**13GPP TSG-RAN WG2 Meeting #131 R2-250xxxx**

**Bengaluru, India, 25 - 29 August 2025**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  | **38.300** | **CR** | **1015** | **rev** | **draft** | **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:***  | Introduction of Low-Power Wake-Up Signal and Receiver for NR |
|  |  |
| ***Source to WG:*** |  |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_LPWUS-Core |  | ***Date:*** | 2025-08-15 |
|  |  |  |  |  |
| ***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 and Rel-19 RRM relaxation features into the specifications |
|  |  |
| ***Summary of change:*** | * Introduction of the LP-WUS monitoring (in idle/inactive and connected)
* Introduction of RRM relaxation (serving and neighbor cells) and offloading of measurements to low power receiver for LP-WUS UEs
 |
|  |  |
| ***Consequences if not approved:*** | LP-WUS WUR and enhanced RRM measurement relaxation/offloading would not be supported in Rel-19. |
|  |  |
| ***Clauses affected:*** | 3.1, 7.9, 9.2.2, 9.2.5, 11 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **x** |  |  Other core specifications  | TS 38.321 CR 2103TS 38.331 CR 5403TS 38.331 CR 5416TS 38.306 CR 1321TS 38.304 CR 0440TS 37.340 CR 0420 |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** | This is a running CR – agreements (Appendix) to be removed for final version |
|  |  |
| ***This CR's revision history:*** |  |

# 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

HSDN High Speed Dedicated Network

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-SS Low Power Synchronization Signal

LP-WUS Low Power Wake-Up Signal

LR Low Power Wake-Up Receiver

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

MR Main Receiver

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

OFDM Orthogonal Frequency Division Multiplexing

OOK On-Off Keying

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

SpCell Special Cell

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

TN Terrestrial Network

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

<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 colliding 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 time offset for LP-WUS monitoring in RRC\_CONNECTED.

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.

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# 9 Mobility and State Transitions

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9.2.2 Mobility in RRC\_INACTIVE

#### 9.2.2.1 Overvieww

RRC\_INACTIVE is a state where a UE remains in CM-CONNECTED and can move within an area configured by NG-RAN (the RNA) without notifying NG-RAN. In RRC\_INACTIVE, the last serving gNB node keeps the UE context and the UE-associated NG connection with the serving AMF and UPF.

For a UE in RRC\_INACTIVE with eDRX cycle longer than 10.24 seconds, the NG-RAN node may, based on implementation, send a request to the AMF to perform MT Communication Handling as described in TS 23.501 [3]. If the UE accesses a gNB other than the last serving gNB and upon successful UE context retrieval, the AMF considers that the UE is reachable (i.e., the MT Communicating Handling is deactivated) and triggers the MT DL data/signalling delivery upon receiving the NGAP Path Switch Request message.

If the last serving gNB receives DL data from the UPF or DL UE-associated signalling from the AMF (except the UE Context Release Command message) while the UE is in RRC\_INACTIVE, it pages in the cells corresponding to the RNA and may send XnAP RAN Paging to neighbour gNB(s) if the RNA includes cells of neighbour gNB(s).

Upon receiving the RAN Paging Request message from the AMF while the UE is in RRC\_INACTIVE with eDRX beyond 10.24 seconds, the last serving gNB may page in its cells comprised in the RNA and may send XnAP RAN Paging to neighbour gNB(s) if the RNA includes cells of neighbour gNB(s), in order to trigger the UE to resume connection in RRC\_CONNECTED state, or in RRC\_INACTIVE state for DL SDT, based on the DL data size if included in the NGAP RAN Paging Request message.

Upon receiving the UE Context Release Command message while the UE is in RRC\_INACTIVE, the last serving gNB may page in the cells corresponding to the RNA and may send XnAP RAN Paging to neighbour gNB(s) if the RNA includes cells of neighbour gNB(s), in order to release UE explicitly.

Upon receiving the NG RESET message while the UE is in RRC\_INACTIVE, the last serving gNB may page involved UEs in the cells corresponding to the RNA and may send XnAP RAN Paging to neighbour gNB(s) if the RNA includes cells of neighbour gNB(s) in order to explicitly release involved UEs.

Upon RAN paging failure, the gNB behaves according to TS 23.501 [3].

The AMF provides to the NG-RAN node the Core Network Assistance Information to assist the NG-RAN node's decision whether the UE can be sent to RRC\_INACTIVE, and to assist UE configuration and paging in RRC\_INACTIVE. The Core Network Assistance Information includes the registration area configured for the UE, the Periodic Registration Update timer, and the UE Identity Index value, and may include the UE specific DRX, an indication if the UE is configured with Mobile Initiated Connection Only (MICO) mode by the AMF, the Expected UE Behaviour, the UE Radio Capability for Paging, the PEI with Paging Subgrouping assistance information, the LP-WUS with Paging Subgrouping assistance information, the NR Paging eDRX Information, the Paging Cause Indication for Voice Service, the Hashed UE Identity Index Value and the CN support indication for MT Communication Handling. The UE registration area is taken into account by the NG-RAN node when configuring the RNA. The UE specific DRX and UE Identity Index value are used by the NG-RAN node for RAN paging. The Periodic Registration Update timer is taken into account by the NG-RAN node to configure Periodic RNA Update timer. The NG-RAN node takes into account the Expected UE Behaviour to assist the UE RRC state transition decision. The NG-RAN node may use the UE Radio Capability for Paging during RAN Paging. The NG-RAN node takes into account the PEI with Paging Subgrouping assistance information for subgroup paging in RRC\_INACTIVE except when the UE context contains an emergency PDU session in which case the PEI with Paging Subgrouping assistance information shall not be used according to TS 24.501 [28]. The NG-RAN node takes into account the LP-WUS with Paging Subgrouping assistance information for subgroup paging in RRC\_INACTIVE. When sending the XnAP RAN Paging to neighbour NG-RAN node(s), the PEI with Paging Subgrouping assistance information and the LP-WUS with Paging Subgrouping assistance information may be included. The NG-RAN node takes into account the NR Paging eDRX Information to configure the RAN Paging when the NR UE is in RRC\_INACTIVE. When sending XnAP RAN Paging to neighbour NG-RAN node(s), the NR Paging eDRX Information for RRC\_IDLE and for RRC\_INACTIVE may be included. The NG-RAN node takes into consideration the Paging Cause Indication for Voice Service to include the Paging Cause in RAN Paging for a UE in RRC\_INACTIVE state. When sending XnAP RAN Paging to neighbour NG-RAN node(s), the Paging Cause may be included. When sending XnAP RAN Paging to neighbour NG-RAN node(s), the Hashed UE Identity Index Value may be included to determine the start point of PTW. The NG-RAN takes into account the CN support indication for MT Communication Handling when deciding to request the AMF for MT Communication Handling for a UE in RRC\_INACTIVE state with long eDRX beyond 10.24 seconds as described in TS 23.501 [3].

At transition to RRC\_INACTIVE the NG-RAN node may configure the UE with a periodic RNA Update timer value. At periodic RNA Update timer expiry without notification from the UE, the gNB behaves as specified in TS 23.501 [3].

If the UE accesses a gNB other than the last serving gNB, the receiving gNB triggers the XnAP Retrieve UE Context procedure to get the UE context from the last serving gNB and may also trigger an Xn-U Address Indication procedure including tunnel information for potential recovery of data from the last serving gNB. Upon successful UE context retrieval, the receiving gNB shall perform the slice-aware admission control in case of receiving slice information and becomes the serving gNB and it further triggers the NGAP Path Switch Request and applicable RRC procedures. After the path switch procedure, the serving gNB triggers release of the UE context at the last serving gNB by means of the XnAP UE Context Release procedure.

In case the UE is not reachable at the last serving gNB, the gNB shall fail any AMF initiated UE-associated class 1 procedure which allows the signalling of unsuccessful operation in the respective response message. It may trigger the NAS Non Delivery Indication procedure to report the non-delivery of any non PDU Session related NAS PDU received from the AMF as specified in TS 38.413 [26].

If the UE accesses a gNB other than the last serving gNB and the receiving gNB does not find a valid UE Context, the receiving gNB can perform establishment of a new RRC connection instead of resumption of the previous RRC connection. UE context retrieval will also fail and hence a new RRC connection needs to be established if the serving AMF changes.

A UE in the RRC\_INACTIVE state is required to initiate RNA update procedure when it moves out of the configured RNA. When receiving RNA update request from the UE, the receiving gNB triggers the XnAP Retrieve UE Context procedure to get the UE context from the last serving gNB and may decide to send the UE back to RRC\_INACTIVE state, move the UE into RRC\_CONNECTED state, or send the UE to RRC\_IDLE. In case of periodic RNA update, if the last serving gNB decides not to relocate the UE context, it fails the Retrieve UE Context procedure and sends the UE back to RRC\_INACTIVE, or to RRC\_IDLE directly by an encapsulated *RRCRelease* message.

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### 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. If the UE is configured with both LP-WUS and PEI, and it cannot find its subgroup ID with the LP-WUS or if the UE is unable to monitor the LP-WUS it monitors the following PEI and/or paging in its PO.

The gNB configures entry and exit conditions to monitor LP-WUS in system information. 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 [10]. LP-WUS monitoring can be disabled in the UE via NAS signalling. If this NAS signalling is absent LP-WUS monitoring is enabled.

These 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 broadcast 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 has 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 and LP-WUS and the UE 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. In addition to monitoring a codepoint associated with its subgroup ID, a UE configured with LP-WUS monitoring also monitors a common codepoint associated with all subgroups in a PO, if applicable. 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 and 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 using PEI and/or 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. Up to 31 subgroups are supported for LP-WUS. In addition to monitoring a codepoint associated with its subgroup ID, a UE configured with LP-WUS monitoring also monitors a common codepoint associated with all subgroups in a PO, if applicable. 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 using PEI and/or 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**: duration that the UE waits for, after woken up by LP-WUS, to receive PDCCH. In case this timer is configured the UE does not start the on-duration timer. If the UE successfully decodes a PDCCH, the UE stays awake and starts the inactivity timer;

- **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 UE is performing continuous reception while the LP-WUS PDCCH monitoring timer has not expired.



Figure 11-1: DRX Cycle

UE can be configured with LP-WUS for power saving in all RRC states. A LP-WUS is transmitted based on OOK and overlaid OFDM sequence(s) over OOK ON symbols, and can carry up to 5 information bits and one codepoint out of up to 32 codepoints. A UE supports detection of LP-WUS information carried by OOK and/or overlaid OFDM sequences. In RRC\_IDLE and RRC\_INACTIVE, the same information is delivered by OOK and overlaid OFDM sequences. For LP-WUS, the number of OOK symbols within an OFDM symbol can be configured as 1, 2 or 4. For RRC\_IDLE and RRC\_INACTIVE, a UE monitors two codepoints for LP-WUS. In RRC\_CONNECTED, a UE can be configured to monitor up to 8 codepoints for LP-WUS.

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.

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

A UE configured with DRX in RRC\_CONNECTED 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 monitors LP-WUS at occasion(s) at a configured offset before the on-duration, and the UE does not monitor LP-WUS when short DRX cycle is used. If the UE is unable to monitor the LP-WUS occasion, it shall start the on-duration timer.

- If the UE is configured to start LP-WUS PDCCH monitoring timer after LP-WUS reception, the UE monitors LP-WUS at occasion(s) according to the configured periodicity and offset which can be same or different from the periodicity and offset configured for C-DRX cycle, and the UE monitors LP-WUS regardless of which DRX cycle is used. It the UE is unable to monitor the LP-WUS occasion(s), the LP-WUS PDCCH monitoring timer is not started.

Three candidate values for minimum time gap are supported for UE in RRC\_CONNECTED to report via capability signaling, where the minimum time gap is between the LP-WUS reception and MR to start PDCCH monitoring. gNB configures the time offset between LP-WUS monitoring and the corresponding PDCCH monitoring.

~~When LP-WUS is configured, the resources for uplink transmission initiated by the MAC entity (e.g. PUCCH resource for SR, PRACH occasion and CG resource) should occur after MR is ready to transmit.~~

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 UEs supporting LP-WUS to relax serving cell measurements on MR, further relax neighbor cell measurements on MR and/or offload serving cell measurements from MR to LR. Conditions for neighbor and serving cell measurement relaxation are based on MR and optionally LR measurements as specified in TS 38.304[10]. Entry condition for ~~serving cell and further neighbor cell measurement relaxation and/or~~ offloading serving cell measurements from MR to LR is based on MR and optionally LR measurements as specified in TS 38.304 [10]. Exit conditions for offloading serving cell measurements from MR to LR are based on LR measurements as specified in TS 38.304 [10].

For UE in RRC\_IDLE and RRC\_INACTIVE configured with LP-WUS, LP-SS is supported for UE LR to maintain synchronization and perform serving cell RRM measurements. LP-SS transmission is based on OOK with or without overlaid OFDM sequence. For UE capable of detecting overlaid OFDM sequence by LR, PSS/SSS can be used for UE LR to maintain synchronization and perform serving cell RRM measurements. For LP-SS, the number of OOK symbols within an OFDM symbol can be configured as 1, 2 or 4 and the number can be same or larger than LP-WUS. LP-SS is not supported in RRC\_CONNECTED.

For UE in RRC\_IDLE and RRC\_INACTIVE configured with LP-WUS, the frequency resource of LP-WUS and LP-SS can be configured within or outside the initial DL BWP in the carrier where the UE monitors paging. For UE in RRC\_CONNECTED, the frequency resource of LP-WUS can be configured within or outside the UE active DL BWP, where the support of LP-WUS monitoring outside active DL BWP is optional.

For UE in RRC\_IDLE and RRC\_INACTIVE configured with LP-WUS, three candidate values for wake-up delay are supported for UE to report via capability signaling, where wake-up delay is defined as the minimum time gap between the LP-WUS reception and MR to start PDCCH monitoring. gNB can configure one or two time offset values between the reference PF of the PO and the associated LP-WUS monitoring occasions. If at least one of the configured time offset values are no smaller than the wake-up delay that UE reports, the UE monitors LP-WUS monitoring occasions corresponding to the smallest time offset value that is no smaller than its reported wake-up delay, otherwise, the UE does not monitor LP-WUS and monitors PO.

UE is not required to support simultaneous reception using LR and MR, where LR is used for LP-WUS monitoring and MR is used for transmission and/or reception of all other NR signals/channels in RRC\_CONNECTED within the same cell group.

NOTE xy: The use of LR does not imply whether the UE implements LR with the same or a different physical receiver as MR.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.

A UE supporting LP-WUS can be configured with two DRX groups where the UE can be configured to start either on-duration timer or the LP-WUS PDCCH monitoring timer after detecting LP-WUS to enter active-time. After LP-WUS detection the corresponding timer is started on both of the DRX groups. In addition to on-duration and inactivity-timer, the LP-WUS PDCCH monitoring timer is separately configured for each DRX group. The UE monitors for LP-WUS only when both DRX groups are outside active-time.

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

## RAN2#131

### 8.4.1 Organizational

* In the running CR, ‘UE supporting LP-WUS’ is used instead of ‘LP-WUS UE’.
* Nothing is needed on high priority frequency for serving cell measurement offloading or measurement relaxation with LP-WUS in 38.304 running CR if the corresponding higher priority frequency relaxation has been captured in RAN4 specification.
* Same as LP-WUS monitoring, it is up to UE implementation to choose whether SSB measurement based or OOK LP-SS measurement based are used for RRM relaxation/offloading conditions if UE supports both measurement types.
* RAN2 assumes the following value range of ThresholdPLP and ThresholdQLP for LR measurement based threshold for entry/exit condition for LP-WUS monitoring and RRM relaxation/offloading
* The IE ThresholdLP is used to indicate a measured RSRP threshold for LP-WUS. Actual value of threshold = field value \* 2 [dBm].

ThresholdP-LP ::= INTEGER (-80..0)

* The IE ThresholdQ-LP is used to indicate a measured RSRQ threshold for LP-WUS. Actual value of threshold = field value [dB].

ThresholdQ-LP ::= INTEGER (-34..0)

* LR measurement based RX level and cell quality value should be derived by UE implementation in multi-beam operations. We assume this conclusion does not impact the cell reselection procedure.
* RAN2 will keep the current terminologies in RAN2 specification, i.e. LP-WUS, LP-SS, LO (LP-WUS Occasion), LR, and MR.
* Confirm the following working assumption to support LP-WUS with dual DRX group.

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.

* If secondary DRX group is configured, the lpwus-PDCCH-MonitoringTimer configuration for secondary DRX group is different from that for the default DRX group.
* If secondary DRX group is configured, UE monitors LP-WUS only when both DRX groups are not in DRX active time.
* RAN2 understand that the RAN1 agreement on not supporting simultaneous LR and MR operation is only applicable within one cell group (with or without secondary DRX group configuration). Send LS to RAN1 for confirmation.
* The lpwus-PDCCH-MonitoringTimer configuration for secondary DRX group is smaller than or equal to that for the default DRX group.
* Confirm the following RAN2#129bis working assumption for Option 1-1:

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).

* For Option 1-2, UE does not start the lpwus-PDCCH-MonitoringTimer in collision cases, i.e. when the UE is not able to monitor the LP-WUS occasion(s). Can discuss if critical issue identified with this mechanism.
* Agree the addition of the MUSIM gap case), for the UE operation in Option 1-1 for the collision and timing issue.
* There is no MAC spec impact to reflect the LP-WUS operation in Cell DTX operation. Can further check in maintenance phase.
* RAN2 confirm that the available UL occasions (e.g. SR occasion, RACH occasion, CG occasion) are MR-ready. Can further check whether any spec change is needed.

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

On remaining issues

* RAN2 assumes NAS signalling is introduced to support enabling/disabling LP-WUS per UE. Inform SA2, CT1 and RAN3 about this conclusion.
* RAN2 assumes that NAS signalling needs to be extended to enable/disable LP-WUS for a UE in IDLE and INACTIVE. Detail signalling is up to SA2, CT1.
* RAN2 assumes that CN needs to inform gNB that LP-WUS is enabled/disabled for a UE in IDLE and INACTIVE. Details signalling is up to SA2, CT1, RAN3.
* RAN2 assumes that without such NAS singalling, UE is allowed to use LPWUS in IDLE and INACTIVE.
* The LS is approved unseen in R2-2506261
* LP-WUS can be used in any cell, i.e., don’t introduce lastUsedCellOnly for LP-WUS.
* In RRC\_INACTIVE state, for LP-WUS, when the UE uses the same i\_s as for RRC\_IDLE state, the UE shall use the same iPO LP-WUS as for RRC\_IDLE state. Otherwise, the UE determines the iPO for LP-WUS for based on the i\_s for RRC\_INACTIVE state.
* In RRC\_INACTIVE state with CN configured PTW, the SubgroupID for LP-WUS used outside CN PTW is the same as the SubgroupID used inside CN PTW.
* Confirm that SDT can be initiated while UE is monitoring LP-WUS, and there is no impact to the SDT procedure. Can check if any spec change is needed.
* For the RRC-IDLE and RRC-INACTIVE, if the UE is not able to monitor the LP-WUS in all MO then the UE is required to monitor the following PEI and/or PO. Detailed changes to the spec can be further checked.
* RAN2 assumes the entry/exit thresholds for LP-WUS monitoring for OFDM-based WUR measuring LP-SS only are the same as that for OOK-based WUR measuring LP-SS. Network is allowed to provide either OOK based threshold or OFDM based WUR measuring SSB threshold or both.

On UE capability

* The capability for supporting UE\_ID based subgrouping is defined as one of the components of LP-WUS operation basic features based on OOK signal (62-1) and OFDM overlaid sequence (62-1a) in IDLE/INACTIVE.

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

* The exit condition for RRM relaxation is defined as ‘not fulfilling the entry condition’.
* RAN2 assumes UE low mobility criterion is not included for Rel-19 LP-WUS RRM relaxation/offloading mode.
* LR measurement is not used for R16/R17 RRM relaxation condition.

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

* RAN2 assume UE does not start or re-start the bwp-InactivityTimer when receiving the LP-WUS.