**3GPP TSG-RAN WG2 Meeting #124** **R2-230xxxx**

**Chicago, U.S.A, 13th-17th November, 2023**

**Agenda item: 7.3.1**

**Source: InterDigital (Rapporteur)**

**Title: Report of [Post123bis][022][NES] 38.321 Running CR (Interdigital)**

**Document for: Discussion and Decision**

# Introduction

This document collects the comments received during the following email discussion on the draft MAC CR for NES as well as remaining open issues:

* [POST123bis][022][NES] 38.321 Running CR (Interdigital)

Scope:

- Review running CR

- Identify open issues

- Get inputs for subset of open issues (focus on more detailed open issues that would help with CR finalisation.

Deadline: long

## Contact information:

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# Discussion on TS 38.321 running CR

Companies can provide comments and suggestions to the uploaded running CR in this table. Please do not add changes, suggestions, or comments directly to the draft CR document.

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| Company + Issue Number (e.g., ID001) | Issue | Comments and proposed changes |
| A001 | Some IE name inconsistency between RRC parameter list (e.g. *celldtxdrx-Cycle)* and procedure text (e.g.  "- *celldtx-onDurationTimer* is running for the associated Serving Cell."  The issue happens in both 5.x.1 and 5.x.2. | [Rapporteur]: corrected in v01. Thanks |
| A002 | Followed by A001, maybe we can optimize the spec structure by having a separate sub-section on "general" including common RRC parameter list and 1st paragraph of 5.x.1 (i.e. general description on Cell DTX) and 5.x.2 (general description on Cell DRX). | [Rapporteur]: suggestion adopted in v01. |
| Xiaomi-001 | Legacy SP CSI reporting on PUCCH Activation/Deactivation MAC CE reception issue. | it is not clear whether the legacy SP CSI reporting on PUCCH Activation/Deactivation MAC CE is also received or not.  If no, a note is needed to say, e.g., the UE does not expect to receive SP CSI reporting on PUCCH Activation/Deactivation MAC CE reception if at least one CSI report is configured with sub-configuration for the concerned serving cell id and BWP ID. |

# Remaining MAC open issues

* 1. CG bundled transmissions

The following MAC open issue was identified before R2#123bis:

**Issue 3:** **whether to allow CG bundle transmission if only a part of a bundle overlaps with cell DRX Active Period.**

In the draft running MAC CR [2], the UE doesn’t deliver the CG to the HARQ entity if the CG is not in the Active Period. For bundled CG transmissions, one possibility is that the UE transmits only a subset of the repetitions that do not overlap with non-active period, while another possibility is the UE transmits the repetition bundle only if the whole bundle falls within the active period. The draft running CR thus captures the following editor’s note:

Editor’s note: FFS whether to allow configured grant bundle transmission for the case that only a part of a bundle overlaps with cell DRX Active Period.

So far, the R2 agreement on not transmitting on CG during non-active period was general for all transmissions and did not differentiate between repetitions and non-repetitions. This issue was discussed online during RAN2 123bis without conclusion. The following options were outlined:

* **Option 1:** No special handling needed for repetition/bundling grant [4]:
  + even if the first transmission is not within the Active Time, following repetitions could be also for initial transmission with certain RV patterns, as per already specified legacy behaviour. if the following repetitions cannot be used for initial transmission if no TB is obtained, it is already specified legacy behaviour as well.
  + Nothing additional needs to be captured in TS 38.321, and the editor’s note is removed.
* **Option 2:** In case of CG bundle, the UE transmits CG-PUSCH only if all the CG occasions within a bundle completely overlaps with cell DRX Active Time [3].
* **Option 3:** UE performs the transmission within a bundle of the configured grant regardless the cell is in Cell Transmission ON or OFF duration [5].
* **Option 4:** leave it up to RAN1 to decide if anything is needed.

**Question 1: Which of the following options do you prefer?**

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| **Company** | **Preferred Options** | **Comments** |
| Apple | Option 1 or Option 4 | 1. As discussion online, similar issue was discussed in Rel-16/Rel-17 in intra-UE prioritization. And the UE behavior was captured in RAN1 spec (Section 6.1.2.1 of TS 38.214). We assume similar behavior can be reused for Cell DRX, but it should be RAN1 decision as similar case was captured in RAN1 spec. Thus, we think nothing needs to be captured in TS 38.321.  2. In RAN1#114b, RAN1 also discussed this issue in offline although no conclusion was made. |
| Xiaomi | Option 4 | It is RAN1 issue because it will impact the performance. |
| Fraunhofer | Option 4 | In our view this should be left for RAN1 discussion |

* 1. SP CSI reporting on PUCCH Activation MAC CE

RAN1 has been working on spatial and power domain adaption for NES, per the WI objective in [1]. For semi-persistent CSI reporting on PUCCH, the MAC CE design agreed by R1 needs to indicate sub-configuration selection, corresponding to the following RAN1 agreements in RAN1 #113:

**Agreement**

For N>=1 CSI reporting corresponding to N out of L sub-configurations in one reportConfig where each sub-configuration corresponding to an SD adaptation pattern or/[and] a powerControlOffset value,

* For SP-CSI on PUCCH report, support MAC-CE-based triggering
* For MAC-CE based triggering
  + - Opt 2: An indication to select to N sub-configurations in a MAC-CE is supported
    - It is up to RAN2 to decide the signaling designs of the MAC-CE (including whether it is a new MAC CE or an existing MAC CE)
    - Only one MAC CE is used for this triggering

Subsequently, an LS [6] was received towards the end of RAN2#123bis:

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| **1. Overall Description:**  RAN1 has discussed the SP-CSI reporting related issues and made the following agreements  • From RAN1 perspective, up to 4 CSI report configurations can be configured in a BWP for SP CSI reporting on PUCCH where one or more report configurations can contain a list of sub-configuration(s).  Furthermore, it is agreed that  • For the max number of sub-configurations Lmax in one CSI report configuration, the maximum value of Lmax is no larger than 8 for semi-persistent CSI reporting on PUCCH  • For report of N CSI(s) in one SP-CSI report where each CSI corresponds to one sub-configuration, the maximum value of N is no larger than 4 for semi-persistent CSI reporting on PUCCH.  **2. Actions:**  **To RAN2:**  **ACTION: RAN1 kindly ask RAN2 to take the above into account in their future work related to the MAC-CE design for SP-CSI reporting for Rel-18 NES.** |

The following was agreed in RAN2 123bis for the MAC CE design:

**Agreements:**

1. design a new MAC CE for activating/deactivating SP CSI report configurations and selecting N out of L subconfigurations for each CSI reportconfiguration.
2. The new MAC CE can be used to activate/deactivate configuration and sub-configuration. One new bit per sub-configuration will be added to activate/deactivate.

During the online discussion, it was suggested to provide a sample for the MAC CE format to avoid having many formats submitted to the next meeting. The rapporteur is thus providing the following sample as a baseline, based on the agreements above:

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| 6.1.3.y Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE The enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE is identified by a MAC subheader with eLCID as specified in Table 6.2.1-1. It has a variable size and consists of the following fields:  - Serving Cell ID: This field indicates the identity of the Serving Cell for which the MAC CE applies. The length of the field is 5 bits;  - BWP ID: This field indicates a UL BWP for which the MAC CE applies as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9]. The length of the BWP ID field is 2 bits;  - Si: This field indicates the activation/deactivation status of the Semi-Persistent CSI report configuration within *csi-ReportConfigToAddModList*, as specified in TS 38.331 [5]. S0 refers to the report configuration which includes PUCCH resources for SP CSI reporting in the indicated BWP and has the lowest *CSI-ReportConfigId* within the list with type set to *semiPersistentOnPUCCH*, S1 to the report configuration which includes PUCCH resources for SP CSI reporting in the indicated BWP and has the second lowest *CSI-ReportConfigId* and so on. If the number of report configurations within the list with type set to *semiPersistentOnPUCCH* in the indicated BWP is less than i + 1, MAC entity shall ignore the Si field. The Si field is set to 1 to indicate that the corresponding Semi-Persistent CSI report configuration shall be activated. The Si field is set to 0 to indicate that the corresponding Semi-Persistent CSI report configuration i shall be deactivated;  - Ei: This field indicates whether (de)-activation for additional subconfigurations within the Semi-Persistent CSI report configuration *CSI-ReportConfigId* i is indicated. If Ei set to 1, the octet corripsonding to Ni,0 to Ni,7 is present. If Ei set to 0, the octet correspsonding to Ni,0 to Ni,7 is not present.  - Ni,x: this field indicates the activation/deactivation status of the Semi-Persistent CSI report SubConfiguration x within *csi-ReportSubConfigList* of *CSI-ReportConfigId* i, as specified in TS 38.331 [5]. N0,0 refers to the report SubConfiguration which includes PUCCH resources for SP CSI reporting in the indicated BWP and has the lowest *csi-ReportSubConfigID* within the list with type set to *csi-ReportSubConfigList*, N0,1 to the report SubConfiguration which includes PUCCH resources for SP CSI reporting in the indicated BWP and has the second lowest *csi-ReportSubConfigID* and so on. If the number of report configurations within the list with type set to *csi-ReportSubConfigList* in the indicated BWP is less than x + 1, MAC entity shall ignore the Ni,x field. The Ni,x field is set to 1 to indicate that the corresponding Semi-Persistent CSI report SubConfiguration x shall be activated. The Ni,x field is set to 0 to indicate that the corresponding Semi-Persistent CSI report SubConfiguration x shall be deactivated;  - R: Reserved bit, set to 0.    **Figure x: Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE** |

E bits indicate whether to activate the additional reporting of CSI sub-configurations for a given configuration, in addition to S bits, which indicate activation of CSI configurations per legacy. N bits indicate which subconfigurations are activated. Per RAN1’s agreements, some report configurations can be optionally configured with *csi-ReportSubConfigList* for CSI reporting of the subconfigurations. The UE can thus receive a combination of legacy activation of CSI configurations without *csi-ReportSubConfigList* and configurations configured with *csi-ReportSubConfigList* in the same MAC CE, as the R1 agreement states “Only one MAC CE is used for this triggering”. An alternative is to re-use S bits for both activation of SP CSI reporting for the configuration and also reporting for the configured subconfigurations, instead of using E bits, but this would require handling the cases where some configurations are not configured with *csi-ReportSubConfigList*.

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| Company | Comments or proposed changes |
| Apple | We support the variable length MAC-CE format suggested by Rapporteur. Only one comment: below RAN1 agreement also needs to be implemented:  • For report of N CSI(s) in one SP-CSI report where each CSI corresponds to one sub-configuration, the maximum value of N is no larger than 4 for semi-persistent CSI reporting on PUCCH.  Our understanding above agreement means: for one report config, 8bit bitmap is needed as Rapporteur suggested (e.g. N07-N00 for 1st report config) but only up to 4bit among 8bit can be set to 1 (i.e. activated number of sub-configuration is no larger than 4).  [Rapporteur]: I was not sure we need to capture this max four 1s in the bitmap restriction part of the MAC CE design or not, given the NW indicates these. We can add more description in the Ni,x part for this if companies think so. |
| Xiaomi | First, the new MAC CE is addressed by eLCID, not LCID.  [Rapporteur]: corrected to eLCID above. Thanks  Second, the new MAC CE is variable size the correct format of the MAC CE is like as below, no optional indication:    Third, whether the Ei bit is needed?  In my understanding, if the Ei bit is set to 1, the Si bit should also be set to 1. There is a relationship between Si bit and Ei bit. The text is needed for the relationship.  The key point is how to handle the CSI report without sub-configuration.  **Option 1**: The Si filed indicates the CSI report trigger and if the Si is set to 1, then the corresponding sub-configuration trigger filed will be included in the new MAC CE.  **Option 2**: The Si filed indicates the CSI report trigger and if the Si is set to 1 and the sub-configurations are configured for this report, then then the corresponding sub-configuration trigger filed will be included in the new MAC CE.  If there is only Si bit and if the Si bit for CSI report without sub-configuration is set to 1, the N bitmap is also included and is set to 0.  So we prefer option 1 and think the Ei bit is not needed. |
| Fraunhofer | We agree with Xiaomi that the Si bits can control directly the presence of the subconfigurations octets. And within that framework option 1, proposed by Xiaomi |

* 1. Cell DTX/DRX impact on MAC timers

The following issue was identified part of the list of open issue prior to RAN2 123bis:

**[MAC] Issue 7: Any other impact on MAC timers.**

More specifically, the following enhancements were proposed:

* CG and CGRT timers: stopping/pausing the timer during the cell DTX non-active period. The following was proposed:
  + Discuss the potential handling on CGRT and CGT during the cell DRX inactive period (e.g. suspension of the CGRT and CGT). [7]
  + The configuredGrantTimer and cg-RetransmissionTimer should be stopped or paused during cell DRX non-active period. [8]
  + ConfiguredGrantTimer and cg-RetransmissionTimer are suspended at Cell DRX Non-Active Time. [9]
  + Rapporteur comment: in RAN2 123bis, we agreed that “The case that Cell DRX activation is received between delivering a configured grant to the HARQ entity and HARQ processing for the CGO will not be addressed by RAN2, as it is not valid for the MAC model”, which means that the CG is not delivered to the HARQ entity if the PUSCH duration overlaps with the cell DRX non active period and also the TB is not obtained. These timers are only started when a TB is obtained, thus are not started during the non-active period. Further, these timers are typically restarted upon reception of dynamic scheduling (e.g. upon reception of a DG addressed to the UE’s CS-RNTI or C-RNTI), and that should not be changed.
* DRX Inactivity timer: stopping/pausing the timer during the cell DTX non-active period. The following was proposed:
  + Define new conditions for UE behaviour changes when cell DTX non-active period starts during the C-DRX related timer is running, i.e. the drx-InactivityTimer and HARQ timer should be stopped/paused. [8]
  + drx-InactivityTimer or bwp-InactivityTimer can be suspended if it does not expire when the cell DTX/DRX enters non-active period. [10]
  + Rapporteur comment: keeping the inactivity timer running during the non-active period allows the gNB to schedule further data past the On duration expiry, though comes with UE power consumption.
* DRX HARQ RTT timers: The following was proposed:
  + Define new conditions for UE behaviour changes when cell DTX non-active period starts during the C-DRX related timer is running, i.e. the drx-InactivityTimer and HARQ timer should be stopped/paused. [8]
    - HARQ RTT timers are stopped/paused the timer during the Cell DTX/DRX non-active period; timers can be resumed/restarted in Cell DTX/DRX active period
  + Rapporteur comment: we already agreed to keep the DRX retransmission timers running during the non-active period to allow the gNB to complete retransmissions of pending HARQ processes. DRX retransmission timers only start after the expiry of the DRX HARQ RTT timers. This enhancement thus kind of reverts an existing agreement. Further, delaying the start of the HARQ RTT timer to the start of the cell On duration timer creates an unnecessary time offset from when the UE starts to monitor PDCCH (i.e. a HARQ RTT period after the start of the cell DTX On duration timer starts).
* BWP inactivity timer and SCell deactivation timer: the following was proposed:
  + The bwp-InactivityTimer and sCellDeactivationTimer should be paused during cell DTX non-active period and resumed during cell DTX active period to decrease unnecessary BWP fallback and SCell deactivation. [8]
  + drx-InactivityTimer or bwp-InactivityTimer can be suspended if it does not expire when the cell DTX/DRX enters non-active period. [10]

**Question 2: Which of the following proposed enhancements to MAC timers, if any, do you support?**

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| **Company** | **Timer(s)** | **Comments** |
| Apple | CG and CGRT timers (if running before entering non-active duration of Cell DRX) | 1. On CG/CGRT, we agree with Rapporteur's analysis that CG/CGRT is not restarted during non-active duration of Cell DRX because "These timers are only started when a TB is obtained, thus are not started during the non-active period". But we think there is a special case: the UE has transmitted CG before entering non-active duration, so CGT is already started and running after the UE enters non-active duration of Cell DRX. To address this issue, we think a simple way is add one sentence in section 5.x.2:  1> if cell DRX is activated and the Serving Cell is not in the cell DRX Active Period:  2> stop *configuredGrantTimer* and *cg-RetransmissionTimer*, if running.  2> not instruct the physical layer to signal the SR on a PUCCH resource for SR;  2. On DRX Inactivity timer and DRX HARQ RTT timers, we think RAN2 has discussed such kind of modelling (i.e. specify stopping C-DRX timers during Cell DTX inactive duration) but it was not agreed. That is our understanding why MAC CR rapporteur draft the MAC CR in current way. What's more, we don't prefer to change UE behavior related to UE CDRX because it may cause inter-operation issues. In summary, we don't prefer to touch UE CDRX behavior, so these CDRX timers should not have special handling.  3. BWP inactivity timer and SCell deactivation timer. RAN2 discussed similar issues during Rel-16 dormant BWP (which also suspends PDCCH monitoring). And it resulted in no change to these timers (i.e. left to NW implementation to resolve it). |
| Xiaomi | None |  |
| CEWiT | CG and CGRT timers. | These timers are necessary for indication of successful transmissions but there is no PDCCH in the cell DTX/DRX non-active period. Thus its beneficial for these to be paused till non active period and resumes after non active period. |
| Fraunhofer | BWP and SCell timers | BWP and Scell timers could be further discussed for a potential pause during non-active period. |

* 1. Cell DTX UE specific inactivity timer

One FFS left from RAN2#121 is on whether to introduce DTX UE specific inactivity timer: “Pattern configuration for cell DRX/DTX is common for Rel-18 UEs in the cell. FFS whether we have DTX UE specific inactivity timer. FFS on configuration signaling and stage 3.” The issue was then re-discussed in email discussion [11] without reaching enough support.

In RAN2#123 [2], it was agreed that RAN2 focus on the case where Cell DTX can only be configured when UE CDRX is configured: “We focus on the case where DTX in RRC can only be configured when C-DRX is configured. We will not optimize for the case where C-DRX is not configured.”

Further, during the non-active period, the UE already monitors PDCCH when C-DRX retransmission timers are running, , during RACH and when SR is pending. It can thus be sufficient to rely on those timers and behaviours for PDCCH monitoring. However, some companies still propose this enhancement. The following options are therefore possible:

* **Option 1:** not to introduce any new timer for Cell DTX/DRX specific UE inactivity timer.
  + UE already monitors PDCCH when C-DRX retransmission timer is running, the C-DRX inactivity timer is running, during RACH and when SR is pending.
* **Option 2:** UE specific inactivity timer is introduced to extend on duration time of Cell DTX/DRX, i.e. after expiration of the timer, the UE considers the Cell DTX/DRX to be in non-active period.

**Question 3: Which of the following options do you prefer?**

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| **Company** | **Preferred Options** | **Comments** |
| Apple | Option 1 with change | 1. At this stage, we see no valid reason to introduce a new inactivity timer (i.e. Option 2).  2. For option 1, we disagree to introduce new exceptional PDCCH monitoring "when C-DRX inactivity timer is running" because below reasons:   * In our understanding, the existing exceptional PDCCH monitoring "when C-DRX retransmission timer is running" is already a compromise between two camps (high NES gain vs UE QoS).   + The main technique reason to agree this compromise is to help refresh on-going HARQ process and the retransmission time is only a small fraction of the time. * From technique perspective, retransmission timer can already cover duration for gNB to schedule high priority traffic during non-active duration. The benefit to introduce new exceptional PDCCH monitoring on inactivity timer for QoS is quite marginal, but it requires the gNB/UE to wake up more frequently. At this late stage, we don't think RAN2 should do such optimization without clear benefit.   Thus, we suggest to modify Option 1 as:   * **Option 1:** not to introduce any new timer for Cell DTX/DRX specific UE inactivity timer.   + UE already monitors PDCCH when C-DRX retransmission timer is running, ~~the C-DRX inactivity timer is running,~~ during RACH and when SR is pending. |
| Xiaomi | Option 1 | For option 1, the question is whether the extension of cell DTX active duration should be notified to others RRC\_CONNECTED UEs? If the notification is needed then it will result in signalling overhead. If the notification is not needed then the it will result in the unaligned cell DTX operation between UE and network. The other UEs will not share the benefit of the extension of cell DTX active duration.  For option 2, the pattern of cell DTX is up to the semi-static configuration and the mechanism of cell DTX is simple, but the flexibility is lost. |
| Fraunhofer | New Option 3, | First and foremost, it need to be understood what problem we have. Then, if the problem is agreed by everyone we can list and down-select from solutions (which UE specific inactivity timer is just one potential solution).  Our agreements on strict PDCCH monitoring restrictions (for new data) aimed at balancing “high NES gain” vs “UE QoS” and ended up with a very poor trade-off. We affect the “UE QoS” considerably, specially delay only to achieve a very minor “NES gain”. A detailed analysis backed up by simulations was provided in our contribution to R2#123-bis (R2-2311260)  In general, as long as the gNB has data on the buffer there is no NES gain (nor UE power saving gain) in postponing that transmission artificially (restricting scheduling via PDCCH restrictions) but it adversely increases delay. We consider a key issue to still be addressed in Rel-18  Option 2 could be a solution to that, but in our understanding, it is not ideal as it adds a lot to UE complexity and UE power consumption. Instead, we prefer the following option which addresses the problem more directly with less complexity:  **“Option 3 –** explicit signaling to prolong PDCCH monitoring into Cell DTX/DRX non-active time when the gNB deem as needed“  @Rapporteur In order to streamline the discussion we kindly suggest it would it be better to divided the discussion into 2 questions, e.g. “Question 3A – do you agree exceptional PDCCH monitoring behavior (on non-active time) is needed to address data bursts which do not fit the on-duration?” and “3B – If exceptional behavior (3A) is agreed, which option do you prefer?” |

# Conclusion

TBD

# References

1. RP-223540, “New WID: Network energy savings for NR”, Huawei
2. R2-2310233, “Running CR to 38.321 for Network energy savings”, InterDigital
3. R2-2310479, “SPS and Multicast Impacts of Cell DTX/DRX”, Samsung
4. R2-2310685, “Remaining issues on Cell DTX/DRX Nokia”, Nokia Shanghai Bell
5. R2-2307178, “Various (RRC Procedure, Measurement, SR, CG etc.) alignment aspects”, Lenovo
6. R1-2310578, “SP-CSI reporting for network energy savings”, RAN1, Huawei
7. R2-2310982, “UL considerations for Cell DTX/DRX”, NEC Telecom MODUS Ltd.
8. R2-2309998, “Discussion on remaining issues of cell DTX and DRX”, Huawei, HiSilicon
9. R2-2310479, “SPS and Multicast Impacts of Cell DTX/DRX”, Samsung
10. R2-2310262, “Discussion on cell DTX/DRX”, CMCC
11. R2-2302796, “Outcome of [POST121][312][NES] DTX/DRX - Configuration/ activation/ deactivation and alignment”, Huawei, HiSilicon