**3GPP T****SG-RAN WG2 Meeting #116e**   **R2-2111341**

**E-Meeting, Nov 1st – Nov 12th, 2021**

**Agenda item:**  **8.10.3.2**

**Source: Intel Corporation**

**Title: Summary of [AT116-e][102][NTN] Idle mode aspects (Intel)**

**Document for: Discussion and Decision**

# Introduction

This is the summary of the following offline discussion.

* [AT116-e][102][NTN] Idle mode aspects (Intel)

Initial scope: Continue the discussion on cell (re)selection aspects, based on proposals in [R2-2111332](file:///C:\Data\3GPP\RAN2\Inbox\R2-2111332.zip)

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

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

Initial deadline (for companies' feedback): Thursday 2021-11-04 1000 UTC

Initial deadline (for rapporteur's summary in R2-2111341): Thursday 2021-11-04 1600 UTC

Proposals marked "for agreement" in R2-2111341 not challenged until Friday 2021-11-05 0800 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).

# Discussion

## Confirmation of working assumption

Working Assumption:

1. Location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell and/or neighbor cell) taken into account, is supported for quasi-earth fixed cell, if UE has valid location information, which means location acquisition will not be triggered at UE side only for location assisted cell reselection. FFS on the details.

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| **paper** | **proposals** | **Category** |
| **[2]** | **Proposal 1: Confirm location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell or the neighbor cells) taken into account, is supported for quasi-earth fixed cell.** | **support** |
| **[10]** | **Proposal 5: Turn the WA of location assisted cell reselection into an agreement.** | **support** |
| **[14]** | **[Proposal 1]: RAN2 is asked to confirm location assisted cell reselection as an agreement.** | **support** |
| **[3]** | **Proposal 1: it depends on UE implementation to perform location acquisition, instead of forbid location acquisition only for location assisted cell reselection.** | **Location acquisition** |
| **[9]** | **Proposal 1: For cell reselection, it is proposed to utilize the GNSS to intermittently or periodically to track the location of the UEs instead of continuously tracking, e.g. combining constellation deployment information, TA value, neighboring PCI and/or other information to decide the conditions for starting GNSS to update UE location info while reducing energy consumption.** | **Location acquisition** |
| **[6]** | **Proposal 6: Location-based cell reselection criterion is introduced for both inter-frequency and intra-frequency cell reselection criterion.** | **both inter-frequency and intra-frequency cell reselection** |

There are three papers [2][10][14] which propose to confirm the working assumption on location assisted cell reselection. Considering companies also propose the detailed solution on how to enable distance based cell reselection criteria [1][3][6][10][12][14][15], the first part of the WA above seems agreeable.

But regarding how UE performs location acquisition, there are still different views, e.g., “it depends on UE implementation” [3] or “intermittently or periodically to track the location” [9].

During online discussion, the following agreement has been made as below:

Agreements:

1. Location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell and/or neighbor cell) taken into account, is supported for quasi-earth fixed cell. FFS on how UE performs location acquisition.

In this offline discussion, companies are invited to provide views on the Q1 to further discuss how UE performs location acquisition.

**Q1: regarding how UE performs location acquisition, which option below can be agreeable:**

**Option 1: location acquisition will not be triggered at UE side only for location assisted cell reselection;**

**Option 2: it depends on UE implementation to perform location acquisition for cell reselection;**

**Option 3: UE tracks the location intermittently or periodically instead of continuously tracking for cell reselection.**

**Option 4: Whether to apply location assisted cell reselection or not depends on UE implementation, but once selected, UE’s tracking the location is required (with option3 or other option to allow UE to track the location)**

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| **Company** | **Which option is agreeable?** | **Comments** |
| Samsung | Option 4 |  |
| Xiaomi | Option 2 | We think the UE location acquisition should not be a mandatory requirement for UE to perform cell reselection, in other words, if location related parameters is configured by the network, UE still can use legacy cell reselection mechanism to perform cell reselection, but if UE is willing to acquire to location to perform cell reselection, it is also OK. So we support option 2. |
| LG | Option 2 | We think it is not really need to specify the UE location acquisition procedure. It will increase UE complexity and power consumption. Even if the UE location information is not available to UE, UE can just follow the existing measurement rule/cell reselection criteria. |
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## Distance based cell reselection criteria

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| **Paper** | **Proposals** | **Category** |
| **[1]** | **Proposal 1 Among the N best cells using RSRP ranking, UE selects the target cell with the shortest distance to the satellite’s cell center. Cell center information can be provided for each satellite.** | **Take distance into account** |
| **[3]** | **Proposal 2: adopt the following criteria for location assisted cell reselection:**  **Distance between UE and the PCell’s reference location becomes larger than absolute threshold1 AND the distance between UE and the neighbour cell becomes shorter than absolute threshold2.** | **Take distance into account** |
| **[10]** | **Proposal 7: Adopt the option 1: Configure a threshold of the distance between UE and the reference location and only neighbour cells with distance shorter than the threshold will be considered during cell reselection as the location based cell reselection criteria** | **distance shorter than the threshold** |
| **[12]** | **Proposal 3: Regarding using Distance to Neighbouring Cell, RAN2 discuss following alternatives:**  ** Alternative 1: not to support it in Rel17 (i.e., distance to neighboring cell is not taken into account for cell reselection)**  ** Alternative 2: support it with simple solution that UE excludes the neighboring cells to which the (valid) distance is longer than a threshold from cell reselection.** | **distance is longer than a threshold** |
| **[14]** | **[Proposal 2]: Location assisted cell reselection should be applied on top of RSRP/RSRQ criterion.**  **[Proposal 5]: If location assisted cell reselection is used, RAN2 is asked to discuss options for ranking procedure above.**  **- Option1: first ranking based on RSRP/RSRQ criterion then second ranking based on location criterion among the cells ranked higher than the serving cell in the first ranking.**  **- Option2: first ranking based on location criterion then second ranking based on RSRP/RSRQ criterion among the cells ranked higher than the serving cell in the first ranking.**  **- Option3: dependent on network configuration, either RSRP/RSRQ or location criterion based ranking.**  **[Proposal 6]: If location assisted cell reselection is used, RAN2 is asked to discuss options for inter-F cell reselection (with the different cell reselection priority) / inter-RAT cell reselection.**  **- Option1: Both RSRP/RSRQ AND location criteria are considered. For example:**  **- Option2: Dependent on network configuration, either RSRP/RSRQ or location criterion is considered.** | **Two ranking procedures for location assisted cell reselection** |
| **[15]** | **Proposal 6: The legacy R criterion or the R criterion combined distance between UE and neighbour cells can be considered for UE to decide the target cell.** | **R criterion combined distance** |

In legacy cell reselection mechanism, for NR Inter-frequency case, if more than one cell meets the reselection criteria, the UE shall reselect the highest ranked cell; for Intra-frequency and equal priority inter-frequency case, the UE shall reselect the highest ranked cell. So the R criteria can be applied in both cases. When a new trigger is introduced, the first question is how to coordinate these two conditions. According to companies’ paper, the majority view is to combine them, but not to apply new trigger only. Regarding the detailed solution, [10][12][15] propose to update the neighbour cell list with distance condition, i.e., only neighbour cells with distance shorter than a threshold will be considered during cell reselection; and [1][14] propose to introduce distance based ranking working together with legacy R criteria.

Since the agreement below only allows UE to get reference location of cells in quasi-earth fixed case, the distance based cell reselection has to be applied to quasi-earth fixed case as well.

1. For quasi-earth fixed cell, the reference location of the cell (serving cell or the neighbor cells) is broadcast in system information

**Q2: Regarding how to apply distance based cell reselection** **criteria** **for quasi-earth fixed cell, which option is agreeable:**

**Option 1: only neighbour cells with distance shorter than a threshold will be considered during cell reselection;**

**Option 2: distance based ranking is used together with legacy R criteria.**

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| **Company** | **Which option is agreeable?** | **Comments** |
| Samsung | Option 2 | Option 1 is not clear to us. It said “during cell reselection”, then is it after R criteria or before R criteria? I think for any case, it is used together with legacy R criteria, which is same with option 2. |
| Xiaomi | Option 1 | For option 1, we think UE can choose a cell with the best signal quality among the multiple neighbour cells with distance shorter than a threshold. But for option 2, UE may not reselect to a cell with the best signal quality. |
| LG | No | We think distance from serving cell-based measurement rule is enough and distance from neighbour cell-based cell reselection is not useful because it will increase too much UE power consumption if UE should calculate distance from each neighbour cell. Furthermore, for earth-fixed neighbour cell, if the cell quality satisfies the cell reselection criteria, the distance from the cell is not really meaningful because satisfying the cell quality condition means the UE is already close enough to the cell coverage.  Thus, we think the location condition is not really needed in addition to the existing cell quality based cell reselection criteria. |
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## Remaining serving time based cell reselection criteria

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| **Paper** | **Proposals** | **Category** |
| **[5]** | **Proposal 1 A UE selects the second-best ranked cell if the selected cell has cell stop time that is too near.** | **Take neighbour cell stop time into account** |
| **[8]** | **Proposal 2: For intra-frequency and equal-priority inter-frequency cell reselection, UE performs cell reselection to the cell whose remaining service time is the longest among the cells whose cell quality value is higher than a threshold.** | **remaining service time** |
| **[10]** | **Proposal 2: The cell reselection criteria needs to consider the remaining valid time of the neighbour cells.** | **remaining valid time** |
| **[10]** | **Proposal 3: If there are multiple candidate cells whose R value is within rangeToBestCell of the R value of the highest ranked cell, then UE performs cell reselection to the cell with longest serving time.** | **longest serving time** |
| **[11]** | **Proposal 5:** **The cell stop time of neighbor cells, if available is also broadcast as assistance information for UE to prioritize cells with longer valid time.**  **Proposal 6: 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.** | **longer valid time** |
| **[12]** | **Proposal 1: Regarding using Neighbouring cell’s expire time, RAN2 discuss follow alternatives:**  ** Alternative 1: not to support it in Rel17 (i.e., neighboring cells’ remaining serving time is not taken into account for cell reselection)**  ** Alternative 2: support it such as UE excludes the neighboring cells whose remaining serving time is less than a threshold from cell reselection.** | **remaining serving time** |
| **[15]** | **Proposal 4: The legacy R criterion or the stop time combined legacy R criterion can be used by UE to decide the target cell.** | **stop time combined legacy R criterion** |

Companies also propose to consider remaining serving time in cell reselection. As currently RAN2 only agree to broadcast stop time of the serving cell for quasi-earth fixed case, so the prerequisite should be that the cell stop time of neighbor cells need to be broadcast [11].

**Q3: if the following proposal can be agreeable:**

**For quasi-earth fixed cell, the cell stop time of neighbor cell(s) is broadcast.**

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| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| Samsung | N | We have Srxlev and/or Squal criteria for cell reselection, and we added UE location based criteria for cell reselection. Shouldn’t it be too much and complicated if we add remaining time based criteria for cell reselection? To us, time for cell’s incoming or disappearing are helpful to decide when the measurement needs to be performed and when the cell (re)selection performs, but not needed directly into cell reselection criteria itself. |
| Xiaomi | No | We think the motivation of introducing the timing information assisted cell reselecton is to handle the issue that the neighbor cell measurement can’t be performed timely based on the legacy S criterion. So we think the cell stop time of serving cell is enough and how to determine the neighbour cell can be based on the legacy R criterion.  Moreover, the serving time general based on the stellite altitude, the satellite with the high altitude will provide long serving time, but the signal quality may be not as good as the satellite with low altitude, so we don’t think UE should choose the neighbour cell based on the serving time. |
| LG | Yes | As we commented in Q2, we think location based cell reselection criteria is not useful because distance from the neighbour cell does not really effective for cell reselection criteria. Furthermore, only cell quality-based cell reselection criteria may not be effective because cell quality does not different much in an NTN cell coverage.  So if neighbour cell quality is above the threshold, we think neighbour cell stop time should be considered to reselect to the neighbour cell with longer remaining service time. If not, the new serving cell may disappear soon so that the UE should perform cell reselection soon again, which brings too frequent cell reselection. |
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On the usage of remaining serving time, there are several options.

Option 1: only neighbour cells with remaining serving time longer than a threshold will be considered during cell reselection [12];

Option 2: remaining serving time based ranking is used together with legacy R criteria [8][10][11];

Option 3: remaining serving time is used as supplementary condition, e.g. a UE selects the second-best ranked cell if the selected cell has cell stop time that is too near [5].

**Q4: if the answer to Q4 is YES, regarding the usage of remaining serving time in cell reselection criteria, which option below is agreeable:**

**Option 1: only neighbour cells with remaining serving time longer than a threshold will be considered during cell reselection;**

**Option 2: remaining serving time based ranking is used together with legacy R criteria;**

**Option 3: remaining serving time is used as supplementary condition, e.g. a UE selects the second-best ranked cell if the selected cell has cell stop time that is too near.**

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| **Company** | **Which option is agreeable?** | **Comments** |
| LG | Option 2 | If UE reselects to the neighbour cell with longest remaining service time, UE can camp on the cell as long as possible and avoid frequent cell reselection. |
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## Neighbour cell measurements

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| **paper** | **proposals** | **Category** |
| **[2]** | **Proposal 2: At least for earth fixed scenario, UE should initiate the measurement on neighbor cells when the distance between UE and serving cell’s reference location is above a configured threshold.**  **Proposal 5: At least for earth fixed scenario, considering stop serving time, reference location and RSRP are supported as candidate measurement initiation conditions, UE can initiate the cell reselection measurement when any of the conditions is met.** | **Consider distance as a trigger** |
| **[4]** | **Proposal 1:UEs use the location information to indetify the edge of cell and triger cell reselection measurement.** | **Consider distance as a trigger** |
| **[10]** | **Proposal 1: UE should start measurements on all neighbour cells in SIB before the broadcast stop time of the serving cell** | **Cell stop time** |
| **[10]** | **Proposal 6: Introduce the location based measurement rule.** | **Consider location** |
| **[11]** | **Proposal 7: A threshold for distance between UE and the serving cell reference location should be configured. UE shall perform measurements on neighbor cells if the distance to serving cell reference location is larger than or equal to the threshold.** | **Consider distance as a trigger** |
| **[12]** | **Proposal 2: RAN2 discuss whether UE can stop measurement or relax measurement on certain neighbouring frequencies (e.g., equal or lower priority inter/intra frequencies) if its Distance to Serving Cell Centre is shorter than a threshold.** | **Distance to Serving Cell Centre is shorter than a threshold.** |
| **[14]** | **[Proposal 4a]: If location assisted cell reselection is used, the measurement rule is determined based on whether the condition (Srxlev > threshold#1, Squal > threshold#2, AND distance between the UE and serving cell’s reference < threshold#3) is met.**  **[Proposal 4b]: If location assisted cell reselection is not used, the measurement rule is determined based on whether the condition (Srxlev > threshold#1 AND Squal > threshold#2) is met.** | **Consider distance as a trigger** |
| **[15]** | **Proposal 1: When the cell stop time is configured, UE should check both signal quality and stop time of the serving cell and the UE shall perform measurement on neighbour cells if one of the conditions is met.** | **stop time of the serving cell** |
| **[15]** | **Proposal 5: If UE has available location, it will only check the distance between UE and serving cell to decide whether to perform neighbour cell measurement, if UE doesn’t have the available location, UE will only check the signal quality of the serving cell to decide whether to perform neighbour cell measurement.** | **distance between UE and serving cell** |

Regarding the stop time of the serving cell triggers neighbour cell measurements, RAN2 already made the following agreement, so we don’t need to repeat the discussion.

1. For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area.

As for the distance between UE and serving cell, companies share the common understanding that UE should perform measurements on neighbor cells if the distance to serving cell reference location is larger than a threshold [2][4][11][14][15]. And [12] also proposes that UE can stop measurement or relax measurement on certain neighbouring frequencies if its Distance to Serving Cell Centre is shorter than a threshold.

During online discussion, companies showed concern about the feasibility in “higher priority NR inter-frequency or inter-RAT frequencies” and “NR intra-freq or inter-freq with equal or lower priority” cases. In this offline discussion, rapporteur suggests considering these two cases respectively.

**Q5: Is the following proposal agreeable:**

**For quasi-earth fixed cell, UE should perform neighbour cell measurements of “higher priority NR inter-frequency or inter-RAT frequencies” if the distance between UE and serving cell reference location is larger than a threshold. In other words, UE may choose not to perform neighbour cell measurements of “higher priority NR inter-frequency or inter-RAT frequencies” if the distance between UE and serving cell reference location is shorter than a threshold.**

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| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| Samsung | Y or N (see the comments) | With the following proposal, it’s not clear if the legacy Srxlev and Squal based measurement rule is not used or not? We think location based measurement rule is an addition to the legacy measurement rule. If so, our response is “Y”. However, if we only rely on the distance based measurement rule, our response is “N” at the moment. We think radio condition is basically important and shorter distance/longer distance does not always guarantee good/bad radio condition of the serving cell. |
| Xiaomi | No | For higher priority NR inter-frequency or inter-RAT frequencies, the UE shall perform measurements of higher priority frequencies as legacy procedure, in other words, UE shall ignore the distance threshold and perform neighour cell measurement. |
| LG | No | First of all, we should clarify whether this location-based measurement rule is addition to the existing measurement rule. We think existing cell quality-based measurement rule is not needed in NTN and new measurement rule based on the location condition in the proposal and serving cell stop time agreed in the last meeting should be introduced separately.  Then, we think measurement on higher priority frequency should be mandatory regardless of the distance, as is in existing measurement rule (i.e. higher priority frequency measurement is mandatory regardless of serving cell quality) It may also impact TN-NTN idle mode mobility. |
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**Q6: Is the following proposal agreeable:**

**For quasi-earth fixed cell, UE should perform neighbour cell measurements of “NR intra-freq or inter-freq with equal or lower priority” if the distance between UE and serving cell reference location is larger than a threshold. In other words, UE may choose not to perform neighbour cell measurements of “NR intra-freq or inter-freq with equal or lower priority” if the distance between UE and serving cell reference location is shorter than a threshold.**

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| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| Samsung | Y or N | Please see the above comment. |
| Xiaomi | Yes | It aligns the legacy procedure. |
| LG | Yes | We are fine with proposal that we prefer to keep the existing mechanism similarly. |
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## Location based cell reselection in earth-moving cell

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| **paper** | **proposals** | **Category** |
| **[2]** | **Proposal 3: For earth moving scenario, location based cell (re-)selection can also be introduced, and how to calculate the real-time cell center can be further discussed.** | **support** |
| **[6]** | **Proposal 5: Broadcast of the reference location of the cell in SIB is not applicable to earth-moving cells.** | **No support** |
| **[8]** | **Proposal 1: For earth moving cell, location condition is used for neighbor cell measurement. The UE shall perform neighbor cell measurement when the distance between the UE and serving cell center is longer than a threshold.** | **measurements** |
| **[13]** | **Proposal 1: For earth moving cell, the reference location of the cell (serving cell or the neighbour cells) is broadcast in system information.**  **Proposal 2: For earth moving cell, cell reselection is biased proportional to relative distance between the UE and neighbouring/serving cell centre, with incoming cells positively biased and receding cells negatively biased.**  **Proposal 4: Location assisted cell reselection is supported for earth-moving cells at least if UE has valid location information, which means location acquisition will not be triggered at UE side only for location assisted cell reselection. FFS on the details.** | **support** |
| **[13]** | **Proposal 3: For earth moving cell, the UE may use distance between UE and reference point to decide when to perform measurements on neighbouring cell.** | **measurements** |

Currently we don’t have agreed enhancements to cell reselection in earth moving cell. Companies propose to also apply location based cell reselection, and the key issue is whether to broadcast cell reference location in earth moving cell. The different views can be found in [2][6][13], i.e., Yes in [2][13] and NO in [6]. How to apply distance between UE and cell reference location has also been mentioned in [8][13], e.g., use distance to determine whether to initiate neighbour cell measurements.

**Q7: whether to broadcast the reference location of the cell (serving cell and/or neighbor cell) for earth moving cell.**

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| **Company** | **Views (Y or N)** | **Comments** |
| Samsung |  | First we would like to have clearer understanding how to indicate/signal moving reference location of the cell in earth moving cell. |
| Xiaomi | No | It is more complicated for earth moving cells since the reference location is moving continuously. |
| LG | Yes, but see comments | For earth-moving cell, we believe that the cell reference location should be provided to UE and it can be part of ephemeris information. Based on that, UE can expect the cell coverage position by time. The time granularity of the reference location can be defined by other WG. |
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## Upcoming cell’s information

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| **paper** | **proposals** | **Category** |
| **[1]** | **Proposal 4 In addition to the time information of upcoming cell, RAN2 discuss whether to introduce other information for UE to obtain the upcoming cell’s radio quality, e.g. feeder link’s path loss change for the upcoming cell.** | **upcoming cell’s information** |
| **[5]** | **Proposal 4 The UE should be provided with the information of the next candidate cell(s) for cell reselection.** | **upcoming cell’s information** |
| **[6]** | **Proposal 3: The** **timing information about the new upcoming cell is not needed.** | **upcoming cell’s information** |
| **[14]** | **[Proposal 3]: For quasi-earth fixed cell, system information includes the new incoming cell with the timing information. The UE only performs measurement on the incoming cell if the serving cell is good enough.** | **upcoming cell’s information** |

Companies propose to consider assistance information about the upcoming cell, which could be used to make UE more focused on the next serving cell and avoid unnecessary power consumption on neighbour cell measurements [1][5][14]. But meanwhile there is also paper to oppose providing timing information about the new upcoming cell [6].

**Q8: whether to provide** **the information of the next candidate cell(s) to UE, e.g., timing information or feeder link’s path loss change.**

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| **Company** | **Views (Y or N)** | **Comments** |
| Samsung | Y |  |
| Xiaomi | No | For cell reselection enhancements, the timing assisted and location assisted cell reselection is enough, the other enhancements can be considered in the future. |
| LG | Yes | As NTN cell’s appearance schedule information is predictable, we think it will be very beneficial if the information is provided to UE. The network can provide the upcoming neighbour cell information in advance, so the network does not need to trigger SI update whenever new neighbour cell appears. Based on the automatically updated neighbour cell list, the UE can perform neighbour cell measurement and cell reselection.  Actually, we already introduced such upcoming cell information in CHO – UE can perform CHO only during [t1, t2]. So we think there is no reason not to introduce such upcoming cell in idle mode. |
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# Conclusion

** List of proposals for agreement (if any)**

** List of proposals that require online discussions**

** List of proposals that should not be pursued (if any)**

# References

1. R2-2109501 Discussion on idle/inactive mode procedures in NTN OPPO
2. R2-2109554 Further Discussion on the Leftover Issues of IDLE/INACTIVE CATT
3. R2-2109637 Discussion on enhancements to cell reselection Intel Corporation
4. R2-2109765 Cell selection and reselection enhancements for NTN China Telecom
5. R2-2109970 Enhancement to cell selection and reselection Qualcomm Incorporated
6. R2-2109976 Remaining issues on cell reselection for NTN vivo
7. R2-2110046 NTN Cell Selection and Cell Reselection Apple
8. R2-2110228 Remaining issues in NTN idle mode LG Electronics Inc.
9. R2-2110265 Discussion on cell reselection CMCC
10. R2-2110275 Discussion on cell reselection Huawei, HiSilicon
11. R2-2110468 Consideration on the system information and idle mode mobility for intra-NTN and TN-NTN case ZTE corporation, Sanechips
12. R2-2110769 Time and Location-assisted cell reselection NEC Telecom MODUS Ltd.
13. R2-2110862 Cell reselection for earth moving cells InterDigital
14. R2-2110943 Further considerations on idle/inactive behaviours Samsung Research America
15. R2-2111111 Cell selection and reselection enhancements for NTN Xiaomi
16. R2-2111332 [102][NTN] Summary of cell (re)selection aspects in AI 8.10.3.2 Intel