**3GPP TSG-RAN WG2 Meeting #124** **R2-230xxxx** **Chicago, U.S.A, 13th - 17th November, 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **38.321** | **CR** | DraftCR | **rev** | **-** | **Current version:** | 17.6.0 |  |
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| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:***  | Running CR to 38.321 for Network energy savings |
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| ***Source to WG:*** | InterDigital |
| ***Source to TSG:*** | RAN2 |
|  |  |
| ***Work item code:*** | Netw\_Energy\_NR-Core |  | ***Date:*** | 2023-08-21 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Introduction of Release-18 support for Network Energy Saving (NES), including:* Abbreviation should be added for DTX
* R2 agreed that the UE doesn’t monitor SPS occasions during Cell DTX non-active period. gNB is assumed to be not transmitting PDSCH to that UE on such SPS occasions during the Cell DTX non-active period
* UE does not consider CG occasions during the Cell DRX non-active period, per R2 agreement.
* R2 agreed that the UE does not transmit on CG occasions during Cell DRX non-active periods
* R2 agreed that UE does not transmit SR occasions overlapping with Cell DRX non-active periods, e.g. SR transmissions are dropped during the non-active period
* R2 agreed that UE doesn’t monitor PDCCH for dynamic grants/assignments for new transmissions during Cell DTX non-active period, even if the UE is in C-DRX Active time. When the retransmission timer is running (if C-DRX is configured), the UE is expected to monitor PDCCH, like in legacy
* R2 agreed that a periodic cell DTX/DRX configuration is explicitly signalled to the UEs by RRC configuration. Cell DTX/DRX configuration contains at least: periodicity, start slot/offset, on duration. Cell DTX/DRX is activated/deactivated implicitly by RRC signalling or explicitly by reception of L1 signalling.
* R2 agreed that when the retransmission timer is running (if C-DRX is configured), the UE is expected to monitor PDCCH, like in legacy. i.e., when the DRX retransmission timer is running, the UE should monitor PDCCH regardless of the Cell DTX.
* For NES spatial domain adaptation, RAN1 agreed to support SP-CSI reporting on PUCCH for a subset of subconfigurations within a given SP CSI configuration using a MAC CE.
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| ***Summary of change:*** | A new section self-contained (5.x) is added to capture the agreements on Cell DTX (5.x.1) and Cell DRX configuration (5.x.1), including: activation/de-activation, determination of the Cell DTX/DRX Active periods, and UE behaviour during the non-active period. The following changes have been applied in this running CR to capture agreements for Release-18 Network energy savings for NR up to RAN2#123 meeting:* Abbreviation added for DTX
* Limit SPS PDSCH reception to occasions overlapping with the cell DTX active period, if activated.
* UE doesn’t consider CG occasions not overlapping with the cell DRX active period, if activated. UE doensn’t deliver the UL grant to the HARQ entity during such occasions.
* Limit SR transmission to the Cell DRX active period.
* UE doesn’t monitor PDCCH for dynamic grants/assignments for new transmissions during Cell DTX non-active period, even if the UE is in C-DRX Active time.
* when the DRX retransmission timer is running, a transmitted SR is pending, or RA timers are running, the UE should monitor PDCCH regardless of the Cell DTX.
* Addition of a new MAC CE “Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE” to support activation of CSI reporting on PUCCH for spatial domain CSI sub-configurations.
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| ***Consequences if not approved:*** | The new feature Network Energy Saving can not be well supported by the MAC specification. |
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| ***Clauses affected:*** | 3.2 Abbreviations,5.x Cell-Level Energy Saving 5.x.1 Cell Discontinuous Transmission5.x.2 Cell Discontinuous Reception6.1.3 MAC Control Elements (CEs)6.1.3.y Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | Ver0 in RAN2#123: R2-230xxxx |

====================================CHAGNE BEGINS===================================

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

AP Aperiodic

BFR Beam Failure Recovery

BSR Buffer Status Report

BWP Bandwidth Part

CE Control Element

CG Cell Group

CG-SDT Configured Grant-based SDT

CI-RNTI Cancellation Indication RNTI

CSI Channel State Information

CSI-IM CSI Interference Measurement

CSI-RS CSI Reference Signal

CS-RNTI Configured Scheduling RNTI

DAPS Dual Active Protocol Stack

DCP DCI with CRC scrambled by PS-RNTI

DL-PRS DownLink-Positioning Reference Signal

DTX Discontinuous Transmission

G-CS-RNTI Group Configured Scheduling RNTI

G-RNTI Group RNTI

IAB Integrated Access and Backhaul

INT-RNTI Interruption RNTI

LBT Listen Before Talk

LCG Logical Channel Group

LCP Logical Channel Prioritization

MBS Multicast/Broadcast Services

MCCH MBS Control Channel

MCCH-RNTI MBS Control Channel RNTI

MCG Master Cell Group

MPE Maximum Permissible Exposure

MTCH MBS Traffic Channel

NCD-SSB Non Cell Defining SSB

NSAG Network Slice AS Group

NUL Normal Uplink

NZP CSI-RS Non-Zero Power CSI-RS

PDB Packet Delay Budget

PEI-RNTI Paging Early Indication RNTI

PHR Power Headroom Report

PS-RNTI Power Saving RNTI

PTAG Primary Timing Advance Group

PTM Point to Multipoint

PTP Point to Point

QCL Quasi-colocation

PPW PRS Processing Window

PRS Positioning Reference Signal

RA-SDT Random Access-based SDT

RS Reference Signal

SCG Secondary Cell Group

SDT Small Data Transmission

SFI-RNTI Slot Format Indication RNTI

SI System Information

SL-RNTI Sidelink RNTI

SLCS-RNTI Sidelink Configured Scheduling RNTI

SpCell Special Cell

SP Semi-Persistent

SP-CSI-RNTI Semi-Persistent CSI RNTI

SPS Semi-Persistent Scheduling

SR Scheduling Request

SS Synchronization Signals

SSB Synchronization Signal Block

STAG Secondary Timing Advance Group

SUL Supplementary Uplink

TAG Timing Advance Group

TCI Transmission Configuration Indicator

TPC-SRS-RNTI Transmit Power Control-Sounding Reference Signal-RNTI

TRIV Time Resource Indicator Value

TRP Transmit/Receive Point

TRS CSI-RS for tracking

U2N UE-to-Network

UCI Uplink Control Information

V2X Vehicle-to-Everything

ZP CSI-RS Zero Power CSI-RS

=====================================NEXT CHANGE===================================

## 5.x Cell-Level Energy Saving

### 5.x.1 Cell Discontinuous Transmission

Each Serving Cell may be configured by RRC with a periodic cell DTX pattern (i.e., Active and Non-Active Periods). The cell DTX operation affects UE’s monitoring activity of PDCCH and configured downlink assignments in RRC\_CONNECTED. For all activated Serving Cells with cell DTX configured and activated, the MAC entity may monitor PDCCH and configured downlink assignments using the cell DTX operation specified in this clause.

Editor’s note: FFS whether to support multiple cell DTX/DRX pattern configurations.

RRC controls cell DTX operation by configuring the following parameters in *CellDTXDRX-Config per Serving Cell*:

- *cellDTXDRXconfigType*: defines whether cell DTX is configured, cell DRX is configured, or both are configured;

- *celldtxdrx-onDurationTimer*: the active duration at the beginning of a cell DTX cycle;

- *celldtxdrx-StartOffset*: defines the subframe where the cell DTX cycle starts;

- *celldtxdrx-SlotOffset*: the delay before starting the *celldtx-onDurationTimer*;

- *celldtxdrx-Cycle*: the cell DTX cycle period.

- *cellDTXDRXactivationStatus*: the initial activation status of cell DTX/DRX operation.

Cell DTX operation is activated and deactivated for each Serving Cell by:

- receiving a cell DTX activation indication from lower layers indicating *activation* or *deactivation* of cell DTX operation, as specified in TS 38.213 [6];

- configuring *CellDTXDRX-Config* by upper layers: if cell DTX is configured and *cellDTXDRXactivationStatus* is set to *activated*, cell DTX operation is activated; if *CellDTXDRX-Config* is released, cell DTX operation is deactivated and all the corresponding configurations are released.

Editor’s note: FFS if/how RRC-based activation works when L1-based cell DTX/DRX activation is configured.

When cell DTX is configured for a Serving Cell, the cell DTX Active Period includes the time while:

- *celldtx-onDurationTimer* is running for the associated Serving Cell.

For each Serving Cell configured with cell DTX, the MAC entity shall:

1> if cell DTX is activated for this Serving Cell:

2> if [(SFN × 10) + subframe number] modulo (*celldtx-Cycle*) = (*celldtx-StartOffset*):

3> start *celldtx-onDurationTimer* for this serving cell after *celldtx-SlotOffset* from the beginning of the subframe.

For each Serving Cell configured with cell DTX, the MAC entity may:

1> if cell DTX is activated and the Serving Cell is not in the cell DTX Active Period:

2> not instruct the physical layer to receive transport block on the DL-SCH according to any configured downlink assignment for SPS;

2> not indicate the presence of any configured downlink assignment and deliver the stored HARQ information to the HARQ entity;

2> not set the HARQ Process ID to the HARQ Process ID associated with this PDSCH duration;

2> not consider the NDI bit for the corresponding HARQ process to have been toggled.

For each Serving Cell configured with cell DTX, the MAC entity shall:

1> if cell DTX operation is deactivated for this Serving Cell; or

1> if the Serving Cell is in the cell DTX Active Period:

2> monitor PDCCH on this Serving Cell, as specified in TS 38.213 [6] and other clauses of this specification.

1> if any *drx-RetransmissionTimerDL*, *drx-RetransmissionTimerUL* or *drx-RetransmissionTimerSL* (as described in clause 5.7) is running on any Serving Cell in the DRX group; or

1> if *ra-ResponseWindow* (as described in clause 5.1.4), *ra-ContentionResolutionTimer* (as described in clause 5.1.5), or *msgB-ResponseWindow* (as described in clause 5.1.4a) is running; or

1> if a Scheduling Request is sent on PUCCH and is pending (as described in clause 5.4.4 or 5.22.1.5); or

1> if a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble (as described in clauses 5.1.4 and 5.1.4a):

2> monitor PDCCH on the Serving Cells in this DRX group, as specified in TS 38.213 [6] and other clauses of this specification.

### 5.x.2 Cell Discontinuous Reception

Each Serving Cell may be configured by RRC with a periodic cell DRX pattern (i.e., Active and Non-Active Periods). The cell DRX operation controls Scheduling Request and configured uplink grant transmission activity in RRC\_CONNECTED. For all activated Serving Cells with cell DRX configured and activated, the MAC entity may transmit configured uplink grant transmissions and Scheduling Request using the cell DRX operation specified in this clause.

RRC controls cell DRX operation by configuring the following parameters in *CellDTXDRX-Config per Serving Cell*:

- *cellDTXDRXconfigType*: defines whether cell DTX is configured, cell DRX is configured, or both are configured;

- *celldtxdrx-onDurationTimer*: the active duration at the beginning of a cell DRX cycle;

- *celldtxdrx-StartOffset*: defines the subframe where the cell DRX cycle starts;

- *celldtxdrx-SlotOffset*: the delay before starting the *celldrx-onDurationTimer*;

- *celldtxdrx-Cycle*: the cell DRX cycle period.

- *cellDTXDRXactivationStatus*: the initial activation status of cell DTX/DRX operation.

Cell DRX operation is activated and deactivated for each Serving Cell by:

- receiving a cell DRX activation indication from lower layers indicating *activation* or *deactivation* of cell DRX operation, as specified in TS 38.213 [6];

- configuring *CellDTXDRX-Config* by upper layers: if cell DRX is configured and *cellDTXDRXactivationStatus* is set to *activated*, cell DRX operation is activated; if *CellDTXDRX-Config* isreleased, cell DRX operation is deactivated and all the corresponding configurations are released.

When cell DRXis configured for a Serving Cell, the cell DRX Active Period includes the time while:

- *celldrx-onDurationTimer* is running for the associated Serving Cell.

For each Serving Cell configured with cell DRX, the MAC entity shall:

1> if cell DRX is activated for this Serving Cell:

2> if [(SFN × 10) + subframe number] modulo (*celldrx-Cycle*) = (*celldrx-StartOffset*):

3> start *celldrx-onDurationTimer* for this serving cell after *celldrx-SlotOffset* from the beginning of the subframe.

1> if cell DRX is activated and the Serving Cell is not in the cell DRX Active Period:

2> not instruct the physical layer to signal the SR on a PUCCH resource for SR;

2> not increment the SR counter for a pending SR;

2> not start the *sr-ProhibitTimer* for a pending SR;

2> not deliver any configured uplink grant and the associated HARQ information to the HARQ entity;

2> not instruct a HARQ process associated with a configured uplink grant to trigger a new transmission or a retransmission.

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.

=====================================NEXT CHANGE===================================

### 6.1.3 MAC Control Elements (CEs)

#### 6.1.3.y Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE

Editor’s note: contents of the new MAC CE are TBD.

===============================CHANGE ENDS=========================================

# Annex A: R2 agreements affecting TS 38.321

Fully implemented
partially implemented but additional agreements/FFSs needed before conclusion
Doesn’t impact MAC spec or already specified

## RAN2#121

**Agreements**

1. There will be no impact to RACH, paging, and SIBs in idle/inactive for both gNB and Rel-18 and legacy UEs
2. Rel-18 NES capable CONNECTED UE(s) can perform RACH and receive SIBs in non-active duration of cell DTX and/or DRX (i.e., same behavior for cell DTX and cell DRX). No further enhancements for CBRA and CFRA will be pursued.
3. 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.
4. Confirm study item agreement that we can have separate DTX and DRX configuration. We will focus on designing DTX/DRX for at least single configuration. FFS whether multiple configuration of cell DTX or DRX will be supported.

## RAN2#121-bis

**Agreements**

1. A periodic cell DTX/DRX configuration is explicitly signalled to the UEs.
2. A periodic cell DTX/DRX pattern is configured by UE specific RRC signalling.
3. The Cell DTX/DRX configuration contains at least: periodicity, start slot/offset, on duration.
4. As a baseline Cell DTX/DRX is activated/deactivated implicitly by RRC signalling, i.e. activated immediately once configured by RRC and deactivated once the RRC configuration is released.
5. From RAN2 point of view, majority companies see a benefit with L1 signalling for Cell DTX/DRX activation/deactivation, send a LS to RAN1 (email 308) with our preference and ask about feasibility and design details. Ask about feasibility and reliability of using L1 signaling. Clarify that the question is about activation/deactivation copy the agreement from last meeting that we are focusing on single configuration. Extract a few key benefits of dynamic signaling from email discussion and online discussions
6. As baseline, UE doesn’t monitor SPS occasions during Cell DTX non-active period. As baseline, gNB is assumed to be not transmitting PDSCH to that UE on such SPS occasions during the Cell DTX non-active period
7. As baseline, UE does not transmit on CG occasions during Cell DRX non-active periods
8. As baseline, UE does not transmit SR occasions overlapping with Cell DRX non-active periods, e.g. SR transmissions are dropped during the non-active period

FFS: whether we will allow to configure the UE per SR configuration with whether SR can be transmitted during Cell DRX non-active period to to support high priority traffic

1. (for the SRs that will be dropped) If SR is not to be transmitted on an PUCCH occasion during Cell DRX non-active time, the UE keep the SR pending, i.e., the UE delays the SR transmission till the Cell DRX active period without triggering RACH. For the FFS case there may be some exceptions.
2. The understanding for the gNB scheduling behaviour for new transmissions during Cell DTX non-active period is that the gNB does not schedule UE-specific dynamic grants/assignments, even if the UE is in C-DRX Active Time. UE doesn’t monitor PDCCH for dynamic grants/assignments for new transmissions during Cell DTX non-active period, even if the UE is in C-DRX Active time. FFS how to deal with any exceptions (e.g. SR if agreed and RACH).

FFS how to deal with retransmissions

## RAN2#122

**Agreements:**

1 UE monitors PDCCH for RAR during Cell DTX non-active time. The ra-ResponseWindow could be started as legacy.

2 UE monitors PDCCH for msg4 during Cell DTX non-active time. The ra-ContentionResolutionTimer could be started as legacy.

3 Working assumption: When the retransmission timer is running (if C-DRX is configured), the UE is expected to monitor PDCCH, like in legacy. It is up to the network whether it schedules retransmissions out of the Cell DTX active period, i.e., when the DRX retransmission timer is running, the UE should monitor PDCCH regardless of the Cell DTX.

4 Once gNB recognizes there is an emergency call or public safety related service (e.g. MPS/MCS), the NW should ensure there is no impact to the emergency call (e.g. may deactivate Cell DTX/DRX). The behavior is captured in stage 2 spec

*5* When an DG grant is received, by the gNB during cell DRX/DTX, the UE follows the grant assignment (i.e. like in legacy). This includes DL HARQ feedback.

## RAN2#123

**Agreements:**

1 Activation/deactivation is per serving cell. FFS if the configuration is per cell or per MAC entity

2 RAN2 will reuse the start timer formula of the onDurationTimer from UE C-DRX (including SlotOffset) to specify the start of cellDTX-onDurationTimer (and cellDRX-onDurationTimer) in 38.321.

3 The gNB should ensures that there is at least partial overlapping between UE C-DRX on-duration and cell DTX/DRX on-duration. It is up to network implementation to ensure the alignment. We will capture this in stage 2 specification.

 Understanding is that alignment means that the cell DTX/DRX and C-DRX periodicity should be multiple of each other. FFS if we anything needs to be specified in stage 3 (i.e. in IE description)

4 As a baseline legacy C-DRX reconfiguration is used to change UE C-DRX configuration once Cell DTX/DRX is activated/deactivated.

5 RAN2 specifies *cellDTX-onDurationTimer* (and *cellDRX-onDurationTimer*) to have the same value range as UE C-DRX on-duration timer.

6 RAN2 specifies *cellDTX-Cycle* (and *cellDRX-Cycle*) to have the same value range as UE C-DRX Long cycle.

7 Separate DTX and DRX configuration means that the features can be enabled separately (i.e. Cell DTX can be configured without Cell DRX)

8 On-duration and Cycle parameters are common between cell DTX and DRX, when both are configured. FFS if we have different *start offset* configuration for cell DTX and cell DRX

9 RAN2 will not introduce a MAC CE for cell DTX/DRX (de)activation.

10 Confirm working assumption, when the retransmission timer is running (if C-DRX is configured), the UE is expected to monitor PDCCH, like in legacy. It is up to the network whether it schedules retransmissions out of the Cell DTX active period, i.e., when the DRX retransmission timer is running, the UE should monitor PDCCH regardless of the Cell DTX.

11 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.

## RAN2#123bis

**Agreements**

1. Cell DTX/DRX configuration is provided per Serving Cell with the following restrictions:

 - A maximum of two cell DTX/DRX patterns can be configured per MAC entity

 - The two configured patterns are aligned,

 o The start and slot offset are common for the two patterns.

 o one periodicity is an integer multiple of the other.

2. Working assumption: UE triggers RACH upon determining that an emergency call is initiated during the cell DTX/DRX non active period. We rely on the UE implementation to determine whether an emergency call is initiated. We will take time to check until next meeting to confirm the WA.

=> Rapporteur will specify the alignment in the field description in his CR (stage 3 alignment description)

1. Introduce explicit activation/deactivation in RRC once DTX/DRX is configured (i.e. not for dynamic activation/deactivation). This reverses previous agreement on implicit activation.

2. Start offset and slot offset configuration is also common between Cell DTX and Cell DRX when both are configured

3. Standalone cell DRX configuration is possible to configure

4. Multiple configurations of Cell DTX/DRX are not pursued in Rel-18 for serving cell.

=> The rapporteur will implement all fields as optional and companies can review to see if there is any issues (cellDTX-config)

=> Rapporteurs will capture it in RRC (the focus was on the case where cell DTX in RRC can only be configured when C-DRX is configured)

1. 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.

Others

**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.