**3GPP TSG-RAN WG2 Meeting #113e R2-20xxxxx**

**Electronic Meeting, 25th Jan – 5th Feb 2021**

**Source: ZTE Corporation**

**Title: Email discussion 155 – RRM Relaxations**

**Agenda item:**  **x.x.x**

**Document for:** **Discussion and Decision**

# Background

After RAN2\_112e meeting, the following email discussion was agreed to progress the discussion on RRM relaxation solutions for Redcap UE:

* **[Post112-e][155][REDCAP] RRM relaxations (ZTE)**

 Scope: Progress on solutions for RRM relaxations

 Intended outcome: email discussion report

 Deadline: Long

Rapporteur would like to have following schedule for this email discussion to have enough time for preparing the summary report.

* Phase 1 (2021-01-06): Companies are invited to provide inputs and comments to questions.
* Phase 2 (2021-01-12): Rapporteur will provide draft summary with proposals, companies are invited to provide comments to the summary proposals.

# Contact information

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| Company  | Email address |
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# Background—Rel-16 RRM relaxation mechanism

## UE identification criteria (or triggering condition)

For Rel-16 RRM relaxation in power saving WID, on whether a UE can perform relaxed measurement, the spec has defined two triggering evaluation criteria: Low-mobility and not-at-cell-edge, the corresponding evaluation formulas are given as below (see details in TS 38.304). In addition, network can configure the triggering criteria independently (i.e. either low-mobility, or not-at-cell-edge, or both).

* **Low-mobility criterion:**

- (SrxlevRef – Srxlev) < SSearchDeltaP for a period of TSearchDeltaP;

Note: based on the fluctuation of serving cell’s RSRP.

* **Not-at-cell-edge criterion:**

- Srxlev > SSearchThresholdP, and,

- Squal > SSearchThresholdQ, if SSearchThresholdQ is configured,

Note: based on comparison between serving cell’s RSRP (or RSRP&RSRQ) with absolute threshold(s).

## Measurement relaxation methods

Basically, Rel-16 spec has defined two methods for measurement relaxation:

* Method 1: Relax measurements with longer intervals (scaling factor), defined in TS 38.133.
* Method 2: Stop measurements for up to 1 hour.

UE applies different relaxation methods based on low-mobility, not-at-cell-edge evaluation and cell reselection priority of target inter-freq, inter-RAT frequencies. The application of method 1&2 is briefly summarized in below table (see details in TS 38.304):

(Condition 1: serving cell fulfils Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ)

Table 3.2-1 Rel-16 RRM relaxation mechanism

|  |  |  |
| --- | --- | --- |
|  | Single condition is configured | Both triggering conditions are configured |
| low mobility | not-at-cell-edge | either one of conditions is met | both are met |
| Intra-freq measurement  |  Method 1 | Method 1 | Method 1 | Method 2 |
| equal or low priority of inter-freq, inter-RAT measurements |  Method 1 | Method 1 | Method 1 | Method 2 |
| high priority of inter-freq, inter-RAT measurements  | * Condition 1 is met:

>> Method 2 or no relaxing* otherwise:

>> Method 1  | * Condition 1 is met:

>> no relaxing* otherwise:

>> Method 1  | * Condition 1 is met:

>> no relaxing* otherwise:

>> Method 1  | Method 2 |

# Skeleton of RRM relaxation for Redcap

Regarding RRM relaxation for Redcap UEs, rapporteur lists all scenarios in below Table, and the progress of RAN2 discussion is also provided in the table.

Note: the terms “fixed or immobile UEs” and “slightly moving UEs” are excerpted from endorsed TP[24]

Table 4-1 RRM relaxation scenarios for Redcap UEs

|  |
| --- |
| **RRM relaxation scenarios for Redcap UEs**  |
|  | Fixed or immobile UEs | Slightly moving UEs |
| RRC\_IDLE and RRC\_INACTIVE | Neighbor cell measurement | Take Rel-16 RRM relaxation as a baseline, FFS on enhancement | Take Rel-16 RRM relaxation as a baseline, FFS on enhancement |
| Serving cell measurement | FFS | FFS |
| RRC\_CONNECTED | Neighbor cell measurement | Will be studied, FFS on solutions | Will be studied, FFS on solutions |
| Serving cell measurement | FFS | FFS |

In the summary [23] of offline #114 in last RAN2 meeting, there was a tentative proposal related to the number of relaxation levels for Redcap UEs:

**Proposal 7 (14/18): RAN2 will study ways and feasibility of supporting different relaxation levels for fixed UEs and slightly moving UEs.**

Rapporteur understands the original motivation of this proposal is that, for Redcap UEs, RAN2 will study/define different triggering criteria and relaxation mechanisms for “**fixed UEs**” and “**slightly moving UEs**”. However, during the last round of offline discussion, some companies showed different understandings of this proposal.

In this document, instead of discussing this high level question (e.g. number of relaxation levels), rapporteur would suggest we directly discuss the potential solutions for each scenario (i.e. focus on those FFS points in Table 4-1), so questions are provided for each scenario separately. Company who prefers unified solution can keep it in mind when providing the inputs. In addition, rapporteur will try to summarize the inputs to find if we can get unified solution in the end.

The previous RAN2 agreements are given as below for your reference.

RAN2\_112e Agreements:

1. The target REDCAP UE, considering mobility, is not limited to a fixed UE, but can also experience some low mobility, and this, during some “stationary” periods of time.
2. The RRM relaxation of REDCAP UEs is triggered based on measurements, as a baseline. Other triggering conditions for the “level-1” (still device at fixed location) UEs are not excluded, e.g. the possibility to signal their stationary property explicitly.
3. R16 NR RRM relaxation procedures are taken as a baseline to study further enhancements of neighbor cells RRM relaxation for REDCAP UEs in RRC IDLE/INACTIVE.
4. Relaxation of neighbor cells RRM measurements in RRC\_CONNECTED will be studied in this SI/WI

# General principles

As mentioned in section 3, the Rel-16 RRM relaxation mechanism mainly includes two parts:

* Part 1: UE identification criteria/triggering conditions (e.g. low mobility, not-at-cell-edge)
	+ Identify in which cases the UE can perform relaxed measurements;
* Part 2: Measurement relaxation methods (e.g. longer interval, stop measurements)
	+ Identify the detail methods for intra-freq, inter-freq, inter-RAT measurement relaxation.

So regarding RRM relaxation for Redcap UEs, the discussion is organized into two parts:

* Part 1: UE identification criteria/triggering conditions
* Part 2: Measurement relaxation methods.

Based on the experience of Rel-16 power saving discussion, RAN2 is mainly responsible for determining the solutions for UE identification criterion and inform RAN4 about the decision.

While for measurement relaxation methods, RAN2 can discuss potential and preferable solutions, but from RAN2’s point of view, it is hard to evaluate the power saving gain and risk of performance impact for each solution. So in any case, RAN4 should be consulted before making the final decision. Thus for providing guidance to future discussion, principle 1 is given as below:

**Principle 1: RAN2 is mainly responsible for discussing and deciding solutions for Part 1 (UE identification criteria). For Part 2 (measurement relaxation methods), RAN2 can discuss preferable solutions, but RAN4 should be consulted before making the final decision.**

**Q0-1: Do companies agree with above Principle 1 (if no, please provide your comments)?**

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| Company  | Agree/ Disagree | Comments |
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Another aspect is about the control of enabling RRM relaxation mechanism, in Rel-16 power saving, RRM relaxation is only supported for neighbour cell measurement in RRC\_IDLE/INACTIVE, and network can decide whether to enable the function by the presence/absence of the “*lowMobilityEvaluation*” and “*cellEdgeEvaluation*” configuration in system information.

Regarding RRM relaxation for Redcap UEs, rapporteur understands the same principle can also be applied, that whether to enable/disable the RRM relaxation function is within network’s control, which means we will not consider UE autonomously performing measurement relaxation without network awareness. For instance, network may want to disable RRM relaxation function during the period of deployment change, or load balancing.

**Principle 2: Irrespective of RRC state, whether to enable/disable RRM relaxation function for Redcap UEs is within network’s control.**

**Q0-2: Do companies agree with above Principle 2 (if no, please provide your comments)?**

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| Company  | Agree/ Disagree | Comments |
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# Neighbour cell RRM relaxation in RRC\_IDLE/INACTIVE

After RAN2\_112e meeting, RAN2 agreed to take Rel-16 RRM relaxation mechanism as a baseline for Redcap UEs in RRC\_IDLE/INACTIVE, and enhancements can be further studied.

1. R16 NR RRM relaxation procedures are taken as a baseline to study further enhancements of neighbor cells RRM relaxation for REDCAP UEs in RRC IDLE/INACTIVE.

As mentioned before, the Rel-16 NR RRM relaxation mechanism includes two steps:

* Step 1: Identify whether UE can perform RRM relaxation, by evaluating two criteria:
	+ low mobility criterion;
	+ not-at-cell-edge criterion;
* Step 2: Perform relaxed RRM measurement for intra-freq, inter-freq, inter-RAT measurements accordingly.

Based on company contributions, different enhancement solutions were proposed for both steps. So we can discuss them separately:

* **Part 1:** Applicability and enhancement to UE identification criteria (e.g. “low mobility”, “not-at-cell-edge” criteria):
* **Part 2:** Applicability and enhancement to measurement relaxation methods.

## UE identification criteria

* **Applicability of Rel-16 UE identification criteria**

In this section, we first discuss the applicability of Rel-16 UE identification criteria for Redcap UEs. As mentioned in section 3.1, in Rel-16, network can enable “low mobility criterion” and “not-at-cell-edge criterion” independently (e.g. only low mobility, only not-at-cell-edge, or both).

For Redcap UEs, according to SID and previous RAN2 agreements, RRM relaxation can be considered for both fixed UEs and slightly moving UEs. Generally, both of them belong to “low mobility” case. So different from Rel-16 non-Redcap UEs, it is straightforward that Redcap UEs who can perform RRM relaxation must fulfill “low mobility” criterion. So rapporteur thinks there is no need to consider case of which “only not-at-cell-edge” is configured.

More specifically, for Redcap neighbour cell RRM relaxation in RRC\_IDLE/INACTIVE, based on Rel-16 mechanism, we can narrow-down the cases into followings:

* Case 1: only “low mobility” criterion is configured (i.e. irrespective of UE’s location)
* Case 2: both “low mobility” and “not-at-cell-edge” criteria are configured (i.e. differentiate “low mobility + cell center” and “low mobility + cell edge” UEs);

**Q1: For Redcap neighbour cell RRM relaxation in RRC\_IDLE/INACTIVE, only above two Cases from Rel-16 mechanism need to be considered?**

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| Company  | Agree/ Disagree | Comments |
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* **Enhancement to Rel-16 UE identification criteria**

Regarding enhancement solutions to UE identification criteria for Redcap UEs, based on company contributions and online/offline comments, following enhancements have been proposed:

* Enhancement 1: Introduce additional SsearchDeltaP\_stationary threshold to support 2 level speed evaluation (i.e. stationary, low mobility); [13]
* Enhancement 2: Take into account of beam switching in low mobility evaluation; [13][20]
* Enhancement 3: UE determines its stationary property based on subscription information (e.g. USIM);
* Other?

Enhancement 1&2 are optimization of Rel-16 low mobility criterion. While Enhancement 3 is based on UE’s subscription information instead of measurement results of serving cell.

Companies are invited to show your views on the proposed enhancement solutions.

Note: This is try to collect potential preferable enhancements that can be captured in TR. Proponent of each solution are encouraged to provide the Pros and Cons and spec impact in your inputs.

**Q2: Companies are invited to provide your preference to the enhancement solutions of UE identification criteria for neighbour cell RRM relaxation in RRC\_IDLE/INACTIVE?**

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| Company  | Preferred enhancement(s)  | Comments |
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## Enhancement to measurement relaxation methods

Based on contributions, following enhancements have been proposed by companies.

* Enhancement 1: UE can stop measurements on neighbour cells for T (T>>1) hours; [17][18]
* Enhancement 2: Enabling further relaxation via reducing the number of monitored RS; [15][20]
* Enhancement 3: UE only perform measurements on a number of dedicated intra-freq, inter-freq cells; [18]
* Enhancement 4: Minimize the number of measured frequencies; [21]
* Other?

Note: This is try to collect potential preferable enhancements that can be captured in TR. RAN4 will be consulted before making the final decision. Proponent of each solution are encouraged to provide the Pros and Cons and spec impact in your inputs.

**Q3: Companies are invited to provide your preference to the enhancement solutions of measurement relaxation method for neighbour cell RRM relaxation in RRC\_IDLE/INACTIVE?**

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| --- | --- | --- |
| Company  | Preferred enhancement(s)  | Comments |
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# Neighbour cell RRM relaxation in RRC\_CONNECTED

Neighbour cell RRM relaxation in RRC\_CONNECTED is not supported in Rel-16. However, considering Redcap stationary UEs may not have handover requirement, thus RAN2 has agreed to study this scenario in this SI/WI. As indicated in Table 4-1, for neighbour cell measurements relaxation in RRC\_CONNECTED mode, following scenarios need to be discussed:

* Case 1: Fixed or immobile devices in RRC\_CONNECTED;
* Case 2: Slightly moving devices in RRC\_CONNECTED.

Companies are invited to show your preference that in which cases (e.g. Case 1~2) RRM relaxation can be performed (e.g. without significant performance impact).

**Q4: Companies are invited to provide your preference on support of neighbour cell RRM relaxation in different scenarios.**

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| --- | --- | --- |
| Company | **RRC\_CONNECTED** | Comments |
| Fixed or immobile(Yes or No) | slightly moving(Yes or No) |
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In [17], it is observed that it is unlikely Redcap devices stay for long periods of time in RRC\_CONNECTED, and RRC\_CONNECTED power consumption may already be reduced significantly through other means, e.g., lower supported bandwidth, so we should focus on RRM relaxation in RRC\_IDLE/INACTIVE states. Also in [], it is proposed to consider RRC\_CONNECTED RRM relaxation as low priority because it can yield power saving gain with risk of degrade network performance.

Thus companies are invited to show your views on whether RRM relaxation in RRC\_CONNECTED can be considered as low priority.

**Q5: Compare to RRC\_IDLE/INACTIVE, do companies agree that RRM relaxation in RRC\_CONNECTED can be considered with low priority?**

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| Company  | Agree/ Disagree | Comments |
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## UE identification criteria

Based on company contributions and online/offline comments, following solutions have been proposed:

* Solution 1: UE reports “stationary” property to network in Msg5; [2]
* Solution 2: Network provides (e.g. low mobility, not-at-cell-edge) evaluation parameters to UE via dedicated signalling; [15]
* Solution 3: AMF sends “stationary” indication to gNB (based on UE subscription); [17]
* Other?

Companies are invited to show your views on the solutions.

Note: This is try to collect potential preferable solutions that can be captured in TR. Proponent of each solution are encouraged to provide the Pros and Cons and spec impact in your inputs.

**Q6: Companies are invited to show your preference to the solutions of UE identification criteria for neighbour cell RRM relaxation in RRC\_CONNECTED?**

(Can differentiate “fixed UEs” and “slightly moving UEs” if needed)

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| Company  | Preferred solution(s) | Comments |
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## Measurement relaxation methods

Regarding measurement relaxation methods, rapporteur understands Rel-16 IDLE/INACTIVE relaxation methods cannot be directly reused, because for RRM measurements in RRC\_CONNECTED mode, there is no *Sintrasearch*, *Snonintrasearch* thresholds, and there is no priority configured for measured target frequencies. In addition, the relaxed measurement requirements defined in TS 38.133 are not applicable to connected mode measurements.

Based on company contributions and online/offline comments, following solutions have been proposed so far:

* Solution 1: Ask RAN4 to define relaxed measurement intervals;
* Solution 2: Network does not configure RRM configuration for mobility purpose; [6]
* Solution 3: Perform measurement on single RS type (SSB or CSI-RS, not both) during relaxing period; [15]
* Other?

Companies are invited to show your views on the solutions.

Note: This is try to collect potential preferable solutions that can be captured in TR. RAN4 will be consulted before making the final decision. Proponent of each solution are encouraged to provide the Pros and Cons and spec impact in your inputs.

**Q7: Companies are invited to show your preference to the solutions of RRM relaxation mechanism for neighbour cell RRM relaxation in RRC\_CONNECTED?**

(Can differentiate “fixed UEs” and “slightly moving UEs” if needed)

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| Company  | Preferred solution(s) | Comments |
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# Serving cell RRM relaxation

Serving cell RRM relaxation is not supported in Rel-16 due to the concern of performance impact. So far, RAN2 haven’t concluded whether to support serving cell RRM relaxation for Redcap UEs because of the different views from companies. In [9][15], it is observed that serving cell relaxation may lead to too late cell reselection(or handover), and considering RRM relaxation of neighbour cell is based on the results of serving cell, due to relaxed serving cell measurement, UE may continue relaxing neighbour cell measurement even if the relaxation criteria is not fulfilled any more, which leads to bad mobility performance. During email disc [16], some companies also commented there is limited power saving gain with serving cell measurement relaxation, as the UE has to monitor serving cell for paging reception, and by introducing eDRX, the measurement interval of serving cell is already relaxed. However, in [14], it is observed UE can achieve about 10% power saving gain if Redcap UEs to process SSBs in serving cell once per 5.12s (every four paging cycles). And in [13][14], it is observed that stationary UE may not moving, so there may be no bad impact to mobility performance.

In this section, rapporteur would suggest to first discuss the necessity of supporting serving cell measurement relaxation for Redcap UEs. As indicated in Table N, the following scenarios are involved:

* Case 1: Fixed or immobile devices in RRC\_IDLE and RRC\_INACTIVE;
* Case 2: Slightly moving devices in RRC\_IDLE and RRC\_INACTIVE;
* Case 3: Fixed or immobile devices in RRC\_CONNECTED;
* Case 4: Slightly moving devices in RRC\_CONNECTED.

Companies are invited to show your preference that in which cases (e.g. Case 1~4) serving cell RRM relaxation can be performed (e.g. consider power saving gain vs performance impact from RAN2 perspective).

**Q8: Companies are invited to show your preference on support of serving cell RRM relaxation in different scenarios.**

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| --- | --- | --- | --- |
| Company | **RRC\_IDLE/RRC\_INACTIVE** | **RRC\_CONNECTED** | Comments |
| Fixed or immobile(Yes or No) | slightly moving(Yes or No) | Fixed or immobile(Yes or No) | slightly moving(Yes or No) |
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If “serving cell RRM relaxation” is supported, then similar to neighbor cell measurement relaxation, we need to further discuss the triggering condition for serving cell RRM relaxation. As we can see, the Rel-16 low mobility criterion or not-at-cell-edge criterion are both evaluated based on the measurement results of serving cell, and serving cell RRM relaxation is not supported in Rel-16. Therefore, when the quality of serving cell fluctuates, the UE may evaluate the triggering criteria is not fulfilled immediately, and switches from “RRM relaxed mode” to “normal RRM mode”, this can avoid impact to cell-reselection performance.

For Redcap UEs, we need to consider whether it is still appropriate to use “serving cell measurement result” to define the triggering condition? For instance, the wearable device may evaluate itself to be in “stationary” state at night, but it may move at any time, thus if serving cell measurement is relaxed, then the UE switches from “RRM relaxed mode” to “normal RRM mode” may be delayed as well.

Based on the agreements made last meeting, RRM relaxation for Redcap UEs can be triggered based on measurements or UE property… etc. So companies are invited to show your views on how to define the triggering condition for serving cell RRM relaxation.

* Option 1: Serving cell relaxation is triggered based on the evaluation of serving cell measurement results;
* Option 2: Serving cell relaxation is triggered based on UE’s stationary property (e.g. derived from UE subscription information);
* Other?

Note: This is try to collect potential preferable solutions that can be captured in TR (if serving cell RRC relaxation is supported). Proponent of each solution are encouraged to provide the Pros and Cons and spec impact in your inputs.

**Q9: If “serving cell RRM relaxation” is supported, which option do you prefer to define the triggering condition for serving cell RRM relaxation?**

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| Company  | Preferred option(Option 1, 2…) | Comments |
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As mentioned in section 3.2, the Rel-16 measurement relaxation mainly includes two methods (e.g. longer interval, stop measurement for 1hour), so companies are invited to provide your preferred solution for serving cell measurement relaxation.

Note: This is try to collect potential preferable solutions that can be captured in TR (if serving cell RRC relaxation is supported). RAN4 will be consulted before making the final decision. Proponent of each solution are encouraged to provide the Pros and Cons and spec impact in your inputs.

In addition, as commented by companies during previous RAN2 meeting. For IDLE/INACTIVE Redcap UEs, the UE needs to monitor Paging message, thus typically, UE needs to wake up before paging occasion to detect/measure the best SSB beam for paging reception. So when providing serving cell measurement relaxation solution for IDLE/INACTIVE states UEs, please take this into consideration, and indicate whether it would need any change of paging monitoring behaviour.

**Q10: If answers “Yes” to any scenario in Q8, please provide your preferred solution for serving cell RRM relaxation. E.g. stop measurement, or increase measurement interval…etc.**

Note: When providing solutions, please also indicate whether it would need any change of basic IDLE/INACTIVE behaviour (e.g. paging monitoring).

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| Company  | Preferred solution for serving cell measurement relaxation(Note: can differentiate Case 1~4 if needed) |
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# Other

Besides the previous questions, do companies identify any issue that needs discussion?

**Qn: Besides previous questions, any other issue that needs discussion?**

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| --- | --- |
| Company  | Comments |
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# Summary

To be provided later…

# Reference

RAN2\_111e

1. R2-2006607 Power saving enhancements for RedCap UEs Qualcomm Inc discussion Rel-17 FS\_NR\_redcap
2. R2-2006662 RRM relaxation for stationary devices Samsung discussion Rel-17 FS\_NR\_redcap
3. R2-2006693 RRM relaxation for power saving vivo, Guangdong Genius discussion Rel-17 FS\_NR\_redcap
4. R2-2006748 Use cases target to extend paging DRX cycle and relax measurements for stationary devices Intel Corporation discussion Rel-17 FS\_NR\_redcap
5. R2-2006788 Discussion on RRM relaxation OPPO discussion Rel-17 FS\_NR\_redcap
6. R2-2006902 Consideration on RRM relaxation for Redcap UE ZTE Corporation, Sanechips discussion Rel-17 FS\_NR\_redcap
7. R2-2006913 Reducing power consumption in RedCap devices Ericsson discussion FS\_NR\_redcap
8. R2-2007111 Impact of power-saving aspects on RedCap UEs Apple discussion Rel-17 FS\_NR\_redcap
9. R2-2007347 RRM measurement relaxation for REDCAP UE Huawei, HiSilicon discussion Rel-17 FS\_NR\_redcap
10. R2-2007471 RRM relaxation for stationary UE with reduced capability Lenovo, Motorola Mobility discussion Rel-17
11. R2-2007561 Power saving and battery lifetime enhancement for REDCAP UE Nokia, Nokia Shanghai Bell discussion Rel-17 FS\_NR\_redcap
12. R2-2007745 Considerations on RRM for reduced capability UEs LG Electronics France discussion Rel-17 FS\_NR\_redcap

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1. R2-2009022 Relax measurement for stationary and low mobility devices Intel Corporation discussion Rel-17 FS\_NR\_redcap
2. R2-2009087 RRM relaxation for power saving vivo, Guangdong Genius discussion Rel-17 FS\_NR\_redcap
3. R2-2009106 Discussion on RRM relaxation OPPO discussion Rel-17 FS\_NR\_redcap
4. R2-2009364 Summary of email discussion 915 - UE power saving features CATT discussion Rel-17 FS\_NR\_redcap
5. R2-2009620 RedCap power saving enhancements Ericsson discussion FS\_NR\_redcap
6. R2-2009877 RRM relaxation for stationary UE with reduced capability Lenovo, Motorola Mobility discussion Rel-17
7. R2-2009917 Power saving and battery lifetime enhancement for REDCAP UE Nokia, Nokia Shanghai Bell discussion Rel-17 FS\_NR\_redcap
8. R2-2009935 eDRX and RRM measurement relaxation for RedCap UE Huawei, HiSilicon discussion Rel-17 FS\_NR\_redcap
9. R2-2010580 RRM relaxation for stationary RedCap Ues LG Electronics Inc. discussion Rel-17 FS\_NR\_redcap
10. R2-2010592 RRM relaxation for RedCap devices Samsung Electronics discussion Rel-17
11. R2-2010787 Summary of offline 114 - RedCap power saving CATT discussion Rel-17 FS\_NR\_redcap

RAN2 endorsed TP

1. R2-2011165 TP for TR38875 Ericsson discussion FS\_NR\_redcap