3GPP TSG-RAN WG2 #114-e draftR2-2106530

Electronic meeting, 19th – 27th May, 2021

Agenda Item: 8.12.3.1

Source: Ericsson

Title: Summary of [AT114-e][110][REDCAP] eDRX aspects (Ericsson)

Document for: Discussion, Decision

# Introduction

The document summarizes the following offline discussion:

* [AT114-e][110][RedCap] eDRX aspects (Ericsson)

Initial scope: Discuss PTW length + starting point and min eDRX cycle value

Initial intended outcome: Summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals that require online discussions
    - List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Tuesday 2021-05-25 08:00 UTC

Initial deadline (for rapporteur's summary in R2-2106530): Tuesday 2021-05-25 12:00 UTC

Proposals marked "for agreement" in R2-2106530 not challenged until Tuesday 2021-05-25 22:00 UTC will be declared as agreed via email by the session chair.

For the rest the discussion will continue online in the Wednesday CB session.

# Minimum eDRX cycle length

Based on the tdocs submitted to RAN2#114-e, two different minimum lengths have been proposed for eDRX in Rel-17:

* 2.56 seconds, proposed in [3], [5], [9] and [13]
* 5.12 seconds, proposed in [1], [2], [7], [8], [10], [12] and [14]

**Discussion point 1: What should be the lower bound for extended DRX cycle in RRC\_IDLE and RRC\_INACTIVE?**

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| **Company** | **Lower bound for eDRX?** | **Comments / arguments** |
| Ericsson | 5.12 s | We think we can keep the existing lower bound from LTE. The use cases of shorter (=2.56 s) eDRX are not clear to us, remembering UE should request eDRX only when the MT traffic is delay tolerant. |
| Apple | 2.56s | We do not agree with Ericsson’s statement on the applicability of delay tolerance for eDRX. This was before RedCap was discussed.  eDRX is also used for power-savings. It is already agreed that wearables are part of RedCap and eDRX here is for power-savings. We should assess the eDRX bounds from this perspective as well.  If 2.56s is not agreed, **then a wearable UE has to choose either 1.28sec (the current behavior with NO power-saving) or the next avalible 5.12sec** which impacts the user-interaction aspect of wearables, while we have a **large gap between 1.28sec and 5.12sec!!**  We request companies to also consider wearables and their requirements as RedCap instead of purely looking at industrial sensors etc. which are on other side of RedCap spectrum.  **We also request companies to provide technical reasons on why 2.56sec is a bad choice**. The NWs would anyway have to deal with 5.12sec RedCap devices, in terms of handling paging from CN (buffering the page until the paging occasion) and the interface from CN on the DRX config is already present. If the NW can handle 5.12sec, we do not see why 2.56s cannot be handled (which is even shorter).  Regarding the emergency message reception, the NW anyway would broadcast the SI change page multiple times, and per spec, 2.56sec RAN paging cycle is already present as an option (if the argument is on the 4sec requirement of EM broadcast), **and we are not adding anything new here**.  From wearable perspective, a DRX cycle of 2.56 over 1.28sec (which is the practical deployment for legacy NR) is twice in terms of power-saving, or atleast 80% additional savings, when the UE wake-up time is twice as longer. |
| Qualcomm | 2.56s | We think the wearable use case explained by Apple is a real issue that needs to be addressed. We understand that there are alternative solutions (e.g. through network configuration). But from UE’s perspective, eDRX is the most desirable solution among them, because it allows UE to request and then use the exact paging cycle it wants, if default or RAN paging cycle is not configured to the desired value (e.g. 1.28s). |
| OPPO | 5.12s | An ETWS or CMAS capable Redcap UE should not be expected to be configured with eDRX, i.e., the minimum value of eDRX cycle is kept as 5.12s as LTE and for an ETWS or CMAS capable UE, it may be configured with DRX but should not be configured with eDRX. In this way, no specification impact is needed. |
| Lenovo | 5.12s | The network could configure the UE with short DRX cycle other than eDRX cycle. The eDRX cycle with 5.12s is aligned to the legacy one in LTE, and no significant impact to other group will be introduced. |
| Xiaomi | 5.12 s | We also want to reuse the LTE way for simplicity. |
| Nokia, Nokia Shanghai Bell | 2.56s | We are OK to define this value to have more flexibility on the lower end values for eDRX. |
| CATT | 5.12s | We agree the eDRX should be applied for latency tolerant service, so the use case that needs emergency service shouldn’t be configured with eDRX. And currently it supports of 2.56s for legacy DRX cycle configuration, so it doesn’t need to introduce 2.56s for eDRX cycle, furthermore, the motivation of the eDRX is power saving, the shorter of the eDRX cycle, the less benefit the UE can gain on power saving. As for the argument that wearables are expected to closely interact with human, hence need EM reception, in our view such wearables are typically used with a “hub” device e.g. a smart watch or a smartphone with less power-critical requirements and which can handle the EM reception. |
| Huawei, HiSilicon | 5.12s | We think to benefit from both eDRX power saving and supporting emergency broadcast services, RedCap UE can request an eDRX configuration while still monitoring for ETWS and CMAS in between the paging occasions. The lower bound of eDRX cycle can be kept to baseline 5.12s as in LTE. |
| MediaTek | 2.56s | Agree with Apple and Qualcomm. 2.56s eDRX cycle will enable wearables to be individually configured with 2.56s when the default paging cycle in the network is 1.28s (which is common in current deployments). |
| ZTE | 2.56s | 2.56s is acceptable to us if majority prefer it. |
| Futurewei | 5.12s | Agree with Huawei. |
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# Paging transmission window

The configuration details of PTW have been discussed in previous meetings, e.g. during RAN2#113bis-e in Offline 101. However, no consensus has been sreached e.g. on whether the PTW for RRC\_INACTIVE can be of different length compared to PTW for RRC\_IDLE, and whether the starting location of PTW for RRC\_INACTIVE and RRC\_IDLE, i.e. for RAN paging and CN paging, respectively, should be the same.

The following related agreements were made in RAN2#113bis-e:

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| * RAN decides and configures eDRX via RRC for RRC\_INACTIVE (FFS on the need and details of coordination with the CN) * At least for eDRX cycle, the configurations of the eDRX for RRC\_IDLE and RRC\_INACTIVE can be different (FFS for PTW, e.g. length and starting point, when eDRX cycles are longer than 10.24s) |

Assuming that RAN paging cycle is always equal or shorter compared to CN paging cycle, it is possible there are paging frames where either RAN or CN paging may occur, or paging frames where only RAN paging may occur.

Illustration from [3] is copied below to clarify the existing LTE eDRX configuration, where A denotes start of a PH and B denotes the start of a PTW in the PH (i.e. the starting location PTW\_start in TS 36.304):



Figure 1. LTE eDRX according to [3].

On PTW length, the following have been proposed in the tdocs submitted to RAN2#114-e:

* Common PTW length is used for RRC\_IDLE and RRC\_INACTIVE, proposed in [1], [4], [6], [8], [10], [14]
* The PTW length can be configured to be different for RRC\_IDLE and RRC\_INACTIVE, proposed in [2], [3], [7], [9], [11], [12], [13]

The assumption is that common length, if agreed, would be configured for the CN paging, i.e. by AMF.

**Discussion point 2: Should it be possible for RAN to configure different PTW length for RAN paging compared to PTW length configured for CN paging?**

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| **Company** | **Yes / No** | **Comments / arguments** |
| Ericsson | Yes, shorter | In particular we think RAN should be able to configure a shorter PTW compared to the CN PTW when CN PTW is relatively long. This will benefit of UE power consumption as it doesn’t need to monitor for long CN PTW for RAN paging.  Whether RAN uses the same PTW or a different one should be up to RAN to decide.  We provided the following example in [R2-2105236](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_114-e/Docs//R2-2105236.zip):  *Let’s consider another example where the RAN paging cycle is 61.44 s and the CN paging cycle is 122.88 s. The CN has configured a PTW of 20.48 s. We expect that the PTW for RAN paging does not always need to be configured to the same length as the PTW for CN paging – and in such case it would benefit the UE power consumption to allow the possibility to configure different PTW lengths for RAN and CN paging. Thus, in the example, RAN should be able to configure a shorter PTW than 20.48 s, let’s say 10.24 s PTW is enough. In this case the UE can save power compared to always using 20.48 s PTW.*  We don’t see a reason why RAN should not be able to configure different length for RAN paging. |
| Apple | Should be possible | While we would have preferred to have same config between RAN/CN, our main aim now is to ensure that UE is able to receive CN page while in INACTIVE, if there is a problem where NW assumes the UE is in IDLE. As long as the UE can receive the CN page, we are ok with diff PTW config. |
| Qualcomm | Yes | We think that as long as PTWs configured for RRC Idle and RRC Inactive have some overlapping POs, UE in RRC Inactive can still receive CN paging. Hence it is OK for their PTWs to have different lengths.  Being able to configure different PTWs when two RRC states have different eDRX cycles can save UE power. For example, NW may configure the length of PTW in proportion to eDRX cycle, e.g. to ensure it has enough number of POs to reach a UE if that UE is highly mobile. In that case, if UE is configured with a long eDRX cycle for RRC Idle but much shorter eDRX cycle for RRC Inactive, forcing a common PTW length would cost UE extra power when UE operates in RRC Inactive. |
| OPPO | No | In our understanding, the intention of PTW is to improve the paging robustness for UE configured with eDRX, regardless of whether the UE is in RRC IDLE and RRC INACTIVE. So we think for UE in RRC INACTIVE configured with eDRX, RAN should also follow the CN configured PTW length to page the UE.  Following the same PTW length with CN eDRX has another benefit of saving signaling overhead of RAN eDRX configuration. |
| Lenovo | Yes | Considering that network may perform the CN paging if the RAN paging is failed, so the PTW length is better to be longer for CN paging than the one for RAN paging, then the UE could have more paging occasions in CN paging to avoid paging failure for UE.  The PTW length for RRC\_IDLE and RRC\_INACTIVE is suggested to be different from the view of flexibility of eDRX configuration and the possible case with a following CN paging for UE in inactive mode. |
| Xiaomi | No | Not necessary.  We need to know that the PTW is introduced in R13 to improve paging reliability for mobile UEs thus only loose H-SFN synchronization between cells may be required.  Currently for CN paging the PTW provided by CN is set according to the factors such as SFN misalignment among gNBs, latency of N2 interface, gNB scheduling and so on. For RAN paging, these same factors may apply. Since the CN is expected to have the overall knowledge of the synchronization performances in both the UE and the gNB, it seems feasible that the CN configures the PTW for both CN and RAN paging. We do not see a need for RAN to configure a shorter PTW length. The synchronization between cells does not need to differentiate RRC status.  If we do, we need to consider which PTW length for UE to monitoring, to use the max{CN PTW length, RAN PTW length } when the PH based on eDRX cycle for RRC\_IDLE overlaps with a PH based on eDRX cycle for RRC\_INACTIVE?  A lot of details need to consider.  Also, we think the e-DRX cycle contributes more than the PTW to the power consumption gain. So it is not worthwhile to spend so much time on this. |
| Nokia, Nokia Shanghai Bell | Yes | Agree with Ericsson and QC. |
| CATT | No | Firstly, if UE is configured with different length of the PTW for idle and inactive, the UE behavior will be complex considering both the overlapped PTW and separate PTW for idle or inactive. Secondly, the PTW is used to avoid UE missing the paging, it seems not reasonable to configure different PTW length for idle and inactive, unless there exists other consideration that UE in idle could miss the paging with higher probability than UE in inactive so that longer PTW length is needed. |
| Huawei, HiSilicon | Yes | We agree with Ericsson. Especially in non-overlapping PH, a shorter PTW length would be beneficial for power saving. |
| MediaTek | Yes | This can be left to the network implementation. The coordination between RAN and CN can be used to ensure that CN paging occasions for Idle are covered by the RAN paging occasions for Inactive, if necessary. In our understanding this RAN-CN coordination already exists in the current specifications. There is no strong motivation to define restrictions for PTW lengths for RAN and CN paging in the specifications. |
| ZTE | No | The intention of introducing PTW is to improve paging robustness. When eDRX cycle for the two RRC states are longer than 10.24s, we think the robustness requirements are the same no matter the UE is in IDLE or INACTIVE. And from standard point of view, common PTW is simpler for defining UE behaviour. |
| Futurewei | Yes | Agree with Ericsson. |

On PTW starting location, the following have been proposed in the tdocs submitted to RAN2#114-e:

* Common PTW starting locations are used, proposed in [1], [4], [6], [8], [10], [14]
* Leave configuration up to network implementation, or that starting point can be same or different, proposed in [2], [3], [9], [12]
* Use the LTE baseline, and update if needed resulting in overlapping PTWs, proposed in [7]
* Consider either configurable locations, which can be different, or fixed locations in the specification resulting in the same starting locations for RAN and CN PTWs [11]

As the eDRX cycles can be different for RAN and CN paging, the same PTW starting location discussion is relevant for the case where both RAN and CN paging would occur in the same PH (i.e. the PTWs would start in the same PH), see Figure 1.

**Discussion point 3: When RAN paging and CN paging coincide in the same paging hyperframe (PH), should both PTWs start at the same time?**

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| **Company** | **Yes / No** | **Comments** |
| Ericsson | Maybe | It would be possible to specify same starting location for PTW in case paging coincide in the same PH, as proposed in some of the submitted Tdocs.  But it is also possible to leave this configuration up to NW e.g. so that it has possibility to distribute PTWs of different UEs when needed.  We don’t have a strong view. |
| Apple | Yes | Helps with UE power saving. |
| Qualcomm | Yes | It helps ensure there would be some overlapping between the PTWs of two RRC states, as well as saves UE power. |
| OPPO | Yes | Using a common PTW starting point for both CN paging and RAN paging would be beneficial for UE power saving.  For simplicity, we propose to use CN eDRX cycle to derive the PTW starting point based on the legacy calculation formula in LTE for all the PHs. |
| Lenovo | No | It may have some restriction to the network configuration to the PTW and eDRX cycle. We think it could be left to network implementation to configure out the overlapped PTW. |
| Xiaomi | Yes | Separate PTW\_start is not power efficient for the UE.  And it is better to solve the RRC state mismatch problem, i.e., if UE has separate PTW start point in different RRC states, when state mismatch happens and UE will not be able to get page from network to recover(UE is monitoring in PTW for RRC Inactive while the network is paging UE in PTW for RRC idle).  UEs in different RRC states share the same set of POs is better to solve the RRC state mismatch problem. |
| Nokia, Nokia Shanghai Bell | No strong view | We think network can handle this by configuration. |
| CATT | Yes | Helps with UE power saving |
| Huawei, HiSilicon | Yes | It ensures the overlap of the PTWs for RAN paging and CN paging, which benefits power saving.  Moreover, we think a common PTW can be achieved via specifying that only one of the two PTWs is used, i.e. the IDLE PTW, in overlapping PHs. |
| MediaTek | No | Agree with Ericsson and Lenovo that this can be left to the network implementation. |
| ZTE | Yes | We think overlapped PTWs and same PTW starts can save UE’s power.  Note that according to current spec (i.e. LTE-M eDRX as copied below), different eDRX cycles will result in different PTW start point, so unless new rule is defined, it is hard for network to ensure the PTW starts are always the same.  *PTW\_start denotes the first radio frame of the PH that is part of the PTW and has SFN satisfying the following equation:*  *SFN = 256\* ieDRX, where*  *- ieDRX = floor(UE\_ID\_H /TeDRX,H) mod 4* |
| Futurewei | Yes | As it helps with UE power saving. |

Depending on the outcome of DP2 and DP3, one remaining question e.g. in the case RAN configures a shorter PTW length is which PTW the UE should follow in the case when the PTWs fully overlap. As the UE is required to follow CN paging e.g. for possible state mismatch, it seems reasonable that the UE would in this case follow the CN configured PTW.

**Discussion point 4: Do you agree that when RAN paging and CN paging coincide in the same paging hyperframe and the PTWs overlap each other, UE should follow the CN PTW for paging monitoring?**

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| **Company** | **Yes / No** | **Comments** |
| Ericsson | Yes | In case it is agreed the starting locations are same and e.g. RAN PTW can be shorter then yes the UE should monitor according to CN PTW as the UE is in any case required to monitor for CN paging.  We can discuss later once the set of allowed eDRX cycles is agreed what to do e.g. for cases PTWs started in different PHs overlap (i.e. whether this is allowed or left up to NW to configure in a way it doesn’t happen). |
| Apple | Needs clarification | It is our assumption that UE in INACTIVE only monitors RAN paging and the CN paging should coincide (other wise the UE does not receive the CN page for resolving error cases). We are not sure about UE following the CN PTW/PH config while in INACTIVE.  In IDLE, from UE perspective, it’s the CN paging cycle, and the RAN should configure the default paging cycle to align with RAN paging cycle (like in legacy). |
| Qualcomm | No | If we understand the proposal correctly, our preference is no. Our assumption on UE’s monitoring behavior is the following: when UE is in RRC Inactive, it follows the PTW configured for RRC Inactive; when UE is in RRC Idle, it follows the PTW configured for RRC Idle. Within a PTW, UE follows the legacy “T” to monitor paging, i.e. when UE is in RRC Idle, it monitors only CN paging; when UE is in RRC Inactive, it monitors both RAN and CN paging.  Otherwise (i.e. as suggested in the proposal by the rapporteur), we lose the whole purpose of being able to have different PTW lengths for RRC Idle and RRC Inactive. |
| OPPO | Yes, for RAN eDRX and CN eDRX using the same PTW length | As comment to Q2, we see no need for RAN to configure a separate PTW length for UE in RRC INACTIVE, we think RAN paging should always following the CN configured PTW. |
| Lenovo | May be Yes | Positive to the view from Ericsson, but the issue from apple should be clarified. |
| Xiaomi | yes | If the answer is yes for this question to use the CN PTW for paging monitoring for possible state mismatch, people can be more convinced to use a common PTW for Q2. |
| Nokia, Nokia Shanghai Bell | Yes | Agree with Ericsson. |
| CATT | Yes | Considering the possible state mismatch, UE in inactive should also monitor the paging from CN, so from this point, UE should follow the longer PTW to avoid missing paging. But this will reduce the benefit UE can get on power saving. If UE is in idle, the UE should follow the PTW from CN. |
| Huawei, HiSilicon | Yes | In RRC\_INACTIVE, UE monitors paging for both CN paging and RAN paging to cover the state mismatch between UE and RAN/NW. If it is agreed that the PTW in RRC\_INACTIVE can be shorter, then, in overlapping PH, the UE should monitor the longer of the two, i.e. the RRC\_IDLE PTW. |
| MediaTek | No | We share Qualcomm’s assumptions about UE’s monitoring behavior in Idle and Inactive modes: When the UE is in Idle mode, it follows eDRX configuration for Idle (configured by Registration Accept message). When the UE is in Inactive mode, it follows the eDRX configuration for Inactive (configured by RRCRelease message).  We prefer that the coordination between CN and RAN paging occasions is handled by the network, and the UE just applies the relevant configuration (either Idle or Inactive) depending on its current mode. This would greatly simplify the UE operation. |
| ZTE | No | We understand for RRC inactive state, the UE monitors RAN paging within RAN PTW, and UE monitors CN paging within CN PTW.  If different PTW lengths for idle and inactive is supported, and the PTWs are partial overlapped, then our understanding is that, UE monitors both CN and RAN paging on overlapped occasions; and only CN paging for non-overlapped occasions (if the length of idle PTW is longer than the PTW for inactive).  Below figure shows an example of our understanding:  图片2 |
| Futurewei | Yes | Agree with Huawei. |

# Summary

TBD

# References

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1. [R2-2105135](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_114-e/Docs//R2-2105135.zip), RedCap UE power-saving with 2.56 DRX cycle, Apple Inc, FaceBook Inc, MediaTek Inc, RAN2#114e, e, May 2021

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1. [R2-2105464](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_114-e/Docs//R2-2105464.zip), Open issues on eDRX cycles, DENSO CORPORATION, RAN2#114e, e, May 2021

1. [R2-2105636](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_114-e/Docs//R2-2105636.zip), eDRX for RedCap UE, Huawei, HiSilicon, RAN2#114e, e, May 2021

1. [R2-2105671](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_114-e/Docs//R2-2105671.zip), Remaining issues for eDRX, MediaTek Inc., RAN2#114e, e, May 2021

1. [R2-2105813](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_114-e/Docs//R2-2105813.zip), Consideration on eDRX for RedCap UE, Lenovo, Motorola Mobility, RAN2#114e, e, May 2021

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# Delegate contact information

|  |  |
| --- | --- |
| Company | Delegate contact |
| COMPANY\_NAME | NAME ([email@address.com](mailto:email@address.com)) |
| Ericsson | tuomas.tirronen@ericsson.com |
| OPPO | Haitao Li (lihaitao@oppo.com) |
| Lenovo | Shijie4@lenovo.com |
| Xiaomi | Liyanhua1@xiaomi.com |
| Huawei, HiSilicon | odile.rollinger@huawei.com |
| MediaTek | Pradeep Jose (pradeep[dot]jose[at]mediatek[dot]com) |
| Futurewei | Yunsong Yang (yyang1@futurewei.com) |
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