**3GPP T****SG-RAN WG2 Meeting #113bis-e R2-2104361**

**Online, April 12 – 20, 2021**

**Agenda item: 8.12.3.2**

**Source: Qualcomm Incorporated**

**Title: Summary of [AT113-e][102][RedCap] RRM relaxations**

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

**Document for: Discussion and Decision**

# Introduction

This document is for the initial round of offline discussion on RRM relaxations for R17 stationary UEs. We will focus the discussion on the following three topics:

1.     Definition of stationarity,

2.     RRM relaxation criteria in RRC Idle/Inactive,

3.     RRM relaxation criteria in RRC Connected.

As the goal of this offline is to help facilitate efficient online discussion in the GTW session, we focus on only proposals related to the key issues and hence may not cover all specific enhancements proposed in the contributions. In addition, relaxation methods or network control/signalling aspects etc are NOT discussed in this offline.

Deadlines:

* Initial deadline for companies' feedback: **Tuesday 2021-04-13 14:00 UTC**
* Initial deadline for rapporteur's summary: **Tuesday 2021-04-13 18:00 UTC**

# Discussion

## Definition of stationarity

Different definitions of stationary UEs for the purpose of R17 RRM relaxations have been proposed in the contributions ([1]~[19]). They can be broadly categorized in the following three options:

Option 1: UE determines its stationarity ***only*** base on an enhanced version of R16 low-mobility criterion ([5], [8], [10], [17], [18], [19]) (*Note: Details of the enhancement to R16 criterion will be discussed in a later question*);

Option 2: UE determines its stationarity ***only*** base on its subscription information ([6], [7], [15]);

Option 3: ***Either*** Option 1 and Option 2 may be used by UE to determine its stationarity, depend on the type of stationarity that UE has. For example, if a UE’s location is fixed, it may determine its stationarity based on information provisioned in its subscription, without evaluating RSRP-based stationarity criterion such as the one described in Option 1 ([1], [3], [4], [16], [11], [14]).

Option 4: R16 low-mobility criterion [12] is sufficient.

Companies are invited to comment in the question below on which of the above options they prefer to use in determining whether a UE is stationary. Since no company discussed the necessity in having different definitions of stationarity in different RRC states, it is assumed that the same definition is used in all RRC states, unless one indicates otherwise in the Comments column.

**Question 1: Among these options described above, which one do you prefer for defining UE’s stationarity?**

|  |  |  |
| --- | --- | --- |
| Company | Preference(1, 2, 3, or 4) | Comments (if any) |
| Nokia, Nokia Shanghai Bell | 4 | We think that REL16 relaxation triggering condition is sufficient and we assume that RedCap device can implement RRM relaxations specified in REL16 for IDLE/INACTIVE and the same condition for relaxation shall be used also for CONNECTED as per WID objectives:“for RRC\_Connected the mechanism reuses the Rel-16 RRM relaxation criteria from RRC\_Idle/Inactive” |
| Apple | 3 | RedCap has some unique mobility attributes and these need to be used (either by UE explicitly informing via subscription or capability, and/or by NW configuring enhanced thresholds that reflect the RedCap mobility characteristic) |
| Qualcomm | 3 | We think stationary UEs, due to their more predictable channel conditions, can benefit from further relaxations than those for R16 low-mobility UEs. Hence it is worthwhile to define them separately. For UEs with fixed locations, we expect they would have much less fluctuation in their S measures than other UEs (even low-mobility ones). Hence it is feasible for them to use some preconfigured/provisioned information to determine their stationarity instead of going through some RSRP based evaluation process. That would enable faster triggering of RRM relaxation and thus more power savings for them.  |
| Ericsson | Not 2/3 | From WID:* RRM relaxations for neighbouring cells for RedCap devices: for RRC\_Idle/Inactive/Connected, considering the alternatives identified in the RedCap SI:
	+ Study until RAN#92e, and, if agreed, specify RRM measurement relaxation criteria (where, for RRC\_Idle/Inactive the Rel-16 mechanism is the baseline, and for RRC\_Connected the mechanism reuses the Rel-16 RRM relaxation criteria from RRC\_Idle/Inactive so as to maximize the commonality with Idle/Inactive UEs) [RAN2]
		- Enabling/disabling of RRM relaxation should be under the network’s control. Specify both broadcast and dedicated signalling for enabling/disabling of RRM relaxation.
	+ After RAN#92e, if agreed in RAN2, specify RRM measurement relaxation [RAN4]
	+ No RRM relaxations are specified for the serving cell.

Based on this, we assume the discussion we are having here is which option we should study further? I.e. is there any alternative we can exclude even without have done any evaluation? Assuming this, we say:Option 2 (subscription info) has been evaluated by RAN2 earlier but was excluded. One of the drawbacks is that it is not reliable, e.g. what happens when the UE starts to move?Hence, we think that option 1 can be further studied and evaluated. |
| vivo | 3 | According to the previous discussion, it is widely believed that R16 RRM relaxation mechanism can be a starting point for the R17 RRM relaxation. Besides, introducing 2 relaxation levels (i.e. for fixed and moving UEs respectively) for RedCap UEs is considered which could provide enough flexibility to save the UE power for different scenarios. Thus, it is better to apply option1 in Rel-17. Although one may argue option2 is only applicable to limited scenarios (UE is expected to be stationary or moving slowly in a localized area), it needs to notice a large percentage of RedCap UEs are expected to be used in the target scenarios of option2, e.g. Video Surveillance, industrial wireless sensors in an automated assembly line, Handling robot in a warehouse. From the implementation perspective, the enhancements are expected to be very simple and easy to use. Therefore, the cost to apply this enhancement is expected to be very low. For RedCap UEs in the above scenarios, we assume they are more power sensitive, so it is expected to have more/longer relaxation for RRM measurement. Thus, we prefer to support the solution in option2. |
| Intel | 3 | For fixed UE, subscription based approach is sufficient, and faster than measurement based approach. For temporary stationary UE, enhancements on R16 criteria is needed in order distinguish between them.  |
| Futurewei | 1/4 | We are open to enhancements to R16 low-mobility criterion. |
| Sharp | 1 | UE can determine its stationarity base on enhancement of R16 low-mobility criterion. |
| Huawei, HiSilicon | 1 | At first we understand the “stationary UE” includes “fixed UE” and “temporary stationary UE”, subscription information is only useful for “fixed” scenario which is limited, so we think R16 style low-mobility criterion is more suitable. If R16 style low-mobility criterion needs to be introduced, a unified criterion for “fixed” and “temporary stationary” is enough. |
| NEC | 3 | For option1. We have discussed that Rel\_16 or enhanced low mobility evaluation criteria can be used to RRM relaxation for stationary UE. This unified solution can be also used for non-redcap UE. Further more, regarding option 2, we think the stationary UE can autonomously apply the RRM relaxation in accordance with the subscription information, e.g. Video Surveillance, industrial wireless sensors in an automated assembly line, Handling robot in a warehouse. From the implementation perspective, the subscription information to trigger RRM relaxation are expected to be very simple, effective and easy to use. No additional configuration for low mobility is required. Therefore, the cost to apply this enhancement is expected to be very low. Therefore we think option 2 is also accepted for RRM relaxation for stationary UE.  |
| MediaTek | 2/4 | Option 2 is applicable to RedCap scenarios that justify further RRM relaxations (stationary deployments in IIoT, surveillance use-cases). These scenarios are not the same as typical smartphones/ wearables in a network which are subject to mobility. Instead these are tightly controlled scenarios (at deployment) and do not need to consider the case where the UEs move (i.e. these are similar to IoT devices such as smart meters in fixed locations). Therefore, as an enhancement for Rel-17, only such a mechanism is needed.For other RedCap scenarios (wearables), Rel-16 based mechanisms such as Option 4 are sufficient. We are also open to introduce Option 4 to connected mode. |
| Xiaomi | 1/3 | We think an enhancement of R16 low-mobility criterion can be used for all types of RedCap UE (i.e. including fixed-location UE and temporarily stationary UE). On the other hand, stationary property based on subscription would limit device type to fixed-location UE. So we think option 1 is necessary and we are also OK for using stationary property as a supplementary. |
| CATT | 3 | The subscription information is sufficient for fixed UEs. For slightly moving UEs or UEs not permanently fixed, the number of beam changes can be taken into consideration on top of R16 criterion. |
| CMCC | 3 | UE could determine its stationary based on its subscriptions if configured or based on the low-mobility criterion. |
| Samsung | 1 | The way to determine R16 RRM relaxation is already too complicated according to whether or not 1) cell center, 2) not-cell-edge, 3) low-mobility 4) type of frequencies, 5) *highPriorityMeasRelax*, 6) *combineRelaxedMeasCondition* and so on. Hence, for R17, we don't want to classify more cases by distinguishing according to subscription information. Instead, RAN2 can simply enhance R16 RRM relaxation. |
| Sony | 1 | We understand that option 2 is already ruled out and probably not entirely in RAN2 domain. Between option 1 and 4, Rel-16 baseline wont work well for FR2/beams.  |
| ZTE | 2 | The subscription information can be used to identify fixed-location UEs. For these kind of UEs, it is ok to take more aggressive RRM relaxation methods. But whether such UE can perform aggressive methods should be within network’s control.We understand the benefit of 1 is to also identify temporarily stationary UEs, but our concern is it is hard for network to configure accurate thresholds for differentiate temporarily stationary UEs and low-mobility UEs. The RSRP may still fluctuate even if the UE does not move. |
| OPPO | 1 or 4 | Based on the guidance given in the WID, the Rel-16 RRM relaxation mechanism for RRC Idle/Inactive should be the baseline for Rel-17 RedCap UEs for both RRC Idle/Inactive and RRC Connected.  |
| Sequans | 1Maybe 3 | Since channel conditions are not necessarily constant (even more so in FR2), we are not sure that subscription information can be enough and that there is a real difference between “truly fixed” and “temporarily stationary” UEs. Therefore, we think R16-style criteria should be enough for all cases. We do think some enhancements could be in order to account for the more specialized RedCap scenarios. |

Within the Option 1 above, there are different views on what the additional enhancements to the R16 low-mobility criterion should be:

Option 1a: Configure a separate set of thresholds (e.g. SSearchDeltaP and/or TSearchDeltaP) in the R16 low-mobility criterion for stationary UEs ([1], [3], [4], [10], [19]);

Option 1b: In addition to Option 1.a, also take in account changes in serving cell beams (e.g. whether number of beam changes within a period is less than a threshold) in the definition of stationarity ([3], [7], [8], [17], [18], [16]).

Option 1c: Without a separate set of thresholds but instead rely on the (single) set of thresholds from Rel-16, also take in account changes in serving cell beams (e.g. whether number of beam changes within a period is less than a threshold) in the definition of stationarity ([5]).

Companies are invited to comment below on which of the above two options is preferred.

**Question 2: If you have selected Option 1 or Option 3 in Question 1, which one do you prefer between the above sub-options to option 1?**

|  |  |  |
| --- | --- | --- |
| Company | Preference(1a,1b, 1c) | Comments (if any) |
| Apple | 1b | 1b includes 1a as well. |
| Qualcomm | 1a | We think 1a is robust enough for the purpose. Beam change may not add much value to the evaluation of UE’s stationarity, for the following reasons.1. In RRC Idle/Inactive, UEs use only SSBs for their RRM measurements. Since SSBs are wide beams, a UE with fixed location or low speed may not experience frequent changes in the set of beams it monitors between its RRM measurement instances.
2. Another counter example can be a UE located near cell center but experiences periodic signal blockage on its neighbor cell beams. Although this UE may have frequent beam changes, it is still safe for it to relax its RRM measurements on neighbor cells.
 |
| Ericsson | Not 1a/1bContinue to study 1c | So far no one har really shown that the gain exceeds the “cost” of adding a new set of thresholds (1a or 1b). So until that has happened we think we can exclude these options.We do think that RAN2 could continue to study if changes in beams brings any meaningful gain (which is worth the pain) and if so we could consider specifying that. By the way, since option 1b had option 1a included, we created option 1c. |
| vivo | 1a | We prefer to specify 2-level relaxation criteria and corresponding relaxation methods by configuring a separate set of thresholds (e.g. SSearchDeltaP and/or TSearchDeltaP) on top of the R16 low-mobility criterion for stationary UEs.The main motivation of option1b/1c is to detect UE moving among beams but without changing the cell level measurement results. As we known, the measurement result of beam is not stable and changes fast. Hence, it may cause misjudgment on UE’s movement state, which may lead to more power consumption or mobility issue. With this in mind, we think option1b can be considered with low priority. We could also accept it if majority agree its feasibility. |
| Intel | 1b | To consider 2 level mobility as agreed in SI phase, additional threshold is needed. In addition, the beam switching should also be considered since the cell level measurement may be same when the UE moves among beams. |
| Futurewei | 1b | Beam quality change can be used in evaluating “stationarity” |
| Sharp | 1a |  |
| Huawei, HiSilicon | 1c, but | As it focuses on “stationary UE”, the criterion should be more accurate to define “stationary”, so we think beam dimension should be taken into account. But for the details, we prefer to consider beam quality change (e.g. the best beam), it reflects the link quality and also the beam change (e.g. spinning). Besides, the beam quality may change rapidly due to the impact of small-scale fading, to avoid this bad impact on “stationary” evaluation, L3 filter can be used to smooth the beam quality. Thus, we would like to update:…(e.g. whether number of beam changes within a period is less than a threshold, whether the change of beam measurement within a period is less than a threshold) |
| NEC | 1b | In the UE measurement, UE is configured to measurement the number of ***nrofSS-BlocksToAveragelevel*** SSBs for achieve the cell level measurement result. For stationary UE, it is impossible to evaluate so many beams, so it makes sense to only measurement a small number of beams changes to made decision of a stationary UE to trigger RRM relaxation. |
| Xiaomi | 1b | As we described in our contribution, even a UE satisfying the enhanced R16 criterion is able to move in the cell (i.e. UE spins around cell), which brings two drawbacks: 1.UE moves to a cell with better coverage but can not camp on it; 2. The signal fluctuates more often during movement, which results in entering or leaving criterion frequently.As some companies worry that beam change mechanism is not stable, we think it doesn’t mean there is no beam change when evaluate stationary criterion. We can give a threshold N to restrict the number of beam change to avoid unstable situation but can limit UE moving (like spin) around cell. |
| CATT | 1c | We don’t think we need new thresholds. The beam information can be used on top of R16 thresholds. |
| CMCC | 1a |  |
| Samsung | 1a | Beam-level measurement is not reliable, since it fluctuates more than cell-level measurement.  |
| Sony | 1b | 1b includes 1a. The benefit of 1b over 1c is that Rel-16 evaluation criteria can still be used in our understanding.  |
| OPPO | 1a, but | We understand the motivation of option 1a is to introduce more stringent thresholds for Rel-17 stationary RedCap UEs compared to Rel-16 low mobility UEs, and so as to further relax RRM measurement to save UE power. But we think we may need some evaluation before making the conclusion. If the benefit is significant based on evaluation, we are ok to option 1a.  |
| Sequans | 1a,Maybe 1b | 1a would probably be enough, but we are OK to continue and pursue both for a while more. |

## RRM relaxation in RRC Idle/Inactive

As to triggers for RRM relaxation in RRC Idle/Inactive, most contributions ([1] [8] [16] [18] [19]) except one ([12]) support reusing the R16 RRM relaxation triggering criteria, with the R16 low-mobility criterion replaced by the R17 stationarity criterion discussed in Section 2.1. More specifically,

* If a R17 UE determines that it is stationary (based on the definition(s) to be agreed in Question 1 and 2), then it can apply relaxation methods associated with the stationary criterion (the exact methods are to be discussed later);
* If not-at-cell-edge criterion is also configured and this UE meets that criterion, then it can apply relaxation methods associated with both stationary and not-at-cell-edge criteria (the exact methods are to be discussed later).

Please note that the exact relaxation methods associated with the different criteria specified above are not within the scope of this offline discussion and will be discussed later.

Companies are invited to indicate their preference on the above proposal in the following question:

**Question 3: Do you support reusing the R16 RRM relaxation triggering criteria for R17 stationary UEs in RRC Idle/Inactive, with the R16 low-mobility criterion replaced by the R17 stationarity criterion?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments (if any) |
| Nokia, Nokia Shanghai Bell | No | We think that REL16 relaxation triggering condition is sufficient for IDLE/INACTIVE, |
| Apple | Yes | This would be the direction to go, with details discussed later. |
| Qualcomm | Yes | See our comment to Question 1. |
| Ericsson | See comment | We understand the question to mean that: in case RAN2 enhances the criteria used to determine low/no mobility as per question 2, then that enhanced criteria could be used to apply a potential Rel-17-way of relaxing measurements. I.e. the Rel-16 criteria is replaced by the Rel-17 criteria? If that understanding is correct, our response is "Yes". |
| vivo | Yes | This allows the reuse of existing mechanism and avoids repeating the discussion in R16. |
| Intel | Yes (comments) | I assume question is “low mobility” and “not at cell edge criterion” are applicable for R17 stationary UE with enhancements. Then our answer is yes.  |
| Futurewei | Yes | We support this as a general direction to take for now, with details to be discussed later. |
| Sharp | Yes |  |
| Huawei, HiSilicon | Yes |  |
| NEC | Yes, basically | But whether to apply Rel-17 stationary criterion or use Rel-16 low-mobility criterion for RedCap UE (if ReCap UE supports Rel-16 one) can be up to network implementation.  |
| MediaTek | See comment | With the same understanding as Ericsson, i.e. in case R2 introduces new criteria for ‘stationary’ UE determination, this would replace the Rel-16 criteria to determine when measurements can be relaxed, then ‘Yes’ |
| Xiaomi | Yes | A stationary UE but located in the edge of cell can also consider its signal quality, so R16 RRM relaxation can be used. |
| CATT | Yes | That’s the generic idea, details FFS. |
| CMCC | Yes |  |
| Samsung | Yes |  |
| Sony | Yes |  |
| ZTE | See comment | Same understanding as Ericsson and MTK about this question.  |
| OPPO | Yes with comment | See our reply to Question 2. |
| Sequans | Yes |  |

It is proposed in [1] and [19] that because stationary UEs have less uncertainties in their mobility than low-mobility UEs, separate thresholds (e.g. SSearchThresholdP\_Stationary and/or SSearchThresholdQ\_Stationary) used in the R16 not-at-cell-edge criterion can be introduced for R17 stationary UEs.

Companies are invited to indicate their preference on the above proposal in the following question:

**Question 4: If you answered “Yes” in Question 3, do you support introducing separate thresholds, SSearchThresholdP\_Stationary and/or SSearchThresholdQ\_Stationary, for the not-at-cell-edge criterion for R17 stationary UEs in RRC Idle/Inactive?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments (if any) |
| Apple | Yes |  |
| Qualcomm | Yes | Because stationary UEs have more predictable mobility, the thresholds for not-at-cell-edge criterion can be further relaxed than those used in R16. |
| vivo | Yes | Besides, we have agreed that some reduced capabilities for RedCap UEs, e.g. at least both the number of Rx antennas and maximum bandwidth supported by RedCap UEs are smaller than non-RedCap UEs, which may cause some difference in the measurement results for RedCap UE comparing with non-RedCap UEs. In this way, when reusing the existing criteria in Rel-16 to RedCap UEs, we should consider introducing separate thresholds (e.g. SSearchThresholdP\_Stationary and/or SSearchThresholdQ\_Stationary) for R17 stationary RedCap UEs. |
| Intel | Yes |  |
| Futurewei | Yes |  |
| Sharp | Yes |  |
| Huawei, HiSilicon |  | No strong view. Reusing Rel-16 not-at-cell-edge criterion works. |
| NEC | Yes  | Agree the not cell edge criterion can be further relaxed than the cell edge UE.  |
| MediaTek | No | We do not need new ‘cell edge’ definitions. We can reuse the Rel-16 thresholds for this purpose. |
| Xiaomi | - | We are not sure if it is a redundant. But it is noted that RedCap UE and non-RedCap UE can be decoupled, and even a same threshold can be configured with different value to RedCap and non-RedCap UE. |
| CATT | No | Only beam information, if available, should be used on top of legacy thresholds. |
| Samsung | Yes |  |
| Sony | Yes |  |
| OPPO |  | It may depend on whether to reuse R16 low-mobility criterion or configure a separate R17 stationarity criterion for R17 stationary UEs.If RAN2 agree to reuse R16 low-mobility criterion for R17 stationary UEs, we see no need to introduce separate thresholds for the not-at-cell-edge criterion for R17 stationary UEs. |
| Sequans | Yes |  |

It is possible that network may configure both R16 and R17 RRM relaxations at the same time. [1][6][8] discuss what UE behaviors should be in this case. Their proposals are captured in the following options:

* Option 1: If a R17 stationary UE satisfies more than one R16/17 RRM relaxation criteria configured by network, it should be up to UE implementation to choose which criterion(a) to apply relaxation methods [1];
* Option 2: If RedCap UE fulfils the R16 RRM relaxation criteria, then R16 RRM relaxation method is applied without further enhancement. The legacy lowMobilityEvaluation-r16, cellEdgeEvaluation-r16 parameters are applicable to both RedCap and non-RedCap UEs [6];
* Option 3: A R17 UE evaluates the R17 RRM relaxation criterion first; if it is not fulfilled, fall back to R16 RRM relaxation [8].
* Option 4: R16 low-mobility criterion [12] is sufficient
* Option 5: A R17 UE evaluates the R17 RRM relaxation criterion if configured by the network;

Companies are invites to indicate which of the above options they support in the follow question:

**Question 5: Among the three options described above, which one(s) do you support?**

|  |  |  |
| --- | --- | --- |
| Company | Preference(1, 2, 3 or 4) | Comments (if any) |
| Nokia, Nokia Shanghai Bell | 4 | We think that R16 RRM relaxation criteria is sufficient  |
| Apple | 3 | But we also think its up to NW configuration and NW can just use R17 config for R17 RedCap UEs |
| Qualcomm | 1 | Since R17 UEs do not need to take separate measurements for R16 and R17, a single set of S measures can be used by a R17 UE to evaluate both R16 and R17 relaxation criteria. Hence there does not exist any particular order for UE to follow in its evaluation of relaxation criteria. If network configures both R16 and R17 relaxation criteria and a R17 UE meets both criteria, then the UE should be allowed to decide by itself which release’s criterion it may choose to apply. |
| Ericsson | None | Again, this seems to be something RAN2 can discuss if it is decided that we should specify anything.Anyway, on the technical question, it seems unnecessary complex that a UE considers two different evaluation criteria and then we need to sort out which criteria is "active" at which point in time, and priorities between the Rel-16 and Rel-17 criteria.We always assumed and hoped that RAN2 should go for a simple solution where RAN2 may in Rel-17 "enhance" the Rel-16 criteria. A Rel-17 UE would then apply those criteria… without any if:s and but:s. I.e. the UE would not evaluate a Rel-16 set of criteria and a Rel-17 set of criteria and select between these two.If RAN2 are considering a solution this complex, perhaps it is not worth the effort? |
| vivo | 3 / 1 | In our understanding, R17 would provide more power saving gains than R16, assuming more critical criteria would be defined. In this way, R17 RRM relaxation methods (with more relaxation) should be applied even if both R16 and R17 RRM relaxation criteria are satisfied.Otherwise (i.e. RRM relaxation in R17 may have less relaxation than R16), it should be up to UE implementation to decide which relaxation approach should be applied.  |
| Intel | 5 | The UE shall follow network guidance. If the network indicates R17 criteria, then R17 UE shall only use it.  |
| Futurewei | 5 | Agree with Intel.  |
| Sharp | 5 and see comments | If the network knows the UE’s mobility characteristic, it is ok to configure either R16 or R17 relaxation criteria to UE. R17 UE checks R17 criteria if configured. R17 UE checks R16 criteria if R17 criteria is not configured and R16 criteria is configured. |
| Huawei, HiSilicon | 1 | We understand if R17 criteria is fulfilled, UE can perform R17 RRM relaxations, if R16 criteria is fulfilled, UE (if supports) can perform R16 RRM relaxations. If both R17 and R16 criteria are fulfilled, it is up to UE implementation. |
| NEC | 3 | Rel 17 RRM relaxation revaluation criterion should be more rigorous than Rel\_16 criterion, so it should perform the Rel\_17 RRM relaxation first, if it applies, then the UE relax the measurement of Rel\_17. But in addition, we should LS to RAN4 to ask what is the difference between UE behavior of Rel\_16 RRM relaxation and Rel\_17 RRM relaxation, to confirm whether Rel\_17 RRM relaxation can achieve more power gain compared to Rel\_16 RRM relaxation.  |
| MediaTek | Too early to decide | We need to first decide what the Rel-17 criteria will be. Once we decide this, the interactions with Rel-16 criteria, when both are configured by the network, will become clearer. For the moment, we agree with Qualcomm that no order needs to be specified. |
| Xiaomi | 1/3 | In our contribution, we analysis option 1 and 3, and we think option 1 is an enhancement on top of R16 RRM relaxation by adding stationary criterion. For option 3, stationary criterion (R17 RRM relaxation) is separated from R16 RRM relaxation, and R17 RRM relaxation is a higher level relaxation than R16 RRM relaxation. We think both can be further considered. |
| CATT | 3 | For example, stationary property based on subscription info does not need any other evaluation. |
| CMCC | 3 | The R17 Redcap UE could check the R17 relaxation criteria if configured and take more relaxation actions.  |
| Samsung | 3 | This WID's aim is to reduce more energy consumption by adopting more aggressive relaxation method. Thus we expect RAN4 will define more powerful relaxation method for Rel-17 than Rel-16. Accordingly, RAN2 should define more demanding triggering condition for Rel-17 than Rel-16. Then, as described in option 3, UE checks R17 criterion first. If it is fulfilled, R17 relaxation (more powerful than R16) is performed. Otherwise, UE falls back to R16 RRM relaxation.  |
| Sony | 1 or 5 | We should avoid specifying complex rules for interactions between features of different releases unless there is a clear gain. |
| ZTE | 3 | If network configures both Rel-16 and Rel-17 criteria, then a Rel-17 RedCap UE that does not fulfill Rel-17 criteria is allowed to do Rel-16 RRM relaxation.But we don’t think option 1 makes sense, the aim of this study is to define more power saving RRM relaxation methods for Rel-17. If a UE already fulfills Rel-17 criteria, why does the UE choose to perform Rel-16 RRM relaxation method? BTW, please see our clarification to option 2. Basically, it is different from this question. |
| OPPO | 3 | Agree with Apple. |
| Sequans | 5 | We understand Rel-17 solution to be based on the Rel-16 one. If there are enhancements, then we do not see how applying Rel-16 criteria makes sense. This could be a way to implement de-facto two levels (one defined by Rel-17, one by Rel-16), but this seems very unelegant. |

## RRM relaxation in RRC Connected

Among the submitted proposals, there are two different approaches to design relaxation criteria for stationary UEs in RRC Connected. One approach is “to reuse”, e.g. either use R16 relaxation criteria (e.g. low-mobility, not-at-cell-edge) as baseline or use the same criteria as the R17 relaxation criteria to be developed for stationary UEs in RRC Idle/Inactive. The other approach is to introduce new relaxation criteria.

Among the proposals supporting the “reuse” approach, there are two approaches with subtle differences, which are described in the following:

* Option 1a: A R17 stationary UE in RRC Connected applies the same types of RRM relaxation criteria as those for RRC Idle/Inactive. FFS whether parameters used in the relaxation criteria and relaxation methods can be different [1]. This approach is based on the observation that for stationary UEs, there is no fundamental difference in their neighbor cell measurements in RRC Connected and RRC Idle/Inactive. Hence RAN2 may prioritize the discussion on RRC Idle/Inactive relaxations and then reuse them for RRC Connected.
* Option 1b: R16 mechanism can be taken as baseline for neighbour cell measurement relaxation for R17 stationary UEs in RRC connected [2][12][17]. What this approach suggests is that RAN2 will separately study relaxation criteria that are based on R16 relaxation criteria for RRC Connected. RAN2 may or may not develop different relaxation criteria for RRC Connected and RRC Idle/Inactive for R17 stationary UEs.
* Option 1c: RRC\_Connected reuses the Rel-16 RRM relaxation criteria from RRC\_Idle/Inactive as per WID

Among the contributions supporting new criteria for RRC Connected, there are two proposals:

* Option 2a: Introduce a new parameter, s-MeasureConfig\_Stationary, configured within MeasConfig. A stationary UE decides whether to relax its RRM measurements based on the new stationary criterion and how the RSRP of its SpCell compares against s-MeasureConfig\_Stationary [19];
* Option 2b: Introduce beam based criterion for allowing/disallowing RRM measurement relaxation in RRC Connected [12].

Companies are invited to indicate their preference on the various proposals described above in the following questions:

**Question 6. Do you prefer “reuse” (Option 1a & 1b) or introduce new relaxation criteria (Option 2a & 2b)?**

|  |  |  |
| --- | --- | --- |
| Company | Reuse or new | Comments (if any) |
| Nokia, Nokia Shanghai Bell | Reuse | It is already very clearly defined in the WID that Rel-16 relaxation criteria shall be used:“for RRC\_Connected the mechanism reuses the Rel-16 RRM relaxation criteria from RRC\_Idle/Inactive” |
| Apple | reuse |  |
| Qualcomm | Reuse |  |
| Ericsson | None | We do not think we should introduce any relaxation in CONNECTED. Note that the network could, when it has determined that a UE is of low/no mobility simply deconfigure RRC measurements for the UE if the network finds suitable. However, as was noted in some of the contributions: RRM measurements are **not only** performed for mobility. For example, the network may need measurements from the UE for the sake of load balancing and the UE shall of course not relax measurements.So, in CONNECTED the network is in full control of which measurements the UE performs and can adjust the measurements freely, e.g. also based on observed mobility of the UE. There is no need for any enhancements.In our paper we suggested that RAN2 can investigate if any UE to network reporting of the mobility of the UE would be beneficial. So far there has not been shown any real gains of this, but we are open to keep evaluating this. |
| vivo | Reuse | We agree with Rapporteur’s observation that that for stationary UEs, there is no fundamental difference in their neighbor cell measurements in RRC Connected and RRC Idle/Inactive. Meanwhile, to save the time for discussion on RRM relaxation, it is more reasonable to reuse criteria from RRC Idle/Inactive to RRC Connected. |
| Intel | See comments | The first question should be whether we consider both fixed UE and temporary stationary UE. If we consider both of them, then IDLE/INACTIVE approach could be “reused” but changes are needed to adapt CONNECTED mode, e.g. subscription based approach, RAN may get this information from CN.  |
| Futurewei | Reuse |  |
| Sharp | Reuse |  |
| Huawei, HiSilicon | None | There is still concerns on the performance in RRC\_connected state, if RRM relaxation in RRC Connected will be supported, “Reuse” is preferred. |
| NEC | Reuse | Agree with what is already very clearly defined in the WID that Rel-16 relaxation criteria shall be used:“for RRC\_Connected the mechanism reuses the Rel-16 RRM relaxation criteria from RRC\_Idle/Inactive” |
| MediaTek | Reuse |  |
| Xiaomi | Reuse | For RRC\_Connected the mechanism reuses the Rel-16 RRM relaxation criteria from RRC\_Idle/Inactive so as to maximize the commonality with Idle/Inactive UEs. But the difference is that in RRC\_Connected, UE can determine relaxation by itself or let network to decide it when UE satisfies the criterion. |
| CATT | Reuse, if any | Relaxation in Connected should take minimum specification effort, if any, on top of Idle/Inactive. We share similar view as Ericsson. |
| CMCC | Reuse |  |
| Samsung | Reuse with 2a | There are two points we want to discuss.1) We wonder if RAN2 assumes "reuse" also includes broadcast singalling as in R16. In R16, the thresholds for triggering conditions are provided via SIB. But, in RRC\_Conncected, we understand dedicated signalling per UE looks reasonable.2) If RAN2 agrees to reuse R16 "not-at-cell-edge" in dedicated way, we first note that, for RRM measurement in RRC\_Connected, *s-MeasureConfig* (in *MeasConfig)* is being used as RSRP threshold to determine whether to perform measurements on neighboring cells. ***s-MeasureConfig***Threshold for NR SpCell RSRP measurement controlling when the UE is required to perform measurements on non-serving cells. Choice of *ssb-RSRP* corresponds to cell RSRP based on SS/PBCH block and choice of *csi-RSRP* corresponds to cell RSRP of CSI-RS.Having these in mind, option 2a (i.e., introducing *s-MeasureConfig\_Stationary*) is one way to reuse/enhance R16 not-at-cell-edge with dedicated signalling. |
| Sony |  | We think it is bit early to discuss the exact method for connected mode. RAN2 may start with idle/inactive first and then discuss if these methods are found suitable for connected and if there is a gain for connected mode. |
| ZTE | None | Same view as HW. |
| OPPO | Reuse with 1b | We prefer to use Rel-16 RRM relaxation criteria for RRC Idle/Inactive as a baseline, but with some change to adapt RRC Connected, e.g. different parameters for RRM relaxation criteria are configured for Rel-16 low mobility UEs in RRC Idle/Inactive and Rel-17 stationary UEs in RRC Connected. |
| Sequans | Reuse, if any | Agree with Ericsson. NW control in Connected already gives enough flexibility in configuration, so we do not see the benefit beyond possible new assistance information from UE. |

If you selected “reuse” in Question 6, please indicate your preference between Option 1a and 1b in the following question:

**Question 7: For R17 stationary UEs in RRC Connected, do you prefer applying the relaxation criteria to be developed for R17 stationary UEs in RRC Idle/Inactive (Option 1a), or separately studying the relaxation criteria based on the existing R16 relaxation mechanism (Option 1b)?**

|  |  |  |
| --- | --- | --- |
| Company | Preference(1a or 1b or 1c) | Comments (if any) |
| Nokia, Nokia Shanghai Bell | 1c | It is already very clearly defined in the WID that Rel-16 relaxation criteria shall be used:“for RRC\_Connected the mechanism reuses the Rel-16 RRM relaxation criteria from RRC\_Idle/Inactive” |
| Apple | 1a |  |
| Qualcomm | 1a | We do not see any fundamental difference in the neighbor cell measurement relaxation criteria between RRC Idle/Inactive and RRC Connected. Hence whatever relaxation criteria we agree in one RRC state can be applied to the other.  |
| Vivo | 1a | We agree with Qualcomm. Besides, we think RedCap UEs may have different measurement performance from non-RedCap UEs due to reduced capabilities. Thus, it is more proper to reuse the criteria to be developed for R17 stationary UEs but not the criteria based on existing R16 relaxation. |
| Futurewei | 1a |  |
| Sharp | 1a |  |
| NEC | 1a | For RRC connected, it is controlled by the gNB. Besides this, the RRM has the same requirement with other RRC states.  |
| MediaTek | At least 1b | 1b should be considered as the baseline for Connected mode measurement relaxation study. 1a can be considered if there are significant advantages over 1b. |
| Xiaomi | 1a |  |
| CATT | 1a | The objective of RRM relaxation in RRC Connected is still for stationary RedCap UEs. Hence, the same criteria for stationary Redcap UEs in RRC Idle/inactive can be used. |
| CMCC | 1a |  |
| Samsung |  | We wonder if whether RAN2 assumes broadcast or dedicated signalling for RRC\_Connected. If broadcast, we agree option 1a. Otherwise, we prefer option 1b.  |
| OPPO | 1b | We prefer to use Rel-16 RRM relaxation criteria for RRC Idle/Inactive with some change to adapt RRC Connected, e.g. different parameters for RRM relaxation criteria are configured for Rel-16 low mobility UEs in RRC Idle/Inactive and Rel-17 stationary UEs in RRC Connected. |
| Sequans | 1a | We do not see fundamental difference between Idle/Inactive and Connected for this case. |

If you selected “new” in Question 6, please indicate whether you support Option 2a and 2b described above in the following question. If you do not support either Option 2a or 2b but have other proposals for new relaxation criteria, you may indicate “other” as your preference and your motivation in the Comments column.

**Question 8: Do you support introducing a new threshold against RSRP of UE’s SpCell as described in Option 2a, or beam based criterion as described in Option 2b, or other enhancements?**

|  |  |  |
| --- | --- | --- |
| Company | Option 2a, 2b or other | Comments (if any) |
| Samsung | Reuse with 2a | Please see our responses for Q7 and Q8. |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

The last issue to discuss is whether it is UE or network that has the power to trigger measurement relaxation when UE meets relaxation criteria. Two types of approaches have been proposed in the contributions, as follows:

* Option 1: If network provides evaluation parameter for relaxation criteria (either in SIB or by dedicated signaling), UE can relax its RRM measurements on neighbor when it meets the relaxation criteria [1] [2] [12] [17];
* Option 2: When UE meets relaxation criteria configured by network, it provides an indication to network and then wait for network’s confirmation to trigger its relaxation. This indication from UE can be in the form of a measurement report [2] or other signaling method [18].
* Option 3: Only UE to network indication is considered, but existing procedures already in spec are used to achieve relaxation, e.g. deconfigure measurements.
* Option 4: On top of Option 1, network can indicate which frequencies (measObjects) can be relaxed when UE meets the relaxation criteria.

Companies are invited to indicate their preference between the above two options:

**Question 9: Do you think UE is allowed to trigger relaxation by itself after meeting the relaxation criteria configured by network (Option 1) or UE always needs a confirmation from network to trigger relaxation even after UE has met the relaxation criteria (Option 2)?**

|  |  |  |
| --- | --- | --- |
| Company | Preference(Option 1 or 2) | Comments (if any) |
| Nokia, Nokia Shanghai Bell | 2 | We assume that this question is only for CONNECTED |
| Apple | No strong preference, but 2 is feasible as the UE is in CONNECTED mode |  |
| Qualcomm | 1 | If network has configured relaxation criteria, that means network authorizes UEs to evaluate relaxation criteria by themselves. Otherwise, network can evaluate UE’s eligibility by itself based on UE’s measurement reports (this can be done in RRC Connected but no RRC Idle). Hence we do not see any need for an extra signaling step by UE to get a confirmation from network before it can trigger RRM relaxations. |
| Ericsson | 3 | As said, the network is in full control over which measurements a UE in CONNECTED needs to perform. The network can deconfigure measurements if deemed suitable by the network.Our interpretation of option 2 above seem to be some type of new mechanism should be added? But a simple deconfiguration of measurements will suffice and luckily(!) RAN2 does not need even to change the spec for this. |
| vivo | 1 and 2 | We think the network is in full control even in option1, as the network can decide how and even whether to configure the parameters for RRM relaxation.In our understanding, it is too early to make the decision on this issue. We could agree to list the options here from RAN2 point of view. After RAN4 defining the relaxation method based on the criteria developed above, we could further discuss which approach should be adopted in both RAN2 and RAN4.  |
| Intel | 1 | The relaxation criteria is configured by the network, and therefore the network already have full control on this , i.e. the network can decide whether the UE is allowed to do this, and based on what. Therefore the UE can follow network guidance and relax RRM measurement directly when the criteria (configured by network ) is met.  |
| Futurewei | 2 |  |
| Sharp | 1 and 2 | The gNB can control relaxation by sending relaxation parameters or not, which is a kind of rough control. In that case, UE is allowed to trigger relaxation by itself according to gNB’s control. The gNB also can control relaxation exactly, i.e. to indicate when to start or stop relaxation to UE. The indication mentioned in Option2 is unnecessary. |
| Huawei, HiSilicon | 2 | If RRM relaxation in RRC Connected will be supported, it should be strictly under network control, the network should be aware of RRM relaxation performed by the UE. |
| NEC | Option 1 or 2 | Similar view to vivo. Probably it’s good to wait for further RAN4 progress regarding defining how the RRM relaxation is done for stationary UE and then RAN2 can decide later. |
| MediaTek | 1 | We agree with QC that if the NW has configured relaxation criteria, it is an implicit authorization to relax measurements when that criteria is met. The extra signaling does not add value, and has the disadvantage of increasing the signaling load in the system. |
| Xiaomi | 1 | We understand that option 2 is to ensure that UE can perform relaxed measurement more carefully, but we think once network can provide a UE with evaluation parameter for relaxation criteria, it means network can let UE decide whether to relax, so we think option 1 is a better way which can perform relaxation more fast and reduce signal overhead. |
| CATT | 2 or 3 | How to relax RRM measurement in RRC Connected is decided in RAN4. We can decide whether RRM configurations need to be updated based on RAN4’s conclusion for RRM relaxation in RRC Connected. |
| CMCC | 2 | The network should pre-configured trigger condition and sends indications with dedicated signaling to control the desired RedCap UEs to perform the RRM relaxation in connected mode. |
| Samsung | 1 | We share the view from Qualcomm.  |
| Sony | 1 |  |
| ZTE | 4 | As we indicated in our paper [6], only mobility based RRM measurements can be relaxed, considering the UE is not moving.But there are other measurements that network will expect UE to report as soon as possible (usually these RRM measurement won’t last for a long time, but early reporting is needed). If only Option 1 is adopted, and network wants to configure such kind of RRM measurements (e.g. load balance) to UE, the network can only disable entire RRM relaxation function. By doing this, the UE cannot be benefit from RRM relaxation on other frequencies, and it will take additional time for speed evaluation when network enable the RRM relaxation function again.  |
| OPPO | 2 | For option 1, whether to perform relaxed neighbour cell measurement is determined by UE based on the configured creteria, but network does not know whether UE has triggered relaxed neighbour cell measurement or not. For option 2, network is fully in control of RRM relaxation of the UE. Considering that RRM measurement in Connected state should be relaxed with more carefulness since any mobility impacts is quite unacceptable, we prefer option 2. |
| Sequans | 2 or 3 | Option 3 looks like a special case of option 2. In any case it doesn’t look RRM relaxation would be used in Connected if option 1 is selected and NW is not in full control. |

# Conclusion

# Contact information

|  |  |
| --- | --- |
| Company | Contact Info (name and email address) |
| Apple | Naveen Palle, naveen.palle@apple.com |
| Qualcomm | Linhai He (linhaihe@qti.qualcomm.com) |
| Ericsson | Mattias Bergström (mattias.a.bergstrom@gmail.com) |
| vivo | Chenli (Chenli5g@vivo.com)  |
| Futurewei | Yunsong Yang (yyang1@futurewei.com)  |
| Sharp | Lei Liu (lei.liu@cn.sharp-world.com) |
| Huawei, HiSilicon | Yiru Kuang (kuangyiru@huawei.com) |
| MediaTek | Pradeep Jose (pradeep[dot]jose@mediatek[dot]com) |
| Xiaomi | Rao (shirao@xiaomi.com) |
| CATT | Pierre Bertrand (pierrebertrand@catt.cn) |
| CMCC | Min Wu(wumin@chinamobile.com) |
| Sony | Vivek Sharma (Vivek.sharma@sony.com) |
| ZTE | LiuJing (liu.jing30@zte.com.cn) |
| OPPO | Haitao Li (lihaitao@oppo.com) |
| Sequans | Noam Cayron (noam.cayr@outlook.com) |

# References

1. R2-2102682, RRM relaxation enhancements for stationary UEs, Qualcomm Incorporated.
2. R2-2102737, Discussion on RRM relaxation for RedCap UEs, OPPO.
3. R2-2102853, RRM measurement relaxation criteria for RedCap devices, Intel Corporation.
4. R2-2102860, Discussion on RRM relaxation criteria for neighboring cells, vivo, Guangdong Genius.
5. R2-2102966, Mechanisms for RRM relaxation for RedCap, Ericsson.
6. R2-2103038, RRM relaxation for RedCap UE, ZTE Corporation, Sanechips.
7. R2-2103113, Discussion on RRM Relaxations, CATT.
8. R2-2103150, Discussion on RRM relaxation for RedCap UE, Xiaomi Communications.
9. R2-2103206, RRM relaxation in RRC\_CONNECTED for RedCap UEs, SHARP Corporation.
10. R2-2103309, RRM relaxation for RedCap devices, LG Electronics Inc.
11. R2-2103402, RRM relaxation for stationary UE with reduced capability, Lenovo, Motorola Mobility.
12. R2-2103495, On RRM relaxations for REDCAP, Nokia, Nokia Shanghai Bell.
13. R2-2103691, Discussion on the RRM relaxation for RedCap UEs, CMCC.
14. R2-2103781, Discussion on RRM Relaxation of REDCAP UE, China Telecommunications.
15. R2-2103784, On RRM relaxation for RedCap devices, MediaTek Inc.
16. R2-2103888, RRM relaxation down selection of options for RedCap, Apple.
17. R2-2103974, RRM relaxation for RedCap UE, InterDigital.
18. R2-2104060, RRM measurement relaxation for RedCap UE, Huawei, HiSilicon.
19. R2-2104081, RRM relaxation criteria for RedCap devices, Samsung.