**3GPP TSG- Meeting # *R2-240xxxx***

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** | **-** | **Current version:** |  |  |
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| *For* [***HE******LP***](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:*** |  | | | | | | | | | |
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| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | Netw\_Energy\_NR-Core | | | | |  | ***Date:*** | | |  |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **F** |  | | | | | ***Release:*** | | |  |
|  | *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 can be 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-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Capture the changes agreed for stage 2 in RAN2#126. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | * Clarify cellDTRX-RNTI behaviour * Remove “(e.g. MPS or MCS)” in 38.300 for the public safety related service handling in NES | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Stage 2 description remains unclear for cellDTRX-RNTI and wrong reference of MPS and MCS for cell DTX/DRX. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 3, 8 and 15 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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:*** | |  | | | | | | | | |

START OF FIRST CHANGE

# 3 Abbreviations and Definitions

## 3.1 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], in TS 36.300 [2] 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] and TS 36.300 [2].

5GC 5G Core Network

5GS 5G System

5QI 5G QoS Identifier

A2X Aircraft-to-Everything

A-CSI Aperiodic CSI

AGC Automatic Gain Control

AI Artificial Intelligence

AKA Authentication and Key Agreement

AMBR Aggregate Maximum Bit Rate

AMC Adaptive Modulation and Coding

AMF Access and Mobility Management Function

AR Augmented Reality

ARP Allocation and Retention Priority

ATG Air to Ground

BA Bandwidth Adaptation

BCCH Broadcast Control Channel

BCH Broadcast Channel

BFD Beam Failure Detection

BH Backhaul

BL Bandwidth reduced Low complexity

BPSK Binary Phase Shift Keying

BRID Broadcast Remote Identification

C-RNTI Cell RNTI

CAG Closed Access Group

CAPC Channel Access Priority Class

CBRA Contention Based Random Access

CCE Control Channel Element

cellDTRX-RNTI Cell Discontinuous Transmission and Reception RNTI

CD-SSB Cell Defining SSB

CFR Common Frequency Resource

CFRA Contention Free Random Access

CG Configured Grant

CHO Conditional Handover

CIoT Cellular Internet of Things

CLI Cross Link interference

CMAS Commercial Mobile Alert Service

CORESET Control Resource Set

CP Cyclic Prefix

CPA Conditional PSCell Addition

CPC Conditional PSCell Change

DAA Detect And Avoid

DAG Directed Acyclic Graph

DAPS Dual Active Protocol Stack

DFT Discrete Fourier Transform

DCI Downlink Control Information

DCP DCI with CRC scrambled by PS-RNTI

DCR Direct Communication Request

DL-AoD Downlink Angle-of-Departure

DL-SCH Downlink Shared Channel

DL-TDOA Downlink Time Difference Of Arrival

DMRS Demodulation Reference Signal

DRX Discontinuous Reception

DSR Delay Status Report

DTX Discontinuous Transmission

E-CID Enhanced Cell-ID (positioning method)

EC Energy Cost

EHC Ethernet Header Compression

ePWS enhancements of Public Warning System

ETWS Earthquake and Tsunami Warning System

FS Feature Set

FSA ID Frequency Selection Area Identity

G-CS-RNTI Group Configured Scheduling RNTI

G-RNTI Group RNTI

GFBR Guaranteed Flow Bit Rate

GIN Group ID for Network selection

GNSS Global Navigation Satellite System

GSO Geosynchronous Orbit

H-SFN Hyper System Frame Number

HAPS High Altitude Platform Station

HRNN Human-Readable Network Name

IAB Integrated Access and Backhaul

IFRI Intra Frequency Reselection Indication

I-RNTI Inactive RNTI

INT-RNTI Interruption RNTI

KPAS Korean Public Alarm System

L2 Layer-2

L3 Layer-3

LBT Listen Before Talk

LDPC Low Density Parity Check

LEO Low Earth Orbit

LTM L1/L2 Triggered Mobility

MBS Multicast/Broadcast Services

MCE Measurement Collection Entity

MCCH MBS Control Channel

MDBV Maximum Data Burst Volume

MEO Medium Earth Orbit

MIB Master Information Block

MICO Mobile Initiated Connection Only

MFBR Maximum Flow Bit Rate

ML Machine Learning

MMTEL Multimedia telephony

MNO Mobile Network Operator

MO-SDT Mobile Originated SDT

MP Multi-Path

MPE Maximum Permissible Exposure

MRB MBS Radio Bearer

MT Mobile Termination

MT-SDT Mobile Terminated SDT

MTCH MBS Traffic Channel

MTSI Multimedia Telephony Service for IMS

MU-MIMO Multi User MIMO

Multi-RTT Multi-Round Trip Time

MUSIM Multi-Universal Subscriber Identity Module

N3C Non-3GPP Connection

NB-IoT Narrow Band Internet of Things

NCD-SSB Non Cell Defining SSB

NCGI NR Cell Global Identifier

NCL Neighbour Cell List

NCR Neighbour Cell Relation

NCRT Neighbour Cell Relation Table

NES Network Energy Savings

NGAP NG Application Protocol

NGSO Non-Geosynchronous Orbit

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

NSAG Network Slice AS Group

NTN Non-Terrestrial Network

END OF FIRST CHANGE

START OF SECOND CHANGE

# 8 NG Identities

## 8.1 UE Identities

In this clause, the identities used by NR connected to 5GC are listed. For scheduling at cell level, the following identities are used:

- C-RNTI: unique UE identification used as an identifier of the RRC Connection and for scheduling;

- CG-SDT-CS-RNTI: unique UE identification used for Configured Grant-based SDT in the uplink;

- CI-RNTI: identification of cancellation in the uplink;

- CS-RNTI: unique UE identification used for Semi-Persistent Scheduling in the downlink or configured grant in the uplink;

- INT-RNTI: identification of pre-emption in the downlink;

- MCS-C-RNTI: unique UE identification used for indicating an alternative MCS table for PDSCH and PUSCH;

- P-RNTI: identification of Paging and System Information change notification in the downlink;

- SI-RNTI: identification of Broadcast and System Information in the downlink;

- SP-CSI-RNTI: unique UE identification used for semi-persistent CSI reporting on PUSCH.

For power and slot format control, the following identities are used:

- SFI-RNTI: identification of slot format;

- TPC-PUCCH-RNTI: unique UE identification to control the power of PUCCH;

- TPC-PUSCH-RNTI: unique UE identification to control the power of PUSCH;

- TPC-SRS-RNTI: unique UE identification to control the power of SRS.

During the random access procedure, the following identities are also used:

- RA-RNTI: identification of the Random Access Response in the downlink;

- MSGB-RNTI: identification of the Random Access Response for 2-step RA type in the downlink;

- Temporary C-RNTI: UE identification temporarily used for scheduling during the random access procedure;

- Random value for contention resolution: UE identification temporarily used for contention resolution purposes during the random access procedure.

For NR connected to 5GC, the following UE identity is used at NG-RAN level:

- I-RNTI: used to identify the UE context in RRC\_INACTIVE.

For UE power saving purpose, the following identities are used:

- PS-RNTI: used to determine if the UE needs to monitor PDCCH on the next occurrence of the connected mode DRX on-duration;

- PEI-RNTI: used to determine if the UE needs to monitor the associated PO.

For IAB the following identity is used:

- AI-RNTI: identification of the DCI carrying availability indication for soft symbols of an IAB-DU.

For Network-Controlled Repeater the following identity is used:

- NCR-RNTI: identification of the DCI carrying side control information.

For MBS, the following identities are used:

- G-RNTI: Identifies dynamically scheduled PTM transmissions of MTCH(s);

- G-CS-RNTI: Identifies configured scheduled PTM transmissions of MTCH(s) scheduled with configured grant;

- MCCH-RNTI: Identifies transmissions of MCCH and MCCH change notification.

For sidelink, the following identities are used:

- SL-RNTI: unique UE identification used for NR sidelink communication scheduling;

- SL-CS-RNTI: unique UE identification used for configured sidelink grant for NR sidelink communication;

- SL Semi-Persistent Scheduling V-RNTI: unique UE identification used for semi-persistent scheduling for V2X sidelink communication;

- SL-PRS-RNTI: unique UE identification used for SL-PRS transmission scheduling on dedicated SL-PRS resource pool;

- SL-PRS-CS-RNTI: unique UE identification used for configured sidelink grant for SL-PRS transmission on dedicated SL-PRS resource pool.

For network energy saving purpose, the following identity is used:

- cellDTRX-RNTI: identification used for network energy saving indication.

END OF SECOND CHANGE

START OF THIRD CHANGE

## 15.4 Support for Energy Saving

### 15.4.1 General

The aim of this function is to reduce operational expenses through energy savings.

The function allows, for example in a deployment where capacity boosters can be distinguished from cells providing basic coverage, to optimize energy consumption enabling the possibility for an E-UTRA or NR cell providing additional capacity via single or dual connectivity, to be switched off when its capacity is no longer needed and to be re-activated on a need basis, or to support various adaptation techniques in time, frequency, spatial and power domains.

### 15.4.2 Solution description

#### 15.4.2.1 Intra-system energy saving

The solution builds upon the possibility for the NG-RAN node owning a capacity booster cell to autonomously decide to switch-off such cell to lower energy consumption (inactive state). The decision is typically based on cell load information, consistently with configured information. The switch-off decision may also be taken by O&M.

The NG-RAN node may initiate handover actions in order to off-load the cell being switched off and may indicate the reason for handover with an appropriate cause value to support the target node in taking subsequent actions, e.g. when selecting the target cell for subsequent handovers.

All neighbour NG-RAN nodes are informed by the NG-RAN node owning the concerned cell about the switch-off actions over the Xn interface, by means of the NG-RAN node Configuration Update procedure.

All informed nodes maintain the cell configuration data, e.g., neighbour relationship configuration, also when a certain cell is inactive. If basic coverage is ensured by NG-RAN node cells, NG-RAN node owning non-capacity boosting cells may request a re-activation over the Xn interface if capacity needs in such cells demand to do so. This is achieved via the Cell Activation procedure. During switch off time period of the boost cell, the NG-RAN node may prevent idle mode UEs from camping on this cell and may prevent incoming handovers to the same cell.

The NG-RAN node receiving a request should act accordingly. The switch-on decision may also be taken by O&M. All peer NG-RAN nodes are informed by the NG-RAN node owning the concerned cell about the re-activation by an indication on the Xn interface.

The solution also builds upon the possibility for the NG-RAN node owning a coverage cell to request neighbouring NG-RAN node(s) owning a capacity booster cell to switch on some SSB beams within the cell which are deactivated. The receiving NG-RAN node should act accordingly.

The solution also builds upon the possibility for an NG-RAN node to page certain UEs (e.g., stationary UEs) in RRC\_INACTIVE state on a limited set of beams, instead of paging on all the beams within the cell. It is up to the gNB's implementation to select the UEs in RRC\_INACTIVE for which paging in limited set of beams applies. If the paging over the limited set of beams fails, the gNB performs subsequent paging by implementation, e.g., by ensuring the same paging message is repeated in all the transmitted SSB beams.

#### 15.4.2.2 Inter-system energy saving

The solution builds upon the possibility for the NG-RAN node owning a capacity booster cell to autonomously decide to switch-off such cell to dormant state. The decision is typically based on cell load information, consistently with configured information. The switch-off decision may also be taken by O&M. The NG-RAN node indicates the switch-off action to the eNB over NG interface and S1 interface. The NG-RAN node could also indicate the switch-on action to the eNB over NG interface and S1 interface.

The eNB providing basic coverage may request a NG-RAN node's cell re-activation based on its own cell load information or neighbour cell load information, the switch-on decision may also be taken by O&M. The eNB requests a NG-RAN node's cell re-activation and receives the NG-RAN node's cell re-activation reply from the NG-RAN node over the S1 interface and NG interface. Upon reception of the re-activation request, the NG-RAN node's cell should remain switched on at least until expiration of the minimum activation time. The minimum activation time may be configured by O&M or be left to the NG-RAN node's implementation.

#### 15.4.2.3 Cell DTX/DRX

To facilitate reducing gNB downlink transmission/uplink reception active time, UE can be configured with a periodic cell DTX/DRX pattern (i.e. active and non-active periods). The pattern configuration for cell DTX/DRX is common for the UEs configured with this feature in the cell. The cell DTX and cell DRX patterns can be configured and activated separately. A maximum of two cell DTX/DRX patterns can be configured per MAC entity for different serving cells. When cell DTX is configured and activated for the concerned cell, the UE may not monitor PDCCH in selected cases or does not monitor SPS occasions during cell DTX non-active duration. When cell DRX is configured and activated for the concerned cell, the UE does not transmit on CG resources or does not transmit a SR during cell DRX non-active duration. This feature is only applicable to UEs in RRC\_CONNECTED state and it does not impact Random Access procedure, SSB transmission, paging, and system information broadcasting. Cell DTX/DRX operation is only supported for single TRP scenario. Cell DTX/DRX can be activated/deactivated by RRC signalling or L1 group common signalling. Cell DTX/DRX is characterized by the following:

- **active duration**: duration that the UE waits for to receive PDCCHs or SPS occasions, and transmit SR or CG. In this duration, the gNB transmission/reception of PDCCH, SPS, SR, CG, periodic and semi-persistent CSI report are not impacted for the purpose of network energy saving;

- **cycle**: specifies the periodic repetition of the active-duration followed by a period of non-active duration.

Active duration and cycle parameters are common between cell DTX and cell DRX, when both are configured;

Once the gNB recognizes there is an emergency call or public safety related service, the network should ensure that there is no impact to that service (e.g. it may release or deactivate cell DTX/DRX configuration). The network should also ensure that there is at least partial overlapping between UE's connected mode DRX on-duration and cell DTX/DRX active duration, i.e. the UE's connected mode DRX periodicity is a multiple of cell DTX/DRX periodicity or vice versa.

#### 15.4.2.4 Conditional Handover

The same principle as described in 9.2.3.4 applies to conditional handover in case the source cell is using a network energy saving solution (e.g., the cell is activating cell DTX/DRX or turning off), unless hereunder specified. In this case, the following additional triggering conditions are supported, upon which UE may use NES-specific CHO event for executing CHO to a candidate cell, as defined in TS 38.331 [12]:

- The UE may be notified via DCI to enable CHO conditions(s) configured with NES event indication.

#### 15.4.2.5 Camping Restrictions

If a cell is activating or going to activate NES cell DTX/DRX, the cell can allow the access of UEs capable of NES cell DTX/DRX via a single bit in SIB1 but prevent the access of UEs not capable of cell DTX/DRX using barring mechanisms described in clause 7.4.

#### 15.4.2.6 SSB-less SCell

For an intra-band or inter-band CA SCell, a UE may obtain timing reference and AGC source from another serving cell in case the UE is not provided with SSB nor SMTC configuration for this SCell, as described in TS 38.331 [12].

#### 15.4.2.7 Spatial and power domain adaptation

To assist the gNB on muting transceivers and/or adapting transmission power, the UE can be configured to report multiple CSI entries in a CSI report based on two or more sub-configurations, as specified in clause 5.2.1.6 in TS 38.214 [56]. Each sub-configuration corresponds to a spatial domain adaptation pattern (subsets of available spatial elements) and/or a power offset between PDSCH and CSI-RS.

### 15.4.3 O&M requirements

Operators should be able to configure the energy saving function.

The configured information should include:

- The ability of an NG-RAN node to perform autonomous cell switch-off;

- The ability of an NG-RAN node to request the re-activation of a configured list of inactive cells owned by a peer NG-RAN node.

O&M may also configure:

- policies used by the NG-RAN node for cell switch-off decision;

- policies used by peer NG-RAN nodes for requesting the re-activation of an inactive cell;

- The minimum time an NG-RAN node's cell should remain activated upon reception of a re-activation request from an eNB.

END OF THIRD CHANGE