**3GPP TSG-RAN WG2 Meeting#124 *R2-231xxxx***

**Chicago, USA, Nov. 13th – 17th, 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **38.321** | **CR** | **1701** | **rev** | **1** | **Current version:** | **17.6.0** |  |
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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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| ***Title:***  | Introduction of NR MBS enhancements  |
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| ***Source to WG:*** | Apple |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_MBS\_enh-Core |  | ***Date:*** | 2023-11-16 |
|  |  |  |  |  |
| ***Category:*** |  **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | This CR introduces the enhancements specified on support of MBS in R18. |
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| ***Summary of change:*** | Introduction of multicast reception for UEs in RRC\_INACTIVE and shared processing for simultaneous reception of broadcast and unicast. RAN2#119 Agreements* HARQ feedback and PTP are not supported for multicast reception in RRC\_INACTIVE.

RAN2#121 agreements* We introduce a new MCCH logical channel for multicast in INACTIVE (different from broadcast MCCH)

RAN2#121bis agreements* On support of multicast SPS in RRC\_INACTIVE, postpone RAN2 discussion to next meeting.
* On DRX operation for multicast in RRC\_INACTIVE, take the multicast DRX as baseline. FFS handling on PTM related HARQ RTT Timer and DRX Retransmission Timer.
* The common LCID space is used for multicast MRB and unicast DRB regardless of UE RRC state (i.e. no change on the LCID table for MTCH).

RAN2#123 agreements* SPS is not supported for multicast reception in RRC\_INACTIVE.
* RAN2 enables RRC\_INACTIVE UE receiving multicast to also receive possible PTM retransmissions initiated by UEs receiving multicast in RRC\_CONNECTED.
* Allow configuration of drx-HARQ-RTT-TimerDL-PTM and drx-RetransmissionTimerDL-PTM for INACTIVE UEs (38.331).
* UE receiving MBS multicast in RRC\_INACTIVE should start drx-HARQ-RTT-TimerDL-PTM and drx-RetransmissionTimerDL-PTM when reception of the transport block has not been successful. FFS the details, e.g. when the timers are started exactly.
* This is optional UE capability.

RAN2#123bis agreements* A UE starts the drx-HARQ-RTT-TimerDL-PTM for the corresponding HARQ process in the first symbol after the end of the corresponding multicast transmission.

RAN2#124 agreements* DRX Command MAC CE is applicable for inactive multicast DRX operation.
* Remove EN1 in section 5.7b of running MAC CR for eMBS.
* Introduce a new fix RNTI value for Multicast MCCH-RNTI. We will call the new RNTI: “multicast MCCH-RNTI”
* The same LCID value is used for multicast MCCH and broadcast MCCH.
* Remove the Editor Note 1 in section 5.3.1 of MAC running CR.
* Clarify in MAC specs section 5.8.1a only applies to UEs in RRC CONNECTED.
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| ***Consequences if not approved:*** | Rel-18 MBS enhancements are not supported in NR. |
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| ***Clauses affected:*** | 5.3.1, 5.3.2.1, 5.3.2.2, 5.7b, 5.8.1a, 6.2.1(Table 6.2.1-1c), 7.1(Table 7.1-1) |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **x** |  |  Other core specifications  | TS 38.300 CR 0732TS 38.331 CR 4490TS 38.306 CR 1015TS 38.331 CR 4510 (UE Cap) |
| ***affected:*** |  | **x** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR’s revision history:*** |  |

### 5.3.1 DL Assignment reception

Downlink assignments received on the PDCCH both indicate that there is a transmission on a DL-SCH for a particular MAC entity and provide the relevant HARQ information.

When the MAC entity has a C-RNTI, Temporary C-RNTI, CS-RNTI, G-RNTI or G-CS-RNTI, the MAC entity shall for each PDCCH occasion during which it monitors PDCCH and for each Serving Cell:

1. if a downlink assignment for this PDCCH occasion and this Serving Cell has been received on the PDCCH for the MAC entity’s C-RNTI, or Temporary C‑RNTI, or G-RNTI configured for multicast MTCH:

2> if this is the first downlink assignment for this Temporary C-RNTI:

3> consider the NDI to have been toggled.

2> if the downlink assignment is for the MAC entity’s C-RNTI, and if the previous downlink assignment indicated to the HARQ entity of the same HARQ process was either a downlink assignment received for the MAC entity’s CS-RNTI or G-CS-RNTI, or a configured downlink assignment for unicast or MBS multicast; or

2> if the downlink assignment is for the MAC entity’s G-RNTI configured for multicast MTCH, and if the previous downlink assignment indicated to the HARQ entity of the same HARQ process was either a downlink assignment received for the MAC entity’s CS-RNTI or G-CS-RNTI, or other G-RNTI, or C-RNTI, or a configured downlink assignment for unicast or MBS multicast:

3> consider the NDI to have been toggled regardless of the value of the NDI.

2> stop the *cg-SDT-RetransmissionTimer*, if it is running, for the corresponding HARQ process for initial transmission with CCCH message;

2> stop the *configuredGrantTimer*, if it is running, for the corresponding HARQ process for initial transmission with CCCH message;

2> indicate the presence of a downlink assignment and deliver the associated HARQ information to the HARQ entity.

1. else if a downlink assignment for this PDCCH occasion has been received for this Serving Cell on the PDCCH for the MAC entity’s CS-RNTI or G-CS-RNTI:

2> if the NDI in the received HARQ information is 1:

3> consider the NDI for the corresponding HARQ process not to have been toggled;

3> indicate the presence of a downlink assignment for this Serving Cell and deliver the associated HARQ information to the HARQ entity.

2> if the NDI in the received HARQ information is 0:

3> if PDCCH contents indicate SPS deactivation:

4> clear the configured downlink assignment for this Serving Cell (if any);

4> if the *timeAlignmentTimer*, associated with the TAG containing the Serving Cell on which the HARQ feedback is to be transmitted, is running:

5> indicate a positive acknowledgement for the SPS deactivation to the physical layer.

3> else if PDCCH content indicates SPS activation:

4> store the downlink assignment for this Serving Cell and the associated HARQ information as configured downlink assignment;

4> initialise or re-initialise the configured downlink assignment for this Serving Cell to start in the associated PDSCH duration and to recur according to rules in clause 5.8.1 or in clause 5.8.1a;

For each Serving Cell and each configured downlink assignment, if configured and activated, the MAC entity shall:

1. if the PDSCH duration of the configured downlink assignment does not overlap with the PDSCH duration of a downlink assignment received on the PDCCH for this Serving Cell:

2> instruct the physical layer to receive, in this PDSCH duration, transport block on the DL-SCH according to the configured downlink assignment and to deliver it to the HARQ entity;

2> set the HARQ Process ID to the HARQ Process ID associated with this PDSCH duration;

2> consider the NDI bit for the corresponding HARQ process to have been toggled;

2> indicate the presence of a configured downlink assignment and deliver the stored HARQ information to the HARQ entity.

For configured downlink assignments without *harq-ProcID-Offset*, the HARQ Process ID associated with the slot where the DL transmission starts is derived from the following equation:

 HARQ Process ID = [floor (CURRENT\_slot × 10 / (*numberOfSlotsPerFrame* × *periodicity*))]
 modulo *nrofHARQ-Processes*

where CURRENT\_slot = [(SFN × *numberOfSlotsPerFrame*) + slot number in the frame] and *numberOfSlotsPerFrame* refers to the number of consecutive slots per frame as specified in TS 38.211 [8].

For configured downlink assignments with *harq-ProcID-Offset*, the HARQ Process ID associated with the slot where the DL transmission starts is derived from the following equation:

 HARQ Process ID = [floor (CURRENT\_slot × 10 / (*numberOfSlotsPerFrame* × *periodicity*))]
 modulo *nrofHARQ-Processes* + *harq-ProcID-Offset*

where CURRENT\_slot = [(SFN × *numberOfSlotsPerFrame*) + slot number in the frame] and *numberOfSlotsPerFrame* refers to the number of consecutive slots per frame as specified in TS 38.211 [8].

NOTE 1: In case of unaligned SFN across carriers in a cell group, the SFN of the concerned Serving Cell is used to calculate the HARQ Process ID used for configured downlink assignments.

NOTE 2: CURRENT\_slot refers to the slot index of the first transmission occasion of a bundle of configured downlink assignment.

When the MAC entity needs to read BCCH, the MAC entity may, based on the scheduling information from RRC:

1. if a downlink assignment for this PDCCH occasion has been received on the PDCCH for the SI-RNTI;

2> indicate a downlink assignment and redundancy version for the dedicated broadcast HARQ process to the HARQ entity.

When the MAC entity needs to read MCCH, the MAC entity may, based on the scheduling information from RRC:

1. if a downlink assignment for this PDCCH occasion has been received on the PDCCH for the MCCH-RNTI or Multicast MCCH-RNTI:

2> indicate a downlink assignment and redundancy version for the selected HARQ process to the HARQ entity.

When the MAC entity needs to read broadcast MTCH, the MAC entity may, based on the scheduling information from RRC and DCI:

1. if a downlink assignment for this PDCCH occasion has been received on the PDCCH for the G-RNTI configured for broadcast MTCH:

2> indicate the presence of a downlink assignment and deliver the associated HARQ information for the selected HARQ process to the HARQ entity.

5.3.2 HARQ operation

5.3.2.1 HARQ Entity

The MAC entity includes a HARQ entity for each Serving Cell, which maintains a number of parallel HARQ processes. Each HARQ process is associated with a HARQ process identifier. The HARQ entity directs HARQ information and associated TBs received on the DL-SCH to the corresponding HARQ processes (see clause 5.3.2.2).

The number of parallel DL HARQ processes per HARQ entity is specified in TS 38.214 [7]. The dedicated broadcast HARQ process is used for BCCH.

The HARQ process supports one TB when the physical layer is not configured for downlink spatial multiplexing. The HARQ process supports one or two TBs when the physical layer is configured for downlink spatial multiplexing.

When the MAC entity is configured with *pdsch-AggregationFactor* > 1, the parameter *pdsch-AggregationFactor* provides the number of transmissions of a TB within a bundle of the downlink assignment. Bundling operation relies on the HARQ entity for invoking the same HARQ process for each transmission that is part of the same bundle. After the initial transmission, *pdsch-AggregationFactor* – 1 HARQ retransmissions follow within a bundle.

The MAC entity shall:

1. if a downlink assignment has been indicated:

2> allocate the TB(s) received from the physical layer and the associated HARQ information to the HARQ process indicated by the associated HARQ information.

1. if a downlink assignment has been indicated for the broadcast HARQ process:

2> allocate the received TB to the broadcast HARQ process.

NOTE: It is up to UE implementation to allocate the received TB for multicast MCCH or broadcast MCCH or broadcast MTCH to one HARQ process.

#### 5.3.2.2 HARQ process

When a transmission takes place for the HARQ process, one or two (in case of downlink spatial multiplexing) TBs and the associated HARQ information are received from the HARQ entity.

For each received TB and associated HARQ information, the HARQ process shall:

1. if the NDI, when provided, has been toggled compared to the value of the previous received transmission corresponding to this TB; or
2. if the HARQ process is equal to the broadcast process, and this is the first received transmission for the TB according to the system information schedule indicated by RRC; or
3. if the HARQ process is associated with a transmission indicated with a MCCH-RNTI for MBS broadcast, and this is the first received transmission for the TB according to the broadcast MCCH schedule indicated by RRC; or
4. if the HARQ process is associated with a transmission indicated with a Multicast MCCH-RNTI for MBS multicast, and this is the first received transmission for the TB according to the multicast MCCH schedule indicated by RRC; orif the HARQ process is associated with a transmission indicated with a G-RNTI for MBS broadcast, and this is the first received transmission for the TB according to the MTCH schedule indicated by RRC or according to the scheduling indicated by DCI as specified in TS 38.214 [7]; or
5. if this is the very first received transmission for this TB (i.e. there is no previous NDI for this TB):

2> consider this transmission to be a new transmission.

1. else:

2> consider this transmission to be a retransmission.

The MAC entity then shall:

1. if this is a new transmission:

2> attempt to decode the received data.

1. else if this is a retransmission:

2> if the data for this TB has not yet been successfully decoded:

3> instruct the physical layer to combine the received data with the data currently in the soft buffer for this TB and attempt to decode the combined data.

1. if the data which the MAC entity attempted to decode was successfully decoded for this TB; or
2. if the data for this TB was successfully decoded before:

2> if the HARQ process is equal to the broadcast process:

3> deliver the decoded MAC PDU to upper layers.

2> else if this is the first successful decoding of the data for this TB:

3> deliver the decoded MAC PDU to the disassembly and demultiplexing entity.

1. else:

2> instruct the physical layer to replace the data in the soft buffer for this TB with the data which the MAC entity attempted to decode.

1. if the HARQ process is associated with a transmission indicated with a Temporary C-RNTI and the Contention Resolution is not yet successful (see clause 5.1.5); or
2. if the HARQ process is associated with a transmission indicated with a MSGB-RNTI and the Random Access procedure is not yet successfully completed (see clause 5.1.4a); or
3. if the HARQ process is equal to the broadcast process; or
4. if the HARQ process is associated with a transmission indicated with a MCCH-RNTI or a G-RNTI for MBS broadcast; or
5. if the HARQ process is associated with a transmission indicated with a Multicast MCCH-RNTI for MBS multicast; or
6. if the HARQ process is associated with a transmission indicated with a G-RNTI or a G-CS-RNTI or a configured downlink assignment for MBS multicast and HARQ feedback is disabled for this G-RNTI or G-CS-RNTI, as specified in clause 18 of TS 38.213 [6]; or
7. if the HARQ process is associated with a transmission indicated with a G-RNTI or a G-CS-RNTI or a configured downlink assignment for MBS multicast and NACK only HARQ feedback is configured for this G-RNTI or G-CS-RNTI and the data for this TB is successfully decoded and the transmission is not the first transmission of PDSCH where the configured downlink assignment was (re-)initialised; or
8. if the *timeAlignmentTimer*, associated with the TAG containing the Serving Cell on which the HARQ feedback is to be transmitted, is stopped or expired and if the *cg-SDT-TimeAlignmentTimer*, if configured, is not running; or
9. if the HARQ process is configured with disabled HARQ feedback:

2> if *harq-FeedbackEnablingforSPSactive* is configured with value *true* and the transmission is the first transmission on the configured downlink assignment after activation of the configured downlink assignment:

3> instruct the physical layer to generate acknowledgement(s) of the data in this TB.

2> else:

3> not instruct the physical layer to generate acknowledgement(s) of the data in this TB.

1. else:

2> instruct the physical layer to generate acknowledgement(s) of the data in this TB.

The MAC entity shall ignore NDI received in all downlink assignments on PDCCH for its Temporary C-RNTI when determining if NDI on PDCCH for its C-RNTI has been toggled compared to the value in the previous transmission.

NOTE: If the MAC entity receives a retransmission with a TB size different from the last TB size signalled for this TB, the UE behavior is left up to UE implementation.

## 5.7b Discontinuous Reception (DRX) for MBS Multicast

For MBS multicast, the MAC entity may be configured by RRC with a DRX functionality per G-RNTI or per G-CS-RNTI that controls the UE’s PDCCH monitoring activity for the MAC entity’s G-RNTI(s) and G-CS-RNTI(s) as specified in TS 38.331 [5]. When in RRC\_CONNECTED, if multicast DRX is configured for a G-RNTI or G-CS-RNTI, the MAC entity is allowed to monitor the PDCCH for this G-RNTI or G-CS-RNTI discontinuously using the multicast DRX operation specified in this clause; otherwise the MAC entity monitors the PDCCH for this G-RNTI or G-CS-RNTI as specified in TS 38.213 [6]. When in RRC\_INACTIVE, if the UE is configured to receive multicast in RRC\_INACTIVE and multicast DRX is configured for a G-RNTI, the MAC entity is allowed to monitor the PDCCH for this G-RNTI discontinuously using the multicast DRX operation specified in this clause; otherwise the MAC entity monitors the PDCCH for this G-RNTI as specified in TS 38.213 [6]. The multicast DRX operation specified in this clause is performed independently for each G-RNTI or G-CS-RNTI and independently from the DRX operation specified in clauses 5.7 and 5.7a.

RRC controls multicast DRX operation per G-RNTI or per G-CS-RNTI by configuring the following parameters:

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

- *drx-SlotOffsetPTM*: the delay before starting the *drx-onDurationTimerPTM*;

- *drx-InactivityTimerPTM*: the duration after the PDCCH occasion in which a PDCCH indicates a new DL multicast transmission for the MAC entity;

- *drx-LongCycleStartOffsetPTM*: the long DRX cycle *drx-LongCycle-PTM* and *drx-StartOffset-PTM* which defines the subframe where the long DRX cycle starts;

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

- *drx-HARQ-RTT-TimerDL-PTM* (per DL HARQ process for MBS multicast): the minimum duration before a DL multicast assignment for HARQ retransmission is expected by the MAC entity.

When multicast DRX is configured for a G-RNTI or G-CS-RNTI, the Active Time includes the time while:

- *drx-onDurationTimerPTM* or *drx-InactivityTimerPTM* or *drx-RetransmissionTimerDL-PTM* for this G-RNTI or G-CS-RNTI is running.

When multicast DRX is not configured for a G-RNTI or G-CS-RNTI, and the *cfr-ConfigMulticast* is configured for at least one of the active BWP(s) of the Serving Cell(s), and unicast DRX is configured, the MAC entity shall for this G-RNTI or G-CS-RNTI:

1. monitor the PDCCH as specified in TS 38.213 [6];
2. if the PDCCH addressed to G-RNTI indicates a DL multicast transmission; or
3. if the PDCCH addressed to G-CS-RNTI indicates a DL multicast transmission and CS-RNTI is configured; or
4. if a MAC PDU is received in a configured downlink multicast assignment and CS-RNTI is configured:

2> if the first HARQ-ACK reporting mode (i.e. ack-nack) is used as specified in TS 38.213 [6]; and

2> if HARQ feedback is enabled:

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.

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

When multicast DRX is configured for a G-RNTI or G-CS-RNTI, and the *cfr-ConfigMulticast* is configured for at least one of the active BWP(s) of the Serving Cell(s), the MAC entity shall for this G-RNTI or G-CS-RNTI:

1. if a MAC PDU is received in a configured downlink multicast assignment:

2> if HARQ feedback is enabled:

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

3> if the first HARQ-ACK reporting mode (i.e. ack-nack) is used as specified in TS 38.213 [6]; and

3> if CS-RNTI is configured:

4> 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.

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

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

1. if a *drx-HARQ-RTT-TimerDL-PTM* expires:

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

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

1. if a DRX Command MAC CE indicated by PDCCH addressed to a G-RNTI or G-CS-RNTI, or by a configured downlink multicast assignment is received:

2> stop *drx-onDurationTimerPTM* of the DRX for this G-RNTI or G-CS-RNTI, or the corresponding G-CS-RNTI;

2> stop *drx-InactivityTimerPTM* of the DRX for this G-RNTI or G-CS-RNTI, or the corresponding G-CS-RNTI.

1. if [(SFN × 10) + subframe number] modulo (*drx-LongCycle-PTM*) = *drx-StartOffset-PTM*:

2> start *drx-onDurationTimerPTM* after *drx-SlotOffsetPTM* from the beginning of the subframe.

1. if the MAC entity is in Active Time for this G-RNTI or G-CS-RNTI:

2> monitor the PDCCH for this G-RNTI or G-CS-RNTI as specified in TS 38.213 [6];

2> if the PDCCH indicates a DL multicast transmission:

3> if HARQ feedback is enabled:

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

4> if the first HARQ-ACK reporting mode (i.e. ack-nack) is used as specified in TS 38.213 [6]:

5> if the PDCCH addressed to G-RNTI indicates a DL multicast transmission; or

5> if the PDCCH addressed to G-CS-RNTI indicates a DL multicast transmission and CS-RNTI is configured:

6> 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.

3> else if *drx-HARQ-RTT-TimerDL-PTM* is configured in RRC\_INACTIVE, and the UE supports *ptm-RetransmissionInactive-r18*:

4> start the *drx-HARQ-RTT-TimerDL-PTM* for the corresponding HARQ process in the first symbol after the end of the corresponding multicast transmission.

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

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

2> if the PDCCH indicates a new multicast transmission for this G-RNTI or G-CS-RNTI:

3> start or restart *drx-InactivityTimerPTM* in the first symbol after the end of the PDCCH reception.

NOTE 1: A PDCCH indicating activation of multicast SPS is considered to indicate a new transmission.

NOTE 2: The UE may start the *drx-HARQ-RTT-TimerDL* after receiving a PTM transmission only if *ptp-Retx-Multicast* or *ptp-Retx-SPS-Multicast* was included in the *UECapabilityInformation* message to network.

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

### 5.8.1a Downlink for Multicast

MBS Semi-Persistent Scheduling (SPS) is only applicable for Ues in RRC\_CONNECTED and is configured by RRC on one Serving Cell per BWP. Multiple assignments can be active simultaneously in the same BWP.

For the DL MBS SPS, a DL assignment is provided by PDCCH, and stored or cleared based on L1 signalling indicating SPS activation or deactivation.

RRC configures the following parameters when the MBS SPS is configured:

- cs-RNTI: CS-RNTI for MBS SPS deactivation, PTP for PTM retransmission if configured;

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

- nrofHARQ-Processes: the number of configured HARQ processes for MBS SPS;

- harq-ProcID-Offset: Offset of HARQ process for MBS SPS;

- periodicity: periodicity of configured downlink assignment for MBS SPS.

When the MBS SPS is released by upper layers, all the corresponding configurations shall be released.

After a downlink assignment is configured for MBS SPS, the MAC entity shall consider sequentially that the Nth downlink assignment occurs in the slot for which:

 (numberOfSlotsPerFrame × SFN + slot number in the frame) =
[(numberOfSlotsPerFrame × SFNstart time + slotstart time) + N × periodicity × numberOfSlotsPerFrame / 10]
 modulo (1024 × numberOfSlotsPerFrame)

where SFNstart time and slotstart time are the SFN and slot, respectively, of the first transmission of PDSCH where the configured downlink assignment was (re-)initialised.

## 6.2 Formats and parameters

### 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, 6.2.1-1c and 6.2.1-2 for the DL-SCH and UL-SCH respectively. 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, 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, 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;

- 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 226 | 64 to 290 | Reserved |
| 227 | 291 | Serving Cell Set based SRS TCI State Indication MAC CE |
| 228 | 292 | SP/AP SRS TCI State Indication MAC CE |
| 229 | 293 | BFD-RS Indication MAC CE |
| 230 | 294 | Differential Koffset |
| 231 | 295 | Enhanced SCell Activation/Deactivation MAC CE with one octet Ci field |
| 232 | 296 | Enhanced SCell Activation/Deactivation MAC CE with four octet Ci field  |
| 233 | 297 | Unified TCI States Activation/Deactivation MAC CE |
| 234 | 298 | PUCCH Power Control Set Update for multiple TRP PUCCH repetition MAC CE |
| 235 | 299 | PUCCH spatial relation Activation/Deactivation for multiple TRP PUCCH repetition MAC CE |
| 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**

|  |  |
| --- | --- |
| **Codepoint/Index** | **LCID values** |
| 0 | CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331 [5]), except for a 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 (referred to as "CCCH" in TS 38.331 [5]) for a RedCap UE  |
| 36 | CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331 [5]) 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 (referred to as "CCCH" in TS 38.331 [5]), except for a 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 |

**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 228 | 64 to 292 | Reserved |
| 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 |

# 7 Variables and constants

## 7.1 RNTI values

RNTI values are presented in Table 7.1-1.

Table 7.1-1: RNTI values.

|  |  |
| --- | --- |
| Value (hexa-decimal) | RNTI |
| 0000 | N/A |
| 0001–FFF2 | RA-RNTI, MSGB-RNTI, Temporary C-RNTI, C-RNTI, CI-RNTI, MCS-C-RNTI, CS-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, TPC-SRS-RNTI, INT-RNTI, SFI-RNTI, SP-CSI-RNTI, PS-RNTI, SL-RNTI, SL-CS-RNTI, SL Semi-Persistent Scheduling V-RNTI, AI-RNTI, G-RNTI, G-CS-RNTI, and CG-SDT-CS-RNTI |
| FFF3–FFFA | Reserved |
| FFFB | Multicast MCCH-RNTI |
| FFFC | PEI-RNTI |
| FFFD | MCCH-RNTI |
| FFFE | P-RNTI |
| FFFF | SI-RNTI |

Table 7.1-2: RNTI usage.

|  |  |  |  |
| --- | --- | --- | --- |
| RNTI | Usage | Transport Channel | Logical Channel |
| P-RNTI | Paging and System Information change notification | PCH | PCCH |
| SI-RNTI | Broadcast of System Information | DL-SCH | BCCH |
| RA-RNTI | Random Access Response | DL-SCH | N/A |
| MSGB-RNTI | Random Access Response for 2-step RA type | DL-SCH | CCCH, DCCH, DTCH |
| Temporary C-RNTI | Contention Resolution(when no valid C-RNTI is available) | DL-SCH | CCCH, DCCH, DTCH |
| Temporary C-RNTI | Msg3 transmission | UL-SCH | CCCH, DCCH, DTCH |
| C-RNTI, MCS-C-RNTI | Dynamically scheduled unicast transmission | UL-SCH | DCCH, DTCH |
| C-RNTI | Dynamically scheduled unicast transmission | DL-SCH | CCCH, DCCH, DTCH |
| MCS-C-RNTI | Dynamically scheduled unicast transmission | DL-SCH | DCCH, DTCH |
| C-RNTI | Triggering of PDCCH ordered random access | N/A | N/A |
| C-RNTI | Dynamically scheduled PTP retransmission for initial PTM transmission for multicast MBS. | DL-SCH | MTCH |
| CG-SDT-CS-RNTI | Dynamically scheduled unicast transmission(retransmission) | UL-SCH | CCCH, DCCH, DTCH |
| CS-RNTI | Configured scheduled unicast transmission(activation, reactivation and retransmission) | DL-SCH, UL-SCH | DCCH, DTCH |
| CS-RNTI | Configured scheduled unicast transmission(deactivation) | N/A | N/A |
| CS-RNTI | Configured scheduled unicast transmission(PTP retransmission for initial PTM transmission) | DL-SCH | MTCH |
| CS-RNTI | Configured scheduled unicast transmission(MBS SPS deactivation) | N/A | N/A |
| G-CS-RNTI | Configured scheduled multicast transmission(activation, reactivation and retransmission) | DL-SCH | MTCH |
| G-CS-RNTI | Configured scheduled multicast transmission (deactivation) | N/A | N/A |
| TPC-PUCCH-RNTI | PUCCH power control | N/A | N/A |
| TPC-PUSCH-RNTI | PUSCH power control | N/A | N/A |
| TPC-SRS-RNTI | SRS trigger and power control | N/A | N/A |
| INT-RNTI | Indication pre-emption in DL | N/A | N/A |
| SFI-RNTI | Slot Format Indication on the given cell | N/A | N/A |
| SP-CSI-RNTI | Activation of Semi-persistent CSI reporting on PUSCH | N/A | N/A |
| CI-RNTI | Cancellation indication in UL | N/A | N/A |
| PS-RNTI | DCP to indicate whether to start *drx-onDurationTimer* for associated DRX cycle | N/A | N/A |
| SL-RNTI | Dynamically scheduled sidelink transmission | SL-SCH | SCCH, STCH |
| SL-CS-RNTI | Configured scheduled sidelink transmission(activation, reactivation and retransmission) | SL-SCH | SCCH, STCH |
| SL-CS-RNTI | Configured scheduled sidelink transmission(deactivation) | N/A | N/A |
| SL Semi-Persistent Scheduling V-RNTI (NOTE 2) | Semi-Persistently scheduled sidelink transmission for V2X sidelink communication(activation, reactivation and retransmission) | SL-SCH | STCH |
| SL Semi-Persistent Scheduling V-RNTI(NOTE 2) | Semi-Persistently scheduled sidelink transmission for V2X sidelink communication(deactivation) | N/A | N/A |
| AI-RNTI | Availability indication on the given cell | N/A | N/A |
| G-RNTI | Dynamically scheduled MBS PTM transmission | DL-SCH | MTCH |
| MCCH-RNTI | Dynamically scheduled MCCH signalling and MCCH change notification | DL-SCH | MCCH |
| PEI-RNTI | Paging Early Indication | N/A | N/A |
| NOTE 1: The usage of MCS-C-RNTI is equivalent to that of C-RNTI in MAC procedures (except for the C-RNTI MAC CE).NOTE 2: The MAC entity uses SL Semi-Persistent Scheduling V-RNTI to control semi-persistently scheduled sidelink transmission on SL-SCH for V2X sidelink communication as specified in clause 5.14.1.1 of TS 36.321 [22].NOTE 3: The usage of CG-SDT-CS-RNTI is equivalent to that of CS-RNTI when there is an CG-SDT procedure ongoing. |