**3GPP T****SG-RAN WG2 Meeting #114e R2-2106531**

**Online, April 12 – 20, 2021**

**Agenda item: 8.12.3.2**

**Source: Samsung**

**Title: Summary of [AT114-e][111][RedCap] RRM relaxation criteria in idle/inactive**

**WID/SID: FS\_NR\_redcap**

**Document for: Discussion and Decision**

# Introduction

This document aims at gathering and summarizing company's views for the following offline discussion:

* [AT114-e][111][RedCap] RRM relaxation criteria in idle/inactive (Samsung)

Initial scope: Discuss RSRP/RSRQ based stationarity criterion + not-at-cell-edge criterion + coexistence with R16 configuration, e.g. based on proposals in R2-2106403 and R2-2105637

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): Tuesday 2021-05-25 08:00 UTC

Initial deadline (for rapporteur's summary in R2-2106531): Tuesday 2021-05-25 12:00 UTC

Proposals marked "for agreement" in R2-2106531 not challenged until Tuesday 2021-05-25 22:00 UTC will be declared as agreed via email by the session chair.

For the rest the discussion will continue online in the Wednesday CB session.

Note this discussion is limited to RRM relaxation criteria in idle/inactive. We will focus on the following three topics for RRM relaxation criteria in idle/inactive:

1.     RSRP/RSRQ based stationarity criterion,

2.     Not-at-cell-edge criterion,

3.     Coexistence with R16 configuration.

As stated in the scope from VC, the discussion would be mainly based on the proposals in the two contributions (i.e., R2-2106403 [1] and R2-2105637 [2]) and other contributions related to three topics above are also considered as much as possible.

# Contact information

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# Discussion

## RSRP/RSRQ based stationarity criterion

In RAN2#113bis-e, RAN2 made the following agreements for RRM relaxation criteria in RRC\_IDLE/INACTVE:

Agreements:

1. Assuming there will be a stationary property based on subscription (which is FFS), we will not restrict to this and will continue to assume that a UE can use some RSRP/RSRQ based criteria (FFS whether reuse R16 thresholds or new ones. FFS also on the use of a beam based criteria)

Considering RAN2 has agreed the following in 1st week online in RAN2#114e, we can only focus on RSRP/RSRQ based criteria for Rel-17 stationary criterion.

Agreements:

1. Subscription based relaxation criteria will not be considered in Rel-17 RRM relaxation

Different methods as R17 stationary criterion have been proposed in the contributions ([1]~[21]). Among them, many companies [1,3,4,8,15,16,18] proposed to reuse Rel-16 low mobility criterion (as captured below) for Rel-17 stationary criterion.

|  |
| --- |
| 5.2.4.9.1 Relaxed measurement criterion for UE with low mobility  The relaxed measurement criterion for UE with low mobility is fulfilled when:  - (SrxlevRef – Srxlev) < SSearchDeltaP,  Where:  - Srxlev = current Srxlev value of the serving cell (dB).  - SrxlevRef = reference Srxlev value of the serving cell (dB), set as follows:  - After selecting or reselecting a new cell, or  - If (Srxlev - SrxlevRef) > 0, or  - If the relaxed measurement criterion has not been met for TSearchDeltaP:  - The UE shall set the value of SrxlevRef to the current Srxlev value of the serving cell. |

Their solutions can be categorized into the following three options:

- Option 1) Reuse R16 low mobility criterion with the same thresholds (i.e., SSearchDeltaP/ TSearchDeltaP)

- Option 2) Reuse R16 low mobility criterion with different thresholds (e.g., SSearchDeltaP\_stationary/ TSearchDeltaP\_stationary)

- Option 3) Do not reuse R16 low mobility criterion and introduce a new mechanism (e.g. beam-level RSRP/RSRQ measurement)

Companies are invited to comment in the question below on which of the above options they prefer to use as a part or entire of R17 RRM relaxation criterion in RRC\_IDLE/INACTIVE. Note beam-level criterion will be discussed separately in the rest of this paper.

**Q1. Among the three options described above, which one do you prefer as a part or entire Rel-17 stationary criterion in RRC\_IDLE/INACTIVE? If your preferred option is not listed, please describe your option in the following table with Option 3 below.**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments (if any) |
| Apple | Op2 (op3 is also ok) | We think atleast new thresholds are needed. |
| Qualcomm | Option 2 or 3 | We support reuse R16 low mobility criterion with different thresholds (e.g. smaller SSearchDeltaP and longer TSearchDeltaP\_stationary), to enable further relaxations for stationary UEs than R16 low-mobility UEs. Here we assume that NW needs to use different thresholds only when it configures both R17 stationary criterion and R16 low-mobility criterion at the same time. Otherwise, NW should be able to configure any thresholds for the R17 stationary criterion.  If companies can’t converge on Option 2 and prefer using beam-level measurements, we can support Option 3 too. But we don’t support using beam change count as a criterion. We prefer using Doppler shift as a relaxation trigger, as it offers a more reliable way of determining UE’s stationarity. |
| Futurewei | Option 2 or modified option 3 | Modified option 3 is to introduce a new beam-level based criterion, which can be combined with option 2 (i.e., a UE needs to fulfill both). |
| Huawei, HiSilicon | Option 3 | For the “stationarity criterion”, as we focus on the stationary case, it is important to precisely define the “stationary”, so beam-level RSRP/RSRQ measurement is preferred. But we find that it is difficult to identify whether UE is moving or not by evaluating the number of switched beams, no suitable threshold can be defined for all UE located in different distance to the gNB. We think the quality change of beam(s) is more useful. |
| MediaTek | Option 2 | Reusing R16 with different thresholds to detect stationary property of the UE is appropriate here. |
| NEC | Option 2/3 | For option 2, we think the stationary UE and Rel\_16 low mobility UE should have different thresholds. For option 3, we think for stationary, the beam level RSRP/RSRQ measurement makes sense and it is more accurate than cell level RSRP/ RSRQ measurement. |
| Xiaomi | Option 2  (Option 3?) | First, different thresholds can be supported to differentiate stationary and low mobility.  For option 3, if the new mechanism means that stationary criterion is based on low mobility as a baseline and beam-related can be considered, then our answer is yes. |
| Lenovo | Option.2 | A new threshold for R17 stationary UE is sufficient. If option.3 is introduced, it needs to confirm to introduce it by RAN1 or RAN4. |
| Nokia, Nokia Shanghai Bell | Option 3 & 1 | We preferer option 3, because beam quality measurement is more accurate than cell quality measurement for determining “stationary” of the UE. Furthermore, it is not clear to us why option 3 excludes R16 low mobility criterion. We think they would work nicely also together. |
| OPPO | Option 2 | If RAN4 agrees to define more relaxed measurement for R17 stationary UEs compared to R16 low mobility UEs, we should support separate thresholds configuration for R17 stationary UEs and R16 low mobility UEs, e.g. NW configures more stringent criterion for R17 stationary UEs. |

### Details on Option 1 in Q1

If Option 1 in Q1 is chosen, no further discussion would be needed.

### Details on Option 2 in Q1

If Option 2 in Q1 is chosen, RAN2 could further discuss details on the different thresholds. For instance, some companies [1,3,4,18] proposed to define more stringent stationary criterion (as shown below) for Rel-17 than Rel-16 low mobility criterion.

1) SSearchDeltaP\_stationary ≤ SSearchDeltaP (and/or)  
2) TSearchDeltaP\_stationary ≥ TSearchDeltaP.

They assume RAN4 will define more powerful RRM relaxation method for Rel-17 (i.e. stationary) compared to the one for Rel-16 (i.e. low mobility), as RedCap devices require much more energy saving than normal UEs. However, excessive RRM relaxation of neighbouring cells may lead to performance degradation related to cell reselection. To avoid this side-effect, RAN2 should define more careful (i.e., stringent) criterion for Rel-17, rather than reusing Rel-16 thresholds.

Companies are invited to comment in the question below on whether they support more stringent stationary criterion for Rel-17 than Rel-16 low mobility criterion, "If" option 2 in Q1 is adopted.

**Q2. "If" option 2 in Q1 is adopted,** **do you support more stringent stationary criterion for Rel-17 than Rel-16 low mobility criterion:  
1) SSearchDeltaP\_stationary ≤ SSearchDeltaP (and/or)  
2) TSearchDeltaP\_stationary ≥ TSearchDeltaP.**

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments (if any) |
| Apple | No for stringent | We think the other way. The goal is to allow UE to ‘relax’ more for power-saving, esp for stationary UEs, where the changes in signal strength do not necessarily translate into mobility like the Rel-16. It is up for discussion on how the thresholds should be, but atleast the logic and the config of thresholds should not be limited by rel-16. |
| Qualcomm | Yes | That should be the principle for how those two parameters are configured, when R16 low-mobility is also configured by network at the same time. Otherwise (i.e. only R17 stationary criterion is configured), network can configure whatever values it likes to. |
| Futurewei | Yes | When the NW configures both R16 low mobility criterion and R17 stationary criterion. |
| MediaTek | In principle yes, but left to NW implementation | This should be the principle for how these parameters should be configured. Ultimately, it is up to NW implementation to determine what values to choose. Only the expected UE outcome on meeting the configured threshold(s) needs to be defined. |
| NEC | No | We think it can be up to network implementation. |
| Xiaomi | Yes, but | At least SsearchdeltaP\_stationary can be supported.  But we think using the two of parameters is redundant as they are synergistic. What’s more, TSearchDeltaP\_stationary is not reliable, because longer duration may allow opportunity for RSRP to be adjusted. The case is that RSRP may goes through a big change then it comes back to its original value during this longer period. Then it turns out the criterion is still fulfilled.  Therefore, we think only SsearchdeltaP\_stationary being used is OK. |
| Lenovo | Yes | We think it is network implementation to configure a stringent stationary criterion. |
| Nokia, Nokia Shanghai Bell |  | If option 2 is selected dedicated control for the configuration would be beneficial. In this way network is able to configure different configurations for different UEs |
| OPPO | Yes | This should be the principle for how these parameters should be configured. |

### Details on Option 3 in Q1

If Option 3 in Q1 is chosen, for the new mechanism, some companies [2,3,6,9,11,14,17] understand beam-level RSRP/RSRQ measurement is beneficial to determine UE's stationariness. Among them, companies [2,6,11] propose to use beam level criterion with reusing Rel-16 low mobility criterion. Assuming the details of beam level criterion/measurement is FFS, we can discuss the following options:

- Option 1) Rel-16 low mobility criterion is enhanced with beam-level measurement.

- Option 2) Beam level criterion is configured separately with Rel-16 low mobility criterion.

Companies are invited to comment in the question below on which of the above options they prefer to use for Rel-17 stationary criterion. Companies are also allowed to add other options, if any.

**Q3. Among the two options described above, which one do you prefer as Rel-17 stationary criterion in RRC\_IDLE/INACTIVE?**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments (if any) |
| Apple | Op2 | With FR1, beam-level variations are not much. And UE operating with 1Rx does not work in exactly the same way as a legacy NR device would (in terms of capability). So beam-based relaxation is not an option, but does not necessarily be tied to other RRM relaxations. |
| Qualcomm | Option 2 | In our paper [3], we propose to use Doppler shift based methods (e.g. a UE is considered stationary if Doppler shift of the N best beams from its serving cell are below a threshold for the last K rounds of measurement) as a criterion to determine UE’s stationarity. |
| Futurewei | Option 2 | Beam-level based criterion can be configured separately or be combined with SSearchDeltaP\_stationary based criterion (i.e., a UE needs to fulfill both). |
| Huawei, HiSilicon | Option 2 | The quality change of beam(s) for a period of time can be considered, i.e. the quality variation of the beam(s) is larger than a certain threshold. The quality of beam will change during UE moves, the quality variation of the beam(s) is a relative value, it will be more accurate to evaluate “stationary” criterion. |
| NEC | Option 2 | The legacy cell level RRM measurement is based on the measurement of multiple SSBs. With a single beam level measurement, we need separate Beam level criterion |
| Xiaomi | Option 2 | Our understanding is that RSRP-based criterion (i.e. low mobility criterion with different thresholds) is mandatory, and beam-related can be optionally configured to precisely define what stationary is. |
| Lenovo | Option.2 | It could be separate with Rel-16 low mobility criterion. |
| Nokia, Nokia Shanghai Bell | Option 1 & 2 | Both options are ok |
| OPPO | none | We think cell level criterion is sufficient.  We understand the motivation to use beam level criterion is that using beam level measurement results can assess UE's movement more accurately than cell measurement. However, in our view, even if UE moves in some cases, e.g., when the UE moves among beams (like a circle around the gNB), as long as the UE’s cell level measurement results do not change, the UE would not reselect to another cell, therefore there would be no problem to relax neighbour cell measurement. So we think there is no need to introduce beam-change based criterion. |

## Not-at-cell-edge criterion

In RAN2#113bis-e, RAN2 agreed not-at-cell-edge criterion can be configured with R17 stationary criterion.

Agreements - via email (from offline [102]):

1. Network can configure R17 stationarity criterion/criteria together with a not-at-cell-edge criterion, to trigger RRM relaxations in RRC Idle/Inactive for R17 UEs supporting the feature. FFS whether the R16 not-at-cell-edge thresholds can be reused or separate R17 not-at-cell-edge thresholds are needed.

In RAN2#114e, many companies [1,2,3,4,8,11,15,18,20] suggested reusing Rel-16 not-at-cell-edge criterion (as shown below) for Rel-17 not-at-cell-edge criterion.

|  |
| --- |
| 5.2.4.9.2 Relaxed measurement criterion for UE not at cell edge The relaxed measurement criterion for UE not at cell edge is fulfilled when:  - Srxlev > SSearchThresholdP, and,  - Squal > SSearchThresholdQ, if SSearchThresholdQ is configured,  Where:  - Srxlev = current Srxlev value of the serving cell (dB).  - Squal = current Squal value of the serving cell (dB). |

The proposals are split into two options:

- Option 1) Reuse Rel-16 not-at-cell-edge criterion with the same thresholds (i.e., SSearchThresholdP / SSearchThresholdQ­) [1,2,11]

- Option 2) Reuse Rel-16 not-at-cell-edge criterion with the different thresholds [3,4,8,15,18,20]

Companies are invited to comment in the question below on which of the above options they prefer to use for Rel-17 not-at-cell-edge criterion. Companies are also allowed to add other options, if any.

**Q4. Among the two options described above, which one do you prefer as Rel-17 not-at-cell-edge criterion in RRC\_IDLE/INACTIVE?**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments (if any) |
| Apple | Op2 |  |
| Qualcomm | Option 2 | Because stationary UEs have less uncertainties in their mobility than low-mobility UEs, we think it makes sense to allow stationary UEs to have a more relaxed not-at-cell-edge criterion than the R16 one (e.g. smaller SSearchThresholdP and SSearchThresholdQ) for not-at-cell-edge criterion. In other words, stationary UEs closer to cell edge than R16 low-mobility UEs can also relax their RRM measurements, because they are less likely to reselect their cells. |
| Futurewei | Option 2 | In [18], we discuss that many sensors may be installed at awkward locations such as basements or close to the ground. Due to poor RF reception at these locations, they may be deemed as at cell edge if current thresholds are used. However, because they are stationary, once they select a cell, they will likely stay with the cell for a long time (e.g., until cell planning changes). So, they should be allowed to benefit from RRM relaxation.  Therefore, when a UE fulfills R17 stationary criterion, either the UE doesn’t need to fulfill any not-at-cell-edge criterion at all, or if the UE also needs to fulfill not-at-cell-edge criterion, the UE should be allowed to apply lower thresholds in the evaluation.  On the other hand, if the UE doesn’t fulfill R17 stationary criterion, the UE should evaluate not-at-cell-edge criterion with higher thresholds, if the UE is also configured to fulfill such criterion (either as a standalone criterion or in combination with R16 low mobility criterion, as specified today), in order to perform RRM relaxation. |
| Huawei, HiSilicon | Option 1 | The measurement result is not an accurate and fixed value, and may vary within a certain range, we do not see much gain to define a new not-at-cell-edge threshold. Beside, the “stationary UE” considered in Rel-17 includes the “temporary stationary UE”, the UE can move in some case that’s why we need to additionally introduce not-at-cell-edge criterion. If it is the case, the case of UE moving is similar as Rel-16 UE, so we think the same threshold is enough.  This should be clarified as “Rel-17 not-at-cell-edge criterion only used together with R17 stationary criterion” |
| MediaTek | Option 1 | We do not see significant gains associated with a new cell-edge definition |
| NEC | Option 2 |  |
| Xiaomi | - | We do not have a strong view on this issue and open for both. But it is noted that not-at-cell-edge only can be used when UE is stationary. Which means R17 RRM relaxation has two level relaxation methods. I.e. 1. Satisfying stationary and not-at-cell-edge, 2.only satisfying stationary. |
| Lenovo | Option.2 | A new value is introduced for RedCap UE. |
| Nokia, Nokia Shanghai Bell |  | Option 2 is ok to us if network can configure not-at-cell-edge criterion with dedicated signaling. Otherwise option 1 seems sufficient. |
| OPPO | Option 2 | In our understanding, since stationarity criterion is stricter than low-mobility criterion, it seems reasonable to combine the stationarity criterion with a looser not-at-cell-edge criterion compared to Rel-16 not-at-cell-edge criterion. But meanwhile this depends on how RAN4 will define the RRM relaxation method for stationary UEs. |

According to the statement (i.e., "The study includes an objective on RRM relaxation for stationary RedCap UEs") from TR 38.875, some companies [1,3,18] assume, when NW configures Rel-17 RRM relaxation, Rel-17 stationary criterion is mandatory, but Rel-17 not-at-cell-edge criterion is optional configuration.

Companies are invited to comment in the question below on whether they support the following proposal: When NW configures Rel-17 RRM relaxation,1) Rel-17 stationary criterion is mandatory, and 2) Rel-17 not-at-cell-edge criterion is optional configuration.

**Q5. Do you support the proposal (i.e., When NW configures Rel-17 RRM relaxation, Rel-17 stationary criterion is mandatory, and Rel-17 not-at-cell-edge criterion is optional configuration**)**?**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments (if any) |
| Apple | We support. |  |
| Qualcomm | Agree | We support the proposal |
| Futurewei | Yes | The optionality of not-at-cell-edge criterion is in-line with P4 in our paper [18]. |
| Huawei, HiSilicon | Agree | If Rel-16 not-at-cell-edge criterion with the same thresholds will be agreed, the above Rel-17 not-at-cell-edge criterion means Rel-16 not-at-cell-edge criterion, right? |
| MediaTek | Agree |  |
| NEC | Yes |  |
| Xiaomi | Support | It means that R17 RRM relaxation has two level relaxation method. I.e. 1.Satisfying both stationary and not-at-cell-edge, 2.Only satisfying stationary. |
| Lenovo | Yes |  |
| Nokia, Nokia Shanghai Bell | No | It can be left up to network implementation which conditions are configured. |
| OPPO | Agree |  |

## Coexistence with R16 configuration

In this discussion, the following scenario is considered: NW configures R17 RRM relaxation configuration with R16 RRM relaxation configuration together, and a UE fulfills both R16 relaxation criterion and R17 relaxation criterion. For a such case, there were some proposals [1,2,4776], which showed different understanding on how UE performs RRM relaxation, as follows:

- Option 1) UE performs Rel-17 RRM relaxation method [1,4776]

- Option 2) It is up to UE implementation to select either Rel-16 or Rel-17 relaxation operation [2]

- Option 3) It is up to RAN4's decision

Companies are invited to comment in the question below on which of the above options they prefer to use when NW configures both R16 and R17 RRM relaxation configuration and UE fulfills both R16 and R17criterion.

**Q6. Among the three options described above, which one do you prefer, when NW configures both R16 and R17 RRM relaxation configuration and UE fulfills both R16 and R17criterion?**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments (if any) |
| Apple | Op1 | We think the NW can just configure rel-17 method or the RedCap UEs applies rel17 method (as these are geared towards redcap UEs). |
| Qualcomm | Option 1 or 2 | Either Option 1 or Option 2 is fine with us. |
| Futurewei |  | It may depend on what Rel-17 RRM relaxation method will be specified by RAN4. We can wait for or work with RAN4 in deciding on this. |
| Huawei, HiSilicon | Option 2 | We are not sure about the relaxed operation for R17 yet. It is difficult to say whether R17 or R16 relaxation is better in the case. UE implementation should be also flexible and sufficient. |
| MediaTek | Option 2 at the moment | Until we know what the Rel-17 RRM relaxation method is, it is difficult to say which option may be better for a given scenario. |
| NEC | Option 1 | Agree apple’s view. Later release configuration should take precedence. |
| Xiaomi | See comment | In our understanding, R17 RRM relaxation is a higher level relaxation than R16’s (however it is up to RAN4). In this way, when both criterions are configured, UE could first check R17 criterion (assuming 1.Both stationary and not-at-cell-edge; 2. Only stationary). If UE doesn’t satisfy these criterions, then it can check a lower level relaxation (i.e. R16 combination of low mobility and not-at-edge-cell). |
| Lenovo | Option 1 | Same view as Apple, this Rel-17 RRM relaxation is for RedCap UE. |
| Nokia, Nokia Shanghai Bell |  | Too early to answer, it is not clear yet whether any Rel-17 RRM relaxation method will be defined or not, in case not, Rel-16 RRM relaxation method should be applied by the UE. |
| OPPO |  | Agree with Futurewei. |

# Conclusion

TBD

# References

1. R2-2106403, RRM relaxation criteria in RRC\_Idle/Inactive, Samsung
2. R2-2105637, RRM measurement relaxation for RedCap UE, Huawei, HiSilicon
3. R2-2104776, RRM measurement relaxations for stationary UEs, Qualcomm Incorporated
4. R2-2104811, Discussion on RRM relax for RedCap UEs, OPPO
5. R2-2104913, RRM relaxation for neighboring cell for RedCap UEs, vivo, Guangdong Genius
6. R2-2104926, RRM measurement relaxation criteria for RedCap devices, Intel Corporation
7. R2-2105138, Confined Mobility impact on RRM Relaxation, Apple Inc
8. R2-2105159, RRM relaxation for RedCap UEs, ZTE Corporation, Sanechips
9. R2-2105229, RRM Relaxation for RedCap UE, NTT DOCOMO INC.
10. R2-2105246, RRM Relaxation, Ericsson
11. R2-2105296, Discussion on RRM relaxations for RedCap UE, Xiaomi Communications
12. R2-2105521, RRM relaxation in RRC\_CONNECTED for RedCap UEs, SHARP Corporation
13. R2-2105705, Redcap relaxed measurements and number of beams, Sony
14. R2-2105706, RedCap Relaxed measurements, stationary definition, Sony
15. R2-2105788, RRM relaxation for stationary RedCap Ues, LG Electronics Inc.
16. R2-2105812, RRM relaxation for stationary UE with reduced capability, Lenovo, Motorola Mobility
17. R2-2105909, On RRM relaxations for REDCAP, Nokia, Nokia Shanghai Bell
18. R2-2105959, Discussion on R17 stationarity criterion and not-at-cell-edge criterion for RedCap UEs, Futurewei Technologies
19. R2-2106229, Discussion on the RRM relaxation for RedCap Ues, CMCC
20. R2-2106272, RRM relaxation of RedCap UE, China Telecommunications
21. R2-2106404, RRM relaxation criteria in RRC\_Connected, Samsung