**3GPP TSG-WG2 #**

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

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  |
| *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:***  | MAC Running CR for LP-WUS |
|  |  |
| ***Source to WG:*** | Apple  |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** | 2025-07-07 |
|  |  |  |  |  |
| ***Category:*** |  |  | ***Release:*** |  |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories 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 Rel-19 LP-WUS in TS 38.321 |
|  |  |
| ***Summary of change:*** | Introduction of Rel-19 LP-WUS in TS 38.321* Support of LP-WUS in CONNECTED state
 |
|  |  |
| ***Consequences if not approved:*** | Rel-19 LP-WUS is not captured in TS 38.321. |
|  |  |
| ***Clauses affected:*** | 3.2, 5.7 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **Y** |  |  Other core specifications  | TS 38.300 CRxxxxTS 38.331 CRxxxx |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | R2-2502307, initial version based on version 18.5.0R2-2503807, updated version to include the RAN2#129bis agreementR2-250xxxx, updated version to include the RAN2#130 agreement, based on version 18.6.0 |

Start of change

## 3.2 Abbreviations

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

A2X Aircraft-to-Everything

AP Aperiodic

BFR Beam Failure Recovery

BRID Broadcast Remote Identification

BSR Buffer Status Report

BWP Bandwidth Part

CE Control Element

CG Cell Group

CG-SDT Configured Grant-based SDT

CI-RNTI Cancellation Indication RNTI

CSI Channel State Information

CSI-IM CSI Interference Measurement

CSI-RS CSI Reference Signal

CS-RNTI Configured Scheduling RNTI

DAA Detect And Avoid

DAPS Dual Active Protocol Stack

DCP DCI with CRC scrambled by PS-RNTI

DL-PRS DownLink-Positioning Reference Signal

DSR Delay Status Report

DTX Discontinuous Transmission

G-CS-RNTI Group Configured Scheduling RNTI

G-RNTI Group RNTI

IAB Integrated Access and Backhaul

INT-RNTI Interruption RNTI

LBT Listen Before Talk

LCG Logical Channel Group

LCP Logical Channel Prioritization

LTM L1/L2 Triggered Mobility

LP-WUS Low Power-Wake up Signal

MBS Multicast/Broadcast Services

MCCH MBS Control Channel

MCCH-RNTI MBS Control Channel RNTI

MCG Master Cell Group

MO-SDT Mobile Originated SDT

MPE Maximum Permissible Exposure

MTCH MBS Traffic Channel

MT-SDT Mobile Terminated SDT

N3C Non-3GPP Connection

NCD-SSB Non Cell Defining SSB

NCR Network-Controlled Repeater

NSAG Network Slice AS Group

NUL Normal Uplink

NZP CSI-RS Non-Zero Power CSI-RS

PDB Packet Delay Budget

PEI-RNTI Paging Early Indication RNTI

PHR Power Headroom Report

PQI PC5 QoS Identifier

PS-RNTI Power Saving RNTI

PSI PDU Set Importance

PTAG Primary Timing Advance Group

PTM Point to Multipoint

PTP Point to Point

QCL Quasi-colocation

PPW PRS Processing Window

PRS Positioning Reference Signal

RA-SDT Random Access-based SDT

RRH Remote Radio Head

RS Reference Signal

SCG Secondary Cell Group

SDT Small Data Transmission

SFI-RNTI Slot Format Indication RNTI

SI System Information

SL-PRS-CS-RNTI SL-PRS-Configured Scheduling-RNTI

SL-PRS-RNTI SL-PRS-RNTI

SL-CS-RNTI Sidelink-Configured Scheduling-RNTI

SL-PRS Sidelink-PRS

SL-RNTI Sidelink-RNTI

SpCell Special Cell

SP Semi-Persistent

SP-CSI-RNTI Semi-Persistent CSI RNTI

SPS Semi-Persistent Scheduling

SR Scheduling Request

SRI SRS Resource Indicator

SS Synchronization Signals

SSB Synchronization Signal Block

STAG Secondary Timing Advance Group

STx2P Simultaneous Transmission with 2 Panels

SUL Supplementary Uplink

TAG Timing Advance Group

TCI Transmission Configuration Indicator

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

TRIV Time Resource Indicator Value

TRP Transmit/Receive Point

TRS CSI-RS for tracking

U2N UE-to-Network

U2U UE-to-UE

UCI Uplink Control Information

UTO-UCI Unused Transmission Occasion - UCI

UTW Uplink Time Window

V2X Vehicle-to-Everything

ZP CSI-RS Zero Power CSI-RS

## 5.7 Discontinuous Reception (DRX)

The MAC entity may be configured by RRC with a DRX functionality that controls the UE's PDCCH monitoring activity for the MAC entity's C-RNTI, CI-RNTI, CS-RNTI, INT-RNTI, SFI-RNTI, SP-CSI-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, TPC-SRS-RNTI, AI-RNTI, SL-RNTI, SL-CS-RNTI, SL-PRS-RNTI, SL-PRS-CS-RNTI, SL Semi-Persistent Scheduling V-RNTI and cellDTRX-RNTI. When using DRX operation, the MAC entity shall also monitor PDCCH according to requirements found in other clauses of this specification. When in RRC\_CONNECTED, if DRX is configured, for all the activated Serving Cells, the MAC entity may monitor the PDCCH discontinuously using the DRX operation specified in this clause; otherwise the MAC entity shall monitor the PDCCH as specified in TS 38.213 [6].

DRX functionality can be configured with LP-WUS. There are two LP-WUS options to control the UE’s PDCCH monitoring activity. In LP-WUS Option 1-1, if the MAC entity does not receive a LP-WUS indication from lower layer, it does not monitor the PDCCH during the next occurrence of the on-duration. In LP-WUS Option 1-2, if the MAC entity receives a LP-WUS indication from lower layer, after a time offgset it starts a PDCCH monitoring timer for UE’s PDCCH monitoring. NOTE 1: Void

RRC controls DRX operation by configuring the following parameters:

- *drx-onDurationTimer*: the duration at the beginning of a DRX cycle;

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

- *drx-InactivityTimer*: the duration after the PDCCH occasion in which a PDCCH indicates a new UL, DL or SL transmission for the MAC entity;

- *drx-RetransmissionTimerDL* (per DL HARQ process except for the broadcast process): the maximum duration until a DL retransmission is received;

- *drx-RetransmissionTimerUL* (per UL HARQ process): the maximum duration until a grant for UL retransmission is received;

- *drx-LongCycleStartOffset*: the Long DRX cycle and *drx-StartOffset* which defines the subframe where the Long and Short DRX cycle starts;

- *drx-NonIntegerLongCycleStartOffset* (optional): the Long DRX cycle and *drx-StartOffset* which defines the subframe where the Long and Short DRX cycle start, when the length of the Long DRX cycle and/or the short DRX cycle is not an integer;

- *drx-ShortCycle* (optional): the Short DRX cycle;

- *drx-NonIntegerShortCycle* (optional): the Short DRX cycle whose length is not an integer;

- *drx-ShortCycleTimer* (optional): the duration the UE shall follow the Short DRX cycle;

- *drx-HARQ-RTT-TimerDL* (per DL HARQ process except for the broadcast process): the minimum duration before a DL assignment for HARQ retransmission is expected by the MAC entity;

- *drx-HARQ-RTT-TimerUL* (per UL HARQ process): the minimum duration before a UL HARQ retransmission grant is expected by the MAC entity;

- *drx-RetransmissionTimerSL* (per sidelink process): the maximum duration until a grant for SL retransmission is received;

- *drx-HARQ-RTT-TimerSL* (per sidelink process): the minimum duration before an SL retransmission grant is expected by the MAC entity;

- *drx-LastTransmissionUL* (optional): the configuration to start *drx-HARQ-RTT-TimerUL* after the last transmission within a bundle;

- *ps-Wakeup* (optional): the configuration to start associated *drx-onDurationTimer* in case DCP is monitored but not detected;

- *ps-TransmitOtherPeriodicCSI* (optional): the configuration to report periodic CSI that is not L1-RSRP on PUCCH during the time duration indicated by *drx-onDurationTimer* in case DCP is configured but associated *drx-onDurationTimer* is not started;

- *ps-TransmitPeriodicL1-RSRP* (optional): the configuration to transmit periodic CSI that is L1-RSRP on PUCCH during the time duration indicated by *drx-onDurationTimer* in case DCP is configured but associated *drx-onDurationTimer* is not started;

- *downlinkHARQ-FeedbackDisabled* (optional): the configuration to disable HARQ feedback per DL HARQ process;

- *uplinkHARQ-Mode* (optional): the configuration to set *HARQmodeA* or *HARQmodeB* per UL HARQ process;

- *disableCG-RetransmissionMonitoring* (optional): the configuration to disable starting *drx-HARQ-RTT-TimerUL* for UL transmission over a configured uplink grant;

- *drx-TimeReferenceSFN* (optional): the configuration to indicate how UE initializes of *DRX\_SFN\_COUNTER*;

- *lpwus-TransmitOtherPeriodicCSI* (optional): the configuration to report periodic CSI that is not L1-RSRP on PUCCH during the time duration indicated by *drx-onDurationTimer* in case LP-WUS is configured but associated *drx-onDurationTimer* is not started;

- *lpwus-TransmitPeriodicL1-RSRP* (optional): the configuration to transmit periodic CSI that is L1-RSRP on PUCCH during the time duration indicated by *drx-onDurationTimer* in case LP-WUS is configured but associated *drx-onDurationTimer* is not started;

- *lpwus-PDCCH-MonitoringTimer* (optional): the duration of the UE's PDCCH monitoring activity for the MAC entity after receiving the LP-WUS indication in LP-WUS Option 1-2.

Editor’s NOTE: The parameter name may be further updated to align with the name used in RRC specification.

The following UE variable is used for the DRX operation if *drx-NonIntegerLongCycleStartOffset* is configured:

- *DRX\_SFN\_COUNTER*: the counter that increments when SFN changes to 0. The maximum value of this counter is at least 65535.

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: *drx-onDurationTimer*, *drx-InactivityTimer*. The DRX parameters that are common to the DRX groups are: *drx-SlotOffset*, *drx-RetransmissionTimerDL*, *drx-RetransmissionTimerUL*, *drx-LongCycleStartOffset*, *drx-NonIntegerLongCycleStartOffset*, *drx-ShortCycle* (optional), *drx-NonIntegerShortCycle* (optional), *drx-ShortCycleTimer* (optional), *drx-HARQ-RTT-TimerDL*, and *drx-HARQ-RTT-TimerUL*.

When DRX is configured, the Active Time for Serving Cells in a DRX group includes the time while:

- *drx-onDurationTimer,* *drx-InactivityTimer* or *lpwus-PDCCH-MonitoringTimer* configured for the DRX group is running; or

Editor’s NOTE: FFS whether *lpwus-PDCCH-MonitoringTimer* is configured per DRX group or common to DRX groups.

- *drx-RetransmissionTimerDL*, *drx-RetransmissionTimerUL* or *drx-RetransmissionTimerSL* is running on any Serving Cell in the DRX group; or

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

- a Scheduling Request is sent on PUCCH and is pending (as described in clause 5.4.4 or 5.22.1.5). If this Serving Cell is part of a non-terrestrial network, the Active Time is started after the Scheduling Request transmission that is performed when the *SR\_COUNTER* is 0 for all the SR configurations with pending SR(s) plus the UE-gNB RTT; or

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

- there is an ongoing RACH-less LTM cell switch; or

- there is an ongoing RACH-less handover in a terrestrial network.

The following MAC timers are used for DRX operation in a non-terrestrial network:

- *HARQ-RTT-TimerDL-NTN* (per DL HARQ process configured with HARQ feedback enabled): the minimum duration before a DL assignment for HARQ retransmission is expected by the MAC entity;

- *HARQ-RTT-TimerUL-NTN* (per UL HARQ process configured with *HARQModeA*): the minimum duration before a UL HARQ retransmission grant is expected by the MAC entity.

When DRX is not configured and multicast DRX is configured for a G-RNTI or G-CS-RNTI, the MAC entity shall:

1> monitor the PDCCH as specified in TS 38.213 [6];

1> if a MAC PDU is received in a configured downlink assignment for unicast; or

1> if the PDCCH indicates a DL unicast transmission:

2> stop the *drx-RetransmissionTimerDL-PTM* for the corresponding HARQ process.

When DRX is configured, the MAC entity shall:

1> if a MAC PDU is received in a configured downlink assignment for unicast:

2> if this Serving Cell is configured with *downlinkHARQ-FeedbackDisabled*:

3> if the corresponding HARQ process is configured with HARQ feedback enabled:

4> set *HARQ-RTT-TimerDL-NTN* for the corresponding HARQ process equal to *drx-HARQ-RTT-TimerDL* plus the latest available UE-gNB RTT value;

4> start the *HARQ-RTT-TimerDL-NTN* for the corresponding HARQ process in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback.

2> else:

3> start the *drx-HARQ-RTT-TimerDL* for the corresponding HARQ process in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback.

NOTE 1a: Void.

NOTE 1b: Void.

2> stop the *drx-RetransmissionTimerDL* for the corresponding HARQ process;

2> stop the *drx-RetransmissionTimerDL-PTM* for the corresponding HARQ process.

1> if a MAC PDU is transmitted in a configured uplink grant and LBT failure indication is not received from lower layers:

2> if this Serving Cell is configured with *uplinkHARQ-Mode*:

3> if the corresponding HARQ process is configured as *HARQModeA*:

4> set *HARQ-RTT-TimerUL-NTN* for the corresponding HARQ process equal to *drx-HARQ-RTT-TimerUL* plus the latest available UE-gNB RTT value;

4> if *drx-LastTransmissionUL* is configured:

5> start the *HARQ-RTT-TimerUL-NTN* for the corresponding HARQ process in the first symbol after the end of the last transmission (within a bundle) of the corresponding PUSCH transmission.

4> else:

5> start the *HARQ-RTT-TimerUL-NTN* for the corresponding HARQ process in the first symbol after the end of the first transmission (within a bundle) of the corresponding PUSCH transmission.

2> else:

3> if *disableCG-RetransmissionMonitoring* is not configured for the configured uplink grant:

4> if *drx-LastTransmissionUL* is configured:

5> start the *drx-HARQ-RTT-TimerUL* for the corresponding HARQ process in the first symbol after the end of the last transmission (within a bundle) of the corresponding PUSCH transmission.

4> else:

5> start the *drx-HARQ-RTT-TimerUL* for the corresponding HARQ process in the first symbol after the end of the first transmission (within a bundle) of the corresponding PUSCH transmission.

2> stop the *drx-RetransmissionTimerUL* for the corresponding HARQ process at the first transmission (within a bundle) of the corresponding PUSCH transmission.

1> if a MAC PDU is transmitted in a configured sidelink grant:

2> if the PUCCH resource is configured:

3> start the *drx-HARQ-RTT-TimerSL* for the corresponding HARQ process in the first symbol after the end of the corresponding PUCCH transmission carrying the SL HARQ feedback; or

3> start the *drx-HARQ-RTT-TimerSL* for the corresponding HARQ process in the first symbol after the end of the corresponding PUCCH resource for the SL HARQ feedback when the PUCCH is not transmitted;

3> stop the *drx-RetransmissionTimerSL* for the corresponding HARQ process.

2> else:

3> start the *drx-HARQ-RTT-TimerSL* for the corresponding HARQ process at the first symbol after the end of the corresponding PSSCH transmission;

3> stop the *drx-RetransmissionTimerSL* for the corresponding HARQ process.

1> if a *drx-HARQ-RTT-TimerDL* expires:

2> if the data of the corresponding HARQ process was not successfully decoded:

3> start the *drx-RetransmissionTimerDL* for the corresponding HARQ process in the first symbol after the expiry of *drx-HARQ-RTT-TimerDL*.

1> if a *HARQ-RTT-TimerDL-NTN* expires:

2> if the data of the corresponding HARQ process was not successfully decoded:

3> start the *drx-RetransmissionTimerDL* for the corresponding HARQ process in the first symbol after the expiry of *HARQ-RTT-TimerDL-NTN*.

1> if a *drx-HARQ-RTT-TimerUL* expires:

2> start the *drx-RetransmissionTimerUL* for the corresponding HARQ process in the first symbol after the expiry of *drx-HARQ-RTT-TimerUL*.

1> if a *HARQ-RTT-TimerUL-NTN* expires:

2> start the *drx-RetransmissionTimerUL* for the corresponding HARQ process in the first symbol after the expiry of *HARQ-RTT-TimerUL-NTN*.

1> if a *drx-HARQ-RTT-TimerSL* expires:

2> if a HARQ NACK feedback for the corresponding HARQ process is transmitted on PUCCH; or

2> if a HARQ NACK feedback for the corresponding HARQ process is generated but not transmitted on PUCCH; or

2> if the PUCCH resource is not configured for the SL grant:

3> start the *drx-RetransmissionTimerSL* for the corresponding HARQ process in the first symbol after the expiry of *drx-HARQ-RTT-TimerSL*.

NOTE 1c: The UE handles the *drx-RetransmissionTimerSL* operation when *sl-PUCCH-Config* is configured by RRC but PUCCH resource is not scheduled same as when *sl-PUCCH-Config* is not configured.

1> if a DRX Command MAC CE indicated by PDCCH addressed to C-RNTI or CS-RNTI, or by a configured downlink assignment for unicast transmission or a Long DRX Command MAC CE is received:

2> stop *drx-onDurationTimer* for each DRX group;

2> stop *drx-InactivityTimer* for each DRX group;

2> stop *lpwus-PDCCH-MonitoringTimer* for each DRX group*.*

1> if *drx-InactivityTimer* for a DRX group expires:

2> if the Short DRX cycle is configured:

3> start or restart *drx-ShortCycleTimer* for this DRX group in the first symbol after the expiry of *drx-InactivityTimer*;

3> use the Short DRX cycle for this DRX group.

2> else:

3> use the Long DRX cycle for this DRX group.

1> if a DRX Command MAC CE indicated by PDCCH addressed to C-RNTI or CS-RNTI, or by a configured downlink assignment for unicast transmission is received

2> if the Short DRX cycle is configured:

3> start or restart *drx-ShortCycleTimer* for each DRX group in the first symbol after the end of DRX Command MAC CE reception;

3> use the Short DRX cycle for each DRX group.

2> else:

3> use the Long DRX cycle for each DRX group.

1> if *drx-ShortCycleTimer* for a DRX group expires:

2> use the Long DRX cycle for this DRX group.

1> if a Long DRX Command MAC CE is received:

2> stop *drx-ShortCycleTimer* for each DRX group;

2> use the Long DRX cycle for each DRX group.

1> if the *drx-NonIntegerLongCycleStartOffset* is configured:

2> increment *DRX\_SFN\_COUNTER* by 1 in the first symbol of a slot in which SFN changes to 0;

2> if DRX is (re-)configured by RRC:

3> if *drx-TimeReferenceSFN* is included in the RRC (re-)configuration which is received during the first half of a hyper frame (i.e., SFN is between 0 and 511):

4> set *DRX\_SFN\_COUNTER* to 1.

3> else:

4> set *DRX\_SFN\_COUNTER* to 0.

1> if the Short DRX cycle is used for a DRX group and the drx-NonIntegerShortCycle is not configured, and [(SFN × 10) + subframe number] modulo (drx-ShortCycle) = (drx-StartOffset) modulo (drx-ShortCycle); or

1> if the Short DRX cycle is used for a DRX group and the drx-NonIntegerShortCycle is configured, and floor([(DRX\_SFN\_COUNTER × 10240) + (SFN × 10) + subframe number − drx-StartOffset] modulo (drx-NonIntegerShortCycle)) = 0:

2> if the *lpwus-PDCCH-MonitoringTimer* is not configured:

3> start drx-onDurationTimer for this DRX group after drx-SlotOffset from the beginning of the subframe.

Editor’s NOTE: The case where *lpwus-PDCCH-MonitoringTimer* is not configured includes legacy DRX operation and LP-WUS option 1-1, but not LP-WUS option 1-2.1> if the Long DRX cycle is used for a DRX group and the *drx-NonIntegerLongCycleStartOffset* is not configured, and [(SFN × 10) + subframe number] modulo (*drx-LongCycle*) = *drx-StartOffset*; or

1> if the Long DRX cycle is used for a DRX group and the *drx-NonIntegerLongCycleStartOffset* is configured, and floor([(*DRX\_SFN\_COUNTER* × 10240) + (SFN × 10) + subframe number] modulo (*drx-NonIntegerLongCycle*)) = *drx-StartOffset*:

2> if DCP monitoring is configured for the active DL BWP as specified in TS 38.213 [6], clause 10.3:

3> if DCP indication associated with the current DRX cycle received from lower layer indicated to start *drx-onDurationTimer*, as specified in TS 38.213 [6]; or

3> if all DCP occasion(s) in time domain, as specified in TS 38.213 [6], associated with the current DRX cycle occurred in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to start of the last DCP occasion, or during a measurement gap, or when the MAC entity monitors for a PDCCH transmission on the search space indicated by *recoverySearchSpaceId* of the SpCell identified by the C-RNTI while the *ra-ResponseWindow* is running (as specified in clause 5.1.4); or

3> if *ps-Wakeup* is configured with value *true* and DCP indication associated with the current DRX cycle has not been received from lower layers:

4> start *drx-onDurationTimer* after *drx-SlotOffset* from the beginning of the subframe.

2> else if LP-WUS monitoring is configured:

3> if *lpwus-PDCCH-MonitoringTimer* is not configured:

4> if LP-WUS indication associated with the current DRX cycle received from lower layer indicates to start *drx-onDurationTimer*, as specified in TS 38.213 [6]; or

4> if all LP-WUS monitoring occasion(s) in time domain, as specified in TS 38.213 [6], associated with the current DRX cycle occurred in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to start of the last LP-WUS occasion, or during a measurement gap, or when the MAC entity monitors for a PDCCH transmission on the search space indicated by *recoverySearchSpaceId* of the SpCell identified by the C-RNTI while the *ra-ResponseWindow* is running (as specified in clause 5.1.4):

5> start *drx-onDurationTimer* for this DRX group after *drx-SlotOffset* from the beginning of the subframe.

Editor’s NOTE: The case where LP-WUS monitoring is configured without lpwus-PDCCH-MonitoringTimer is LP-WUS Option 1-1.

Editor’s NOTE: The DRX operation in LP-WUS Option 1-1 takes DCP description as baseline.

Editor’s NOTE: The working assumption for UE operation under collision for Option 1-1 needs to be confirmed.

2> else:

3> start *drx-onDurationTimer* for this DRX group after *drx-SlotOffset* from the beginning of the subframe.

1> if LP-WUS monitoring is configured and the *lpwus-PDCCH-MonitoringTimer* for this DRX group is configured

2> if LP-WUS indication is received from lower layer indicates to start *lpwus-PDCCH-MonitoringTimer*, as specified in TS 38.213 [6]:

3> start *lpwus-PDCCH-MonitoringTimer* from the beginning of the subframe indicated from lower layer.

Editor’s NOTE: The case where lpwus-PDCCH-MonitoringTimer is configured is LP-WUS Option 1-2.

Editor’s NOTE: The LP-WUS based DRX model is that LP-WUS monitoring and sending LP-WUS indication (together with the timepoint to start timer in Option 1-2) to MAC is captured in RAN1 spec (38.213), and the DRX operation based on the LP-WUS indication is captured in MAC spec.

Editor’s NOTE: The relationship between UE's LP-WUS monitoring and DRX active time is assumed to be reflected in RAN1 spec (38.213), so we will not capture this part in MAC spec.

Editor’s NOTE: FFS in Option 1-2 whether the UE should start the *lpwus\_PDCCHMonitoringTimer* (as if LP-WUS was detected) when the UE is not able to monitor the LP-WUS occasion(s).

NOTE 2: In case of unaligned SFN across carriers in a cell group, the SFN of the SpCell is used to calculate the DRX duration.

1> if a DRX group is in Active Time:

2> monitor the PDCCH on the Serving Cells in this DRX group as specified in TS 38.213 [6];

2> if the PDCCH indicates a DL transmission; or

2> if the PDCCH indicates a one-shot HARQ feedback as specified in clause 9.1.4 of TS 38.213 [6]; or

2> if the PDCCH indicates a retransmission of HARQ feedback as specified in clause 9.1.5 of TS 38.213 [6]:

3> if this Serving Cell is configured with *downlinkHARQ-FeedbackDisabled*:

4> if at least one of the corresponding HARQ process(es) is configured with HARQ feedback enabled:

5> set *HARQ-RTT-TimerDL-NTN* for the corresponding HARQ process(es) equal to *drx-HARQ-RTT-TimerDL* plus the latest available UE-gNB RTT value;

5> if the UE is configured with one-shot HARQ Feedback:

6> start or restart the *HARQ-RTT-TimerDL-NTN* for the corresponding HARQ process(es) whose HARQ feedback is enabled and reported in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback.

5> else:

6> start the *HARQ-RTT-TimerDL-NTN* for the corresponding HARQ process in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback.

3> else:

4> start or restart the *drx-HARQ-RTT-TimerDL* for the corresponding HARQ process(es) whose HARQ feedback is reported in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback.

NOTE 3: When HARQ feedback is postponed by PDSCH-to-HARQ\_feedback timing indicating an inapplicable k1 value, as specified in TS 38.213 [6], the corresponding transmission opportunity to send the DL HARQ feedback is indicated in a later PDCCH requesting the HARQ-ACK feedback.

3> stop the *drx-RetransmissionTimerDL* for the corresponding HARQ process(es) whose HARQ feedback is reported;

3> stop the *drx-RetransmissionTimerDL-PTM* for the corresponding HARQ process;

3> if the PDSCH-to-HARQ\_feedback timing indicate an inapplicable k1 value as specified in TS 38.213 [6]:

4> start the *drx-RetransmissionTimerDL* in the first symbol after the (end of the last) PDSCH transmission (within a bundle) for the corresponding HARQ process.

2> if the PDCCH indicates a UL transmission:

3> if this Serving Cell is configured with *uplinkHARQ-Mode*:

4> if the corresponding HARQ process is configured as *HARQModeA*:

5> set *HARQ-RTT-TimerUL-NTN* for the corresponding HARQ process equal to *drx-HARQ-RTT-TimerUL* plus the latest available UE-gNB RTT value;

5> if *drx-LastTransmissionUL* is configured:

6> start the *HARQ-RTT-TimerUL-NTN* for the corresponding HARQ process in the first symbol after the end of the last transmission (within a bundle) of the corresponding PUSCH transmission.

5> else:

6> start the *HARQ-RTT-TimerUL-NTN* for the corresponding HARQ process in the first symbol after the end of the first transmission (within a bundle) of the corresponding PUSCH transmission.

3> else:

4> if *drx-LastTransmissionUL* is configured:

5> start the *drx-HARQ-RTT-TimerUL* for the corresponding HARQ process in the first symbol after the end of the last transmission (within a bundle) of the corresponding PUSCH transmission.

4> else:

5> start the *drx-HARQ-RTT-TimerUL* for the corresponding HARQ process in the first symbol after the end of the first transmission (within a bundle) of the corresponding PUSCH transmission.

3> stop the *drx-RetransmissionTimerUL* for the corresponding HARQ process.

2> if the PDCCH indicates an SL transmission:

3> if the PUCCH resource is configured:

4> start the *drx-HARQ-RTT-TimerSL* for the corresponding HARQ process in the first symbol after the end of the corresponding PUCCH transmission carrying the SL HARQ feedback; or

4> start the *drx-HARQ-RTT-TimerSL* for the corresponding HARQ process in the first symbol after the end of the corresponding PUCCH resource for the SL HARQ feedback when the PUCCH is not transmitted;

4> stop the *drx-RetransmissionTimerSL* for the corresponding HARQ process.

3> else:

4> start the *drx-HARQ-RTT-TimerSL* for the corresponding HARQ process at the first symbol after end of PDCCH occasion;

4> stop the *drx-RetransmissionTimerSL* for the corresponding HARQ process.

2> if the PDCCH indicates a new transmission (DL, UL or SL) on a Serving Cell in this DRX group:

3> start or restart *drx-InactivityTimer* for this DRX group in the first symbol after the end of the PDCCH reception.

NOTE 3a: A PDCCH indicating activation of SPS, configured grant type 2, or configured sidelink grant of configured grant Type 2 is considered to indicate a new transmission.

NOTE 3b: If the PDCCH reception includes two PDCCH candidates from corresponding search spaces, as described in clause 10.1 in TS 38.213 [6], start or restart *drx-InactivityTimer* for this DRX group in the first symbol after the end of the PDCCH candidate that ends later in time.

2> if a HARQ process receives downlink feedback information and acknowledgement is indicated:

3> stop the *drx-RetransmissionTimerUL* for the corresponding HARQ process.

1> if DCP monitoring is configured for the active DL BWP as specified in TS 38.213 [6], clause 10.3, or if LP-WUS monitoring is configured as specified in TS 38.213 [6], clause 10.X; and

1> if the current symbol n occurs within *drx-onDurationTimer* duration; and

1> if *drx-onDurationTimer* associated with the current DRX cycle is not started as specified in this clause:

2> if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause; and

2> if *lpwus-PDCCH-MonitoringTimer* is not running (if configured); and

2> if *allowCSI-SRS-Tx-MulticastDRX-Active* is not configured, or if *cfr-ConfigMulticast* is not configured for any of the active BWP(s) of the Serving Cell(s), or if all multicast DRXes would not be in Active Time considering multicast assignments/DRX Command MAC CE for MBS multicast received until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in Clause 5.7b and all multicast sessions are configured with multicast DRX:

3> not transmit periodic SRS and semi-persistent SRS defined in TS 38.214 [7];

3> not report semi-persistent CSI configured on PUSCH;

3> not report semi-persistent CSI on PUCCH;

3> if neither *ps-TransmitPeriodicL1-RSRP nor*  *lpwus-TransmitPeriodicL1-RSRP* is configured with value *true*:

4> not report periodic CSI that is L1-RSRP on PUCCH.

3> if neither *ps-TransmitOtherPeriodicCSI* nor *lpwus-TransmitOtherPeriodicCSI* is configured with value *true*:

4> not report periodic CSI that is not L1-RSRP on PUCCH.

1> else:

2> in current symbol n, if a DRX group would not be in Active Time considering grants/assignments scheduled on Serving Cell(s) in this DRX group and DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause; and

2> if *allowCSI-SRS-Tx-MulticastDRX-Active* is not configured, or if *cfr-ConfigMulticast* is not configured for any of the active BWP(s) of the Serving Cell(s), or, in current symbol n, if all multicast DRXes corresponding to the DRX group would not be in Active Time considering multicast assignments/DRX Command MAC CE for MBS multicast received until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in Clause 5.7b and all multicast sessions corresponding to the DRX group are configured with multicast DRX:

3> not transmit periodic SRS and semi-persistent SRS defined in TS 38.214 [7] in this DRX group;

3> not report CSI on PUCCH and semi-persistent CSI configured on PUSCH in this DRX group.

2> if CSI masking (*csi-Mask*) is setup by upper layers:

3> in current symbol n, if *drx-onDurationTimer* of a DRX group would not be running considering grants/assignments scheduled on Serving Cell(s) in this DRX group and DRX Command MAC CE/Long DRX Command MAC CE received until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause; and

3> if *allowCSI-SRS-Tx-MulticastDRX-Active* is not configured, or if *cfr-ConfigMulticast* is not configured for any of the active BWP(s) of the Serving Cell(s), or, in current symbol n, if *drx-onDurationTimerPTM(s)* of all multicast DRXes corresponding to the DRX group would not be running considering DRX Command MAC CE for MBS multicast received until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in Clause 5.7b and all multicast sessions corresponding to the DRX group are configured with multicast DRX:

4> not report CSI on PUCCH in this DRX group.

NOTE 4: If a UE multiplexes a CSI configured on PUCCH with other overlapping UCI(s) according to the procedure specified in TS 38.213 [6] clause 9.2.5 and this CSI multiplexed with other UCI(s) would be reported on a PUCCH resource either outside DRX Active Time of the DRX group in which this PUCCH is configured or outside the on-duration period of the DRX group in which this PUCCH is configured if CSI masking is setup by upper layers, it is up to UE implementation whether to report this CSI multiplexed with other UCI(s).

The MAC entity shall ensure no rounding error is generated when performing the modulus operation with *drx-NonIntegerShortCycle* or *drx-NonIntegerLongCycle* as the divisor.

Regardless of whether the MAC entity is monitoring PDCCH or not on the Serving Cells in a DRX group, the MAC entity transmits HARQ feedback, aperiodic CSI on PUSCH, and aperiodic SRS defined in TS 38.214 [7] on the Serving Cells in the DRX group when such is expected.

The MAC entity needs not to monitor the PDCCH if it is not a complete PDCCH occasion (e.g. the Active Time starts or ends in the middle of a PDCCH occasion).

When *drx-LastTransmissionUL* is configured, *drx-HARQ-RTT-TimerUL* or *HARQ-RTT-TimerUL-NTN* is started after the last PUSCH transmission occasion of a bundle regardless of whether that last PUSCH transmission occasion is used for a PUSCH transmission for that bundle or not.

End of change

Annex A – RAN2 agreements

RAN2#126 Agreements

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| * 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.
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RAN2#127 Agreements on Option 1-2

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| * 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.
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RAN2#127bis Agreements

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| * 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.
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RAN2#128 Agreements

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| * The 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.
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RAN2#129 Agreements

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| * 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.
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RAN2#129bis Agreements

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| 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.
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RAN2#130 Agreements

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| * 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.
 |

Annex B – Related RAN1 agreements

RAN1#121 Agreements

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| * 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.

**Agreement**For LP-WUS MOs in connected mode for Option 1-1/1-2, the time offset1/3 in previous agreement are configured relative to the start of SFN0 where the offset is a symbol-level offset**Agreement**As the initial reply to RAN2 LS in R1-2503616, RAN1 confirms that at least the collision with Active Time, measurement gap, and RAR window monitoring for BFR can be considered for the cases/scenarios on when the UE is not able to monitor LP-WUS.**Agreement**For LP-WUS monitoring in RRC CONNECTED mode, when Rel-17 unified TCI framework is NOT configured or UE does NOT support Rel-17 unified TCI framework* Alt1: RRC provides the CORESET ID that UE shall derive the active TCI state for LP-WUS

**Conclusion**There is no consensus in RAN1 whether to specify UE autonomous fallback to PDCCH monitoring when UE monitors LP-WUS in RRC CONNECTED mode**Agreement**As the reply to RAN2 LS in R1-2503616, RAN1 assumes that UE is not able to operate LR and MR simultaneously in Rel-19. RAN1 understanding is that the terminology of LR and MR operations are for discussion purpose and will not be specified* LR operation is the UE operation for LP-WUS monitoring
* MR operation is the UE operation for all other NR signals/channels transmissions/receptions in connected mode

**Conclusion**From RAN1 perspective, for the case of potential collision (if any) in Option 1-2, when the UE is not able to monitor all the LP-WUS MO(s) in a LP-WUS periodicity,* It is up to RAN2 to further discuss and finalize the specification support, if any.

**Agreement**For the UE capability report on the minimum time gap between the end of the last symbol of LP-WUS and the time where MR starts PDCCH monitoring regardless of SCS, the same candidate values {V1, V2, V3} are supported for different receiver types* V1=5ms
* V2=13ms
* V3=37ms

**Agreement**For the UAI of preferred time offset for LP-WUS monitoring in RRC connected mode,* The candidate values are same as those for the UE capability of minimum time gap, i.e., {V1=5, V2=13, V3=37}ms
* The reported UAI value is equal to or longer than the minimum time gap reported by UE capability for a UE

Note: There is no change to the RAN1 agreed definition for UAI**Agreement**Nominal MO duration (X1, in unit of OFDM symbols) and actual LP-WUS duration (X2, in unit of OFDM symbols) are configured for LP-WUS in connected mode. (Alt C)* A LP-WUS MO spans the nominal MO duration (i.e., the LP-WUS MO duration is the same as the nominal MO duration.)
* If the number of available OFDM symbols within the nominal MO duration is no less than the actual LP-WUS duration, UE monitors LP-WUS on the first X2 available symbols within the LP-WUS MO.
* Otherwise, UE does not monitor LP-WUS in this MO (i.e., the MO is dropped).
* Note: Any symbols that are not defined as unavailable are available symbols for LP-WUS.
* Further discuss possible introduction of UE capability to restrict configuration of LP-WUS MO and LP-WUS duration. For example,
	+ A LP-WUS spans a number of consecutive OFDM symbols according to the configured LP-WUS duration
	+ If there is at least one OFDM symbol unavailable for the LP-WUS MO within the OFDM symbols where the LP-WUS would span, the UE does not monitor the LP-WUS in the MO

**Agreement**For UE to determine whether a symbol is available for LP-WUS in connected mode, at least the following is supported:* A unit level bitmap with a periodicity 10, 20, or 40 units and a 14-bit or 28-bit symbol-level bitmap that covers 1 or 2 slots can be configured, where each unit is 1 or 2 slots for 14-bit or 28-bit symbol-level bitmap, respectively, with a maximum periodicity of 40ms.
	+ ‘1’ in unit-level bitmap means the symbol level bitmap is applied to determine which symbols are unavailable in the unit for LP-WUS (‘0’ means unavailable).
	+ ‘0’ in unit-level bitmap means: all the symbols in the unit are unavailable for LP-WUS
* If the slot-level bitmap is not configured, UE assumes all 1’s for the bitmap.
* If the symbol-level bitmap is not configured, UE assumes all 1’s for the bitmap.

**Agreement**For the handling of at least PCell/PSCell SSB for connected mode, the SSB symbols are considered as unavailable for LP-WUS **Agreement**The UL symbols/slots configured in *tdd-UL-DL-configurationCommon* or *tdd*-*UL-DL-ConfigurationDedicated* are considered as unavailable for LP-WUS in connected mode |