3GPP TSG-RAN WG2 #116-e draftR2-210ABCD

**Electronic meeting, 1st – 12th November 2021**

Agenda Item: 8.12.3.1

Source: Apple Inc.

Title: [Draft] Summary of [AT116-e][105][RedCap] eDRX cycles aspects (Apple)

Document for: Discussion and Decision

# Introduction

The document summarizes the following offline discussion:

* [116-e][105][RedCap] eDRX cycle aspects (Apple)

Initial scope: Discuss proposals in AI 8.12.3.1 (skipping those on INACTIVE eDRX >10.24sec and on pure ASN.1 aspects)

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 2021-11-02 2000 UTC

Initial deadline (for rapporteur's summary in R2-2111335): Wednesday 2021-11-03 00:00 UTC

Proposals marked "for agreement" in R2-2111335 not challenged until Wednesday 2021-11-03 1100 UTC will be declared as agreed via email by the session chair (for the rest the discussion will continue online during the CB session).

# Contact information

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| --- | --- |
| Company | Name and email address |
| MediaTek | Pradeep Jose (pradeep dot jose at mediatek dot com) |
| DENSO | Haruhiko.sogabe.j4r@jp.denso.com |
| Xiaomi | Liyanhua1@xiaomi.com |
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# Discussion

## Topics that are likely to have consensus

#### Max eDRX cycle length for INACTIVE

As noted in [1][6][8][12], SA2 confirmed that eDRX cycle length of >10.24sec is not considered for Rel-17.

In SA2’s LS to RAN2 (S2-2106978), SA2 provided their agreements on eDRX for RRC Inactive:

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| * For RRC Inactive, SA2 agreed to support eDRX of up to 10.24s. * Regarding eDRX extension beyond 10.24s for RRC Inactive, SA2 did not agree to support it in Rel-17 and instead will study potential solutions in Rel-18. |

1. Do companies agree that max eDRX cycle length for RRC Inactive is 10.24s in Rel-17?

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| **Company** | **Yes / No** | **Comments** |
| MediaTek | Yes |  |
| DENSO | Yes | Agree to respect SA2 decision. |
| Xiaomi | Yes | Respect SA2 decision |
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#### Relation between INACTIVE and IDLE eDRX configurations

RAN2 has reached agreement the following two configurations are not supported. According to [9] it is better to explicitly capture the restriction (which was FFS from last meeting).

Agreements via email - from offline 105 third round

1. RAN2 considers the configuration as an invalid case, where INACTIVE eDRX cycle is configured but IDLE eDRX cycle is not configured. FFS whether to capture this restriction in RAN2 spec.
2. RAN2 considers the configuration as invalid case, where INACTIVE eDRX cycle is longer than IDLE eDRX cycle. FFS whether to capture this restriction in RAN2 spec.

In [6], one company proposes that TS38.304 can include a table depicting the interpretation of the DRX cycle in different configurations, along with adding a NOTE to the configurations that are not allowed, including the above.

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| **UE**  **in** | **eDRX configured by upper layer** | **eDRX configured by RRC layer** | **UE specific (e)DRX configured by**  **upper layer** | **UE specific (e)DRX configured by**  **RRC layer** | **Default DRX value** |
| **RRC\_IDLE** | **None** | **None** | Applies if it is the shortest of the configured ones (legacy operation). | | |
| **Less or equal to 1024 rf** | **None, or**  **any value** | Applies | NA | NA |
| **More than 1024 rf** | **None, or**  **any value** | Applies during PTW if it is the shortest of the configured ones. | NA | Applies during PTW if it is the shortest of the configured ones. |
| **RRC\_INACIVE** | **None** | **None** | Applies if it is the shortest of the configured ones (legacy operation). | | |
| **Less or equal to 1024 rf** | **None** | FFS-1 | FFS-1 | FFS-1 |
| **Less or equal to 1024 rf** | **Less or equal to 1024 rf** | Applies if it is the shortest of the configured ones. | | NA |
| **Less or equal to 1024 rf** | **More than 1024 rf** | NA (note-1) | NA (note-1) | NA (note-1) |
| **More than 1024 rf** | **None** | * During CN configured PTW, applies if it is the shortest of the configured ones. * Outside of CN configured PTW, NA | * During CN configured PTW, applies if it is the shortest of the configured ones. * Outside of CN configured PTW, FFS-2 | * During CN configured PTW, applies if it is the shortest of the configured ones. * Outside of CN configured PTW, FFS-2 |
| **More than 1024 rf** | **Less or equal to 1024 rf** | * During CN configured PTW, applies if it is the shortest of the configured ones. * Outside of CN configured PTW, NA | * During CN configured PTW, applies if it is the shortest of the configured ones. * Outside of CN configured PTW, applies eDRX one | * During CN configured PTW, applies if it is the shortest of the configured ones. * Outside of CN configured PTW, NA |
| **More than 1024 rf** | **More than 1024 rf** | NA (note-2) | NA (note-2) | NA (note-2) |

1. Companies are requested to provide views on the below:

**2.1** Add to TS 38.304 the above table summarizing how T is determined for a UE in RRC\_IDLE and RRC\_INACTIVE with different DRX cycle configurations.

**2.2** Agree to capture the configuration restrictions from the below into the specification?

Agreements via email - from offline 105 third round

RAN2 considers the configuration as an invalid case, where INACTIVE eDRX cycle is configured but IDLE eDRX cycle is not configured.

RAN2 considers the configuration as invalid case, where INACTIVE eDRX cycle is longer than IDLE eDRX cycle.

**2.3** If yes to 2.2, agree to include this in the table from 2.1?

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| **Company’s name** | **Do companies agree to** | | | **Comments, suggestions if any, for each of the items** |
| **2.1** | **2.2** | **2.3** |
| MediaTek | No | Yes | No | We are concerned that the table could be confusing and difficult to maintain. Agreements can be captured in a note. |
| DENSO | Y | Y | Y | Support to capture the table, e.g. in the Annex section to see the whole picture of possible eDRX configurations. |
| Xiaomi | No | Yes | No | We do not think a table is needed as long as we put it clearly in the context of the spec. |
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#### RAN and CN paging PO non-overlap topic

In [9] one company brings out the CN/RAN PO non-overlap issue from the below formula:

*The PF and PO for paging are determined by the following formula:*

*SFN for the PF is determined by:*

*(SFN + PF\_offset) mod T = (T div N)\*(UE\_ID mod N)*

*Index (i\_s), indicating the index of the PO is determined by:*

*i\_s = floor (UE\_ID/N) mod Ns*

According to definition of N (the number of total paging frames in T), different T results in different N. Thus, the PO determined for RRC\_IDLE and RRC\_INACTIVE may be different if Ns is not 1.

In NR control plane discussion in last RAN2 meeting, following agreement is reached to address this problem, with the solution being that the **UE in RRC\_INACTIVE should use the same i\_s to determine PO as for RRC\_IDLE**:

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| * **We introduce a solution, from R17, where the following is the baseline:**    + - **R2-2109077 Solution 2 (i.e. UE in RRC \_INACTIVE should use the same i\_s to determine PO as for RRC \_IDLE) is supported to address the RAN and CN paging PO non-overlap problem.**     - **UE capability should be introduced to indicate support for using the same i\_s in PO determination in RRC \_INACTIVE state as in RRC \_IDLE state.** |

In the same paper from [9], the company proposes that for the below 4 cases, the same solution from NR control plane discussion should be applied for eDRX as well.

1. Companies are requested to provide views on the below sub-proposals:

**3.0 : Do companies think that the PO determination for non-overlapping CN/RN case is also valid and should be applied for eDRX?**

**If yes, do companies agree with the below:**

**3.1 : When IDLE eDRX and INACTIVE eDRX are configured and both cycles are no longer than 10.24s, PO is determined by IDLE eDRX.**

**3.2 : When IDLE eDRX is configured and is no longer than 10.24s, INACITVE eDRX cycle is not configured, PO is determined by IDLE eDRX.**

**3.3: During CN PTW when IDLE eDRX is configured and longer than 10.24s, and INACTIVE eDRX is configured, PO is determined by the shortest value of default paging cycle and UE specific paging cycle if configured by upper layer.**

**3.4 : During CN PTW when IDLE eDRX is configure and is longer than 10.24s, INACTIVE eDRX cycle is not configured, PO is determined by the shortest value of default paging cycle and UE specific paging cycle if configured by upper layer.**

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| **Company’s name** | **Do companies agree to** | | | | | **Comments, if any** |
| **3.0** | **3.1** | **3.2** | **3.3** | **3.4** |
| MediaTek | Yes | Yes | Yes | Yes | Yes | It seems that PO mismatch issue can also exist in some eDRX cases, which can be resolved similar to the legacy I-DRX solution: do not consider RAN paging for PO determination. |
| DENSO | Y | Y | Y | Y | Y |  |
| Xiaomi | Y | Y | Y | Y | Y | We agree with this intention. |
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In the same paper from [9], the company also proposes a UE capability for both eDRX and non eDRX supporting UEs. While the moderator thinks that the support for non-eDRX supporting UEs might be out of scope of the RedCap session, it is wise to get views from companies:

1. Assuming that the PO determination for non-overlapping CN/RN case is also valid and should be applied for eDRX, companies are requested to provide views on the below:

**4.1 : Since a new UE capability is already agreed to be supported for non-eDRX UEs, the UE capability on PO determination for non overlapping CN/RN case for eDRX supporting UEs, is needed**

**4.2 : (assuming a ‘yes’ for 4.1) the support of eDRX by the UE also indicates the UE capability on PO determination for non overlapping CN/RN case and no new capability is needed. Pls note: there is no explicit capability (so far) for eDRX support in RAN.**

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| **Company’s name** | **Do companies agree to** | | **Comments, suggestions if any, for each of the items** |
| **4.1** | **4.2** |
| MediaTek | Yes | Yes | We assumed that eDRX capability would anyway be introduced in Rel-17. As the PO mismatch problem will not be present for eDRX from the beginning, and all UEs supporting eDRX would apply the solution in DP 3, a separate capability is not needed. |
| DENSO | Y | Y | The new UE capability for non-eDRX UE together with the eDRX capability via NAS can cover the eDRX non-overlapping CN/RN case. |
| Xiaomi | Y | Y | UEs supporting e-DRX in R17 would naturally apply the solution to avoid mismatching. |
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#### PTW\_Start calculation

In the last meeting, progress in terms of agreements were done on PH and PTW\_end calculation, and the PTW length and step length are also agreed.

But for PTW\_start the below working assumption with the FFS was reached:

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| **Working Assumption:**   1. When IDLE eDRX cycle is longer than 10.24s, CN PTW\_start calculation formula defined in LTE is re-used as the baseline, as below. FFS whether CN PTW\_start position could be configurable by network and in case which node decides the N value. Note: this formula would be revisited if INACTIVE eDRX cycle can be above 10.24s   PTW\_start denotes the first radio frame of the PH that is part of the PTW and has SFN satisfying the following equation:  SFN = 1024/N\* ieDRX, where  ieDRX = floor(UE\_ID\_H /TeDRX,H) mod N  FFS N = 4 or 8, FFS if N can take other values |

Regarding the value of N, the companies views are divergent. [4][6][14] prefer the LTE operation with N=4, while [8][9][13] prefer a fixed value of N=8, while some other companies are ok with a configurable value, and some also propose that this value is given to the CN by RAN.

The moderator would like to first check if there are any objections to the working assumption and then proceed to get company views on the value of N.

1. companies are requested to provide views on the below:

**5.1 : Do companies object to the working assumption?**

**If no to 5.1:**

**5.2 : N=4?**

**5.3 : N=8?**

**5.4 : N= 4 or 8, configurable by the RAN**

**5.5 : N can be other values, configurable by the NW (pls add info in comments).**

**5.6 : RAN informs CN about N (if N is variable)**

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| **Company’s name** | **Do companies agree to** | | | | | | **Comments, if any** |
| **5.1 (object to WA)?** | **5.2**  **N=4** | **5.3**  **N=8** | **5.4**  **N=4 or 8 configurable by RAN** | **5.5**  **N can have other values configurable by RAN** | **5.6**  **RAN informs CN about N (if N is variable)** |
| MediaTek | No |  | Yes |  |  |  | In Rel-17, for simplicity, we can go with N=8, that resolves unused time gaps during PTW, and has minimal impact on signalling/CT1. |
| DENSO | N | N | N | Y | Open | N | On 5.5, fine to add more values, albeit there are not any other values than 4 and 8 proposed from our side.  On 5.6, CN should decide the value of N, instead of RAN, since the other eDRX parameters (eDRX cycle, PTW length) are determined by CN in case of LTE eDRX. |
| Xiaomi | No | Yes |  |  |  |  | We think currently using the LTE way is sufficient.  If we want to change this, we need to confirm with CT1/SA2 first. |
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#### UE\_ID topic

Assuming the calculation from discussion point 5 is changed from working assumption to an agreement, there are some open items on the UE\_ID calculation (UE\_ID\_H as well as UE\_ID itself).

In [8][13][14], companies proposed that UE\_ID\_H follows the same hashed UE ID calculation from the UE\_ID formula from LTE. While in [3], one company proposes to change the UE\_ID used for eDRX claiming that UEs can be mapped only to 1024 POs and other POs will remain unused in eDRX with N=1024.

1. companies are requested to provide views on the below:

**6.1 : Do companies agree to the using the same LTE hashed UE\_ID calculation for UE\_ID\_H for NR?**

**6.2 : Separate from the PTW/PH (i.e., irrespective of whether PTW/PH is used or not) do companies agree to the proposal that for extended DRX, the UE\_ID is given by 5G-S-TMSI mod 4096**

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| **Company’s name** | **Do companies agree to** | | **Comments, suggestions if any, for each of the items** |
| **6.1** | **6.2** |
| MediaTek | Yes | Yes |  |
| DENSO | Y | Y | Although 6.2 is O.K, the similar issue is supposed to be discussed for the paging sub-grouping under the ePower saving WI. The details have to be discussed for further. |
| Xiaomi | Yes | Yes |  |
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## System Information Related

#### Applicable DRX cycle for SI modification period

In RAN2#113bis-e, RAN2 made the following agreements on eDRX acquisition period and about taking the LTE as the baseline.

1. RAN2 confirms that SI modification mechanism from LTE is used as a baseline for SI change (other than ETWS and CMAS), i.e. by using an eDRX acquisition period and a flag to indicate SI modification for eDRX in Short Message (e.g. systemInfoModification-eDRX)

There are several open items related to the eDRX acquisition period and if there would be any diff between eDRX in IDLE and INACTIVE, esp with different possible configurations. Also, the decisions made here affect the DRX cycle calculation (T) for the two open items (which would be discussed in the later sections).

We start with the topic of which DRX cycle the UE should compare with the modification period to decide if the eDRX acquisition period is to be used. [7] proposes to reuse the LTE method and the same theme is maintained in [13] as well. In [4] a different method is proposed.

1. companies are requested to provide views on the below:

**Which DRX cycle the UE uses for comparing with the modification period to decide if the eDRX acquisition period is to be used:**

**Op7.1 : LTE style : CN\_eDRX for both RRC\_IDLE and RRC\_INACTIVE**

**Op7.2 : CN eDRX for RRC\_IDLE, and RAN eDRX if configured for RRC\_INACTIVE (CN\_eDRX in RAN eDRX is not configured)**

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| **Company’s name** | **Do companies agree to** | | | **Comments, suggestions if any, for each of the items** |
| **Op 7.1** | **Op 7.2** | **Others (pls provide more info in comments)** |
| MediaTek |  | Yes |  | Because the difference between the maximum eDRX cycles for IDLE and INACTIVE is large, we think different values can be used unless there are any critical issues. |
| DENSO | Y | N |  | To simply the UE behaviour. Not sure if the SI update is critical for RedCap UEs. |
| Xiaomi | Y |  |  | Since currently the RAN e-drx cycle is below 10.24s, we can reuse LTE. We can further study if RAN e-DRX cycle beyond 10.24s is introduced. |
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#### eDRX acquisition period value

In [13] one company proposes that the eDRX acquisition period should be set to the maximum configurable value of the eDRX cycle, while in [2] an different view point is presented (which deviates from the LTE logic) in that the eDRX acquisition period is different for INACTIVE and IDLE (stating that UE monitors the RAN/INACTIVE paging cycle in INACTIVE, and that this can be used for SI change reception).

1. companies are requested to provide views on the below:

**Op 8.1 : eDRX acquisition period should be set to the maximum configurable value of the eDRX cycle**

**Op 8.2 : Introduce separate eDRX acquisition periods and SI modification indications for RRC idle UEs and RRC inactive UEs.**

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| **Company’s name** | **Do companies agree to** | | | **Comments, suggestions if any, for each of the items** |
| **Op 8.1** | **Op 8.2** | **Others (pls provide more info in comments)** |
| MediaTek | Yes | No |  | Inactive eDRX cycle can be compared against the existing SI modification period so that the UE will only use the longer value (e.g. eDRX acquisition period) if the Inactive eDRX cycle is longer than the existing SI modification period (unlikely as the Inactive eDRX values are quite short). |
| DENSO | Y | N |  | Same reason as the discussion point 7. |
| Xiaomi | Yes |  |  | The same as in LTE. |
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It is the view of the moderator, that depending on the direction discussion topic 8 goes, further details on this in terms of applicability in various cases (if needed) would be discussed later.

#### On-Demand SI

In [3] one company proposes that the on-demand for SI acquisition for UEs with eDRX configuration. The moderator wants to check the companies view to see if this is worth pursuing.

1. Do companies agree that for SI update of eDRX UEs configured to use DRX cycle longer than modification period, on-demand SI request is reused, with details and further enhancements as FFS.

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| **Company** | **Yes / No** | **Comments** |
| MediaTek | Maybe | Whether on-demand SI request can also be used needs further discussion, and signaling overhead may need to be considered. However, LTE baseline (eDRX acquisition period) should be the baseline. |
| DENSO | No | For UEs configured with the long eDRX cycle, it can be assumed that the service is delay tolerant. Therefore, the delay of acquiring SIB is not so urgent. |
| Xiaomi | - | Not sure. LTE baseline e-DRX acquisition should be the baseline. |
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## DRX (T) cycle determination for the FFS case

And finally the open item from the last meeting on the UE determination of T for the below FFS case. The arguments for/against both option-1/2 were already discussed in the last meeting.

Agreements online:

1. For RRC\_INACTIVE UE, when IDLE eDRX cycle is no longer than 10.24s and INACTIVE eDRX cycle is not configured, FFS which option below is adopted for paging monitoring:

Option 1: T is determined by the shortest of RAN paging cycle, IDLE eDRX cycle, and default paging cycle.

Option 2: T is determined by the shortest of RAN paging cycle and IDLE eDRX cycle.

1. For RRC\_INACTIVE UE, when IDLE eDRX cycle is longer than 10.24s and INACTIVE eDRX cycle is not configured, outside CN PTW, FFS which option below is adopted for paging monitoring:

Option 1: T is determined by the shortest of RAN paging cycle and default paging cycle.

Option 2: T is determined by RAN paging cycle.

While many companies (that have submitted papers on this) preferred op2 for both scenarios [13][12][9][8][7][5][2] (with main reason being that it’s aligned with LTE), in [1][4][6][14] op1 is preferred.

However, there are (at least in the moderator’s view) some items that might need consideration when discussing this topic:

1. The eDRX support is optional for the gNB (meaning there could be gNBs that support and configure to RedCap UEs, but do not support eDRX – so would NOT configure eDRX for INACTIVE)
2. We can have non RedCap UE supporting eDRX (this is not precluded as of now) and these UEs could be handle by gNBs that do not support RedCap (as well as gNBs that do).
3. Forcing the UE to include ‘default paging cycle’ into the determination of T implies that SI change update is important for the UE (redcap or non-redcap with eDRX support) and important enough to have the UE also monitor the default paging cycle outside of PTW: In other words, if the NW allowed the UE to operate in CN-eDRX mode, is the SI update critical for the UE during RAN inactive (while it isn’t during RAN eDRX – if configured by the gB).
4. Also the discussion on the SI update from 3.2 might be a factor in this discussion.

The moderator requests the companies to provide their (initial) view on which of Op1/Op2 is needed, also noting that the same option for scenarios is preferred (as also voiced in [15]).

1. Companies are requested to input which option for both the FFS scenarios:

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| **Company’s name** | **Which option do companies prefer? (pls justify if the same option is not selected for both scenarios).** | | **Comments** |
| **Option for RRC\_INACTIVE without eDRX, while eDRX for IDLE is 10.24 or lower**  Op1: T is determined by the shortest of RAN paging cycle, IDLE eDRX cycle, and default paging cycle.  Op2: T is determined by the shortest of RAN paging cycle and IDLE eDRX cycle. | **Option for RRC\_INACTIVE without eDRX, while eDRX for IDLE is more than 10.24**  Op1: T is determined by the shortest of RAN paging cycle, and default paging cycle.  Op2: T is determined by the RAN paging cycle |
| MediaTek | Op2 | Op2 | Any possibility of missed SI change notification can be resolved by introducing an eDRX acquisition period.  Op2 aligns with LTE.  Op1 does not give the network any chance to configure the UE with T > default paging cycle, which reduces the benefit of eDRX in Inactive. |
| DENSO | Op2 | Op2 | If the service is delay tolerant for RedCap UEs, SI update may not be critical. |
| Xiaomi | Opt2 | Op2 | Op2 aligns with LTE. We do not see strong reason to deviate from LTE way. |
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## Others

1. Any other relevant issues need to be discussed?

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| **Company** | **Issue description** |
| Xiaomi | We want to confirm with people whether we need to differentiate gNB’s capability for idle mode e-DRX or for inactive mode e-DRX.  An example is UE with an idle mode e-DRX with a CN PTW moves to a gNB not supporting idle mode e-DRX will trigger CN PTW disabled while may be not impacted under a gNB not supporting inactive mode e-DRX. |
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# Summary

TBD

# References

1. R2-2109449 Remaining issues on eDRX Qualcomm Incorporated discussion Rel-17 FS\_NR\_redcap
2. R2-2109495 Discussion on eDRX for RedCap Ues OPPO discussion Rel-17 NR\_redcap-Core
3. R2-2109537 UE\_ID for extended DRX cycle and SI update aspects Samsung Electronics Co., Ltd discussion Rel-17 NR\_redcap-Core
4. R2-2109578 eDRX for RedCap UE Huawei, HiSilicon discussion Rel-17 NR\_redcap-Core
5. R2-2109649 Discussion on e-DRX for Redcap Devices Beijing Xiaomi Mobile Softwar discussion
6. R2-2109671 Leftover issues for eDRX Intel Corporation discussion Rel-17 NR\_redcap
7. R2-2109699 Further Discussion on eDRX for NR RRC Inactive and Idle CATT discussion Rel-17 NR\_redcap-Core
8. R2-2109743 Discussion on eDRX for RedCap UEs vivo, Guangdong Genius discussion Rel-17 NR\_redcap-Core
9. R2-2109898 Discussion on eDRX for RedCap UE ZTE Corporation, Sanechips discussion Rel-17 NR\_redcap-Core
10. R2-2110151 Leftover issues on derivation of PTW\_start DENSO CORPORATION discussion Rel-17 NR\_redcap-Core
11. R2-2110331 Consideration on eDRX for RedCap UE Lenovo, Motorola Mobility discussion Rel-17
12. R2-2110584 Discussion on eDRX for RRC\_IDLE and RRC\_INACTIVE LG Electronics UK discussion Rel-17
13. R2-2110755 Remaining issues for eDRX MediaTek Inc. discussion Rel-17 NR\_redcap-Core
14. R2-2111099 Extended DRX for Reduced Capability UEs Ericsson discussion NR\_redcap-Core
15. R2-2111129 Remaining issues in paging monitoring Samsung discussion Rel-17