3GPP TSG-RAN WG2 Meeting #112 electronic draftR2-2010787

Online, November 2nd – 13th, 2020

Source: CATT

Title: Summary of [AT112-e][114][REDCAP] Power saving (CATT)

Agenda Item: 8.12.3

Document for: Discussion and Decision

# Introduction

This contribution provides a summary of the following email discussion:

* [AT112-e][114][REDCAP] Power saving (CATT)

Scope: Continue the proposals from [R2-2009364](file:///C:\Data\3GPP\Extracts\R2-2009364%20Summary%20of%20email%20discussion%20915%20-%20Summary%20-%20final.docx), apart those on eDRX cycle in Inactive longer than 10.24s and on RRM relaxation for serving cell

Intended outcome: summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals that require online discussions

Initial deadline (for companies' feedback): Tuesday 2020-11-11 05:00 UTC

Initial deadline (for rapporteur's summary in R2-2010787): Tuesday 2020-11-10 11:00 UTC

Proposals marked "for agreement" in R2-2010787 not challenged until Tuesday 2020-11-10 23:00 UTC will be declared as agreed by the session chair and can be considered for inclusion in the TP for the TR. For the rest there is a (little) chance to continue online in the final CB session on Friday 2020-11-13.

# Discussion

# eDRX cycle in idle and inactive

In this section we aim at agreeing proposals based on the outcome of the email discussion [Post111-e][915][REDCAP] UE power saving features [1]. Per the scope of this offline we will only focus on non-controversial issues identified after RAN2#111-e, namely:

* For RRC\_IDLE, should the eDRX cycle be extended beyond 10.24s, and if yes, what should be the maximum value?
* What baseline mechanism should be used when NR eDRX cycle is less or equal to 10.24s?

### Maximum eDRX cycle in RRC\_IDLE

In LTE, the maximum value of eDRX cycle in RRC\_IDLE is 2621.44s (almost 44 min) for eMTC UEs and 10485.76s (max of Hyper SFN cycle, almost 3 hours) for NB-IOT UEs. In addition, eMTC UEs can connect to 5GC so 5GC already supports extended DRX parameters up to 2621.44s in Registration procedure so there is no additional work expected for CN to support this value.

From companies’ inputs in [1] the following summary was derived:

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| **Summary:**  **Do you agree to extend the eDRX cycle in RRC\_IDLE beyond 10.24s for REDCAP UEs?**  23 companies provided answers to this question.   * Yes: 16/23 + one company supports “yes” only if it is clarified that we aim to support years long battery life for REDCAP UEs. * No: 4/23   The answers essentially end-up discussing the requirement to support years-long battery life for REDCAP UEs: those companies supporting extending the eDRX cycle in RRC\_IDLE beyond 10.24s assume this requirement should be supported (e.g. referring to TS22.104), whereas opponents claim this requirement is not in the scope of the WID, and may impact the latency requirements of REDCAP UEs, which may not be as loose as NB-IoT and eMTC UEs.  From the above split of answers, it is clear that a large majority of companies support the years-long battery life requirement for REDCAP UEs which calls for extending the eDRX cycle in RRC\_IDLE beyond 10.24s for REDCAP UEs.  **Proposal 1: Supporting years-long battery life is a requirement of REDCAP UEs**  **Proposal 2: The eDRX cycle in RRC\_IDLE is extended beyond 10.24s for REDCAP UEs.**  **Do you agree to extend the eDRX cycle in RRC\_IDLE up to 2621.44s for REDCAP UEs?**  18 companies provided answers to this question.   * Yes: 17/18 amongst which 5 companies think the 2621.44s value should be considered as baseline while exact value can be further refined e.g. during the WI * No: 1/18, suggesting 10485.76s   Based on the above, it is proposed:  **Proposal 3: The eDRX cycle in RRC\_IDLE is extended up to 2621.44s for REDCAP UEs, as a baseline.** |

Given the large support for the above proposals, it is proposed to agree them altogether.

**Companies who do not agree with any of the above proposals are invited to express their concerns.**

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| Company | Proposal | Comments |
| vivo | P1-P3 | We are not convinced that long paging DRX cycle beyond 10.24s is needed. Normally, RedCap UE should not be delay-tolerant for paging. But we are open to first discuss the potential use cases for this long DRX cycle beyond 10.24s.  Regarding battery life for RedCap UEs, some existing power saving features could be considered, e.g. MICO like PSM has been already introduced from Rel-15. |
| Qualcomm | P1-P3 | These three proposals are all based on the assumption that multi-year battery life is required by some RedCap use case (industrial sensor). But we think this assumption needs a closer look.  First, when it is mentioned in the Justification section of the RedCap SID, which is more of a guideline than a requirement, no assumption on the corresponding battery capacity is given. And unlike wearables, industry sensors have a wide range of form factors and hence may use batteries of any sizes. As engineers, we all know specifying battery life without an assumption on battery size is senseless and basically invalidates that requirement.  Second, RedCap is not intended for the same use cases as eMTC/NB-IoT devices. Among the ~30 use cases specified in TS 22.104, traffic periods (aka target transfer interval in the TS) in most of them are 1s or less. The use case with the maximum traffic period is 100ms ~ 60s, with an end-to-end latency less than the traffic period. To satisfy this requirement, we believe the maximum paging cycle can’t be longer than the low bound of the latency requirement.  Therefore, we can conclude that there is really no critical requirement to extend paging cycle beyond the current maximum of 10.24 sec. Even though eDRX cycles longer than 10.24 sec is already supported by NR core network, we, as a UE chip vendor, do not want to include unnecessary features/enhancements in RedCap, because development and testing all add to costs and RedCap chips are more cost sensitive, especially those for industrial sensors. |
| Apple | We agree P1-P3, but…. | P1 is a little too restrictive. RedCap UEs cater to a wide range of application needs and so the devices have very wide range of operation requirements depending on the application. A better proposal would be “ **“RAN2 to design assuming that atleast some RedCap UEs require** **years-long battery life”**  While we sympathize with Qualcomm’s reasoning on traffic periods and end-to-end latency (esp for wearables), making an agreement by generalizing this for all RedCap, esp at study item phase is narrowing this too early without proper discussion/evaluation. |
| OPPO | P1-P3 | We are concerned about the impact of such long eDRX cycle on the paging latency. Redcap UEs are not intended for the same use cases as eMTC/NB-IoT devices, and we don’t think eDRX cycle should be extended above 10.24s for RedCap UEs. |
| Ericsson | P2/3 | There is a clear use case for multi-year battery life described in the SID (IWSN), thus we agree to P1. In our understanding this scenario was discussed when drafting the SID and the purpose is to make multi-year lifetime possible for some RedCap use cases (e.g. some IWSN cases). Of the solutions discussed so far, the only practical mean to realize this is eDRX. Such feature can be optional for RedCap UEs to support, and NW should not configure it in any case if short downlink latency is required.  Thus, to realize the requirements for all RedCap use cases to be studied, from RAN perspective it would be required to extend the eDRX cycle beyond 10.24 s. The use case exists regardless of the RRC state – we do not see the motivation to separate the discussion whether to extend or not based on RRC state from RAN2 point of view.  At the SI phase we think RAN2 should capture the analyses of both/all presented solutions in TR. We further think RAN2 should recommend extension > 10.24 s for both states at the end of WI. Extension beyond 10.24 s then requires communicating RAN2 preference to SA2/CT1 *regardless of the RRC state* as eDRX functionality is not currently allowed for NR.  Therefore, at this point we propose to capture descriptions of the solutions for RRC\_IDLE and RRC\_INACTIVE in the TR and continue the discussion on the possible RAN2 recommendation for a possible WI phase.  The exact length of the extension for a particular state can be decided in the normative phase – it is not clear at this point why it should be exactly 2621.44 s. |
| Sharp |  | We agree with P1-P3. For P1, share the same view with Apple that the wording can be clearer. |
| Nokia | P1 | We think that it is not RAN2 topic to discuss on battery life requirement for REDCAP UEs. Such aspects are already described in the SID. |
| Sequans | P1-P3 | Agree with QC’s comments. In addition, scenarios that specify multi-year battery life, such as IWSN also specify very short latencies, which are incompatible even with the eDRX values already specified. Scenarios that allow large latencies do not require multi-year battery life, and so the added complexity of supporting long periods of eDRX is not required. |
| Convida |  | We support extend eDRX beyond 10.24s. As mentioned by Apple, RedCap UEs have very wide range of operation requirements depending on the application. Multi-year battery life requirement described in SID and Table 5.2-2 of TS 22.104 is one of them. We think the traffic period requirements mentioned by Qualcomm and OPPO are for uplink not for downlink. |

### eDRX mechanism when cycle ≤ 10.24s

A first aspect to clarify is what should be the lowest eDRX value for RRC\_IDLE and RRC\_INACTIVE. If we follow the LTE principle, there is only one value lower than 10.24s, i.e. 5.12s.

From companies’ inputs in [1] the following summary was derived:

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| **Summary:**  **Do you agree the lowest value of eDRX cycle is 5.12s for RRC\_IDLE and RRC\_INACTIVE REDCAP UEs?**  23 companies provided answers to this question.   * Yes: 22/23 * No: 1/23   Except one company supporting 2.56s as minimum value, all companies support 5.12s as lowest value of eDRX cycle for RRC\_IDLE and RRC\_INACTIVE.  **Proposal 4: The lowest value of eDRX cycle is 5.12s for RRC\_IDLE and RRC\_INACTIVE REDCAP UEs.**  **Proposal 5: For UE in RRC IDLE/INACTIVE and eDRX cycle is less than 10.24s, paging monitoring is based on eDRX cycle and PTW, PH, if any, are not used.**  23 companies provided their view on the above proposal.   * Yes: 22/23 * 1/23: Agree that PTW and PH do not need to be used, but the actual T used in the calculation in TS 38.304 depends on whether the UE is in RRC\_IDLE or RRC\_INACTIVE, exact details should be specified during the normative phase.   **Proposal 6: For UE in RRC IDLE and eDRX cycle is equal to 10.24s:**   * **If eDRX cycle > 10.24s is not supported (Proposal #2 is not agreed), paging monitoring is based on eDRX cycle (taking eDRX cycle as T in PF/PO formula);** * **If eDRX cycle > 10.24s is supported (Proposal #2 is agreed), paging monitoring involves PTW, PH, similar to the LTE ‎eDRX mechanism beyond 10.24s**   23 companies provided their view on the above proposal. All companies agree with the proposal. |

**Companies who do not agree with any of the above proposals are invited to express their concerns.**

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| Company | Proposal | Comments |
| vivo |  | Clarification on P5:  I assume the intention is only to avoid the use of PTW and PH. For eDRX cycle, i.e. 5.12s, it could be used for calculation of paging monitoring. |
| Apple | **No to P4**, atleast some re-wording or clarification is needed. | Currently we have NR DRX ranging upto 2.56sec. We can start eDRX with 5.12 sec, BUT, the current specification requires that the UE follows the RAN paging cycle if it is shorter than the UE requested (and NAS agreed) paging cycle. So starting with 5.12sec means that RedCap UEs which require/request 2.56sec would need to follow shorter RAN paging cycle even if NAS agrees to 2.56sec DRX.  While P5 tries to clarify that UE uses the eDRX cycle over RAN paging cycle, without including 2.56sec into this, it does not work. We can try to clarify here.  Also, while RAN2 has not yet discussed, we think reception of emergency broadcast is applicable to “some” RedCap UEs like wearables, and from this angle 2.56sec eDRX is needed to satify the 4sec reception time.  We think 2.56sec should be part of eDRX, and in stage-3 we can clarify how to implement the signaling in RAN2 (and CT1 if needed). |
| Ericsson | P5 | We still think P5 should be clarified: In RRC\_INACTIVE the monitoring depends on the eDRX cycle configured by CN and the RAN paging cycle configured by RAN. In RRC\_IDLE the monitoring depends (only) on the eDRX cycle configured by CN. |
| Facebook | P4 (No) | We agree with Apple on the need to reduce minimum eDRX cycle to 2.56s. This provides a better flexibility for wearables in optimizing power saving features while meeting the latency requirements for some use cases as discussed in [R2-2009532](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_112-e/Docs/R2-2009532.zip) |

# RRM relaxation for stationary devices

### Scope and identification of stationary Ues

Different levels of mobility were proposed in [1] for REDCAP UEs based on contributions and on-line comments from RAN2#11-e GTW session:

* Level 1: still device at fixed location (e.g. fixed static sensor)
* Level 2: moving (e.g. rotary) device at a fixed location (e.g. camera, robot)
* Level 3: temporarily fixed device (e.g. smart watch at night)
* Level 4: device is moving around slowly (e.g. medical wearables)

From companies’ inputs in [1] the following summary was derived:

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| **Summary:**  **Does the scope of “stationary” only include Level #1, or includes up to Level #2, or #3 or #4 (low) mobility levels?**  23 companies provided answers to this question.   * Level 4: 21/23 * Level 3: 5/23 * Level 1/2: 1/23   A large majority of companies support including all 4 mobility levels in the study. Three companies question whether level 4 is different from what is already considered as low mobility in Rel-16. One company comments that levels 3/4 can be considered as low mobility during period of time but can also experience high mobility (e.g. wearables). Rapporteur thinks that this would then fall in the level 3 category. One company would restrict the mobility scope to level 1 only in RRC\_CONNECTED, if supported, but that can be further discussed in Section 2.2.4.  In the end the common view is that the target REDCAP UE, considering mobility, is not limited to a fixed UE, but can experience some low mobility, and this only during some “stationary” periods of time.  **Proposal 7: 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.**  **How many relaxation levels would you consider to address the above scope of mobility?**  23 companies provided answers to this question.   * 1 relaxation level: 6/23 (we interpret “no level” answers as 1 level i.e. stationary/non-stationary) * 2 relaxation levels: 16/23 * More: 0   A majority of companies support studying 2 relaxation levels, allowing distinguishing fixed UEs from slightly moving UEs. One company thinks we should rather focus on the configuration flexibility and study when/if it is possible for NW understand that there are “truly fixed” UEs. While rapporteur agrees with the intention, we think this is precisely the purpose of this question, i.e. based on the target relaxation levels we can study the feasibility of associated triggers and configurability.  **Proposal 8: RAN2 will study ways and feasibility of supporting different relaxation levels for fixed UEs and slightly moving UEs.**  There are essentially two main options for how the “stationary” criterion is identified:   * Option 1: a UE non-mobility attribution (subscription information) * Option 2: evaluated by criterions based on measurements   **Which of Option 1 or 2 do you prefer?**  22 companies provided answers to this question.   * Option 1: 2/22 * Option 2: 17/22 * Both: 3/22   A majority of companies support identifying stationary UEs based on measurements rather than based on subscription information, main argument being that the latter would not allow supporting the range of mobility levels from Section 2.2.1. Few companies would also support using both criterions. Based on the majority views, we suggest:  **Proposal 9: The RRM relaxation of REDCAP UEs is triggered based on measurements.** |

**Companies who do not agree with any of the above proposals are invited to express their concerns.**

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| Company | Proposal | Comments |
| vivo | P9 | We are OK to agree P9 as the baseline.  Furthermore, for “true stationary” UEs, we assume option 1 could be also considered as an alternative to trigger relaxation. Details could be discussed in WI. In this way, we prefer to change P9 as:  **The RRM relaxation of REDCAP UEs could be triggered based on measurements, other triggering conditions for “true stationary” UEs are not excluded.** |
| Qualcomm | P9 | We wonder whether P9 is necessary, if P8 is agreed. If it is, then we prefer keeping both options. It is more power efficient for level 1 UEs (maybe level 2 UEs too) if they can signal their stationarity explicitly. |
| OPPO | P8 | We don’t want to increase UE’s complexity in evaluating RRM relaxation and we prefer to have a unified relaxation level. |
| Intel | P9 | Agree vivo’s suggestion on the proposal. |
| Nokia | P8 | We think that it would be sufficient to study stationary and non-stationary use cases to reduce the complexity. |
| Sequans |  | We prefer option 2 but are fine to keep both options. W.r.t to P8 we support studying 2 levels, assuming 1 can be agreed in WI if deemed better, no change in wording is needed. |

### RRM relaxation in RRC\_IDLE/INACTIVE

Given RRM relaxation of the serving cell was removed from this offline, we focus here one the RRM relaxation for neighbor cells, which is already supported in legacy. As discussed in [1], the very first thing to decide is whether we introduce any enhancements to R16 RRM relaxation procedure in support of neighbor cells measurement relaxation of REDCAP UEs. Hence we have two options:

* Option 1: Support studying R16 NR RRM relaxation procedures (taken as baseline) enhancements
* Option 2: No support (nothing new is needed on top of R16).

From companies’ inputs in [1] the following summary was derived:

**Q2.3: Which of Option 1 or 2 do you prefer?**

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| **Summary:**  **Which of Option 1 or 2 do you prefer?**  23 companies provided answers to this question.   * Option 1: 22/23 * Option 2: 1/23   A vast majority of companies support studying R16 NR RRM relaxation procedures (taken as baseline) enhancements for REDCAP UEs.  **Proposal 10: RAN2 takes R16 NR RRM relaxation procedures as a baseline to study further enhancements for REDCAP UEs.** |

**Companies who do not agree with the above proposal are invited to express their concerns.**

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| Company | Comments |
| vivo | We think the enhancement could happen in RAN2 and RAN4. Thus, we prefer to change it to:  **Taking R16 NR RRM relaxation procedures as a baseline to study further enhancements for REDCAP UEs.** |
| Huawei, HiSilicon | It is discussed under 2.2.2 RRM relaxation in RRC\_IDLE/INACTIVE, to make it more explicitL:  **…R16 NR RRM relaxation procedures as a baseline to study further enhancements in RRC\_IDLE/INACTIVE for REDCAP UEs.** |
| Nokia | We agree with Huawei. In addition it would be good to clarify that neighbor cell relaxations are studied. |
|  |  |

### RRM relaxation in RRC\_CONNECTED

This would be a new feature as it is currently supported neither in LTE nor in NR.

As a first step, we primarily focus on relaxing RRM measurements of neighbor cells, since serving cell relaxation should be first solved in Idle/Inactive.

In [1] the below three options were listed based on companies’ contributions:

* Option 1: There is benefit in relaxing RRM measurements of neighbour cells in RRC\_CONNECTED for REDCAP UEs and associated specification and performance impacts should be studied.
* Option 2: There is benefit in relaxing RRM measurements of neighbour cells in RRC\_CONNECTED but it can be all left to NW implementation/configuration and there is no need to study anything.
* Option 3: There is no benefit in relaxing RRM measurements of neighbour cells in RRC\_CONNECTED so there is no need to study anything.

From companies’ inputs in [1] the following summary was derived:

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| **Summary:**  **Which option do you prefer?**  23 companies provided answers to this question.   * Option 1: 8/23 * Option 1/2: 5/23 * Option 2: 5/23 * Option 2/3: 4/23 * Option 3: 1/23   From the cumulated answers “1”, “1/2”, and “2”, a clear majority of companies (18/23) see benefit in relaxing RRM measurements of neighbor cells in RRC\_CONNECTED for REDCAP UEs. On the other hand the cumulated answers “2” and “2/3” show some support (9/23) for not specifying anything for that, and no RAN2 work is foreseen. Given the comments from companies answering “1/2” seem to also allow leaving this feature to network implementation, Rapporteur concludes that there are split views on whether RAN2 needs to specify anything in support of RRM measurements of neighbor cells in RRC\_CONNECTED. |

In order to progress this issue we can simplify the choice to only two options and check again companies’ views:

* Option 1: There is benefit in relaxing RRM measurements of neighbour cells in RRC\_CONNECTED for REDCAP UEs and it has specification impacts.
* Option 2: There is no specification impact (and so no RAN2 work) foreseen by relaxing RRM measurements of neighbour cells in RRC\_CONNECTED for REDCAP UEs because it is either unnecessary (no benefit) or can be all left to NW implementation/configuration

**Q1: Which option do you support?**

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| Company | Option | Comments |
| CATT | 2 | 1) The time spent in RRC\_CONNECTED for redcap UEs is expected to be short. 2) RRM is not the main contributor to UE power consumption in RRC\_CONNECTED. 3) Anyways, we also agree that the network can reduce the RRM measurement objects via dedicated signaling to reduce UE power consumption on RRM |
| vivo | 1 | Actually, in study phase of Rel-16 Power Saving, RRM relaxation in connected mode has also been studied and evaluated, and it was also captured in the TR.  Here, as summarized by rapporteur, a clear majority of companies see benefit in relaxing RRM measurements of neighbor cells in RRC\_CONNECTED for REDCAP UEs. Could we first capture this observation in the TR?  For the above options, we assume relaxation could be studies at least for stationary UEs, which has almost no impact on mobility performance. Network implementation approach could achieve some kind of relaxation, but the power saving gain is very limited. What could be further relaxed need to be discussed in RAN4, e.g. similar as in Rel-16 NR or NB-IoT. This anyway needs some specification impacts, at least in RAN4. |
| Qualcomm | 1 |  |
| Apple | 1 |  |
| Lenovo | 1 | For stationary UE with at least level 1/2/3, the relaxed RRM neighbor cell measurement could introduce some power saving for UE. |
| OPPO | 1 |  |
| Samsung | 2 | RedCap device would stay RRC\_INACTIVE or RRC\_IDLE for most of time. Besides, even if more energy consumption is required in RRC\_CONNECTED, NW should manage this carefully, avoiding network performance degradation. To this end, some UE assistance information may be required. |
| Ericsson | 2 | Agree with CATT |
| Sharp | 1 |  |
| Huawei, HiSilicon |  | RRM measurements relaxation for RRC\_CONNECTED should be considered under network control without system performance degradation. As a majority of companies see benefit in relaxing RRM measurements of neighbor cells, we understand the power saving gain only depending on NW implementation would be limited, at least RAN4 impacts may be needed, e.g. measurement requirement for relaxation may be needed if the benefit is approved. |
| Intel | 1 |  |
| Nokia | 1 |  |
| Sequans |  | We do not see this as especially beneficial, but agree it can be studied while taking RAN4 impact into account |
| Facebook | 1 |  |
| Convida | 1 |  |

# Conclusion

# Reference

1. R2-2009364 Summary of email discussion 915 - UE power saving features; CATT