**3GPP 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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|  | **38.321** | **CR** | **draft** | **rev** | **-** | **Current version:** | **18.6.0** |  |
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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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| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_MIMO\_Ph5-Core | | | | |  | ***Date:*** | | |  |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | |  |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Introduce the Rel-19 MIMO features based on the the following agreements.  RAN2#128:   * New MAC CE is introduced for PL offset update for asymmetric DL sTRP/UL mTRP. This new MAC CE is identified by new eLCID. * Absolute value of PL offset is indicated in the new MAC CE. For the offset value, the value range is [-12, 60] dB and the step size is 4dB. * In the MAC CE, PL offset value can be updated for any configured TCI states with RRC configured PL offset, i.e., not limited to the activated TCI states.   RAN2#129:   * One PL offset value is indicated for each TCI state included in the new MAC CE. * The new MAC CE contains one serving cell ID and one BWP ID * TCI state ID is used to indicate a TCI state in the new MAC CE (i.e., no bitmap for TCI states is needed) * The new MAC CE can include flexible number of PL offset values. * RAN2 understands that if a joint/UL TCI state is configured with a PL offset, PHR trigger is based on the PL change of the PL-RS associated to the joint/UL TCI, where the PL change takes into account the PL offset. FFS whether/how to capture this.   RAN2#129bis:   * No need to add a maximum number restriction of the TCI states indicated by the PL offset MAC CE. * RAN2 understand the PL offset update MAC CE is at least applicable to PUCCH, PUSCH, SRS, and PDCCH-order CFRA. * We will capture in a note to reflect the previous understanding ‘RAN2 understands that if a joint/UL TCI state is configured with a PL offset, PHR trigger is based on the PL change of the PL-RS associated to the joint/UL TCI, where the PL change takes into account the PL offset.’. FFS on exact wording. * From RAN2 point of view, UE applies the latest PL offset value received in RRC or MAC CE. * For PRACH transmission, PL offset is applicable only to PDCCH-order CFRA. * In Mode A of UE-initiated CSI reporting, the active time of a DRX operation includes the time after a new UCI for UE-initiated beam reporting is sent on first PUCCH. * Confirm the following RAN2 understandings:   + - * **The CG type-1 PUSCH carrying the beam report of Mode-B does not carry MAC PDU (i.e. UL-SCH).**       * **The DG PUSCH carrying the beam report of Mode-A carries MAC PDU (i.e. UL-SCH) as legacy.** * FFS if any other MAC impact for UL skipping * The UE continues to perform CSI measurements for the UEIBM procedure when the active BWP is the dormant BWP. * If the BWP in an SCell is a dormant BWP, the UE should not report mode-A beam measurement results. The UE cannot perform mode-B beam reporting on this BWP. * RAN2 understand the event evaluation and report triggering for UE-initiated beam report is captured by RAN1 spec.   RAN2#130:   * UL skipping is not applicable to mode-B type-1 CG event-triggered beam report (i.e., MAC PDU is not generated). * For Rel-16 UL skipping (enhancedSkipUplinkTxDynamic), the UCI for mode-A DG-based UE-initiated report follows the existing procedure (i.e., MAC PDU is generated), there is no MAC impact. * The existing rule is applied to handle the overlapping/prioritization between the PUSCH of mode-A UE-initiated report and SR/other PUSCH in MAC. No MAC impact is expected. * For Rel-15 UL skipping (skipUplinkTxDynamic is configured), same principle as legacy aperiodic CSI applies for multiplexing UCI of mode-A DG-based UE-initiated report in PUSCH. Exact MAC spec can be discussed further. * Rel-17/18 Unified TCI States A/D MAC CE is reused for asymmetric DL sTRP/UL mTRP deployment. No MAC spec impact is expect, can confirm in the post meeting email discussion. * RAN2 to confirm that the PL offset value stored in the UE, i.e. in the internal UE configuration is not updated based on the MAC CE for PL update. * When the TAT of the pTAG expires, UE releases PUCCH resource for mode-A/B UEI report and clears type-1 CG for mode-B UEI report. FFS for the case when the TAT expires on the sTAG. | | | | | | | | |
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| ***Summary of change:*** | | 1. In 5.18, 6.1.3, 6.2.1, introduced a new MAC CE for pathloss offset update  2. In 5.4.6, added a note for PHR trigger based on pathloss offset.  3. In 5.7, added DRX active time for mode-A UE-initiated report.  4. In 5.8.2, added a clarification for mode-B UE-initiated report type-1 CG.  5. In 5.15.1, added procedure on UE-initiated report for dormant BWP.  6. In 5.4.3.1.3, added mode-A UE-initiated report as an exception case of UL MAC PDU generation skipping. | | | | | | | | |
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| ***Consequences if not approved:*** | | Rel-19 MIMO features cannot be supported. | | | | | | | | |
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| ***Clauses affected:*** | | 5.4.3.1.3, 5.4.6, 5.7, 5.8.2, 5.15.1, 5.18, 6.1.3, 6.2.1 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **x** |  | Other core specifications | | | | TS/TR 38.331 CR xxxx | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | R2-2502664, R2-2504209 | | | | | | | | |

## 5.2 Maintenance of Uplink Time Alignment

RRC configures the following parameters for the maintenance of UL time alignment:

- *timeAlignmentTimer* (per TAG) which controls how long the MAC entity considers the Serving Cells to the associated TAG to be uplink time aligned for the TAG;

- *inactivePosSRS-TimeAlignmentTimer* which controls how long the MAC entity considers the Positioning SRS transmission in RRC\_INACTIVE in clause 5.26 to be uplink time aligned;

- *cg-SDT-TimeAlignmentTimer* which controls how long the MAC entity considers the uplink transmission for CG-SDT to be uplink time aligned;

- *inactivePosSRS-ValidityAreaTAT* which controls how long the MAC entity considers Positioning SRS transmission in RRC\_INACTIVE in clause 5.26 to be uplink time aligned when SRS positioning validity area is configured.

The MAC entity shall:

1> when a Timing Advance Command MAC CE is received, and if an NTA (as defined in TS 38.211 [8]) has been maintained with the indicated TAG:

2> apply the Timing Advance Command for the indicated TAG;

2> if there is ongoing Positioning SRS Transmission in RRC\_INACTIVE as in clause 5.26:

3> if SRS positioning validity area is configured:

4> start or restart the *inactivePosSRS-ValidityAreaTAT* associated with the indicated TAG.

3> else:

4> start or restart the *inactivePosSRS-TimeAlignmentTimer* associated with the indicated TAG.

2> if CG-SDT procedure triggered as in clause 5.27 is ongoing:

3> start or restart the *cg-SDT-TimeAlignmentTimer* associated with the indicated TAG.

2> else:

3> start or restart the *timeAlignmentTimer* associated with the indicated TAG.

1> when a Timing Advance Command is received in a Random Access Response message for a Serving Cell configured with two TAGs or in a MSGB for an SpCell configured with two TAGs:

2> if the Random Access Preamble was not selected by the MAC entity among the contention-based Random Access Preamble:

3> apply the Timing Advance Command for the TAG indicated in the received Random Access Response message or MSGB;

3> start or restart the *timeAlignmentTimer* associated with TAG indicated in the received Random Access Response message or MSGB.

2> else if the *timeAlignmentTimer* associated with the TAG indicated in the received Random Access Response message or MSGB is not running:

3> apply the Timing Advance Command for this TAG;

3> start the *timeAlignmentTimer* associated with this TAG;

3> when the Contention Resolution is considered not successful as described in clause 5.1.5:

4> stop the *timeAlignmentTimer* associated with this TAG.

2> else:

3> ignore the received Timing Advance Command.

1> when a Timing Advance Command is received in a Random Access Response message for a Serving Cell not configured with two TAGs or in a MSGB for an SpCell not configured with two TAGs:

2> if the Random Access Preamble was not selected by the MAC entity among the contention-based Random Access Preamble:

3> apply the Timing Advance Command for this TAG;

3> start or restart the *timeAlignmentTimer* associated with this TAG.

2> else if the *timeAlignmentTimer* associated with this TAG is not running:

3> apply the Timing Advance Command for this TAG;

3> start the *timeAlignmentTimer* associated with this TAG;

3> when the Contention Resolution is considered not successful as described in clause 5.1.5; or

3> when the Contention Resolution is considered successful for SI request as described in clause 5.1.5, after transmitting HARQ feedback for MAC PDU including UE Contention Resolution Identity MAC CE:

4> stop *timeAlignmentTimer* associated with this TAG.

3> when the Contention Resolution is considered not successful as described in clause 5.1.5:

4> if CG-SDT procedure triggered as in clause 5.27 is ongoing; or

4> if SRS transmission in RRC\_INACTIVE as in clause 5.26 is ongoing:

5> set the NTA value to the value before applying the received Timing Advance Command as in TS 38.211 [8].

3> when the Contention Resolution is considered successful for Random Access procedure while the CG-SDT procedure is ongoing:

4> stop *timeAlignmentTimer* associated with this TAG;

4> start or restart the *cg-SDT-TimeAlignmentTimer* associated with this TAG.

3> when the Contention Resolution is considered successful for Random Access procedure while Positioning SRS transmission in RRC\_INACTIVE is ongoing as in clause 5.26:

4> if SRS positioning validity area is configured:

5> start or restart the *inactivePosSRS-ValidityAreaTAT* associated with the indicated TAG.

4> else:

5> start or restart the *inactivePosSRS-TimeAlignmentTimer* associated with this TAG.

2> else:

3> ignore the received Timing Advance Command.

1> when an Absolute Timing Advance Command is received in response to a MSGA transmission including C-RNTI MAC CE, as specified in clause 5.1.4a, for an SpCell configured with two TAGs:

2> apply the Timing Advance Command for the PTAG indicated in the Absolute Timing Advance Command MAC CE;

2> start or restart the *timeAlignmentTimer* associated with this PTAG.

1> when an Absolute Timing Advance Command is received in response to a MSGA transmission including C-RNTI MAC CE, as specified in clause 5.1.4a, for an SpCell not configured with two TAGs:

2> apply the Timing Advance Command for PTAG;

2> if there is ongoing Positioning SRS Transmission in RRC\_INACTIVE as in clause 5.26:

3> if SRS positioning validity area is configured:

4> start or restart the *inactivePosSRS-ValidityAreaTAT* associated with the indicated TAG.

3> else:

4> start or restart the *inactivePosSRS-TimeAlignmentTimer* associated with the indicated TAG.

2> if CG-SDT procedure is ongoing:

3> start or restart the *cg-SDT-TimeAlignmentTimer* associated with PTAG.

2> else:

3> start or restart the *timeAlignmentTimer* associated with PTAG.

1> when the MAC entity is configured with *rach-LessHO*:

2> set the NTA value (as defined in TS 38.211 [8]) to the value indicated by *targetNTA* in *rach-LessHO* for PTAG;

2> start the *timeAlignmentTimer* associated with PTAG.

1> when the indication is received from upper layer for stopping the *inactivePosSRS-TimeAlignmentTimer*:

2> stop the *inactivePosSRS-TimeAlignmentTimer*.

1> when the indication is received from upper layer for starting the *inactivePosSRS-TimeAlignmentTimer*:

2> start or restart the *inactivePosSRS-TimeAlignmentTimer*.

1> when instruction from the upper layer has been received for starting the *cg-SDT-TimeAlignmentTimer*:

2> start the *cg-SDT-TimeAlignmentTimer*.

1> when instruction from the upper layer has been received for stopping the *cg-SDT-TimeAlignmentTimer*:

2> consider the *cg-SDT-TimeAlignmentTimer* as expired.

1> when the indication is received from upper layer for starting the *inactivePosSRS-ValidityAreaTAT*:

2> start or restart the *inactivePosSRS-ValidityAreaTAT*.

1> when the indication is received from upper layer for stopping the *inactivePosSRS-ValidityAreaTAT*:

2> stop the *inactivePosSRS-ValidityAreaTAT*.

1> when instruction from the upper layer has been received for starting the *TimeAlignmentTimer* associated with PTAG:

2> start the *TimeAlignmentTimer* associated with the indicated PTAG.

1> when an LTM Cell Switch Command MAC CE is received and the Timing Advance Command is not set as FFF:

2> apply the Timing Advance Command for the PTAG as specified in clause 6.1.3.75;

2> start or restart the *timeAlignmentTimer* associated with the PTAG as specified in clause 6.1.3.75.

1> when an LTM Cell Switch Command MAC CE is received, and the Timing Advance Command is set as FFF, and the UE has successfully measured the Timing Advance as in clause 5.18.35:

2> apply the measured Timing Advance for the PTAG;

2> start or restart the *timeAlignmentTimer* associated with the PTAG.

1> when a *timeAlignmentTimer* expires:

2> if the *timeAlignmentTimer* is associated with a PTAG and the SpCell is not configured with two PTAGs; or

2> if the *timeAlignmentTimer* is associated with a PTAG, the SpCell is configured with two PTAGs, and the *timeAlignmentTimer* associated with the other PTAG is not running:

3> flush all HARQ buffers for all Serving Cells;

3> notify RRC to release PUCCH for all Serving Cells, if configured;

3> notify RRC to release SRS for all Serving Cells, if configured;

3> clear any configured downlink assignments and configured uplink grants;

3> clear any PUSCH resource for semi-persistent CSI reporting;

3> consider all running *timeAlignmentTimer*s as expired;

3> maintain NTA (defined in TS 38.211 [8]) of all TAGs.

2> else:

3> if the *timeAlignmentTimer* is associated with a TAG for an SCell configured with only this TAG; or

3> if the *timeAlignmentTimer* is associated with a TAG for an SCell, and if the SCell is configured with two TAGs and *the timeAlignmentTimer* associated with the other TAG is not running:

4> flush all HARQ buffers for all such SCells;

4> notify RRC to release PUCCH, if configured for all such SCells;

4> notify RRC to release SRS, if configured for all such SCells;

4> clear any configured downlink assignments and configured uplink grants for all such SCells;

4> clear any PUSCH resource for semi-persistent CSI reporting for all such SCells;

4> maintain NTA (defined in TS 38.211 [8]) of this TAG.

3> else if the *timeAlignmentTimer* is associated with a TAG for a Serving Cell configured with two TAGs, and if the *timeAlignmentTimer* associated with the other TAG is running, for all such Serving Cells:

4> clear any configured downlink assignment, if the activated TCI state(s) for all PUCCH resources configured for the configured downlink assignment is associated with the TAG of the expired *timeAlignmentTimer*;

4> clear any configured uplink grant, if the activated TCI state(s) for the configured uplink grant is associated with the TAG of the expired *timeAlignmentTimer*;

4> clear any PUSCH resource for semi-persistent CSI reporting, if the activated TCI state(s) for the PUSCH resource is associated with the TAG of the expired *timeAlignmentTimer*;

4> maintain NTA (defined in TS 38.211 [8]) of this TAG.

1> when the *inactivePosSRS-TimeAlignmentTimer* expires:

2> notify RRC to release Positioning SRS for RRC\_INACTIVE configuration(s).

1> when the *cg-SDT-TimeAlignmentTimer* expires:

2> clear any configured uplink grants;

2> if a PDCCH addressed to the MAC entity's C-RNTI after initial transmission for the CG-SDT with CCCH message has not been received:

3> consider ongoing CG-SDT procedure as terminated;

3> indicate the expiry of *cg-SDT-TimeAlignmentTimer* to the upper layer.

2> flush all HARQ buffers;

2> maintain NTA (defined in TS 38.211 [8]) of this TAG.

When the MAC entity stops uplink transmissions for an SCell not configured with two TAGs due to the fact that the maximum uplink transmission timing difference between TAGs of the MAC entity or the maximum uplink transmission timing difference between TAGs of any MAC entity of the UE is exceeded, the MAC entity considers the *timeAlignmentTimer* associated with the SCell as expired.

When the MAC entity stops uplink transmissions associated to a STAG for an SCell configured with two TAGs due to the fact that the maximum uplink transmission timing difference between TAGs of the MAC entity or the maximum uplink transmission timing difference between TAGs of any MAC entity of the UE is exceeded, the MAC entity considers the *timeAlignmentTimer* associated with the STAG as expired.

The MAC entity shall not perform any uplink transmission on a Serving Cell except the Random Access Preamble and MSGA transmission when the *timeAlignmentTimer*(s) associated with all TAG(s) to which this Serving Cell belongs is not running, CG-SDT procedure is not ongoing and Positioning SRS transmission in RRC\_INACTIVE as in clause 5.26 is not ongoing. Furthermore, when the *timeAlignmentTimer*(s) associated with all PTAG(s) is not running, CG-SDT procedure is not ongoing and Positioning SRS transmission in RRC\_INACTIVE as in clause 5.26 is not ongoing, the MAC entity shall not perform any uplink transmission on any Serving Cell except the Random Access Preamble and MSGA transmission on the SpCell. The MAC entity shall not perform any uplink transmission except the Random Access Preamble and MSGA transmission when the *cg-SDT-TimeAlignmentTimer* is not running during the ongoing CG-SDT procedure as triggered in clause 5.27 and the *inactivePosSRS-TimeAlignmentTimer* or *inactivePosSRS-ValidityAreaTAT* is not running. The MAC entity shall not perform any uplink transmission except the Random Access Preamble and MSGA transmission on a Serving Cell using TCI state(s) associated with a TAG for which the *timeAlignmentTimer* is not running.

##### 5.4.3.1.3 Allocation of resources

Before the successful completion of the Random Access procedure initiated for DAPS handover, the target MAC entity shall not select the logical channel(s) corresponding to non-DAPS DRB(s) for the uplink grant received in a Random Access Response or the uplink grant for the transmission of the MSGA payload. The source MAC entity shall select only the logical channel(s) corresponding to DAPS DRB(s) during DAPS handover.

The MAC entity shall, when a new transmission is performed:

1> allocate resources to the logical channels as follows:

2> logical channels selected in clause 5.4.3.1.2 for the UL grant with *Bj* > 0 are allocated resources in a decreasing priority order. If the PBR of a logical channel is set to *infinity*, the MAC entity shall allocate resources for all the data that is available for transmission on the logical channel before meeting the PBR of the lower priority logical channel(s);

2> decrement *Bj* by the total size of MAC SDUs served to logical channel *j* above;

2> if any resources remain, all the logical channels selected in clause 5.4.3.1.2 are served in a strict decreasing priority order (regardless of the value of *Bj*) until either the data for that logical channel or the UL grant is exhausted, whichever comes first. Logical channels configured with equal priority should be served equally.

NOTE 1: The value of *Bj* can be negative.

If the MAC entity is requested to simultaneously transmit multiple MAC PDUs, or if the MAC entity receives the multiple UL grants within one or more coinciding PDCCH occasions (i.e. on different Serving Cells), it is up to UE implementation in which order the grants are processed.

The UE shall also follow the rules below during the scheduling procedures above:

- the UE should not segment an RLC SDU (or partially transmitted SDU or retransmitted RLC PDU) if the whole SDU (or partially transmitted SDU or retransmitted RLC PDU) fits into the remaining resources of the associated MAC entity;

- if the UE segments an RLC SDU from the logical channel, it shall maximize the size of the segment to fill the grant of the associated MAC entity as much as possible;

- the UE should maximise the transmission of data;

- if the MAC entity is given a UL grant size that is equal to or larger than 8 bytes (when eLCID is not used) or 10 bytes (when eLCID is used) while having data available and allowed (according to clause 5.4.3.1) for transmission, the MAC entity shall not transmit only padding BSR and/or padding.

The MAC entity shall:

1> if the MAC entity is configured with *enhancedSkipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or if the MAC entity is configured with *enhancedSkipUplinkTxConfigured* with value *true* and the grant indicated to the HARQ entity is a configured uplink grant:

2> if there is no UCI to be multiplexed on this PUSCH transmission as specified in TS 38.213 [6]; and

2> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and

2> if the MAC PDU includes zero MAC SDUs; and

2> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:

3> not generate a MAC PDU for the HARQ entity.

1> else if the MAC entity is configured with *skipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or the grant indicated to the HARQ entity is a configured uplink grant:

2> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and

2> if there is no mode-A UE-initiated CSI reporting triggered for this PUSCH transmission as specified in TS 38.214 [7]; and

2> if the MAC PDU includes zero MAC SDUs; and

2> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:

3> not generate a MAC PDU for the HARQ entity.

Editor’s Note: FFS if the change is needed for the agreement: For Rel-15 UL skipping (skipUplinkTxDynamic is configured), same principle as legacy aperiodic CSI applies for multiplexing UCI of mode-A DG-based UE-initiated report in PUSCH.

Logical channels shall be prioritised in accordance with the following order (highest priority listed first):

- MAC CE for C-RNTI, or data from UL-CCCH;

- MAC CE for (Enhanced) BFR, or MAC CE for Configured Grant Confirmation, or MAC CE for Multiple Entry Configured Grant Confirmation;

- MAC CE for Sidelink Configured Grant Confirmation;

- MAC CE for LBT failure;

- MAC CE for SL LBT failure according to clause 5.31.2;

- MAC CE for Timing Advance Report;

- MAC CE for Delay Status Report;

- MAC CE for SL-BSR prioritized according to clause 5.22.1.6;

- MAC CE for (Extended) BSR, with exception of BSR included for padding;

- MAC CE for (Enhanced) Single Entry PHR, or MAC CE for (Enhanced) Multiple Entry PHR or MAC CE for Single Entry PHR with assumed PUSCH, or MAC CE for Multiple Entry PHR with assumed PUSCH, or MAC CE for Enhanced Single Entry PHR for multiple TRP or MAC CE for Enhanced Multiple Entry PHR for multiple TRP, or MAC CE for Enhanced Single Entry PHR for multiple TRP STx2P or MAC CE for Enhanced Multiple Entry PHR for multiple TRP STx2P;

- MAC CE for Positioning Measurement Gap Activation/Deactivation Request;

- MAC CE for the number of Desired Guard Symbols;

- MAC CE for Case-6 Timing Request;

- MAC CE for (Extended) Pre-emptive BSR;

- MAC CE for SL-BSR, with exception of SL-BSR prioritized according to clause 5.22.1.6 and SL-BSR included for padding;

- MAC CE for SL-PRS Resource Request;

- MAC CE for IAB-MT Recommended Beam Indication, or MAC CE for Desired IAB-MT PSD range, or MAC CE for Desired DL Tx Power Adjustment;

- data from any Logical Channel, except data from UL-CCCH;

- MAC CE for Recommended bit rate query;

- MAC CE for BSR included for padding;

- MAC CE for SL-BSR included for padding.

NOTE 2: Prioritization among MAC CEs of same priority is up to UE implementation.

The MAC entity shall prioritize any MAC CE listed in a higher order than 'data from any Logical Channel, except data from UL-CCCH' over NR sidelink transmission.

### 5.4.6 Power Headroom Reporting

The Power Headroom reporting procedure is used to provide the serving gNB with the following information:

- Type 1 power headroom: the difference between the nominal UE maximum transmit power and the estimated power for UL-SCH transmission per activated Serving Cell;

- Type 2 power headroom: the difference between the nominal UE maximum transmit power and the estimated power for UL-SCH and PUCCH transmission on SpCell of the other MAC entity (i.e. E-UTRA MAC entity in EN-DC, NE-DC, and NGEN-DC cases);

- Type 3 power headroom: the difference between the nominal UE maximum transmit power and the estimated power for SRS transmission per activated Serving Cell;

- MPE P-MPR: the power backoff to meet the MPE FR2 requirements for a Serving Cell operating on FR2;

- DPC: the adjustment to maximum output power for a given power class for a Serving Cell operating on FR1;

- DPCBC: the adjustment to maximum output power for a given power class for a Band Combination operating on FR1.

RRC controls Power Headroom reporting by configuring the following parameters:

- *dpc-Reporting-FR1*;

- *phr-AssumedPUSCH-Reporting*;

- *phr-PeriodicTimer*;

- *phr-ProhibitTimer*;

- *phr-Tx-PowerFactorChange*;

- *phr-Type2OtherCell*;

- *phr-ModeOtherCG*;

- *multiplePHR*;

- *mpe-Reporting-FR2*;

- *mpe-ProhibitTimer*;

- *mpe-Threshold*;

- *numberOfN*;

- *mpe-ResourcePoolToAddModList*;

- *twoPHRMode*.

A Power Headroom Report (PHR) shall be triggered if any of the following events occur:

- *phr-ProhibitTimer* expires or has expired and the path loss has changed more than *phr-Tx-PowerFactorChange* dB for at least one RS used as pathloss reference for one activated Serving Cell of any MAC entity of which the active DL BWP is not dormant BWP since the last transmission of a PHR in this MAC entity when the MAC entity has UL resources for new transmission;

NOTE 1: The path loss variation for one cell assessed above is between the pathloss measured at present time on the current pathloss reference and the pathloss measured at the transmission time of the last transmission of PHR on the pathloss reference in use at that time, irrespective of whether the pathloss reference has changed in between. The current pathloss reference for this purpose does not include any pathloss reference configured using *pathlossReferenceRS-Pos* in TS 38.331 [5].

NOTE 1a: If *pathlossOffset* is not configured for TCI state(s), the measured pathloss, as specified in clause 7 of TS 38.213 [6], is used to determine the path loss variation in NOTE 1; otherwise, the pathloss is set to the measured pathloss minus the latest pathloss offset of the TCI state associated with the pathloss reference.

- *phr-PeriodicTimer* expires;

- upon configuration or reconfiguration of the power headroom reporting functionality by upper layers, which is not used to disable the function;

- activation of an SCell of any MAC entity with configured uplink of which *firstActiveDownlinkBWP-Id* is not set to dormant BWP;

- activation of an SCG;

- addition of the PSCell except if the SCG is deactivated (i.e. PSCell is newly added or changed);

- *phr-ProhibitTimer* expires or has expired, when the MAC entity has UL resources for new transmission, and the following is true for any of the activated Serving Cells of any MAC entity with configured uplink:

- there are UL resources allocated for transmission or there is a PUCCH transmission on this cell, and the required power backoff due to power management (as allowed by P-MPRc as specified in TS 38.101-1 [14], TS 38.101-2 [15], and TS 38.101-3 [16]) for this cell has changed more than *phr-Tx-PowerFactorChange* dB since the last transmission of a PHR when the MAC entity had UL resources allocated for transmission or PUCCH transmission on this cell.

- Upon switching of activated BWP from dormant BWP to non-dormant DL BWP of an SCell of any MAC entity with configured uplink;

- if *dpc-Reporting-FR1* is configured, ΔPPowerClass /ΔPPowerClass, CA/ΔPPowerClass, EN-DC/ΔPPowerClass, NR-DC reporting is triggered upon uplink duty cycle exceedance or upon return to the power class after the duty cycle exceedance, as specified in TS 38.101-1 [14] and TS 38.101-3 [16]).

- if *mpe-Reporting-FR2* is configured, and *mpe-ProhibitTimer* is not running:

- the measured P-MPR applied to meet FR2 MPE requirements as specified in TS 38.101-2 [15] is equal to or larger than *mpe-Threshold* for at least one activated FR2 Serving Cell since the last transmission of a PHR in this MAC entity; or

- the measured P-MPR applied to meet FR2 MPE requirements as specified in TS 38.101-2 [15] has changed more than *phr-Tx-PowerFactorChange* dB for at least one activated FR2 Serving Cell since the last transmission of a PHR due to the measured P-MPR applied to meet MPE requirements being equal to or larger than *mpe-Threshold* in this MAC entity.

in which case the PHR is referred below to as 'MPE P-MPR report'.

NOTE 2: The MAC entity should avoid triggering a PHR when the required power backoff due to power management decreases only temporarily (e.g. for up to a few tens of milliseconds) and it should avoid reflecting such temporary decrease in the values of PCMAX,f,c/PH when a PHR is triggered by other triggering conditions.

NOTE 3: If a HARQ process is configured with *cg-RetransmissionTimer* and if the PHR is already included in a MAC PDU for transmission on configured grant by this HARQ process, but not yet transmitted by lower layers, it is up to UE implementation how to handle the PHR content.

If the MAC entity has UL resources allocated for a new transmission the MAC entity shall:

1> if it is the first UL resource allocated for a new transmission since the last MAC reset:

2> start *phr-PeriodicTimer*.

1> if the Power Headroom reporting procedure determines that at least one PHR has been triggered and not cancelled; and

1> if the allocated UL resources can accommodate the MAC CE for PHR which the MAC entity is configured to transmit, plus its subheader, as a result of LCP as defined in clause 5.4.3.1:

2> if *multiplePHR* with value *true* is configured:

3> for each activated Serving Cell with configured uplink associated with any MAC entity of which the active DL BWP is not dormant BWP; and

3> for each activated Serving Cell with configured uplink associated with E-UTRA MAC entity:

4> if this MAC entity is configured with *twoPHRMode*:

5> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> if the UE supports *mTRP-PUSCH-PHR-Type1-Reporting-r17*:

7> obtain two values of the Type 1 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell.

6> else:

7> obtain two values of the Type 1 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell.

5> else if this Serving Cell is configured with multiple TRP PUSCH repetition (i.e., not configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*) and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> obtain two values of the Type 1 or the value of Type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell.

5> else:

6> obtain the value of the Type 1 or Type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell and clause 5.1.1.2 of TS 36.213 [17] for E-UTRA Serving Cell.

4> else (i.e. this MAC entity is not configured with *twoPHRMode*):

5> if this Serving Cell is configured with multiple TRP PUSCH repetition or *multipanelSchemeSDM* or *multipanelSchemeSFN* and if the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> if there is at least one real PUSCH transmission at the slot where the PHR MAC CE is transmitted:

7> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

8> if the first *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission:

9> obtain the value of the Type 1 power headroom of the real PUSCH transmission associated with the first *TCI-State* or *TCI-UL-State* for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

8> else:

9> obtain the value of the Type 1 power headroom of the real PUSCH transmission associated with the second *TCI-State* or *TCI-UL-State* for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

7> else if this Serving Cell is configured with multiple TRP PUSCH repetition:

8> obtain the value of the Type 1 power headroom of the first real transmission of the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

6> else if there is no real PUSCH transmission at the slot where the PHR MAC CE is transmitted:

7> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

8> obtain the value of the Type 1 power headroom of the reference PUSCH transmission associated with the first *TCI-State* or *TCI-UL-State* for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

7> else if this Serving Cell is configured with multiple TRP PUSCH repetition:

8> if the UE supports *mTRP-PUSCH-PHR-Type1-Reporting-r17*:

9> obtain the value of the Type 1 power headroom of the reference PUSCH transmission associated with the *SRS-ResourceSet* with a lower *SRS-resourceSetID* for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

8> else:

9> obtain the value of the Type 1 power headroom of the reference PUSCH transmission associated with the *SRS-ResourceSet* with a lower *SRS-resourceSetID* or the value of the Type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

5> else:

6> obtain the value of the Type 1 or Type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell and clause 5.1.1.2 of TS 36.213 [17] for E-UTRA Serving Cell.

4> if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

5> if this MAC entity has UL resources allocated for transmission on this Serving Cell; or

5> if the other MAC entity, if configured, has UL resources allocated for transmission on this Serving Cell and *phr-ModeOtherCG* is set to *real* by upper layers:

6> if *dynamicTransformPrecoderFieldPresenceDCI-0-1-r18* or *dynamicTransformPrecoderFieldPresenceDCI-0-2-r18* is set to *enabled* in the active BWP of this Serving Cell:

7> obtain the value for the corresponding PCMAX,f,c field for assumed PUSCH from the physical layer if available, as specified in clause 7.7 of TS 38.213 [6].

6> obtain the value for the corresponding PCMAX,f,c field from the physical layer.

6> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

7> obtain the value for the corresponding MPE field from the physical layer.

4> else (i.e. if this MAC entity is not configured with *phr-AssumedPUSCH-Reporting*):

5> if this MAC entity is configured with *twoPHRMode* and any Serving Cell belonging to this MAC entity is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*; and

5> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> obtain two values for the corresponding PCMAX,f,c,k fields from the physical layer.

6> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:

7> obtain two values for the corresponding MPEk fields from the physical layer.

5> else if this MAC entity is not configured with *twoPHRmode*, or if this MAC entity is configured with *twoPHRMode* and any Serving Cell belonging to this MAC entity is configured with multiple TRP PUSCH repetition; and

5> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> if the first *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission at the slot where the PHR MAC CE is transmitted:

7> obtain the value for the PCMAX,f,c field for the PUSCH transmission associated to the first *TCI-State* or *TCI-UL-State* from the physical layer.

7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:

8> obtain the value for the corresponding MPE field for the PUSCH transmission associated to the first *TCI-State* or *TCI-UL-State* from the physical layer.

6> else if the second *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission at the slot where the PHR MAC CE is transmitted:

7> obtain the value for the PCMAX,f,c field for the PUSCH transmission associated to the second *TCI-State* or *TCI-UL-State* from the physical layer.

7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:

8> obtain the value for the corresponding MPE field for the PUSCH transmission associated to the second *TCI-State* or *TCI-UL-State* from the physical layer.

5> else:

6> if this MAC entity has UL resources allocated for transmission on this Serving Cell; or

6> if the other MAC entity, if configured, has UL resources allocated for transmission on this Serving Cell and *phr-ModeOtherCG* is set to *real* by upper layers:

7> obtain the value for the corresponding PCMAX,f,c field from the physical layer.

7> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

8> obtain the value for the corresponding MPE field from the physical layer.

7> if *mpe-Reporting-FR2-r17* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

8> obtain the value for the corresponding MPEi field from the physical layer;

8> obtain the value for the corresponding Resourcei field from the physical layer.

7> if *dpc-Reporting-FR1* is configured and ΔPPowerClass /ΔPPowerClass, CA/ΔPPowerClass, EN-DC/ΔPPowerClass, NR-DC reporting is triggered and this Serving Cell operates on FR1 and this Serving Cell is associated to this MAC entity:

8> obtain the value for the corresponding DPC field(s) from the physical layer.

3> if *phr-Type2OtherCell* with value *true* is configured:

4> if the other MAC entity is E-UTRA MAC entity:

5> obtain the value of the Type 2 power headroom for the SpCell of the other MAC entity (i.e. E-UTRA MAC entity);

5> if *phr-ModeOtherCG* is set to *real* by upper layers:

6> obtain the value for the corresponding PCMAX,f,c field for the SpCell of the other MAC entity (i.e. E-UTRA MAC entity) from the physical layer.

3> if this MAC entity is configured with *mpe-Reporting-FR2-r17*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple entry PHR as defined in clause 6.1.3.49 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and any Serving Cell belonging to this MAC entity is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple Entry PHR for multiple TRP STx2P MAC CE as defined in clause 6.1.3.82 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and any Serving Cell belonging to this MAC entity is configured with multiple TRP PUSCH repetition:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple Entry PHR for multiple TRP MAC CE as defined in clause 6.1.3.51 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Multiple Entry PHR with assumed PUSCH MAC CE as defined in clause 6.1.3.79 based on the values reported by the physical layer.

3> else:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Multiple Entry PHR MAC CE as defined in clause 6.1.3.9 based on the values reported by the physical layer.

2> else (i.e. Single Entry PHR format is used):

3> if this MAC entity is configured with *twoPHRMode* for multiple TRP PUSCH repetition or *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> obtain two values of the Type 1 power headroom from the physical layer for the corresponding uplink carrier of the PCell.

3> else:

4> obtain the value of the Type 1 power headroom from the physical layer for the corresponding uplink carrier of the PCell.

3> if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

4> if *dynamicTransformPrecoderFieldPresenceDCI-0-1-r18* or *dynamicTransformPrecoderFieldPresenceDCI-0-2-r18* is set to *enabled* in the active BWP of this Serving Cell:

5> obtain the value for the corresponding PCMAX,f,c field for assumed PUSCH from the physical layer, if available, as specified in clause 7.7 of TS 38.213 [6].

3> if this MAC entity is configured with *twoPHRMode* and if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> obtain two values for the corresponding PCMAX,f,c,k fields from the physical layer.

4> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

5> obtain two values for the corresponding MPEk fields from the physical layer.

3> else:

4> obtain the value for the corresponding PCMAX,f,c field from the physical layer;

4> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2:

5> obtain the value for the corresponding MPE field from the physical layer.

4> if *mpe-Reporting-FR2-r17* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

5> obtain the value for the corresponding MPEi field from the physical layer;

5> obtain the value for the corresponding Resourcei field from the physical layer.

4> if *dpc-Reporting-FR1* is configured and this Serving Cell operates on FR1:

5> obtain the value for the corresponding DPC field from the physical layer.

3> if this MAC entity is configured with *mpe-Reporting-FR2-r17*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Single entry PHR as defined in clause 6.1.3.48 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Single Entry PHR for multiple TRP STx2P MAC CE as defined in clause 6.1.3.81 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and this Serving Cell is configured with multiple TRP PUSCH repetition:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Single Entry PHR for multiple TRP MAC CE as defined in clause 6.1.3.50 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Single Entry PHR with assumed PUSCH MAC CE as defined in clause 6.1.3.78 based on the values reported by the physical layer.

3> else:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Single Entry PHR MAC CE as defined in clause 6.1.3.8 based on the values reported by the physical layer.

2> if this PHR report is an MPE P-MPR report:

3> start or restart the *mpe-ProhibitTimer*;

3> cancel triggered MPE P-MPR reporting for Serving Cells included in the PHR MAC CE.

2> start or restart *phr-PeriodicTimer*;

2> start or restart *phr-ProhibitTimer*;

2> cancel all triggered PHR(s).

All triggered PHRs shall be cancelled when there is an ongoing SDT procedure as in clause 5.27 and the UL grant(s) can accommodate all pending data available for transmission but is not sufficient to additionally accommodate the PHR MAC CE plus its subheader.

## 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].

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*.

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* or *drx-InactivityTimer* configured for the DRX group is running; or

- *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; or

- a PDCCH indicating a UE-initiated CSI reporting has not been received after transmitting UE Initiated Report Indication on PUCCH for mode-A UE-initiated CSI reporting (as specified in TS 38.214 [7]).

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.

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

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:

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

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; 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 *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 *ps-TransmitPeriodicL1-RSRP* is not configured with value *true*:

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

3> if *ps-TransmitOtherPeriodicCSI* is not 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).

NOTE 5: In NTN, if a DRX group would not be in Active Time or *drx-onDurationTimer* would not be running prior to symbol n, it is up to UE implementation whether to report periodic and semi-persistent CSI/SRS.

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.

### 5.8.2 Uplink

There are two types of transmission without dynamic grant:

- configured grant Type 1 where an uplink grant is provided by RRC, and stored as configured uplink grant;

- configured grant Type 2 where an uplink grant is provided by PDCCH, and stored or cleared as configured uplink grant based on L1 signalling indicating configured uplink grant activation or deactivation.

Type 1 and Type 2 are configured by RRC for a Serving Cell per BWP. Multiple configurations can be active simultaneously in the same BWP. For Type 2, activation and deactivation are independent among the Serving Cells. For the same BWP, the MAC entity can be configured with both Type 1 and Type 2.

A multi-PUSCH configured grant has multiple consecutive configured uplink grants within a *periodicity*. Both Type 1 and Type 2 can be configured for a multi-PUSCH configured grant by RRC.

Only configured grant Type 1 can be configured for CG-SDT or for RACH-less LTM cell switch or for RACH-less handover. CG-SDT can only be configured on initial BWP.

The MAC entity shall not use the configured grant Type 1 for mode-B UE-initiated CSI reporting to generate MAC PDU in the procedures specified in this clause and in clause 5.4.

RRC configures the following parameters when the configured grant Type 1 is configured:

- *cs-RNTI*: CS-RNTI for retransmission;

- *cg-SDT-CS-RNTI*: CS-RNTI for CG-SDT retransmission;

- *cg-SDT-RSRP-ThresholdSSB*: an RSRP threshold configured for SSB selection for CG-SDT;

- *cg-RRC-RSRP-ThresholdSSB*: an RSRP threshold configured for SSB selection for RACH-less handover;

- *periodicity*: periodicity of the configured grant Type 1;

- *timeDomainOffset*: Offset of a resource with respect to SFN = *timeReferenceSFN* in time domain;

- *timeDomainAllocation*: Allocation of configured uplink grant in time domain which contains *startSymbolAndLength* (i.e. *SLIV* in TS 38.214 [7]) or *startSymbol* (i.e. *S* in TS 38.214 [7]);

- *nrofHARQ-Processes*: the number of HARQ processes for configured grant;

- *harq-ProcID-Offset*: offset of HARQ process for configured grant configured with *cg-RetransmissionTimer* for operation with shared spectrum channel access;

- *harq-ProcID-Offset2*: offset of HARQ process for configured grant not configured with *cg-RetransmissionTimer*;

- *timeReferenceSFN*: SFN used for determination of the offset of a resource in time domain. The UE uses the closest SFN with the indicated number preceding the reception of the configured grant configuration;

- *timeReferenceHyperSFN*: H-SFN used for determination of the offset of a resource in time domain. The UE uses the closest H-SFN with the indicated number preceding the reception of the configured grant configuration.

RRC configures the following parameters when the configured grant Type 2 is configured:

- *cs-RNTI*: CS-RNTI for activation, deactivation, and retransmission;

- *periodicity*: periodicity of the configured grant Type 2;

- *nrofHARQ-Processes*: the number of HARQ processes for configured grant;

- *harq-ProcID-Offset*: offset of HARQ process for configured grant configured with *cg-RetransmissionTimer* for operation with shared spectrum channel access;

- *harq-ProcID-Offset2*: offset of HARQ process for configured grant not configured with *cg-RetransmissionTimer*.

RRC configures the following parameter when retransmissions on configured uplink grant is configured:

- *cg-RetransmissionTimer*: the duration after a configured grant (re)transmission of a HARQ process when the UE shall not autonomously retransmit that HARQ process;

- *cg-SDT-RetransmissionTimer*: the duration after a configured grant (re)transmission of a HARQ process of the initial CG-SDT transmission with CCCH message when the UE shall not autonomously retransmit the HARQ process;

- *cg-RRC-RetransmissionTimer*: the duration after a configured grant (re)transmission of a HARQ process of the first PUSCH transmission of RACH-less handover and RACH-less LTM cell switch when the UE shall not autonomously retransmit the HARQ process.

RRC configures the following parameter when a multi-PUSCH configured grant is configured:

*- nrofSlotsInCG-Period*: the number of configured uplink grants in a *periodicity* of a multi-PUSCH configured grant.

RRC configures the following parameter when UTO-UCI (as specified in clause 9.3 in TS 38.213 [6]) is configured for a configured grant:

*- nrofBitsInUTO-UCI*: number of bits in a UTO-UCI bitmap.

For a configured uplink grant, the MAC entity shall:

1> if its associated configured grant is configured with UTO-UCI and it has not been indicated to the lower layers as unused for PUSCH transmission; or

1> if its associated configured grant is not configured with UTO-UCI:

2> if it is associated with a multi-PUSCH configured grant and meets the validity conditions specified in the clause 6.1 in TS 38.214 [7]; or

2> if it is not associated with a multi-PUSCH configured grant:

3> consider it available for use.

The MAC entity shall not include the UL-SCH resource of a configured uplink grant not available for use in its procedures (e.g. in clauses 5.4.1 and 5.4.4).

For a configured grant configured with UTO-UCI, the MAC entity determines if a configured uplink grant which is within the subsequent *nrofBitsInUTO-UCI* valid occasions of its associated configured grant configuration is going to be used for PUSCH transmission by considering at least the amount of buffered data that can be transmitted on the available occasions of the associated configured grant and other available UL-SCH resources. Upon this determination, the MAC entity sends an indication to lower layers, for use in the procedure for reporting UTO-UCI.

Upon configuration of a configured grant Type 1 for a BWP of a Serving Cell by upper layers, the MAC entity shall:

1> store the uplink grant provided by upper layers as a configured uplink grant for the indicated BWP of the Serving Cell;

1> if *cg-SDT-PeriodicityExt* is configured:

2> initialise or re-initialise the configured uplink grant to start in the symbol according to *timeDomainOffset*, *timeReferenceHyperSFN, timeReferenceSFN*, and *S* (derived from *SLIV* or provided by *startSymbol* as specified in TS 38.214 [7]), and to reoccur with *cg-SDT-PeriodicityExt*.

1> else:

2> initialise or re-initialise the configured uplink grant to start in the symbol according to *timeDomainOffset*, *timeReferenceSFN*, and *S* (derived from *SLIV* or provided by *startSymbol* as specified in TS 38.214 [7]), and to reoccur with *periodicity*.

If *cg-SDT-PeriodicityExt* (as defined in TS 38.331 [5]) is not configured, after an uplink grant is configured for a configured grant Type 1, the MAC entity shall consider sequentially that the configured uplink grant, or the first configured uplink grant in a multi-PUSCH configured grant, in the Nth (N ≥ 0) *periodicity* occurs in the symbol for which:

[(SFN × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  
 + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  
 (*timeReferenceSFN* × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + *timeDomainOffset* × *numberOfSymbolsPerSlot* + S + N × *periodicity*)  
 modulo (1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)

If *cg-SDT-PeriodicityExt* (as defined in TS 38.331 [5]) is configured, after an uplink grant is configured for a configured grant Type 1, the MAC entity shall consider sequentially that the configured uplink grant in the Nth (N ≥ 0) *periodicity* occurs in the symbol for which:

[(H-SFN × *numberOfSFNperH-SFN* + SFN) × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  
 ((*timeReferenceHyperSFN* × *numberOfSFNperH-SFN + timeReferenceSFN*)  
 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + *timeDomainOffset* × *numberOfSymbolsPerSlot* + S + N × *cg-SDT-PeriodicityExt*)  
 modulo (1024 × 1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)

For a multi-PUSCH configured grant Type 1, the Mth (1 < M ≤ *nrofSlotsInCG-Period*) configured uplink grant within a *periodicity* occurs (M-1) × *numberOfSymbolsPerSlot* symbols after the symbol in which the first configured uplink grant in that *periodicity* occurs.

For an uplink grant configured for configured grant Type 1 for CG-SDT on the selected uplink carrier as in clause 5.27, when CG-SDT is triggered and not terminated, for each configured uplink grant valid according to TS 38.214 [7] for which the above formula is satisfied, the MAC entity shall:

1> if, after initial transmission for CG-SDT with CCCH message has been performed according to clause 5.4.1, PDCCH addressed to the MAC entity's C-RNTI has not been received:

2> if the SSB corresponding to the configured UL grant has the same SSB index as the SSB selected for initial transmission for CG-SDT with CCCH message (i.e., retransmission of initial transmission of CG-SDT):

3> select this SSB;

3> indicate the SSB index corresponding to the configured uplink grant to the lower layer;

3> consider this configured uplink grant as valid.

1> else if at least one SSB corresponding to the configured uplink grant with SS-RSRP above the *cg-SDT-RSRP-ThresholdSSB* is available:

2> if this is the initial transmission of CG-SDT with CCCH message after the CG-SDT procedure is initiated as in clause 5.27 (i.e., initial transmission for CG-SDT):

3> select an SSB with SS-RSRP above *cg-SDT-RSRP-ThresholdSSB* amongst the SSB(s) associated with the configured uplink grant.

2> else if PDCCH addressed to C-RNTI has been received after the initial transmission of CG-SDT with CCCH message (i.e., subsequent new transmission for CG-SDT):

3> if SS-RSRP of the SSB selected for the previous transmission for CG-SDT is above *cg-SDT-RSRP-ThresholdSSB* and this SSB is associated with this configured uplink grant:

4> select this SSB.

3> else if SS-RSRP of the SSB selected for the previous transmission for CG-SDT is not above *cg-SDT-RSRP-ThresholdSSB*:

4> select an SSB with SS-RSRP above *cg-SDT-RSRP-ThresholdSSB* amongst the SSB(s) associated with the configured uplink grant.

2> if SSB is selected above:

3> indicate the SSB index to the lower layer;

3> consider this configured uplink grant as valid.

The MAC entity shall:

1> if no SSB configured for CG-SDT with SS-RSRP above *cg-SDT-RSRP-ThresholdSSB* is available:

2> if PDCCH addressed to C-RNTI after the initial transmission of the CG-SDT with CCCH message has been received:

3> if there is data available for transmission for at least one RB configured for SDT:

4> initiate Random Access procedure in clause 5.1.

NOTE 1: Void.

For an uplink grant configured for configured grant Type 1 for RACH-less LTM cell switch, when there is an ongoing RACH-less LTM cell switch procedure, for each configured uplink grant valid according to TS 38.214 [7] for which the above formula is satisfied, the MAC entity shall:

1> if an SSB corresponding to the configured UL grant has the same SSB index as the SSB associated with the TCI state indicated by the UL TCI state ID field, if present, or by the TCI state ID field otherwise, in the LTM Cell Switch Command MAC CE, as specified in clause 21.1 in TS 38.213 [6]:

2> select the SSB associated with the TCI state indicated by LTM Cell Switch Command MAC CE.

2> indicate the SSB index to the lower layer;

2> consider this configured uplink grant as valid.

1> else:

2> consider this configured uplink grant as not valid.

NOTE 1a: When there is an ongoing RACH-less LTM cell switch, the configured grant Type 1 which is not specifically configured for LTM (see *cg-LTM-Configuration* in TS 38.331 [5]) is not used.

NOTE 1b: After completion of LTM cell switch, the UE stops using the grant configured for RACH-less LTM cell switch (see *cg-LTM-Configuration* in TS 38.331 [5]).

For the uplink grant configured for configured grant Type 1 for RACH-less handover, if the configured uplink grant is valid according to TS 38.214 [7] for which the above formula is satisfied and RACH-less handover is not successfully completed, the MAC entity shall:

1> if the first PUSCH transmission of RACH-less handover has been performed according to clause 5.4.1 and 5.33:

2> if the SSB corresponding to the configured UL grant has the same SSB index as the SSB selected for the first PUSCH transmission of RACH-less handover (i.e., retransmission of the first PUSCH transmission of RACH-less handover):

3> select this SSB;

3> indicate the SSB index corresponding to the configured uplink grant to the lower layer;

3> consider this configured uplink grant as valid.

1> else if at least one SSB corresponding to the configured uplink grant with SS-RSRP above *cg-RRC-RSRP-ThresholdSSB* is available:

2> select an SSB with SS-RSRP above *cg-RRC-RSRP-ThresholdSSB* amongst the SSB(s) associated with the configured uplink grant;

2> indicate the selected SSB index to the lower layer;

2> consider this configured uplink grant as valid.

The MAC entity shall:

1> if no SSB configured for RACH-less handover with SS-RSRP above *cg-RRC-RSRP-ThresholdSSB* is available:

2> initiate Random Access procedure in clause 5.1.

NOTE 1A: When the UE determines if there is an SSB with SS-RSRP above *cg-RRC-RSRP-ThresholdSSB* or *cg-SDT-RSRP-ThresholdSSB*, the UE uses the latest unfiltered L1-RSRP measurement.

After an uplink grant is configured for a configured grant Type 2, the MAC entity shall consider sequentially that the configured uplink grant, or the first configured uplink grant in a multi-PUSCH configured grant, in the Nth (N ≥ 0) *periodicity* occurs in the symbol for which:

[(SFN × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  
 + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  
 [(SFNstart time × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + slotstart time × *numberOfSymbolsPerSlot* + symbolstart time) + N × *periodicity*]  
 modulo (1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)

where SFNstart time, slotstart time, and symbolstart time are the SFN, slot, and symbol, respectively, of the first transmission opportunity of PUSCH where the configured uplink grant was (re-)initialised.

For a multi-PUSCH configured grant Type 2, the Mth (1 < M ≤ *nrofSlotsInCG-Period*) configured uplink grant within the same *periodicity* occurs (M-1) × *numberOfSymbolsPerSlot* symbols after the symbol in which the first configured uplink grant in that *periodicity* occurs.

If *cg-nrofPUSCH-InSlot* or *cg-nrofSlots* is configured for a configured grant Type 1 or Type 2, the MAC entity shall consider the uplink grants occur in those additional PUSCH allocations as specified in clause 6.1.2.3 of TS 38.214 [7].

NOTE 2: In case of unaligned SFN across carriers in a cell group, the SFN of the concerned Serving Cell is used to calculate the occurrences of configured uplink grants.

When the configured uplink grant is released by upper layers, all the corresponding configurations shall be released and all corresponding uplink grants shall be cleared.

The MAC entity shall:

1> if at least one configured uplink grant confirmation has been triggered and not cancelled; and

1> if the MAC entity has UL resources allocated for new transmission:

2> if, in this MAC entity, at least one configured uplink grant is configured by *configuredGrantConfigToAddModList*:

3> instruct the Multiplexing and Assembly procedure to generate a Multiple Entry Configured Grant Confirmation MAC CE as defined in clause 6.1.3.31.

2> else:

3> instruct the Multiplexing and Assembly procedure to generate a Configured Grant Confirmation MAC CE as defined in clause 6.1.3.7.

2> cancel all triggered configured uplink grant confirmation(s).

For a configured grant Type 2, the MAC entity shall clear the configured uplink grant(s) immediately after first transmission of Configured Grant Confirmation MAC CE or Multiple Entry Configured Grant Confirmation MAC CE which confirms the configured uplink grant deactivation.

Retransmissions use:

- repetition of configured uplink grants; or

- received uplink grants addressed to CS-RNTI; or

- configured uplink grants with *cg-RetransmissionTimer*, *cg-RRC-RetransmissionTimer* or *cg-SDT-RetransmissionTimer* configured.

### 5.15.1 Downlink and Uplink

In addition to clause 12 of TS 38.213 [6], this clause specifies requirements on BWP operation.

A Serving Cell may be configured with one or multiple BWPs, and the maximum number of BWP per Serving Cell is specified in TS 38.213 [6].

The BWP switching for a Serving Cell is used to activate an inactive BWP and deactivate an active BWP at a time. The BWP switching is controlled by the PDCCH indicating a downlink assignment or an uplink grant, by the *bwp-InactivityTimer*, by RRC signalling, or by the MAC entity itself upon initiation of Random Access procedure or upon detection of consistent LBT failure on SpCell. Upon RRC (re-)configuration of *firstActiveDownlinkBWP-Id* and/or *firstActiveUplinkBWP-Id* for SpCell except for PSCell when SCG is deactivated (see clause 5.29) or activation of an SCell, the DL BWP and/or UL BWP indicated by *firstActiveDownlinkBWP-Id* and/or *firstActiveUplinkBWP-Id* respectively (as specified in TS 38.331 [5]) is active without receiving PDCCH indicating a downlink assignment or an uplink grant. Upon RRC (re-)configuration of *firstActiveDownlinkBWP-Id* for PSCell when SCG is deactivated, the DL BWP is switched to the *firstActiveDownlinkBWP-Id* as specified in TS 38.331 [5]. The active BWP for a Serving Cell is indicated by either RRC or PDCCH (as specified in TS 38.213 [6]). For unpaired spectrum, a DL BWP is paired with a UL BWP, and BWP switching is common for both UL and DL.

For each SCell a dormant BWP may be configured with *dormantBWP-Id* by RRC signalling as described in TS 38.331 [5]. Entering or leaving dormant BWP for SCells is done by BWP switching per SCell or per dormancy SCell group based on instruction from PDCCH (as specified in TS 38.213 [6]). The dormancy SCell group configurations are configured by RRC signalling as described in TS 38.331 [5]. Upon reception of the PDCCH indicating leaving dormant BWP, the DL BWP indicated by *firstOutsideActiveTimeBWP-Id* or by *firstWithinActiveTimeBWP-Id* (as specified in TS 38.331 [5] and TS 38.213 [6]) is activated. Upon reception of the PDCCH indicating entering dormant BWP, the DL BWP indicated by *dormantBWP-Id* (as specified in TS 38.331 [5]) is activated. The dormant BWP configuration for SpCell or PUCCH SCell is not supported.

BWP for SRS for positioning Tx frequency hopping can be configured for a Serving Cell in TS 38.331 [5]. BWP for SRS Tx frequency hopping is considered as activated when it is configured. BWP switching is not applicable for BWP for SRS Tx frequency hopping.

For each activated Serving Cell configured with a BWP, the MAC entity shall:

1> if a BWP is activated and the active DL BWP for the Serving Cell is not the dormant BWP and the Serving Cell is not the PSCell of deactivated SCG:

2> transmit on UL-SCH on the BWP;

2> transmit on RACH on the BWP, if PRACH occasions are configured;

2> monitor the PDCCH on the BWP;

2> transmit PUCCH on the BWP, if configured;

2> report CSI for the BWP;

2> transmit SRS on the BWP, if configured;

2> receive DL-SCH on the BWP;

2> (re-)initialize any suspended configured uplink grants of configured grant Type 1 on the active BWP according to the stored configuration, if any, and to start in the symbol according to rules in clause 5.8.2;

2> if *lbt-FailureRecoveryConfig* is configured:

3> stop the *lbt-FailureDetectionTimer*, if running;

3> set *LBT\_COUNTER* to 0;

3> monitor LBT failure indications from lower layers as specified in clause 5.21.2.

1> if a BWP is activated and the active DL BWP for the Serving Cell is dormant BWP:

2> stop the *bwp-InactivityTimer* of this Serving Cell, if running.

2> not monitor the PDCCH on the BWP;

2> not monitor the PDCCH for the BWP;

2> not receive DL-SCH on the BWP;

2> not report CSI on the BWP, report CSI except aperiodic CSI and mode-A UE-initiated CSI for the BWP;

2> not transmit SRS on the BWP;

2> not transmit on UL-SCH on the BWP;

2> not transmit on RACH on the BWP;

2> not transmit PUCCH on the BWP;

2> clear any configured downlink assignment and any configured uplink grant Type 2 associated with the SCell respectively;

2> suspend any configured uplink grant Type 1 associated with the SCell;

2> if configured, perform beam failure detection and beam failure recovery for the SCell if beam failure is detected;

2> if the SCell is configured as a scheduled cell in *MC-DCI-SetOfCells* and with the search space for DCI to schedule multiple cells (as specified in TS 38.213 [6]) of the same *searchSpaceId* as the serving cell in which *MC-DCI-SetOfCells* containing the SCell is configured:

3> not monitor the PDCCH for scheduling multiple cells (as specified in TS 38.213 [6]) for the set of cells in *MC-DCI-SetOfCells* including the SCell.

1> if a BWP is deactivated or the Serving Cell is PSCell of deactivated SCG:

2> not transmit on UL-SCH on the BWP;

2> not transmit on RACH on the BWP;

2> not monitor the PDCCH on the BWP;

2> not transmit PUCCH on the BWP;

2> not report CSI for the BWP;

2> not transmit SRS on the BWP;

2> not receive DL-SCH on the BWP;

2> clear any configured downlink assignment and configured uplink grant of configured grant Type 2 on the BWP;

2> suspend any configured uplink grant of configured grant Type 1 on the inactive BWP.

Upon initiation of the Random Access procedure on a Serving Cell, after the selection of carrier for performing Random Access procedure as specified in clause 5.1.1, the MAC entity shall for the selected carrier of this Serving Cell:

1> if PRACH occasions are not configured for the active UL BWP:

2> if the UE is an (e)RedCap UE; and

2> if *initialUplinkBWP-RedCap* is configured:

3> switch the active UL BWP to BWP indicated by *initialUplinkBWP-RedCap*.

2> else:

3> switch the active UL BWP to BWP indicated by *initialUplinkBWP*.

2> if the Serving Cell is an SpCell:

3> if the UE is an (e)RedCap UE; and

3> if *initialDownlinkBWP-RedCap* is configured:

4> switch the active DL BWP to BWP indicated by *initialDownlinkBWP-RedCap*.

3> else:

4> switch the active DL BWP to BWP indicated by *initialDownlinkBWP*.

1> else:

2> if the Serving Cell is an SpCell:

3> if the active DL BWP does not have the same *bwp-Id* as the active UL BWP:

4> switch the active DL BWP to the DL BWP with the same *bwp-Id* as the active UL BWP.

1> stop the *bwp-InactivityTimer* associated with the active DL BWP of this Serving Cell, if running.

1> if the Serving Cell is SCell:

2> stop the *bwp-InactivityTimer* associated with the active DL BWP of SpCell, if running.

1> perform the Random Access procedure on the active DL BWP of SpCell and active UL BWP of this Serving Cell.

If the MAC entity receives a PDCCH for BWP switching of a Serving Cell, the MAC entity shall:

1> if there is no ongoing Random Access procedure associated with this Serving Cell; or

1> if the ongoing Random Access procedure associated with this Serving Cell is successfully completed upon reception of this PDCCH addressed to C-RNTI (as specified in clauses 5.1.4, 5.1.4a, and 5.1.5):

2> cancel, if any, triggered consistent LBT failure for this Serving Cell;

2> perform BWP switching to a BWP indicated by the PDCCH.

If the MAC entity receives a PDCCH for BWP switching for a Serving Cell(s) or a dormancy SCell group(s) while a Random Access procedure associated with that Serving Cell is ongoing in the MAC entity, it is up to UE implementation whether to switch BWP or ignore the PDCCH for BWP switching, except for the PDCCH reception for BWP switching addressed to the C-RNTI for successful Random Access procedure completion (as specified in clauses 5.1.4, 5.1.4a, and 5.1.5) in which case the UE shall perform BWP switching to a BWP indicated by the PDCCH. Upon reception of the PDCCH for BWP switching other than successful contention resolution, if the MAC entity decides to perform BWP switching, the MAC entity shall stop the ongoing Random Access procedure and initiate a Random Access procedure after performing the BWP switching; if the MAC decides to ignore the PDCCH for BWP switching, the MAC entity shall continue with the ongoing Random Access procedure on the Serving Cell.

Upon reception of RRC (re-)configuration for BWP switching for a Serving Cell while a Random Access procedure associated with that Serving Cell is ongoing in the MAC entity, the MAC entity shall stop the ongoing Random Access procedure and initiate a Random Access procedure after performing the BWP switching.

Upon reception of RRC (re-)configuration for BWP switching for a Serving Cell, cancel any triggered consistent LBT failure in this Serving Cell.

The MAC entity shall for each activated Serving Cell configured with *bwp-InactivityTimer*:

1> if the *defaultDownlinkBWP-Id* is configured, and the active DL BWP is not the BWP indicated by the *defaultDownlinkBWP-Id*, and the active DL BWP is not the BWP indicated by the *dormantBWP-Id* if configured; or

1> if the UE is neither a RedCap nor an eRedCap UE, and if the *defaultDownlinkBWP-Id* is not configured, and the active DL BWP is not the *initialDownlinkBWP*, and the active DL BWP is not the BWP indicated by the *dormantBWP-Id* if configured; or

1> if the UE is an (e)RedCap UE, and if the *defaultDownlinkBWP-Id* is not configured, and *initialDownlinkBWP-RedCap* is not configured, and the active DL BWP is not the *initialDownlinkBWP*; or

1> if the UE is an (e)RedCap UE, and if the *defaultDownlinkBWP-Id* is not configured, and *initialDownlinkBWP-RedCap* is configured, and the active DL BWP is not the *initialDownlinkBWP-RedCap*:

2> if a PDCCH addressed to C-RNTI or CS-RNTI indicating downlink assignment or uplink grant is received on the active BWP; or

2> if a PDCCH addressed to G-RNTI or G-CS-RNTI configured for multicast indicating downlink assignment is received on the active BWP; or

2> if a PDCCH addressed to C-RNTI or CS-RNTI indicating downlink assignment or uplink grant is received for the active BWP; or

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

2> if a MAC PDU is received in a configured downlink assignment for unicast or MBS multicast:

3> if there is no ongoing Random Access procedure associated with this Serving Cell; or

3> if the ongoing Random Access procedure associated with this Serving Cell is successfully completed upon reception of this PDCCH addressed to C-RNTI (as specified in clauses 5.1.4, 5.1.4a and 5.1.5):

4> start or restart the *bwp-InactivityTimer* associated with the active DL BWP.

2> if the *bwp-InactivityTimer* associated with the active DL BWP expires:

3> if the *defaultDownlinkBWP-Id* is configured:

4> perform BWP switching to a BWP indicated by the *defaultDownlinkBWP-Id*.

3> else:

4> if the UE is a (e)RedCap UE; and

4> if *initialDownlinkBWP-RedCap* is configured:

5> perform BWP switching to the *initialDownlinkBWP-RedCap*.

4> else:

5> perform BWP switching to the *initialDownlinkBWP*.

NOTE: If a Random Access procedure is initiated on an SCell, both this SCell and the SpCell are associated with this Random Access procedure.

1> if a PDCCH for BWP switching is received, and the MAC entity switches the active DL BWP:

2> if the *defaultDownlinkBWP-Id* is configured, and the MAC entity switches to the DL BWP which is not indicated by the *defaultDownlinkBWP-Id* and is not indicated by the *dormantBWP-Id* if configured; or

2> if the UE is neither a RedCap nor an eRedCap UE, and if the *defaultDownlinkBWP-Id* is not configured, and the MAC entity switches to the DL BWP which is not the *initialDownlinkBWP* and is not indicated by the *dormantBWP-Id* if configured; or

2> if the UE is an (e)RedCap UE, and if the *defaultDownlinkBWP-Id* is not configured, and *initialDownlinkBWP-RedCap* is not configured, and the MAC entity switches to the DL BWP which is not the *initialDownlinkBWP*; or

2> if the UE is an (e)RedCap UE, and if the *defaultDownlinkBWP-Id* is not configured, and *initialDownlinkBWP-RedCap* is configured, and the MAC entity switches to the DL BWP which is not the *initialDownlinkBWP-RedCap*:

3> start or restart the *bwp-InactivityTimer* associated with the active DL BWP.

Upon initiation of the Random Access procedure, after selection of the carrier for performing Random Access procedure as specified in clause 5.1.1, if the UE is an (e)RedCap UE in RRC\_IDLE or RRC\_INACTIVE mode, the MAC entity shall:

1> if *initialUplinkBWP-RedCap* is configured for the selected carrier:

2> perform the Random Access procedure as specified in clause 5.1 by using the BWP configured by *initialUplinkBWP-RedCap*.

1> else:

2> perform the Random Access procedure as specified in clause 5.1 by using the BWP configured by *initialUplinkBWP*.

1> if *initialDownlinkBWP-RedCap* is configured:

2> if the Random Access procedure was initiated for SI request (as specified in TS 38.331 [5]) and the Random Access Resources for SI request have been explicitly provided by RRC, and if the selected carrier is SUL carrier:

3> monitor the PDCCH on the BWP configured by *initialDownlinkBWP*.

2> else:

3> monitor the PDCCH on the BWP configured by *initialDownlinkBWP-RedCap*.

1> else:

2> monitor the PDCCH on the BWP configured by *initialDownlinkBWP*.

## 5.18 Handling of MAC CEs

### 5.18.1 General

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

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

- Aperiodic CSI Trigger State Subselection MAC CE;

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

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

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

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

- SP SRS Activation/Deactivation MAC CE;

- PUCCH spatial relation Activation/Deactivation MAC CE;

- Enhanced PUCCH spatial relation Activation/Deactivation MAC CE;

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

- Recommended Bit Rate MAC CE;

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

- SRS Pathloss Reference RS Update MAC CE;

- PUSCH Pathloss Reference RS Update MAC CE;

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

- SP Positioning SRS Activation/Deactivation MAC CE;

- Timing Delta MAC CE;

- Guard Symbols MAC CEs;

- Positioning Measurement Gap Activation/Deactivation Command MAC CE;

- PPW Activation/Deactivation Command MAC CE;

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

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

- Unified TCI States Activation/Deactivation MAC CE;

- Differential Koffset MAC CE;

- Case-7 Timing advance offset MAC CE;

- DL TX Power Adjustment MAC CEs;

- Child IAB-DU Restricted Beam Indication MAC CE;

- Timing Case Indication MAC CE;

- PSI-Based SDU Discard Activation/Deactivation MAC CE;

- BFD-RS Indication MAC CE;

- IAB-MT Recommended Beam Indication MAC CE;

- UL PSD range adjustment for IAB MAC CE;

- Case-6 Timing Request MAC CE;

- NCR Backhaul Link Beam Indication MAC CEs;

- NCR Access Link Beam Indication MAC CE;

- Enhanced Unified TCI States Activation/Deactivation MAC CE;

- LTM Cell Switch Command MAC CE;

- Candidate Cell TCI States Activation/Deactivation MAC CE;

- Aggregated SP Positioning SRS Activation/Deactivation MAC CE;

- Pathloss Offset Update MAC CE.

### 5.18.XX Update of Pathloss Offset

The network may indicate updated value(s) of pathloss offset(s) for joint TCI state(s) or UL TCI state(s) of a Serving Cell by sending the Pathloss Offset Update MAC CE described in clause 6.1.3.YY.

The MAC entity shall:

1> if the MAC entity receives a Pathloss Offset Update MAC CE for a Serving Cell:

2> indicate to lower layers the information included in the Pathloss Offset Update MAC CE.

#### 6.1.3.YY Pathloss Offset Update MAC CE

The Pathloss Offset Update MAC CE is identified by a MAC subheader with eLCID as specified in Table 6.2.1-1b. It has a variable size with the following fields:

- Serving Cell ID: This field indicates the identity of the Serving Cell to which the MAC CE is applied. The length of this field is 5 bits;

- BWP ID: This field indicates a BWP as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9]. If the value of *unifiedTCI-StateType* in the Serving Cell indicated by Serving Cell IDis *joint*, this field indicates a DL BWP to which the MAC CE is applied. If the value of *unifiedTCI-StateType* in the Serving Cell indicated by Serving Cell ID is *separate*, this field indicates a UL BWP to which the MAC CE is applied. The length of this field is 2 bits;

- TCI state ID: This field indicates a TCI state identified by *TCI-StateId* or *TCI-UL-State-Id* as specified in TS 38.331 [5]. The length of this field is 7 bits. If the value of *unifiedTCI-StateType* in the Serving Cell indicated by Serving Cell IDis *joint*, this field indicates a *TCI-StateId* for a joint TCI state. If the value of *unifiedTCI-StateType* in the Serving Cell indicated by Serving Cell ID is *separate*, the most significant bit of the field is considered as the reserved bit and remainder 6 bits indicate a *TCI-UL-State-Id* for a UL TCI state;

- Pathloss Offset: This field indicates the updated value of pathloss offset for the TCI state indicated by the preceding TCI state ID field. The range of the indicated pathloss offset is from -12 dB to 60 dB with a step size of 4 dB. The field value 0 corresponds to -12 dB, the field value 1 corresponds to -8 dB and so on. The field values from 19 onwards are reserved. The length of this field is 5 bits;

- R: Reserved bit, set to 0.



Figure 6.1.3.YY: Pathloss Offset Update MAC CE

### 6.2.1 MAC subheader for DL-SCH and UL-SCH

The MAC subheader consists of the following fields:

- LCID: The Logical Channel ID field identifies the logical channel instance of the corresponding MAC SDU or the type of the corresponding MAC CE or padding as described in Tables 6.2.1-1 and 6.2.1-1c for the DL-SCH and Tables 6.2.1-2 and 6.2.1-2c for the UL-SCH. There is one LCID field per MAC subheader. The size of the LCID field is 6 bits. If the LCID field is set to 34 as in Table 6.2.1-1 or 6.2.1-2, one additional octet is present in the MAC subheader containing the eLCID field and follow the octet containing LCID field. If the LCID field is set to 33 as in Table 6.2.1-1 or 6.2.1-2, two additional octets are present in the MAC subheader containing the eLCID field and these two additional octets follow the octet containing LCID field;

NOTE 1: For MBS broadcast, a logical channel is identified based on G-RNTI and LCID if the same LCID is allocated for logical channels corresponding to different G-RNTIs.

- eLCID: The extended Logical Channel ID field identifies the logical channel instance of the corresponding MAC SDU or the type of the corresponding MAC CE as described in tables 6.2.1-1a, 6.2.1-1b, 6.2.1-2a and 6.2.1-2b for the DL-SCH and UL-SCH respectively. The size of the eLCID field is either 8 bits or 16 bits.

NOTE 2: The extended Logical Channel ID space using two-octet eLCID and the relevant MAC subheader format is used, only when configured, on the NR backhaul links between IAB nodes or between IAB node and IAB Donor, or for multicast MTCHs.

- L: The Length field indicates the length of the corresponding MAC SDU or variable-sized MAC CE in bytes. There is one L field per MAC subheader except for subheaders corresponding to fixed-sized MAC CEs, padding, and MAC SDUs containing UL CCCH. The size of the L field is indicated by the F field;

- F: The Format field indicates the size of the Length field. There is one F field per MAC subheader except for subheaders corresponding to fixed-sized MAC CEs, padding, and MAC SDUs containing UL CCCH. The size of the F field is 1 bit. The value 0 indicates 8 bits of the Length field. The value 1 indicates 16 bits of the Length field;

- LX: The LCID extension field indicates the use of extended LCID space. The size of the LX field is 1 bit. The LX field set to 1 indicates the use of Table 6.2.1-2c, otherwise R bit is present instead (i.e. set to 0);

- R: Reserved bit, set to 0.

The MAC subheader is octet aligned.

Table 6.2.1-1: Values of LCID for DL-SCH

|  |  |
| --- | --- |
| Codepoint/Index | LCID values |
| 0 | CCCH |
| 1–32 | Identity of the logical channel of DCCH, DTCH and multicast MTCH |
| 33 | Extended logical channel ID field (two-octet eLCID field) |
| 34 | Extended logical channel ID field (one-octet eLCID field) |
| 35–46 | Reserved |
| 47 | Recommended bit rate |
| 48 | SP ZP CSI-RS Resource Set Activation/Deactivation |
| 49 | PUCCH spatial relation Activation/Deactivation |
| 50 | SP SRS Activation/Deactivation |
| 51 | SP CSI reporting on PUCCH Activation/Deactivation |
| 52 | TCI State Indication for UE-specific PDCCH |
| 53 | TCI States Activation/Deactivation for UE-specific PDSCH |
| 54 | Aperiodic CSI Trigger State Subselection |
| 55 | SP CSI-RS/CSI-IM Resource Set Activation/Deactivation |
| 56 | Duplication Activation/Deactivation |
| 57 | SCell Activation/Deactivation (four octets) |
| 58 | SCell Activation/Deactivation (one octet) |
| 59 | Long DRX Command |
| 60 | DRX Command |
| 61 | Timing Advance Command |
| 62 | UE Contention Resolution Identity |
| 63 | Padding |

Table 6.2.1-1a: Values of two-octet eLCID for DL-SCH

|  |  |  |
| --- | --- | --- |
| Codepoint | Index | LCID values |
| 0 to (216 – 1) | 320 to (216 + 319) | Identity of the logical channel |

Table 6.2.1-1b: Values of one-octet eLCID for DL-SCH

|  |  |  |
| --- | --- | --- |
| Codepoint | Index | LCID values |
| 0 to 2xx | 64 to 2xx | Reserved |
| 2xx | 2xx | Pathloss Offset Update |
| 216 | 280 | Aggregated SP Positioning SRS Activation/Deactivation |
| 217 | 281 | Enhanced SP CSI reporting on PUCCH Activation/Deactivation |
| 218 | 282 | Cross-RRH TCI State Indication for UE-specific PDCCH |
| 219 | 283 | LTM Cell Switch Command |
| 220 | 284 | Candidate Cell TCI States Activation/Deactivation |
| 221 | 285 | PSI-Based SDU Discard Activation/Deactivation |
| 222 | 286 | Enhanced Unified TCI states Activation/Deactivation MAC CE for Joint TCI States |
| 223 | 287 | Enhanced Unified TCI states Activation/Deactivation MAC CE for Separate TCI States |
| 224 | 288 | NCR Access Link Beam Indication |
| 225 | 289 | NCR Downlink Backhaul Link Beam Indication |
| 226 | 290 | NCR Uplink Backhaul Link Beam Indication |
| 227 | 291 | Serving Cell Set based SRS TCI State Indication |
| 228 | 292 | SP/AP SRS TCI State Indication |
| 229 | 293 | BFD-RS Indication |
| 230 | 294 | Differential Koffset |
| 231 | 295 | Enhanced SCell Activation/Deactivation (one octet Ci field) |
| 232 | 296 | Enhanced SCell Activation/Deactivation (four octet Ci field) |
| 233 | 297 | Unified TCI States Activation/Deactivation |
| 234 | 298 | PUCCH Power Control Set Update for multiple TRP PUCCH repetition |
| 235 | 299 | PUCCH spatial relation Activation/Deactivation for multiple TRP PUCCH repetition |
| 236 | 300 | Enhanced TCI States Indication for UE-specific PDCCH |
| 237 | 301 | Positioning Measurement Gap Activation/Deactivation Command |
| 238 | 302 | PPW Activation/Deactivation Command |
| 239 | 303 | DL Tx Power Adjustment |
| 240 | 304 | Timing Case Indication |
| 241 | 305 | Child IAB-DU Restricted Beam Indication |
| 242 | 306 | Case-7 Timing advance offset |
| 243 | 307 | Provided Guard Symbols for Case-6 timing |
| 244 | 308 | Provided Guard Symbols for Case-7 timing |
| 245 | 309 | Serving Cell Set based SRS Spatial Relation Indication |
| 246 | 310 | PUSCH Pathloss Reference RS Update |
| 247 | 311 | SRS Pathloss Reference RS Update |
| 248 | 312 | Enhanced SP/AP SRS Spatial Relation Indication |
| 249 | 313 | Enhanced PUCCH Spatial Relation Activation/Deactivation |
| 250 | 314 | Enhanced TCI States Activation/Deactivation for UE-specific PDSCH |
| 251 | 315 | Duplication RLC Activation/Deactivation |
| 252 | 316 | Absolute Timing Advance Command |
| 253 | 317 | SP Positioning SRS Activation/Deactivation |
| 254 | 318 | Provided Guard Symbols |
| 255 | 319 | Timing Delta |

Table 6.2.1-1c: Values of LCID for MBS multicast MCCH and MBS broadcast on DL-SCH

|  |  |
| --- | --- |
| Codepoint/Index | LCID values |
| 0 | Broadcast MCCH or multicast MCCH |
| 1–32 | Identity of the logical channel of broadcast MTCH |
| 33–63 | Reserved |

Table 6.2.1-2: Values of LCID for UL-SCH when the LX field is not present or is set to 0

|  |  |
| --- | --- |
| Codepoint/Index | LCID values |
| 0 | CCCH of size 64 bits, except for an (e)RedCap UE |
| 1–32 | Identity of the logical channel of DCCH and DTCH |
| 33 | Extended logical channel ID field (two-octet eLCID field) |
| 34 | Extended logical channel ID field (one-octet eLCID field) |
| 35 | CCCH of size 48 bits for a RedCap UE |
| 36 | CCCH of size 64 bits for a RedCap UE |
| 37–42 | Reserved |
| 43 | Truncated Enhanced BFR (one octet Ci) |
| 44 | Timing Advance Report |
| 45 | Truncated Sidelink BSR |
| 46 | Sidelink BSR |
| 47 | Reserved |
| 48 | LBT failure (four octets) |
| 49 | LBT failure (one octet) |
| 50 | BFR (one octet Ci) |
| 51 | Truncated BFR (one octet Ci) |
| 52 | CCCH of size 48 bits, except for an (e)RedCap UE |
| 53 | Recommended bit rate query |
| 54 | Multiple Entry PHR (four octets Ci) |
| 55 | Configured Grant Confirmation |
| 56 | Multiple Entry PHR (one octet Ci) |
| 57 | Single Entry PHR |
| 58 | C-RNTI |
| 59 | Short Truncated BSR |
| 60 | Long Truncated BSR |
| 61 | Short BSR |
| 62 | Long BSR |
| 63 | Padding |
| NOTE: CCCH of size 48 bits and CCCH of size 64 bits are referred to as CCCH and CCCH1, respectively, in TS 38.331 [5]. | |

Table 6.2.1-2a: Values of two-octet eLCID for UL-SCH

|  |  |  |
| --- | --- | --- |
| Codepoint | Index | LCID values |
| 0 to (216 – 1) | 320 to (216 + 319) | Identity of the logical channel |

Table 6.2.1-2b: Values of one-octet eLCID for UL-SCH

|  |  |  |
| --- | --- | --- |
| Codepoint | Index | LCID values |
| 0 to 218 | 64 to 282 | Reserved |
| 219 | 283 | Enhanced Multiple Entry PHR for multiple TRP STx2P (four octets Ci) |
| 220 | 284 | Enhanced Multiple Entry PHR for multiple TRP STx2P (one octets Ci) |
| 221 | 285 | Enhanced Single Entry PHR for multiple TRP STx2P |
| 222 | 286 | SL LBT Failure |
| 223 | 287 | Multiple Entry PHR with assumed PUSCH (four octets Ci) |
| 224 | 288 | Multiple Entry PHR with assumed PUSCH (one octets Ci) |
| 225 | 289 | Single Entry PHR with assumed PUSCH |
| 226 | 290 | SL-PRS Resource Request |
| 227 | 291 | Refined Long BSR |
| 228 | 292 | Delay Status Report |
| 229 | 293 | Enhanced Multiple Entry PHR for multiple TRP (four octets Ci) |
| 230 | 294 | Enhanced Multiple Entry PHR for multiple TRP (one octets Ci) |
| 231 | 295 | Enhanced Single Entry PHR for multiple TRP |
| 232 | 296 | Enhanced Multiple Entry PHR (four octets Ci) |
| 233 | 297 | Enhanced Multiple Entry PHR (one octets Ci) |
| 234 | 298 | Enhanced Single Entry PHR |
| 235 | 299 | Enhanced BFR (one octet Ci) |
| 236 | 300 | Enhanced BFR (four octet Ci) |
| 237 | 301 | Truncated Enhanced BFR (four octet Ci) |
| 238 | 302 | Positioning Measurement Gap Activation/Deactivation Request |
| 239 | 303 | IAB-MT Recommended Beam Indication |
| 240 | 304 | Desired IAB-MT PSD range |
| 241 | 305 | Desired DL Tx Power Adjustment |
| 242 | 306 | Case-6 Timing Request |
| 243 | 307 | Desired Guard Symbols for Case 6 timing |
| 244 | 308 | Desired Guard Symbols for Case 7 timing |
| 245 | 309 | Extended Short Truncated BSR |
| 246 | 310 | Extended Long Truncated BSR |
| 247 | 311 | Extended Short BSR |
| 248 | 312 | Extended Long BSR |
| 249 | 313 | Extended Pre-emptive BSR |
| 250 | 314 | BFR (four octets Ci) |
| 251 | 315 | Truncated BFR (four octets Ci) |
| 252 | 316 | Multiple Entry Configured Grant Confirmation |
| 253 | 317 | Sidelink Configured Grant Confirmation |
| 254 | 318 | Desired Guard Symbols |
| 255 | 319 | Pre-emptive BSR |

Table 6.2.1-2c: Values of LCID for UL-SCH when the LX field is set to 1

|  |  |  |
| --- | --- | --- |
| Codepoint | Index | LCID values |
| 0 | (216 + 320) | CCCH of size 48 bits for an eRedCap UE |
| 1 | (216 + 321) | CCCH of size 64 bits for an eRedCap UE |
| 2 | (216 + 322) | CCCH of size 48 bits for PUCCH repetition of Msg4 HARQ-ACK, except for an (e)RedCap UE |
| 3 | (216 + 323) | CCCH of size 64 bits for PUCCH repetition of Msg4 HARQ-ACK, except for an (e)RedCap UE |
| 4 | (216 + 324) | CCCH of size 48 bits for PUCCH repetition of Msg4 HARQ-ACK of a RedCap UE |
| 5 | (216 + 325) | CCCH of size 64 bits for PUCCH repetition of Msg4 HARQ-ACK of a RedCap UE |
| 6 | (216 + 326) | CCCH of size 48 bits for PUCCH repetition of Msg4 HARQ-ACK of an eRedCap UE |
| 7 | (216 + 327) | CCCH of size 64 bits for PUCCH repetition of Msg4 HARQ-ACK of an eRedCap UE |
| 8 to 63 | (216 + 328) to (216 + 383) | Reserved |
| NOTE 1: The MAC entity may use the code point corresponding to a given feature or feature combination in Table 6.2.1-2c only if network indicates support for the corresponding feature or feature combination.  NOTE 2: CCCH of size 48 bits and CCCH of size 64 bits are referred to as CCCH and CCCH1, respectively, in TS 38.331 [5].  NOTE 3: For UE capable of PUCCH repetition of Msg4 HARQ-ACK, the MAC entity uses the code points corresponding to PUCCH repetition of Msg4 HARQ-ACK if *numberOfMsg4HARQ-ACK-Repetitions* is configured and *rsrp-ThresholdMsg4HARQ-ACK* is not configured, or if both are configured and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg4HARQ-ACK.* | | |