**3GPP TSG-RAN WG2 Meeting #124** **R2-231xxxx
Chicago, U.S.A., 13th - 17th November, 2023**

|  |
| --- |
| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.321** | **CR** | **1717** | **rev** | **1** | **Current version:** | 17.6.0 |  |
|  |
| *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)*.* |
|  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

|  |
| --- |
|  |
| ***Title:***  | Introduction of Network energy savings to TS 38.321 |
|  |  |
| ***Source to WG:*** | InterDigital |
| ***Source to TSG:*** | RAN2 |
|  |  |
| ***Work item code:*** | Netw\_Energy\_NR-Core |  | ***Date:*** | 2023-11-03 |
|  |  |  |  |  |
| ***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)* |
|  |  |
| ***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.
* R1 agreed Rel-18 UE supporting cell DRX is not expected to transmit Periodic/Semi-persistent CSI reports to the gNB during non-active periods of cell DRX.
 |
|  |  |
| ***Summary of change:*** | A new section self-contained (5.x) is added to capture the agreements on Cell DTX (5.x.2) and Cell DRX configuration (5.x.3), 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#123bis 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, periodic and SP CSI reporting 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.
* UE triggers RACH upon determining that an emergency call is initiated during the cell DTX/DRX non active period
 |
|  |  |
| ***Consequences if not approved:*** | NR Network Energy Saving feature is not supported in the MAC specification. |
|  |  |
| ***Clauses affected:*** | 3.2 Abbreviations,5.x Cell-Level Energy Saving5.x.1 General5.x.2 Cell Discontinuous Transmission5.x.3 Cell Discontinuous Reception5.18.1 General5.18.6 Activation/Deactivation of Semi-persistent CSI reporting on PUCCH6.1.3.16 SP CSI reporting on PUCCH Activation/Deactivation MAC CE6.1.3.y Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.300 CR 0689 |
| ***affected:*** |  | **X** |  Test specifications | TS 38.331 CR 4453  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS 38.306 CR 0990 |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | Ver0 in R2-2310233 was endorsed in RAN2#123bisVer1 in R2-2313019 was endorsed in RAN2#124 |

====================================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 General

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 clause 5.x.2.

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 clause 5.x.3.

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

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

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

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

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

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

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

### 5.x.2 Cell Discontinuous Transmission

Cell DTX is configured if *cellDTXDRXconfigType* is set to *dtx* or *dtxdrx*. 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 upon cell DTX configuration; if cell DTX is configured and *cellDTXDRXactivationStatus* is set to *dectivated*, cell DTX operation is deactivated upon cell DTX configuration; if *CellDTXDRX-Config* is released, cell DTX operation is deactivated and all the corresponding configurations are released.

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

- *celldtxdrx-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 (*celldtxdrx-Cycle*) = (*celldtxdrx-StartOffset*):

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

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 of this Serving Cell; 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 the DRX group of this Serving Cell, as specified in TS 38.213 [6] and other clauses of this specification.

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

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

2> not monitor PDCCH irrespective of the requirements of clause 5.7, unless stated otherwise in this clause;

2> not instruct the physical layer to receive transport block on the DL-SCH of this Serving Cell according to a configured downlink assignment for SPS;

2> not indicate the presence of a 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 the PDSCH duration of a configured downlink assignment;

2> not consider the NDI bit for the HARQ process corresponding to the PDSCH duration of a configured downlink assignment to have been toggled.

### 5.x.3 Cell Discontinuous Reception

Cell DRX is configured if *cellDTXDRXconfigType* is set to *drx* or *dtxdrx*. 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 upon cell DRX configuration; if cell DRX is configured and *cellDTXDRXactivationStatus* is set to *deactivated*, cell DRX operation is deactivated upon cell DRX configuration; 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:

- *celldtxdrx-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 (*celldtxdrx-Cycle*) = (*celldtxdrx-StartOffset*):

3> start *celldtxdrx-onDurationTimer* for this serving cell after *celldtxdrx-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 a SR on a PUCCH resource for SR;

2> not increment the *SR\_COUNTER* for a SR;

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

2> not report CSI on PUCCH and semi-persistent CSI configured on PUSCH.

2> if an emergency service is initiated by upper layers:

3> initiate a Random Access procedure (as specified in clause 5.1.1).

NOTE: How the MAC layer in the UE is aware of an ongoing emergency service is up to UE implementation.

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

## 5.18 Handling of MAC CEs

### 5.18.1 General

This clause specifies the requirements upon reception of the following MAC CEs:

- SP CSI-RS/CSI-IM Resource Set Activation/Deactivation MAC CE;

- Aperiodic CSI Trigger State Subselection MAC CE;

- TCI States Activation/Deactivation for UE-specific PDSCH MAC CE;

- TCI State Indication for UE-specific PDCCH MAC CE;

- SP CSI reporting on PUCCH Activation/Deactivation MAC CE;

- Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE;

- SP SRS Activation/Deactivation MAC CE;

- PUCCH spatial relation Activation/Deactivation MAC CE;

- Enhanced PUCCH spatial relation Activation/Deactivation MAC CE;

- SP ZP CSI-RS Resource Set Activation/Deactivation MAC CE;

- Recommended Bit Rate MAC CE;

- Enhanced SP/AP SRS Spatial Relation Indication MAC CE;

- SRS Pathloss Reference RS Update MAC CE;

- PUSCH Pathloss Reference RS Update MAC CE;

- Serving Cell set based SRS Spatial Relation Indication MAC CE;

- SP Positioning SRS Activation/Deactivation MAC CE;

- Timing Delta MAC CE;

- Guard Symbols MAC CEs;

- Positioning Measurement Gap Activation/Deactivation Command MAC CE;

- PPW Activation/Deactivation Command MAC CE;

- PUCCH spatial relation Activation/Deactivation for multiple TRP PUCCH repetition MAC CE;

- PUCCH Power Control Set Update for multiple TRP PUCCH repetition MAC CE;

- Unified TCI States Activation/Deactivation for UE-specific PDSCH MAC CE;

- Differential Koffset MAC CE;

- Case-7 Timing advance offset MAC CE;

- DL TX Power Adjustment MAC CE;

- Child IAB-DU Restricted Beam Indication MAC CE;

- Timing Case Indication MAC CE.

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

### 5.18.6 Activation/Deactivation of Semi-persistent CSI reporting on PUCCH

The network may activate and deactivate the configured Semi-persistent CSI reporting on PUCCH of a Serving Cell by sending the SP CSI reporting on PUCCH Activation/Deactivation MAC CE described in clause 6.1.3.16 or the Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE described in clause 6.1.3.x. The network may activate and deactivate the configured sub configuration of a configured Semi-Persistent CSI report on PUCCH of a Serving Cell by sending the Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE described in clause 6.1.3.x. The configured Semi-persistent CSI reporting on PUCCH is initially deactivated upon (re-)configuration by upper layers and after reconfiguration with sync.

The MAC entity shall:

1> if the MAC entity receives an SP CSI reporting on PUCCH Activation/Deactivation MAC CE or an Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE on a Serving Cell:

2> indicate to lower layers the information regarding the SP CSI reporting on PUCCH Activation/Deactivation MAC CE or the Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE.

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

#### 6.1.3.16 SP CSI reporting on PUCCH Activation/Deactivation MAC CE

The SP CSI reporting on PUCCH Activation/Deactivation MAC CE is identified by a MAC subheader with LCID as specified in Table 6.2.1-1. It has a fixed size of 16 bits with 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. If the Semi-Persistent CSI report configuration i is configured with *csi-ReportSubConfigList*, the Si field is set to 0 additionally indicates that all SubConfigurations within *csi-ReportSubConfigList* shall be deactivated;

- R: Reserved bit, set to 0.



Figure 6.1.3.16-1: SP CSI reporting on PUCCH Activation/Deactivation MAC CE

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

### 6.1.3 MAC Control Elements (CEs)

#### 6.1.3.x 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;

- 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]. If Si set to 1, the octet corresponding to Ni,0 to Ni,7 is present. If Si set to 0, the octet corresponding to Ni,0 to Ni,7 is not present. 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, 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 SubConfigurations 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 6.1.3.x-1: Enhanced SP CSI reporting on PUCCH Activation/Deactivation MAC CE**

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