3GPP TSG-RAN WG2 Meeting #113 electronic R2-200xxxx

Online, January 25th – February 5th 2021

Source: CATT

Title: Summary of email discussion 154 - eDRX cycles

Agenda Item: 8.12.3

Document for: Discussion and Decision

# Introduction

This contribution provides a summary of the following email discussion:

* [Post112-e][154][REDCAP] eDRX cycles (CATT)

Scope: Progress on eDRX cycles for Idle and Inactive

Intended outcome: email discussion report

Deadline: Long

Rapporteur would like to have the 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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# Discussion

As a follow-up of the offline #111 [1][2], the following agreements on eDRX for REDCAP UEs were achieved in RAN2#111-e:

Agreements:

1. RAN2 study eDRX mechanism for both RRC\_IDLE and RRC\_INACTIVE in this SI. ‎
2. For RRC\_INACTIVE, the DRX cycle is extended to 10.24s as baseline.

Agreements via email - from offline 111:

1. For RRC\_IDLE, the DRX cycle is at least extended to 10.24s. FFS on further extension ‎beyond 10.24s.
2. For RRC\_IDLE and/or RRC\_INACTIVE, if the NR DRX cycle range is extended beyond 10.24s, the LTE ‎eDRX mechanism beyond 10.24s (e.g., PTW, PH, etc.) is used as baseline when NR eDRX cycle is configured beyond 10.24s.

FFS:

1. For RRC\_IDLE and/or RRC\_INACTIVE, FFS on baseline mechanism when the configured NR eDRX cycle is less or equal to 10.24s

Then, the above FFSs were further progressed in RAN2#112-e where the following agreements were achieved on eDRX for Idle and Inactive:

1. For UE in RRC IDLE/INACTIVE and eDRX cycle is less than 10.24s, paging monitoring does not use PTW and PH, if any.
2. RAN2 will study whether lower values than 5.12s for eDRX cycle for RRC\_IDLE and RRC\_INACTIVE REDCAP UEs, e.g. 2.56s, can also be considered.
3. eDRX cycle extension in RRC\_IDLE beyond 10.24s for REDCAP UEs will be studied in this SI/WI. For UE in RRC IDLE and eDRX cycle is equal to 10.24s, among the solution options, we start from the assumption that paging monitoring does not use PTW and PH.
4. the eDRX cycle in RRC\_IDLE is extended up to 2621.44s for REDCAP UEs, as a baseline (longer value e.g. 10485.76s can also be considered)

This discussion will focus on the leftover issues from RAN2#112-e on eDRX for Idle and Inactive:

1. eDRX in Idle: next steps on the solutions:
   1. solutions for 10.24s
   2. issues associated with upper and lower bounds
2. eDRX in Inactive
   1. Support > 10.24s?
   2. Inactive-specific issues (concurrent RAN/CN paging), difference with LTE, …

In general the trend should focus more on contents to be captured in the TR: listing pros and cons of the different options, and providing recommendations among the different solutions.

# eDRX in idle

### Solution for 10.24s

In RAN2#111-e, it was agreed that eDRX cycles up to (and including) 10.24s would be supported in RRC\_IDLE and then a long discussion took place in RAN2#112-e on the need to support eDRX cycles *beyond* 10.24s. Finally a compromise was reached to recommend supporting eDRX cycles beyond 10.24s where the solution for eDRX cycle = 10.24s would not use PTW and PH.

Given this compromise took place at the last stage of the meeting, it can be useful to elaborate pros/cons of this approach versus other approaches for capturing in the TR. Rapporteur’s understanding is that the benefit of such approach is that it would allow a UE requesting eDRX cycle always ≤ 10.24s during UE-CN negotiation to not support PTW/PH features, while the drawback is a departure from the legacy LTE solution for which the solution for eDRX cycle = 10.24s involves PTW and PH.

Companies are invited to further provide their views on the pros/cons of the recommended solution for eDRX cycle = 10.24s in RAN2#112-e versus other solutions, e.g. LTE solution.

**Q1: Companies are invited to provide their views on the pros/cons of the solution recommended in RAN2#112-e for eDRX cycle = 10.24s for RRC\_IDLE versus other solutions, e.g. LTE solution.**

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| --- | --- |
| Company | Comments |
| CATT | The benefit of not using PTW and PH for eDRX cycle = 10.24s is that a UE which, by implementation, would never express a preference for an eDRX cycle > 10.24s during the UE/CN negotiation phase would not need to implement the PTW/PH functionality without a need for an explicit capability signaling. On the other hand, for UEs supporting such functionality and aiming at requesting eDRX cycle > 10.24s, there should not be much implementation difference if PTW and PH are used or not for eDRX cycle = 10.24s. |
| Apple | We see that NR already has 10.24sec interval in C-DRX while is different from LTE, and NR UEs are already used to 10.24 sec DRX timing. So it shouldn’t be that different to use 10.24 eDRX without PTW/PH. On the other hand, implementing the LTE aspects for 10.24 with PTW/PH should also be straight-froward. We are ok to go with the majority. We do recognize that the CN part from LTE eDRX may need some changes for the RedCap anyway, |
| Ericsson | Agree with above views – additionally, for 10.24 s and RRC\_INACTIVE similar solution was adopted for LTE. |

### Issues associated with upper and lower bounds

Although it is a common understanding that final upper and lower bounds of eDRX cycles should be finalized during the normative phase, it is useful to capture in the TR some preliminary recommendations with associated justifications.

It was agreed in RAN2#112-e that 5.12s and 2621.44s should be considered as baseline lower and upper bounds respectively, while lower/larger values e.g. 2.56s and 10485.76s could also be considered. Although the reasoning for baseline values is to stick to LTE values, it is interesting to capture the pros/cons of supporting the lower/larger values.

For the lower bound, [9] claims that 2.56s is required to support the reception of emergency broadcast services (e.g. ETWS primary notification) within the required delay budget (of 4 seconds), which is not possible with 5.12s eDRX cycle lengths. And since REDCAP UEs include wearables, they should be able to receive emergency broadcast services. On the contrary, [6] thinks this is no different from LTE where it was decided that optimizations were not needed for these scenarios, because a UE supporting ETWS or CMAS is not expected to be configured with eDRX. And the similar argument is valid for REDCAP use-cases that require long eDRX cycles.

Therefore the issue of the eDRX lower bound seems primarily related to the need to receive emergency broadcast services.

**Q2: Do you agree that the lower bound of the eDRX cycle should be designed to allow REDCAP UEs to receive emergency broadcast services?**

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| --- | --- | --- |
| Company | Yes/No | Argument(s) |
| CATT | No | Current specification already supports configuring a UE with UE-specific DRX cycle = 2.56s, so if the network and UE want to support REDCAP UE to receive emergency broadcast services with short DRX cycle, the CN can configure a UE-specific DRX cycle with 2.56s instead of configuring an eDRX cycle with 2.56s. The CN can configure the UE without eDRX cycle, if shorter cycle less than 5.12s is preferred. So no matter whether redcap UE is allowed to receive emergency broadcast services, once shorter DRX cycle less than 5.12s is preferred, the current UE specific DRX can work. |
| Apple | Pls see our comments. | UEs (including the RedCap ones) which need to receive emergency broadcast need to use 2.56sec DRX or lower, as anything above might not work. But whether eDRX cycle should allow this or not, is probably answered in a different way.  There are two aspects to look at.  The first one is the key difference between eDRX and DRX which is that the UEs with eDRX in LTE are not expected to follow the LTE RAN paging cycle if this RAN paging cycle is shorter. For RedCap UEs where power saving is very important for longer battery life and with bigger antenna impairments (especially with 1Rx/1Tx), since more effort (power) is needed to be able to receive the paging (by for eg., waking up early to read more than one burst of SSB to re-sync in time/freq), longer DRX cycle is an important way to save power. From this aspect, we would like to propose that **RedCap UE follow the DRX cycle that NAS has accepted, instead of following the RAN paging cycle which suits well for legacy NR devices.** This is the reason to propose to include 2.56sec in eDRX.  If we agree in RAN2 that RedCap UEs follow their NAS DRX cycle independent of the RAN paging cycle, then we do not need to have a discussion on inclusion/exclusion of 2.56 as part of eDRX. The legacy DRX values are anyway part of RedCap option if certain RedCap UEs want to use these DRX values.  The second aspect is the reception of emergency broadcast services, and as per SID, wearables are part RedCap and any devices that interact with the humans should not be precluded from receiving emergency broadcast. It can be argued that such wearables should not request eDRX cycles, and we tend to agree, and the above proposal (of including 2.56 DRX to be followed by RedCap UEs even if the RAN paging cycle is shorter) would be a good compromise. Meaning the wearable RedCap UEs which intend to receive emergency broadcast should not request for eDRX cycles > 2.56 sec.  To summarize, we think the two below proposals would be worth pursing:  **P1 :** **Atleast for the DRX 2.56 or larger, RedCap UE follow the DRX cycle that NAS has accepted, instead of following the RAN paging cycle which suits well for legacy NR devices.**  **P2: Atleast some of the RedCap UEs are not precluded from emergency broadcast reception.** |
| Ericsson | No | Question should not be about emergency broadcast services as in our understanding those would and should be supported by RedCap UEs regardless of eDRX or not. If the UE is configured with longer eDRX cycles, then it may not be always possible to receive such broadcast within a certain latency bound, but this is an aspect which should be understood when configuring a UE with eDRX, and is not a new issue.  Thus, the question is about specific need for “2.56 s eDRX” cycle. We have similar view as CATT and additionally we don’t think monitoring for gNB configured default paging (and RAN paging) cycles should be circumvented in this way. The default paging and RAN paging should be in RAN control. The solutions would have impact at least on gNB configuration for SI acquisition and modification period and related procedures and so on. |

We can also check if other reason/feature/usecase would require/justify supporting a lower value than 5.12s.

**Q3: Do you see any other reason/feature/usecase for supporting a lower value than 5.12s?**

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| --- | --- | --- |
| Company | Yes/No | Argument(s) |
| CATT | No |  |
| Apple | Pls see our comments in Q2. | Pls see our comments in Q2. |
| Ericsson | No | Assuming the question is about eDRX cycle lengths. For “normal” DRX there are use cases with shorter lengths. |

**Q4: Companies are invited to provide their views on the pros/cons of supporting larger values of eDRX cycles in RRC\_IDLE e.g. 10485.76s compared with the baseline value of 2621.44s.**

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| --- | --- |
| Company | Comments |
| CATT | Pros: considering the upper limit of the HSFN (10bit) is 10485.76s, if such large value of eDRX cycle is supported in the spec, it can be flexible to support case for UE with more power saving requirement such as battery life up to several years in future. If there is no such case, the CN can configure the eDRX with other values and the advantage of supporting 10485.76s is future-proof and flexibility. |
| Apple | While we are not very strong on views, we think that longer RRC\_IDLE eDRX times help with the other class of RedCap devices that need very long battery life and so we are ok with 10485.76s. |
| Ericsson | If extended DRX cycles are specified, we do not see the reason why the configuration would be artificially limited especially as there does not seem to be any technical reason.  The long RRC\_IDLE eDRX solution should be captured in the TR, and if the solution is recommended to be specified (this is our preference), the final details of configuration possibilities etc. can also be agreed in normative phase.  Note that also for eDRX in RRC\_IDLE we should inform at least SA2/CT1 of RAN2 views and solution recommendations and we can further consult whether there would be any concerns from CN side when an LS is sent. |

# eDRX in inactive

Whether to support eDRX cycle in RRC\_INACTIVE beyond 10.24s for REDCAP UEs was discussed in the email discussion #915 to RAN2#112-e [3], resulting in the following summary:

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| --- |
| **Summary from email disc #915:**  23 companies provided answers to this question.   * Yes: 12/23 * No: 11/23   Proponents of extending the eDRX cycle in RRC\_INACTIVE beyond 10.24s use similar arguments as for RRC\_IDLE, i.e. the years-long battery life requirement with, in addition, the benefit of leveraging RRC\_INACTIVE to take advantage of the Small Data Transmission feature to be specified in Rel-17.  Opponents also use similar arguments as for RRC\_IDLE while, in addition, pointing that:   * REDCAP UEs needing long battery life can transition to RRC\_IDLE * It has impact on NAS retransmission * If the UE has two eDRX cycles larger than 10.24s (one for IDLE, the other for INACTIVE), we need to first discuss how UE behaves because there are two PTWs and PHs   Based on the above, it is clear that there are split views on this issue and no conclusion can be drawn from this outcome. It is suggested to further discuss this issue online. |

Then, during the GTW online discussion of RAN2#112-e, it was decided to focus on the eDRX in RRC\_IDLE and postpone the discussion for RRC\_INACTIVE. Thus although no progress was done on this issue, some arguments have been exposed during email discussion #915 and it can now be re-discussed considering:

* The progress made in RRC\_IDLE during RAN2#112-e e.g. could similar compromise for 10.24s be recommended?
* The issues brought up during email discussion #915 and in contributions, which were mainly:
  + Impact on NAS retransmission
  + Handling of two PTWs and PHs (one for IDLE, the other for INACTIVE) when the UE has two eDRX cycles larger than 10.24s
  + Which node decides the eDRX cycle for RRC\_INACTIVE [7][8]?

However, it is Rapporteur’s view that we are still in the study phase so we should focus on what is beneficial and possible from RAN side. For possible SA/CT impact we can coordinate with the relevant groups, provide our input and ask for solutions and feasibility. Thus it should not be precluded that the TR recommends a solution conditional to SA/CT response on feasibility during the normalization phase.

Therefore we propose to progress this issue as follows:

1. Re-assess RAN2’s view on the need and motivation to support eDRX cycle in RRC\_INACTIVE beyond 10.24s for REDCAP UEs (independently of the above issues)
2. If the answer is “Yes”, analyse how to address the issues.

### On the need for eDRX cycle > 10.24s in inactive

From companies’ inputs to the email discussion#915 one argument in favour of supporting eDRX cycle > 10.24s also in RRC\_INACTIVE is that REDCAP UEs may actually spend significant time in RRC\_INACTIVE, considering the Small Data Transmission feature to be specified in Rel-17. On the contrary, opponents consider that REDCAP UEs needing long battery life can switch to RRC\_IDLE.

Companies are invited to express their views on the need, from RAN2’s perspective, to support eDRX cycle > 10.24s also in RRC\_INACTIVE, from performance perspective, and highlight the differences, if any, with LTE. Note again that NAS retransmission issue and further RAN issues are addressed in Section 2.2.2.

**Q5: Do you agree it is beneficial, from RAN perspective, to extend the eDRX cycle in RRC\_INACTIVE beyond 10.24s for REDCAP UEs?**

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| --- | --- | --- |
| Company | Yes/No | Argument(s) |
| CATT | Yes | We think a difference with LTE is the support of small data transmission in Inactive from R17 onwards, which can then change the network strategy to keep the UE in inactive more often than in LTE. For example a device sending short payload (e.g. measurements) every 30s could be kept in inactive rather than switching back and forth between idle and connected. As a result it is expected that supporting eDRX cycle > 10.24s in inactive will bring power saving benefits. |
| Apple | Yes | While the support from the NW is needed, we see it as very beneficial to have >10.24 sec in RRC\_INACTIVE to effectively support the usage of SDT (small data transfer) where the RedCap UE can avoid going into connected mode where avoidable and hence save some power during the longer DRX cycle times -> the small data transfer might not be latency critical as well.  While it requires the NW to store the UE context, the other aspects of RRC\_IDLE and RRC\_INACTIVE are pretty similar if we also align on the DRX aspects. We also think the NAS timer part can be solved with additional signaling. |
| Ericsson | Yes | We agree with CATT and Apple views on use cases. It is clear there would be a power consumption benefit, and UEs in RRC\_INACTIVE would additionally be able to benefit from SDT for e.g. use cases with periodic uplink data with periodicity > 10.24 s.  Based on the results in R2-2009620 and in the Appendix of the TR, there is a clear power saving gain vs eDRX in RRC\_IDLE at least for eDRX cycles of 10.24 s – couple of minutes, where the UE in eDRX in RRC\_INACTIVE additionally benefits from less signaling. Based on these results, lifetime of several years would not be achievable in some cases (e.g. 1 minute IAT) if only RRC\_IDLE can be used, because of the signaling overhead.  Signaling reduction is an additional benefit from network point of view – there is need for less RRC signaling. |

### Addressing the impacts of eDRC cycle >10.24s in inactive

### Handling of two PTWs and PHs

[7] raises this issue and one possible solution is proposed in [8][10] and consists in configuring the same PTW and eDRX cycle for both RRC\_IDLE (CN paging) and RRC\_INACTIVE (RAN paging), as shown in below figure from [10].



Figure 1: Shared PTW for RAN and CN paging.

**Q6: If the Q5 answer is “yes”, do you agree considering a common PTW and eDRX cycle configuration for RRC\_IDLE and RRC\_INACTIVE as one of the possible solutions to consider during the WI phase?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| CATT | Yes | We think such simple solution should be the starting point to minimize the complexity, and the details can then be finalized during the WI phase. We do not see any justification of supporting separate PTW and eDRX cycles for idle and inactive. |
| Apple | Yes | Yes common framework is better. |
| Ericsson | Yes | Agree with CATT. |

### Which node is responsible for configuring the eDRX cycle in inactive?

This issue is discussed in [7][8]. In LTE the eDRX parameters are configured by MME to UE via NAS which is transparent to RAN, but in NR, the CN and RAN both can trigger the paging according to the eDRX parameters, so both CN and RAN should be aware of the eDRX configuration for inactive. Irrespective of the details on how RAN and CN exchange this information, both [7][8] conclude that two options should be considered for the deciding node for the eDRX configuration for inactive:

* Option 1: CN decides the eDRX parameters for RRC\_INACTIVE
* Option 2: RAN decides the eDRX parameters for RRC\_INACTIVE

Rapporteur suggests to agree on these two options and to perform the down-selection during the WI phase.

**Q7: If the Q5 answer is “yes”, do you agree considering the above two options regarding which node decides the eDRX parameters for RRC\_INACTIVE. Companies are also welcome to express their preference, if any.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| CATT | Yes | Clearly both options are obvious candidates and could be captured in the TR. We would prefer that CN decides the eDRX parameters for inactive when > 10.24s, especially if they are common for idle and inactive, as proposed in Q6. Thus CN, which has better insight on UE traffic profile, would decide on the common PTW and eDRX cycle for both idle and connected. |
| Apple | Yes | Opt-1 can help address the NAS re-tranmission timer issue. |
| Ericsson | Yes | Both options should be captured in TR with pros/cons. We currently think Option 1 should be the way and in any case CN is responsible for eDRX in RRC\_IDLE (and UE needs to monitor for CN paging also in RRC\_INACTIVE).  We can work out the details in WI phase also after sending LS to SA2/CT1 as this requires coordination with other groups. |

### Case of eDRX cycle = 10.24s

As discussed in Section 2.1.1, a compromise was reached to recommend supporting eDRX cycles beyond 10.24s in RRC\_IDLE where the solution for eDRX cycle = 10.24s would not use PTW and PH. For the case where eDRX > 10.24s would also be supported in RRC\_INACTIVE (Q5 answer is “yes”), Rapporteur believes it is worth considering such compromise as well.

**Proposal: For UE in RRC INACTIVE and eDRX cycle is equal to 10.24s, among the solution options, we start from the assumption that paging monitoring does not use PTW and PH.**

**Q8: If the Q5 answer is “yes”, do you agree considering the above proposal, similar to RRC\_IDLE?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| CATT | Yes | We would indeed prefer to have a common design for both idle and connected regarding eDRX cycle = 10.24s, which is obviously simpler. |
| Apple | Neutral | We agree to CATT view and are ok to go with majority. |
| Ericsson | Yes | Agree with CATT, also this is the solution which was adopted for LTE-M connected to 5GC. |

### NAS retransmission issue

For eMTC UEs connected to 5GC, eDRX cycles in RRC\_INACTIVE are already supported up to 10.24 sec. One reason for not extending this value further is given in [4] (same argument also used in [5]):

“*For UE in CM-CONNECTED mode with RRC\_INACTIVE, the impacts of eDRX on CN should be considered. The value of eDRX period has impact on NAS signalling transmission in CM-CONNECTED. As specified in 5GS for Rel-15, the smallest NAS retransmission timer is 6s and the maximum retransmission times is 4. To avoid the failure of the procedure, the response from UE in eDRX should be given within 30s after initial transmission. Considering all potential factors, the longest eDRX period without impacting 5GC is set to 10.24s for RRC\_INACTIVE eMTC UE in Rel-16*”.

If the answer to Q5 is “Yes” the likely most secure way to assess the impact on the NAS timers is to ask CT1/SA2 (+ RAN3?) on the feasibility of this solution.

**Q9: If the Q5 answer is “yes”, would you agree sending an LS to (at least) CT1/SA2 informing them about RAN2’s preference and asking about feasibility?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| CATT | Yes | We should inform CT1/SA2 about RAN2’s preference soon enough to let them study the impact and potential workaround, if needed. |
| Apple | Yes | We like the line of the LS as indicating RAN2 preference and asking for any in-feasibility. |
| Ericsson | Yes | Yes, eDRX is a feature with CN impacts thus we need to send LS in any case to CT1 and SA2.  We don’t think this should be referred to as an issue in RAN as this has been discussed in SA2 where solutions are already available (see e.g. TR 23.724 soln 24). The detailed discussion is not in RAN2 scope, but if CN is aware the UE is not reachable (because the UE has been configured with longer eDRX) it can manage the NAS procedures properly.  (Also note the mentioned timers have actually been extended for LTE-M/NB-IoT case already, but this is not referred to above or in all discussion). |

# Other

**Q10: Any other relevant issue to discuss?**

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| --- | --- |
| Company | Issue description |
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# Conclusion

# Reference

1. R2-2008193 Summary of offline 111 - DRX aspects; CATT
2. R2-2008216 Summary of offline 111 - DRX aspects - second round; CATT
3. R2-2009364 Summary of email discussion 915 - UE power saving features; CATT
4. R2-2007346 Discussion on eDRX for RRC\_INACTIVE and RRC\_IDLE; Huawei, HiSilicon
5. R2-2006748 Use cases target to extend paging DRX cycle and relax measurements for stationary devices; Intel Corporation
6. R2-2009116 Further considerations for eDRX; MediaTek Inc.
7. R2-2009247 Discussion on eDRX for Redcap UE; ZTE Corporation, Sanechips
8. R2-2009363 On eDRX for NR RRC Inactive and Idle; CATT
9. R2-2009532 Support of 2.56 eDRX cycle and emergency broadcast reception for RedCap UEs; Apple, Facebook
10. R2-2009620 RedCap power saving enhancements; Ericsson