**

**Document for: Discussion and Decision**

# 1 Introduction

This is the summary of the following email discussion in RAN2#115-e meeting.

* [AT115-e][108][NTN] idle mode aspects (ZTE)

Scope: Continue the discussion on cell (re)selection aspects, with focus on stage3 details for usage of the cell expire time for quasi-earth fixed cells, but also on possible usage of cell expire time / ephemeris information for earth moving cells, considering e.g. the proposals in [R2-2107733](file:///C:\Data\3GPP\Extracts\R2-2107733_Further%20consideration%20on%20cell%20selection%20and%20reselection%20in%20NTN.docx) and [R2-2108320](file:///C:\Data\3GPP\Extracts\R2-2108320_Cell-Reselection_NR-NTN.docx)

Intended outcome: Summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals for further discussion
    - List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Thursday 2021-08-19 1000 UTC

Initial deadline (for rapporteur's summary in R2-2108889): Thursday 2021-08-19 1600 UTC

Proposals marked "for agreement" in R2-2108889 not challenged until Friday 2021-08-20 1000 UTC will be declared as agreed via email by the session chair (for the rest the discussion will further continue offline until the CB session in Week2).

Status: Ongoing

# 2 Contact information

|  |  |
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# 3 Discussion

## 3.1 Usage of the cell expire time for quasi-earth fixed cell

The following agreements have been made at RAN2#114e on the usage and provisioning of the cell expire time for quasi-earth fixed case.

*1. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is needed to assist cell reselection in NTN for earth fixed scenario.*

*2. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is used to decide when to perform measurement on neighbor cells.*

*3. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area for earth fixed scenario is broadcast to UE via system information.*

Some proposal have been shared on the details of using the timing information on when a cell is going to stop serving the area to assist measurement on neighbor cells and cell reselection for quasi-earth fixed cell.

### **Timing info assisted measurements**

Similar to the existing rules to trigger intra-frequency and inter-frequency measurements by evaluating Srxlev and Squal of the serving cell:

* Intra-frequency: UE shall perform intra-frequency measurements if the serving cell fulfils Srxlev <= SIntraSearchP or Squal <=SIntraSearchQ.
* Higher priority inter-frequency: UE shall perform measurements of higher priority NR inter-frequency or inter-RAT frequencies according to TS 38.133.
* Equal or lower priority inter-frequency: UE shall perform measurements of NR inter-frequency cells of equal or lower priority if the serving cell fulfils Srxlev <= SnonIntraSearchP or Squal <= SnonIntraSearchQ

It is proposed [1] to trigger intra-frequency and inter-frequency measurements in NTN by evaluating the remaining valid time of the serving cell:



Figure 1. An example showing the remaining valid time of the serving cell

* UE shall perform intra-frequency measurements if the remaining valid time of the serving cell Tremaining <= TIntraSearch is fulfilled.
* UE shall perform measurements of NR inter-frequency cells of equal or lower priority if the remaining valid time of the serving cell fulfils Tremaining <= TnonIntraSearch.

In [2], companies understand the use of satellite serving duration information is not an essential feature to have a working NR-NTN solution and would like to deprioritize it.

Agreements from RAN2#114:

Agreements:

1. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is needed to assist cell reselection in NTN for earth fixed scenario.
2. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is used to decide when to perform measurement on neighbor cells.
3. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area for earth fixed scenario is broadcast to UE via system information.

**Q1.1: Do companies support to introduce threshold(s) of the remaining valid time and UE will perform measurements on neighbour cells if the remaining valid time of the serving cell is shorter than or equal to the threshold(s)?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed Comments |
| Samsung | No | We think the valid time would be configured for neighboring cell (e.g. incoming neighboring cells) and the UE performs measurement on the neighboring cells when the neighboring cell starts covering the corresponding geo-location. Since in quasi-earth fixed cell, the geo-location is temporarily covered by two cells (cell to disappear and incoming cell), we don’t think the threshold is required to trigger neighboring cells measurements. For example, assuming at T1, it is covered only by satellite#1 and from T2 to T3, it is covered by both satellite#1 and satellite#2 and at T3, it is covered only by satellite#2, then we think t2 can be configured as the starting time for neighboring cell measurement and in the case, no additional threshold to trigger measurement is needed since the time duration between t2 and t3 can provide enough time for measurements. |
| Ericsson | yes | Useful for Earth fixed LEO |
| LG | Yes, but | We also think time condition is needed for triggering neighbor cell measurements, but we prefer to introduce single threshold for the service time of the serving cell.   * If remaining service time of the serving cell is shorter than a threshold, the UE performs neighbor cell measurements based on existing measurement rule (i.e. SnonIntraSearch, SIntraSearch). * If remaining service time of the serving cell is longer than a threshold, the UE is not required to perform neighbor cell measurements. |
| Sony | No | Agree with Samsung and think the time information without threshold is enough to trigger neighbour cell measurements |
| MediaTek | No | While such mechanisms could be useful to control neighbor cell measurements, in the first release of NTN we should focus on getting a working solution first before looking into such optimizations. |
| Intelsat | Yes |  |
| Thales | Yes |  |
| InterDigital | No | Agree with Samsung. UE may perform neighbour cell measurements once the new cell starts covering the corresponding location. Assistance information may be provided to the UE (i.e. measurements can be performed on neighbouring cell from time T1 to T2), however this is unrelated to remaining valid time of serving cell. |
| Intel | No | We understand that time information remaining in current cell and the one about the new cell (i.e. the time when a new upcoming cell starts to be available) is beneficial for some of the satellite scenarios. However we are not sure whether new thresholds are required. |
| Apple | No | Agree with SS. |
| vivo | Yes with some comments | We share the spirit of this proposal, and think also that a specified UE behavior on when to start intra-frequency measurements and lower-priority inter-frequency measurements is needed, similar to the legacy operation. We wonder, comparing to the threshold method, whether it is a simpler and more straightforward way to directly introduce another time value defined as the starting time of such measurements. Or an offset is introduced w.r.t. to the stopping time to directly calculate the specific time starting the measurements. But this is the stage-3 details, and we agree different implementation methods take actually similar effect. |
| Lenovo | Neutral | Legacy triggering of neighboring cell measurement can work for NTN, i.e. when the serving cell becomes invalid the RSRP/RSRQ will drop and UE triggers neighboring cell measurement. Triggering neighboring cell measurement based on valid time may be an optimization and we are open to discuss if significant benefit is identified. |
| Xiaomi | No | We think the intention to introduce the threshold of the remaining valid time is to avoid service interruption. If the threshold is introduced, serving cell can provide a period to UE, in this period, the serving cell still provide service to UE and UE can perform neighour cell measurement. However, we think it is not necessary since the network can configure a proper Tremaining to avoid service interruption, for instance, the Tremaining is not the actual stopping service time, when the Tremaining is expired and the network still can provide a short period service. |
| Huawei, HiSilicon | Yes | It is be hard to set proper RSRP/RSRQ threshold to manage cell reselection due to the unobvious near-far effect in NTN. |
| Qualcomm | Yes | For measurement trigger, we do not think neighbor cell expiry time is needed.  This could be left to UE. The UE would know how long before the serving cell stops it would have to trigger the measurement.  But how to capture it in spec? it would be simple if we specify a minimum threshold. |
| OPPO | No | Agree with Samsung. UE may perform neighbour cell measurements once the neighbour cell starts to cover the area. So, in addition to the leaving time of the serving cell, the incoming time of the neighbour cell(s) is needed to assist UE to decide when to perform measurement on neighbor cells/frequencies. Besides these, we see no need for additional thresholds. |
| Convida | Yes | We think thresholds of the remaining valid time for the serving cell may be beneficial for performing measurements and cell reselection. Additionally, valid time could be configured for e.g., incoming neighboring cells as well. |
| KT | No | Agree with Samsung. Neighbor Cell Measurement is not required until T2. Neighbor Cell Measurement can be performed during T2 and T3. |
| BT | Yes | It can be a good trigger to start the measurements |
| CATT | Yes | Legacy triggering of neighboring cell measurement is based on the serving cell link quality. The legacy mechanism is not effective since the near-far effect is not obvious in NTN. Hence, if leaving time should be considered to trigger the measurement, it should consider how to specify it in TS38.304. In order to specify it, a remaining serving time threshold can be introduced. |
| Nokia | Maybe | For quasi-Earth-fixed scenario this may be implemented and used in a clear manner (although we believe IDLE mode cell measurements and reselections can also work without this and we also think what Samsung says make sense).  We think it is too complicated to introduce that for Earth-moving scenario |
| ZTE | Yes | Since we have already agreed that at least in the quasi-earth fixed case, the timing information on when a cell is going to stop serving the area is used to decide when to perform measurement on neighbor cells, we need to work further on the details on how to use the cell expire time to assist measurements. Introducing threshold(s) of the serving cell remaining valid time is a workable solution, which is similar to the existing RSRP thresholds to trigger intra-frequency and inter-frequency measurements.  Whether to provide the start time of neighbor cells and use it to assist measurements is another issue which require further discussion but we think it makes more sense to progress on what we have agreed under this question. |

**Q1.2: Do companies support to introduce two thresholds, one for intra-frequency measurements, e.g. TIntraSearch, and one for inter-frequency measurements, e.g. TnonIntraSearch, and UE will perform measurements following the rules below?**

* **UE shall perform intra-frequency measurements if the remaining valid time of the serving cell Tremaining <= TIntraSearch is fulfilled.**
* **UE shall perform measurements of NR inter-frequency cells of equal or lower priority if the remaining valid time of the serving cell fulfils Tremaining <= TnonIntraSearch.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed Comments |
| Samsung | No | See our inputs in Q1.1 We don’t think additional threshold is required. |
| Ericsson | neutral | We are ok using one time or separate for intra/inter freq. |
| LG | No | See our comments in Q1.1 We prefer to introduce only single threshold. |
| Sony | No |  |
| MediaTek | No | We don’t think any threshold is required. See our response to Q1.1. |
| Thales | neutral | Same view as E/// |
| InterDigital | No | See input to Q1.1 |
| Intel | No |  |
| Apple | No |  |
| vivo | Yes | For the measurement trigger conditions in the legacy TN, it can be seen that two RSRP/RSRQ-based thresholds are applied as the criteria to determine when the UE shall start the intra-frequency measurements and measurements on the inter-frequencies with equal or lower cell reselection priority than the current serving frequency.  For the time-based measurement rule in NTN, this principle should be inherited as well. |
| Lenovo | Neutral | See reply for Q1.1, we think legacy triggering of neighboring cell measurement can work for NTN. |
| Xiaomi | No | See comments in Q1.1 |
| Huawei, HiSilicon | No | We do not see the strong reasons to introduce two thresholds. In our understanding, the remaining valid time is to indicate the remaining valid time of the serving cell. Therefore it is the same for the intra- frequency and inter-frequency measurement. |
| Qualcomm | No | We agree with HW.  Broadcasting cell expiry time of neighbor cells by serving cell is too much signaling overhead. What just need it serving cell stop time only. |
| OPPO | No | See our reply to Q1.1. |
| Convida | Yes | Similar to Ericsson, we are ok using one time or separate for intra/inter frequency. |
| KT | No |  |
| BT | neutral |  |
| CATT | No | Agree with LG |
| Nokia | Not necessary | Probably each UE knows how long it takes to execute intra-f/inter-f measurements. So knowing the cell expiry time, it shall know when to start measuring. Thus, no strong need to have those parameters. |
| ZTE | Neutral | We are ok using one time or separate for intra/inter freq. |

### **Timing info assisted cell reselection**

Figure 2. An example showing the serving time of the serving cell and neighbor cells

With awareness of the information on when a cell is going to stop serving the area, the serving time of a neighbour cell can be derived based on the following equation:

TServingTime = TExpire – T0

TServingTime refers to the serving time of a neighbor cell;

TExpire refers to the expire time of the neighbor cell which is broadcast in the serving cell’s system information;

T0: The time when UE detects the neighbor cell and starts evaluation.

Among cells with similar RSRP/RSRQ, camping on a cell with longer serving time would help reduce the cell reselection due to satellite movement. Thus, it is proposed [1] to prioritize the cells with longer serving time. While in [2], companies understand the use of satellite serving duration information is not an essential feature to have a working NR-NTN solution and would like to deprioritize it.

**Q1.3: Do companies support to prioritize cells with longer serving time during cell reselection?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed Comments |
| Samsung | No | We think the UE should prioritize the incoming cell soon during the time duration where the location is served by both disappearing cell and incoming cell. We don’t think serving time is a criterion for cell reselection. |
| Ericsson | yes | If UE selects cell that is going to disappear it causes another reselection. |
| LG | Yes | We agree to reselect to the cell with longest remaining service time. |
|  |  |  |
| Sony | No | Serving time shouldn’t be a criterion for cell reselection |
| MediaTek | No | It is not essential to have this mechanism in the first release. |
| Thales | Yes |  |
| InterDigital | Yes |  |
| Intel | No | We prefer not to change cell reselection at lease for the first release. |
| Apple | No |  |
| vivo | NO | From our perspective, there is no need to additionally broadcast the stopping time of neighbor cell, since this information will anyway be broadcast by the upcoming cell itself, the UE can obtain such information through receiving the SIB of the upcoming cell after it starts its service.  Therefore, regarding how to reselect to the target cell, following the legacy R criterion is sufficient. |
| Lenovo | Neutral | Legacy cell ranking can work for NTN. To avoid frequent reselection NW may adjust the offset of a neighboring cell for cell ranking according to its serving time. Cell priority or ranking based on valid time may be an optimization and we are open to discuss if significant benefit is identified. |
| Xiaomi | No | We think the critical issue of cell reselection in earth fixed case is how to trigger neighour cell measurement, and the timing information of the serving cell resolve this issue, so for how to determine the target cell, the legacy R criterion is enough. |
| Huawei, HiSilicon | Yes | It can reduce the number of cell reselection and the power consumption of the UE |
| Qualcomm | No | Something is missing here. What UE needs to check to select a neighbor cell is if the selected cell meets minimum service duration.   1. Select the best ranked cell as existing procedure. 2. Read SIB. Then it knows cell stop time. 3. If cell stop time < threshold, UE may go to step (1) and select the second best ranked cell. |
| OPPO | No | Serving time shouldn’t be a criterion for cell reselection as it cannot reliably guarantee radio quality. |
| Convida | Yes with comments | We think that prioritization of cells with longer serving time could be an optimization, but may not always be the ideal priority. For example, in a mixed NTN scenario deployment, e.g., MEO satellites would always be prioritized with LEO satellites as lower priority. However, we are ok to support a framework that would allow for prioritization based on various criterion (e.g., frequency, TN/NTN type or scenario) as an optimization of legacy cell ranking. |
| KT | No |  |
| BT | No | This information is broadcasted so is a single value valid for all UEs that has reselect the cell? It looks an optimization |
| CATT | No | If the neighbor cell with longer serving time is prioritized, the UE should know the start time and leaving time of neighbor cell. In our understanding, there is no strong motivation to let UE to know the neighbor cell’s start time. |
| Nokia | No | This can be left up to the UE implementation if there are multiple cells which meet the cell reselection criteria. |
| ZTE | Yes | Agree with HW and Ericsson that selecting cells with longer serving time would reduce cell reselection. |

**Q1.4: Do companies agree with the following understanding on the serving time of neighbour cells？**

**TServingTime = TExpire – T0**

**TServingTime refers to the serving time of a neighbour cell;**

**TExpire refers to the expire time of the neighbour cell which is broadcast in the serving cell’s system information;**

**T0: The time when UE detects the neighbour cell and starts evaluation.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed Comments |
| Samsung | No | See our input in Q1.3. We don’t think serving time is a criterion for cell reselection. |
| Ericsson | yes |  |
| LG | Yes, but see comments | We understand the intention of the formula, but we think we can represent it in simpler way. The T0 means the start timing that the neighbor cell is visible from the UEs and TExpire means end of time that the neighbor cell is visible from the UE. So we propose to represent this similarly with what we did in connected mode – service time period [t1, t2] of each neighbor cell. Here, the time duration between t1 and t2 is TServingTime in the proposed formula. |
| Sony | No |  |
| MediaTek | No | We don’t think serving time is a criterion for cell reselection. See our input in Q1.3 |
| Thales | Yes |  |
| InterDigital | Yes, but see comments | Agree with LG’s interpretation |
| Intel | No | See response in Q1.3. |
| Apple | No |  |
| vivo | No, with comments | There is no need to additionally broadcast the stopping time of neighbor cells since this information will anyway be broadcast by the neighbor cell itself. So, the TExpire refers to the expiry time of the neighbor cell which is broadcast in the system information of the neighbor cells themselves. |
| Lenovo | See comments | We may first discuss whether serving time is considered as a new parameter for evaluation or can be represented by e.g. legacy offset in cell ranking.  For the definition itself, as T0 is the time when UE detects the neighbour cell and starts evaluation, we understand TServingTime as UE-specific and should refer to the serving time of a neighbour cell **for a UE**. |
| Xiaomi | No | See comments in Q1.3. |
| Huawei, HiSilicon | Yes with comments | The time when UE detects the neighbour cell and the time when the UE starts evaluation may be different. We think the T0 is the time when the UE starts evaluation. |
| Qualcomm | No | Providing time information of each neighbor cell by a serving cell is too much signaling overhead. |
| OPPO | No | See our reply to Q1.3 |
| Convida | No | See input for 1.3. Additionally, for this formula to be valid, assumptions about the deployment scenarios need to be clarified. For example, earth fixed versus earth moving cells, or moving UE relative to satellite versus static UE, etc. |
| KT | No |  |
| CATT | No | See our reply to Q1.3 |
| Nokia |  | The definition is reasonable, but as argued above, we do not think this is necessary. |
| ZTE | Yes |  |

Some options on how to prioritize cells with longer serving time during cell reselection are given below:

* Option 1: A threshold of the serving time ThreshServingtTime is broadcast in system information. A cell selection time criterion T-criterion is defined: TServingTime > ThreshServingTime. UE will only rank cells fulfills T-criterion and cell selection criterion S during cell reselection evaluation so that cells with valid time shorter than this threshold will be excluded.
* Option 2: A threshold of the serving time ThreshServingtTime is broadcast in system information along with QoffsetTime as adjustment to cell-ranking criterion Rs for serving cell and Rn for neighboring cells so that cells with serving time longer than the threshold will get a bonus:

Rs = Qmeas,s +Qhyst - Qoffsettemp+QoffsetTime

Rn = Qmeas,n -Qoffset - Qoffsettemp+QoffsetTime

* Option 3: A threshold of the serving time ThreshServingtTime is broadcast in system information along with CellReselectionPriorityOffset as adjustment to the cell reselection priority so that the cells with serving time longer than the threshold will be further prioritized.
* Option 4: A rangeToBestCellNTN is broadcast in system information. UE rank the neighbor cells based on the R-criterion while the cells whose R value is within range to best cell of the R value of the highest ranked cell will be considered as candidate cells. Among all these candidate cells, UE will reselect to the cell with longest serving time.

**Q1.5: Which option(s) do companies prefer to prioritize cells with longer serving time?**

|  |  |  |
| --- | --- | --- |
| Company | Option 1/2/3/4/  other | Detailed Comments  (Please explain your solution in this column if you select “other”) |
| Samsung | No | See our input in Q1.3. We don’t think serving time is a criterion for cell reselection. |
| Ericsson | 4 | This options seems to be the simplest to implement the RAN2 agreement that serving time is taken into account in cell reselection. |
| LG | Option 4 | We agree with the mechanism described in option 4. This is the simple approach to consider the service time and cell quality. |
| Sony | No |  |
| MediaTek | None | See our input in Q1.3. We don’t think serving time is a criterion for cell reselection. |
| Thales | None |  |
| InterDigital | Option 4 |  |
| Intel | No | See response in Q1.3. |
| Apple | No/None |  |
| vivo | other | The legacy R criterion is sufficient from our perspective. No further impact on reselection criteria based on serving time is needed. |
| Lenovo | other | See reply in Q1.3. We think legacy cell ranking can work for NTN. NW may adjust the offset of a neighboring cell for cell ranking according to its serving time. |
| Xiaomi | None | The legacy R criterion is enough. |
| Huawei, HiSilicon | Option 1/4 |  |
| Qualcomm | Other | We have concern on broadcasting cell stop time of each neighbor cell. So we should do following.   1. Select the best ranked cell as existing procedure. 2. Read SIB. Then the UE knows cell stop time. 3. If cell stop time < threshold, UE may go to step (1) and select the second best ranked cell. |
| OPPO | No | See our reply to Q1.3 |
| Convida | N/A | See answers for Q1.3, however, we think that there will be some SI defined to enable prioritization based on certain criteria, e.g., frequency, RAT, TN/NTN type or scenario. Also see, R2-2108413 NTN Cell (re)selection enhancements for further discussion. |
| KT | No |  |
| CATT | No | See response in Q1.3. |
| Nokia | None | As commented above. |
| ZTE | Option 2/3 | Since it is impossible for NW to provide the expire time of all the neighbor cells in the serving cell’s system information, we understand it is better not to use the serving time as a criterion to exclude cells as suggested in option1.  For option4, it is also possible that some cells within the range are not provided with expire time via the serving cell’s system information thus UE is not able to derive the serving time and make decision.  Thus, we understand option2/3 would be better by offering some bonus to neighbor cells with longer serving time. |

## 3.2 Timing info for earth moving cell

For earth moving cell, we have the following FFS left mainly because it is challenging to provide the timing information.

*1. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is needed to assist cell reselection in NTN for earth fixed scenario.*

*2. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is used to decide when to perform measurement on neighbor cells.*

*3. At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area for earth fixed scenario is broadcast to UE via system information.*

**Q2.1: Do companies support to use the timing information on when a cell is going to stop serving the area to assist measurements and cell reselection in idle mode also in earth moving cell scenario? If Yes, how to make UE aware of the timing information?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed comments  （Please explain how to make UE aware of the timing info in this column if answering “Yes”） |
| Ericsson | no | This should at least be downprioritized so we ensure that those items we have high level agreements can progess to stage 3 and into the running CRs |
| LG | No | Explicit timing information is not appropriate for the earth-moving beam. |
| Sony | Yes | The timing information on when a cell is going to stop serving the cell is a pre-defined reference area e.g., cell centre for Earth moving case. |
| MediaTek | No | It is not useful in earth-moving case, as it will be difficult to distinguish between UEs at different locations within the serving cells beam footprints. |
| Intelsat | Yes |  |
| InterDigital | No | In earth moving cells timing information on when a cell is going to stop serving an area depends on the location of the UE relative to cell centre and direction of cell movement.In this case a location-based solution may be necessary (as described in our contribution to RAN2#113bis-e: R2-2103965). |
| Intel | No | It does not seem essential for earth moving cell. |
| Apple | No |  |
| vivo | Up to NW implementation | For the case of feeder link switch, there seems no big difference between an earth-moving cell and an earth-fixed cell in terms of the stopping time: as in an earth-fixed cell, once the feeder link switch occurs, all UEs in an earth-moving cell can be treated as facing a common time when the current serving cell stops providing service and thus necessary to perform cell reselection. Therefore, the stopping time as concluded for the earth-fixed beam case may also apply to the earth-moving cell case for feeder link switch. By contrast, for the service link switch case, different UEs under the coverage of an earth-moving cell may face different time to lose the coverage of this cell, as this depends on the movement of the satellite/UE and the position of each UE in the cell (e.g. whether for a UE the cell is moving towards or apart it, cell moving speed/radius, etc). So, intuitively a cell-level stopping time as in the earth-fixed cell case may not fit an earth-moving cell for the service link switch case.  However, from the specification point of view, it may not be needed to intentionally place a restriction on the applicable scenario of this feature, as it can be left to NW implementation to decide whether to configure this stopping time or not, based on the cell’s beam type and whether it is service/feeder link switch that really happens. If it is not configured, the legacy cell reselection procedure applies. |
| Lenovo | No | For earth moving case the serving time is dynamic for different locations. Considering that the signal strength will decrease as satellite moves away, legacy mechanism based on signal strength will work well. |
| Xiaomi | Yes | The feeder link switch timing can be broadcasted by network, the all UEs will perform neighour cell measurement at the feeder link switch timing. |
| Huawei, HiSilicon | Yes | The network broadcast the location of the cell center for the serving cell. The UE can calculate the time when the serving cell is going to stop serving the UE based on the ephemeris and UE location. |
| Qualcomm | Yes | Only difference in moving cell is UE can estimate cell stop time from beam/satellite information based on whether it is the incoming satellite or outgoing satellite. |
| OPPO | No | This time information is useless in earth moving case as it is different for different UEs. |
| Convida | No | For earth moving case, we think that this is of less value. However, we would be ok with some solutions that are based on RTT/distance/angle, etc. that would make more sense in the moving case. |
| KT | Yes | Agree with Sony and Huawei. |
| BT | No | Agree with Ericsson, we need to make progress.  Apart, the UE is in idle therefore the information is broadcasted. How a common value is valid for all the UEs under the same cell coverage? |
| CATT | Yes | The main difficulty of using the stop time for earth moving scenario is that how to determine the real-time cell center. Considering there is alreay agreement in mobility of RRC\_CONNECTED:  **Agreements in RAN2#112**  1. Time or timer based CHO triggering event, in combination with the existing R16 CHO measurement based event, should be introduced for both moving cell and fixed cell scenario. FFS on how to configure the time or timer based CHO triggering event. Also FFS how to consider the feeder/service link switch timing.  Based on the above agreements, since the time/timer based CHO is supported for earth moving cell, it means the UE capability should support calculating the real-time cell center in earth moving scenario. If the UE capability supporting the calculation of the real-time cell center, there is no reason to prohibit introducing serving cell stop time based cell (re-)selection for IDLE/INACTIVE UE. |
| Nokia | No | Too complex to be specified within the remaining Rel-17 timeline. |
| ZTE | No | Too complex for NW to provide assistance information and for UE to derive the serving time of neighbor cells. |

**Q2.2: If the answer to Q2.1 is “Yes”, do companies support to use the timing information to assist measurements and cell reselection in earth moving cell in the same way as in quasi-earth fixed cell, as discussed in Q1.1-Q1.5?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed comments |
| Ericson | yes | There is one specification for all LEO/GEO. What we specify can be used in all systems by default if it fits the purpose. Q2.1 is the essesntial one that if anything optimized to LEO moving is added. |
| Sony | Yes | Same with our reply to Q1.1-Q1.5 |
| Intelsat | Yes |  |
| vivo | Yes | If the timing information on when an earth moving cell is going to stop serving the area is configured by NW (e.g., feeder link switch), the same way to use the information to assist measurements as in the earth fixed beam scenario can be supported. |
| Xiaomi | Yes | The feeder link switch timing can be broadcasted by network, the all UEs will perform neighour cell measurement at the feeder link switch timing. And UE still needs to monitor signal quality to perform neighbour cell measurement due to service link switch. |
| Huawei, HiSilicon | Yes |  |
| Qualcomm | Yes |  |
| Convida | No | See Q2.1 |
| KT | Yes |  |
| CATT | Yes |  |
|  |  |  |

## Location/Ephemeris assisted cell reselection

In email discussion [POST113bis-e] [101] [NTN] cell reselection [3], the ephemeris/Location assisted cell reselection has been discussed. The majority prefers to support such enhancement in NTN by taking the distance between the UE and the reference location of the cell (serving cell and/or neighbor cell) into consideration but the proposals are postponed without online discussion.

While in [2], companies observe that the use of UE’s Location information does not provide significant additional performance gain over existing re-selection mechanisms and also results in increased power consumption.

**Q3.1: Do companies support location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell and/or neighbour cell) taken into account, for quasi-earth fixed cell and/or earth moving cell?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Yes/No | | Detailed comments |
| **Quasi-earth fixed cell** | **Earth moving cell** |
| Samsung | Yes | FFS |  |
| ericsson | yes | yes | It would be one specification, also to GEO. Our prioritized use case is earth fixed thus we think the design should start assuming earth fixed. |
| Yes | Yes | Yes | In quasi-earth fixed cell case, in order to avoid UEs at the boundary of cell coverage to camp on, the network can configure the maximum distance threshold and the UE can perform cell reselection to the neighbor cell if the distance between UE and cell center is shorter than the threshold.  In earth-moving cell case, when the moving beam is moving closer to the UE, then the location condition can be configured that the UE can reselect to the approaching cell if the distance becomes shorter than a threshold. |
| Sony | Yes | Yes |  |
| MediaTek | No | No | As mentioned in R2-2108320 [2], this will incur large power consumption in UE, with limited benefits to Idle Mode mobility. |
| Intelsat | Yes | Yes |  |
| Thales | Yes | FFS | But this would assume that all beams are of same size, which may not be necessary the case. In which case, cell size info would also be needed |
| InterDigital | Yes | Yes | Especially for earth moving cell |
| Intel | Yes | FFS |  |
| Apple | No | No | Any location assisted mechanisms in idle mode have severe power impact on Ues. |
| Vivo | No | No | From our perspective, location-based cell reselection should not be supported for NTN in this release with the following reasons.   1. **GNSS may be frequently visited for positioning information, resulting in high power consumption.**   If RAN2 decides to support location-based cell reselection, as the cell reselection is a procedure consistently happening, GNSS module may need to be frequently visited by the UE to get its location information to obtain such distance, which will lead to big impact on UE’s battery consumption.  **2. A distance-based criterion (e.g. threshold) is hard to be configured/applied at a per-cell level.**  The criterion for triggering the location-based cell reselection and/or related measurements, (e.g., a threshold like in the legacy RSRP/RSRQ-based mechanism) can only be configured in a cell-specific way. However, as the shape of a cell covered by a satellite may be irregular, it is possible that the Ues located in the different position in the cell may finally use this cell-specific criterion differently, instead of in a common way, thus triggering the measurement either too early or too late (e.g., UE on the long side of an ellipse cell to perform the measurement too early and a UE on the short side of the ellipse cell to perform the measurement too late). Considering the shape of a satellite-covered cell may even be more irregular than an ellipse (e.g., due to the variant propagation environments in the atmosphere), this problem may be even more severe. |
| Lenovo | Yes for measurement triggering | Yes for measurement triggering | Considering the fuzzy RSRP/RSRQ difference in an NTN cell, the distance between UE and the reference location of the serving cell can be considered for neighboring cell measurement triggering. Evaluation on candidate cells can be based on signal strength as in legacy and distances to them may not be considered. |
| Xiaomi | Yes | FFS | We think the near-far issue should be addressed, but the UE power consumption also should be considered. So we think the UE location based cell reselection should be combined with the existing cell reselection solution to reduce the number of times of UE acquiring the location. |
| Huawei, HiSilicon | Yes | Yes |  |
| Qualcomm | May be | May be | Once it is clear how long the GNSS information is valid, i.e., periodicity of GNSS validity, we can decide on location based enhancement at least for UE to determine if it is in cell edge. UE can know from ephemeris if the serving cell is incoming or outgoing. If periodicity is large enough, then it may be beneficial to use relaxed measurement. |
| OPPO | Yes | Yes |  |
| Convida | Yes | Yes | Per TR 38.821, ephemeris information and UE location information can be used to help UEs perform measurement and cell selection/reselection. Also see, R2-2108413 NTN Cell (re)selection enhancements for further discussion. |
| KT | Yes | Yes |  |
| CATT | Yes | Yes | At least for earth fixed scenario, if location based cell reselection is used, the UE can initiate the cell reselection measurement when the distance between the UE and serving cell center is above a configured threshold. The serving cell center and threshold can be broadcast in serving cell’s SIB.  In earth moving cell, UE can calculate the cell reference location based on the Ephemeris information. And combining with UE location information can be used to initiate the cell reselection measurement. |
| Nokia | No | No | Agree with MTK, vivo.  We think time-based is enough and should be specified properly instead of addressing also location-based cell reselections. In addition, we have concerns regarding the UE power consumptions due to the need to continuously monitor its geolocation while in IDLE. |
| ZTE | Yes | FFS | We understand it is helpful for UE to exclude some cells too far from UE as considerate transmission delay is foreseen.  We understand it is easier to provide the location of the cell center to UE for the earth fixed cell. But for earth moving cell, considerate complexity is foreseen. |

**Q3.2: If the answer to Q3.1 is “Yes”, how to make UE aware of the distance between itself and the reference location of the cell (serving cell and/or neighbour cell)?**

* **Solution 1: Broadcast the location of the cell center for the serving cell and neighbor cells in system information.**
* **Solution 2: Provide the association between cell and satellite as well the beam information (e.g. boresight and/or 3dB bandwidth of each beam) for UE to derive the cell center (i.e. the reference location) and such information can be provided as part of the ephemeris.**
* **Other**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Solution ½/ other | | Detailed Comments  (Please explain your solution in this column if you select “other”) |
| **Quasi-earth fixed cell** | **Earth moving cell** |
| Samsung | Solution-1 with the comment | FFS | We think the cell reference location is better term than the location of the cell center. |
| Ericsson | Sol 1 | Sol 1 | We assume this is part of Ephemeris SI |
| LG | Solution 1 | Solution ½ | We could consider more detailed beam coverage information to inform dynamic coverage information of earth-moving cell. Based on the information, the UE may expect its service time. |
|  |  |  |  |
| Sony | Solution 1 | Solution 1 |  |
| MediaTek | Nothing | Nothing | In Idle Mode power consumption is the most important consideration and UE’s location should not be used. |
| Intelsat | Solution 1 | Solution 1 |  |
| Thales | Solution 1 | FFS | Also assuming beam size are same |
| InterDigital | Sol 1 | Sol 1 |  |
| Intel | See comment | See comment | We prefer having a common/aligned definition of the term “location” information across different mechanisms that rely in this. E.g. RAN2#113bis agreement on this for CHO was “T*he location in location-based CHO execution triggering for NTN describes the distance between the UE and the reference location of the cell (serving cell or the target cell). FFS what the reference location of the cell is (e.g cell center or other) and how this is provided to the UE*” therefore we suggest having a single mechanism and reuse the same definition. Said that solution 1 seems reasonable. |
| Apple | Solution 2 | Solution 2 | This solution should take care of both fixed and earth moving scenarios and is probably future proof. |
| Lenovo | Option 1 | Option 1 | Option 2 requires UE derivation and which SIB to include ephemeris has not been decided. |
| Xiaomi | Option 1 | FFS | For earth moving, how to provide the cell location of the serving cell is more complicated, it needs more study. |
| Huawei, HiSilicon | Solution 1 | Solution 1 | The solution 1 is simper. |
| Qualcomm | Other | Other | It is sufficient to use serving cell reference to determine whether UE is at cell edge.  Similar to time information, we have concern on broadcasting cell reference of each neighbor cell. |
| OPPO | Solution 1 | Solution 1/2 | Solution 1 is simper.  For earth moving cell, solution 2 can also be considered to reduce the signaling overhead. |
| Convida | Other | Other | Per the Study Item, we focused on leveraging satellite ephemeris information (e.g., TLE, ECEF), which can be provided in, e.g., broadcast system information and/or preconfigured on the UE. This along with UE location can be used to aid UEs perform measurement and cell selection/reselection. R2-2108413 NTN Cell (re)selection enhancements for further discussion. |
| KT | Solution 2 | Solution 2 |  |
| CATT | Solution 1 with comment | FFS | For earth fixed case, only the cell center of serving cell needs to be broadcasted. |
| Nokia | none | none |  |
| ZTE | Solution 1 | Solution 2 | It is easier for NW to broadcast the cell center location for the earth fixed cell.  If the majority also wants to have the location assisted cell reselection for earth moving cell, solution 2 can be considered. |

Some detailed solutions on how to use the distance between UE and the reference location to assist cell reselection are given below:

* Option 1: Configure a threshold of the distance between UE and the reference location and only neighbor cells with distance shorter than the threshold will be considered during cell reselection.
* Option 2: Configure a threshold of the distance between UE and the reference location along with an adjustment to the cell reselection priority or Qoffset. Cells with shorter distance between the serving satellite and UE will get a bonus in determination of the reselection priority or R-value calculation.
* Option 3: Configure a rangeToBestCellNTN, cells with R-value within this range will be considered as candidate cells for reselection while UE will re-select to the cell with shortest distance between the reference location and UE.

**Q3.3: If the answer to Q3.1 is “Yes”, which option(s) do companies prefer for utilization of the location/ephemeris in cell reselection?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Option ½/3/  other | | Detailed Comments  (Please explain your solution in this column if you select “other”) |
| **Quasi-earth fixed cell** | **Earth moving cell** |
| Samsung | Option-1 | FFS |  |
| Ericsson | other | other | Similar to Q1.1, if UE’s location is further away from Serving cell reference location, UE should start cell reselection related measurements. This enables measurements relaxations when UE is near cell center. |
| LG | Option 1 | Option 1 | We think just basic threshold for the distance between UE and cell center is enough and the shortest distance is not appropriate because the shortest distance between UE and cell center does not mean that the cell can provide the longest service time. If shortest distance earth moving cell is moving farther from the UE, another cell approaching to the UE can provide longer service time even if the distance from the cell center is longer. |
| Sony | Option 1 | Option 1 |  |
| MediaTek | Nothing | Nothing | In Idle Mode power consumption is the most important consideration and UE’s location should not be used. |
| Intelsat | Option 1 | Option 1 |  |
| Thales | Option 1 | FFS | For NTN-TN mobility, some bonus may be considered to cells related to TN or NTN whatever is prioritized |
| InterDigital | Option 1 | Option 1 | May also consider position of satellite relative to UE (i.e. if satellite is moving away from UE or towards UE) which would have an impact on how long UE may remain within coverage. This could be determined via satellite ephemeris. |
| Intel | Option 1 | FFS |  |
| Lenovo | Other | Other | See reply in Q3.1, the distance between UE and the reference location of the serving cell can be considered for neighboring cell measurement triggering. Evaluation on candidate cells can be based on signal strength as in legacy and distances to them may not be considered. |
| Xiaomi | other | FFS | Configure a threshold of the distance between UE and the reference location for each neibhour cell, and UE selects the cell with highest rank, if the distance between UE and this cell is smaller than the threshold, UE will reselect to this cell. |
| Huawei, HiSilicon | Option 1 | Option 1 |  |
| Qualcomm | Other | Other | It is sufficient to use distance between UE to serving cell reference to determine whether UE is at cell edge. Obviously UE knows whether it is the incoming satellite or outgoing satellite in case of moving cell. |
| OPPO | Option 3 | Option 3 |  |
| Convida | Option 1 | Option 1 | We think that Option 1 sounds reasonable for a baseline approach, but other potential solutions are not precluded |
| CATT | Other | Other | We shares the same view as Ericsson. |
| ZTE | Option 1/2 | Option 1/2 | Option 1 would be helpful to exclude cells too far from UE and option 2 would be helpful to prioritize cells closer to UE.  For option 3, since it is not possible for the serving cell to broadcast the cell center location of all the neighbor cells, UE may not be aware of the distance to cell center of all the cells within the range thus not able to make decision. |

In [2], it is proposed to identify the coverage holes in LEO via the satellite’s ephemeris and coverage information and allow UE to use the knowledge of coverage holes to assist cell reselection.

**Q3.4: Do companies support to identify the coverage holes in LEO via the satellite’s ephemeris and coverage information and allow UE to use the knowledge of coverage holes to assist cell reselection? If Yes, what kind of information should be provided for UE to identify the coverage holes?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Detailed comments  (Please explain what kind of information should be provided in this column if answering “Yes”) |
| Samsung | No |  |
| Ericsson | yes | If time this can be discussed.  We assume the cells broadcast timing information as part of Ephemeris. This is related to TAC timing information and similar structure can be used. From that UE can have understanding when there is and is not coverage around where UE is located. This can be utilized in the UE as per implementation but also specified measurement relaxations can be based on this and RAN2 should inform RAN4 about this. |
| LG | See comments | The coverage hole information might be effective for connected mode mobility to avoid sudden RLF, but what is impact in idle mode? |
| Sony | No |  |
| MediaTek | Yes | If the network and satellite can provide the UE with the satellite ephemeris information or the duration of coverage hole, it can assist the UE to stop unnecessary cell search and associated power consumption during the coverage holes. |
| Intelsat | No |  |
| Thales | Yes | Signaling FFS |
| InterDigital | Yes | This has been discussed in IoT NTN SI. In the interest of time, can use those discussions as baseline. |
| Intel | FFS | We suggest discussing this information after clarifying how satellite’s ephemeris information is provided. |
| Apple | Yes | Just provide the ephemeris to the UE for calculation of these coverage holes themselves. |
| Vivo | No | We should first complete the basic designs for the normal cases, before looking into some exceptional/corner cases. Furthermore, the existing procedure seems still able to work in this case (though not optimal), e.g., if no suitable cell is found in idle state, the UE enters any cell selection state; if the RLF is detected in connected mode, the UE will perform RRC connection re-establishment, and if no suitable cell is found, the UE will go to RRC\_IDLE. |
| Lenovo | Yes | Considering that no cell selection/reselection is needed when UE is in coverage holes, the network can provide some assistance information including the satellite ephemeris and time to start/stop serving, to help UE determine its coverage interruption period. There is similar discussion for discontinuous in IoT NTN and we may reuse agreements if made in future. |
| Xiaomi | Yes | If UE can predict the coverage hole based on ephemeris data, the UE can keep dormancy in the coverage hole to reduce power consumption. |
| Huawei, HiSilicon | No with comments | We think RAN2 are discussing the same issues in IoT NTN. We can wait the progress in IoT NTN. |
| Qualcomm | No | TN cell will be anyway prioritized for better performance.  Instead, the NTN cell can broadcast assistance information (e.g., reference location) for UE to determine whether it needs to search TN cell. |
| OPPO | FFS | RAN2 is discussing discontinuous coverage in IoT NTN WI. After it concludes, we can discuss whether and how to reuse that for NR NTN. |
| Convida | No | We think that UEs can determine coverage holes by implementation, e.g., UE location along with satellite ephemeris. |
| KT | No |  |
| BT | No | It looks an optimization. The UE is in idle so it is impossible to know if it will attempt a RACH in that area.  Second point, are we assuming that another satellite will cover the hole in a the same or different orbit? |
| CATT | No |  |
| Nokia | Yes | We think it could be helpful, but we acknowledge time in Rel-17 is scarce.    It could be implemented via providing cell centre location at multiple time instances, possibly with a cell radius. This may allow the UE to extrapolate the cell coverage in certain area and time. |
| ZTE | - | We understand UE can be aware of the coverage based on the ephemeris provided and derivation of the coverage hole can be done via UE implementation. |

# 4 Conclusion

TBD

# 5 References

1. R2-2107733\_Further consideration on cell selection and reselection in NTN(ZTE corporation, Sanechips)
2. R2-2108320\_On Cell Re-selection in NR-NTN(MediaTek Inc)
3. R2-2104805\_Report of [POST113bis-e][101][NTN] cell reselection(ZTE corporation, Sanechips)