**3GPP TSG-RAN WG2 Meeting #131 R2-25xxxxx**

**St Julian, Malta, 19th – 23rd May 2025**

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| --- |
| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
|  |
|  | **38.300** | **CR** | draftCR | **rev** |  | **Current version:** | **18.4.0** |  |
|  |
| *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:***  | Introduction of Low-Power Wake-Up Signal and Receiver for NR |
|  |  |
| ***Source to WG:*** |  |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_LPWUS-Core |  | ***Date:*** | 2025-06-25 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-19 |
|  | *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-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Introduction of the LP-WUS/WUR feature into specifications |
|  |  |
|  | See RAN2 agreements at the end of this Running CR. Captured agreements are shown in green color. Some earlier comments to be discussed, if needed:* Configuration for OFDM-based nd OOK-based thresholds (Nokia): Suggestion to wait for progress in RAN2 or some input from RAN1 (should we have some PHY definition of WUS in 300?)
	+ Not updated => at least need a PHY definition but also wondering wheter we need such details in stage-2?
* Number of subgroups: Is it 31 or 32 (Nokia): Should “non-subgrouping” be counted as one?
	+ Updated to 31 – there is also the “All” codepoint but assumption is that is in NAS signalling and not allocated for CN-assigned subgroup ID. In calculation *subgroupsNumForUEID* = 31.
* Definition of [new timer] (Lenovo): Not captured so far in 11.
	+ Not updated yet, waiting to align with other specs
* Better definition of Option 1-1 and option 1-2 (Oppo)
	+ Naming and labelling should be discussed and aligned with other specs eventually
	+ Option 1-1 and 1-2 are not good descriptive names and will not mean anything after spec is written
 |
|  |  |
| ***Consequences if not approved:*** | Feature not supported |
|  |  |
| ***Clauses affected:*** | 3.1, 7.9, 9.2.5, 11 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **x** |  |  Other core specifications  | TS/TR 38.321 CR ...TS/TR 38.331 CR ...TS/TR 38.306 CR ...TS/TR 38.304 CR ...TS/TR 37.340 CR ...  |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** | This is a running CR, to be lifted to latest version of TS 38.300 (18.6.0) |
|  |  |
| ***This CR's revision history:*** |  |

# 1 Scope

The present document provides an overview and overall description of the NG-RAN and focuses on the radio interface protocol architecture of NR connected to 5GC (E-UTRA connected to 5GC is covered in the 36 series). Details of the radio interface protocols are specified in companion specifications of the 38 series.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[3] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[4] 3GPP TS 38.401: "NG-RAN; Architecture description".

[5] 3GPP TS 33.501: "Security Architecture and Procedures for 5G System".

[6] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[7] 3GPP TS 38.322: "NR; Radio Link Control (RLC) protocol specification".

[8] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) specification".

[9] 3GPP TS 37.324: " E-UTRA and NR; Service Data Protocol (SDAP) specification".

[10] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[11] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[12] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[13] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[14] 3GPP TS 22.168: "Earthquake and Tsunami Warning System (ETWS) requirements; Stage 1".

[15] 3GPP TS 22.268: "Public Warning System (PWS) Requirements".

[16] 3GPP TS 38.410: "NG-RAN; NG general aspects and principles".

[17] 3GPP TS 38.420: "NG-RAN; Xn general aspects and principles".

[18] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[19] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

[20] 3GPP TS 38.202: "NR; Physical layer services provided by the physical layer"

[21] 3GPP TS 37.340: "NR; Multi-connectivity; Overall description; Stage-2".

[22] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[23] IETF RFC 4960 (2007-09): "Stream Control Transmission Protocol".

[24] 3GPP TS 26.114: "Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS); Multimedia Telephony; Media handling and interaction".

[25] Void.

[26] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[27] IETF RFC 3168 (09/2001): "The Addition of Explicit Congestion Notification (ECN) to IP".

[28] 3GPP TS 24.501: "NR; Non-Access-Stratum (NAS) protocol for 5G System (5GS)".

[29] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[30] 3GPP TS 38.415: "NG-RAN; PDU Session User Plane Protocol".

[31] 3GPP TS 38.340: "NR; Backhaul Adaptation Protocol (BAP) specification".

[32] 3GPP TS 38.470: "NG-RAN; F1 application protocol (F1AP) ".

[33] 3GPP TS 38.425: "NG-RAN; NR user plane protocol".

[34] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[35] 3GPP TS 38.101-2: "User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[36] 3GPP TS 38.101-3: "User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[37] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access".

[38] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[39] 3GPP TS 22.104 "Service requirements for cyber-physical control applications in vertical domains".

[40] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[41] 3GPP TS 23.285: "Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services".

[42] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".

[43] 3GPP TS 37.355: "LTE Positioning Protocol (LPP)".

[44] 3GPP TS 29.002: "Mobile Application Part (MAP) specification".

[45] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services; Stage 2".

[46] 3GPP TS 26.517: "5G Multicast-Broadcast User Services; Protocols and Formats".

[47] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

[48] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

[49] 3GPP TS 28.541: "5G Network Resource Model (NRM)".

[50] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[51] NIMA TR 8350.2, Third Edition, Amendment 1, 3 January 2000: "DEPARTMENT OF DEFENSE WORLD GEODETIC SYSTEM 1984".

[52] 3GPP TS 38.211: "NR; Physical channels and modulation".

[53] 3GPP TS 24.587: "Vehicle-to-Everything (V2X) services in 5G System (5GS)".

[54] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".

[55] 3GPP TS 24.554: "Technical Specification Group Core Network and Terminals; Proximity-services (ProSe) in 5G System (5GS) protocol".

[56] 3GPP TS 38.214: "Technical Specification Group Radio Access Network; NR; Physical layer procedures for data".

[57] 3GPP TR 38.835: "NR; Study on XR enhancements for NR".

[58] 3GPP TS 26.522: "5G Real-time Media Transport Protocol Configurations".

[59] 3GPP TS 38.215: "NR; Physical layer measurements".

[60] 3GPP TS 23.256: "Support of Uncrewed Aerial Systems (UAS) connectivity, identification and tracking; Stage 2".

[61] IETF RFC 9330: "Low Latency, Low Loss, Scalable Throughput (L4S) Internet Service: Architecture".

[62] IETF RFC 9331: "Explicit Congestion Notification (ECN) Protocol for Very Low Queuing Delay (L4S)".

[63] IETF RFC 9332: "Dual-Queue Coupled Active Queue Management (AQM) for Low Latency, Low Loss, and Scalable Throughput (L4S)".

[64] 3GPP TS 28.105: "Management and orchestration; Artificial Intelligence/ Machine Learning (AI/ML) management".

[65] 3GPP TS 38.351: "NR; Sidelink Relay Adaptation Protocol (SRAP) Specification".

# 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

CD-SSB Cell Defining SSB

cellDTRX-RNTI Cell Discontinuous Transmission and Reception RNTI

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

LP-RSRP Low Power Reference Signal Received Power

LP-RSRQ Low Power Reference Signal Received Quality

LP-WUS Low Power Wake-Up Signal

LP-WUR Low Power Wake-Up Receiver

LR Low Power Wake-Up Receiver

LTM L1/L2 Triggered MobilityMBS 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

MR Main Radio

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

P-MPR Power Management Maximum Power Reduction

P-RNTI Paging RNTI

PCH Paging Channel

PCI Physical Cell Identifier

PDB Packet Delay Budget

PDC Propagation Delay Compensation

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PEI Paging Early Indication

PER Packet Error Rate

PH Paging Hyperframe

PLMN Public Land Mobile Network

PNI-NPN Public Network Integrated NPN

PO Paging Occasion

PQI PC5 5QI

PRACH Physical Random Access Channel

PRB Physical Resource Block

PRG Precoding Resource block Group

PRS Positioning Reference Signal

PS-RNTI Power Saving RNTI

PSDB PDU Set Delay Budget

PSER PDU Set Error Rate

PSI PDU Set Importance

PSIHI PDU Set Integrated Handling Information

PSS Primary Synchronisation Signal

PTM Point to Multipoint

PTP Point to Point

PTW Paging Time Window

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

PWS Public Warning System

QAM Quadrature Amplitude Modulation

QFI QoS Flow ID

QMC QoE Measurement Collection

QoE Quality of Experience

QPSK Quadrature Phase Shift Keying

RA Random Access

RA-RNTI Random Access RNTI

RACH Random Access Channel

RANAC RAN-based Notification Area Code

REG Resource Element Group

RIM Remote Interference Management

RLM Radio Link Monitoring

RMSI Remaining Minimum SI

RNA RAN-based Notification Area

RNAU RAN-based Notification Area Update

RNTI Radio Network Temporary Identifier

RQA Reflective QoS Attribute

RQoS Reflective Quality of Service

RS Reference Signal

RSRP Reference Signal Received Power

RSRQ Reference Signal Received Quality

RSSI Received Signal Strength Indicator

RSTD Reference Signal Time Difference

RTT Round Trip Time

RVQoE RAN visible QoE

SCS SubCarrier Spacing

SD Slice Differentiator

SDAP Service Data Adaptation Protocol

SDT Small Data Transmission

SD-RSRP Sidelink Discovery RSRP

SFI-RNTI Slot Format Indication RNTI

SHR Successful Handover Report

SIB System Information Block

SI-RNTI System Information RNTI

SLA Service Level Agreement

SL-PRS Sidelink Positioning Reference Signal

SL-RSRP Sidelink RSRP

SMC Security Mode Command

SMF Session Management Function

SMTC SS/PBCH block Measurement Timing Configuration

S-NSSAI Single Network Slice Selection Assistance Information

SNPN Stand-alone Non-Public Network

SNPN ID Stand-alone Non-Public Network Identity

SPR Successful PSCell Addition/Change Report

SPS Semi-Persistent Scheduling

SR Scheduling Request

SRAP Sidelink Relay Adaptation Protocol

SRS Sounding Reference Signal

SRVCC Single Radio Voice Call Continuity

SS Synchronization Signal

SSB SS/PBCH block

SSS Secondary Synchronisation Signal

SSSG Search Space Set Group

SST Slice/Service Type

SU-MIMO Single User MIMO

SUL Supplementary Uplink

TA Timing Advance

TB Transport Block

TCE Trace Collection Entity

TNL Transport Network Layer

TPC Transmit Power Control

TRP Transmit/Receive Point

TRS Tracking Reference Signal

TSS Timing Synchronization Status

U2N UE-to-Network

U2U UE-to-UE

UAV Uncrewed Aerial Vehicle

UCI Uplink Control Information

UDC Uplink Data Compression

UDM Unified Data Management

UE-Slice-MBR UE Slice Maximum Bit Rate

UL-AoA Uplink Angles of Arrival

UL-RTOA Uplink Relative Time of Arrival

UL-SCH Uplink Shared Channel

UPF User Plane Function

URLLC Ultra-Reliable and Low Latency Communications

VR Virtual Reality

V2X Vehicle-to-Everything

Xn-C Xn-Control plane

Xn-U Xn-User plane

XnAP Xn Application Protocol

XR eXtended Reality

## 3.2 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], in TS 36.300 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1] and TS 36.300 [2].

**2Rx XR UE**: two antenna port XR UE as specified in TS 38.101-1 [18].

**A2X communication**: A communication to support A2X services leveraging PC5 reference points. A2X services are realized by various types of A2X applications, i.e. BRID or DAA.

**Aerial UE communication:** functionality enabling Aerial UE function, as defined in 16.18.

**Air to Ground network:** An NG-RAN consisting of ground-based gNBs, which provide cell towers that send signals up to an aircraft's antenna(s) of onboard ATG terminal, with typical vertical altitude of around 10,000m and take-off/landing altitudes down to 3000m.

**BH RLC channel**: an RLC channel between two nodes, which is used to transport backhaul packets**.**

**Boundary IAB-node:** as defined in TS 38.401 [4].

**Broadcast MRB**:A radio bearer configured for MBS broadcast delivery.

**CAG Cell**:a PLMN cell broadcasting at least one Closed Access Group identity.

**CAG Member Cell**:for a UE, a CAG cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN, and for that PLMN, a CAG identifier belonging to the Allowed CAG list of the UE for that PLMN.

**CAG-only cell**: a CAG cell that is only available for normal service for CAG UEs.

**Cell-Defining SSB**: an SSB with an RMSI associated.

**Child node**: IAB-DU's and IAB-donor-DU's next hop neighbour node; the child node is also an IAB-node.

**Conditional Handover (CHO**): a handover procedure that is executed only when execution condition(s) are met.

**CORESET#0**: the control resource set for at least SIB1 scheduling, can be configured either via MIB or via dedicated RRC signalling.

**DAPS Handover**: a handover procedure that maintains the source gNB connection after reception of RRC message for handover and until releasing the source cell after successful random access to the target gNB.

**Data Burst:** A set of multiple PDUs generated and sent by the application in a short period of time, as defined in TS 23.501 [3].

**Direct Path**: a type of UE-to-Network transmission path, where data is transmitted between a UE and the network without sidelink relaying.

**Downstream**: direction toward child node or UE in IAB-topology.

**Early Data Forwarding**: data forwarding that is initiated before the UE executes the handover.

**Earth-centered, earth-fixed**: a global geodetic reference system for the Earth intended for practical applications of mapping, charting, geopositioning and navigation, as specified in NIMA TR 8350.2 [51].

**eRedCap UE**: a UE with enhanced reduced capabilities as specified in clause 4.2.22.1 in TS 38.306 [11].

**Feeder link**: wireless link between the NTN Gateway and the NTN payload.

**Geosynchronous Orbit**: earth-centered orbit at approximately 35786 kilometres above Earth's surface and synchronised with Earth's rotation. A geostationary orbit is a non-inclined geosynchronous orbit, i.e. in the Earth's equator plane.

**Group ID for Network Selection**: an identifier used during SNPN selection to enhance the likelihood of selecting a preferred SNPN that supports a Default Credentials Server or a Credentials Holder, as specified in TS 23.501 [3].

**gNB**: node providing NR user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**High Altitude Platform Station**: airborne vehicle embarking the NTN payload placed at an altitude between 8 and 50 km.

**IAB-donor**:gNB that provides network access to UEs via a network of backhaul and access links.

**IAB-donor-CU**: as defined in TS 38.401 [4].

**IAB-donor-DU**:as defined in TS 38.401 [4].

**IAB-DU**: gNB-DU functionality supported by the IAB-node to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in TS 38.401 [4], on the IAB-donor.

**IAB-MT**: IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise. IAB-MT function used in 38-series of 3GPP Specifications corresponds to IAB-UE function defined in TS 23.501 [3].

**IAB-node**: RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes. The IAB-node does not support backhauling via LTE.

**IAB topology**: the unison of all IAB-nodes and IAB-donor-DUs whose F1 and/or RRC connections are terminated at the same IAB-donor-CU.

**Indirect Path**: a type of UE-to-Network transmission path, where data is forwarded via a U2N Relay UE between a U2N Remote UE and the network.

**Inter-donor partial migration:** migration of an IAB-MT to a parent node underneath a different IAB-donor-CU while the collocated IAB-DU and its descendant IAB-node(s), if any, are terminated at the initial IAB-donor-CU. The procedure renders the said IAB-node as a boundary IAB-node.

**Intra-system Handover**:handover that does not involve a CN change (EPC or 5GC).

**Inter-system Handover**:handover that involves a CN change (EPC or 5GC).

**Late Data Forwarding**: data forwarding that is initiated after the source NG-RAN node knows that the UE has successfully accessed a target NG-RAN node.

**L1/L2 Triggered Mobility**: a cell switch procedure that the network triggers via MAC CE based on L1 or L3 measurement report.

**Mapped Cell ID**: in NTN, it corresponds to a fixed geographical area.

**MBS Radio Bearer**: A radio bearer configured for MBS delivery.

**Mobile-IAB cell**: a cell of a mobile IAB-DU.

**Mobile IAB-DU**: gNB-DU functionality supported by the mobile IAB-node to terminate the NR access interface to UEs, and to terminate the F1 protocol to the gNB-CU functionality on the IAB-donor, as defined in TS 38.401 [4].

**Mobile IAB-DU migration**: procedure for a mobile IAB-node as defined in TS 38.401 [4].

**Mobile IAB-MT**: mobile IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise.

**Mobile IAB-MT migration**: procedure for a mobile IAB-MT as defined in TS 38.401 [4].

**Mobile IAB-node**: RAN node that supports NR access links to UEs and an NR backhaul link to a parent node, and that can conduct physical mobility across the RAN area. The mobile IAB-node function used in 38-series of 3GPP Specifications corresponds to the MBSR function defined in TS 23.501 [3].

**MP Relay UE**: a UE that provides functionality to support connectivity to the network for MP Remote UE(s).

**MP Remote UE**: a UE that communicates with the network via a direct Uu link and a MP Relay UE.

**MSG1**: preamble transmission of the random access procedure for 4-step random access (RA) type.

**MSG3**: first scheduled transmission of the random access procedure.

**MSGA**:preamble and payload transmissions of the random access procedure for 2-step RA type.

**MSGB**:response to MSGA in the 2-step random access procedure. MSGB may consist of response(s) for contention resolution, fallback indication(s), and backoff indication.

**Multicast/Broadcast Service**: A point-to-multipoint service as defined in TS 23.247 [45].

**Multicast MRB**:A radio bearer configured for MBS multicast delivery.

**Multi-hop backhauling**: using a chain of NR backhaul links between an IAB-node and an IAB-donor.

**NCR-Fwd**: Network-Controlled Repeater node function, which performs amplifying-and-forwarding of UL/DL RF signals between gNB and UE. The behaviour of the NCR-Fwd is controlled according to the side control information received by the NCR-MT from a gNB.

**NCR-Fwd access link**: link used for transmissions between the NCR-Fwd and UEs.

**NCR-Fwd backhaul link**: link used for backhauling between the NCR-Fwd and gNB.

**NCR-MT**: NCR-node entity which communicates with a gNB via a control link to receive side control information. The control link is based on NR Uu interface.

**NCR-node**: RAN node comprising NCR-MT and NCR-Fwd.

**ng-eNB**: node providing E-UTRA user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**NG-C**: control plane interface between NG-RAN and 5GC.

**NG-U**: user plane interface between NG-RAN and 5GC.

**NG-RAN node**: either a gNB or an ng-eNB.

**Non-CAG Cell**: a PLMN cell which does not broadcast any Closed Access Group identity.

**Non-Cell Defining SSB**: an SSB without an RMSI associated.

**Non-Geosynchronous orbit**: earth-centered orbit with an orbital period that does not match Earth's rotation on its axis. This includes Low and Medium Earth Orbit (LEO and MEO). LEO operates at altitudes between 300 km and 1500 km and MEO at altitudes between 7000 km and 25000 km, approximately.

**Non-terrestrial network**: an NG-RAN consisting of gNBs, which provide non-terrestrial NR access to UEs by means of an NTN payload embarked on an airborne or space-borne NTN vehicle and an NTN Gateway.

**NR backhaul link**: NR link used for backhauling between an IAB-node and an IAB-donor, and between IAB-nodes in case of a multi-hop backhauling.

**NR sidelink communication**: AS functionality enabling at least V2X communication as defined in TS 23.287 [40] and/or A2X communication as defined in TS 23.256 [60] and/or the ProSe communication (including ProSe non-Relay and UE-to-Network Relay communication) as defined in TS 23.304 [48], between two or more nearby UEs, using NR technology but not traversing any network node.

**NR sidelink discovery**: AS functionality enabling ProSe non-Relay Discovery and ProSe UE-to-Network Relay discovery for Proximity based Services as defined in TS 23.304 [48] between two or more nearby UEs, using NR technology but not traversing any network node.

**NTN Gateway**: an earth station located at the surface of the earth, providing connectivity to the NTN payload using the feeder link. An NTN Gateway is a TNL node.

**NTN payload**: a network node, embarked on board a satellite or high altitude platform station, providing connectivity functions, between the service link and the feeder link. In the current version of this specification, the NTN payload is a TNL node.

**Numerology**: corresponds to one subcarrier spacing in the frequency domain. By scaling a reference subcarrier spacing by an integer *N*, different numerologies can be defined.

**Parent node**: IAB-MT's or mobile IAB-MT's next hop neighbour node; the parent node can be an IAB-node or IAB-donor-DU

**PC5 Relay RLC channel**: an RLC channel between L2 U2N Remote UE and L2 U2N Relay UE, or between L2 U2U Remote UE and L2 U2U Relay UE, which is used to transport packets over PC5 for L2 UE-to-Network/UE-to-UE Relay**.**

**PDU Set**: one or more PDUs carrying the payload of one unit of information generated at the application level (e.g. frame(s) or video slice(s) for XR Services), as defined in TS 23.501 [3].

**PLMN Cell**: a cell of the PLMN.

**RACH-less LTM**: an LTM cell switch procedure where UE skips the random access procedure.

**RedCap UE**: a UE with reduced capabilities as specified in clause 4.2.21.1 in TS 38.306 [11].

**Relay discovery**: AS functionality enabling 5G ProSe UE-to-Network Relay Discovery as defined in TS 23.304 [48], using NR technology but not traversing any network node.

**Satellite**:a space-borne vehicle orbiting the Earth embarking the NTN payload.

**Service link**:wireless link between the NTN payload and UE.

**Sidelink Discovery RSRP:** RSRP measurements on PC5 link related to NR sidelink discovery.

**Sidelink RSRP:** RSRP measurements on PC5 link related to NR sidelink communication.

**SNPN Access Mode**: mode of operation whereby a UE only accesses SNPNs.

**SNPN-only cell**: a cell that is only available for normal service for SNPN subscribers.

**SNPN Identity**: the identity of Stand-alone NPN defined by the pair (PLMN ID, NID).

**Transmit/Receive Point**:part of the gNB transmitting and receiving radio signals to/from UE according to physical layer properties and parameters inherent to that element.

**U2N Relay UE**: a UE that provides functionality to support connectivity to the network for U2N Remote UE(s).

**U2N Remote UE**: a UE that communicates with the network via a U2N Relay UE.

**U2U Relay UE**: a UE that provides functionality to support connectivity between two U2U Remote UEs.

**U2U Remote UE**: a UE that communicates with other UE(s) via a U2U Relay UE.

**Upstream**: direction toward parent node in IAB-topology.

**Uu Relay RLC channel**: an RLC channel between L2 U2N Relay UE or MP Relay UE and gNB, which is used to transport packets over Uu for L2 UE-to-Network Relay or for indirect path in case of MP.

**V2X sidelink communication**: AS functionality enabling V2X communication as defined in TS 23.285 [41], between nearby UEs, using E-UTRA technology but not traversing any network node.

**Xn**: network interface between NG-RAN nodes.

# 4 Overall Architecture and Functional Split

<snip>

# 7 RRC

<snip>

## 7.9 UE Assistance Information

When configured to do so, the UE can signal the network through *UEAssistanceInformation*:

- If it prefers an adjustment in the connected mode DRX cycle length, for the purpose of delay budget reporting;

- If it is experiencing internal overheating;

- If it prefers certain DRX parameter values, and/or a reduced maximum number of secondary component carriers, and/or a reduced maximum aggregated bandwidth and/or a reduced maximum number of MIMO layers and/or minimum scheduling offsets K0 and K2 for power saving purpose;

- If it expects not to send or receive any more data in the near future, and in this case, it can provide its preference to transition out of RRC\_CONNECTED where this indication may express its preferred RRC state, or alternately, it may cancel an earlier indicated preference to transition out of RRC\_CONNECTED;

- If it prefers (not) to be provisioned with reference time information;

- If it prefers to transition out of RRC\_CONNECTED state for MUSIM operation and its preferred RRC state after transition;

- If it wants to include assistance information for setup or release of MUSIM gaps, and/or for setup the priority of periodic MUSIM gaps, and/or for keeping the collided MUSIM gaps;

- If it prefers to restrict UE capability temporarily or remove the restriction for MUSIM operation;

- When affected by IDC problems that it cannot solve by itself:

- The list of frequencies affected by IDC problems (see clause 23.4 of TS 36.300 [2]);

- The list of frequency ranges/frequency range combinations affected by the IDC problems;

- DRX based TDM assistance information (see clause 23.4.2 of TS 36.300 [2]);

- Its RRM measurement relaxation status indicating whether RRM measurement relaxation criteria are met or not;

- Its RLM measurement relaxation status indicating whether the UE is applying RLM measurements relaxation;

- Its BFD measurement relaxation status indicating whether the UE is applying BFD measurements relaxation;

- If it prefers not operating on multi-Rx (i.e. not supporting simultaneous reception with different QCL-typeD) for FR2;

- If it prefers to be configured with a specific offset for LP-WUS monitoring.

 Editor’s note: Can be updated based on existing FFS, if needed

NOTE: The requirements on RRM/RLM/CSI measurements in different phases of IDC interference defined in TS 36.300 [2] are applicable except that for NR serving cell, the requirements in TS 38.133 [13] and TS 38.101-1 [18], TS 38.101-2 [35], TS 38.101-3 [36] apply.

In the second case, the UE can express a preference for temporarily reducing the number of maximum secondary component carriers, the maximum aggregated bandwidth and the number of maximum MIMO layers. In all cases, it is up to the gNB whether to accommodate the request.

For sidelink, the UE can report SL traffic pattern(s) to NG-RAN, for periodic traffic.

<snip>

# 9 Mobility and State Transitions

<snip>

### 9.2.5 Paging

Paging allows the network to reach UEs in RRC\_IDLE and in RRC\_INACTIVE state through *Paging* messages, and to notify UEs in RRC\_IDLE, RRC\_INACTIVE and RRC\_CONNECTED state of system information change (see clause 7.3.3) and ETWS/CMAS indications (see clause 16.4) through *Short Messages*. Both *Paging* messages and *Short Messages* are addressed with P-RNTI on PDCCH, but while the former is sent on PCCH, the latter is sent over PDCCH directly (see clause 6.5 of TS 38.331 [12]).

While in RRC\_IDLE the UE monitors the paging channels for CN-initiated paging. While in RRC\_INACTIVE with no ongoing SDT procedure (see clause 18.0) the UE monitors paging channels for RAN-initiated paging and CN-initiated paging. A UE need not monitor paging channels continuously though; Paging DRX is defined where the UE in RRC\_IDLE or RRC\_INACTIVE is only required to monitor paging channels during one Paging Occasion (PO) per DRX cycle (see TS 38.304 [10]). The Paging DRX cycles are configured by the network:

1) For CN-initiated paging, a default cycle is broadcast in system information;

2) For CN-initiated paging, a UE specific cycle can be configured via NAS signalling;

3) For RAN-initiated paging, a UE-specific cycle is configured via RRC signalling;

- The UE uses the shortest of the DRX cycles applicable i.e. a UE in RRC\_IDLE uses the shortest of the first two cycles above, while a UE in RRC\_INACTIVE uses the shortest of the three.

The POs of a UE for CN-initiated and RAN-initiated paging are based on the same UE ID, resulting in overlapping POs for both. The number of different POs in a DRX cycle is configurable via system information and a network may distribute UEs to those POs based on their IDs.

While in RRC\_CONNECTED and while in RRC\_INACTIVE with ongoing SDT procedure, the UE monitors the paging channels in any PO signalled in system information for SI change indication and PWS notification. In case of BA, a UE in RRC\_CONNECTED only monitors paging channels on the active BWP with common search space configured.

For operation with shared spectrum channel access, a UE can be configured for an additional number of PDCCH monitoring occasions in its PO to monitor for paging. However, when the UE detects a PDCCH transmission within the UE's PO addressed with P-RNTI, the UE is not required to monitor the subsequent PDCCH monitoring occasions within this PO.

If Paging Cause is included in the Paging message, a UE in RRC\_IDLE or RRC\_INACTIVE state may use the Paging Cause as per TS 23.501[3].

**Paging optimization for UEs in CM\_IDLE**: at UE context release, the NG-RAN node may provide the AMF with a list of recommended cells and NG-RAN nodes as assistance info for subsequent paging. The AMF may also provide Paging Attempt Information consisting of a Paging Attempt Count and the Intended Number of Paging Attempts and may include the Next Paging Area Scope. If Paging Attempt Information is included in the Paging message, each paged NG-RAN node receives the same information during a paging attempt. The Paging Attempt Count shall be increased by one at each new paging attempt. The Next Paging Area Scope, when present, indicates whether the AMF plans to modify the paging area currently selected at next paging attempt. If the UE has changed its state to CM CONNECTED the Paging Attempt Count is reset.

**Paging optimization for UEs in RRC\_INACTIVE**: at RAN Paging, the serving NG-RAN node provides RAN Paging area information. The serving NG-RAN node may also provide RAN Paging attempt information. Each paged NG-RAN node receives the same RAN Paging attempt information during a paging attempt with the following content: Paging Attempt Count, the intended number of paging attempts and the Next Paging Area Scope. The Paging Attempt Count shall be increased by one at each new paging attempt. The Next Paging Area Scope, when present, indicates whether the serving NG\_RAN node plans to modify the RAN Paging Area currently selected at next paging attempt. If the UE leaves RRC\_INACTIVE state the Paging Attempt Count is reset.

**UE power saving for paging monitoring:** in order to reduce UE power consumption due to false paging alarms, the group of UEs monitoring the same PO can be further divided into multiple subgroups. With subgrouping, a UE shall monitor PDCCH in its PO for paging if the subgroup to which the UE belongs is paged as indicated via associated PEI and/or LP-WUS. If a UE cannot find its subgroup ID with the PEI and/or LP-WUS configurations in a cell or if the UE is unable to monitor the associated PEI and/or LP-WUS occasion corresponding to its PO, it shall monitor the paging in its PO.

The gNB configures in system information entry and exit conditions to monitor LP-WUS. The UE may start monitoring LP-WUS when measurements using the MR are above the configured entry threshold(s), and the measurements using the LR are above the entry threshold(s), if configured.. Exit conditions for LP-WUS monitoring are based on LR as specified in TS 38.304.

The subgroups have the following characteristics:

- They are formed based on either CN controlled subgrouping or UE ID based subgrouping;

- If CN controlled subgroup ID is not provided from AMF, UE ID based subgrouping is used if supported by the UE and network;

- The RRC state (RRC\_IDLE or RRC\_INACTIVE state) does not impact which subgroup the UE belongs to;

- Subgrouping support for a cell is broadcasted in the system information as one of the following: Only CN controlled subgrouping supported, only UE ID based subgrouping supported, or both CN controlled subgrouping and UE ID based subgrouping supported;

- Total number of subgroups allowed in a cell is up to 8 for PEI and up to 31 for LP-WUS and represents the sum of CN controlled and UE ID based subgrouping configured by the network;

- A UE configured with CN controlled subgroup ID applies CN controlled subgroup ID if the cell supports CN controlled subgrouping; otherwise, it derives UE ID based subgroup ID if the cell supports only UE ID based subgrouping.

PEI or LP-WUS associated with subgroups have the following characteristics:

- If the PEI or LP-WUS monitoring is supported by the UE, it shall at least support UE ID based subgrouping method;

- PEI monitoring can be limited via system information to the last used cell (i.e., the cell in which the UE most recently received *RRCRelease* without indicating that the last used cell for PEI shall not be updated);

- A PEI-capable UE shall store its last used cell information;

- gNBs supporting the PEI monitoring to the last used cell function provide the UE's last used cell information to the AMF in the NG-AP UE Context Release Complete message for PEI capable UEs, as described in TS 38.413 [26];

- UE that expects MBS group notification shall ignore the PEI or LP-WUS and shall monitor paging in its PO.

**CN controlled subgrouping:** For CN controlled subgrouping, AMF is responsible for assigning subgroup ID to the UE. The total number of subgroups for CN controlled subgrouping which can be configured, e.g. by OAM is up to 8 for PEI and up to 31 for LP-WUS. It is assumed that CN controlled subgrouping support is homogeneous within an RNA.

The following figure describes the procedure for CN controlled subgrouping for PEI or LP-WUS:



Figure 9.2.5-1: Procedure for CN controlled subgrouping

1. The UE indicates its support of CN controlled subgrouping via NAS signalling.

2. If the UE supports CN controlled subgrouping, the AMF determines the subgroup ID assignment for the UE.

3. The AMF sends subgroup ID to the UE via NAS signalling.

4. The AMF informs the gNB about the CN assigned subgroup ID for paging the UE in RRC\_IDLE/ RRC\_INACTIVE state.

5. When the paging message for the UE is received from the CN or is generated by the gNB, the gNB determines the PO and the associated PEI and/or LP-WUS occasion for the UE.

6. Before the UE is paged in the PO, the gNB transmits the associated PEI and/or LP-WUS and indicates the corresponding CN controlled subgroup of the UE that is to be paged in the PEI or after LP-WUS.

**UE ID based subgrouping:** For UE ID based subgrouping, the gNB and UE can determine the subgroup ID based on the UE ID and the total number of subgroups for UE ID based subgrouping in the cell. The total number of subgroups for UE ID based subgrouping is decided by the gNB for each cell and can be different in different cells. The following figure describes the procedure for UE ID based subgrouping for PEI or LP-WUS:



Figure 9.2.5-2: Procedure for UE ID based subgrouping

1. The gNB determines the total number of subgroups for UE ID based subgrouping in a cell.

2. The gNB broadcasts the total number of subgroups for UE ID based subgrouping in a cell.

3. UE determines its subgroup in a cell.

4. When paging message for the PEI and/or LP-WUS capable UE is received from the CN at the gNB or is generated by the gNB, the gNB determines the PO and the associated PEI and/or LP-WUS occasion for the UE.

5. Before the UE is paged in the PO, the gNB transmits the associated PEI and/or LP-WUS and indicates the corresponding subgroup derived based on UE ID of the UE that is paged in the PEI or after LP-WUS.

### 9.2.6 Random Access Procedure

<snip>

# 11 UE Power Saving

The PDCCH monitoring activity of the UE in RRC connected mode is governed by DRX, BA, DCP, cell DTX (see clause 15.4.2.3) and LP-WUS.

When DRX is configured, the UE does not have to continuously monitor PDCCH. DRX is characterized by the following:

- **on-duration**: duration that the UE waits for, after waking up, to receive PDCCHs. If the UE successfully decodes a PDCCH, the UE stays awake and starts the inactivity timer;

- **inactivity-timer**: duration that the UE waits to successfully decode a PDCCH, from the last successful decoding of a PDCCH, failing which it can go back to sleep. The UE shall restart the inactivity timer following a single successful decoding of a PDCCH for a first transmission only (i.e. not for retransmissions);

- **LP-WUS PDCCH monitoring timer**: alternatively to starting the on-duration timer, the UE can be configured to start the LP-WUS monitoring timer at a configured offset after LP-WUS is detected. The UE monitors PDCCH while the timer is running;

- **retransmission-timer**: duration until a retransmission can be expected;

- **cycle**: specifies the periodic repetition of the on-duration followed by a possible period of inactivity (see figure 11-1 below);

**- active-time**: total duration that the UE monitors PDCCH. This includes the "on-duration" of the DRX cycle, the time UE is performing continuous reception while the inactivity timer has not expired, the time when the UE is performing continuous reception while waiting for a retransmission opportunity and the time LP-WUS monitoring timer is running.



Figure 11-1: DRX Cycle

A SL UE can be configured with DRX, in which case, PDCCH providing SL grants can be send to the UE only during its active time.

When BA is configured, the UE only has to monitor PDCCH on the one active BWP i.e. it does not have to monitor PDCCH on the entire DL frequency of the cell. A BWP inactivity timer (independent from the DRX inactivity-timer described above) is used to switch the active BWP to the default one: the timer is restarted upon successful PDCCH decoding and the switch to the default BWP takes place when it expires.

In addition, the UE may be indicated, when configured accordingly, whether it is required to monitor or not the PDCCH during the next occurrence of the on-duration by a DCP monitored on the active BWP. If the UE does not detect a DCP on the active BWP, it does not monitor the PDCCH during the next occurrence of the on-duration, unless it is explicitly configured to do so in that case.

A UE can only be configured to monitor DCP when connected mode DRX is configured, and at occasion(s) at a configured offset before the on-duration. If short DRX cycle is configured, DCP is not applicable when short DRX cycle is used. More than one monitoring occasion can be configured before the on-duration. The UE does not monitor DCP on occasions occurring during active-time, measurement gaps, BWP switching, or when it monitors response for a CFRA preamble transmission for beam failure recovery (see clause 9.2.6), in which case it monitors the PDCCH during the next on-duration. If no DCP is configured in the active BWP, UE follows normal DRX operation.

When CA is configured, DCP or LP-WUS is only configured on the PCell and/or PSCell.

Editor’s note: Details of DC operation captured in TS 37.340, above added for similar treatment as for DCP. FFS on secondary DRX.

One DCP can be configured to control PDCCH monitoring during on-duration for one or more UEs independently.

A UE in RRC\_CONNECTED which is configured with DRX can be configured with LP-WUS. LP-WUS is monitored outside active-time. If LP-WUS is detected, the UE shall start the on-duration timer or LP-WUS PDCCH monitoring timer to start PDCCH monitoring and enter active-time. If the UE is configured to start on-duration timer after LP-WUS reception, the UE does not monitor LP-WUS when short DRX cycle is used. If the UE is configured to start LP-WUS PDCCH monitoring timer after LP-WUS reception, the UE monitors LP-WUS regardless of which DRX cycle is used. [FFS on further functionality e.g. timer start if not able to monitor LP-WUS].

Editor’s Note: Above paragraph to be updated and aligned between impacted speficiations regarding functionality, labelling and naming of the options.

Power saving in RRC\_IDLE and RRC\_INACTIVE can also be achieved by UE relaxing neighbour cells RRM measurements when it meets the criteria determining it is in low mobility and/or not at cell edge. When UE is configured with both high speed measurements and RRM measurement relaxation as specified in TS 38.331 [12], it is up to UE implementation whether to apply the FR1 high speed RRM requirements or the relaxed RRM requirements when the low mobility related criterion is configured and fulfilled as specified in TS 38.133 [13].

Power saving in RRC\_IDLE and RRC\_INACTIVE can also be achieved by allowing LP-WUS capable UEs to relax serving cell measurements on MR and/or offload serving cell measurements from MR to the LR and/or further relax neighbour cell measurements on MR. Entry conditions for serving cell measurement relaxation and/or offloading and/or further neighbor cell measurement relaxation are based on MR and optionally LR measurements as specified in TS 38.304. Exit conditions are based on LR as specified in TS 38.304. For further neighbor cells RRM measurement relaxation the UE needs to meet the criteria determining if it is not at cell edge.

A UE supporting LP-WUS also supports further RRM serving/neighbour cell measurement relaxation and RRM serving cell measurement offloading. It is up to network implementation to configure either serving cell relaxation or serving cell offloading or both in one cell when LP-WUS is configured.

UE power saving may be enabled by adapting the DL maximum number of MIMO layers by BWP switching.

Power saving is also enabled during active-time via cross-slot scheduling, which facilitates UE to achieve power saving with the assumption that it won't be scheduled to receive PDSCH, triggered to receive A-CSI or transmit a PUSCH scheduled by the PDCCH until the minimum scheduling offsets K0 and K2. Dynamic adaptation of the minimum scheduling offsets K0 and K2 is controlled by PDCCH.

Serving Cells of a MAC entity may be configured by RRC in two DRX groups with separate DRX parameters. When RRC does not configure a secondary DRX group, there is only one DRX group and all Serving Cells belong to that one DRX group. When two DRX groups are configured, each Serving Cell is uniquely assigned to either of the two groups. The DRX parameters that are separately configured for each DRX group are on-duration and inactivity-timer.

UE power saving in RRC\_IDLE/RRC\_INACTIVE may be achieved by providing the configuration for TRS with CSI-RS for tracking in TRS occasions. The TRS in TRS occasions may allow UEs in RRC\_IDLE/RRC\_INACTIVE to sleep longer before waking-up for its paging occasion. The TRS occasions configuration is provided in either SIB17 or SIB17bis. The availability of TRS in the TRS occasions is indicated by L1 availability indication. These TRSs may also be used by the UEs configured with eDRX.

UE power saving may be achieved by UE relaxing measurements for RLM/BFD. When configured, UE determines whether it is in low mobility state and/or whether its serving cell radio link quality is better than a threshold. The configuration for low mobility and good serving cell quality criterion is provided through dedicated RRC signalling.

RLM and BFD relaxation may be enabled/disabled separately through RRC Configuration. Additionally, RLM relaxation may be enabled/disabled on per Cell Group basis while BFD relaxation may be enabled/disabled on per serving cell basis.

The UE is only allowed to perform RLM and/or BFD relaxation when relaxed measurement criterion for low mobility and/or for good serving cell quality is met. If configured to do so, the UE shall trigger reporting of its RLM and/or BFD relaxation status through UE assistance information if the UE changes its respective RLM and/or BFD relaxation status while meeting the UE minimum requirements specified in TS 38.133 [13].

UE power saving may also be achieved through PDCCH monitoring adaptation mechanisms when configured by the network, including skipping of PDCCH monitoring and Search space set group (SSSG) switching. In this case UE does not monitor PDCCH during the PDCCH skipping duration except for the cases as specified in TS 38.213 [38], or monitors PDCCH according to the search space sets applied in SSSG.

# 12 QoS

<snip>

# RAN2 agreements (to be removed eventually)

## RAN2#125bis

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE INACTIVE

* The LP-WUS related configuration for IDLE/INACTIVE state is provided via system information. FFS if dedicated configuration is needed. (e.g. dedicated signalling to enable/disable LP-WUS)
* Working assumption: the LP-WUS configuration in SIB at least includes the following information:

- LP-SS configuration

- LP-WUS configuration

- FFS on Entry/exit condition for LP-WUS monitoring (chair: RRC config is not a possible entry/exit condition, i.e. full coverage/OFDM unfriendly)

* The PEI subgrouping method is taken as baseline for LP-WUS subgrouping, i.e. CN assigned and UE\_ID based subgrouping. FFS the maximum number of subgroups. (chair thought 3 bits/codepoints might be enough, i.e. did not want to capture that 8 bits is sufficient from RAN2 perspective)

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE INACTIVE

*??* On RRM relaxation of UE MR for serving cell measurements: RAN2 assumes RRM measurement relaxation on serving cell via MR if the configured criteria is fulfilled is possible, final decision is up to RAN4.

?? FFS in this case whether LR is also used for RRM measurement on serving cell.

~~?? Detailed methods of measurement relaxation and offloading are up to RAN4.~~

## RAN2#126

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE/INACTIVE

* RAN2 will further discuss the details about LP-WUS monitoring entry/exit conditions based on RAN1’s existing working assumptions.
* The LP-WUS related configuration in SIB at least include the following information for IDLE/INACTIVE:

- LP-SS configuration

- LP-WUS configuration

- Entry/exit condition for LP-WUS monitoring (FFS if it is always configured)

* Baseline for entry condition definition: If the serving cell quality, e.g. RSRP, RSRQ from MR, is above threshold(s) (if configured), UE may start to monitor LP-WUS, if UE monitors LP-WUS, it may stop monitoring the legacy PO. FFS if any measurement from LR is needed.
* Baseline for exit condition definition: If the serving cell measurement result based on LR is below a threshold (if configured), UE monitors PO as in legacy and it may stop monitoring the LP-WUS.
* RAN2 understand that if UE is configured with CN-based LP-WUS subgrouping, it is up to CN to assign the LP-WUS subgroup ID to the UE.
* RAN2 assume the maximum number of subgroups that can be configured for LP-WUS subgrouping is no less than 8.
* From RAN2 perspective, no new procedure is introduced for SI reception/updates.

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE/INACTIVE

* For serving cell measurement offloading (i.e., serving cell measurement fully offloaded to LR and no serving cell measurement via MR is required), RAN2 should focus on specifying the offloading criterion for serving cell for UEs supporting LP-WUS, and assume that RAN4 will define the measurement offloading requirements for serving cell.
* RAN2 understand that the RRM measurement of the neighboring cell can only be performed by MR. Can discuss again if RAN1 inform us otherwise.
* RAN2 will further discuss the neighbor cell measurement relaxation criteria (if the UE is using LR to measure the serving cell), e.g., considering reuse Rel-16 criteria for ‘not at cell edge’ and ‘low mobility’.

### 8.4.4 Procedures for LP-WUS in RRC\_CONNECTED

* In RRC\_CONNECTED mode, RAN2 to further discuss the impacts of LP-WUS operation methods identified in RAN1.
* For Option 1-1 (as described in RAN1 agreement), the LP-WUS monitoring occasion locates at a configured time offset before the start of drx-onDurationTimer. The range of time offset can be determined by RAN1.
* For Option 1-1, RAN2 assumes the solutions/ operations introduced for DCP mechanism is taken as baseline.
* RAN2 assume that legacy DCP and Option 1-1 is not configured simultaneously for a UE.
* The LP-WUS related configuration for RRC CONNECTED state UE is provided via dedicated RRC message.

## RAN2#127

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE/INACTIVE

* Baseline: The network does not need to be aware of whether the UE is monitoring LP-WUS or not in RRC\_IDLE/INACTIVE
* Separate entry/exit thresholds can be configured for OFDM-based and OOK-based WUR if a cell supports both types of LRs. Signalling details are FFS.
* Working assumption (can revisit if R1/R4 reached different conclusions): If the entry/exit conditions are configured, besides MR-based thresholds, LP-WUS monitoring entry condition can also include LR-based thresholds.
* The metrics for serving cell quality measured by MR/LR for entry condition includes (LP-)RSRP and optional (LP-)RSRQ.
* The metrics for serving cell quality measured by LR for exit condition includes (LP-)RSRP and optional (LP-)RSRQ.

?? In UE\_ID based subgrouping, a mechanism should be applied that allocates PEI and LP-WUS subgroups independently and separately (if UE is configured to use both PEI and LP-WUS and if UE support both) in order to reduce the false paging rate. FFS on detailed configurations.

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE/INACTIVE

* RAN2 only discuss RRM measurement offloading/relaxation for LP-WUS UEs.
* For serving cell measurement offloading (i.e., there is no serving cell measurement by MR):
	+ - The entry conditions for serving cell measurement offloading can be defined as at least MR greater than a certain RSRP threshold, and LR could also be considered.
		- The exit condition is based on the LR measurement results.

### 8.4.4 Procedures for LP-WUS in RRC\_CONNECTED

* For option 1-2,
	+ - After LP-WUS triggers the UE to perform PDCCH monitoring, the UE starts one timer. When the timer is running, the UE monitors PDCCH. FFS on the timer (e.g., newly defined timer or legacy timer.)
		- The timer is started at a time offset after receiving the LP-WUS indication for PDCCH monitoring. The range of time offset is left for RAN1.

## RAN2#127bis

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE/INACTIVE

* If NW configure thresholds for both MR and LR measurements, then the entry condition is met when all the measured results are above the configured threshold(s).
* The LPWUS monitoring exit condition does not include MR measurements.
* For CN assigned LP-WUS subgrouping, RAN2 assumes similar procedure for PEI will be used for LP-WUS subgrouping. Final design is up to SA2/CT1/RAN3 discussion.
* For UE\_ID based subgrouping, similar formula defined for PEI subgrouping is reused for LP-WUS subgrouping.
* RAN2 inform this conclusion to SA2/CT1/RAN3.

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE/INACTIVE

Working assumption

* For neighbor cell measurement relaxation for UEs capable of LP-WUS, do not define additional MR-based criterion over the R16 criteria. RAN2 assume ‘UE not at cell edge’ is reused, FFS on ‘UE with low mobility’.
* FFS (if needed) on enhancements based on R16 criteria (e.g., based on the LR measurements) for the case when MR serving cell measurement results are not available.

### 8.4.4 Procedures for LP-WUS in RRC\_CONNECTED

* For Option 1-2, LP-WUS monitoring is performed at least outside legacy C-DRX Active Time. FFS if the legacy drx-onDurationTimer is started or not if the new timer is configured in Option 1-2.
* In option 1-2, a new timer triggered by LPWUS is introduced. When this new timer is running, UE is in C-DRX active time. When UE is not in C-DRX active time, UE goes back to LPWUS monitoring.
* When UE is in C-DRX active time, UE PDCCH monitoring behaviors related to other legacy DRX timers (except for drx-onDurationTimer) are not affected.

## RAN2#128

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE/INACTIVE

* FFS whether/how to handle the case for UE-ID based subgrouping when the UE has an emergency PDU session.
* FFS on the following options

- Option 1: The subgrouping number for UE\_ID based PEI subgrouping is considered in the formula for UE\_ID based LP-WUS subgrouping.

- Option 2 The subgrouping number for UE\_ID LPWUS subgrouping includes an offset K which is configurable or fixed.

- Option 3: The formula for UE\_ID based PEI subgrouping is reused.

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE/INACTIVE

* The entry condition for serving cell RRM relaxation is at least ‘if serving cell quality measured by MR is higher than relaxation threshold, e.g. RSRP and/or RSRQ’. FFS if LR measurement is needed.
* FFS on exit condition for serving cell RRM relaxation, e.g., whether a separate exit condition other than ‘not fulfilling the entry condition’ is needed, or whether exit condition include MR and/or LR-based measurements
* FFS if the entry condition for serving cell RRM measurement relaxation is the same as neighbour cell RRM measurement relaxation.

### 8.4.4 Procedures for LP-WUS in RRC\_CONNECTED

* drx-onDurationTimer is not started with Option 1-2 LP-WUS.
* For Option 1-2, network can configure whether UE reports periodic CSI/L1-RSRP during the time given by the configured drx-onDurationTimer, for the case when UE is outside C-DRX active time.
* For option 1-2, if UE receives DRX command MAC CE or Long DRX command MAC CE, UE stops the new timer triggered by LP-WUS.
* Don’t support Option 1-1 and Option 1-2 simultaneously configured for the same UE.

For both option 1-1 and option 1-2

* + - ?? The LP-WUS can ~~also~~ be configured ~~with secondary~~ per DRX group.
		- ?? In NR-DC case, LP-WUS can be configured separately in MCG and SCG, and LP-WUS could trigger the PDCCH monitoring of all activated serving cells within the same cell group.

## RAN2#129

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE/INACTIVE

* RAN2 understands that UE can report which band(s) is supported by LR to NW.
* RAN2 understands that any potential overload issues could be addressed by current mechanism in spec.
* Send LS to RAN1 and RAN4 to inform the agreements.
* For UE\_ID based subgrouping, similar formula defined for PEI subgrouping is reused for LP-WUS subgrouping, i.e.,

**SubgroupID = (floor (UE\_ID/(N\*Ns\*Np)) mod subgroupsNumForUEID) + (subgroupsNumPerPO – subgroupsNumForUEID), where**

**- UE\_ID is related to 5G-S-TMSI,**

**- N is the number of total paging frames in one DRX cycle,**

**- Ns is the number of the PO for a PF,**

**- Np is the number of subgroupNumForUEID for PEI, if configured and UE supports PEI; otherwise, Np is 1,**

**- subgroupsNumForUEID and subgroupsNumPerPO are the subgroup number for UE\_ID based subgrouping for LP-WUS and the total subgroup number for LP-WUS, respectively.**

* RAN2 sends reply LS to SA2/RAN3/CT1, and CC RAN1 and RAN4 to confirm the “LP-WUS” terminology.
* Regarding the SA2 raised issue on UE Radio Capability for Paging Information, R2 understand that there is no issue for NW after Release 17 (in which case the LP-WUS UE-ID based subgrouping UE capability is included in the UE-RadioPagingInfo container). Whether there is issue for the other cases (for the features mentioned by SA2 LS [R2-2500050](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_129/Docs//R2-2500050.zip)) can be further discussed in the main session.

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE/INACTIVE

* The entry condition for MR serving cell RRM relaxation can include both MR and LR measurements.
* If LR threshold is configured, the entry condition is when both MR and LR measurement are above the configured thresholds.

### 8.4.4 Procedures for LP-WUS in RRC\_CONNECTED

* For Option 1-1, UE monitors LP-WUS outside C-DRX active time at least when long DRX cycle is used. FFS whether short DRX cycle is used.
* RAN2 confirm the (Long) DRX command MAC CE can be used with option 1-1 to stop drx-onDurationTimer and drx-InactivityTimer.
* RAN2 confirm the (Long) DRX command MAC CE can be used with option 1-2 to stop the new timer and drx-InactivityTimer.

## RAN2#129bis

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE/INACTIVE

Sub-grouping related aspects

* LP-WUS is supported with eDRX, FFS on exact impact if any
* Use 5G-S-TMSI to determine the UE\_ID in the formula of UE\_ID based subgrouping for LP-WUS, i.e., UE\_ID=5G-S-TMSI mod X.
* X is based on 32 subgrouping number. Details can be discussed in the running CR.
* Send LS to RAN3 (CC SA2/SA3) to inform our agreements on UE ID based subgrouping.
* Correct the typo as following for the previous agreed formula of UE\_ID based subgrouping for LP-WUS:
	+ - * + Np is the number of subgroupsNumForUEID for PEI, if configured and UE supports PEI; otherwise, Np is 1.
* Confirm the principle for determining CN assigned subgrouping or UE\_ID based subgrouping for PEI is reused for LP-WUS subgrouping. Details will be discussed in the running CR.

LPWUS configuration

* All the LP-WUS related configurations except for measurement configurations are provided in SIB1. FFS the details on measurement configurations.
* Dedicated configuration in RRC signaling is not needed for providing LP-WUS related configuration in RRC\_IDLE/INACTIVE modes.

Entry/exit condition of LPWUS monitoring

* Use existing Srxlev/Squal for all MR measurement based entry/exit condition evaluation.
* Use measured value for all LR measurement based entry/exit condition evaluation.

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE/INACTIVE

RRM measurement relaxation

* RAN2 assumes for the entry/ exit conditions of serving cell measurement offloading and serving cell RRM measurement relaxation: separate MR thresholds (according to RAN1 agreement)/LR thresholds can be configured for different types of LP WUR if a cell supports both types of LRs (can revisit based on RAN1 and RAN 4 progress, if any).
* RAN2 assumes the entry/exit thresholds for RRM relaxation/offloading for OFDM-based WUR measuring LP-SS only are the same as that for OOK-based WUR measuring LP-SS. It can be revisited based on RAN1/RAN4 process, if any. Network is allowed to provide either OOK based threshold or OFDM based WUR mesasuring SSB threhold or both.
* It is up to NW to configure either serving cell relaxation or serving cell offloading or both in one cell.
* The metrics for RRM measurement offloading/relaxation criteria include (LP-)RSRP and optional (LP-)RSRQ.
* How to define LP-RSRP and LP-RSRQ is up to RAN1.
* The duplication between RAN2 and RAN4 specification on RRM relaxation and offloading should be avoided, details up to running CR rapporteur and companies’ review.
* Merge the entry/exit condition for Serving Cell RRM measurement relaxation and Rel-19 Neighboring Cell RRM measurement relaxation (higher priority frequency is separate discussion).

### 8.4.4 Procedures for LP-WUS in RRC\_CONNECTED

On short DRX cycle

* For Option 1-1, the UE does not monitor LP-WUS when Short DRX cycle is used.
* Working assumption: For option 1-2, it is up to network configuring short DRX cycle with LP-WUS. The UE monitors LP-WUS outside the Active Time regardless of if Short DRX cycle or Long DRX cycle is used.
* Send an LS to RAN1 to inform the above conclusions, can revisit if needed based on RAN1 feedback.

Other aspects related to the procedure (e.g., collision handling, UAI, etc.)

* Working assumption for the case of potential collision (if any): In Option 1-1, when the UE is not able to monitor the LP-WUS occasion(s) the UE should start the drx-OnDurationTimer (as if LP-WUS was detected). FFS for Option 1-2.
* Send LS to inform this working assumption, can also ask a) what are the cases when UE cannot monitor LP-WUS, b) whether UE can monitor LR and MR simultaneously.
* If configured, the UE can signal a preferred time offset via UAI signalling.
* Ask RAN1 for further information regarding their conclusions.

Dual DRX group

* FFS whether/how to support LP-WUS (including Option 1-1 and 1-2) and dual DRX group

MRDC

* For NR-DC, the LP-WUS can be configured to be monitored at least on the PCell and PSCell. Wait for RAN1 progress on whether to allow LP-WUS configuration and monitoring on other Cells.
* For NR-DC, the LP-WUS in MCG and SCG can be configured independently.
* Apart from NR-DC, LP-WUS can also be supported in NE-DC, EN-DC, NGEN-DC. And proposal 1 and 2 also apply to NE-DC, EN-DC, NGEN-DC.

## RAN2#130

On open issues for TS38.304

* For UE\_ID based subgrouping , X is 1048576, i.e., the largest UE ID range in all LP\_WUS cases is be used for all LP-WUS monitoring cases.
* UEs expecting MBS group notification should monitor its PO to receive the MBS group notification regardless of LP-WUS.

On open issues for TS38.331

* RRM relaxation / offloading configuration is provided in SIB2.
* RAN2 assumes the design of UAI reporting for preferred time offset is same as the legacy, e.g. including the configuration, procedure, as well as prohibit timer, etc.

On LP-WUS in MR-DC

* LP-WUS, if supported by UE, can only be configured to be monitored on the PCell, if the MN is a gNB (i.e. for NE-DC and NR-DC) and/or with LP-WUS to be monitored on the PSCell, if the SN is a gNB (i.e. for EN-DC, NGEN-DC and NR-DC).

On UE capabilities

* A UE indicating support of LP-WUS reception in IDLE/INACTIVE shall support UE-ID based subgrouping.
* From R2 point of view, RRM measurement relaxation and RRM measurement fully offloading are defined as RAN2 capability without UE capability signalling.
* UE supporting LP-WUS reception shall also support RRM measurement relaxation and RRM measurement fully offloading

### 8.4.2 Procedure and configuration of LP-WUS in RRC\_IDLE/INACTIVE

* The entry/exit condition for LP-WUS monitoring is mandatory in LP-WUS configuration, if the LP-WUS configuration is provided by the NW.
* Full coverage for LP-WUS is not precluded, e.g., if there needs to be a threshold value so that the condition is always fulfilled for all LPWUS UEs.
* It is up to UE implementation to choose whether SSB measurement based or OOK LP-SS measurement based conditions are used for LP-WUS monitoring entry/exit condition, if UE support both measurement types.
* RAN2 aim at supporting enabling/disabling LP-WUS monitoring in IDLE/INACTVE per UE, if the solution can be concluded in the August meeting.

### 8.4.3 RRM measurement relaxation and offloading in RRC\_IDLE/INACTIVE

* The corresponding threshold(s) of entry condition for serving cell RRM offloading should be higher than the threshold(s) of entry condition for R19 RRM relaxation (serving cell relaxation and neighboring cell relaxation), if there is such configuration. Capture this in the field description. Details will be discussed in the running CR.
* It is up to NW to configure the condition for LP-WUS monitoring and/or [R19 serving/ neighboring cell RRM relaxation /R19 serving cell RRM offloading], as in the current RRC running CR.
* The threshold of the MR based entry condition for serving cell RRM offloading should be higher than or equal to the threshold to stop neighboring cell RRM measurement, which is the maximum of {SIntraSearchP, SnonIntraSearchP}. Capture this in the field description. Details will be discussed in the running CR.

### 8.4.4 Procedures for LP-WUS in RRC\_CONNECTED

* Working assumption: LP-WUS can be configured on the PCell with secondary DRX. LP-WUS with secondary DRX is supported with option 1-1 and 1-2, i.e. the UE monitors LP-WUS before the on-duration occasion or periodically outside ActiveTime. When LP-WUS is detected, then UE starts the drx-onDurationTimer (with option 1-1) or the lpwus-PDCCHMonitoringTimer (with option 1-2) in both DRX groups.
* Check whether we need to capture in MAC that UE is not expected to monitor LP-WUS if not in Cell DTX active period