**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**

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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. |
| Futurewei | No | Agree with Ericsson’s comments. |
| Sequans | No | Even a “truly fixed” UE may experience radio conditions change and so would require some measurements to confirm its status. I addition, as Ericsson mentioned, a UE’s initial purpose may change, so some measurements would also likely be required to confirm the stationary status. From that POV a “truly fixed” UE is not much different than a “temporarily stationary” UE and so we prefer a single solution that covers both cases.  On top of that, any problem that arises from configuring only subscription-based relaxation will result in failures, which may cause an increased power consumption rather than a decreased one. |
| NEC | Yes | If subscription information is used, the UE can perform RRM relaxation as soon as it access to the network. |
| vivo | Yes | It mainly depends on whether RAN4 will specify a dedicated method with more power saving for stationarity criterion based on subscription information.  One may argue more power saving can be achieved by stationarity criterion based on subscription information even the same RRM relaxation method is applied for different stationarity criteria. Because the stationarity criterion based on subscription information is a faster and more efficient way to trigger RRM relaxations than approaches relying solely on periodic RSRP/RSRQ measurements. As a result, more power saving gain could be expected in theory as one UE could apply RRM relaxation method earlier with the stationarity criterion based on subscription information. |
| Sharp |  | Share the same view with Ericsson and Sequans. |
| Lenovo |  | Same as Huawei |
| Thales | Yes | Many use cases considered for REDCAP such as surveillance cameras, smart home installations are static by nature. Measurement based approaches whether being measurement threshold based or based on measurement windows, all such approaches need corresponding measurements and often also fine tuning being power consuming. In case of too loose measurement requirements other devices may be impacted, hence a subscription based relaxation is considered as a power saving addition. |
| Fraunhofer | No | The network or subscription database has no information about the use of the 5G module. A credit card terminal can be stationary in a shop but mobile when mounted in a taxi. A surveillance camera can be fixed at a crossing or moving around in a bus. 3GPP network should not assume too much knowledge about the application of the device – unless there is a dedicated parameter that an application can set in the modem to inform the network e.g. about stationarity or low-mobility. |
| CMCC | Yes | The RRM relaxation based on UE’s subscription information could save the power used in measurement and the network could also check the status of UE if needed. |
| Samsung | No | We share the same view with Huawei and Ericsson. |
| Xiaomi | Yes | A stationary device can suffer from the signal fluctuation, which causes performing measurement-based from time to time. So from the point of view, stationary property indeed can get a little more power saving gain. |
| MediaTek | Yes | There are several use cases such as surveillance cameras which are static. RRM measurements aren’t really needed in these cases, except to occasionally detect if the NW cell layout has changed (e.g. a new base station has been commissioned). |
| Nokia | Maybe | We think that subscription information for allowing measurement relaxation should not be used by the UE without dedicated allowance from RAN. Otherwise some UEs may relax the measurements although they should not i.e. UEs at cell edge or the UEs placed in environment where signal strength of the cells is changing although the UE is not actually moving. |
| ZTE | Yes | Subscription information is useful to identify fix-location devices (e.g. surveillance camera). But we tend to agree with Huawei that subscription based method is only needed if RAN4 defines new relaxation method for it. It is less necessary to define two different criteria that associated with the same relaxation method.  We agree that for fix-location UEs, RSRP/RSRQ may still change a bit, but from network perspective, it is not easy to configure accurate thresholds to distinguish stationary and low-mobility UEs. So even if the fix-location UEs does not meet the “RSRP/RSRQ thresholds” set for stationary criteria, we see no problem because these UEs has no mobility requirement at all.  Regarding the comments from Ericsson, we understand it is up to UE to ensure the reliability of subscription information based solution, e.g. based on IMSI and IMEI if needed.  And in our understanding, network can control whether UE can use subscription based criterion, so if network decides to change cell layout (e.g. add a new base station), network can disable this function until the cell change is complete. |

**Summary for Q1:**

Among 23 companies that have replied,

* 12 companies agree that relaxation based on subscription information can enable more power savings than measurement-based approaches, based on the arguments that UEs do not need to perform extra measurements to evaluate relaxation criteria, and relaxation method associated with the subscription information criterion may target more relaxed measurements than that of measurement based criteria.
* 10 companies do not agree, based on the arguments that whether there are more power savings would depend on if RAN4 defines a new relaxation method for subscription based criterion which provide a greater relaxation. And even if subscription information is used, network still needs to use some measurement-based solution to ensure a UE is “truly stationary”, e.g. to prevent the case where SIM card of a UE is moved to a mobile UE.
* 1 company is not sure (“maybe”), because subscription based relaxation should not be used without dedicated allowance from network.

**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) |  |
| Futurewei | No | Agree with the comments made by Huawei and Ericsson. |
| Sequans | No | As mentioned above, subscription information would not be enough by itself, and by that it would actually become more complex rather than simpler. |
| NEC | Yes, but with comment | The criteria of Measurement to trigger the RRM relaxation can’t be perfect compared to the stationary UE subscription. UE has to spend some time to perform measurement for evaluation which always brings some delay for UE to determine to trigger RRM relaxation. Furthermore, given the radio condition changes even the UE never moves, the UE may perform measurement to evaluate trigger RRM relaxation again.  But on the other hand, since we defined more than 1 levels of stationary UE, it seems only level 1 Still stationary device at fixed location (e.g. fixed static sensor) can completely rely on subscription information. The other stationary UE, e.g. temporary stationary UE may still require measurement to entering/leaving stationary state. |
| vivo | Yes | We agree stationarity in subscription information can be a simpler way for both UE and network to trigger RRM relaxations. There is no need to configure relaxation criteria from NW, and no need to evaluate the criteria at the UE side. |
| Sharp | No | Subscription information cannot work well alone. |
| Lenovo | No | Subscription information may be not reliable for evaluate the channel quality, since the channel quality may be changed based on the wireless environment such as the interference or power adjustment from other gNB/UE, the UE with fixed location will also needs to perform the measurement-based stationarity evaluation to determine the relaxed measurement. |
| Thales | Yes | The subscription information-based RRM relaxation is simpler way for UE because it does not need to perform the required measurements and evaluate RRM relaxation criteria. |
| Fraunhofer | No | Measurements have to be chosen according to the device’s profile, network configuration and the environment the device is in – the subscription has no information about that. |
| CMCC | No | The RRM relaxation based on UE’s subscription information could save the power used in measurement. But the NW still could to evaluate the radio condition of UE based on measurement reports if needed on some conditions. |
| Samsung | No | Even if subscription information is used, it cannot be used solely as it is not reliable than measurement-based criterion. Then, it makes NW/UE operation more complicated: RAN2/4 needs to design the different relaxation criterion/method according to whether UE supports subscription information. Therefore, we prefer a simple and unified solution with measurement-based criterion solely. |
| Xiaomi | No | Although no need for measurements by UEs and no fine-tuning of thresholds by network, some signalling interaction may need to be defined. |
| MediaTek | Yes |  |
| Nokia | No | Maybe for the UE but not for the NW, because not all the subscription based stationary UEs should not be allowed to relax the measurements. See our reply to question 1. |
| ZTE | Yes | The UE is not required to evaluate the thresholds. And network does not need to configure/fine-tune the thresholds. |

**Summary for Q2**:

Among the 23 companies that have replied,

* 10 companies think subscription based criterion is a simpler way to trigger relaxation, because UEs do not need to perform measurements to evaluate the stationarity and network does not have the burden of finetuning thresholds for relaxation.
* 13 companies do not agree, based on the arguments that subscription based relaxation is not reliable enough to be used alone and by that it would actually make NW/UE operations more complex rather than simpler. And it would require additional signaling between UE and RAN/CN.

**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. |
| Huawei | No | Agree with the comments made by Huawei and Ericsson. |
| Sequans | No | See previous comments. Agree with above detractors. |
| NEC | Yes, but with comment | As our answer in Q2, only a still stationary UE can completely rely on subscription information. |
| vivo | Yes | We share the same view as Qualcomm. Besides, even if the UE wants to perform RRM relaxation by cheating the network for some reason, it can always do it no matter the stationarity criterion is based on subscription information or RSRP/RSRQ measurement. Hence, it is not necessary to consider the case that UE intends to cheat the network.  We also think stationarity in subscription information is reliable to be used to determine whether UE is stationary, but it is up to network whether need other criteria (e.g. not-at-cell-edge) to determine whether relaxation can be triggered. |
| Sharp | No | Agree with other companies’ view, the radio condition may change even for stationary UEs. |
| Lenovo | No | See our comment to Q2. The channel quality may be changed even if the UE is really stationary. |
| Thales | Yes | When the device is in a certain use case video surveillance, smart in-home device, such a classification as stationary can be used reliably. For the cases of cell boarder deployed stationary devices which, even when static could potentially change the cell, simple mechanisms can be installed for avoiding any future static indication. |
| Fraunhofer | No | See comment in Question 1. Subscription is not a reliable source of information. |
| CMCC | No | We think it may not always work reliably as a relaxation trigger. |
| Samsung | No | Subscription information is just "indirect" indicator to represent stable signal quality from serving cell. It cannot be reliable as much as direct measurement of signal quality itself. |
| Xiaomi | No | We understand stationary property can be used in most cases. But we are also concerned that this is not a unified solution to apply all types of redcap UE. There is also temporary stationary UE even surveillance camera can be carried in a car (based on user’s preference).  BTW, what if stationary property is defined incorrectly? |
| MediaTek | Yes | When used for specific usecases (Surveillance cameras, Industrial settings), this can be relied upon. |
| Nokia | No | Further NW control would be needed. |
| ZTE | Yes | See our comments to Q1. |

**Summary for Q3:**

Among the 23 companies that have replied,

* 12 companies agree that subscription based criterion can work reliably, as it is used only for specific scenarios and in those scenarios fixed-location UEs would not have fluctuations in their channel conditions significant enough to cause frequent cell reselections.
* 11 companies do not agree, based on the argument that channel or link (RSRP/RSRQ) may change even if UEs have fixed locations, especially those located at cell edge.

**Rapporteur’s suggestion for Q1~3:**

Companies’ views are split on whether subscription-based relaxation criterion can work reliably to enable UE more power saving. The rapporteur thus suggest that we continue the discussion online at the meeting.

**Proposal 1. (12/23) Continue the discussion on whether RRM relaxations based on subscription information can be supported.**

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. |
| Futurewei | None | Option 1, 2, or 3 should not be used alone without being checked with measurement-based criterion. If option 4 means combining option 1, 2, or 3 with measurement-checking, as Ericsson pointed out, there is no advantage over just using measurement-based criterion. |
| Sequans | Option 1 | If it is agreed we prefer to go with a simple solution, especially if additionally measurements are still specified. Agree with HW that option 2 cannot be agreed by RAN2 alone. |
| NEC | 3 | Option 1 applies to level 1 stationary UE.  Option 2 applies to other levels of stationary UE. For example, temporary stationary UE may need specific RRM relaxation configuration in the RRC Release message to enable/disable the RRM relaxation. |
| vivo | At least Option1 | For option2, we think more discussion is needed. E.g. after enabling the RRM relaxation with RRCRelase, one gNB can’t disable the RRM Relaxation for the UE unless the UE enters RRC\_Connected again? Given RedCap UE may stay in Idle for a long period, we think the flexibility to enable/disable RRM relaxation should be kept.  Anyway, option 1 should be supported as the baseline, i.e. to enable/disable RRM relaxation via system information. |
| Sharp | Option 1 | If one option must be chosen, option 1 is simple. |
| Lenovo | Option 1 | Option.1 is simple. |
| Thales | Option 1 and 2 FFS | For option 1 the subscription information needs to be clearly specified to make sure what a device qualifies for being eligible and how this is managed/maintained. And whether such subscription information is applicable to all PLMNs including visited PLMNs or only HPLMN, many devices may be in roaming. |
| CMCC | Option 1 | Option1 is simple one. |
| Samsung | Option 1 | It seems more simple. Besides, when UE determines whether to relax RRM measurement, measurement-based criterion should be used together with subscription information. |
| Xiaomi | Option 1 | It seems that both options can work. But for option 2, it is decided by RAN via RRC message, we understand since UE can check the stationary property based on e.g. subscription information, there is no need for dedicated message. Besides, it is also unclear whether this indication is still valid when UE moves to other cells. |
| MediaTek | Option 1 | This is the simplest option |
| Nokia | Option 2 or 4. | Option 1 is not acceptable because then some UE may relax the measurement although they should not e.g. UEs at cell edge or the UEs placed in the environment where signal strength and quality of the cells is changing. |
| ZTE | Option 1 | Option 1 is simpler. |

**Summary for Q4:**

Among the 21 companies that have replied,

* 15 companies prefer Option 1 (including 3 companies supporting Option 3);
* 5 companies prefer Option 2 (include 3 companies supporting Option 3);
* 4 companies selected Option 4, because they do not support subscription based relaxations.

Based on the outcome of this discussion, the rapporteur recommend the following proposal for agreement:

**Proposal 2. (15/21) If subscription based relaxations is adopted for RRC Idle/Inactive, network advertises in system information if it allows UEs with stationarity provisioned in their subscription to relax their RRM measurements.**

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. |
| Futurewei | Option 3 | During UE’s connection establishment, whether the UE’s stationarity is indicated to RAN by the UE (option 2) or by the CN (option 1), RAN should check with measurements reported by the UE before deciding on whether to enable relaxation in RRC\_CONNECTED.  In addition, RAN can configure the UE with certain criteria and corresponding means for relaxation to enable the UE to trigger the configured relaxation when the configured criteria are met. |
| Sequans | Option 1 | Since RAN would most likely want to check with CN anyway in option 2, we do not see a reason to complicate things. Agree with HW that option 1 cannot be agreed by RAN2 alone. |
| NEC | Option 1/2 | Both of the options can be studied. Option 1 is the baseline for network to be aware of UE stationary property. But for some UE without subscription information, e.g. a temporary stationary UE, UE autonomously report the stationary state may be necessary. |
| vivo | Option1 | In option 1, CN can provide UE’s stationarity to RAN in the INITIAL CONTEXT SETUP REQUEST message, which occurs before AS security activation.  In option 2, UE can only report its stationarity to RAN after AS security activation to protect UE’s privacy.  Hence, option 1 can make RAN obtain UE’s stationarity property earlier than option2. Besides, option1 introduced no impact and signaling overhead in Uu.  Based on this, we prefer option 1. And option 2 is also acceptable for us. |
| Sharp | Option 1 | Option 1 may be more reliable. |
| Lenovo | Option.1 | Since the UE is in connected mode, the network has the information on UE channel quality, the reporting from UE on the UE stationarity may be not necessary, so option.2 is not necessary. |
| Thales | Option 3 | Both methods option 1 and option 2 are possible and could be supported. |
| Fraunhofer | Option 2, 3 | We prefer Option 2 since the UE knows best about its stationarity. The core network may not be aware of where the UE actually is and how much it moves. At the UE this information may be either provided by the subscription (if feasible) in combination with information conveyed from the application. Further, the stationarity may be determined based on the measurements at the UE side and conveyed to RAN. This can be considered as Option 3. |
| CMCC | Option 1/2 | Both of these options may be studied. |
| Samsung | Option 2 | We prefer Option 2, but both can be studied. |
| Xiaomi | Option 1 | We understand stationary property of UE is stable, there is no need for UE capability to report. |
| MediaTek | Option 1 | Option 1 is more reliable, but needs confirmation from SA2/CT1 |
| Nokia | Option 1 | We think option 2 is already supported partially by UE mobility history information. This seems already sufficient information for this purpose. |
| ZTE | Option 1 | Option 2 is a bit unclear to us, if RAN node needs to check the UE’s subscription information with CN (which means the subscription information implies the UE is stationary), then CN should be able to provide this information to RAN in advance (Option 1). |

**Summary for Q5:**

Among the 22 companies that have replied,

* 16 companies prefer Option 1 (including 6 companies that also support both Option 1 and 2);
* 9 companies prefer Option 2 (including 6 companies that support both Option 1 and 2);
* 4 companies that do not support either Option 1 or Option 2.

Given the outcome of this discussion, the rapporteur would recommend the following proposal for agreement:

**Proposal 3. (16/22) If subscription based relaxations is adopted for RRC Connected, core network indicates UE’s stationarity to RAN during UE’s connection establishment.**

## 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). |
| Futurewei | Yes, but | Agree that some measurement reports may be saved. However, both the means for achieving the relaxation and the criteria for UE doing so should be fully controlled by the network (through configuration) for RRC\_CONNECTED. |
| Sequans | No | NW should always be in full control of UE’s action in connected as this may adversely affect mobility. The preconfigured criteria can be used for when the UE can indicate it may be relaxed and for stopping a NW-allowed relaxation or triggering a report, thus not mandating a periodic report, or at least lengthening the period when one is not required. |
| NEC | No | We think if there is no specific configuration for RRM relaxation in RRC CONNECTED, relaxation can be triggered by the criteria being specified for RRC Idle/Inactive. If network provided further configuration for RRM measurement since the UE is in RRC CONNECTED mode, UE should follow the further configuration by the network, which is decided by network implementation, e.g. based on the measurement report. |
| vivo | Yes | Take using stationarity in subscription information to trigger relaxation as an example, it requires no measurement report and is more reliable in determining whether UE is stationary than the measurement based network implementation solution. In this way, less measurement and less measurement reports could be achieved. |
| Sharp | Yes | The gNB can also control the relaxation start/stop when it wants. |
| Lenovo | Yes | The solution in idle/inactive mode could be reused here. No extra enhancement is desired. |
| Thales | Yes | In a simple solution the UE’s stationarity indication should be the first step. Network should relax accordingly and acknowledge for UE indicating stationary. However there also need to be means that network indicates that UE shall apply non-relaxed procedure. In anyway behavior needs to be kept simple. |
| Fraunhofer | Yes | The UE knows its own RF conditions best. Also, any changes on the RF environment are timely measured at the UE itself, and the network can only know about that with delay. The whole point of RRM relaxation in RRC Connected is timely and opportunistically saving power, and if needed leave relaxation timely in order to not delay important RRM decisions. Involving the network in these steps (entering or leaving relaxation) will only lead to less power saving and worse RRM decisions, with increased overhead (reporting).  Furthermore, the network will have conflicting goals if the implementation is solely left to the network: optimizing a UE power saving vs a certain RRM strategy. This would lead to network implementations which focus on the network RRM strategy and save less UE power. In contrast, UE triggering relaxation themselves offer the opportunity to save more power because the implementation can be focused on optimizing UE power savings only. And it can take into account internals only available at the UE. |
| CMCC | Yes | Need to controlled by the NW. |
| Samsung | Yes | We share the same view with Qualcomm. Besides, even if the solution in which UE triggers relaxation is adopted, the configuration for triggering condition (e.g., RSRP threshold) is fully controlled by NW. |
| Xiaomi | Yes | For network implementation, e.g. periodically RSRP report, it will cause more power consumption. Besides, we understand that UE determining RRM relaxation itself based on configured criterion is still under network control. So criterion can be used for connected mode. |
| MediaTek | No | We need to be careful with RRM relaxations in Connected mode as it may be used for load balancing as stated by Ericsson. Therefore the UE relaxing measurements on its own would not be a good idea. |
| Nokia | Yes | We agree with Qualcomm |
| ZTE | Yes, but | RRM relaxation in Connected mode should be evaluated carefully.  In our understanding, it can be:   1. For fix-location UEs, network can identify these UEs based on subscription information, network can de-configure mobility related RRM measurements. Which means the UE is not required to do RRM relaxation autonomously; 2. For temporary stationary UEs, if we adopt the same measurement based relaxation criteria in Idle/Inactive to Connected mode, and network provides those thresholds via RRC dedicated signalling, then UE can do RRM relaxation if it meets the criterion. We don’t prefer to let UE send measurement report periodically, because it is power consuming and may cause signalling burden.   But for 2, network should be able to indicate which frequency(ies) can be relaxed which can not based on measurement purpose (e.g. load balancing). |

**Summary for Q6:**

Among the 23 companies that have replied,

* 15 companies agree that in RRC Connected relaxations triggered by stationary UEs themselves based on configured criteria can offer more benefits than network implementations, because we think UE can send less measurement reports and thus save power. Or they prefer the solution in RRC Idle/Inactive to be reused for RRC Connected, to make things simple.
* 6 companies disagree, based on the arguments that no relaxations for RRC Connected should be allowed or network should always be in full control for relaxations in RRC Connected.
* 2 companies agree to neither. One of them thinks everything is controlled by network and UE is not involved in the triggering decision. The other thinks there is no extra benefit because network can configure relaxation criterion in UE and UE reports to network when the relaxation criterion is met (Note by the rapporteur: if I understood correctly, this is the same procedure as what the 15 proponents think how it should work).

Based on the outcome of this discussion, the rapporteur would suggest the following proposal for agreement:

**Proposal 4. (16/23) In RRC Connected, if network configures relaxation criteria for UE, UE can trigger relaxations themselves when the configured relaxation criteria are met.**

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)? |
| Futurewei | Yes or no | No matter what RRM relaxation criteria is specified for RRC Idle/Inactive, the RRM relaxation criteria for RRC\_CONNECTED should involve the checking of measurement-based criteria. |
| Sequans | Yes |  |
| NEC | Yes |  |
| vivo | Yes | As mentioned by the rapporteur, there are no fundamental differences in the relaxation criteria for neighbor-cell measurements in the two RRC states. To save the time for discussion on RRM relaxation, it is more reasonable to reuse criteria from RRC Idle/Inactive to RRC Connected.  But we are open to discuss new relaxation criteria for RRC Connected different from those for RRC Idle/Inactive. |
| Sharp | Yes |  |
| Lenovo | Yes |  |
| Thales | Yes |  |
| Fraunhofer | No | The implications of relaxed RRM measurements are quite different in RRC Idle/Inactive and RRC Connected. In Idle/Inactive, if RRM relaxation leads to a poor decision (e.g. not camped on the best cell) the impact is solely on the UE doing the decision and it can also be quickly corrected when e.g. the UE is paged or has data to transmit. In RRC Connected, in contrast, poor decisions will have significant impact on the network performance in the form increased handover failure ratio and reduced system capacity. Not to mention service failure at the UE. If, due to wrong relaxation, a UE is not being served by the best cell it will generate extra interference towards neighbor cells affecting other users.  Therefore, in RRC connected the requirements are much more stringent and the network needs better means to influence the UE triggered relaxations. In conclusion, the relaxation criteria for RRC connected should be designed with the peculiarities of this mode. A reuse of the Idle/Inactive solution will not be suitable. |
| CMCC | Yes |  |
| Samsung | No | Given RRM relaxation criteria for RRC Idle/Inactive is not determined yet, we don't understand what "reuse" means, and RAN2 cannot discuss on reusing of RRC Idle/Inactive.  Besides, we don't agree the argument that "there are no fundamental differences in the relaxation criteria for neighbor-cell measurements in the two RRC states". Contrary to idle/inactive, RRM measurement in RRC\_connected is configured by *MeasConfig* in dedicated manner. RAN2 haven't discussed relaxation criterion for connected considering *MeasConfig*.(e.g. whether to use different criterion per measurement object, and how to associate *s-MeasureConfig* with not-at-cell-edge criterion) |
| Xiaomi | Yes | We can focus on idle/inactive mode first, then the criterion for idle/inactive mode can be maximally reused and some redundant work can be avoided. |
| MediaTek | Not at the moment | Agree with Samsung that it’s unclear what’s being agreed to here. When we say ‘reuse’, what does this mean given that the criteria for Idle/Inactive have not been determined yet. |
| Nokia | Yes | We think that also R16 criteria could be used as written in the work item objectives. |
| ZTE | Yes |  |

**Summary for Q7:**

Among the 22 companies that have replied,

* 16 companies agree to reuse the same R17 RRM relaxation criteria being specified for RRC Idle/Inactive for relaxations in RRC Connected, if criteria-triggered relaxations in RRC Connected are adopted.
* 4 companies disagree, because they do not think autonomous relaxations by UE should be reused or can work in RRC Connected
* 2 companies think we should wait until it becomes clear what the exact criteria for RRC Idle/Inactive are determined.

Based on the outcome of this discussion, the rapporteur would suggest the following proposal for agreement:

**Proposal 5. If RAN2 agree that criteria-triggered relaxation is supported in RRC Connected, then the R17 RRM relaxation criteria being specified for RRC Idle/Inactive are reused for RRC Connected.**

# Conclusion

Based on the outcome of the discussion, the rapporteur would suggest the following proposals for agreement:

**Proposal 2. (15/21) If subscription based relaxations is adopted for RRC Idle/Inactive, network advertises in system information if it allows UEs with stationarity provisioned in their subscription to relax their RRM measurements.**

**Proposal 3. (16/22) If subscription based relaxations is adopted for RRC Connected, core network indicates UE’s stationarity to RAN during UE’s connection establishment.**

**Proposal 4. (16/23) In RRC Connected, if network configures relaxation criteria for UE, UE can trigger relaxations themselves when the configured relaxation criteria are met.**

**Proposal 5. If RAN2 agree that criteria-triggered relaxation is supported in RRC Connected, then the R17 RRM relaxation criteria being specified for RRC Idle/Inactive are reused for RRC Connected.**

The rapporteur would suggest the following proposal for further discussion at the meeting:

**Proposal 1. (12/23) Continue the discussion on whether RRM relaxations based on subscription information can be supported.**

# References

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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.
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20. R2-2104375\_[AT113bis-e][102][REDCAP] RRM Relaxations\_Phase 3, Qualcomm.