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)?**

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| --- | --- | --- |
| 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. |
| Apple | No | Agree with SS. |
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**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.**

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| --- | --- | --- |
| 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 |
| Apple | No |  |
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### **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?**

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| --- | --- | --- |
| 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. |
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| 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 |  |
| Apple | No |  |
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**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.**

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| --- | --- | --- |
| 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 |
| Apple | No |  |
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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?**

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| --- | --- | --- |
| 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 |  |
| Apple | No/None |  |
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## 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?**

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| --- | --- | --- |
| 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). |
| Apple | No |  |
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**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?**

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| --- | --- | --- |
| 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 |  |
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## 3.3 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?**

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| --- | --- | --- | --- |
| 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 |
| Apple | No | No | Any location assisted mechanisms in idle mode have severe power impact on UEs. |
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**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**

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| --- | --- | --- | --- |
| Company | Solution 1/2/ 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 1/2 | 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. |
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| 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 |  |
| Apple | Solution 2 | Solution 2 | This solution should take care of both fixed and earth moving scenarios and is probably future proof. |

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?**

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| --- | --- | --- | --- |
| Company | Option 1/2/3/  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. |
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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?**

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| 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. |
| Apple | Yes | Just provide the ephemeris to the UE for calculation of these coverage holes themselves. |
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# 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)