3GPP TSG-RAN WG2 Meeting #117 Electronic R2-22xxxxx

Elbonia, Feb 2022

**Agenda item: 8.10.3.1.1**

**Source: ZTE corporation, Sanechips**

**Title: Report of [Pre117-e][NTN][102] Idle mode open issues**

**Document for: Discussion and Decision**

# 1 Introduction

This is the summary of the following pre-meeting discussion.

* [Pre117-e][NTN][102] Idle mode open issues

Scope: Continue the discussion on idle mode open issues listed in R2-2201898:

- issue 1 and 3-10 will be handled in offline discussion [Pre117-e][NTN][102] Idle mode open issues

- issue 2 will be split among offline [Pre117-e][NTN][101] (ASN.1 aspects of ephemeris signalling) and offline [Pre117-e][NTN][102] (How the satellite ephemeris can assist cell reselection and under what circumstance UE will perform cell selection/reselection based on satellite/HAPS ephemeris)

- issue 11 will be handled in offline discussion [Pre117-e][NTN][101]

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): Feb 14

Initial deadline (for rapporteur's summary): Feb 17

# 2 Contact information

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| Company | Contact: Name (E-mail) |
| Huawei, HiSilicon | Lili Zheng (zhenglili4@huawei.com) |
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# 3 Open issue list

Open issues listed in R2-2201898:

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**Open issue 1:**Which option to adopt for location-based reselection?

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

-      Option 1b: exclude neighbor cells too far away i.e., distance longer than a threshold will not be considered during cell reselection ;

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

-     Other options?

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 2:** For cell selection and reselection in NTN, the satellite/HAPS ephemeris may be used by UE. The ephemeris is divided into serving cell’s ephemeris and neighbor cells’ ephemeris.  FFS on the definition of satellite/HAPS ephemeris , under what circumstance UE will perform cell selection/reselection based on satellite/HAPS ephemeris and how would the serving cell’s ephemeris and neighbor cells’ ephemeris differ regarding e.g. the required accuracy or signaling impact.

[Rapporteur] How the satellite ephemeris can assist cell reselection and under what circumstance UE will perform cell selection/reselection based on satellite/HAPS ephemeris covered in this pre-meeting discussion [102]. The signaling of ephemeris i.e. ASN.1, covered by pre-meeting discussion [101].

**Open issue 3:**Whether Time-based and location-based reselection can be configured simultaneously? If Yes, what is the expected UE behavior when configured together?

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 4:**Any further enhancement on cell reselection priority configuration in NTN?

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 5:**Whether the timing information about new upcoming cell is needed for quasi-earth fixed cell and/or earth moving cell? FFS if such information is known from system information and/or the ephemeris. FFS on the utilization of such information.

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 6:** Regarding UE-based solution for SMTC adjustments in idle and inactive mode, UE autonomously adjust the SMTCs based on location and ephemeris. FFS whether NW assistance information is provided.

[Rapporteur] FFS whether NW assistance information is provided is covered in this pre-meeting discussion [102].

**Open issue 7:**Any enhancement on the SMTC broadcast for measurements in idle and inactive mode?

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 8:** Any enhancement on TN prioritization over NTN?

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 9:** How to prevent non-NTN capable UEs from accessing an NTN cell?

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 10:** Does UE need to be aware whether an NTN cell is quasi-fixed or earth moving? If Yes, how?

[Rapporteur] Covered in this pre-meeting discussion [102].

**Open issue 11:** The ntnUlSyncValidityDuration applies to the whole SIBX. UE acquires the updated SIBX when the timer expires. FFS whether to also include it in the LS to RAN1. FFS if this applies only to connected mode or to idle mode UE as well.

[Rapporteur] Covered in pre-meeting discussion [101].

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# 3 Discussion

## **Open issue 1: location-based reselection**

The following agreements have been made to support location-based reselection in NTN.

**RAN2#116e:**

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

Regarding the utilization of the distance between UE and the reference location of the cell (serving cell and/or neighbor cell), the following options have been proposed and discussions in the past meetings:

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

-      Option 1b: exclude neighbor cells too far away i.e., distance longer than a threshold will not be considered during cell reselection;

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

-     Other options?

**Question 1: On utilization of the distance between UE and the reference location of a cell in cell reselection, which option do companies prefer?**

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| --- | --- | --- |
| Company | Option 1/1b/2 or other | Detailed Comments |
| Huawei, HiSilicon | Option 1 |  |
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## **Open issue 2: Satellite ephemeris assisted cell reselection**

The following agreements have been made on satellite ephemeris assisted cell reselection:

**RAN2#111e**

Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN (FFS what the term satellite/HAPS ephemeris actually means). FFS when this ephemeris based cell selection / reselection can be used. FFS whether UE location (and/or other information) based cell selection and reselection should be introduced for NTN

However, there has not been much discussion on how to use the satellite ephemeris to assist cell reselection, under what circumstance UE will perform cell selection/reselection based on satellite/HAPS ephemeris and the expected UE behavior.

In the past discussions, some examples have been given on how to use the satellite ephemeris in cell reselection. For example, the satellite type, i.e. GEO or NGSO, can be inferred from ephemeris and can be used by UE to determine whether to camp or not.

Thus, the rapporteur would like to understand what kind of information included or inferred from ephemeris would be useful in cell reselection and the expected UE behavior when using such information.

**Question 2: What kind of information included or inferred from ephemeris would be useful to assist cell reselection? And what is the expected UE behaviour when using such information in cell reselection?**

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| --- | --- | --- |
| Company | Information included or inferred from ephemeris that is useful in cell reselection | Expected UE behavior when using such information in cell reselection |
| Huawei, HiSilicon | Our understanding is that “Satellite/HAPS ephemeris based cell selection and reselection” was a term to illustrate the overall NTN selection/reselection enhancements. Considering the agreements achieved in later meetings, “Satellite/HAPS ephemeris based cell selection and reselection” is represented by time-based reselection and location-based reselection. The ephemeris information can help to configure time/location-based reselection parameters (t-Service, reference location).Or, to answer the question literally (what information can be inferred by the UE from ephemeris), service link delay between UE and serving/neighbor cell can be deduced to assist SMTC adjustment for Idle/Inactive mode UEs | Time/location-based measurement triggering, location-based reselection, SMTC adjustment. |
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## **Open issue 3: Configuration of time and location based cell reselection**

The following agreements have been made on time based reselection:

**RAN2#115e**

1. Broadcast of cell stop time in SIB is only applicable to quasi earth fixed cell (not to moving cell). No further work in this release to address any moving cell specific details on using the cell stop time to assist measurements or cell reselection
2. For quasi-earth fixed cell, the reference location of the cell (serving cell or the neighbor cells) is broadcast in system information
3. For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area.
4. 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.
5. 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.

**RAN2#116e**

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).

**RAN2#116bis-e**

1. 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 remaining serving time.
2. Before the stop-time based measurements are triggered, the UE measurements follow Legacy behaviour (i.e., based on Srxlev/Squal) and there is no measurement relaxation.
3. Cell stop time is not applied to cell ranking in determining the target cell for reselection.

The following agreements have been made on location based reselection so far:

**RAN2#116bis-e**

1. Location information can be used to determine when to start measurement.

2. UE may choose not to perform neighbour cell measurements of “NR intra-freq or inter-freq with equal or lower priority, or inter-RAT freq with 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).

3. Location-based measurement initiation is only applied if the cell broadcasts location-related parameters (e.g. a threshold) and by implementation the UE has location information.

**Question 3: Whether Time-based and location-based reselection can be configured simultaneously? If Yes, what is the expected UE behaviour when configured together?**

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| --- | --- | --- |
| Company | Yes/No | Expected UE behavior when configured together |
| Huawei, HiSilicon | Yes | UE can choose to apply one or both of them, which is determined by UE implementation. When UE chooses both of them, the measurement should be started if either time based condition or location based condition is satisfied. |
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## **Open issue 4: Further enhancement on cell reselection priority configuration in NTN**

**Question 4: Any further enhancement on cell reselection priority configuration in NTN? If Yes, please clarify the use case and the detailed enhancement.**

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| Company | Yes/No | Use case and the detailed enhancement |
| Huawei, HiSilicon | No |  |
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## **Open issue 5: Timing information about the new upcoming cell**

It has been proposed to provide the start time of the new upcoming cell to UE to assist cell reselection without reaching any consensus.

**Question 5.1: Whether the timing information about new upcoming cell is needed for quasi-earth fixed cell and/or earth moving cell? If Yes, what is the expected UE behaviour when using such information to assist cell reselection?**

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| --- | --- | --- |
| Company | Yes/No | Expected UE behavior when using such information to assist cell reselection |
| **Fixed cell**  | **Moving cell** |
| Huawei, HiSilicon | See comments | No | For fixed cell, will there be a large gap between the stop time of serving cell and the start time of upcoming cell? We think the stop time is enough, and the “timing information” seems unnecessary.Broadcasting the frequency/PCI information of upcoming cell can be useful in:1) Measurements: UE can start measuring the upcoming cell. 2) Cell ranking: UE can prioritize the upcoming cell, or only consider the upcoming cell as target cell.However, we are not sure whether this has any spec impact. The network can configure the upcoming cell in intraFreqWhiteCellList or interFreqWhiteCellList, and the UE shall consider only the white listed cells, if configured, as candidates for cell reselection. |
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**Question 5.2: If the timing information about new upcoming cell, e.g. the start time of new upcoming cell, is needed, how to provide such information to UE?**

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| Company | Fixed cell  | Moving cell |
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## **Open issue 6: NW assistance information for SMTC adjustments in idle and inactive mode**

The following agreement has been made with an FFS left on the NW assistance information:

**RAN2#116bis-e**

1. Regarding UE-based solution for SMTC adjustments, UE autonomously adjust the SMTCs based on location and ephemeris. FFS whether NW assistance information is provided.

**Question 6: For UE-based SMTC adjustment in idle and inactive mode, in addition to the ephemeris, does UE need other assistance information provided from NW side? If Yes, what kind of assistance information is needed?**

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| Company | Yes/No  | Detailed comments on the required assistance information |
| Huawei, HiSilicon | No |  |
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## **Open issue 7: Enhancement on the SMTC broadcast for measurements in idle and inactive mode**

It has been proposed to enhance the SMTC configuration in idle and inactive mode by configuring up to 4 SMTC per frequency. There has been some discussion but no consensus was reached in RAN2#116bis-e.

**Question 7: Do companies see the need to enhance the SMTC broadcast for measurements in idle and inactive mode? If Yes, what is the expected enhancement?**

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| --- | --- | --- |
| Company | Yes/No  | Expected enhancement on SMTC configuration in idle and inactive mode |
| Huawei, HiSilicon | Yes | No strong view, 4 is ok |
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## **Open issue 8: Enhancement on TN prioritization over NTN**

The following options have been raised in the past discussions on how to prioritize TN over NTN:

* Option 1: It is “hard” coded in the specification, e.g. in 38.304, that UE always prioritizes TN cell in cell reselection.
* Option 2: Indicate in system information of TN or NTN cell or both explicitly, the need to prioritize TN in the area the NTN/TN cells are covering.
* Option 3: Broadcast in system information a TN or NTN specific offset to be applied to RSRP measurement result for cell quality so that TN cell will always rank higher.
* Option 4: UE’s relaxed measurement mode is impacted to prioritize TN. For example, if UE detects TN cell UE stops any relaxed measurement mode for TN UE might have applied.

**Question 8: Do companies see the need to enhance cell reselection procedure to support TN prioritization over NTN? If Yes, which option do companies prefer?**

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| Company | Yes/No  | If Yes, option 1/2/3/4 or other |
| Huawei, HiSilicon | No | Can be postponed to future releases. |
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## **Open issue 9: Prevent non-NTN capable UEs from accessing an NTN cell**

RAN4 has agreed to introduce new frequency bands for NR NTN due to the different frequency allocations for different services based on the ITU radio regulation. With such agreement in RAN4, UE would be aware the serving cell is a NTN cell or not based on the broadcast band information.

However, more frequency bands would be introduced in the future for NTN. The rapporteur understand RAN4 cannot give a promise that there will never be overlapping between TN and NTN frequency bands. With such thinking, we still need to consider whether a specific flag or mechanism is needed in RAN2 to prevent non-NTN capable UE from accessing an NTN cell.

**Question 9: Do companies see the need to define a mechanism in RAN2 to prevent non-NTN capable UE from accessing an NTN cell? If Yes, what would be the expected enhancement?**

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| --- | --- | --- |
| Company | Yes/No  | If Yes, the expected enhancement |
| Huawei, HiSilicon | Yes | For non-NTN capable UEs, cellReservedForOtherUse IE and cellReservedForFutureUse-r16 IE in SIB1 can be set true. For NTN capable UEs, cellReservedForOtherUse IE and cellReservedForFutureUse-r16 IE should be ignored, and a new IE should be introduced in SIB1, e.g., cellReservedForFutureUse-r17. |
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## **Open issue 10: UE awareness of whether an NTN cell is quasi-fixed or earth moving**

**Question 10.1: Do companies see the need for UE to be aware of whether the serving cell and/or neighbour cell is a quasi-fixed or earth moving cell? If Yes, what is the use case?**

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| --- | --- | --- |
| Company | Yes/No  | If Yes, what is the use case? |
| Huawei, HiSilicon | Yes | If the cell is a moving cell, UE may need to predict the reference location by combing the moving trajectory and the coverage information, in order to perform location-based reselection (if RAN2 agrees location-based reselection is also applied to moving cell) or location-based CHO. |
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**Question 10.2: How UE would be aware of whether the serving cell and/or the neighbour cell is a quasi-fixed or earth moving cell if such information is needed?**

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| Company | Detailed comments |
| Huawei, HiSilicon | The indication is mainly useful for location-based CHO, it can be indicated to the UE through RRC message if the network wants to configure location-based CHO to the UE. |
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# 4 Conclusion

*To be added*

# Annex – Agreements for idle/inactive mode in NTN

## RAN2#111e

Agreements:

1. Cell selection / reselection in NR is the baseline in NTN idle mode procedure.
2. Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN (FFS what the term satellite/HAPS ephemeris actually means). FFS when this ephemeris based cell selection / reselection can be used. FFS whether UE location (and/or other information) based cell selection and reselection should be introduced for NTN
3. The satellite ephemeris should be provided to UE, at least for Satellite/HAPS ephemeris based cell selection and reselection (FFS what the term satellite/HAPS ephemeris actually means).
4. The network type (i.e. TN or NTN) should be known to UE. FFS whether to achieve this in an implicit or explicit way.
5. The existing cell reselection priority configuration can be taken as a baseline in NTN. FFS on any further enhancement.
6. Postpone the discussion on whether to introduce a new SIB until we have more progress on the content of NTN specific system information.

## RAN2#112e

Agreements:

1. Existing cell reselection principles are considered as baseline and that information about when a cell is going to stop serving the area and information about new upcoming cell can be further considered. In which form and how this is exactly implemented in the cell reselection principles is FFS.

## RAN2#113e

Agreements:

1. In NTN, the UE determines the TA based on the broadcast information (the use of other information is not excluded). In any case RAN2 will not go in a different direction than other groups
2. In NTN, the network may broadcast more than one TACs per PLMN in a cell, which is to up to network implementation.
3. The NTN ephemeris is divided into serving cell’s ephemeris and neighbour’s ephemeris. FFS how would they differ regarding e.g. the required accuracy or signalling impact.
4. Consider pre-configuration in uSIM, NAS, SIB and RRC signalling for providing the NTN ephemeris. Further discussion depends on the agreed ephemeris contents.
5. RAN2 thinks that a UE needs to know whether the network is a TN or NTN no later than SIB1 reception
6. The information on when a cell is going to stop serving the area and/or the timing information (e.g. timer or absolute time) about new upcoming cell is supported at least in Earth-fixed NTN scenario. FFS if both types of information are needed. FFS if this is known from system information and/or the ephemeris.

## RAN2#114e

Agreements:

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

## RAN2#115e

Agreements via email - from offline 108:

1. Broadcast of cell stop time in SIB is only applicable to quasi earth fixed cell (not to moving cell). No further work in this release to address any moving cell specific details on using the cell stop time to assist measurements or cell reselection
2. For quasi-earth fixed cell, the reference location of the cell (serving cell or the neighbor cells) is broadcast in system information
3. For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area.
4. 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.
5. 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.

Working Assumption:

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.

## RAN2#116e

Agreements:

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.

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.

Agreements via email - from offline 102 - second round:

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).

Agreements online:

Distance based cell reselection criteria for quasi-earth fixed cell is supported

For quasi-earth fixed cell, the cell stop time of neighbour cell(s) is NOT broadcast

## RAN2#116bis-e

Agreements:

1. A new NTN-specific SIB is introduced (SIBx), scheduled by SIB1

2. Introduce the following serving cell information to the corresponding SIBx (scheduled by SIB1):

 - Ephemeris;

 - common TA parameters;

 - validity duration for UL sync information;

 - t-Service;

 - cell reference location;

 - Epoch time.

 Also send a LS to RAN1 asking whether some parameters might be sent more frequently.

1. 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 remaining serving time.

5. RRC\_INACTIVE mode is supported for NTN.

Agreements via email - from offline 102 - second round:

1. Regarding UE-based solution for SMTC adjustments, UE autonomously adjust the SMTCs based on location and ephemeris. FFS whether NW assistance information is provided.

2. UE can know the NW type implicitly no later than SIB1 reception, there is no explicit NW type indication in SIB1.

3. No LS is sent to RAN3 on the support of RRC\_INACTIVE.

Agreements via email - from offline 103 - third round

1. Update of ephemeris and common TA information does not affect the value tag and does not trigger SI modification procedure.

2. The ntnUlSyncValidityDuration applies to the whole SIBX. UE acquires the updated SIBX when the timer expires. FFS whether to also include it in the LS to RAN1. FFS if this applies only to Connected mode or to idle mode UE as well

3. Location information can be used to determine when to start measurement.

4. UE may choose not to perform neighbour cell measurements of “NR intra-freq or inter-freq with equal or lower priority, or inter-RAT freq with 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).

5. Location-based measurement initiation is only applied if the cell broadcasts location-related parameters (e.g. a threshold) and by implementation the UE has location information.

6. Before the stop-time based measurements are triggered, the UE measurements follow Legacy behaviour (i.e., based on Srxlev/Squal) and there is no measurement relaxation.

7. Cell stop time is not applied to cell ranking in determining the target cell for reselection.