**3GPP T****SG-RAN WG2 Meeting #113bis-e R2-210xxxx**

**Online, April 12 – 20, 2021**

**Agenda item: 8.12.3.2**

**Source: Qualcomm Incorporated**

**Title: Summary of [Post113bis-e][102][RedCap] RRM relaxations**

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

**Document for: Discussion and Decision**

# Introduction

This document is for a post-meeting email discussion on RRM relaxation related issues that were unresolved at RAN2#113bis-e [20]. Per suggestion from the session chair, we will focus the discussions on the following aspects:

**1. Possible use of the Stationarity information in subscription information (e.g. any benefits to use this information - besides the measurement-based R17 stationarity criterion being specified - to trigger RRM relaxations? Where does the subscription info come from (UE or CN) and how is it used?)**

**2. Possible reuse of the R17 RRM relaxation criteria being specified for RRC Idle/Inactive also for RRM relaxations in RRC Connected (e.g. pros/cons, etc.)**

If possible, please provide reasons behind your views when commenting. That would help make the discussions more constructive.

The deadlines for this email discussion are the following:

* for companies' initial feedback: **Friday 2021-05-07 15:00 UTC**
* for rapporteur's summary: **Saturday 2021-05-08 00:00 UTC**
* for feedbacks on rapporteur’s summary: **Monday 2021-05-10 15:00 UTC**

# Contact information

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# Discussion

## Use of stationarity in subscription information

One of the unresolved issues with using subscription information for RRM relaxations is whether it offers additional benefits over a measurement-based relaxation criterion (e.g. Proposal 2 in [20]).

The proponents argued that RedCap UEs may have fixed locations in a number of use cases, e.g. video surveillance cameras, industrial wireless sensors, robots in a warehouse etc. Since radio links for those fixed-location UEs are relatively stable, their stationarity is worth leveraging for RRM relaxations [7][15]. It is a simpler, faster and more efficient way to trigger RRM relaxations than approaches relying solely on periodic RSRP/RSRQ measurements. For example, for UEs, it reduces the need for measurements. For networks, it is simpler to apply as it does not require finetuning of any thresholds [4][10]. It allows RAN4 to investigate further relaxations in RRM measurements that may generate more power savings [6].

On the other hand, the opponents were skeptical about whether there may be gains from using subscription information. A single unified solution applicable to all types of RedCap UEs (i.e., fixed, moving or temporary fixed) should be considered instead [5][19][18]. And there were concerns on its reliability too, as RSRP measurements of stationary UEs can still fluctuate over time [2][8][9].

In the following, we will continue our discussions on the benefits and concerns of using subscription information for RRM relaxations:

* Can subscription-information based relaxation trigger enable more power savings than measurement-based approach?
* Is stationarity in subscription information a simpler way for both UE and network to trigger RRM relaxations?
* Can subscription information be used reliably as a relaxation trigger?

**Question 1: Do you think relaxation criteria based on stationarity in subscription information can enable more power savings than measurement-based approaches?**

|  |  |  |
| --- | --- | --- |
| Company | Preference  (YES/NO) | Please provide your justifications/reasons |
| LG | Yes | If subscription information is used, the UE can perform RRM relaxation whole time so it can save more power consumption. |
| Qualcomm | YES | Using subscription information can allow UEs to trigger relaxation without performing measurements required for evaluating its stationarity. Since the evaluation is performed periodically, skipping it does save UE power. Therefore, there are definitely gains in power saving over measurement based criteria.  In addition, we agree with the argument in [6] that it may allow RAN4 to investigate further relaxations in RRM measurements, as stationarity defined by subscription is more predictable than those defined based on measurements. |
| Intel | Yes | Subscription based determination is faster than measurement based approach, and the UE does not need to perform measurement before determine the stationary state. |
| Huawei, HiSilicon |  | If RAN4 does not define a new relaxation method for “subscription” in addition to relaxation method for “stationary based on RSRP/RSRQ measurement”, and the new relaxation provides a greater relaxation, we don’t see there will be more power saving gain. Since for “truly fixed” UE, generally the measurement-based criteria (if it is configured appropriately) should always been fulfilled based on RSRP/RSRQ measurement, so “truly fixed” UE can still perform measurement relaxation based on RSRP/RSRQ measurement. The possible additional power saving gain comes from the case that the measurement-based criteria is not fulfilled for “truly fixed” UE, however, in this case, it’s safer not to relax measurement. |
| CATT | Yes | It could be expected (but that’s FFS RAN4) that the relaxation method associated with the subscription information criterion targets more relaxed measurements than that of the RSRP trigger. But even if it is not the case, a measurement-based approach necessarily takes some margins for evaluating the stationarity to avoid erroneous stationarity estimation that could lead to performance degradation in the UE mobility. Therefore there will be cases where the UE does not trigger the relaxation although it could have done so. On the contrary the subscription approach “guarantees” the UE stationarity hence the associated relaxation is always leveraged thus providing more power saving. |
| OPPO |  | We share the same view as Huawei. |
| Vodafone | need further studies | Agree with Huawei’s comments.  In addition to the comments above the RRM Measurements can be relaxed provided the UE/Device is not sitting at Cell edge and is not subject to cell selection/reselection ping-ponging. In this particular case, even if the UE is stationary, the cell edge radio conditions will prompt the UE to perform RRM measurements, leading to unnecessary power wastage |
| Ericsson | No | If we use subscription information, the gNB would still need to check that the UE is actually stationary and not moving (for any reason). This means some measurement-based solution should be used as well to validate. Then, it is not clear what the advantage of subscription based solution would be – in the end similar relaxation (whatever that will be) can also be triggered through measurement-based criteria alone.  Another issue – if the stationary subscription information is tied to e.g. USIM, what would happen if a physical SIM card is moved from the RedCap UE which is supposed to be stationary to another UE? |
| Apple | Yes | We were one of the proponents and in addition to Qualcomm’s reasoning, we also think the same way as CATT in that the ‘stationariness’ can be used by the NW in parametering the triggering of relaxation methods. |

**Question 2: Do you think stationarity in subscription information can be a simpler way for both UE and network to trigger RRM relaxations (e.g. no need for measurements by UEs, no finetuning of thresholds by network)?**

|  |  |  |
| --- | --- | --- |
| Company | Preference  (YES/NO) | Please provide your justifications/reasons |
| LG | Yes | We think the subscription information-based RRM relaxation is simpler way for UE because it does not need to evaluate RRM relaxation criteria. For network side, anyway the network should consider also the UEs without subscription information to configure the RRM relaxation thresholds. Thus, it seems there will no simplicity difference for the network. |
| Qualcomm | YES | We agree that subscription based trigger can ease network’s burden in configuring/finetuning thresholds used in measurement-based criteria (especially after some infra vendor raised that issue at the last meeting). |
| Intel | Yes |  |
| Huawei, HiSilicon | NO | In our understanding, the measurement-based R17 stationarity criterion will be specified, and addition of subscription will obviously introduce complexity. In the one hand, it may be simple for UE implementation due to no need for measurements. On the other hand, the NW anyway needs to configure thresholds for measurement-based R17 stationarity criterion, it increases complexity. Besides, it introduces additional signaling. For example, UE or CN need to signal subscription information to RAN. |
| CATT | Yes | The justifications are in the parenthesis of the question. |
| OPPO | No | Stationarity in subscription information may not be reliable from radio quality’s perspective. It is simple, but it may not be efficient in that it cannot always guarantee that radio quality does not change. Therefore, we don’t think it could be used alone as the RRM relaxation criterion. Measurement-based R17 stationarity criterion should be used as the baseline. |
| Vodafone |  | for majority of cases RRM Relaxation ‘may’ lead to power saving, however for scenarios where the radio condition changes, or the cell goes offline, and the UE need to re-select another cell etc. this may lead to the device going offline |
| Ericsson | No | See above. Subscription information alone to trigger measurement relaxation should not be used. |
| Apple | Yes (as an option at the NW if the NW knows about the stationariness) |  |

**Question 3: Do you think stationarity in subscription information can be used reliably as a relaxation trigger?**

|  |  |  |
| --- | --- | --- |
| Company | Preference  (YES/NO) | Please provide your justifications/reasons |
| LG | Yes | For a certain UE such as described by the rapporteur (e.g. video surveillance cameras, industrial wireless sensors, robots in a warehouse), it is reliable enough to perform RRM relaxation. |
| Qualcomm | YES | When served with wide beams (e.g. in RRC Idle/Inactive), UEs with fixed location are less likely blocked or impacted by surrounding objects. When served with narrow beams (e.g. in RRC Connected), UEs with fixed locations typically have multiple beams available to use. So even when its serving beam is blocked, it can switch to another one by BFR. Therefore, we do not expect UEs with fixed locations would have fluctuations in their channel conditions significant enough to cause frequent cell reselection. In addition, not-at-cell-edge criterion can be used together with subscription based criterion to increase its reliability as a relaxation trigger. |
| Intel | Yes | For the use cases that the UE location is fixed, e.g. video surveillance cameras, industrial wireless sensors, robots in a warehouse etc., the UE/network do not need to determine the stationarity based on measurement. |
| Huawei, HiSilicon | NO | As discussed in the SI phase and captured in the TR: Channel or link (RSRP/RSRQ) may change (e.g. may be low) even if UE is fixed-location, RRM relaxation only depends on fixed-location information may impact the performance if the UE is located at cell edge. |
| CATT | Yes | The subscription based mechanism is expected to be used for certain scenarios only, e.g. video surveillance cameras, industrial wireless sensors, etc which are expected with fixed location. So it should be reliable. |
| OPPO | No | Measurement-based stationarity criterion should be used as baseline. Note that in NB-IoT, there are also fixed-location/stationary UEs, for which the neighboring cell RRM relaxation is always based on RSRP/RSRQ based criterion. |
| Vodafone | possibly | we must be careful not to ‘over-engineer’ this stationary use case and the solution for this stationary case has to be light, simple and not to put burden on the network |
| Ericsson | No | Even if the device is stationary does not mean that the environment may change such that the "best cell" changes. Further, we can’t guarantee the USIM is always used in the same physical device, and we can’t know such device is truly stationary. |
| Apple | Yes | As reasoned in the earlier question. |

In the next two questions, let us tentatively assume that stationarity in UE’s subscription information is adopted as a relaxation criterion. We then discuss how it may be used in RRC Idle/Inactive and RRC Connected.

In RRC Idle/Inactive, since network does not have direct/immediate control of UEs’ RRM measurements, UEs may trigger RRM relaxation autonomously based configured criteria, if enabled by network. There may be four options for using stationarity in subscription information:

* Option 1: Relaxation is enabled by broadcast. Network advertises in system information whether UEs with stationarity provisioned in their subscription may relax its RRM measurements. There is no signaling exchanged between network and UE in this case, i.e. UE checks its subscription information and determine whether it is eligible (i.e. it is stationary according to its subscription) to apply the RRM relaxation methods enabled by network.
* Option 2: Relaxation is enabled by dedicated signaling. For example, when releasing UE’s RRC connection, AMF indicates UE’s stationarity to RAN (e.g. in the UE Context Release Command message). RAN then enable RRM relaxation for the UE in the RRC Release message. The UE can apply the enabled RRM relaxation method once it is in RRC Idle/Inactive.
* Option 3: Both Option 1 and 2 can be supported.
* Option 4: Other methods, if any.

**Question 4: Among the 4 options described above for using subscription information for relaxations in RRC Idle/Inactive, which one do you support?**

|  |  |  |
| --- | --- | --- |
| Company | Preference  (Option 1/2/3/4) | Please provide your justifications/reasons |
| LG | 1 | We think option 1 is the simple approach. For option 2, we think such UE-dedicated indication for RedCap UE is not really beneficial. So option 2 is not needed. |
| Qualcomm | Option 3 | We think both Option 1 and 2 useful to have and they complement each other in different scenarios. |
| Intel | Option 1/2/3 | For INACTIVE UE, anyway it is network to move the UE to INACTIVE, and the network can indicate whether RRM relaxation is allowed or not based on the information from AMF. |
| Huawei, HiSilicon | See comments | Option 2 is not clear whether the “Relaxation indication” is still valid when UE moves to other cells, and the indication from AMF to RAN is up to SA/CT. For Option 1, measurement-based R17 stationarity criterion can be reused for enabling relaxation based on subscription. If the measurement-based R17 stationarity criterion is configured, UE can perform relaxation based on subscription by UE implementation. |
| CATT | Option 1 at least. FFS option 2. | At least Option 1 should be supported although it is to be further discussed if a specific indication is needed for subscription-based relaxation of it is sufficient to have only one indication indicating that R17 relaxation is allowed in the cell (subscription-based and RSRP-based).  For Option 2, we think it is FFS as we first need to check what would be the reason that AMF allows the relaxation for a given UE and not for another UE, based on subscription info. |
| OPPO |  | Since stationarity in subscription information may not be reliable from radio quality’s perspective, we don’t think it could be used alone as the RRM relaxation criterion. Measurement-based R17 stationarity criterion should be used anyway. |
| Vodafone | Option 2 | Option 2 is more specific and distinguishes between the RedCap and Regular UE/Devices. |
| Ericsson | Option 4 | As described above, checking of subscription info must be combined with measurements and signaling from the NW side. But again, this then does not result in any benefits over only a measurement-based approach for enabling relaxation. |
| Apple | Option 1 atleast. | We are ok with option-2 as well, but need to discuss the dedicated vs broadcast etc.. and the UE is anway on the move in IDLE/INACTIVE. So it might be simpler to just go with option-1. |

In the next question, let us tentatively assume that stationary UEs may relax its RRM measurements in RRC Connected. In past discussions as well as in contributions, two options have been proposed/mentioned:

* Option 1: During UE’s connection establishment, core network provides UE’s stationarity to RAN. RAN then uses this information to enable relaxation for the UE (e.g. [1]).
* Option 2: During UE’s connection establishment, UE may indicate its stationarity to RAN in UE radio capability signaling. RAN then uses this information to enable RRM relaxation for the UE (e.g. [16]). In this procedure, RAN has the option of validating UE’s claim by checking UE’s subscription information with core network.

In both Option 1 and 2, there can be different ways for network to enable relaxations for stationary UEs. For example, network may directly provide a relaxed measurement configuration for a stationary UE. Or in case RAN4 decide that relaxation methods can be different depend on whether a stationary UE is at cell center or cell edge, RAN may provide two sets of measurement configurations and some RSRP/RSRQ based threshold for UE to choose which measurement configuration to apply.

There may be other ways for UE and network to use stationarity in subscription information to apply relaxations in RRC Connected. For completeness, the third option in the following is also included in the discussion:

* Option 3: Other methods, if any.

**Question 5: Among the 3 options described above for using stationarity in subscription information in RRC Connected, which one do you support?**

|  |  |  |
| --- | --- | --- |
| Company | Preference  (Option 1/2/3) | Please provide your justifications/reasons |
| LG | Option 1/2 | For the UEs with stationarity subscription information, option 1/2 is adequate.  By the way, for the UEs evaluating RRM relaxation criteria(no stationarity subscription information), UEs should indicate its stationarity state to the network. (Option 2) |
| Qualcomm | Option 2 | Both Option 1 and 2 would work, but we have a slight preference for Option 2 because it has no impact on CN-RAN interface whereas Option 1 does. |
| Intel | Option 1 | Considering UE stationary property information is stable and it is unnecessary to send this information whenever the UE moves to CONNECTED, e.g. from INACTIVE. Therefore we can reuse CN Assistance Information (as part of “INITIAL CONTEXT SETUP REQUEST, UE CONTEXT MODIFICATION REQUEST, HANDOVER REQUEST and PATH SWITCH REQUEST ACKNOWLEDGE.”.), to transfer the UE stationary property to RAN. |
| Huawei, HiSilicon | Option 1 but up to SA/CT | Option 1 is more reliable compared with Option 2, but it should be confirmed by SA/CT. |
| CATT | Option1 | If only the information from AMF is reliable, option 1 is simpler. |
| Vodafone | Option 2 | the Signaling load on the network is less with this approach and decision on the RRM Relaxation can be taken locally within the RAN or the RAN-cluster |
| Ericsson | Option 3 | UE uses the existing connected mode measurement reporting functionality and gNB based on the report enables relaxation in RRC\_CONNECTED (or doesn’t). |
| Apple | Option 2 | We are one of the proponents of option 2. |

## Possible reuse of relaxation criteria in RRC Idle/Inactive for RRC Connected

In the offline discussion at RAN2#113bis-e [20], companies had different views on RRM relaxations for stationary UEs in RRC Connected. Among 16 companies that participated in the discussion,

* 8 companies stated that relaxations in RRC Connected can be left to network implementation.
* 8 companies argued that it is beneficial to have criteria-triggered relaxations in RRC Connected, which can be based on the R17 relaxation criteria being specified for RRC Idle/Inactive. One of the justifications was that having UEs trigger relaxations themselves based on configured criteria can be a more power efficient solution than approaches based on network implementation, as the latter may require UE to send periodic measurement reports for network to evaluate its stationarity.

Companies are invited to comment on whether having UE trigger relaxations themselves can offer more benefits (e.g. less reporting, more power savings, etc) than network implementations.

**Question 6: In RRC Connected, can solutions in which stationary UE triggering relaxations themselves based on configured criteria offer more benefits than network implementations?**

|  |  |  |
| --- | --- | --- |
| Company | Preference  (YES/NO) | Please provide your justifications/reasons |
| LG | No | RRM relaxation in connected mode without network command may degrade mobility performance. We think indicating UE’s stationarity indication during UE’s connection establishment is enough. Based on the stationarity indication, if UE is regarded as stationary, the network might provide proper relaxed measurement configuration. |
| Qualcomm | YES | If UE has to reply on network implementation to have relaxed measurements at the right time, UE probably has to send its measurement reports periodically to network, so that network can continuously evaluate UE’s mobility status and decide whether to adjust (relax) UE’s measurement configuration. On the contrary, if UE is allowed to trigger relaxation themselves, UE then can send less (if not none) measurement reports and thus save power. |
| Intel | Yes/No? | For RRM relaxation triggering criterion, to our understanding:   * For fixed UE, the RAN can get the UE stationary information from CN, and then the RAN can decide whether to relax the RRM measurement or not; How to determine the stationary state is not network implementation. * For temporary stationary UE, the network can get UE measurements based on RRM configuration, and then decide whether to relax the RRM or not. How to determine the temporary stationary state can be left to network implementation.   For RRM relaxation method, the network may only configure serving frequency, adjust S measurement, etc. New signalling may be needed but it depends on what RRM relaxation will be for CONNECTED mode UE, e.g. whether the UE can stop the serving cell measurement or not. |
| Huawei, HiSilicon | YES | We would like to clarify first that the relaxation criteria/trigger is network implementation instead of how to relax RRM measurements. For the relaxation criteria, if it is left to NW implementation, it may require UE to report measurement results periodically which consumes power. As it should strictly under network control, it is beneficial to have criteria-triggered relaxations. |
| CATT | No | Instead of periodic measurement reports, UE can only report the stationary state to the NW, if the UE triggers relaxation by itself. The benefit on power saving due to avoiding reporting one state to NW is very little. But comparing UE triggering relaxation by itself and UE reporting the state to NW and let NW decide, we think NW control is more reliable in connected state. |
| OPPO |  | Considering that RRM measurement in Connected state should be relaxed with more carefulness since any mobility impacts is quite unacceptable, we think network should be fully in control of RRM relaxation of the UE. However, we don’t think this will mandate UE to periodically report measurements (which is a bad implementation). To save signaling overhead, stationary criteria can be configured to the UE for triggering measurement report, based on which NW can control the RRM relaxation |
| Vodafone | Yes | It would be a simpler solution if the UE reports that it is stationary, rather than complicate network measurement reporting.  The overall solution for this must be kept as simple as possible |
| Ericsson | No | In connected mode the network is able to reconfigure the UE's measurement configuration. If the network deems suitable, the network can e.g. remove measurements of some frequencies. But since the UE does not know the reason why a network configures a UE to perform certain measurements (and for a particular measurement, there may be more than one reason), the UE cannot autonomously relax any measurements. As mentioned by several companies, measurements may for example be done on a frequency for the purpose of load balancing where the UE is requested to measure a certain frequency since the network would like to offload this UE to that frequency so as to improve system capacity. |
| Apple | Yes | We think the IDLE/INACTIVE solution is enough for CONNECTED mode as well. In addition, UE may report its triggering aspects (if needed at all). |

In the same offline discussion [20], among companies that supported UEs triggering relaxations themselves, most companies supported reusing R17 RRM relaxation criteria being specified for RRC Idle/Inactive for RRM relaxations in RRC Connected. They argued that there are no fundamental differences in the relaxation criteria for neighbor-cell measurements in the two RRC states (although it can be FFS whether signaling and thresholds may be different for them). Hence it is desirable to reuse the criteria to maximize the commonality between the two designs and avoid redundant work.

Companies are invited to choose whether to support reusing R17 relaxation criteria being specified for RRC Idle/Inactive for relaxations in RRC Connected, if we assume criteria-triggered relaxations in RRC Connected are adopted (Note: Regardless whether you voted ‘YES’ or ‘NO’ in Question 5, a ‘NO’ to Question 7 means that you prefer developing new relaxation criteria for RRC Connected different from those for RRC Idle/Inactive).

**Question 7: If criteria-triggered relaxations in RRC Connected are adopted, would you support reusing the R17 RRM relaxation criteria being specified for RRC Idle/Inactive for relaxations in RRC Connected?**

|  |  |  |
| --- | --- | --- |
| Company | Preference  (YES/NO) | Please provide your justifications/reasons |
| Qualcomm | YES | For a stationary UE in RRC Connected, its neighbor cell RRM measurements fundamentally are not much different from those it performs in RRC Idle/Inactive. Therefore, it makes sense to reuse the same relaxation criteria specified for RRC Idle/Inactive for RRC Connected. Moreover, for stationary UEs, it makes more sense to reuse a stationary criterion instead of a low-mobility criterion (We hope it does not take more than common sense to see that). |
| Intel | Yes | Would be good to reduce alternatives as much as possible. But it should be discussed case by case. |
| Huawei, HiSilicon | YES |  |
| CATT | Yes | R17 relaxation criteria being specified for RRC Idle/Inactive can be used for RRC Connected irrespective of whether it is criteria-triggered relaxations by UE itself or NW-triggered relaxations. |
| OPPO | No | As commented above, we don't think UE’s autonomous relaxations should be reused for connected UE. We can reuse the same idle/inactive criteria (FFS with different signaling and thresholds), but the criteria will be used to trigger UE report and the final RRM relaxation for connected UE will be based on NW’s command. |
| Vodafone | Yes |  |
| Ericsson |  | Not applicable since we don’t think it works (and also there is no need) that the UE autonomously relaxes measurements in CONNECTED. |
| Apple | Yes | For Oppo’s concern, the UE can inform the NW (as it is in CONNECTED mode)? |

# References

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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.
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