**3GPP T****SG-RAN WG2 Meeting #116e**   **R2-2111352**

**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)

Updated scope: Continue the discussion on cell (re)selection aspects, based on [R2-2111341](file:///C%3A%5CData%5C3GPP%5CRAN2%5CInbox%5CR2-2111341.zip)

Updated 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): Monday 2021-11-08 1600 UTC

Initial deadline (for rapporteur's summary in [R2-2111352](file:///C%3A%5CData%5C3GPP%5CRAN2%5CInbox%5CR2-2111338.zip)): Monday 2021-11-08 1800 UTC

Proposals marked "for agreement" in [R2-2111352](file:///C%3A%5CData%5C3GPP%5CRAN2%5CInbox%5CR2-2111338.zip) not challenged until Tuesday 2021-11-09 0800 UTC will be declared as agreed via email by the session chair (for the rest the discussion will continue in the CB session in Week2).

During online discussion, the following agreement has been made:

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.

And in the first round of this offline discussion, we have made the agreements as below:

Agreements via email - from offline 102:

1. When UE uses location based cell reselection enhancements, it's up to UE implementation to guarantee that a valid location information is available
2. For quasi-earth fixed cell, same as legacy, UE shall perform neighbour cell measurements of “higher priority NR inter-frequency or inter-RAT frequencies” regardless of the distance between UE and serving cell reference location.

In the second round, the other proposals in R2-2111341 can be further discussed. Section 2 and 3 are for background information, and companies are invited to provide views in section 4.

# Phase-1 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. |
| Ericsson | Option 1 or 2 | Also depends on UE capability discussion In general, instead of specifying when the UE shall perform GNSS, the UE should ensure that GNSS measurements do not impair the procedures by implementation. |
| NEC | Option 2 | We do not think we can force UE to **do or not to do** location acquisition for cell reselection. From specification point of view, location-assisted cell reselection (if agreed) will only be applicable to a UE who has valid location, hence the location-assisted cell reselection should be as simple as possible in our understanding.  |
| Lenovo, Motorola Mobility | Option 2 | We share Xiaomi’s view. Location acquisition can be UE implementation depending on whether it is willing to use location-based criterion in addition to legacy mechanism. |
| Apple | Option 2 | The other options do not provide sufficient flexibility to the UE to optimize its performance. |
| Huawei, HiSilicon | Option 2 | Same view as above companies that UEs should not be forced to perform location-based reselection. Option 2 is the simplest way. |
| vivo | Option 1 or option 2 | Our main concern for location assisted cell reselection is the power consumption of location acquisition. From our perspective, among all the options, option 1 is the most power-efficient for UE since the UE can directly use the position obtained in other procedures. Option 2 is also acceptable to us, since anyway whether to switch on/off the GNSS/GPS functions and/or whether to authorize it to an APP should currently both be controlled by the UE itself. |
| intel | Option 2 | It is reasonable to leave it to UE implementation. |
| Spreadtrum | Option 2 | How to track the location for cell reselection is due to UE implementation. |
| OPPO | Option 2 | We see no need to specify the UE location acquisition procedure. |
| ZTE | Option 2 | We understand there is no need to prevent UE from triggering location acquisition for cell reselection if UE is willing to do it. So we understand option 2 offers full flexibility to UE and would make every UE vendor happy. |
| Nokia | Option 2 | We do not think it is necessary to include UE’s location in the cell reselection process. It is already agreed the NW broadcast such reference location, but no need to specify the exact behavior – can be left up to the UE. |
| MediaTek | Option 1 or Option 2 |  |
| Qualcomm | Option 2 | We understand form the last working assumption that it is up to UE whether it wants to acquire GNSS to validate the UE location and use this feature. |
| InterDigital | Option 2 | Okay to support procedure in specification (e.g. broadcast reference point, specify distance based criteria etc) and leave up to UE implementation whether it acquires the necessary UE location to use it as an enhancement or not. |
| ETRI | Option 2 | We prefer to leave it up to UE implementation. |
| CATT | Option 2 | Same view with Xiaomi. The location information is helpful for UE reselection, but not mandatory. UE still can use legacy behaviour for reselection. Considering the power consumption, some relax conditions can be made for location acquisition. For example, if UE near the cell centre or has a low moving speed, it is unnecessary to acquire location information frequently. Since UE can also work without this enhancement, to acquire location or not is depends on UE implementation. |
| CMCC | Option2 | From our perspective, no need to perform location acquisition continuously considering the power consumption. And detailed solution could be up to UE implementation.  |
| China Telecom | Option2, with comment | We notice the agreement is for quasi-earth fixed cell. We are wondering whether the method is applicable for earth moving cell.  |
| Thales | Option 2 |  |

**Summary:**

The majority companies’ view is if/when to perform location acquisition can be up to UE implementation, and specified UE behaviour is not necessary. Several companies that support option 1 also think option 2 is acceptable. And one company further points out that whether to apply location assisted cell reselection also depends on UE implementation.

**(21/22) Proposal 1: it depends on UE implementation whether/when to perform location acquisition for cell reselection.**

## 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 1b: exclude neighbour cells too far away i.e., distance longer than a threshold will no 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. |
| Ericsson | Option 1 | Before or after RSRP based ranking, the distance should be taken into account. |
| NEC | None of the options Or option1b | As answer to Q1, we would like to keep distance-assisted cell reselection simple as it can not be applied to all UEs anyway.So, we propose to exclude certain neighbouring cells which is too far away from UE(If UE knows). option1b is a rewording version of option1, but it avoid clarifying how to handle the neighbouring cells when there is no up to data distance information to it, and also a simple NOTE may be enough for specification. In general, with any options mentioned above, we notice it would be more complicate to configure distance threshold considering mixed deployment of different satellite system (LEO, MEO and GEO) or considering different cell sizes of same satellite system.Hence, we also fine as LG proposed, only use the distance to serving cell to trigger or relax neighbouring cells measurement as we did with remaining time of serving cell. |
| Lenovo, Motorola Mobility | None or Option 1 with lower threshold | We would like to avoid too much calculation of distances (and possibly continuous updating) for power saving in IDLE/INACTIVE. The distance to the serving cell could be sufficient e.g. to assist in triggering neighboring cell measurement. If majority companies prefer to include distances to neighboring cells, we would like to limit the threshold to a lower level so that only the nearest cells can be considered. |
| Apple | Option 1 | Seems more straightforward  |
| Huawei, HiSilicon | Option 1 | We think the Option 1 and Option 2 are not mutually exclusive. For Option 1, if multiple neighbour cells satisfy the threshold, ranking based on RSRP/RSRQ will also be performed. |
| vivo | Option 2 | We prefer distance based ranking to be used together with legacy R criteria, so that UE can reselect a cell with acceptable signal quality and acceptable distance. |
| Intel | Option 1 | For quasi-earth fixed cell, cells are relatively fixed, so only the UE movement and signal quality need to be considered in this case. And option 1 is an easier way. |
| Spreadtrum | Option1 or Option 2 | If the reference location of neighbour cell is broadcasted by serving cell, UE could calculate the distance between the neighbour cell and itself without measurement to neighbour cell, so option 1 is OK. Otherwise, option 2 is preferred. |
| OPPO | Option 2 | After legacy RSRP based ranking, the cell with the shortest distance to the satellite’s cell center is selected. |
| ZTE | Option 1b | * We understand the evaluation of the distance to a neighbour cell reference location should be based on the neighbour cell reference location provided from the serving cell.
* Since it is not possible for a serving cell to provide the reference location of all the neighbour cells, there will anyway be neighbour cells whose reference location info is not provided by the serving cell but the cell quality is quite good.
* Thus, we understand it is better to use the distance threshold as exclusion criteria to exclude cells too far from UE while the neighbour cells whose reference location has not be provided will still be considered by UE during cell ranking.
 |
| Nokia | None | Similar opinion to LG, it should be enough to provide a reference location for the serving cell and the UE starts measurements when its distance to that reference location becomes offset larger. Neighbours can also broadcast this reference location, but no need to specify action the UE takes when reading such information.  |
| MediaTek | None | Location based cell reselection seems to have no tangible benefits to address the quasi-earth fixed cells in NTN. |
| Qualcomm | Option 1b | Agree with LG. It is sufficient for UE to know when to trigger measurement for cell reselection and use already existing relaxed measurement defined for “when not in cell edge”.But option 1b as described by ZTE can also be considered. |
| InterDigital | Option 1 | Preference is to narrow list of candidate cells which satisfy a distance-based criteria first, and then select best ranked cell amongst valid options based on measurements. This seems most like legacy procedure. |
| ETRI | Option 2 | Cell reselection should be done by combining distance and R criteria. |
| CATT | None | In case of quasi-earth fixed cell, the distance to neighbour cell’s reference location has little help in process of choosing a cell. On the one hand, the distance cannot help UE choose a cell with a longer valid time to reduce the reselection frequency. On the other hand, the distance cannot help UE choose a cell with better radio quality than RSRP/RSRQ. Therefore, in our opinion, location is used to initiate measurement, not used to select a target cell. |
| CMCC | Option2 | Anyway, distance based solution should be utilized with the legacy R criteria. |
| China Telecom |  | We can not see the difference between Option 1 and 1b, because they have the same effect. And the R criteria should be used together with location information. |
| Thales | Option 1b or 2 |  |

**Summary:**

Regarding whether/how to apply distance based cell reselection criteria for quasi-earth fixed cell, companies’ views are diverging as follows:

(12/22) Option 1 or 1b: Xiaomi, Ericsson, NEC, (Lenovo, Motorola Mobility), Apple, (Huawei, HiSilicon), Intel, Spreadtrum, ZTE, Qualcomm, InterDigital, Thales

(7/22) Option 2: Samsung, vivo, Spreadtrum, OPPO, ETRI, CMCC, Thales

(6/22) None: LG, NEC, (Lenovo, Motorola Mobility), Nokia, MediaTek, CATT

There is a slight majority to support option 1 compared to the number of companies that support option 2, but most companies support to introduce distance based cell reselection criteria. Meanwhile several companies prefer not to consider this new reselection criteria. Rapporteur suggests to have a relatively high level discussion about whether to apply distance based cell reselection criteria first, and after it can be agreed companies further discuss which way to go.

**(15/22) Proposal 2: For quasi-earth fixed cell, distance based cell reselection criteria is supported. FFS on the detail (e.g., exclude neighbour cells too far away or distance based ranking).**

## 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. |
| Ericsson | Yes, optionally present in SI  | It would be beneficial. Although it may be too much for Rel-17. |
| NEC  | Depends on conclusion of next question  | As discussed in our Tdoc [12]We want to keep it simple:Either not to support it in Rel17 (i.e., neighbouring cells’ remaining serving time is not broadcasted and not considered for cell reselection)Or: support it such as UE excludes the neighbouring cells from cell reselection, if it is going to disappear very soon, i.e. the remaining serving time is less than a threshold. |
| Lenovo, Motorola Mobility | No | We would like to avoid too much calculation of remaining time (and possibly continuous updating) for power saving in IDLE/INACTIVE. The remaining time of the serving cell could be sufficient e.g. to assist in triggering neighboring cell measurement. |
| Apple | No | We think location and time are correlated and it may be best to just stick with location for now. |
| Huawei, HiSilicon | Yes | We think UE should not reselect to a cell which will stop covering the current area soon. |
| vivo | No | On the one hand, we share the same view with Xiaomi that the motivation of introducing the timing information assisted cell reselection is to handle the issue that the neighbour cell measurement can’t be performed timely based on the legacy S criterion. So no enhancement is needed anymore.On the other hand, for the case of quasi-earth fixed cell scenario, it’s highly probable that the UE will reselect to the cell with the same coverage as the current serving cell. It’s a corner case that the UE reselects to a neighbouring cell which is about to disappear soon. So enhancement for such a corner case is not needed either. |
| Intel | No | For quasi-earth fixed cell, we already agreed stop time based enhancement and distance based cell reselection, no need to further complicate the design. |
| Spreadtrum | Yes | If stop timing of neighbour cell is broadcasted by serving cell, UE could reselect a cell with longer duration, and avoid the next cell reselection frequently, which is benefit for power consuming. |
| OPPO | No | Share the same view as Samsung. |
| ZTE | Yes | Agree with HW that such information would be helpful to prevent UE from selecting a cell who is going to stop serving the area very soon. |
| Nokia | No strong view | It is fine to have this time broadcast (i.e. we have agreed any cell can broadcast that - including serving/neighbour). But we do not think this factor should be involved in the reselection process.  |
| MediaTek | No strong view | Share similar views as Nokia. |
| Qualcomm | No | If needed, serving cell should broadcast neighbor cell start time so that at least UE can figure out the gap by neighbor cell start time – current cell stop time. |
| InterDigital | Yes | Reselecting to a cell which is just about to disappear is clearly undesirable. Okay to have this as optional assistance information. |
| ETRI | No | No further information is needed. |
| CATT | No | We agree that the cell stop time can help UE choose a cell with a longer valid time to reduce the reselection frequency, but we need to evaluate the degree of reselection frequency reduction and the consumption of SIB space. Since the legacy R criteria can also work, we tend to not broadcast the neighbour cells’ stop time. |
| CMCC | Neutral | The cell stop time of neighbor cell(s) could help to select a better neighbor cell, however we could also accept the majority views if companies don’t want to be too complicated. |
| China Telecom | No | Taking location based method in mind, we think the burden of SIB is higher than the benefit for cell reselection with stop time of neighbor cell. |
| Thales | Neutral | However note that neighbour and serving cell lifetime may be different |

**Summary:**

According to companies’ feedback, the counting result is as below:

(7/22) YES: LG, Ericsson, NEC, (Huawei, HiSilicon), Spreadtrum, ZTE, InterDigital

(12/22) NO: Samsung, Xiaomi, NEC, (Lenovo, Motorola Mobility), Apple, vivo, Intel, OPPO, Qualcomm, ETRI, CATT, CTC

(4/22) Neutral: Nokia, MediaTek, CMCC, Thales

Even for the neutral companies, the view is even if this value can be broadcast in SIB, “this factor should not be involved in the reselection process”. Taking this into account, the majority view seems to oppose broadcasting the cell stop time of neighbour cell(s).

**(16/22)** **Proposal 3:** **For quasi-earth fixed cell, the cell stop time of neighbour cell(s) is NOT broadcast.**

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 1b: Exclude the neighbouring cells from cell reselection, if it is going to disappear soon, i.e. the remaining serving time is less than a threshold**

**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. |
| Ericsson | Option 1 preferred, Option 2 ok |  |
| NEC | None of above solutionsOrOption 1b if remaining time of a neighbouring cell is broadcasted | See our comments to the previous questionOption1b is a rewording version of option1, but avoid clarifying how to handle the neighbouring cells without remaining serving time info and also a simple NOTE may be enough for specification |
| Huawei, HiSilicon | Option 1 or 2 | Option 3 does not look feasible to us, e.g., what if the second-best ranked cell also has a stop time that is too near? |
| Spreadtrum | Option 2 | The extra threshold in SIB is not needed. |
| ZTE | Option 1b | * We understand the evaluation of the remaining serving time of a neighbour cell should be based on the neighbour stop time provided from the serving cell.
* Since it is not possible for a serving cell to provide the cell stop time of all the neighbour cells, there will anyway be neighbour cells whose stop time is not provided by the serving cell but the cell quality is quite good.
* Thus, we understand it is better to use the remaining serving time as exclusion criteria to exclude cells who are going to stop serving very soon while the neighbour cells whose stop time has not be provided will still be considered by UE during cell ranking.
 |
| Nokia |  | We see no point in using neighbour cell’s remaining time directly in the reselection process. |
| MediaTek |  | Similar to Nokia, we also see no reason in specifying how neighbour cell’s remaining time is used in reselection process. |
| Qualcomm | Option 3(leave it to UE) or option 1b | It is likely UE will not have this information for all neighbor cells for comparison.What if UE has no time information for a cell but that cell would have been best if selected?Simply, this should be left to UE how it wants to use the information.But as explained by ZTE, option1b also works. |
| InterDigital | Option 1b | Okay with ZTE interpretation |

## Neighbour cell measurements

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | Y within NTN freq N among all NR freq | As concluded in TN-NTN mobility discussions, legacy means of inter freq prioritization are assumed for TN-NTN mobility. Thus, we can only consider this among NTN frequencies. |
| NEC | No | Same opinion as Xiaomi, UE shall perform measurement of higher priority frequency as legacy procedure regardless how it is close to serving cell centre or how good the serving cell’s quality is.This is to guarantee UE follows the frequency priority and camp on higher priority frequency whenever the coverage is available. |
| Lenovo, Motorola Mobility | No | Legacy procedures for higher priority frequency are sufficient. Distance-based criterion should not stand above frequency priority. |
| Apple | No | We think higher priority frequency measurements should be performed irrespective of UE’s distance from serving cell, as per legacy mechanism. |
| Huawei, HiSilicon | No | In the last meeting, for quasi-earth fixed cell, RAN2 has agreed that UE should start measurements on neighbour cells before the serving cell stops covering the current area.We think “start measurements” in the agreement includes intra-frequency, inter-frequency and inter-RAT neighbour cells in the NTN network. This is the simplest solution. Anyway this only concerns which cells to be measured, not affecting the reselection result (the determination of the target cell could consider other aspects like frequency priorities as well). |
| Vivo | No | For the measurement trigger conditions in the legacy TN, the UE always performs measurements of higher priority NR inter-frequency or inter-RAT frequencies, regardless of the radio measurement result of the serving cell. For the location-based measurement rule in NTN, this principle should be inherited as well, i.e., the UE should always perform measurements of higher priority NR inter-frequency or inter-RAT frequencies, regardless of the distance between UE and serving cell reference. |
| Intel | No | We tend to keep the “high priority” meaning. |
| Spreadtrum | No | Same as Xiaomi. The frequency with higher priority shall always be measured. |
| OPPO | No | The UE should always perform measurements of higher priority frequencies as legacy procedure |
| ZTE | No | We understand the distance threshold, if introduced, is used to trigger measurements on neighbour cells if UE have not done so, e.g. for the case when there is no higher priority frequencies and the RRM condition to measure intra-frequency or low priority frequencies has not been fulfilled.This is not meant for relaxed measurements at UE side. |
| Nokia | No | We think LG and Xiaomi are right and if there is a higher priority frequency available then it shall be measured irrespective of the distance. |
| MediaTek | No | We also think that higher priority frequency measurements should be performed irrespective of UE’s distance from serving cell, as per legacy mechanism. |
| Qualcomm | No | As mentioned by others, if UE is camping on lower priority frequency, it should always look for higher priority frequency as per existing legacy criteria. |
| InterDigital | No | Same view as others – higher priority frequency should always be measured if available. |
| ETRI | No | The legacy measurement should be performed first. Distance between UE and serving cell can be used for assistance information.  |
| CATT | No | As the legacy behaviour, higher priority frequency measurements should always be measured. |
| CMCC | No | Distance based solution should be an assistance solution rather than a higher-than-existing mechanism. |
| China Telecom | No |  |
| Thales | Y within NTN freq N among all NR freq | Agree with Ericsson comment |

**Summary:**

There is clear majority view that for higher priority NR inter-frequency or inter-RAT frequencies, the UE shall perform measurements of higher priority frequencies as legacy procedure.

**(19/22) Proposal 4: For quasi-earth fixed cell, same as legacy, UE shall perform neighbour cell measurements of “higher priority NR inter-frequency or inter-RAT frequencies” regardless of the distance between UE and serving cell reference location.**

**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.**

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | Y within NTN freq N among all NR freq | As concluded in TN-NTN mobility discussions, legacy means of inter freq prioritization are assumed for TN-NTN mobility. Thus, we can only consider this for NTN frequencies. |
| NEC | Yes | We support with the proposal, but agree with Samsung we need to further discuss the relationship between this new location criteria and legacy S criteria |
| Lenovo, Motorola Mobility | Yes | This can help in preventing too early measurement. |
| Apple | Yes |  |
| Huawei, HiSilicon | No | Same comment as in Q5. |
| Vivo | See comments | We think that the current RSRP/RSRQ-based measurement trigger condition(s) are sufficient. Note that the radio link quality eventually decides whether the communication can really be performed or not. It makes no sense for the UE to keep staying on the serving cell if the radio measurement result is lower than the threshold configured by NW but the distance between UE and serving cell reference location is still shorter than a threshold. If the radio measurement is actually not acceptable, finally the UE will face failure during connection establishment. |
| Intel | Yes |  |
| Spreadtrum | Yes | It is similar to legacy procedure. |
| OPPO | No | We understand the motivation of introducing location-based criterion is to mitigate the unclear near-far effect in NTN. This is more like an enhancement. Considering that we still have many essential open issues, we prefer not to consider this enhancement in R17 due to the limited time left. |
| ZTE | No | We understand the distance threshold, if introduced, is used to trigger measurements on neighbour cells if UE have not done so, e.g. for the case when there is no higher priority frequencies and the RRM condition to measure intra-frequency or low priority frequencies has not been fulfilled.This is not meant for relaxed measurements at UE side. |
| Nokia  | Yes |  |
| MediaTek | No | Please see our response to Question 2. |
| Qualcomm | Yes |  |
| InterDigital | Yes |  |
| ETRI | No | Please see comments in Q5. |
| CATT | Yes |  |
| CMCC | Yes |  |
| CMCC | Yes |  |
| Thales | Y within NTN freq N among all NR freq | Agree with Ericsson comment |

**Summary:**

There is slight majority view to support this proposal, meanwhile 6 companies oppose it as legacy mechanism is sufficient. If this enhancement can be agreed, further discussion is still needed about the co-existence of distance based principle, cell stop time based principle which has been agreed before and legacy measurement principle. Two companies also mentioned this distance based measurement principle is only applied to NTN neighbour cells, but rapporteur suggests to postpone this discussion point for now and come back to it when we have some progress in TN prioritization over NTN.

**(16/22) Proposal 5: For quasi-earth fixed cell, 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.**

**Proposal 6: if P5 is agreed, further discuss the exact UE behaviour under the combination of new distance based measurement principle, cell stop time based measurement principle which has been agreed before, and legacy measurement principle.**

## 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. |
| Ericsson |  | Needs discussion on how moving cell location is represented. |
| NEC | Yes  | If we agree any location/distance assisted cell reselection (e.g. proposal in Q6), we think it is possible to apply it to earth moving cell as well. Of course, it should be optional and only applicable if UE has up to date GNSS and serving/neighbouring cell reference location information. |
| Lenovo, Motorola Mobility | No | The reference location of earth moving cell varies continuously and it would be inefficient to broadcast it. Besides, UE’s calculation of distance will continuously vary as well even it is stationary. |
| Apple | Yes | But final agreement needs more details and discussion. |
| Huawei, HiSilicon | Yes | Ok, otherwise location-based reselection cannot be performed. |
| Vivo | No | For earth-moving cell, the cell center keeps on varying at every moment. So, intuitively a cell-level reference location as in the earth-fixed cell case is not realistic. Moreover, it is hard for the network to provide such a cell center that keeps changing over time, and also unclear whether it is really practical for the UE to calculate the cell center based on the assistant information, e.g., ephemeris data. |
| Intel | No | For earth moving cell, currently we don’t have any enhancements agreed. We could leave it to next release. |
| Spreadtrum | Yes, but see comments | If UE acquire the reference location of moving cell, it could deduce the current reference location continuously, this reference location information shall be broadcasted via SIB. For example, the drift rate of reference location. |
| OPPO | Yes | Share the same view as NEC |
| ZTE | No | From NW’s perspective, provision and update of such a consistently changing parameter would not be easy and we have not agreed on any related enhancements yet. |
| Nokia | Yes, with comments | We understand this is more complex than in Earth-fixed case, but it may also work, if the SIB provides a reference location with a timestamp. This information, jointly with the ephemeris, can allow the UE to calculate how this reference location moves in time. |
| MediaTek | No | We should leave it to future releases. For now it is important to have a working baseline solution. |
| Qualcomm | Yes | Agree with NEC. |
| InterDigital | Yes | Agree with NEC, this should be similar to quasi-earth fixed case. A difference would be whether the cell is approaching or receding, however that should be easily determined via ephemeris data. |
| ETRI |  | Further discussion is needed. |
| CATT | Yes | For earth moving cell, the trajectory of cell center can be seen as a line in a period of time, with knowing the cell center’s position at a time and the moving speed vector, UE can calculate the real-time cell center roughly, and it is enough for UE to judge the cell edge. Compared with the stop serving time, broadcast the reference location is a direct and simple way relatively. |
| CMCC | See comments | For earth moving case, how to get the real-time reference location may be discussed. |
| China Telecom | Yes | Earth moving scenario also needs enhancement for cell reselection. |

**Summary:**

According to companies’ feedback, some counting result is as below:

(11/21) YES: LG, NEC, Apple, (Huawei, HiSilicon), Spreadtrum, OPPO, Nokia, Qualcomm, InterDigital, CATT

(6/21) NO: Xiaomi, (Lenovo, Motorola Mobility), Vivo, Intel, ZTE, MediaTek

(4/21) Not clear: Samsung, Ericsson, ETRI, CMCC

Almost half of companies support location based cell reselection in Earth-moving cell, but for other companies, they prefer not to further optimize idle aspect and leave it to next release, or it’s not quite clear how to indicate/signal moving reference location of earth moving cell. Since the detail is still not clear, rapporteur suggests postponing this discussion point to next meeting.

**(11/21 Support, 10/21 Don’t support/Not clear) Proposal 7: postpone the following discussion point to next meeting:**

**Whether/how to broadcast the reference location of the cell (serving cell and/or neighbour cell) for earth moving cell.**

## Upcoming cell’s information

|  |  |  |
| --- | --- | --- |
| **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.**

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | yes | For Earth fixed LEO the information when new cell starts serving the same location as a cell that is going to disappear is useful. |
| NEC | Neutral |  |
| Lenovo, Motorola Mobility | No | We would like to avoid too much calculation of remaining time (and possibly continuous updating) for power saving in IDLE/INACTIVE. |
| Apple | No | Can be left to later releases. |
| Huawei, HiSilicon | No for timing information or feeder link’s path loss change, Yes for **next frequency or cell ID** | The information helps UE to determine the next cell to be measured. |
| Vivo | No | When the conditions for performing the measurements are met, the UE performs measurements of the corresponding frequency(-ies) and then evaluates the detected cells. If the new cell has not illuminated the area, the UE will not detect the cell, so that the UE cannot actually evaluate/measure the upcoming cells until it really starts its service. Even if the UE knows the time when the new cell starts its service in advance, the UE cannot avoid performing measurements of a frequency. To this end, it seems not of much use for the UE to know the starting time information of the next candidate cell(s). |
| Intel | No | Legacy mechanism can work, in the first release of NTN, we can focus on essential enhancements. |
| Spreadtrum | No | Even this coming cell is indicated to UE, the measurement is still necessary. |
| OPPO | No  | Share the same view as Xiaomi. |
| ZTE | No | The usage and gain of having such information is not clear yet. |
| Nokia | Yes | We think there could be some useful information which may be provided by the serving cell to streamline the UE’s searching/measurements towards the next/neighbour cells. E.g. the information how to obtain the ephemeris of the neighbour satellite or the time/freq. synchronization information (as outlined in our R2-2110613, section 3).  |
| MediaTek | Yes | This seems to be a simpler option than location based cell reselection. Hence, we support this proposal. |
| Qualcomm | Yes | This is helpful information for UE. |
| InterDigital | No | Okay to leave it to later releases |
| ETRI | No | It seems an optimization.  |
| CATT | No | Agree with xiaomi. |
| CMCC | Neutral | The information of the next candidate cell(s) could help to perform reselection better, however we could also accept the majority views if companies don’t want to be too complicated. |
| China Telecom | No | Legacy mechanism can work. |
| Thales | Yes (with comment) | Only timing information but not the feeder link’s path loss change |

**Summary:**

8 companies would like to provide the information of the next candidate cell(s) to UE, but there is no consensus on the detailed content. The candidate information include timing information, feeder link’s path loss change, the information how to obtain the ephemeris of the neighbour satellite or the time/freq. synchronization information, next frequency or cell ID, and the information when new cell starts serving the same location.

Meanwhile other companies prefer not to further enhance idle aspect, and think the timing assisted and location assisted cell reselection, and legacy mechanism are enough.

**(14/22) Proposal 8:** **the information of the next candidate cell(s) is NOT provided to UE.**

# Phase-1 Conclusion

**Based on companies’ feedback, the following proposals are made:**

** List of proposals for agreement:**

**(21/22) Proposal 1: it depends on UE implementation whether/when to perform location acquisition for cell reselection.**

**(19/22) Proposal 4: For quasi-earth fixed cell, same as legacy, UE shall perform neighbour cell measurements of “higher priority NR inter-frequency or inter-RAT frequencies” regardless of the distance between UE and serving cell reference location.**

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

**(15/22) Proposal 2: For quasi-earth fixed cell, distance based cell reselection criteria is supported. FFS on the detail (e.g., exclude neighbour cells too far away or distance based ranking).**

**(16/22)** **Proposal 3:** **For quasi-earth fixed cell, the cell stop time of neighbour cell(s) is NOT broadcast.**

**(16/22) Proposal 5: For quasi-earth fixed cell, 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.**

**Proposal 6: if P5 is agreed, further discuss the exact UE behaviour under the combination of new distance based measurement principle, cell stop time based measurement principle which has been agreed before, and legacy measurement principle.**

**(14/22) Proposal 8:** **the information of the next candidate cell(s) is NOT provided to UE.**

** List of proposals that should not be pursued:**

**(11/21 Support, 10/21 Don’t support/Not clear) Proposal 7: postpone the following discussion point to next meeting:**

**Whether/how to broadcast the reference location of the cell (serving cell and/or neighbour cell) for earth moving cell.**

# Phase-2 Discussion

## Neighbour cell measurements

In this meeting, it has been agreed that “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”. And how to apply the distance between UE and the reference location of the cell can be further discussed, the two directions are applied in neighbour cell measurements and applied as new cell reselection criteria.

Regarding distance based neighbour cell measurement, the following proposals are made in Phase-1:

|  |
| --- |
| **(16/22) Proposal 5: For quasi-earth fixed cell, 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.** **Proposal 6: if P5 is agreed, further discuss the exact UE behaviour under the combination of new distance based measurement principle, cell stop time based measurement principle which has been agreed before, and legacy measurement principle.** |

Some of the opponents’ views are “legacy mechanism is sufficient” and “it could be considered in next release”, meanwhile companies also show the concern about how to apply this new principle together with cell stop time based measurement principle which has been agreed before, and legacy measurement principle. In Phase-2 we could discuss P6 directly to have a clearer understanding on this enhancement.

For the neighbour cell measurements of “NR intra-freq or inter-freq with equal or lower priority”, the specified UE behaviour is as follows.

|  |
| --- |
| - If the serving cell fulfils Srxlev> SIntraSearchP and Squal > SIntraSearchQ, the UE may choose not to perform intra-frequency measurements.- Otherwise, the UE shall perform intra-frequency measurements.--------------------------omitted part-------------------------------------------- For a NR inter-frequency with an equal or lower reselection priority than the reselection priority of the current NR frequency and for inter-RAT frequency with lower reselection priority than the reselection priority of the current NR frequency:- If the serving cell fulfils Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, the UE may choose not to perform measurements of NR inter-frequency cells of equal or lower priority, or inter-RAT frequency cells of lower priority;- Otherwise,the UE shall perform measurements of NR inter-frequency cells of equal or lower priority, or inter-RAT frequency cells of lower priority according to TS 38.133 [8]. |

Based on current specification, if the legacy Srxlev/Squal condition is met, UE may not perform neighbour cell measurements of “NR intra-freq or inter-freq with equal or lower priority”. If the distance based principle is agreed, there could be two options for specification implementation considering the combination of legacy Srxlev/Squal principle and the new distance based principle.

**Option 1:** For quasi-earth fixed cell, 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) **AND** (legacy Srxlev/Squal condition is met, i.e., serving cell’s Srxlev/Squal is better than a threshold);

**Option 2:** For quasi-earth fixed cell, 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) **OR** (legacy Srxlev/Squal condition is met, i.e., serving cell’s Srxlev/Squal is better than a threshold);

**Question 1: for the application of the distance based neighbour cell measurements principle, which option is agreeable?**

**Option 1:** For quasi-earth fixed cell, 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) **AND** (legacy Srxlev/Squal condition is met, i.e., serving cell’s Srxlev/Squal is better than a threshold);

**Option 2:** For quasi-earth fixed cell, 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) **OR** (legacy Srxlev/Squal condition is met, i.e., serving cell’s Srxlev/Squal is better than a threshold).

**Option 3:** don’t support the distance based neighbour cell measurements principle.

|  |  |  |
| --- | --- | --- |
| **Company** | **Which option is agreeable?** | **Comments** |
| MediaTek | Option 3 | If Distance-based principle is agreed, it should work independently of the legacy principles. In that case Option 2 is the only choice. |
| Apple | Option 3 | If option 3 is not agreeable, then our preference would be for option 1 because we think RSRP/RSRQ should still be the primary criteria for cell reselection. Also if distance is not available, then option 1 is the same as legacy procedure while option 2 is not. |
| Qualcomm | Option 2 | To detect whether UE is at cell edge, option 2 is sufficient. |
| Xiaomi | Option 1 | The distance assisted cell reselection is to address the near-far issue, and option 1 is in line with this motivation. |
| Lenovo, Motorola Mobility | Option 1 | We prefer **AND** association as it is stricter. The UE can be considered as at cell edge and shall trigger measurement when distance is large or RSRP is low. |
| Samsung | Option 1  | We think assuming location criterion is used as one of cell reselection criteria, it should be also considered in the measurement rule, otherwise because of inconsistence between measurement rule and cell reselection criteria, UE may perform measurement too late or early than required.  |
| Huawei, HiSilicon | See comments | This is related to whether the location-based measurement triggering and the legacy measurement triggering can be used at the same time. We have similar view as MediaTek that the location-based solution works independently of the legacy one.1) If the cell only broadcasts SnonIntraSearchP/ SnonIntraSearchQ, legacy behaviour applies;2) If the cell broadcast location-related parameters (e.g. a threshold), considering we have the following agreement in phase 1 discussion:*1.     When UE uses location based cell reselection enhancements, it's up to UE implementation to guarantee that a valid location information is available*2-1) If by implementation the UE wants to perform location-based reselection, then the UE ignores SnonIntraSearchP/ SnonIntraSearchQ and whether to measure “NR intra-freq or inter-freq with equal or lower priority” is based on distance;2-2) If by implementation the UE has no location info or does not want to perform location-based reselection, the legacy behaviour applies. |
| Transsion | Option 3 | UE may need to measure for neighbor cells mainly due to the quality of current served cell below a certain threshold, that is, RSRP/RSRQ.Option 1 would be the only choose once the distance based neighbour cell measurements is agreed. |
| Spreadtrum | Option 1 | RRM measurement is an essential condition. |
| CATT | Option 1 | If the distance between UE and serving cell reference location is over a threshold, UE may be at edge of the cell. If the RSRP/RSRQ is lower than the threshold, means the UE is at a poor channel condition. UE should perform neighbour cell measurements as long as one of the conditions is met. That is option1. |
| ITRI | Option 1 | Rely on RRM measurement based cell reselection only may have near-far issue in NTN. Distance based cell reselection could address the issue.  |
| LG | Option 1 | We still think that distance-based measurement rule is acceptable, meanwhile distance-based cell reselection criteria is not acceptable. If distance-based measurement rule is introduced, cell quality should be satisfied. This is similar concept with NTN CHO that cell quality condition should be mandatory for NTN CHO triggering condition. |
| China Telecom | Option1 | RRM is the baseline for cell reselection and location is the enhancement to avoid near-far effect. We think they should work together in NTN. |
| ZTE | Option 1 or option 3 | For option 1, since some UE may not have the location information available or may choose not to use the location information to decide when to perform measurements, we understand the option 1 with “AND” only applies for the case when UE use the location information to decide when to perform measurements. If UE does not have the location info or does not want to use it to decide when to trigger measurements, the legacy behaviour applies.And it mainly depends on the behavior at UE side and whether NW has configured the threshold of distance. The SnonIntraSearchP andSnonIntraSearchQ can be absent but they have default value defined, i.e. infinity for SnonIntraSearchP and 0 dB for SnonIntraSearchQ, so the RRM based condition will always be evaluated. |
| OPPO | Option 3 | We understand it would be challenging for NW to configure the proper distance threshold and it would be sufficient to reuse the current RSRP-based mechanism. |
| vivo | Option 3 | The radio link quality eventually decides whether the communication can really be performed or not. Once the legacy Srxlev/Squal condition of the serving cell is not met, the UE should perform neighbour cell measurements regardless of whether the distance condition is met. So the legacy measurement trigger principle is enough.In addition, if the distance-based neighbour cell measurements trigger principle is supported, option 1 should be adopted. |
| Ericsson | Option 1 | Note that the relaxation for performing measurements can apply only among NTN cells/frequencies. |
| Nokia | Option 3 | We have a similar opinion to vivo, if Srxlev/Squal of the serving cell deteriorates below the threshold, it shall not matter if the distance criteria is met or not. The UE shall measure according to the existing principle.  |
| InterDigital | Option 1 | There should be a minimum measurement quality, however if both distance & measurement conditions are configured, the measurement threshold e.g. could be lower. |
| Turkcell | Option 1 | The distance based solution can be useful with legacy one.  |
| NEC  | Option 2 | UE could use location-based principle when there is valid location information, otherwise, UE use the legacy principle. |
| ETRI | Option 1 | The relaxation for performing measurements should be stricter. |

In last meeting, the following agreements were made for quasi-earth fixed cell to take cell stop time into account:

1. For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area.
2. For quasi-earth fixed cell, the broadcast “timing information on when a cell is going to stop serving the area” refers to the time when a cell stops covering the current area.
3. For quasi-earth fixed cell, specify that UE should start measurements on neighbour cells before the broadcast stop time of the serving cell, i.e. the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation.

As mentioned by companies in Phase-1, since this cell stop time is used to enable timely neighbour cell measurements before a cell stops covering the current area, it should override other relaxed neighbour cell measurement principle.

**Question 2: if the following proposal can be agreeable:**

**For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area, regardless of (the distance between UE and serving cell reference location) or (if legacy Srxlev/Squal condition is met, i.e., serving cell’s Srxlev/Squal is better than a threshold).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| MediaTek | Y | We already agreed to the base principle unconditionally, so there is no point to add the additional conditions. |
| Apple | Y |  |
| Qualcomm | Yes |  |
| Xiaomi | Y |   |
| Lenovo, Motorola Mobility | Y |  |
| Samsung | Yes |  |
| Huawei, HiSilicon | Y |  |
| Transsion | Y |  |
| Spreadtrum | Yes | With the stop timing indication, the measurement could be simplified. |
| CATT | Y |  |
| ITRI | Yes |  |
| LG | Y | Same view with MediaTek. |
| China Telecom | Yes | At RAN2#115, broadcast of serving cell stop time in SIB is applicable to quasi earth fixed cell. UE can use this information to trigger measurement. |
| ZTE | Y |  |
| OPPO | Y |  |
| vivo | Y | We think previous agreements have already been with this meaning. |
| Ericsson | Y | Same view as Mediatek |
| Nokia | Yes |  |
| InterDigital | Yes |  |
| Turkcell | Y |  |
| NEC  | Y | Since the serving cell is going to disappear, all UEs (even the UEs close to serving cell centre and with good radio condition) shall start measurement on neighbouring cells  |
| ETRI | Y |  |

## Distance based cell reselection criteria

As discussed in Phase-1, companies have shown their preferences on cell reselection criteria with reasonable comments. As for the detailed criteria, companies still have different views., i.e., option 1/1b or option 2. But we could try to achieve some high-level consensus bases on majority view.

**Question 3: if the following proposal can be agreeable:**

**(original P2 in Phase-1): For quasi-earth fixed cell, distance based cell reselection criteria is supported. FFS on the detail (e.g., exclude neighbour cells too far away or distance based ranking).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| MediaTek | N | Distance based cell reselection seems to have no tangible benefits to address the quasi-earth fixed cells in NTN. We have already agreed to time-based solutions, which is sufficient. |
| Apple | Y |  |
| Qualcomm | Y |  |
| Xiaomi | Y | For how to define the distance, it would need further discussion, for instance, if the distance is the absolute distance between UE and satellites, the UE may can’t reselect to the GEO based on the distance since the GEO always have the longest distance in the all neighbour satellites, so the normalized distance can be considered. |
| Lenovo, Motorola Mobility | Y |  |
| Samsung | Y |  |
| Huawei, HiSilicon | Y |  |
| Transsion | N | Same view with MTK |
| CATT | N | The distance to neighbour cell’s reference location has little help in process of choosing a cell with longer valid time or has better radio quality. In our opinion, location is used to initiate measurement, but not used to select a target cell. |
| ITRI | Y |  |
| LG | N | We repeat our view that distance between UE and 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, as cell quality is not really different in a cell coverage, 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. |
| China Telecom | Y |  |
| ZTE | Y |  |
| OPPO | Y |  |
| vivo | Y | The difference of RSRP/RSRQ measurement results among neighbouring cells is not obvious in NTN, so distance-based criteria should be used as a complement to the legacy RSRP/RSRQ-based criteria to assist the UE determine the proper target cell. |
| Ericsson | Y | When distance is applied in ranking it simplifies the measurements and ensures real neighbor is reselected. Further, distance metric is important as it will tell about what TA UE needs for accessing and that should be minimized as well. |
| Nokia | N | Agree with LG. Same comment as we made in Phase-1. |
| InterDigital | Yes |  |
| Turkcell | Y |  |
| NEC | Y | We think location-based solution target for different use case comparing with time-based solution, so it would be useful to have simple location-based solution. On the other hand, we are fine to not have it if that is majority preference. |
| ETRI | Y |  |

## Other enhancements

Based on companies’ feedback in Phase-1, the following proposals are made to refuse further enhancements to idle mode or postpone some discussion due to lack of detailed design.

|  |
| --- |
| **(16/22)** **Proposal 3:** **For quasi-earth fixed cell, the cell stop time of neighbour cell(s) is NOT broadcast.****(11/21 Support, 10/21 Don’t support/Not clear) Proposal 7: postpone the following discussion point to next meeting:****Whether/how to broadcast the reference location of the cell (serving cell and/or neighbour cell) for earth moving cell.****(14/22) Proposal 8:** **the information of the next candidate cell(s) is NOT provided to UE.** |

In Phase-2, we could have a quick check on companies’ views and see whether some consensus or easy agreements can be made.

**Question 4: if the following proposal can be agreeable:**

**(Original** **P3 in Phase-1):** **For quasi-earth fixed cell, the cell stop time of neighbour cell(s) is NOT broadcast.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| MediaTek | Y |  |
| Apple | Y |  |
| Qualcomm | Y |  |
| Xiaomi | Y |  |
| Lenovo, Motorola Mobility | Y |  |
| Samsung | N | We think this information is beneficial for UE power saving.  |
| Huawei, HiSilicon | N | If this is taken as an agreement, it means the cell ranking will not consider the stop time of each cell. In other words, it means the stop time is only used for determining when to start measurement, but has no impact on determining the target cell. |
| Transsion | Y |  |
| Spreadtrum | N | This information could decrease the number of cell reselection. |
| CATT | Y |  |
| ITRI | Y |  |
| LG | N | We do not think that cell reselection to a neighbour cell which will disappear soon is not a corner case. If the cell reselection is only based on the cell quality, it is same probability to reselect to a cell with long service time or short service time. (Even if location based cell reselection is introduced, it is same) So the stop time should be considered in the cell reselection to reselect to the neighbour cell longer remaining service time. |
| China Telecom | Y |  |
| ZTE  | N | We understand that such information would be helpful to prevent UE from selecting a cell who is going to stop serving the area very soon. |
| OPPO | Y |  |
| vivo | Y |  |
| Ericsson | Y | We are ok also to have it but it has to be optional parameter |
| Nokia | Y | We agree, the baseline should be to broadcast serving cell’s stop time. Such information for the neighbours is not essential.  |
| InterDigital | Yes | Same view as Ericsson |
| Turkcell | Y | It can be an optional parameter. |
| NEC | N | Acceptable for us to broadcast it optionally, UE can exclude the neighbouring cells which are going to disappear soon. But we are also fine to not broadcast it at all |
| ETRI | Y |  |

**Question 5: if the following proposal can be agreeable:**

**(Original** **P7 in Phase-1): postpone the following discussion point to next meeting:**

**Whether/how to broadcast the reference location of the cell (serving cell and/or neighbour cell) for earth moving cell.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| MediaTek | Y |  |
| Apple | N |  |
| Qualcomm | Y |  |
| Xiaomi | Y |  |
| Lenovo, Motorola Mobility | Y |  |
| Samsung | Y |  |
| Huawei, HiSilicon | Y |  |
| Transsion | Y |  |
| Spreadtrum | Y |  |
| CATT | Y | We support to introduce location based cell (re-)selection in earth moving scenario, but we agree to postpone the discussion to next meeting. In earth moving case, UE also need enhancement for cell reselection. Broadcast the reference location with a timestamp is an effective method. UE could calculate the real-time center position roughly according to the predictability of satellite trajectory. |
| ITRI | Y |  |
| LG | Y |  |
| China Telecom | Y |  |
| ZTE | Y |  |
| OPPO | Y |  |
| vivo | Y |  |
| Ericsson | Y |  |
| Nokia |  | We see some point in providing this information, but we are also OK to postpone the discussion, having other basic aspects to address in Rel-17. |
| InterDigital | Yes | Okay to postpone. |
| Turkcell | Y |  |
| NEC  | Y | Discuss how to broadcast the reference location of the cell after we agree to support distance-based cell reselection criteria or the distance based neighbour cell measurements triggering. |
| ETRI | Y |  |

**Question 6: if the following proposal can be agreeable:**

**(Original** **P8 in Phase-1):** **the information of the next candidate cell(s) is NOT provided to UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Is this proposal agreeable? (Y or N)** | **Comments** |
| MediaTek | N | This seems to be a simpler option than location based cell reselection. |
| Apple | Y |  |
| Qualcomm | N | This is helpful information. |
| Xiaomi | Y |  |
| Lenovo, Motorola Mobility | Y |  |
| Samsung | N | We agree this is helpful information for UE power saving.  |
| Huawei, HiSilicon | N | The information helps UE to determine the next cell to be measured. |
| Transsion | Y |  |
| Spreadtrum | N | It is benefit for power saving. |
| CATT | Y | Considering the SIB space, we don’t think there need any extra inessential information in SIB. |
| ITRI | Y |  |
| LG | N | Same view with MediaTek.  |
| China Telecom | Y |  |
| ZTE | Y |  |
| OPPO | N | The information, e.g. the feeder link’s path loss change of the next candidate cell(s) could be used for UE to quickly obtain the next candidate cell’s radio quality and thus helpful for UE to do quick cell reselection.  |
| vivo | Y |  |
| Ericsson | N | This is helpful information and reduces a lot the interruption due to feeder link switch which will happen regulartly |
| Nokia | N  | Agree this information may be helpful. E.g. the information how to obtain the ephemeris of the neighbour satellite or the time/freq. synchronization information (see our R2-2110613). |
| InterDigital | N | Satellite movement is deterministic, so this would be helpful and known |
| Turkcell | N | This can be helpful for power saving |
| NEC  | Y |  |
| ETRI | Y |  |

# Phase-2 Conclusion

# 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